FUDA

North Yahara

Future Urban Development Area Planning

Environmental Conditions Report

North Yahara FUDA Environmental Conditions Report

June 2012

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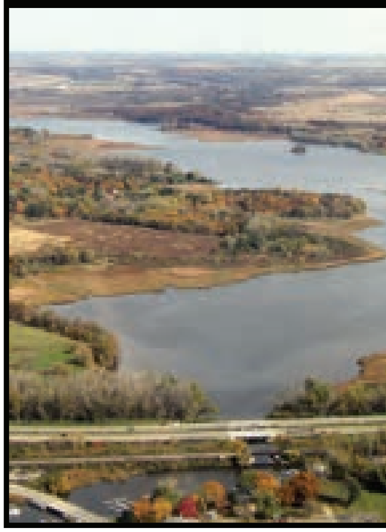
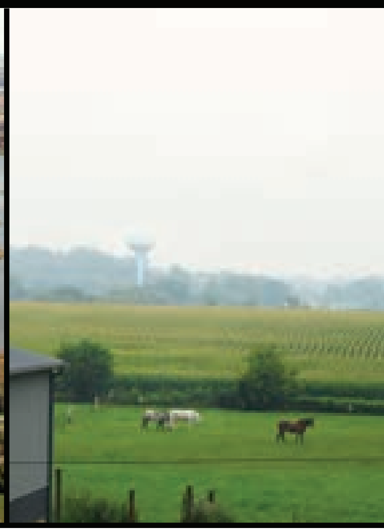
North Yahara

Future Urban Development Area Planning

Environmental Conditions Report





Summary

Introduction

The local resolutions that were adopted to ask the Governor to create the Capital Area Regional Planning Commission (CARPC), included a proactive long-range planning effort to align regional goals and objectives with local needs and desires in a collaborative manner. CARPC was created by Governor Doyle under Wis. State Stats. 66.0309 governing regional planning commissions.[1] Under the statute CARPC has the duty and responsibility of planning for the *harmonious physical development of the region*. CARPC is also created to be *an area-wide water quality management planning agency* under Wisconsin administrative code chapter NR 121,[2] working as an agent of the state to work with the Wisconsin Department of Natural Resources (WDNR) to coordinate various water quality management activities in the region, and advise WDNR about local water quality management needs and conditions.[3]

The proactive, long-rage collaborative planning process was named Future Urban Development Area (FUDA) Planning in local resolutions petitioning the Governor to establish CARPC in 2006. Item 7 in the local resolution outlines this planning initiative as follows:

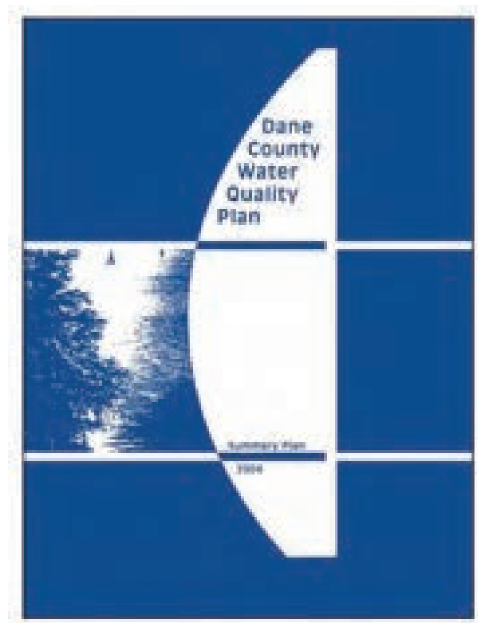
> "The CARPC shall work with communities to update the Dane County Water Quality Plan. In addition to the elements required by NR 121 of the Wisconsin Administrative Code, the Water Quality Plan shall also define areas that should be protected from development based on provisions to protect water quality as contained in NR 121 of the Wisconsin Administrative Code. The Plan shall also define areas that can be developed with measures to protect, restore or minimize degradation of water quality.
>
> "The Plan shall also define a 25-year Future Urban Development Area with 5-year updates. The Plan shall be developed in cooperation with area communities, including towns, and shall consider adopted comprehensive plans and intergovernmental agreements. The Plan shall be developed as follows:
>
> a. CARPC staff shall provide communities with environmental condition reports consisting of maps, text, and information identifying environmental issues that should be addressed.
>
> b. The CARPC shall give priority to areas of the highest environmental sensitivity and growth pressure. These areas are: all communities within the Central Urban Service Area; all communities within the Northern Urban Service Area; all urban service areas with a year 2000 Census population of 3,000 or more; and the Black Earth Urban Service Area…

1 See the following link to ss. 66.0309 https://docs.legis.wisconsin.gov/statutes/statutes/66/III/0309/10
2 See the following link to NR 121 https://docs.legis.wisconsin.gov/code/admin_code/nr/121.pdf
3 For detailed description of CARPC roles, duties, and responsibilities, see the following link www.capitalareapc.org/about_the_carpc.htm

c. The Plan, which will identify the 25 Future Urban Development Area, shall be based on the requirements of NR 121 and shall also consider other factors including the impacts on natural and built systems, the efficient use of land including urban densities, and the ability to efficiently provide services to support the development and farmland preservation planning.

d. There shall be separate rules and policies for limited service areas.

e. The CARPC shall adopt policies and procedures for the considerations of amendments to the *Water Quality Plan* between five-year updates of the *Water Quality Plan*..."[4]



To meet this charge, the towns of Vienna, Windsor, and Burke, the Village of DeForest, and CARPC began developing a collaborative pilot[5] planning and implementation FUDA process in Fall 2010. Each participating unit of government designated three (3) appointees to establish a local Steering Committee. The Committee is supported by local and regional staff. The Steering Committee and staff met monthly for over six months to develop the Environmental Conditions Report (ECR) for this part of the region.

Funding for this project comes from CARPC operating budget and grant funds from the Sustainable Communities Regional Planning Grant Program sponsored by US Department of Housing Urban Development . The communities participating in this grant are also members of the Capital Area Sustainable Communities Consortium. To learn more about the grant and the Consortium visit: http://www.capitalarearpc.org/grant.html

More information on this project is available at:
www.capitalarearpc.org/Northern_FUDA.html

4 For the complete text of the local resolutions see www.capitalarearpc.org/USA_List.html.

5 Another pilot project was undertaken simultaneously for the North Mendota Study Area which includes the City of Middleton and Town of Westport portions of the Central urban Service Area, the Waunakee USA, and the Town of Springfield.

Purpose

Many communities across the U.S. are beginning to discover the need for an integrated approach to planning for growth and development. Fiscal efficiency and economic sustainability require an approach that minimizes the wasteful use of natural and financial resources. Experience shows that inefficient and uncoordinated approaches to resource use result in wasted economic opportunity, increased financial burden on municipalities and taxpayers, and in eroded community well-being and economic competitiveness, and reduced quality of life. The primary natural resources objective of this approach is to maintain and, where possible, enhance the quality of our natural environment and the associated resource functions and values. However, this needs to dovetail with related growth and development strategies related to local community needs and aspirations, infrastructure planning, community economic development, long-term development visioning and planning, maintaining agricultural production of food and fiber, and reserving open spaces for cultural, recreational, aesthetic, and ecosystem functions.

The regional impact of local actions can thereby be considered as part of the decision-making together with the local implications of regional trends and concerns.

The purpose of the ECR is to provide an inventory and assessment of the natural, agricultural, and community resources related to this FUDA study area based on the best available information. This information provides technical data and analysis that can be used by local communities in land use decisions, and in planning for development and preservation that respect the integrity of natural areas and incorporate environmental features into development projects. The natural, agricultural, and community resource data provide the foundation for local communities to evaluate where development can occur most efficiently, where resources need to be protected, and identify opportunities for development and conservation to occur together.

The information presented in the ECR is by necessity comprehensive, voluminous, and technical. It is intended to be used by a diverse audience including community decision-makers, technical staff, land owners, preparers of development proposals, and interested individuals and entities. Therefore, the report is designed with elements that target various audiences, allowing selective reading for specific purpose and content based on the following layered approach:

- The Report Summary is aimed at providing a *report in brief* on issues, findings, and planning considerations targeted for decision-making. Links to specific maps and resources are included in the Report Summary.
- More detailed information and justifications for the Report Summary findings and planning considerations are found in the technical body of the ECR. The ECR also includes technical recommendations that can be used for detailed planning, design, and engineering work by various staff and consultants. This portion can be used as a *technical resource* for the communities in the study area, and a *reference* for consultants and technical professional working in the study area.
- Links to more detailed technical analysis and research references are included in the report.

- CARPC staff are available to work with communities and community leaders and their consultants to provide further content and technical expertise.

The ECR contains ***existing*** natural resource, agricultural, and land demand and supply data and analysis as outlined in the formation resolution quoted above. ***"Environmental Conditions" are therefore defined comprehensively to include various physical systems in the study area, including the natural resources, but not exclusively.*** The ECR provides the data and analysis to inform the FUDA planning process. In particular, existing data covering these topics will inform the baseline conditions for scenario planning exercises and may offer additional planning considerations for alternative growth scenarios. This ECR is organized into four principle chapters:

I. Natural Resources
II. Agricultural Resources
III. Land Demand and Supply
IV. Conclusions and Recommendations

The natural and agricultural resources sections are an assessment of assets in and near the subject communities. The aim of this section is to provide details of the vulnerabilities of each natural resource, the potential for restoration for each, and specific recommendations for protecting these resources as valuable assets that add to the quality of life of the community and reduce infrastructure, maintenance, and environmental costs.

The land demand and supply is an assessment of land development and density trends, and projections of population growth. This population growth and related demographic shifts must be effectively managed to protect the natural and agricultural resources identified in this report.

Hierarchy of Scale in Analysis

The challenge of viewing local actions in the context of their regional impacts is typically one of scale and our ability to evaluate and detect these impacts. Every action has positive and negative impacts if considered in the right time and geographic scale. We typically have limited understanding of the consequences of our actions. However, even the consequences that we know about can go undetected if we are not looking at the right time-frame or geographic area. ***This ECR looks at the geographic area based on areas of impact, starting with the regional or large scale, and based on regional trends, and the capacities and susceptibilities of various regional systems.*** This is somewhat like the point-of-view of a skydiver at 30,000 feet. At that height, the skydiver can see the entire region and the interconnectedness of the streams, roads, landscapes, and other features and systems, though without much detail. As the skydiver gets closer to the ground, the viewpoint becomes smaller and the focus more local, and more detail becomes visible. Both viewpoints are relevant depending on the scale of analysis and impact.

Time scale is another consideration in this evaluation. Small, incremental actions have small impacts that are typically below our detection capability. ***Water quality planning requires a 20-year planning horizon and is based on population growth projections for the region.*** Most impacts are best analyzed in the context of "build-out", which provides an analysis of the end-result. FUDA planning includes evaluation of different growth scenarios for communities. ***As part of this evaluation of various approaches to community growth and development, "build-out" analyses are included.***

This hierarchy of scale has the following implications:

- ***Regional vulnerabilities outlined in the ECR apply to all communities within the study area. These vulnerabilities characterize potential "downstream" effects of local actions.***
- ***Sub-regional vulnerabilities outlined in the ECR apply to specific areas within the study area. The ECR outlines areas that influence these sub-regions. For example, sub-watershed boundaries are shown to indicate the areas where increased sediment in stormwater can exacerbate the health of a stream section.***
- ***Local vulnerabilities apply to the small areas with defined impact on the local resource. For example, an isolated wetland is impacted by stormwater runoff from the relatively small land area that drains into it.***
- ***There are numerous networks and systems that need to be considered in combination as part of planning. The transportation network has different areas and scales of analysis compared to the surface water (rivers and streams) network or the school system. The FUDA process attempts to include as many of these networks and systems as is practicable. The participating communities are encouraged to include additional systems and networks in their deliberations and discussions as part of the planning process. The planning process would ideally facilitate an integrated, inter-related, and comprehensive consideration of all the systems.***

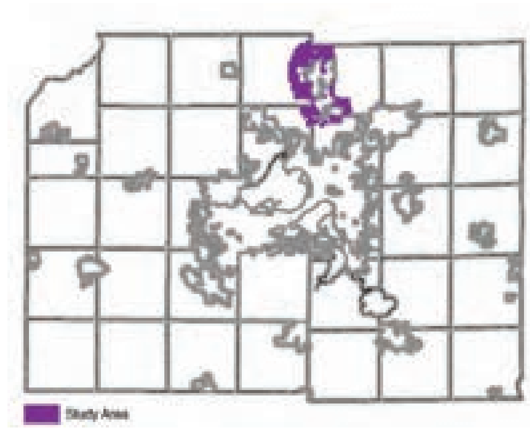
Defining the Study Area

Each FUDA project defines a study area to establish the outer limits of the lands included in the analysis of the ECR and FUDA documents. The lands within the study area are the most likely to develop within the next 25 years.

The outer study area boundary is based on the of the Extra Territorial Jurisdiction of the City or Village. Additionally, redevelopment sites identified in existing local plans are included in the land demand and supply section of this report. The communities may identify additional redevelopment sites through this process and include these in development scenarios. The North Yahara Steering Committee defined the study area and redevelopment areas in Map 1.

Figure 1
North Yahara FUDA Study Area
Regional Context

Breakdown by jurisdiction (acres):	
V. DeForest	509 (outside current USA)
T. Windsor	3,076
T. Westport	844
T. Vienna	4,315
T. Burke	474
Total Area	9,219



As noted in Figure 1, the amount of land within the study area and outside current urban service areas is 9,219 acres. The study area includes portions of the Village of DeForest that are located outside of the Northern and Central urban service areas. Also included in the study area are portions of the Towns of Windsor, Vienna, Westport, and Burke within the DeForest extraterritorial jurisdiction.[6]

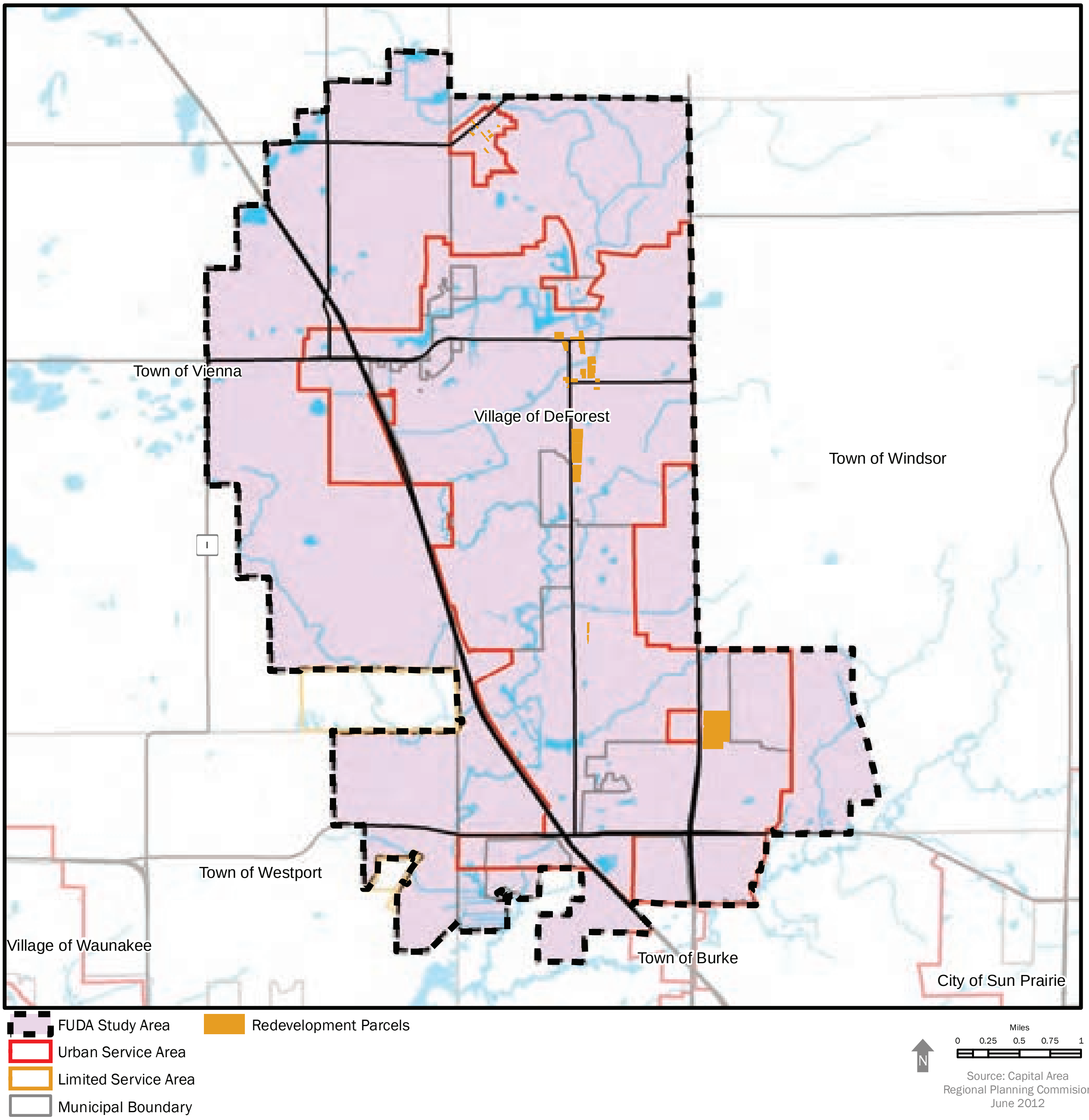
The communities in this project have demonstrated a strong commitment to intergovernmental cooperation in planning and development. This FUDA planning effort will build upon this foundation and existing plans by providing local jurisdictions with more detailed data and analysis to assist them in their local planning and decision-making. Local communities can consider this information as they move into the scenario planning phase of the FUDA planning process. These communities can also integrate recommendations and outcomes from the ECR into the FUDA study and subsequently into local comprehensive and other municipal plan updates. These recommendations will also update regional plans including the *Dane County Water Quality Plan* and the *Land Use and Transportation Plan*.[7] Finally, the ECR can also serve as a resource for communities and CARPC in future planning and plan implementation activities.

More information on this project is available at:
http://www.capitalarearpc.org/Northern_FUDA.html

6 The City of Sun Prairie has been invited to the Steering Committee, and has been kept informed of the progress of the project.
7 The *Dane County Land Use and Transportation Plan* is programmed to be updated during 2014-2018. http://danedocs.countyofdane.com/webdocs/PDF/capd/landuse_and_transportation_plan.pdf

Map 1: Study Area and Redevelopment Sites

North Yahara Study Area, Dane County, WI



The study area was derived using the extra territorial jurisdictional boundaries of the Village of DeForest as the base area.
Redevelopment parcels are based on adopted local plans.

Chapter I. Natural Resources

A. Physical Geography and Surface Geology

The regional physiography of Dane County explains the surface and near-surface features and formations that characterize the landscape of the region. These include land forms, geology, soil and subsoil characteristics, vegetative cover, drainage and surface- and groundwater resources, and associated habitats.

1. Mineral Resources

Mineral Resources in the region are typically near-surface sand, gravel deposits. These deposits represent important economic assets. Sand and gravel deposits are potentially critical local and regional areas for enhanced infiltration and groundwater recharge.

Mineral resource areas should be considered for protection from development until the importance of these areas for infiltration and groundwater recharge have been evaluated, or the resources have been mined and the site is ready for reclamation.[8]

2. Steep Slopes and Woodlands

Development on steep slopes can destabilize slopes and create erosion. Steep wooded slopes also provide significant groundwater recharge, wildlife, water quality, and aesthetic benefits.

Steep slopes with gradient over 20% should be protected from disturbance and stabilized through re-vegetation. Disturbance of steep slopes with gradient between 12% and 20% should only be allowed with the review and approval of the local municipal engineer. Steep wooded slopes with gradient over 12% and within 75 feet of a water body should be delineated as environmental corridors for protection against disturbance and defoliation.[9]
A detailed evaluation of steep slopes is presented on page 52.

Woodlands are important biological and natural resources with critical role in maintaining surface and water quality and quantity and improving air quality. A detailed evaluation of the woodlands of the study area, including the presence of invasive species, are presented on page 52 with an outline of opportunities for woodland restoration in various sub-areas.

3. Soils

Soil characteristics provide significant insight into the suitability for development in a particular area, and impose constraints on some construction practices and stormwater management measures.

The soils of the study area were formed in glacial outwash and glacial till. Sub-surface deposits of glacial till provide ready opportunities for enhanced infiltration of treated or clean rainfall runoff as part of stormwater management for development. For detailed information concerning the infiltration characteristics of the soils of the study area refer to page 56.

8 Map 3 on page 51 shows the extent of mineral resources in the study area.
9 Map 4 on page 53 shows the extent of steep slopes and woodlands in the study area.

The study area also includes small areas with hydric soils, soils with shallow depth to bedrock and shallow depth to water table.[10] These soils characteristics pose limitations on development as outlined below:

- ***Hydric Soils*** (indicators of existing and former wetlands) – ***often present significant constraints to development because of saturated soil conditions and other associated stability problems.*** These areas also offer potential for wetland restoration or enhancement, thereby reclaiming water quality, quantity, and wildlife benefits that have been lost over the last century during which half of the wetlands of the region were filled.

- ***Shallow Depth to Bedrock – can increase the cost of urban infrastructure and housing construction.*** It may also limit the suitability of some stormwater practices due to the potential for groundwater contamination.

- ***Shallow Depth to Water Table –*** soils with seasonably high water tables ***have limited suitability for development because of soil saturation and potential for groundwater induced flooding.***

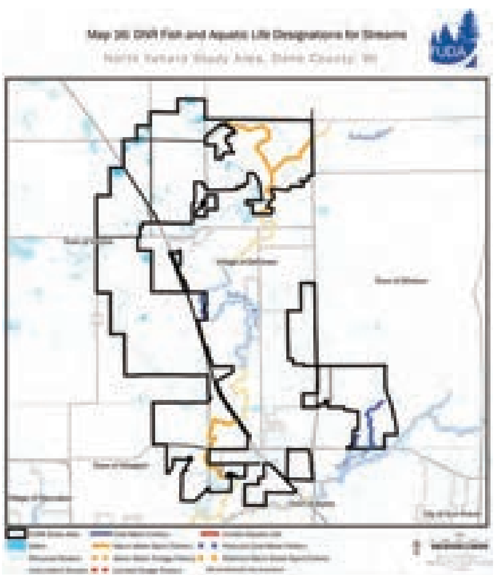
4. Watersheds and Drainage

The region is situated at the headwaters of four river basins (Lower Rock, Wisconsin, Sugar-Pecatonica, and Upper Rock), and the study area is located entirely in the Lower Rock River Basin.[11] Although the main physical and chemical characteristics of water features are defined by surface and sub-surface geology and morphology, the watershed (the land draining to a particular water body) is the basic structural element of water resource protection. While much attention has been directed to protecting, restoring, and enhancing these resources over the last few decades, more work is needed due continued growth pressure in the region and the study area. ***The study area is in the Yahara-Mendota watershed (in the Lower Rock River Basin).*** The report goes into detailed explanations and descriptions of the extent and quality of the surface water features in the study area, along with specific planning and design considerations highlighted as recommendations in Chapter IV of the report.

State water quality standards are based on stream classifications provided by the Wisconsin Department of Natural Resources and codified in state law. Table 1 ***shows these classifications. Maps 15, and 16 on*** page 78***, and*** page 79 ***show these classifications for the streams of the region and for the study area.***

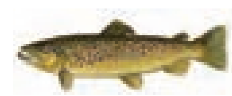
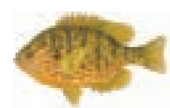
10 These areas are shown on Map 5, page 59, Map 6, page 60, and Map 7, page 61.

11 See Map 10 page 68, and Map 11 page 69.



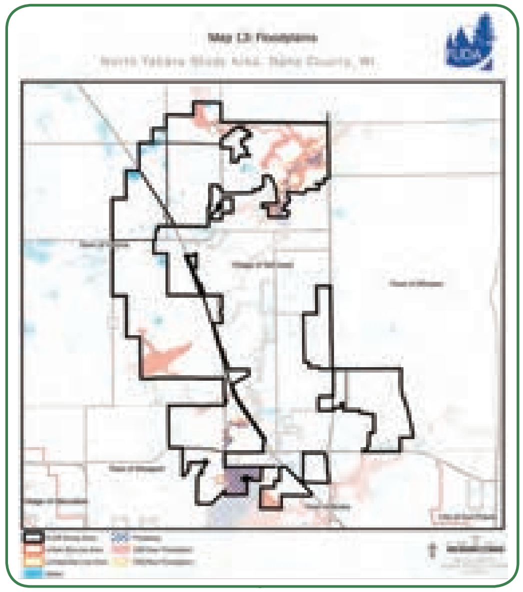
Thumbnail of Map 16.
See full page map on pages 79

Table 1
WDNR Fish and Other Aquatic Life Uses

The Department has classified all surface waters into one of the fish and other aquatic life subcategories described below. Only those use subcategories identified in pars. (a) to (c) shall be considered suitable for the protection and propagation of a balanced fish and other aquatic life community as provided in federal water pollution control act amendments of 1972.	
(a) ***Cold Water Communities.*** This subcategory includes surface waters capable of supporting a community of cold water fish and other aquatic life, or serving as spawning area for cold water fish species.	
(b) ***Warm Water Sport Fish Communities.*** This subcategory includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning are for warm water sport fish.	
(c) ***Warm Water Forage Fish Communities.*** This subcategory includes surface waters capable of supporting an abundant diverse community of forage fish and other aquatic life.	
(d) ***Limited Forage Fish Communities.*** (Intermediate surface waters). This subcategory includes surface waters of limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of forage fish and other aquatic life.	
(e) ***Limited Aquatic Life.*** (Marginal surface waters). This subcategory includes surface waters of severely limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of aquatic life.	

a. Floodplains

One of the most familiar characteristics of bodies of water is their flooding. Map 13, page 71 shows areas with a 1% chance of being inundated in any single year. Zoning regulations restrict the placement of fill and structures in floodplains. ***Because of potential changes in flood frequencies and flood boundaries, it is important to consider additional buffer areas around floodplains to accommodate such changes. Furthermore, keeping susceptible infrastructures out of the 100-year floodplain adds to the resilience of these infrastructure systems.***



Thumbnail of Map 13
See full page map on page 71

b. Internally Drained Areas

There are several small internally drained ponds, ephemeral ponds, and wetlands in the in the study area in the Town of Vienna.[12] Most of these areas are cash cropped with a few dairy farms mixed in. Some of the areas that are currently being farmed were once wetlands. Today these areas provide resting and feeding spots for migratory waterfowl and shorebirds, particularly during spring and fall migration. During wet years these areas are unable to go into agricultural production and, consequently, waterfowl use the areas for brood rearing. During dry periods these wet areas tend to dry up and some are put back into farm production. From a water quality standpoint these areas do not contribute significantly to the degradation of adjacent surface waters. Wildlife would benefit from wetland restoration. However, if portions of the internally drained areas were converted back into functioning wetlands they could be impacted by nutrient and sediment loading. Being internally drained, they would also be flooded more frequently if these areas were developed and stormwater not properly managed.

The unique hydrologic characteristics of closed basins make them especially vulnerable to urbanization and flooding. When the watershed of closed basins are predominantly undeveloped (either pre-settlement or agricultural), closed basins are typically wetter in the spring and dry out during the fall during years of normal precipitation. As urbanization increases, summer rainfall events generate significant runoff, which does not allow the pothole to dry out in the summer. The ponds tend to become dominated by open water, and the potential for extended flooding of nearby development increases. Furthermore, because closed basins are not contributors to nearby streams, attempts to drain them increases rate and volume of flow in receiving streams, changing the hydrologic regime of these streams and increasing the risk of flooding in downstream areas. Therefore, it is advisable to maintain the internal drainage of a closed basin other than in emergency situations where water can be discharged during periods of stream low flow to prevent bed and bank destabilization or flooding.

12 See Map 14, on page 72. See page 67 for more details.

The following summarizes the actions that have been taken, and those that need to be considered to protect closed basin areas:

Measures taken since 1990s

- ***Volume control at pre-development levels in urban areas since 2004***
- ***Special volume and overflow requirements in closed basins in new urban service area amendments to prevent draining the closed basin, maintaining pre-development runoff volumes, and installing emergency overflow structures for temporary release if needed.***

Additional measures that can benefit the health of closed basin areas

- ***Financial resources for reduction of runoff volumes from agricultural areas in closed basins***
- ***Financial resources for retrofit best management practices in older urban areas especially to reduce runoff volumes***
- ***Restore wetlands, woodlands, prairies, and pastures in select areas***

B. Surface Water Features

The study area is located in the Yahara River/Lake Mendota watershed. Analysis generally starts at this scale and moves upstream to smaller, local water features. ***All local land use and land management decisions in areas that drain to Lake Mendota will affect the quality and quantity of water in Mendota and the lower lakes of the Yahara system.***

1. Lake Mendota and its Tributaries

The largest and deepest lake in the Yahara Lakes system, Lake Mendota supports a warm water sport fishery. The Lake is "eutrophic", meaning it possesses high fertility and is susceptible to the addition of phosphorus in storm runoff, which further fertilizes the Lake and encourages algae blooms. The Lake has a watershed area that is 20% urban and 54% in agricultural cropland. Algae blooms have been a continual water quality problem for the Lake since the late 1800s. Algae blooms in Lake Mendota are fed by nutrient phosphorus which is washed into the Lake with sediment carried by stormwater. The following list outlines issues related to Lake Mendota water quality:

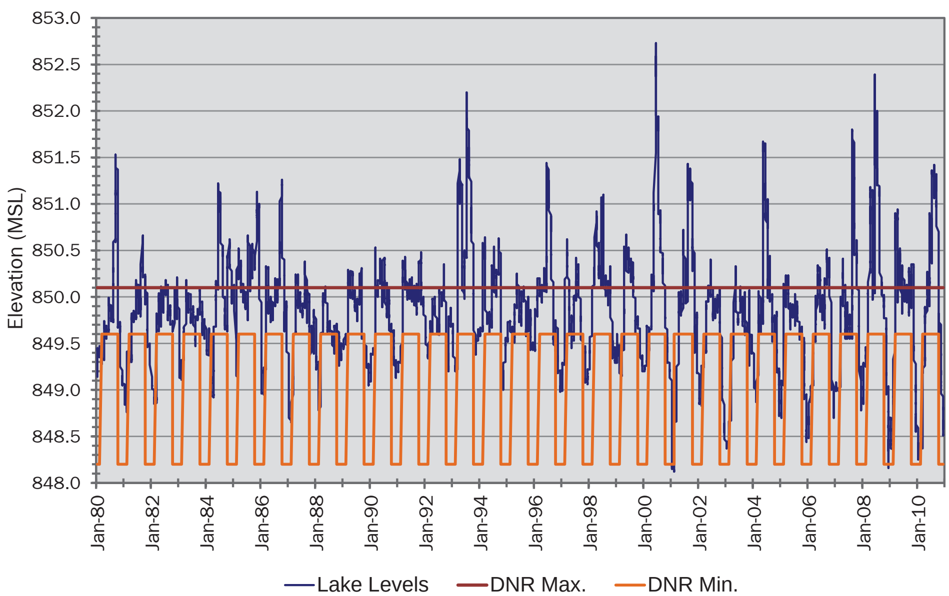
- o ***Modeling in year 2000 showed that 75% of the total annual phosphorus load to the Lake was from agricultural areas of the watershed.*** *This figure pre-dates implementation of new stormwater quality and quantity management ordinances in urban areas.*
- o ***The modeling also showed a higher amount of phosphorus delivered per acre of land from construction erosion in urban areas.***[13] *This figure pre-dates implementation of new stormwater quality and quantity management ordinances in urban areas.*
- o ***Both agricultural and urban conservation practices are necessary to reduce the flow of phosphorus to the Lake.***

13 See Figure 11 on page 86 for details of phosphorus loading to Lake Mendota.

- o *Water quality goal for Lake Mendota is phosphorus concentration of 0.074 mg/L during spring. This is expected to reduce the likelihood of algae blooms by 50% during summer months.*
- o *Phosphorus loading to Lake Mendota cascades into the lower lakes (Monona, Waubesa, Kegonsa) in the system and causes algae bloom in those lakes.*
- o *Algae blooms are not only an unsightly nuisance, but impact the water quality of the lakes and the health of their aquatic habitat. Furthermore, the lakes are significant regional recreational and aesthetic resources that create a desirable regional setting and quality of life, and attract businesses and professionals to the region. Therefore, these water quality problems result in economic loss for the entire region.*
- o *Lake Mendota has been included in the Rock River Total Maximum Daily Load (TMDL) by the USEPA,[14] imposing restrictions on discharge of sediment and phosphorus into the Lake.*

Another concern for Lake Mendota is the potential for flooding, even though lake levels are managed by Tenney Locks. Figure 2 shows lake levels in the past two decades compared to maximum lake levels established by the WDNR. This problem stems mostly from older urban areas which were developed without stormwater management measures and changes in the intensity of rainfall in the region. Furthermore, flooding in Lake Mendota passes downstream to Lake Monona and the lower lakes in the system. Development activities in the Mendota watershed should consider negative effects on flood conditions in the entire system.

Figure 2
Historic Lake Mendota Water Levels and DNR Lake Level Limits



Source: Dane County Dept. of Land & Water Resources

14 For Rock River TMDL Details see http://dnr.wi.gov/org/water/wm/wqs/303d/rockrivertmdl/Final_Rock_River_TMDL_Report_with_Tables.pdf

For a more detailed information on Lake Mendota refer to page 82 through 84. Substantial public monies have been expended to assess and improve the water quality in Lake Mendota, including priority watershed projects. The following list summarizes actions which have been taken in recent years, and those that need to be taken by municipalities and land owners in the Lake Mendota watershed to address issues associated with the health of the Lake:

City of Middleton & Lake Mendota

Measures taken since 1990s

- ***Implementation of agricultural best management practices to provide the following:***
    - ***Reduce soil erosion***
    - ***Utilize nutrient management to optimize the use of fertilizers***
    - ***Reduce the transport of manure by stormwater into streams***
    - ***Prevent livestock from getting into streams***
    - ***Manure digester installations to reduce phosphorus in manure***
- ***Implementation of urban best management practices to provide the following:***
    - ***Control construction erosion***
    - ***Control peak stormwater rates at predevelopment levels in new development***
    - ***Maintain runoff volumes to predevelopment levels in new development areas by including infiltration requirements in stormwater ordinances***
    - ***Provide stormwater treatment in new development areas***
    - ***Require exclusion of phosphorus from lawn fertilizers sold in the region***
    - ***Implement retrofit sediment reduction measures in existing urban areas***

Additional measures that can benefit the health of Lake Mendota[15]

- ***Increase financial resources for broader implementation of agricultural best management practices for water quality and runoff volume reduction***
- ***Increase financial resources for broader implementation of retrofit urban best management practices in old urban areas for water quality and runoff volume reduction***
- ***Restore wetlands, woodlands, prairies, and pastures in select areas for water quality improvement and runoff volume reduction***
- ***Capitalize on opportunities for capturing phosphorus within the watershed and exporting it***

In selecting additional measures for implementation, it is important to consider the cost-effectiveness of urban projects compared to projects in agricultural areas that may result in similar or more effective water quality or quantity improvements at the same cost. CARPC staff can facilitate discussions between municipalities to achieve such cost efficiencies. Such collaborations may require intergovernmental agreements between municipalities to ensure that water quality and quantity improvement measures are maintained.

a. Upper Yahara River

The Upper Yahara River originates in the marshy areas of south central Columbia County and flows approximately 20 miles as a small meandering creek through the Town of Windsor and the Village of DeForest where it empties into the 3,700 acre Cherokee Marsh and eventually into Lake Mendota. The Upper Yahara sub-watershed drains an area of approximately 28 square miles. The primary land use in this sub-watershed is agriculture (64%), residential development (13%), transportation (12%) and wetlands (8%).

15 These measures should be considered in all communities in the study area, since they are all tributary to Lake Mendota.

The problems impacting water quality of the Yahara River include:

- ***Sediment and nutrient loading from agricultural fields and barnyards***
- ***Channelized headwaters for agricultural production***
- ***Historic hydrologic modification and destruction of valuable wetlands***
- ***Areas of heavy instream aquatic plant growth***
- ***Elevated temperatures and periods of low dissolved oxygen***
- ***Lack of suitable habitat for aquatic organisms due to heavy sedimentation***
- ***Historic stormwater runoff from older urban areas***
- ***Historic loss of infiltration areas due to the increase of impervious surfaces***
- ***Reduction in water table levels and stream baseflows due to municipal well withdrawals***

In addition to actions listed above under Lake Mendota actions, the following list summarizes actions which have been taken in recent years, and those that need to be taken by municipalities and land owners within the Pheasant Branch watershed to address issues associated with the health of the River.[16]

Measures taken since 1990s

- ***Implementation of agricultural best management practices (BMPs)***
- ***Implementation of urban BMPs in areas of new development***
- ***Adoption of stormwater volume control standards (100% stay-on) as part of the Village of DeForest stormwater ordinance***

Additional measures that can benefit the health of the Upper Yahara River

- ***Increase financial resources for broader implementation of agricultural best management practices for water quality and runoff volume reduction***
- ***Increase financial resources for broader implementation of retrofit urban best management practices in old urban areas for water quality and runoff volume reduction***
- ***Restore wetlands, woodlands, prairies, and pastures in select areas for water quality improvement and runoff volume reduction***
- ***Broad adoption of higher standards for both urban and agricultural non-point sources of pollution***
- ***Capitalize on opportunities for capturing phosphorus within the watershed and exporting it***

16 See pages 91 through 90 for additional detail on the Upper Yahara River.

b. Ella Wheeler Wilcox Creek

Ella Wheeler Wilcox Creek joins the Yahara River from the west just south of Windsor Road. Limited fishery data indicates many mottled sculpin, an intolerant coldwater species, and large brown trout. WDNR staff is planning to conduct more thorough monitoring of this small stream.

c. Lake Windsor

Lake Windsor is located in the Town of Windsor, sections 31 and 32. It is a drainage lake created by building a dam on an intermittent tributary to the Yahara River. The Windsor impoundment is nine acres in size, a maximum depth of six feet, and a drainage area of 778 acres. Its immediate drainage area is residential, but it also includes agricultural lands and parts of a Town of Windsor industrial park.

Lake Windsor is extremely fertile and turbid due to the tremendous amount of runoff generated by the surrounding agricultural lands. The ratio of the drainage basin to lake area is 86:1. The problems impacting water quality include sediment and phosphorus loading from surrounding agricultural fields being flushed into the impoundment, stormwater runoff from residential and transportation areas, internal phosphorus recycling from lake sediments, turbidity, nuisance algal blooms, winter/summer fish kills, and sediment suspension by carp. The lake's water quality problems are similar to that of other small, shallow impoundments in Southern Wisconsin and limits its fishery.

d. Token Creek

Token Creek is a tributary to the Yahara river that originates in the Town of Windsor, section 24. Token Creek is 10 miles in length and has a drainage area of 27.4 square miles located between the City of Sun Prairie and the Village of DeForest. Token Creek has a diverse fishery containing warmwater, coldwater, forage fish, and rough fish species. ***Token Creek is a major contributor of flow to Lake Mendota,*** with flow of about 19 cubic feet per second (cfs) under baseflow conditions, representing over a quarter (27%) of the flow in the Yahara Chain of Lakes measured at McFarland. ***Combined, Token Creek and the Yahara River contribute nearly half (41%) of the flow to the Yahara Chain of Lakes.***

The WDNR has identified the first three miles upstream of the Yahara River as a Warmwater Sport Fishery, with the potential of becoming a class III (i.e., stocked) trout stream. The segment of stream from approximately USH 51 to Culver Springs is identified as a class II trout stream (exhibiting some natural reproduction). The remaining segment of stream is identified as being a class III trout stream with the potential of becoming a class II fishery.[17]

Land use is dominated by agriculture (56%), followed by residential (14%), transportation (7%), and wetlands (4%). ***Problems impacting the water quality of Token Creek include:***

- ***Sediment and nutrient loading from agricultural fields and barnyards***
- ***Historic hydrologic modification and destruction of wetlands***
- ***Historic urban stormwater runoff from older urban areas***

17 See pages 97 through 102 for additional information on Token Creek.

- ***Heavy instream aquatic plant growth***
- ***Elevated temperatures and periods of low dissolved oxygen***
- ***Sediment suspension by common carp***
- ***Lack of suitable habitat for aquatic organisms due to heavy sedimentation***
- ***Reduction in baseflow due to high capacity municipal well withdrawals***

Token Creek was placed on the state's 303(d) list of impaired waters in 1998, because of water quality impairments due to excessive sediment and suspended solids loading, and also because of the partially failed Token Creek millpond dam was an obstruction to fish passage. In 2002 the EPA approved a Total Maximum Daily Load (TMDL) plan for Token Creek. Project goals included:

- ***Restoration of stream morphology and habitat***
- ***Managing and reducing sediment and other pollutant loading from agricultural lands***
- ***Managing stormwater discharges through the Lake Mendota Priority Watershed Plan and WDNR's stormwater discharge permit program***

The WDNR has added the goal of restoring a native brook trout fishery in the reach downstream of the Culver Springs. Brook trout are a very pollution intolerant coldwater sport fish. Restoration work on Token Creek to improve habitat and hydrologic functions include:

- ***Removing the berm around the Culver Springs (completed) allowing them to flow freely***
- ***Bank stabilization, and***
- ***Removal of pond sediment above the former dam location***

The total sediment load capacity of the creek has been established as being no greater than 746 tons per year. Projected 2020 annual loads have been estimated to be over double that amount or 1560 tons per year (estimated 1416 tons in 1996). Reductions in loading are specified in the TMDL and implemented through agricultural and urban best management practices. Token Creek is also included in the Rock River Basin Total Maximum Daily Load (TMDL) project for required reductions in sediment and phosphorus.

These efforts are just beginning. Implementation measures among agricultural and urban sources have not yet been defined. There may also be opportunities for "nutrient trading" or pollutant reduction credits that could be bartered among the various sources. Such trading opportunities are expected to result in more efficient and cost-effective pollutant reduction and remediation efforts overall.

The natural springs in the Token Creek watershed are a unique resource, being one of the largest complexes in southern Wisconsin according to WDNR. The springs contribute water at a near constant volume and at uniform water quality and temperature supporting

a Class III coldwater fishery. According to WDNR fishery biologists, the stream has the potential to support a naturally reproducing Class II coldwater fishery from its confluence with the Yahara River upstream to and including the former millpond – including brook trout, a highly sensitive species.

Token Creek has been the focus of significant public and private expenditures of funding and volunteer efforts directed at protecting and restoring this unique resource.

Situated between various growing communities, the primary threat to Token Creek water quality is from urban stormwater runoff from impervious development and major roadways. Extraordinary stormwater management measures will need to be taken to maintain or improve the hydroecology of the Creek. Maximizing stormwater infiltration opportunities in new developments as well as retrofitting existing development (where opportunities permit) will be needed to maintain and improve existing baseflow and thermal conditions in the Creek. These actions will protect this coldwater fishery. Recognizing this, the Village of DeForest has adopted a 100 percent stormwater volume control standard for all new development. This will reduce the likely impacts of proposed development and should address the potential impacts on the receiving waters by maintaining existing hydrologic conditions, which are critical to maintaining the health of the stream and the biological communities it supports. The City of Sun Prairie has also installed several stormwater measures in developing areas near the Creek to minimize pollutants reaching the stream and minimize adverse thermal impacts from urban runoff. In addition to what's currently being done, more effort will be needed to address historic impacts from older urban areas not covered by these controls.

The following list summarizes the actions that have been taken, and those that need to be considered to protect Token Creek:

Measures taken since 1990s

- ***Implementation of agricultural best management practices to provide the following:***
    - ***Reduce soil erosion***
    - ***Utilize nutrient management to optimize the use of fertilizers***
    - ***Reduce the transport of manure by stormwater into streams***
    - ***Removal of the Token Creek dam and restoration of the stream***
    - ***Purchase of conservation easements in the riparian areas of the headwater portions of the stream***
- ***Implementation of urban best management practices to provide the following:***
    - ***Control construction erosion***
    - ***Control peak stormwater rates at predevelopment levels in new development***
    - ***Maintain runoff volumes to predevelopment levels in new development areas by including infiltration requirements in stormwater ordinances***

- ***Provide stormwater water quality treatment in new development areas***
- ***Require exclusion of phosphorus from lawn fertilizers sold in the region***
- ***Implement retrofit sediment reduction measures in existing urban areas***
- ***Maintaining stream baseflow by mitigating the impact of groundwater withdrawal through municipal wells for expansions of the Sun Prairie and the Northern urban service areas***

Additional measures that can benefit the health of Black Earth Creek

- ***Increase financial resources for broader implementation of agricultural best management practices for water quality and runoff volume reduction***
- ***Increase financial resources for broader implementation of retrofit urban best management practices in old urban areas for water quality and runoff volume reduction***
- ***Restore wetlands, woodlands, prairies, and pastures in select areas for water quality improvement and runoff volume reduction***
- ***Adopt broader protective local stormwater standards for urban and agricultural areas***

Pederson Tributary of Token Creek

Pederson Tributary originates in the Town of Windsor section 34 and flows south before entering Token Creek in the Town of Burke. The land use in this area is dominated by agriculture, residential development, and wetlands. Factors that impair water quality of this tributary include sediment and nutrient loading from agricultural fields, historic stormwater runoff from older urban areas and highways. The current biological use of the fishery is Coldwater. Fish species found in this tributary include brown trout, white sucker, and mottled sculpin. Macroinvertebrate samples indicate good water quality (HBI = 4.75). There was also an abundance of watercress (Nasturtium spp.) present. Watercress is a biological indicator of good water quality and high groundwater discharge.

Harbison Tributary of Token Creek

Harbison Tributary joins Token Creek approximately one mile east of the USH 51/STH 19 interchange. Baseflow is estimated to be approximately 2.0 cfs. The stream has a large spring complex (Pederson Springs >200 gpm) on the north side of STH 19 on property owned by Dane County. According to WDNR fisheries biologists, the stream contains natural populations of brown trout and likely brook trout as well, since the stocking of brook trout in the early to mid 2000s.

Four coldwater IBIs done in 2000 and 2001 all indicated good biotic integrity. This is consistent with the watershed HBI assessment monitoring of 1994 and 1995. WDNR has been doing habitat improvement projects including removal of a rough fish holding pond and streambank work to improve instream and riparian habitat. A fish survey conducted in 2004 found good numbers of young-of-year brown trout (indicating natural populations) upstream of STH 19 as well as good nursery habitat. Downstream of STH 19 has more adult brown trout from 7-14 inches. This tributary is a valuable resource as both a source of cold water for Token Creek as well as a nursery source for reproduction of brown trout, which provides recruitment of fish for Token Creek.

Because trout and other aquatic organisms typical of a coldwater ecosystem are intolerant to wide environmental variations, the qualities that the springs contribute are vital for a coldwater ecosystem to exist and thrive. In addition to serving as a source of water, the springs bring up clean sand and prevent accumulation of silt in areas of rapid upwelling, thereby providing critical spawning habitat.

2. Wetland Resources

Over half of the wetlands in Dane County and the U.S. have been lost over the last century. Many of the wetlands that remain have been degraded. This has resulted in the loss of ***important wetland functions and values such as flood protection, water quality improvement, wildlife habitat, aesthetics, and natural resource appreciation and recreation opportunities.*** Because of their scarcity and the significant benefits they provide, existing wetlands should be protected and enhanced. An extensive evaluation of the wetlands of the region was conducted by Bradford and Zimmerman in 1974 as part of the initial natural resource inventory for developing the Dane County Water Quality Plan. Additional work was performed by CARPC staff in 2008 to prioritize the wetlands of the region based on susceptibility.

a. Cherokee Marsh

Cherokee Marsh is an extensive peat deposit along the Yahara River and Token Creek, north of Lake Mendota. Covering nearly six square miles, ***the continuous Cherokee complex is the largest wetland in Dane County and the major wetland in the Lake Mendota watershed.*** Abundant groundwater flow is from east to west toward the river, with local discharges appearing in several places to maintain good quality natural vegetation.

Cherokee Marsh contains a diversity of plant communities. ***The rich flora and fauna includes many rare species.*** The less accessible central areas likely retain the condition and appearance of many of the original Yahara basin marshes. The more accessible peripheral areas including river frontage, have in many places been converted to disturbance vegetation, such as reed canary grass or shrubs.

Considerable damage has been caused in Cherokee Marsh by extensive ditching, which has dried out large portions of the marsh; dredging of tributary streams, Cherokee Lake, and the golf course including pumping the spoils into the wetland; planting and invasion of reed canary grass, woodlot and lowland grazing, and siltation from agricultural activities. Introduced carp have removed the wild rice and cause perpetually muddy water.

Major threats include municipal well withdrawals, and ditching in property still in private ownership. Hydrologic studies should be conducted and plans made to place future wells so as not to deplete Cherokee's groundwater supply. Lake Mendota's water quality as well as Cherokee's vegetation depend on adequate moisture to maintain the peat. Cherokee marsh is a major nutrient and flood storage for Lake Mendota. Further drainage would harm the lake by allowing the peat to oxidize; therefore neither ditching nor mining of

essential groundwater should be allowed lest the peat dry out and oxidize, thereby releasing nutrients to the lake. Peripheral development must be guided to protect surface and groundwater supplies and quality, as well as provide a protective buffer zone.

b. Other Wetland Resources

Additional preliminary ecological assessment of wetlands in the FUDA study area were conducted by CARPC staff ecologist in 2011 to identify the quality and restoration potential of other wetland resources in the study area.[18] Wetland restoration methods correct the following three essential elements of a healthy complete wetland:

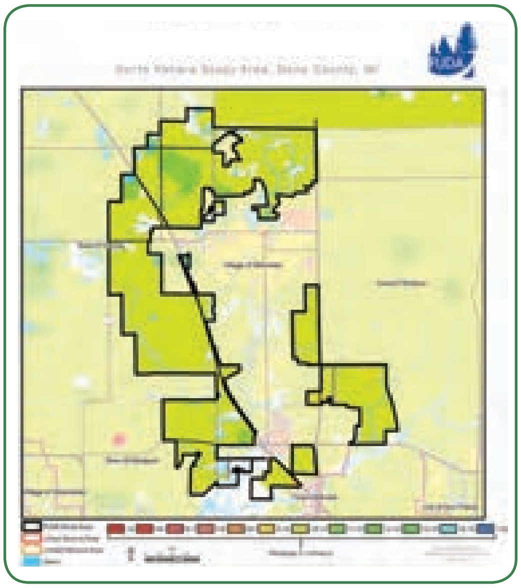
- ***Natural hydrology or water quantity regime***
- ***Natural chemical input to the wetland (water chemistry; pollution levels; fertilizers)***
- ***Natural plant community (generally follows the first two, but invasive species may have to be uprooted to allow natural plan species to re-establish themselves)***

Wetland enhancement methods elevate one or more of these functions to a higher level, leaving the wetland in a healthier, though not original, state.[19]

The following wetland restoration sites were identified in the study area through preliminary assessments:

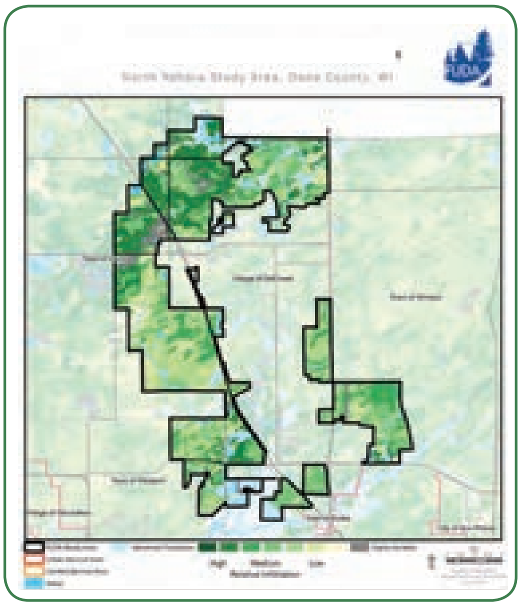
- ***In agricultural areas that are poorly drained, yet persistently fail to produce cash crops***
- ***Two large depressional wetlands northwest of the FUDA study area near interstate 94 in sections 11 and 23 of the Town of Vienna***

18 Map 12, page 70 shows the wetland resources of the study area.
19 For a more detailed treatment of the subject see pages 116 to 113.

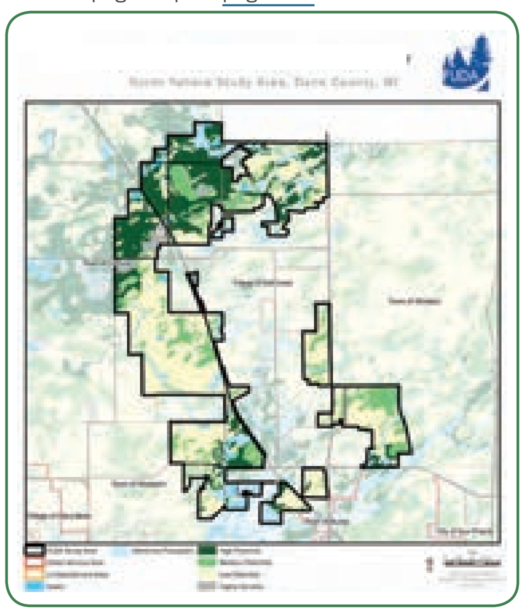


Thumbnail of Map 30
See full page map on page 138

Thumbnail of Map 31
See full page map on page 139



Thumbnail of Map 32
See full page map on page 140



Thumbnail of Map 33
See full page map on page 141

C. Groundwater

All of our domestic water supplies come from underground sources. Groundwater also contributes to surface water resources, providing clean, cold baseflow discharge during dry weather periods. The regional geology does not provide a seal for the deep groundwater which is the source of municipal water. The geologic layer that separates the shallow groundwater and the deep groundwater is absent in places, and is relatively thin in others. The result is that the deep groundwater depends on the shallow groundwater for recharge.[20]

The groundwater/surface water balance can be upset by human activities that reduce natural recharge of groundwater or withdraw more groundwater than is naturally resupplied. Both of these changes have occurred in the region and the study area, resulting in reduced stream and spring base flows[21] and in the lowering of groundwater levels. Natural groundwa-

20 For more detail on groundwater characteristics in the region see page 124 and page 133.
21 See Map 30 on page 138 for major spring locations and flows in the FUDA study area.

ter recharge levels in the FUDA study area and the capacity of the soils of the study area to accommodate enhanced infiltration and recharge measures are shown on Maps 33 through 36, page 141 through page 147. Table 2 shows current and projected baseflow reductions for the stream of the FUDA study area and downstream areas.

Table 2

Simulated Stream Baseflows for Selected Streams in Dane County

Station	Pre-Development cfs	2000 cfs (% reduction)	2030 cfs (% reduction)
Token Creek	23.09	20.11 (13%)	17.94 (22%)
Upper Yahara River	11.71	10.00 (15%)	8.14 (30%)
Yahara R. at McFarland	127.28	70.00 (45%)	54.21 (57%)

Source: DCRPC 2004

To better understand the degree of water quantity impacts to Token Creek and contributing springs as a result of municipal well withdrawals, additional groundwater modeling was conducted to assess the potential water quantity impacts of proposed new high-capacity wells for the Village of DeForest, ***without any mitigation measures*** (see Table 3). The maximum baseflow reduction (in percent of flow) would be 0.19 cfs at Harbison Branch (9.7% decline compared to no wells pumping), 1.05 cfs at Token Creek below Harbison Branch (4.8% decline), 1.10 cfs at Token Creek at I-94 (4.3% decline), and 0.24 cfs in the headwaters near Culver Springs (4.0% decline).

Table 3

Results of Model Simulations for Year 2009 and 2035 DeForest wells without Mitigation

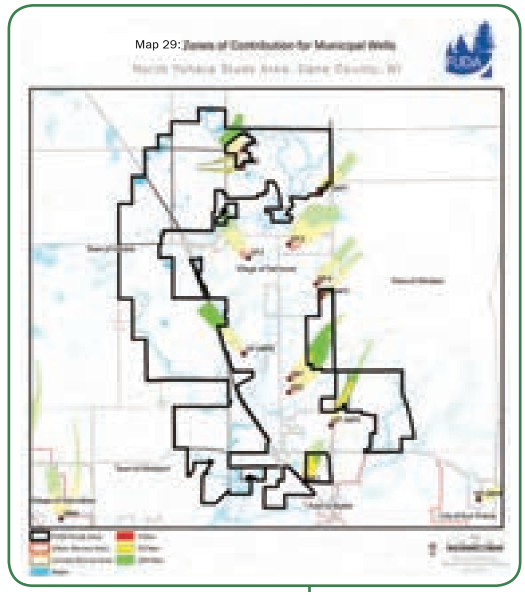
Location		Culver Spring (cfs)	Harbison Branch (cfs)	Token Cr. below Harbison Br. (cfs)	Token Cr. At I-94 (cfs)
Base Run (DeForest wells turned off)		6.00	1.96	21.83	23.09
2009 Pumping	Total	5.90	1.89	21.40	22.64
	change	-0.10 (1.7%)	-0.07 (3.6%)	-0.43 (4.6%)	-0.45 (1.9%)
2035 Pumping	Total	5.77	1.77	20.78	21.99
	change	-0.24 (4.0%)	-0.19 (9.7%)	-1.05 (4.8%)	-1.10 (4.3%)

Source: Ken Bradbury, WGHNS, memo dated 11/11/2010

Recognizing the cumulative impacts of well withdrawals on sensitive water resources, the Village of DeForest and the WDNR entered into a Memorandum of Understanding (MOU) in 2004 “Regarding the Use of New and Existing Wells and Their Impact on Token Creek and Other Area Surface Waters.” In the MOU the Village agrees to take all reasonable management steps to limit the impacts of their well system on Token Creek.

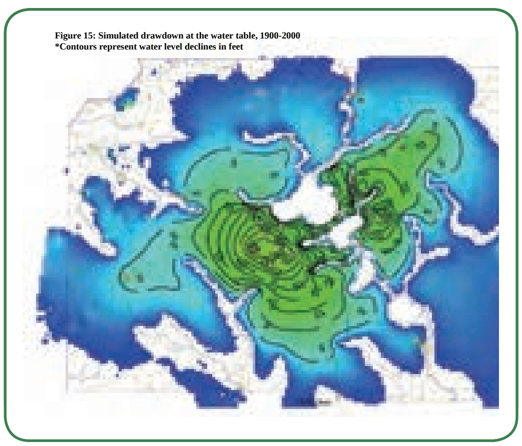
In addition to the reduced pump run-times, new development will be incorporating infiltration practices to maintain pre-development groundwater recharge rates and to replenish the groundwater withdrawals from the wells. The Village intends to continually monitor water use and pumping according to the planned schedule with a Supervisory Control and Data Acquisition (SCADA) system. The schedule will be updated in five-year increments to account for actual versus predicted water use and will be available for discussion with WDNR staff on an annual basis. The results of this annual review will be shared with the Village Public Works Committee and Village Board. This will ensure that Village staff and officials remain aware of the intent of the MOU.

Activities which alter the quality of the groundwater can also make the water unsuitable for domestic and industrial uses, and can result in adverse impact on aquatic habitats that depend on groundwater discharge for their health. Rural private wells generally draw from the shallow groundwater table. This shallow aquifer is more susceptible to contamination from activities on the land surface. Research indicates that over-application of nitrogen fertilizer is elevating background nitrate levels in the shallow groundwater. Elevated salt levels in both the shallow and the deep groundwater is another emerging groundwater quality concern, and is a reflection of winter salt use on roads. Map 31, page 139 shows the zones of contribution for municipal wells in the FUDA study area.

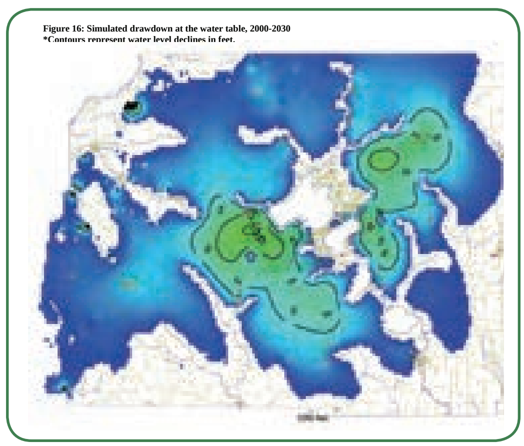


Thumbnail of Map 29
See full page map on page 134

Strategies that are focused on maintaining and restoring infiltration of precipitation and groundwater recharge can reduce both volumes of stormwater as well as pollutant loads to receiving surface waters. In addition, municipal well water withdrawal studies and plans (including water conservation and re-use strategies) will help reduce the impact on our more vulnerable aquatic systems. Figures 17 and 18 on page 135 show the historic and projected lowering of the regional groundwater as the result of groundwater withdrawal.[22]



Thumbnail of Figure 17
See full page graphic on page 135



Thumbnail of Figure 18
See full graphic on page 135

The following planning considerations can minimize the adverse impacts of development in the FUDA study area:

- Preserve areas best suited for active and passive groundwater recharge
- Locate future municipal water wells outside of capture zones for springs
- Increase water conservation with low flow fixtures and rainwater harvesting for irrigation purposes
- Enhance the infiltration of stormwater by directing downspouts to vegetated areas and lawns, by installing raingardens, and by constructing active infiltration basins as part of urban stormwater treatment and management

22 See page 124 for a detailed treatment of groundwater resources and issues, and methods to address these.

D. Open Space Corridors

Open space corridors are mapped based on natural features and environmentally important areas such as streams, lakes, shorelands and riparian areas, floodplains, wetlands, steep wooded slopes, and also include parks and other publicly-owned lands. Open space corridors are a required part of water quality planning under the federal Clean Water Act and Wisconsin state administrative codes (identified as environmentally sensitive areas, or ESAs, in NR 121). ***The Corridors are intended to provide the skeleton for a continuous open space system or framework of connected natural areas among communities, to be expanded upon where opportunities exist and to provide additional recreational easements and open space areas.***

Open space corridors promote important values for protecting water quality and habitat for fish and wildlife, as well as for recreational pursuits. In both the Token Creek and Yahara River watersheds, the type and width of open space corridor varies greatly. For example, in the lower part of the watershed in Token Creek County Park, extensive wetlands border the stream on both sides. Farther upstream and above the former mill pond site, the stream is bordered by hardwood forest species such as box elder and willow. The width of this forested band varies with each land owner. Most of the ephemeral and very small tributaries in the highest reaches of the watershed have very little or no protection provided by a riparian area. Potential opportunities may exist for establishing or expanding riparian buffers in these areas through pollutant trading between agricultural and urban sources involved in the Rock River TMDL project. Potential opportunities also exist through the Conservation Reserve Program and other voluntary cost-share/set-aside/nonpoint source control programs administered through the Dane County Land Conservation Department, based on landowner participation and support.

1. Riparian Areas

Riparian areas, lands immediately adjacent to water bodies, play a significant role in the health of surface water features and are typically included in open space corridors as buffers. Part of this role is due to natural fluctuation and movement of surface water features. Streams shift and meander over time, and expand with changes in precipitation. Wetlands and lakes expand in response to groundwater levels and long-range natural variations in precipitation, and riparian areas accommodate periodic wet conditions. Adequate riparian width provides room for these natural variations and movements. Riparian areas also provide important habitat functions for water bodies. These include temperature and light regulation, infiltration and filtration functions, provision of woody debris for aquatic habitats, and provision of safe access to upland seasonal habitat for amphibians and other wildlife that depend on both water and dry land for their life cycle.

An important opportunity in the study area is in restoring or re-establishing riparian areas. ***Most of the ephemeral and very small tributaries in the highest reaches of the watershed have very little or no protection provided by a riparian area. Potential opportunities may exist for re-establishing or expanding riparian buffers in these areas as part of FUDA planning and as part of collaborative inter-jurisdictional conservation and open space planning.*** Additional opportunities can be foreseen through pollutant trading between agricultural and urban sources involved in the Rock River TMDL project. Potential opportunities also exist through the Conservation Reserve Program and other voluntary cost-share/set-aside/nonpoint source control programs administered through the Dane County Land Conservation Department, based on landowner participation and support.

The following considerations are recommended for the restoration or re-establishment of riparian areas:[23]

- ***Riparian re-establishment and restoration requires land owners to be unified in their support behind the project.***
- ***Riparian areas can be designed to reduce stormwater runoff and sediment input into water bodies from immediately adjacent land areas.***
- ***Riparian areas provide natural landscape breaks in otherwise continuous and densely developed urban environments. This provides a relief from the perception of crowding and high density in urban environments.***
- ***Riparian areas need to be maintained to prevent invasive plants from establishing themselves. In the study area, and emergent understory of willows and cottonwood needs to be controlled.***
- ***Public funding may be available for establishing riparian areas around wetlands as part of wetland restoration funding and stream restoration funding.***
- ***Riparian restoration benefits can be maximized by including consideration of watershed and habitat connectivity.***

23 See page 118 for a more detailed treatment of open space corridors and riparian area considerations.

E. Endangered Resources

Plants and animal species are considered one of the fundamental building blocks of ecological landscapes and biological diversity. Rare species and unique natural communities are often good indictors of ecological significance. The presence of one or more rare species and natural communities in an area can be an indication of an area's health and ecological importance, and should prompt attention directed toward the species' conservation, management, and restoration needs. The WDNR Bureau of Endangered Species maintains a Natural Heritage Inventory database. This information is confidential and site specific. CARPC staff should be consulted early in the planning process for specific development proposals and sites to screen the project and help determine if potential mitigation measures may be needed. Where significant natural features are present (e.g., wetlands, lakes, and streams), an endangered species review may be necessary to determine whether or not endangered species are present or the area is of particularly significant habitat value. Such findings present opportunities for inclusion of such sites in nature preserves and parks. See pages 142 through 139 for a detailed coverage of endangered resources in the study area, and for guidelines for their protection.

F. Wildlife Resources and Biodiversity

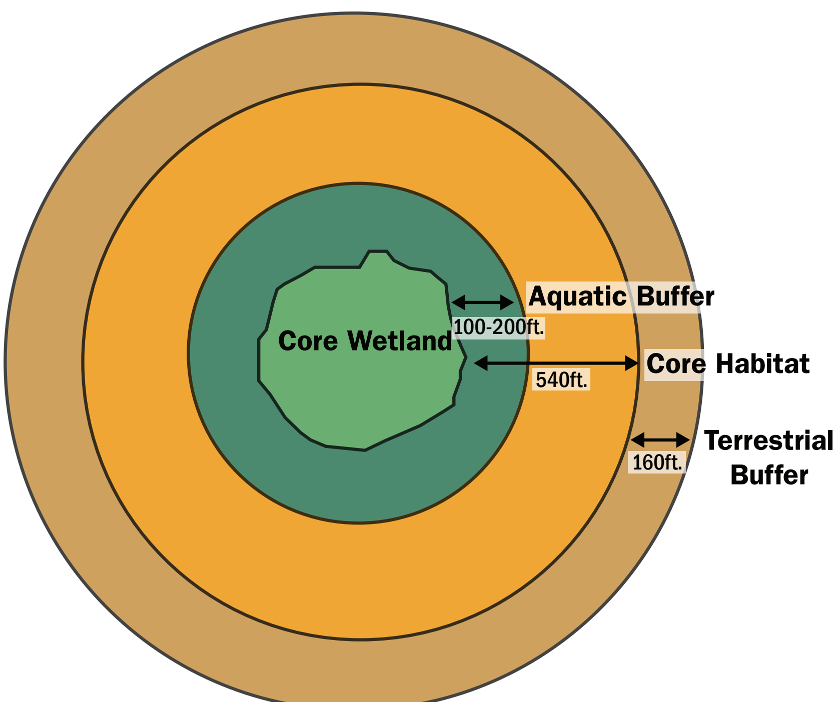
While the protection of water resources from human activities such as agriculture and urban development is obvious, it is often less apparent that the terrestrial areas surrounding our surface waters[24] also serve as "core habitat" for many semi-aquatic species (amphibians and reptiles). These species depend on both aquatic and terrestrial environments to fulfill their full life-cycle requirements (e.g., mating, reproduction, over-wintering, etc.). These in turn serve as food for higher level organisms and the circle of life continues. Scientists sometimes identify certain "umbrella" species in the hopes of saving a whole range of animals and plants in a given area and thereby maintaining overall biologic health and diversity.

24 This is an area beyond the riparian zone.

The idea is that by protecting an important umbrella species and preserving its habitat, various other species that depend on the same habitat will also be protected. Amphibians and reptiles play particularly important roles in biologic food webs because they occupy a middle position as both predator and prey. Development activities that cut too deeply into the food pyramid can upset the stability of these systems and they can become diminished and even collapse. For example, leading ecologists have identified a minimum Core Habitat distance of approximately 540 feet from wetlands and 300 from perennial streams for amphibians as being critical in fulfilling their life-cycle requirements and as an important umbrella species. An additional 160 foot (50 m) buffer is suggested for wetlands to protect Core Habitat from adjacent land uses.[25]

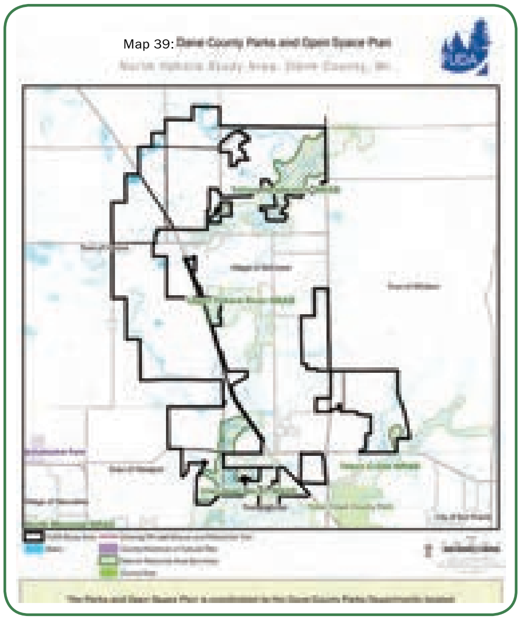
Core Habitat areas are not intended to be restrictive to development or represent "no-build" zones. Instead, these areas are intended to highlight ecological connectivity and stewardship opportunities (e.g., open space and wildlife movement corridors, biofuels, community supported agriculture, etc.). Because of their critical nature and position in the landscape, these areas offer unique constraints and opportunities that need to be considered early on in the community's overall development and resource protection plans. One strategy might be to avoid development in these areas, if possible, directing it to other areas that may be much better suited instead. Another strategy might be more conservation-friendly development designs. These areas could also become the basis of a community's overall park and open space plans.

Figure 3
Zones of Protection for Semi-Aquatic Species



Source: Semlitsch 2001 & 2003

25 Refer to pages 149 through 148 for a detailed description of habitat resources and considerations for planning in the FUDA study area.



Thumbnail of map 39:
See full page map on page 159

G. Parks and Open Space

Dane County plays a special role in the partnership among federal, state, and local units of government as well as private conservation groups. The *Dane County Parks and Open Space Plan* defines that role and recommends how Dane County can work with communities in achieving regionally supportive and mutually beneficial natural resource protection, restoration, and enhancement goals and implementation plans. Dane County Parks staff and their local counterparts should be consulted early on in development planning to promote opportunities and coordination, as well as avoid potentially incompatible or conflicting proposals.[26] Map 39, page 159 shows the elements of the Park and Open Space plan in the study area.

H. Mitigating the Impacts of Urban Development on Natural Resources

Dane County is the second-largest metropolitan area and one of the fastest growing counties in the state. ***This urban growth and development must be properly planned and managed or the quality of our ground and surface water resources, the wildlife communities they support, and the quality of our everyday life will deteriorate.*** The impacts of urban development on natural resources comes from changes in several natural processes:

- Increased volumes and peak discharge of stormwater runoff from impervious surfaces in the absence of stormwater management facilities. This results in changes in the physical character of receiving streams (width, depth, vegetation, and bed material) which adversely impact the health of the stream habitat.[27]
- Changes in water quality from pollution from urban activities that are carried in stormwater runoff in the absence of stormwater treatment facilities. In our region, due to the predominance of agricultural land uses, this change in water quality is generally from an agricultural pollution load to an urban pollution load.
- Loss of habitat and habitat connectivity due to development creates isolated islands of habitat that cannot support wildlife and removes the needed cover for wildlife movement. The consequence is depletion or compromised habitat health and value.[28]

26 For a detailed description of the elements of the Park and Open Space Plan with relevance to the study area refer to pages 156 though 153.

27 A detailed treatment of this subject is provided in page 164 through 161, and in Appendix D of the *Dane County Water Quality Plan* http://danedocs.countyofdane.com/webdocs/PDF/capd/2011_postings/WQP/WQP_Appn_D_Urban_Nonpoint_Source_Analysis_2011_web.pdf

28 A detailed treatment of this subject is provided on pages 166 through 164.

Waunakee Infiltration Basin

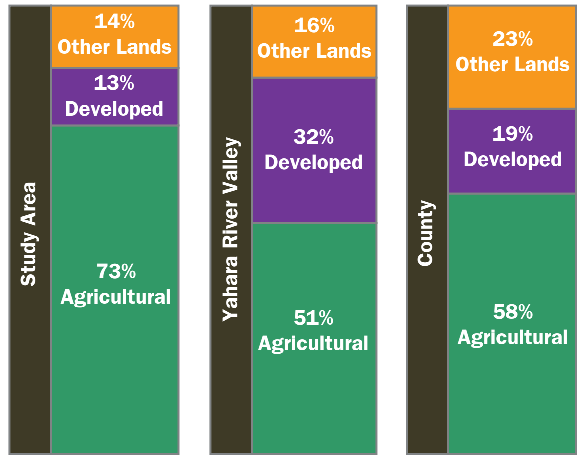
Efforts focused on maintaining pre-development hydrologic characteristics, water quality, and habitat quality and value can help mitigate or offset the negative effects of development on our natural resource base. Urban development strategies to maintain and improve the integrity of the natural resources have been highlighted for a more pro-active consideration in planning and development activities:[29]

- ***Approaching local issues from a regional watershed perspective.***
- ***Directing development away from sensitive natural resource areas to areas better suited for it.***
- ***Increasing the efficient use of land resources through compact development patterns and optimizing the use of current urban areas through infill and re-development.***
- ***Allowing land use density transfers (e.g., Transferable Development Rights) away from sensitive natural areas to areas with lower natural resource risk.***
- ***Incorporating and integrating natural features into development design, and applying conservation design principles.***
- ***Considering the long term impacts when selecting a site location, especially the soil and water resource constraints (e.g., shallow soils, high water tables) and opportunities (e.g., existing or enhanced infiltration, groundwater recharge).***
- ***Minimizing impervious areas in design, which can upset the ground/surface water balance.***
- ***Reducing pollution sources on all land surfaces, and looking at collaborative inter-jurisdictional solutions with broader effectiveness.***
- ***Tailoring stormwater management measures and strategies to the susceptibilities and protection needs of the environment instead of adopted minimum stormwater standards.***

29 For a more detailed treatment of these strategies and additional design recommendations refer to pages 170 through 168.

Chapter II. Agricultural Resources

Figure 4
Regional Land Use Comparison (2005)



The region is a significant agricultural producer, and agriculture is an important contributor to the regional economy. The region also has one of the fastest population growth rates in the state. Because of the predominance of agricultural land uses in the region, most urban expansion comes with an equal loss in agricultural acreage. Furthermore, financial pressures on town government dictates some residential development in rural towns to increase tax revenues for local services. Analysis indicates that in Dane County the acreage of agricultural land lost to urban expansion (through annexation) is approximately equal to that lost to rural residential development in towns.

The towns of Windsor, Westport, and Vienna contain highly productive and economically valuable agricultural lands. The North Yahara FUDA study area covers approximately 9,220 acres with approximately 6,840 acres under agricultural production in 2005, the latest available inventory of land use in the study area.

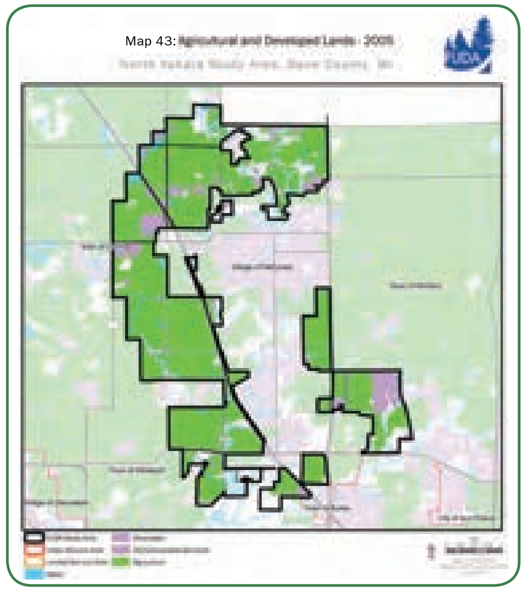
Between 1980 and 2005, the townships in and surrounding the FUDA study area lost approximately 13,000 acres of agricultural land. [30] Table 4 shows the share of each of the towns in the sub-region.[31]

Table 4
Conversion of Land Out of Agriculture

Township	Reduction in Agricultural Use Acreage 1980-2005
Windsor	3,700
Westport	5,346
Burke	2,770
Vienna	1,335

30 Not all of this acreage has been converted for development. Some of the land has been removed from agriculture for conservation purposes, or has been left fallow.
31 Includes townships of Windsor, Westport, Burke, and Vienna.

Map 43, page 179 shows the agricultural and developed acreage in the FUDA study area based on the 2005 land use inventory conducted by the CARPC.[32]



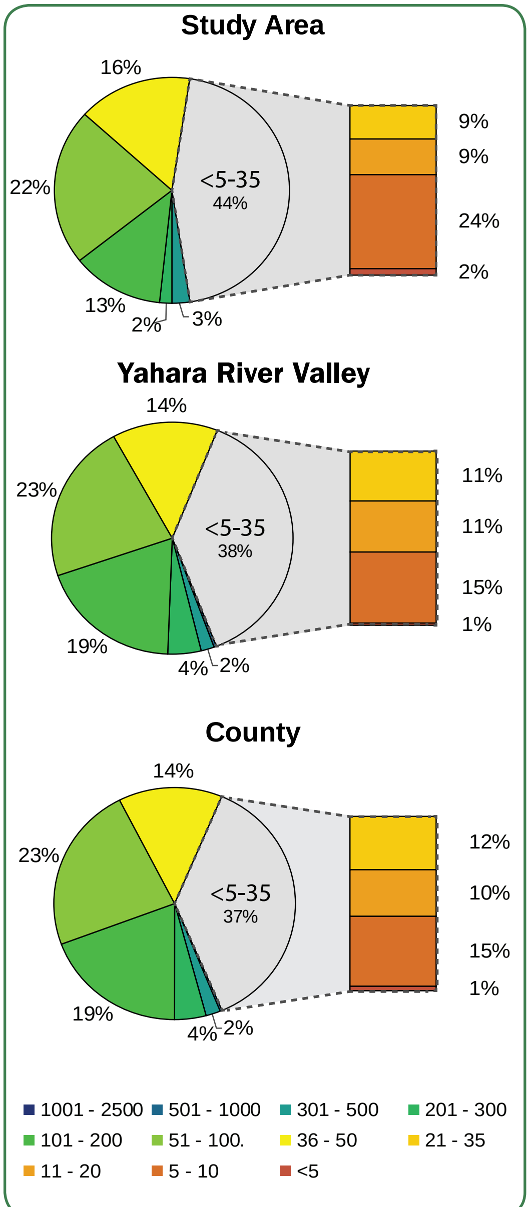
Thumbnail of Map 43
See full page map on page 179

Data and other information in this chapter can be used in local decision-making to identify the agricultural lands a community might preserve, maintain, or develop in the FUDA planning and Comprehensive planning processes. The agricultural inventory presented in this section includes the following:

- Agricultural land area and land conversion trends
- Farmland and farm operation characteristics
- Agricultural parcels and base farm tracts trends
- Agricultural contiguity and concentration trends
- Operation type (livestock, crop, and crop type) characteristics
- Soil quality (prime farm lands and Land Evaluation)
- Tax parcel value assessment
- Support services
- Ecological services and functions on agricultural parcels
- Recommendations for agriculture in comprehensive plans and farmland preservation plans

32 A detailed description of agricultural land acreage, land conversion trends, ownership, tenure, and operation characteristics can be found in pages 177 through 172.

Figure 5
Size Distribution
of Base Farm Tracts (2005)



As populations increase, communities may need to provide land for development both within the existing urban area through infill and redevelopment and in new areas adjacent to existing developed areas. Urban development can also incorporate various types of agriculture, such as community gardens, a community supported farm, or an agrarian community. ***Where agriculture cannot be incorporated into a new neighborhood, protecting large contiguous blocks of agriculture can maintain the economic role of these large blocks and their contribution to the local and regional community.*** With agricultural preservation as a shared region-wide goal, these large areas may be well suited for continued agriculture for the foreseeable future. ***When connecting study area tracts to agricultural tracts outside of the study area boundary, the Westport portion in the study area becomes part of one of the largest swaths of contiguous agricultural land in the general region. A few blocks in Vienna also join with neighboring parcels and move up to the 500-1,000 acres range from the 300-500 acre range.***

Larger contiguous blocks of agricultural lands maintain a critical mass that fosters a viable farming sector. These land masses are well suited for preservation in agricultural use. Smaller blocks, especially near developing areas, might infer where farming may not be as viable in the long-term. If smaller blocks are considered valuable to these communities for agricultural use, these lands may require special efforts to preserve or adapt practices to reduce the burdens from expanding urban development on farm operations and maintain economic viability of an operation.

This is especially observable outside the Morrisonville limited service area just north of DeForest and at the south end of DeForest in the Town of Burke.

Agricultural land uses are dependent on different types of infrastructure, such as transportation, and the support service network needed for operational inputs, such as veterinary assistance, processors, implement sales, and machinery service. Maintaining a critical mass of agricultural operations combined with proper access to support services creates the necessary market base for local and sub-regional agricultural-sector businesses.

At a site specific level, information about soil quality and tax value assessment can help determine how to best develop a site.

Finally, agricultural land located adjacent to open space corridors and the ecological services and functions they provide may be eligible and targeted for natural resource conservation easement funds. Conservation easements typically allow a smaller proportion of land to be used for agriculture. Typically, agricultural lands in these areas are well-suited for restoration or stewardship practices that improve the integrity and health of the natural communities and resources of neighboring conservation or natural areas. Boundary agreements are effective land management tools for agricultural land preservation between jurisdictions. Boundary Agreements currently exist between DeForest and Windsor, DeForest and Vienna, and DeForest and Burke, City of Madison and City and Town of Sun Prairie. The DeForest-Windsor boundary agreement includes agricultural land preservation east of Highway 51 and north of Windsor Road for the next 30 years. DeForest could also establish a boundary agreements with the Town of Westport. Westport currently has boundary agreements with the City of Middleton and Village of Waunakee. Boundary agreements help to ease political tension, creates a more simple, predictable, and stable land management framework, and helps to direct growth to more appropriate locations.

In addition, town farmland preservation maps, in accordance with the State Farmland Preservation Act, designate lands as either “preservation,” “rural development,” or “transition areas.” These designations should be heavily considered when developing boundary agreements and in pursuing rural development. As a tool to preserve farmland the Town of Windsor executed and Agricultural Enterprise Area for the entire area north of Windsor Road and east of Hwy 51 to the township border in 2010 that promises to keep the lands in agriculture for at least 15 years in exchange for tax credits. The North Yahara project communities may benefit from establishing a shared framework for making decisions about farmland preservation and conversion to other land uses, based on the information provided in this chapter and the following recommendations:

Figure 6
Proportion of Total Area by Base Farm Tract Size (2005)

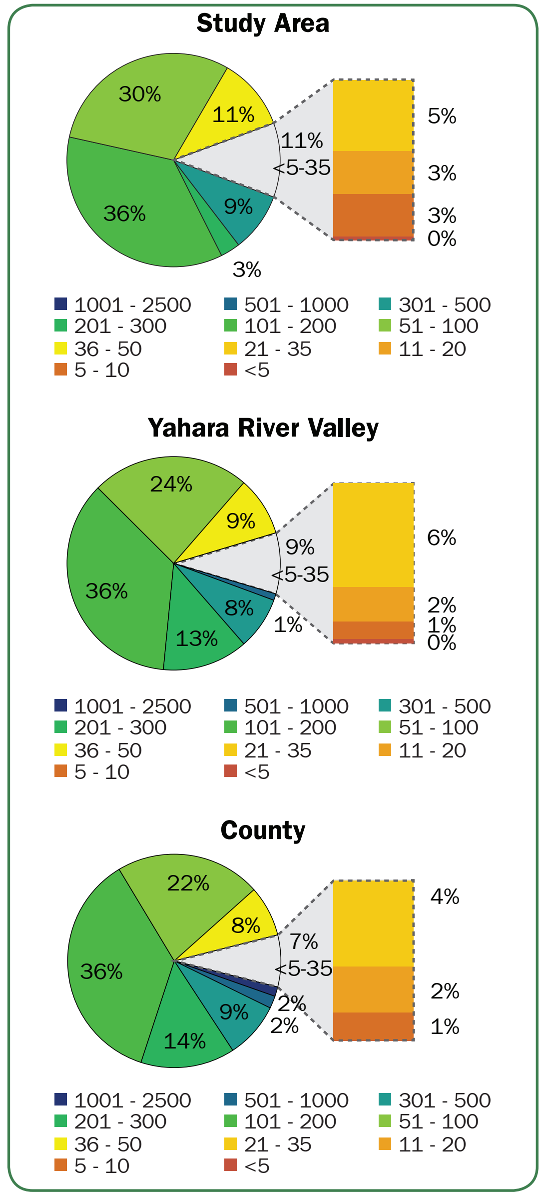
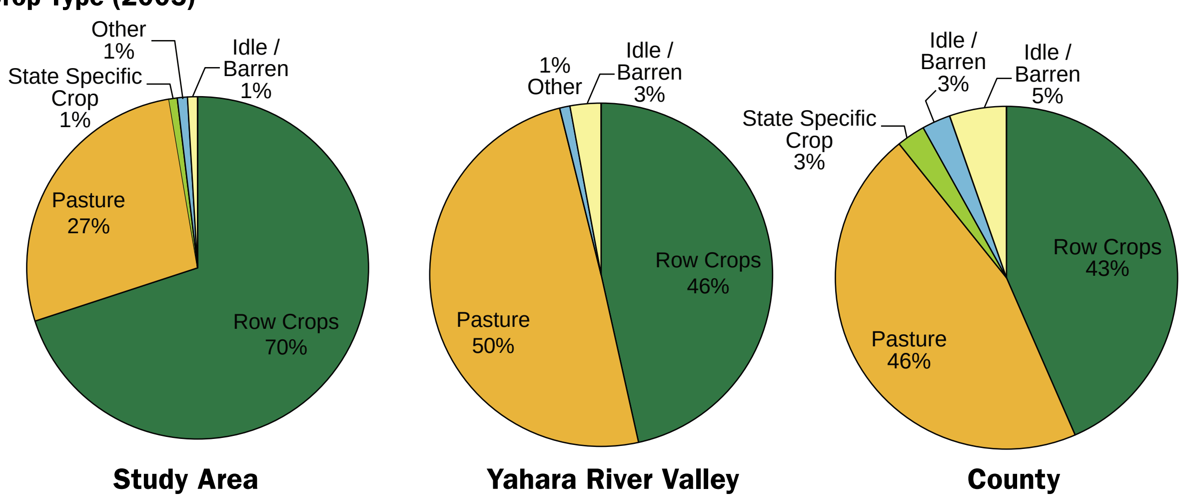


Figure 7
Crop Type (2005)



- ***Maintain diversity in size and operation type to insulate the regional agricultural industry from drastic market changes in any one sector, and to better support and encourage regional food systems.***

- ***Maintain sufficient concentrations of agricultural lands to retain the viability of support service businesses.***

- ***Ensure adequate infrastructure to ensure support services remain accessible to the farming community.***

Consider soil fertility characteristics that specialize these soils for raising crops. Special consideration is warranted when pursuing development in these areas to preserve these lands for food production that is dependent on soils. Arlington Prairie and the Northeastern portion of the study area boast the greatest amount of prime farmlands relative to the rest of the study area and warrant special consideration in determining the direction and form of urban growth.

Because of the variable terrain and the prominence of livestock operations in the study area, soil quality is best considered at a site specific level. Broad-brush categorization of prime farmland as a priority criteria for preservation may significantly limit the viability of an agricultural preservation program, and undermine the predominant and economically productive livestock operations that are being operated in non-prime soils in the region.

To identify, enhance, and maintain ecological services and functions of agricultural land effectively, land management practices and the areal extent of these practices need to be considered together. The open space corridors[33] define a network of sensitive natural resource areas that can be augmented with additional conservation areas and practices.

33 Map 58, pages 207 shows these areas in the FUDA study area.

This approach can integrate various programs and policies to create a network of permanent agricultural and open space conservation areas which are protected from development. Supporting recommendations for low impact agricultural practices, conservation, and restoration for various locations in the study area can be provided based on ecosystem requirements and opportunities. Other areas may be suited for integrated resource management and for accommodating multiple land uses and ecological services simultaneously.

Former wetlands, since drained with underground drainage tiles and ditching, are also presented on the map to illustrate where wetland restoration could benefit ecological systems and water quality and quantity in downstream areas.

In some upland areas, reforestation of agricultural lands could benefit ecological systems and water quality and quantity in downstream areas.

Some conservation practices would greatly benefit from changes in state law and taxing policy. For example, wetlands are typically assessed at higher land values compared to farmland. Consequently, farmers not only lose cropland and income by restoring former wetlands, but also pay higher property taxes under current tax policy.

Ecosystem service areas should be designed with the idea that the land owner would continue to benefit financially from the land. This can be either through sale of products from these conservation areas or through payments for the ecosystem service being provided.

Chapter III. Land Demand and Supply Assessment

The land demand and supply assessment establishes projections of future urban and rural development for the FUDA communities within the 25-year timeframe of the study. ***The land demand and supply assessment contains three major components:***

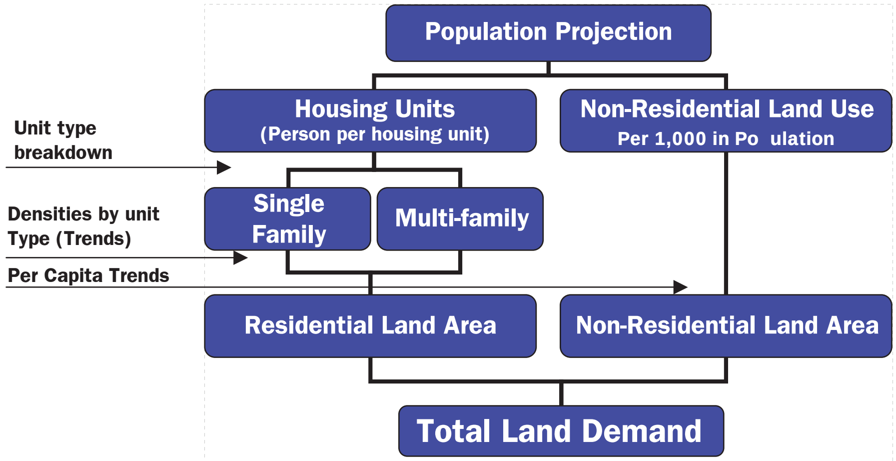
- ***Development Trends:*** Future development projections are based on historic trends for each municipality, documented over the past 30 years, addressing the number of residential units and acreage of major land use categories, including residential, commercial, industrial and outdoor recreation.
- ***Land Demand:*** This component establishes baseline land demand estimates for urban and rural areas for the 25 year planning horizon, Future development projections follow CARPC's 25-year land demand methodology, which utilizes WI Department of Administration (DOA) growth projections. Participating municipalities in the North Yahara Study Area anticipate future growth during the 25 year planning horizon will exceed what is projected by the DOA and CARPC's land demand methodology.
- ***Land Supply:*** This component identifies land available to accommodate anticipated development through infill development and redevelopment, and through "greenfield" development in the FUDA Study Area (within and outside the urban service area).

The other Environmental Condition Report chapters, the Natural Resources and Agricultural sections, provide inventories and assessments of natural and agricultural assets for the purpose of protecting important resources as development continues. This provides bases for locational decisions on how the communities may wish to accommodate future land demand.

The communities within the North Yahara FUDA study area have a total urban land demand of 1,413 acres for the 2010-2035 period.[34] This accommodates the development of 2,229 housing units, and 71.5% are single family homes. Average densities of 3.4 and 10.7 units per acre are projected for single family and multi-family housing respectively, resulting in 526 acres for new residential development. Other uses demand 887 acres (includes commercial, industrial, transportation (streets) and utility, institutional, and outdoor recreation land uses).

34 Land demand is based on a 2005-2035 population growth projection. Increment values are prorated. For a detailed analysis of land demand refer to pages 220 through 222.

Figure 8
Flow Chart for Land Demand Methodology



The Village of DeForest and the Town of Windsor have identified redevelopment areas that can fulfill part of the future land demand for 313,600 commercial square feet and 263 residential units, and could fulfill 53 acres of future land demand. Two redevelopment sites in DeForest provide approximately 50 acres and the potential to accommodate an additional 303,000 commercial square feet and nearly 243 residential units. Two sites in the Town of Windsor were identified for potential infill or redevelopment and have the potential to accommodate over 10,000 commercial square feet and 20 residential units. All together, ***redevelopment scenarios could offset over 53 acres of future land demand between 2010 and 2035.***[35]

The projected land demand and supply numbers form the "current trends" or baseline of future growth. This information is based on Wisconsin Department of Administration (DOA) population projections and approved land demand estimation methodology, as required in NR 121. Any projection is, at best, an educated guess at what will happen in the future. This projection simply tells us what will happen if the development trends of recent decades continue into the future. However, just as past decades were not mere continuations of earlier periods, future decades will not be merely continuations of the past. Therefore, the purpose of extrapolating current trends is to inform future choices, not to constrain them. Continuation of historic trends gives us the baseline from which to make informed choices by considering alternative development scenarios based on community goals and different estimates of future growth. Comparing the costs and benefits of alternative scenarios to current trends, communities can make choices, plans and policies that best advance community goals. and is discussed in the North Yahara FUDA study.

35 For a detailed analysis of infill and redevelopment in the study area refer to pages 225 through 231.

North Yahara

Future Urban Development Area Planning

Environmental Conditions Report

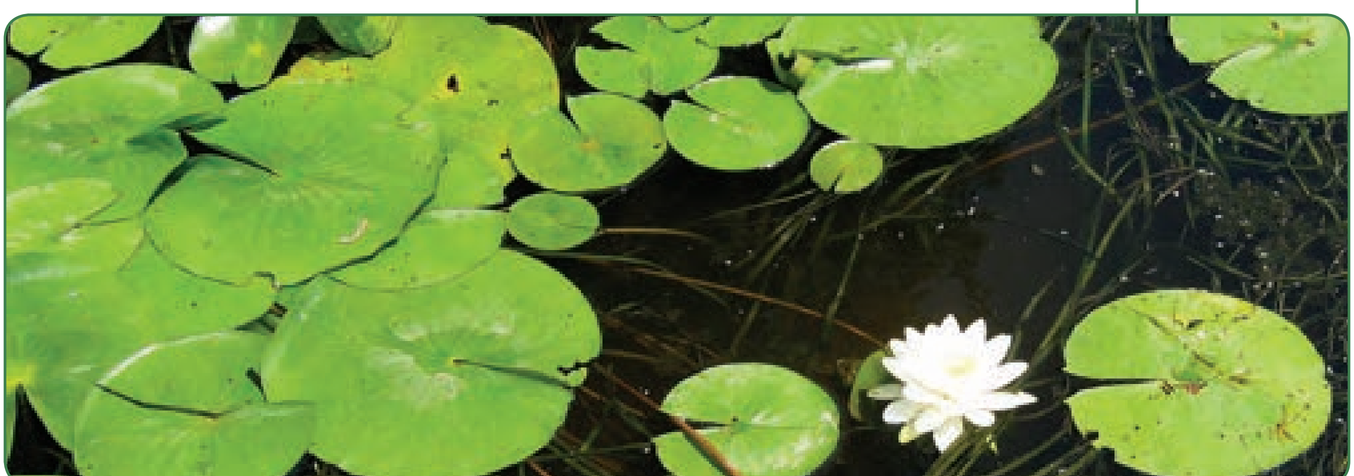
Chapter I. Natural Resources

Introduction

This chapter of the Environmental Conditions Report has three main purposes:

1. ***Provide a natural resource inventory and assessment based on local and regional considerations.***
2. ***Outline considerations for land use planning and decision-making that protect and enhance the integrity of natural areas, both locally and regionally.***
3. ***Outline opportunities for incorporating environmental features in local urban design to enhance the quality of life of local residents and to reduce costs for maintenance and infrastructure locally and regionally.***

Conserving and restoring regionally important natural resources contributes to a healthy natural environment and makes the region a desirable place to live and work. Conserving and restoring local natural resources improves the quality of life of residents and enhances beauty of our cities and villages. Connecting these regional and local features within environmental corridors helps protect water quality, sustain wildlife and plant habitat, and provides valuable opportunities for recreation and education. Assessing this natural resources information along with agricultural, economic, and community information, provides the foundation for local communities to evaluate where development should be encouraged, where resources should be protected, and where both can occur together and in harmony.



The present condition of the region's natural resources is dramatically different from pre-European settlement times and continues to be altered for agriculture and development. Agricultural land use dominates where prairies and scattered oak savanna once flourished. Many wetland acres that once filled the river bottoms and other low lying areas were ditched and drained. Stream channels were dredged and straightened. Development increased as populations in cities and villages and scattered rural communities grew, often with little regard for the natural surroundings. Natural communities and ecological systems were fragmented. Urban development in the 19^{th} and much of the 20^{th} centuries was accompanied by uncontrolled runoff from streets and parking lots, and erosion from construction sites and stream banks added sediment and pollutants and degraded water quality and wildlife habitat. With thoughtful planning, development and management practices these resources can be protected from such impacts, and degraded resources can be restored and enhanced.

Impacts from development are, for most individual sites, relatively small. When considered on a regional basis, however, their cumulative impact can result in substantial consequences. To manage these impacts effectively, it is critical to understand them on a regional basis, and collectively address them at the individual site level. In the end, the site level is where the physical changes to the environment are being made and mitigation measures are easier to implement.

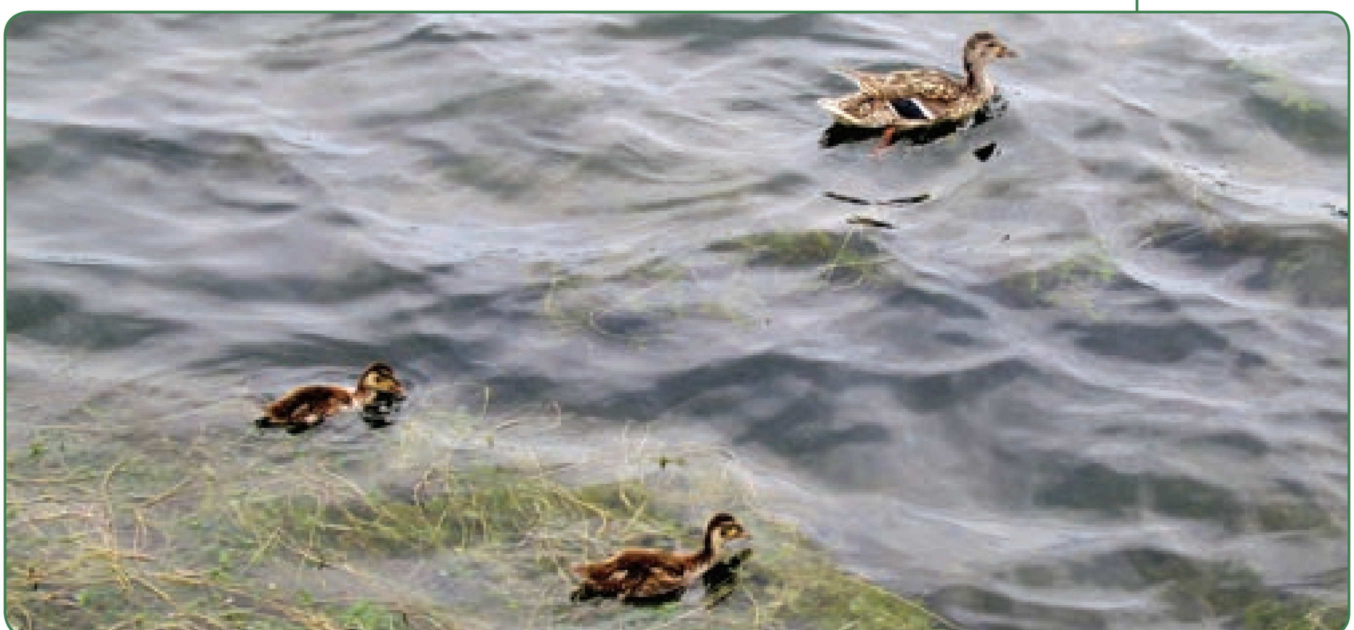
Many communities across the U.S. are discovering that a natural resource-based development strategy is a much better alternative to conventional urban design and development, where traditionally less attention has been focused on the environment. The primary objective is relatively straight forward. The quality of our natural environment and the associated resource functions and values should be maintained and, where possible, enhanced. This dovetails with a host of related growth and development strategies related to infrastructure planning, community development, agriculture, and open space.

A resource-based development approach has several characteristics:

1. Tangible, measurable, and readily understood by the participants in the local development review process.
2. Directly linked to the local development review process by making natural resources protection a priority during all stages of the development process – from the conception of how the landscape is to be altered, through the planning, design, and construction of individual projects, to the maintenance of the necessary infrastructure such as stormwater management facilities after it is completed. Each step of the development process should only proceed when it can be reliably determined that the impacts of the development will be mitigated or minimized.
3. Clear and practical management approaches towards local development by explicitly directing development away from environmentally sensitive areas along with other necessary protections and safeguards.

A resource-based strategy should streamline the local review process, reduce administrative burdens on local government, and be fully responsive to the needs of the development community for clear direction, timely review, and reduction of uncertainty and mitigation costs.

The regional physiography of Dane County explains the surface and near-surface features and formations that characterize the landscape of the region. These include land forms, geology, soil and subsoil characteristics, vegetative cover, drainage and surface- and ground-water resources, and associated habitats. Information in this section is organized based on a layered approach and starts with large-scale characteristics followed by characterization at successively smaller scales of analysis. Planning and design implications of these features and characteristics are discussed and highlighted at each step. Information concerning past and current actions and efforts to address problems and issues have also been included to provide the pertinent context for future decision-making.



A. Physical Geography and Surface Geology

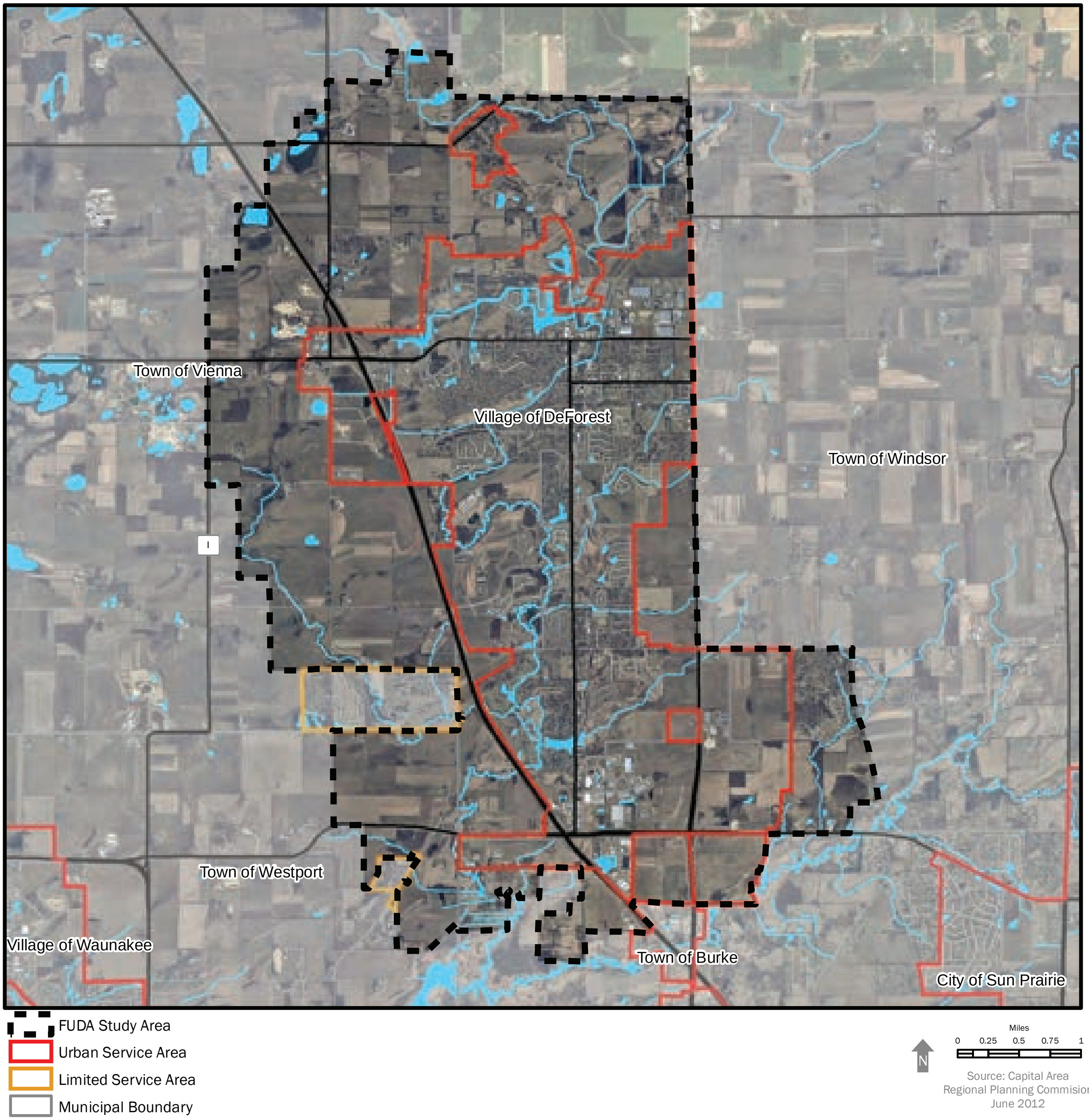
The North Yahara study area is in the river and marsh physiographic area of Dane County. The physical geography of Dane County has been generally influenced by three major forces: glaciation, the Yahara River, and the Wisconsin River. The county can be divided into four physiographic areas with distinctive features shown in Map 2.

The study area is located in the center of the county, in the Yahara River Valley. The Yahara River Valley consists primarily of glacial ground moraine with extensive areas of peat and marsh deposits. The Yahara River Valley has an irregular topography, ranging from flat and rolling to hummocky and hilly. Slopes are relatively gentle. Here deep glacial deposits up to 350 feet dammed up a large preglacial valley, forming a chain of large lakes and wetlands. Lakes Mendota, Monona, Waubesa, and Kegonsa dominate the valley. Lowlands along the Yahara River are generally marshy, whereas uplands are well drained. Streams in this physiographic area are generally flatter and more sluggish than those in the driftless area, and fewer are spring fed. The Village of DeForest and the Towns of Westport, Windsor, Vienna, and Burke are located in this physiographic area.

Cherokee Marsh

Map 2: Physiography of the Area

North Yahara Study Area, Dane County, WI



Aerial imagery is from spring 2010.

1. Mineral Resources

Map 3 shows potential mineral extraction sites throughout the study area. ***High Potential*** mineral extraction sites have deposits of either ice contact stratified glacial material or coarse outwash, providing the best potential for an economically viable source of high quality aggregate. ***Low Potential*** sites have deposits of either pitted outwash or finer outwash and are much less likely to be an economically viable source of high quality aggregate.

Planning Considerations:

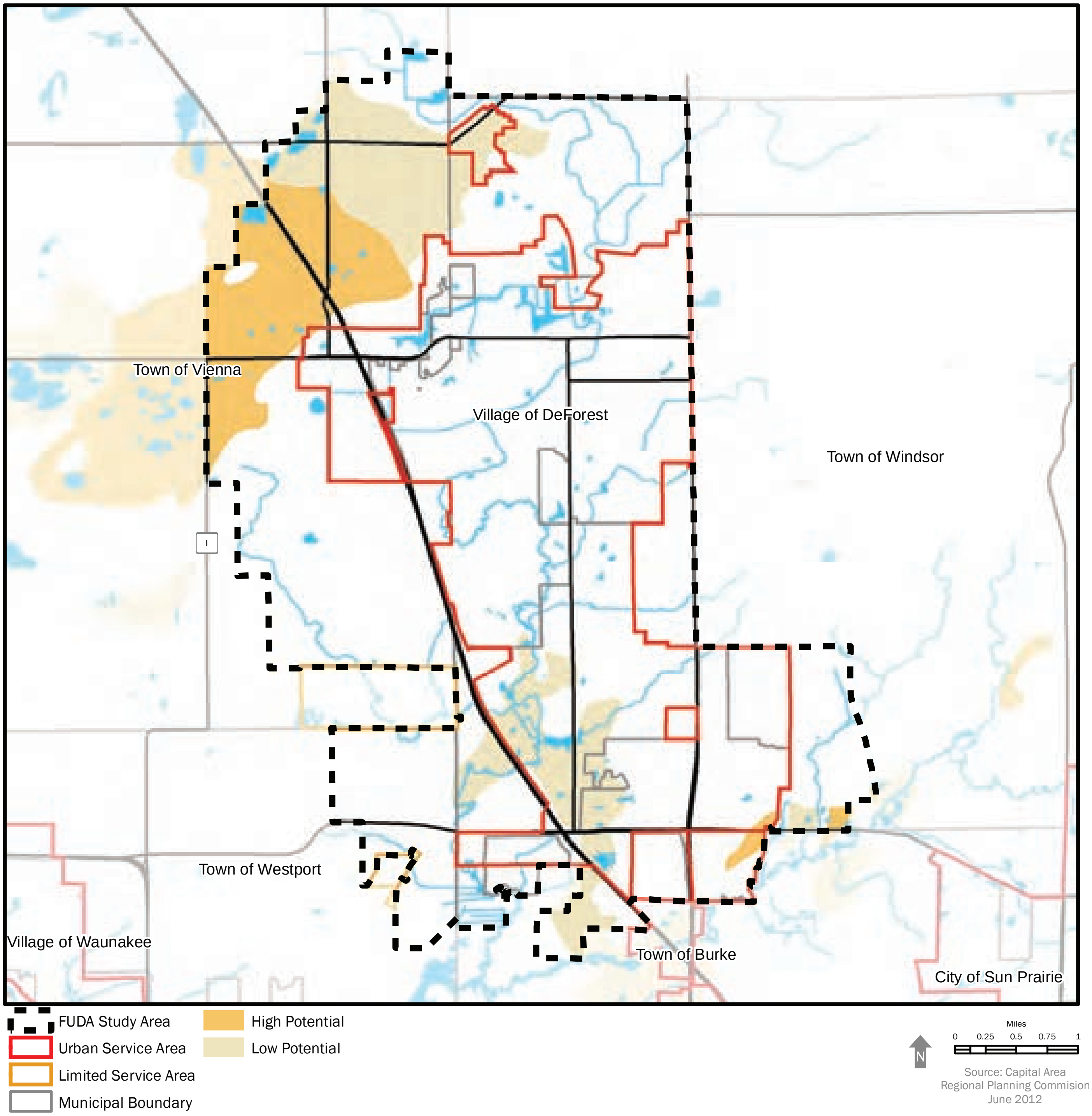
- Preserve mineral resource areas until after the resources have are used.
- Preserve mineral resource areas until their value as regional infiltration and groundwater recharge is investigated.

Mineral extraction operations are eligible uses under the Dane County Zoning Ordinance as a conditional use in agricultural zoning. Section 10.191 establishes procedures and standards of operation for mineral extraction operations. ***Mineral resources are important economic and environmental assets. It is recommended that these areas be protected from development until after the mineral resources have been utilized and the site reclaimed.*** These areas also provide significant opportunities for large-scale enhancement to infiltration and groundwater recharge to maintain the hydrologic regime of area waters. This strategy needs to include stringent measures to protect groundwater quality, and is covered more fully on page 136.

Town of Vienna

Map 3: Mineral Resources

North Yahara Study Area, Dane County, WI



Mineral resources are important economic assets. These areas also provide significant opportunities for regional infiltration practices to replenish the groundwater.

2. Steep Slopes and Woodlands

Planning Considerations:

- Protect, preserve, or restore perennial vegetation on slopes greater than 20% to protect against development and slope destabilization.
- Limit development on slopes greater than 12%. Preserve or restore them in perennial vegetation wherever possible.
- All slope disturbance and stabilization measures should be reviewed and approved by municipal engineers.

Typical definitions for steep slope in Wisconsin vary from 12% to greater gradients. Steep slopes pose a number of development-related concerns and constraints. A significant concern is that developments on steep slopes increase erosion and stormwater runoff. This is problematic since it can adversely affect water quality as debris and excess sediment is washed into surface waters. A scattering of areas with slopes greater than 12% exist in the North Yahara FUDA study area (Map 4). Some of these slopes are wooded, providing the added benefits of wildlife habitat, groundwater recharge, and water quality protection.

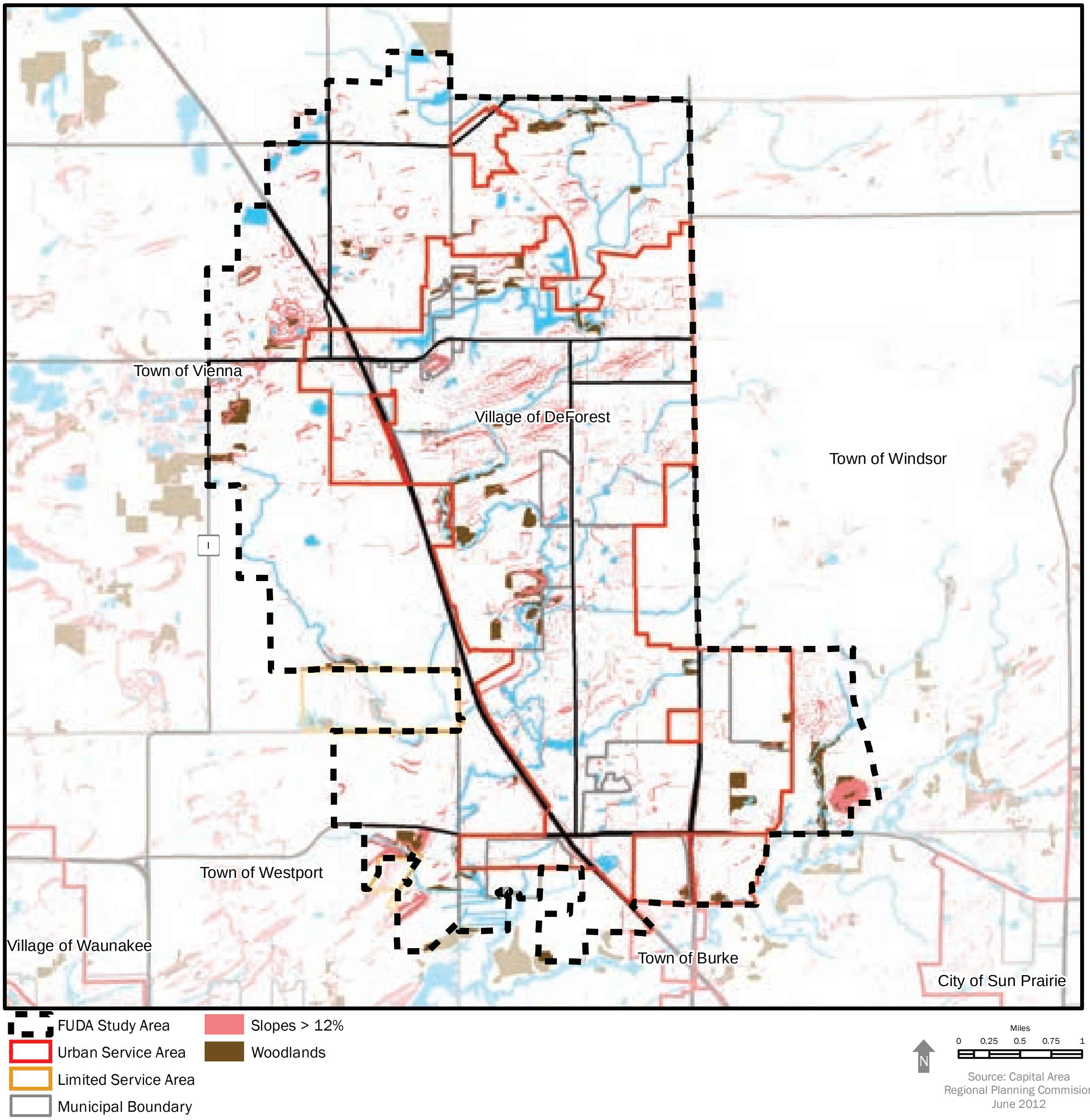
Slopes steeper than 20% should be protected from disturbance and development, and protected with permanent vegetation, because such areas are extremely susceptible to slope destabilization.

All proposed slope disturbance and stabilization measures for steep slopes with gradient between 12% and 20% should be reviewed and overseen by municipal engineers for the risk of destabilization. It is broadly recommended that areas identified as having slopes in excess of 12% be avoided for development through inclusion in open space amenities or in Environmental Corridors.[39]

39 Environmental Corridors are continuous systems of open space in urban and urbanizing areas that include environmentally sensitive lands and natural resources requiring protection from disturbance and development (DCRPC 2004).

Map 4: Steep Slopes and Woodlands

North Yahara Study Area, Dane County, WI



Development projects on steep slopes can increase erosion and stormwater runoff, negatively impacting surface water features. They can also negatively affect the natural terrain and aesthetic qualities of an area. Detailed analysis and design is need to prevent slope destabilization in these areas. Revegetation of bare steep slopes can reduce erosion and stabilze these areas. Steep wooded slopes left in a natural condition provide significant groundwater recharge, wildlife habitat, and water quality benefits.

a. Woodland Restoration

There are few woodland habitat patches within the Northern FUDA study area. These woodlands are very isolated patches within the greater landscape context and far removed from contiguous woodlands beyond the planning area. Of these isolated patches most are surrounded by agriculture or perform as riparian buffers. The largest woodland patch found within this FUDA study area is approximately 47 acres, with all others substantially smaller. Most of these woodland plots are square or rounded in shape, giving them a larger internal area to perimeter ratio, allowing for more ecological processes that are dependent upon core habitat. However, considering that there are so few woodland patches and patch size is small, it is unlikely that larger animals, other than raptors would use these areas for habitat.

According to biodiversity and biogeography theory, small areas tend to have low species diversity. Low species diversity, the raw number of species, is associated with low functional diversity, the number of ecological jobs performed by species, which leads to low resilience, an inability to recover after environmental stress. Low diversity areas are more susceptible to ecological disturbances, which leads to higher colonization by invasive species.

Planning Considerations:

- Identify local stressor causing ecosystem degradation.
- Invasive species.
- Restore connectivity within the landscape for organism movement.
- An entire landscape does not need to be re-vegetated back into woodlands.

With restoration projects, identifying and removing the factor(s) that caused ecosystem degradation is important. If restoration projects proceed without this consideration, they will eventually fail. One cause for woodland ecosystems to lose function is through the introduction of invasive species. ***The main invasive tree species detected during surveys were cottonwoods, black locust and Tree-of-Heaven.*** Cottonwood *(Populus deltoides)*, found along riparian areas and adjacent to drainage ditches, this tree species is problematic because as they fall into streams, their woody debris will alter stream width leading to a variety of ecological problems. There were instances of black locust *(Robinia pseudoacacia)* found along some road sides, within woodland patches and maintained on private residential lawns. Black locust trees, when in dense stands, shade out native vegetation, release chemical compounds that inhibit other plant species (allelopathy) and have leaves, seeds and bark that are toxic to livestock. Tree-of-Heaven *(Ailanthus altissima)* has been found along margins of woodlands and some roadsides. This species also shades out competing species, expands prodigiously and releases chemicals that negatively impair the growth of other species.

There were no indications of ozone induced chlorosis, or leaf death in any of the tree stands surveyed, this indicates that ozone air pollution is not enough of a problem to impair tree function. Detecting tree damage, particularly at the trunk, was difficult to discern given the sampling period allotted. In some woodland stands, there were instances where the understory was completely filled by shrub species and absent of forbs, and others had good representation across canopy types. Excessive shrub density within a woodland patch will make it unusable for larger species such as deer, but may make it more conducive for smaller prey rodent species that will use it for cover.

Restoration of wooded areas does not mean that an entire area will need to become contiguous in order to regain functionality. Using forest landscape ecology as an operating framework will promote ecological functionality over pursuing forest cover. Focusing on creating and expanding forest cover is not tenable given the agricultural needs of this area. However, identifying areas that will improve connectivity and reduce patch criticality are important for large scale planning. After critical landscape patches have been detected, restoration efforts should be focused on improving forest and woodland quality. This type of restoration plan may yield greater benefits at reduced costs.

Management or restoration of these small isolated woodlands may not be warranted given limited resources. If these areas are to be considered for larger landscape connectivity and open space corridors, caution should be taken to identify the presence of invasive species, and remove them prior to establishing a contiguous corridor. If not, then it may allow some ground creeping vegetation to expand into other patches. The greatest opportunities for woodland habitat connectivity for this region will not be through the outlying properties to the east or west of the FUDA study plan. The best opportunities will be to improve the open space areas through the Village of Deforest. Restoring these areas will provide habitat connectivity south to Cherokee Marsh. This type of woodland restoration yields more benefits for riparian woodlands and their functions. Given the importance of riparian woodlands and their functions, this topic will be discussed more fully in the Open Space Corridors section on page 118.

3. Soils

The geologic history of Dane County is responsible for the productive soils found in the area. Clay and silt loams are found primarily in the glaciated portion of the county while shallower sandy loams are found in the driftless area. Soil type is an important indicator of structural difficulties posed for development. The following characterizes the soils found in the North Yahara FUDA study area:

a. Soils Underlain by Sandy Loam Glacial Till

The soils in this group formed mainly by wind born deposits of silt loam underlain by sandy loam glacial till. Most of these soils have moderate permeability and high available water capacity. ***These soils pose slight to moderate limitations for farming and for urban use.***

Dodge-St. Charles-McHenry Association

This association has a varied landscape that is characterized by ground, end, and recessional moraines. The landscape is mostly gently sloping to sloping. Some areas on benches and in depressions and drainageways can be nearly level, and small areas of moderately steep to steep slopes can also be present. ***Except for small areas in drainageways and steep slopes, this association poses slight limitation for development.***

Plano-Ringwood-Griswold Association

This association consists mainly of gently sloping areas on glacial uplands. Some areas on uplands are nearly level to sloping. There is also a small areas of moderately steep rises or ridges. ***Except for small areas of steep slopes, this association poses slight limitation for development.***

b. Soils Formed in Outwash Material

The soils in this group consist of associations formed mainly in outwash material near streams or adjacent to glacial moraines. These soils are generally loamy and underlain by sand, gravel, or both. These soils have moderate permeability and medium available water capacity. Many of them are good sources of sand and gravel. ***Where these soils are well drained and gently sloping to sloping, they have slight to moderate limitations for most urban uses***.

Batavia-Houghton-Dresden Association

This association has a landscape that consists of outwash plains with depressions and old lake beds. The soil material was deposited by wind and by water from melting glaciers. The texture of the material in which the soils formed is variable, but it is dominantly silt, sand, or gravel. ***Areas with poor drainage (silt and finer soils located in old lake beds) can pose limitation to development from induced flooding.***

Planning Considerations:

- Soils with seasonal high water tables of less than 3 feet and classified as poorly drained can have limited suitability for infrastructure due to potential for groundwater induced flooding.
- Hydric soils are good indicators of existing and former (potentially restorable) wetlands.
- Consider the potential of areas with high infiltration rates for enhanced regional infiltration and groundwater recharge.

c. Hydric Soils

These soil associations contain soils that are "hydric," possessing signature characteristics associated with prolonged periods of wetness or saturation. Hydric soils are good indicators of existing and former (drained) wetlands (see Map 5). Hydric soils with potential for wetland restoration lie along the streams in this area. These include Orion (Or), Otter (Ot), Elburn (Eg), Radford (Ra), Troxel (Tr), and Virgil (Vw) soils. Depth to water table in these areas are generally 0 to 3 feet (see Map 6).

Soils with seasonal high water tables of less than 3 feet and classified as poorly drained can have limited suitability for infrastructure due to their potential for groundwater induced flooding. These areas are well suited for park and open space areas. If these areas are developed, on-site soils investigations are recommended to determine the actual extent of seasonal high groundwater areas and potential increases in groundwater levels as a result of stormwater management practices and increased precipitation. Restrictions are recommended in confirmed problem areas to establish the lowest allowable level of any structure so that it is situated well above the high water table to reduce the potential for groundwater induced flooding. ***These soil conditions may also limit the suitability of some stormwater infiltration practices due to the potential for groundwater pollution.*** More detailed information is provided on page 137.

Hydric Soils

d. Depth to Bedrock

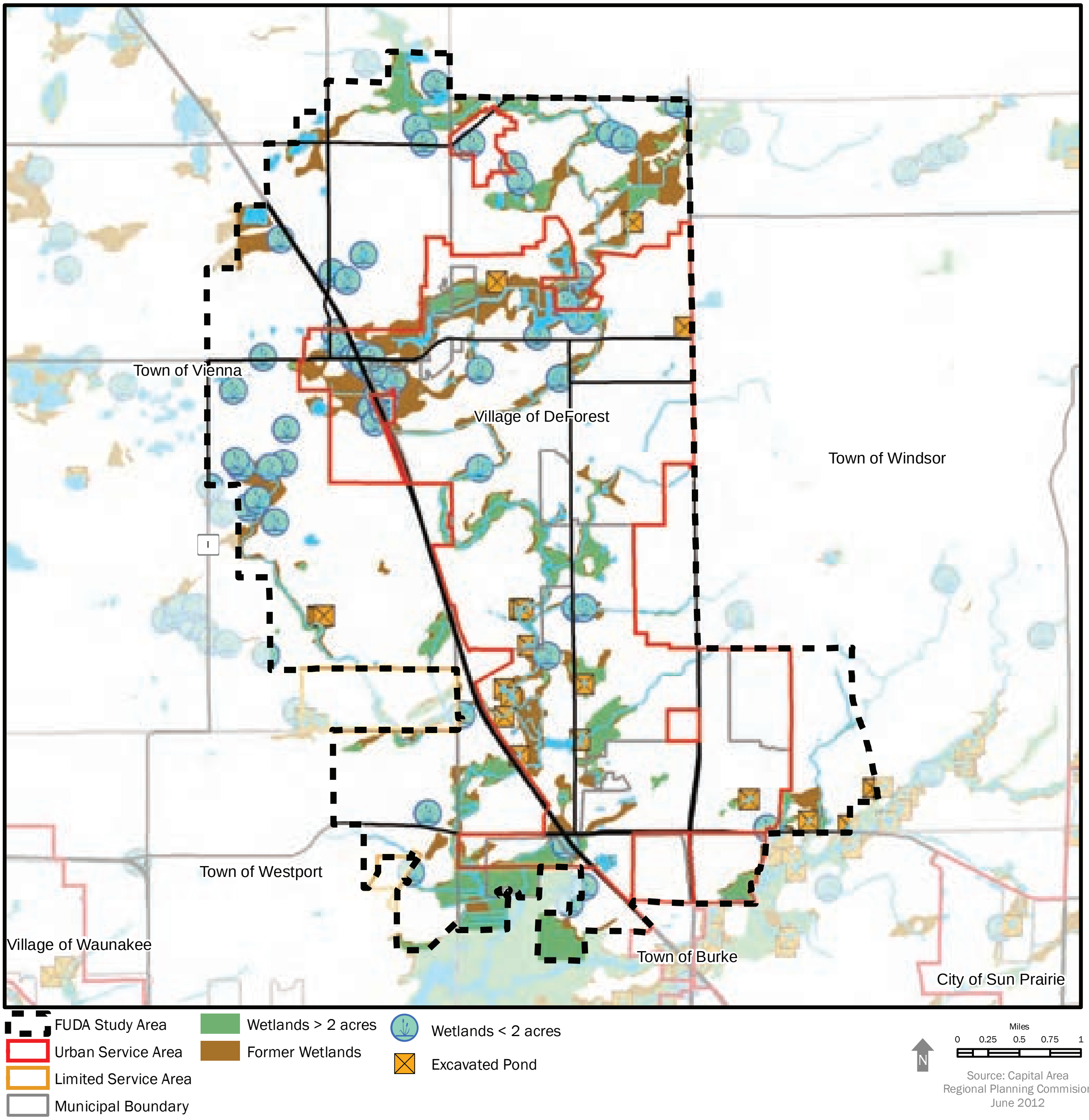
The excavation of bedrock can increase the cost of infrastructure and construction. Bedrock at a depth of 3 feet or less and karst features may also limit the suitability of some stormwater infiltration practices due to the potential for groundwater pollution. Shallow depth to bedrock is less of a concern in the glaciated part of the county. This is because of the significant amount of till left behind by the retreating glacier. This situation is more of an opportunity for development in these areas since the deep soils generally provide considerably greater pollutant removal and easier stormwater management. ***In the North Yahara study area depth to bedrock generally exceeds 5 feet and is more than 50 feet in many areas*** (see Map 7).

Planning Considerations:

- Bedrock excavation can increase the cost of infrastructure and construction.
- Bedrock at a depth of 3 feet or less and karst features may limit the suitability of some stormwater infiltration practices due to the potential for groundwater pollution.

Map 5: Existing and Former Wetlands

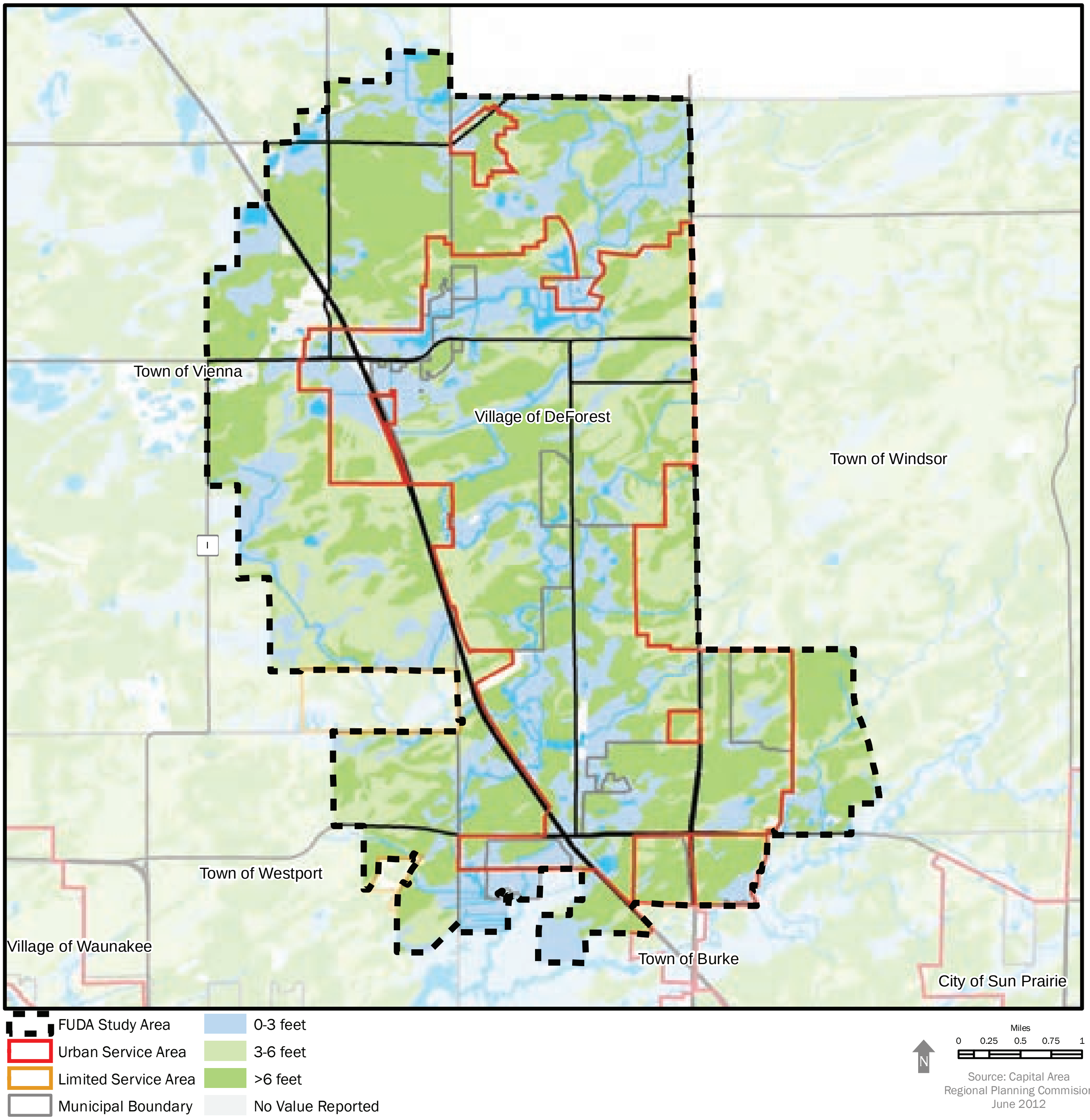
North Yahara Study Area, Dane County, WI



Existing and former wetland soils often present significant constraints to development because of saturated soil conditions with poor bearing capacity. Conversely, these are areas of potential opportunity for restoration and providing additional water quality, flood storage, and wildlife habitat benefits. These areas should be studied in more detail to mitigate potential adverse impacts and promote potential community benefits.

Map 6: Depth to Water Table

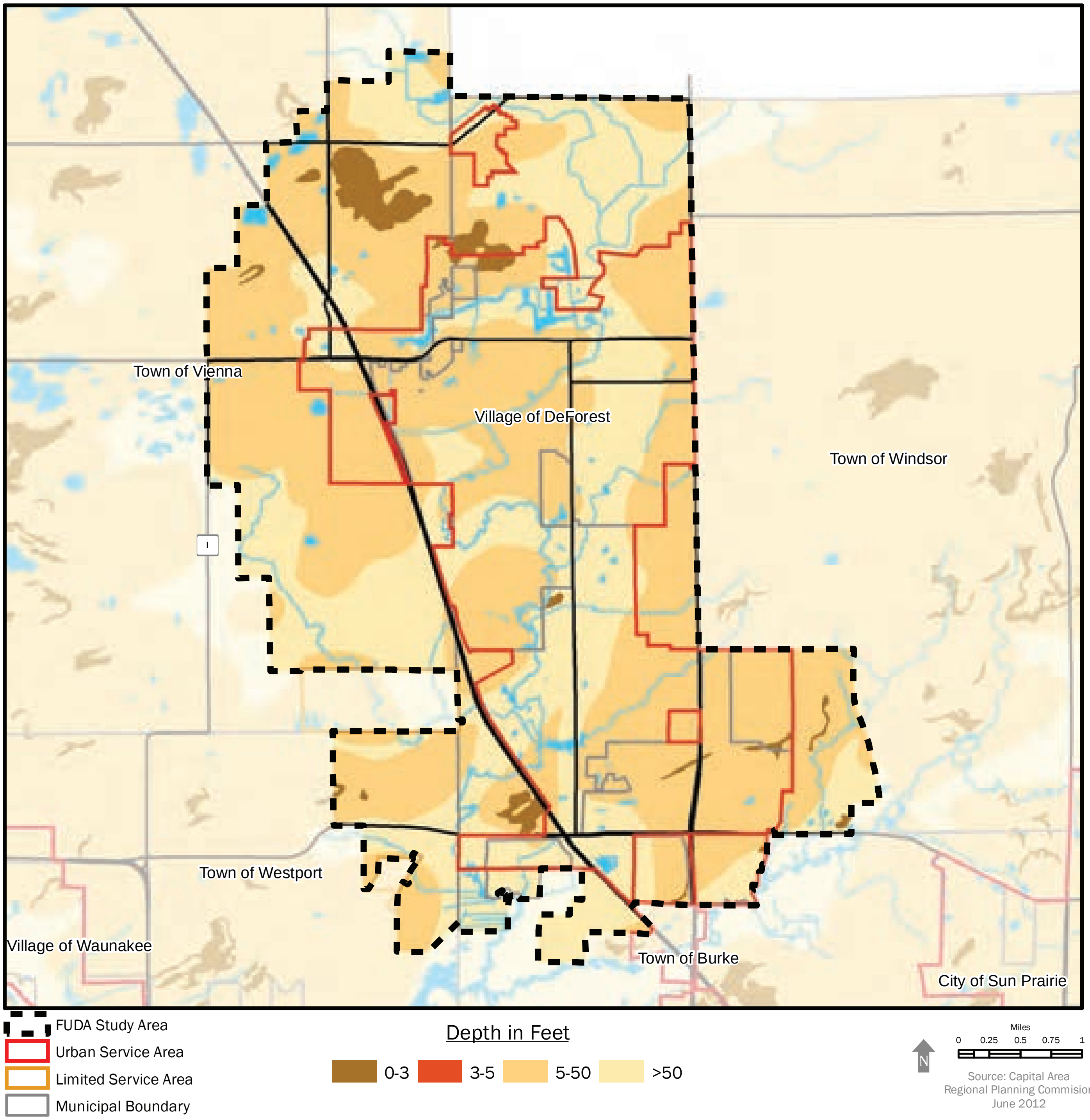
North Yahara Study Area, Dane County, WI



Soils with seasonal high water tables of less than three feet and classified as poorly drained can have limited suitability for roads and buildings due to their potential for groundwater induced flooding.

Map 7: Depth to Bedrock

North Yahara Study Area, Dane County, WI



Shallow depth to bedrock three feet or less and karst features can increase the cost of urban infrastructure and housing construction. It may also limit the suitability of some stormwater practices due to the potential for groundwater contamination. This is less of a concern in the glaciated portions of the county (such as the FUDA area) compared to the "driftless area," and may actually provide greater opportunity for infiltrating precipitation and runoff as a key stormwater management strategy.

e. Development Site Analysis

The USDA Natural Resources Conservation Service (NRCS) Soil Survey for Dane County[40] is a valuable planning tool. Soil borings or other onsite soils investigation are necessary for detailed engineering analysis and site design work. For example, Map 8 shows building site potential for dwelling units with basements based on soil characteristics. Each situation will be different depending on the intended or anticipated land use, existing or potential soil limitations, and any special planning, design, or implementation that may be needed or employed to minimize or overcome the limitations encountered.

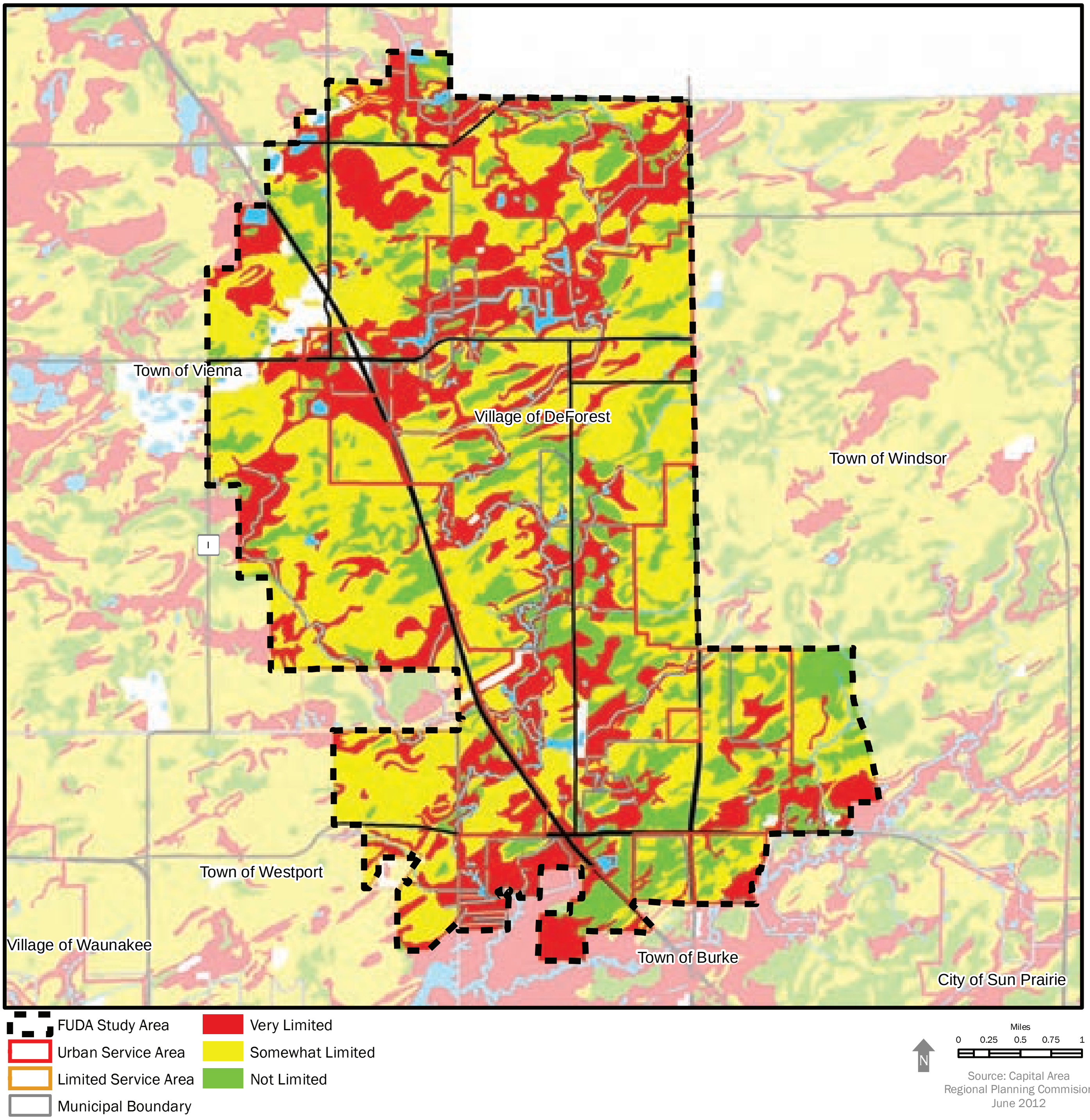
f. Relative Infiltration

CARPC staff, with cooperation from the Dane County Land and Water Resources Department, have conducted an analysis of the stormwater infiltration potential of soils in this area. This analysis used existing topography and soils data to infer infiltration potential based on slope, soil permeability, depth to the water table, and depth to bedrock. ***Infiltration potential in the North Yahara FUDA study area is generally medium, with the potential for enhancement in some areas through the use of engineered soils tapping into deeper sand and gravel deposits. More detailed information on infiltration and groundwater recharge is provided on*** page 137***.***

40 http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Map 8: Building Site Potential for Dwellings with Basements

North Yahara Study Area, Dane County, WI



The ratings for dwellings are based on the soil properties that affect the load-bearing capacity and the ease and amount of excavation needed.

Source: USDA Natural Resource Conservation Service Soil Survey for Dane County.

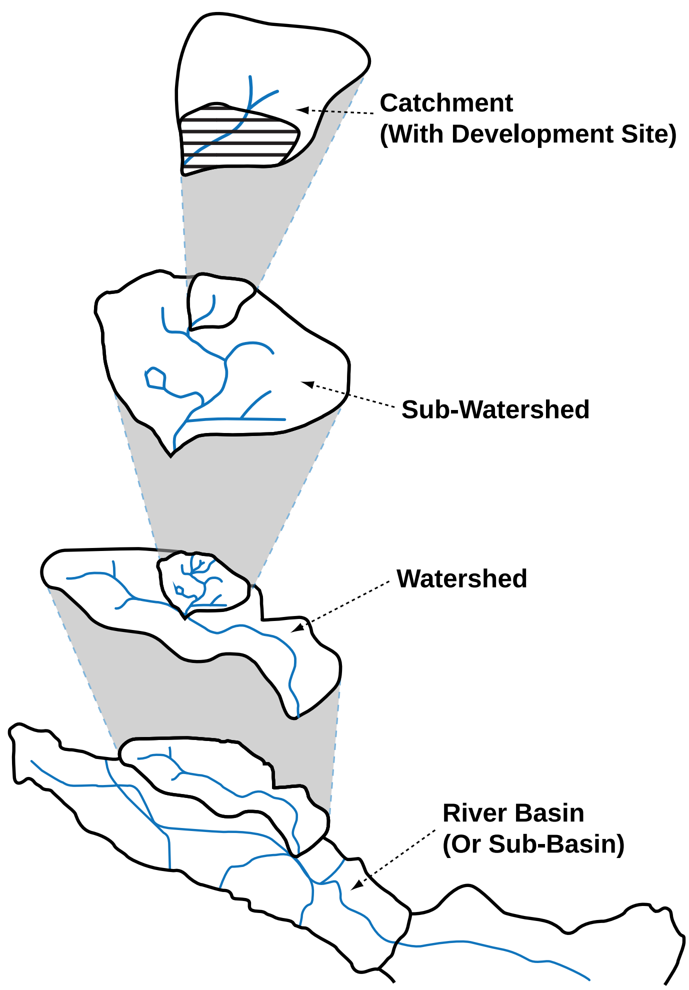
4. Watersheds and Drainage

The basic structural element of natural resources protection is the watershed. A watershed is defined as the land area that drains to a specific body of water (river, lake, or wetland). It has been compared to a topographic bowl, bathtub, or basin separated from neighboring watersheds by ridgelines.

Watersheds are scalable. Like nested Russian dolls they flow into successively larger versions of themselves (see Figure 9). While similar in form and function, for purposes of clarity watersheds are often given more descriptive names depending on the scale being used. For example, a particular ***catchment area*** for a neighborhood in the Village of DeForest or Town of Windsor might drain to the larger Token Creek ***subwatershed,*** which drains to the Yahara River watershed, which drains to the Lower Rock River ***basin,*** which drains to the Mississippi River basin, and ultimately to the Gulf of Mexico.

All organisms, whether aquatic and terrestrial, are dependent on water and are shaped by watershed dynamics. Many conservation and natural resource management plans use the watershed concept as a means of organization. Careful consideration of development plans in the context of the watershed concept is very important, given that local actions have implications downstream far beyond their point of origin. It is said that "we all live downstream". It is therefore critical to consider potential downstream impacts of changes to land cover and land use as part of the planning or conceptualization of such changes.

Figure 9
Watershed Management Units



Source: Clements, et al. 1996

Hydrology and drainage are highly dependent on climate and climate variability. The climate of Dane County is typical of the Great Lakes states. Winters tend to be long, cold and snowy, while summers are short and sometimes humid. Average annual precipitation is about 33 inches, with 67 percent falling from April through September. Average groundwater recharge in Dane County is estimated to be 7.6 in/yr; however, this varies by location (see Map 9). Most recharge occurs in late fall, winter, and early spring when vegetation is dormant and evapotranspiration is minimal. Runoff and evapotranspiration vary widely due to seasonal conditions and land use. August is the wettest month with 4.3 inches of precipitation (1971-2000), and January is the driest with about 1.2 inches. About 84% of the precipitation events are half an inch or less. Snowfall averages 50 inches per year. The ground usually begins to freeze at the end of November and thaws in mid-April. The potential for runoff and severe erosion is often highest in March and early April when heavy rainstorms and snowmelt occur on ground sparsely covered by dead vegetation. Climate change studies and predictions suggest changes in intensity and timing of precipitation have already occurred in our region, and additional changes are expected. The subject of climate variation is covered in more detail in *Technical Appendix D of the Dane County Water Quality Plan*.[41]

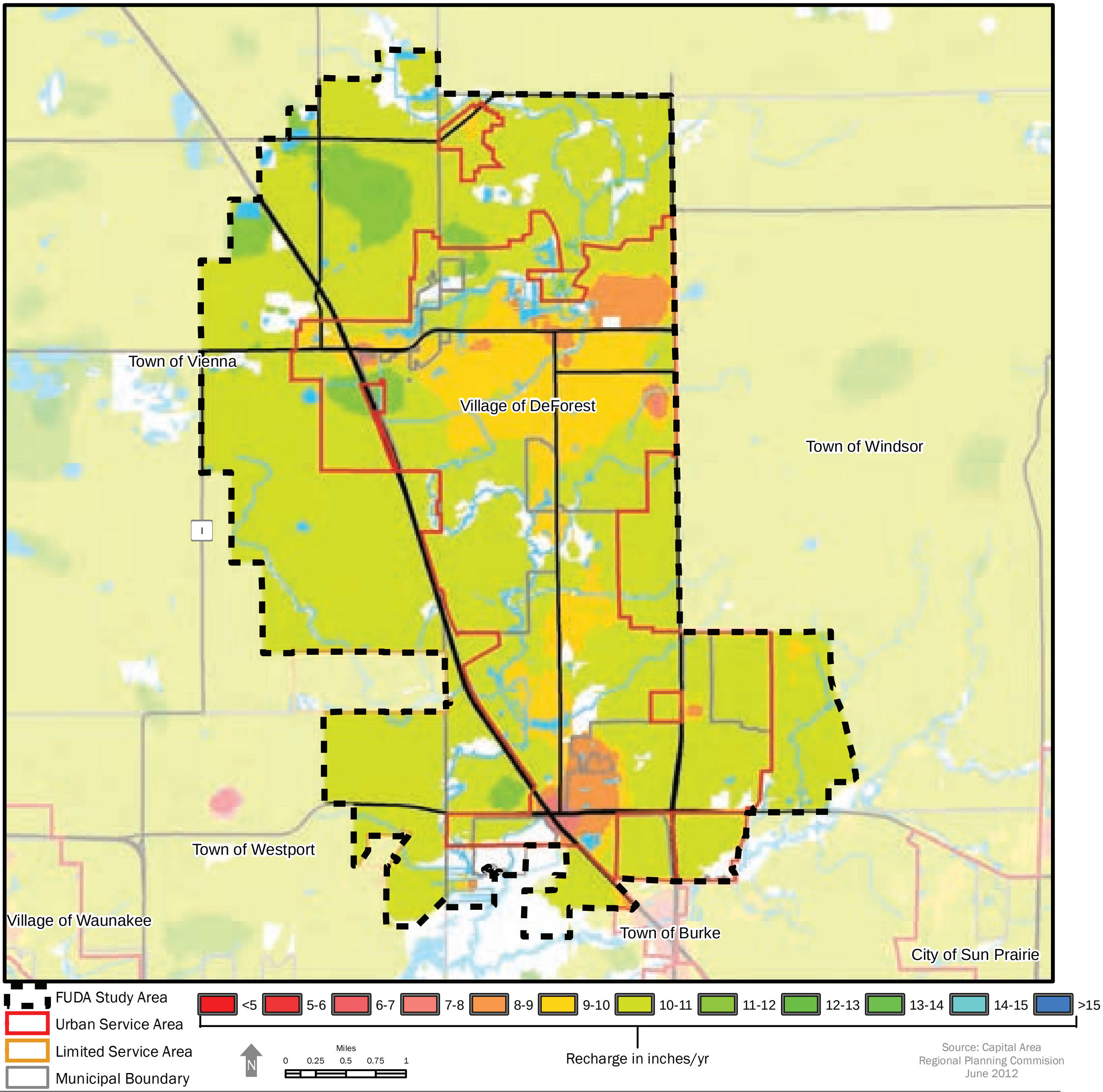
Map 10 shows the streams and watersheds of the region and provides the regional context for the streams and watersheds of the North Yahara study area, shown on Map 11. The principal streams of the study area are the Yahara River and Token Creek. Lake Mendota is the major lake immediately downstream. Large portions of wetlands have been drained for agriculture or filled for development. Cherokee Marsh is the last large wetland complex in the watershed. Smaller wetlands also exist (see Map 12). In spring, numerous ephemeral ponds that are used extensively by migratory waterfowl.

Cherokee Marsh

41 Link___ to Appendix D of the WQP

Map 9: Groundwater Recharge

North Yahara Study Area, Dane County, WI



Precipitation that soaks into the ground and recharges the groundwater, eventually discharges to streams and other water bodies, helping keep water temperatures low and enhancing oxygen supplies. This favors habitat for fish and other sensitive aquatic species. Development without mitigation measures can disrupt the ground/surface water balance resulting in less recharge and more stormwater runoff.

a. Floodplains

A survey of 100-year floodplain boundaries offers insights into the areas most susceptible to flooding (see Map 13). These are areas that have a 1% chance of being inundated in any single given year. Floodplains are designated by the Federal Emergency Management Agency (FEMA) and present significant limitations to development. It is important to note that floodplains are mapped using historic data. Floodplain boundaries can change over time with changes in precipitation and land use. A problem with high water levels has repeatedly occurred in the Yahara Lakes over the last several decades. While measures have been taken in recent years to control the timing and volume of stormwater runoff from new urban development in the watershed, the impacts associated with historic land cover changes from their natural pre-settlement state to agricultural and urban land uses will need to be addressed to ameliorate high water levels in the Yahara system.

Planning Considerations:

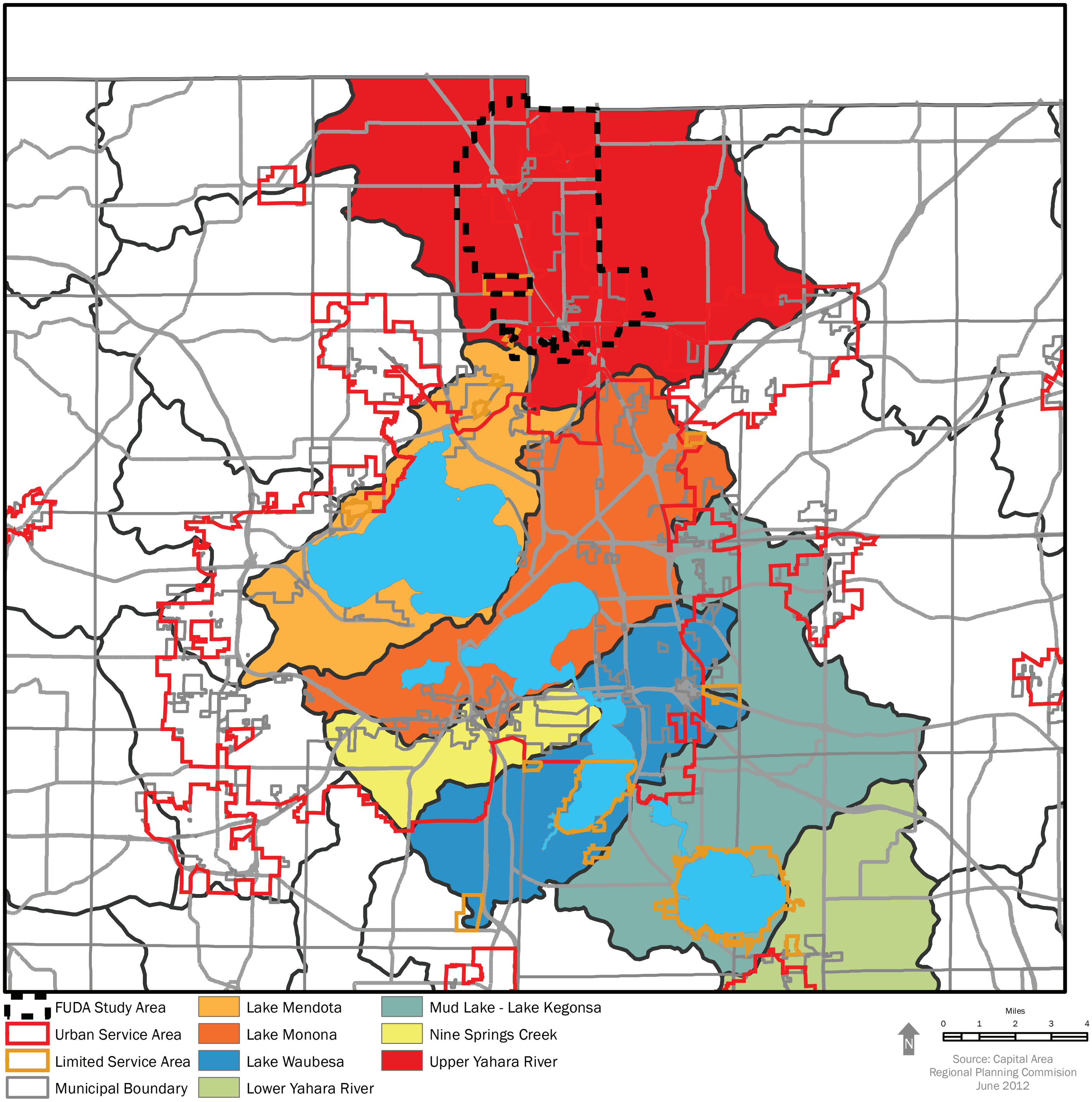
- Keep infrastructure that can be damaged by flooding out of the 100-yr floodplain.
- Include an additional buffer area around floodplains to account for changes in floodplain boundaries over time.

b. Internally Drained Areas

There are several small ponds, ephemeral ponds, and wetlands in the watershed found in the Town of Vienna. Most of these areas are cash cropped, with a few dairy farms mixed in. Some of the areas that are currently being farmed were once wetlands. Today these areas provide resting and feeding spots for migratory waterfowl and shorebirds, particularly during spring and fall migration. During wet years these areas are unable to go into agricultural production and, consequently, waterfowl use the areas for brood rearing. During dry periods these wet areas tend to dry up and some are put back into farm production. From a water quality standpoint these areas do not contribute significantly to the degradation of adjacent surface waters. Wildlife would benefit from wetland restoration. However, if portions of the internally drained areas were converted back into functioning wetlands they could be impacted by nutrient and sediment loading. Being internally drained, they would also be flooded more frequently if these areas were developed and stormwater not properly managed.

Map 10: Subregional Watersheds

North Yahara Study Area, Dane County, WI

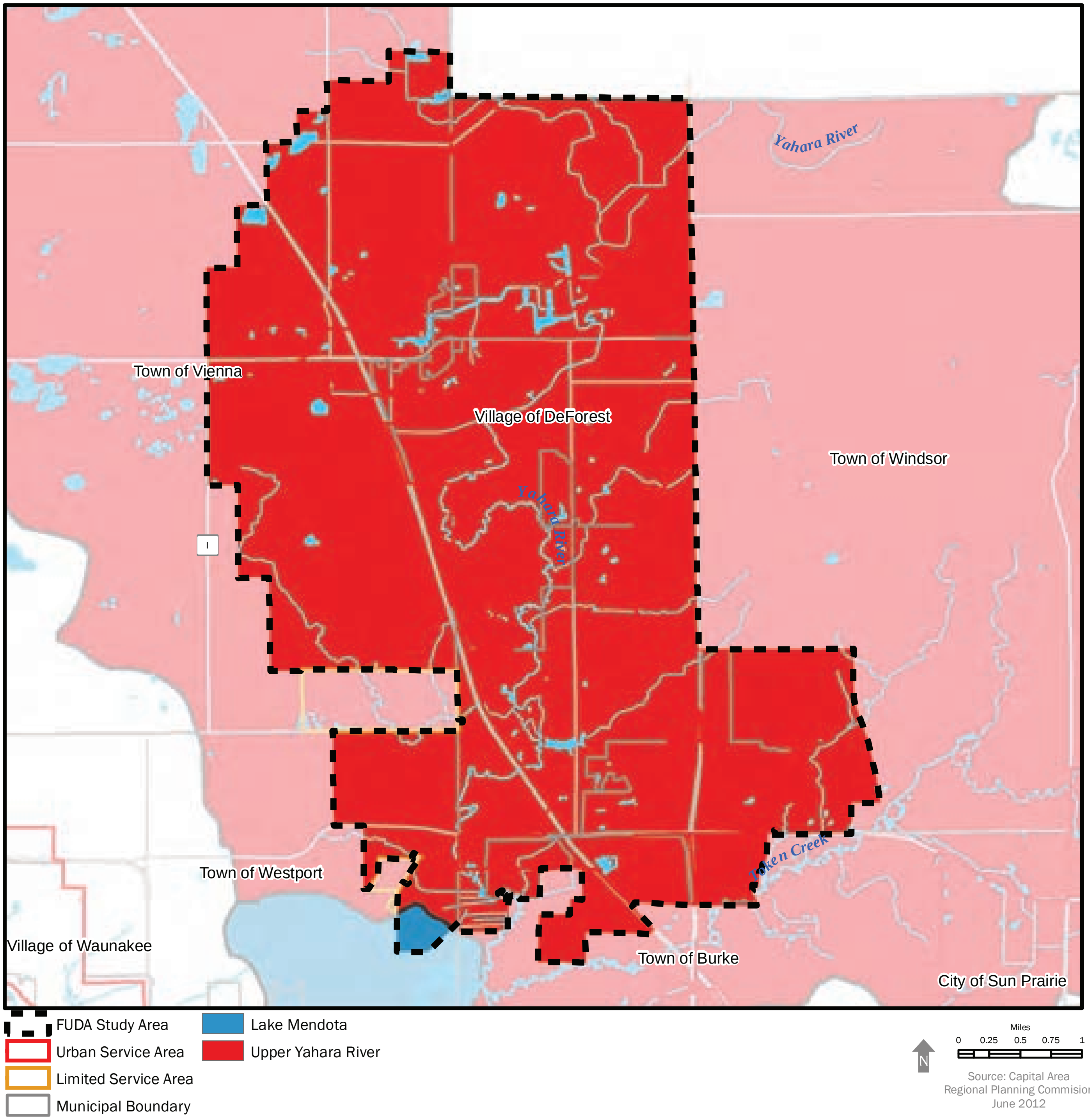


Source: Capital Area Regional Planning Commision June 2012

Our water resources are the lifeblood of the region and watersheds, representing the land draining to a particular water body, are the basic structural elements of water resource protection. The health of a particular water body is primarily dependent on the types and land use and practices within its watershed. Note that watersheds are scalable and are defined by the area of scope or interest.

Map 11: Streams and Watersheds

North Yahara Study Area, Dane County, WI

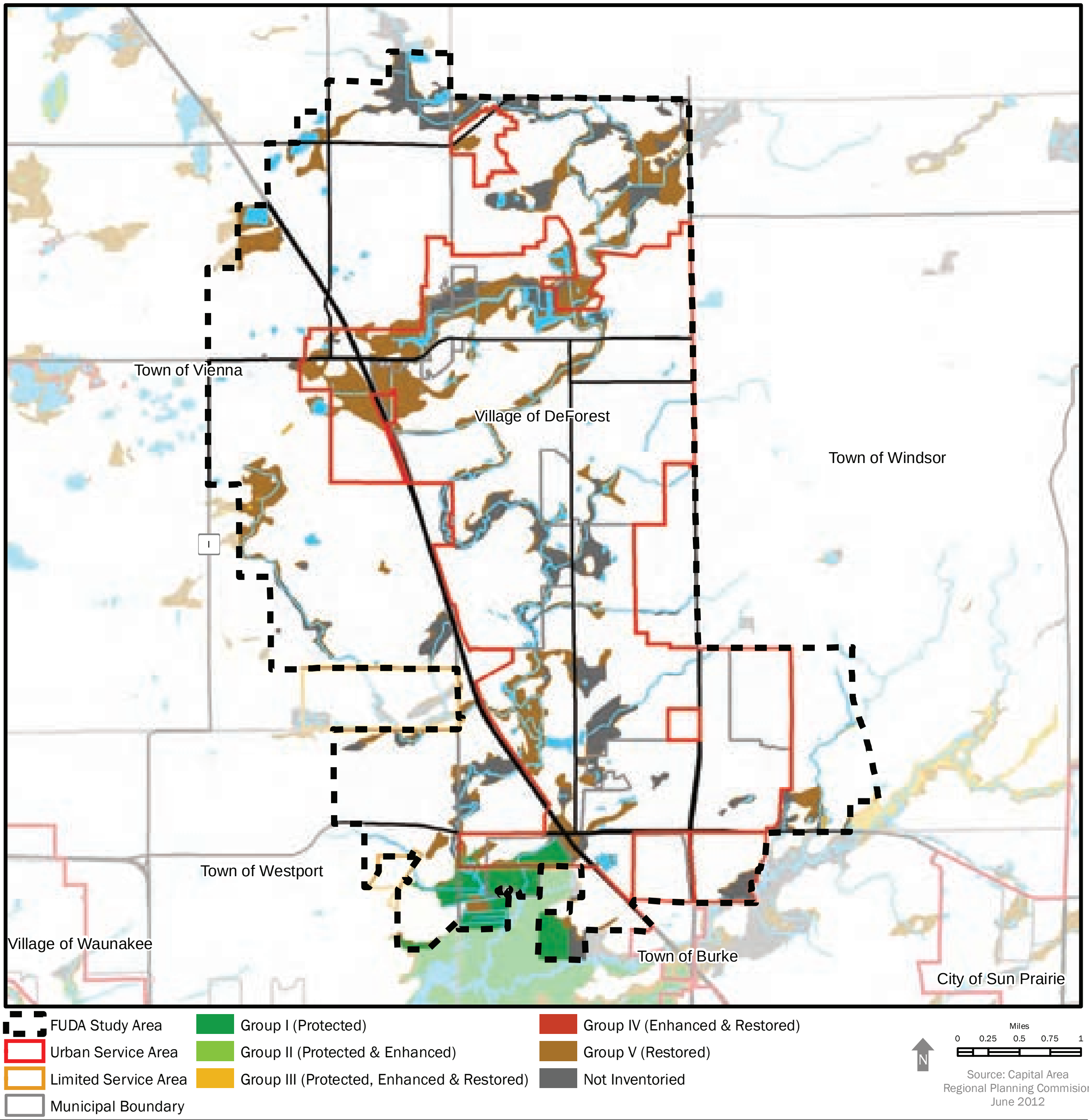


Source: Capital Area Regional Planning Commision June 2012

Our water resources are the lifeblood of the region and watersheds, representing the land draining to a particular water body, are the basic structural elements of water resource protection. The health of a particular water body is primarily dependent on the types and land use and practices within its watershed. Note that watersheds are scalable and are defined by the area of scope or interest.

Map 12: Wetland Groups

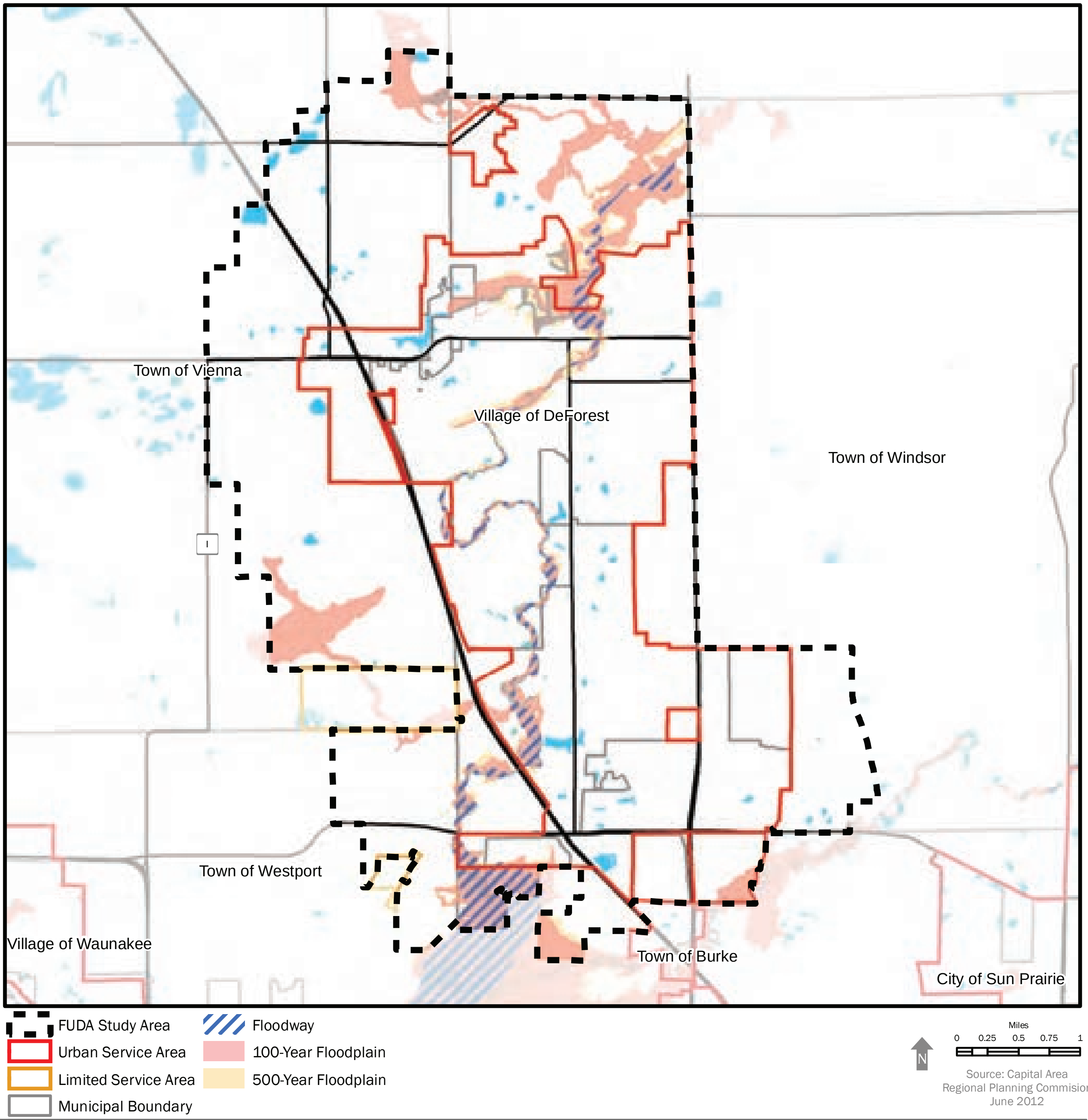
North Yahara Study Area, Dane County, WI



Wetlands are grouped based on their present or potential biological condition, scientific value, public use, extent of degradation, and immediate or long-range threats. While all wetlands have value, decisions must sometimes be made as to where specific approaches and efforts are best tailored or targeted.

Map 13: Floodplains

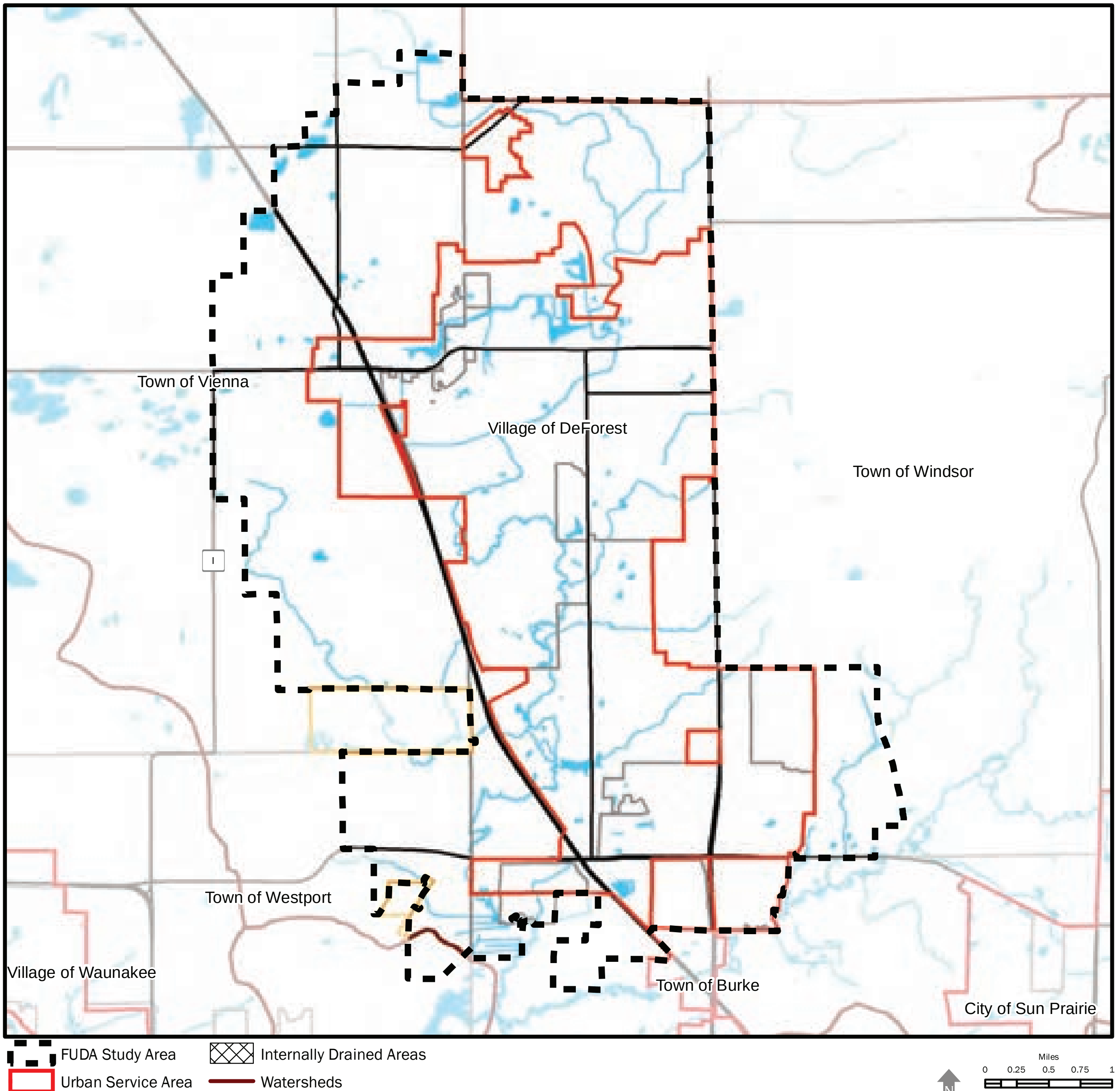
North Yahara Study Area, Dane County, WI



Floodplains present significant limitations to development. Development should be avoided in floodplain areas. These areas represent current conditions. Increased development in the watershed along with accompanying increases in volumes of stormwater runoff can expand the areal extent of the delineated areas.

Map 14: Internally Drained Areas

North Yahara Study Area, Dane County, WI



Source: Capital Area Regional Planning Commision June 2012

The unique hydrologic characteristics of internally drained areas make them especially vulnerable to the effects of urbanization. As urbanization increases, rainfall events generate significant runoff, which does not allow the pothole to dry out. The ponds tend to become dominated by open water, and the potential for extended flooding of nearby development increases.

The unique hydrologic characteristics of closed basins make them especially vulnerable to urbanization. When the watershed of closed basins are predominantly undeveloped (either pre-settlement or agricultural), closed basins are typically wetter in the spring and dry out during the fall during years of normal precipitation. As urbanization increases, summer rainfall events generate significant runoff, which does not allow the pothole to dry out in the summer. The ponds tend to become dominated by open water, and the potential for extended flooding of nearby development increases. In the region, the City of Middleton has first-hand experience with these consequences of urbanization in prairie pothole watersheds as evidenced by Stricker, Tiedeman, and Esser Ponds.

All three of these ponds have required engineered outlets to lower water levels because of flooding problems caused by urbanization. ***In closed basins, pre-development runoff volumes need to be maintained, and emergency overflow measures included to prevent flooding in case volume control measures fail or are off-line for maintenance.***

Issue:

Runoff Volume

What has been done:

- Volume control in urban areas since 2004
- Special volume and overflow requirements in closed basins in new USA amendment areas

What else can be done:

- More resources for agricultural BMP implementation
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.

Stricker Pond

c. Stream Classifications and Biological Indicators

Water quality standards are the foundation of Wisconsin's water quality management program. They serve to define the goals for a water body by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants. The WDNR is authorized to establish water quality standards that are consistent with the Federal Clean Water Act (Public Law 92-500) through Chapter 281 of the Wisconsin Statutes. These water quality standards are explained in detail in Chapters NR 102, NR 103, NR 104, NR 105, and NR 207 of the Wisconsin Administrative Code. These water quality standards rely on three elements to collectively meet the goal of protecting and enhancing the state's surface waters. They include:

- ***Designated Uses,*** which define the goals for a water body,
- ***Water Quality Criteria,*** which are set to protect the water body's designated uses, and
- ***Anti-Degradation Provisions,*** to protect water quality from declining.

Designated Uses

Designated uses are goals or intended uses for surface water bodies in Wisconsin which are classified into the following categories[42] (also see Table 5).

Recreational Use

All surface waters are considered appropriate for recreational use unless a sanitary survey has been completed to show that humans are unlikely to participate in activities requiring full body immersion.

Public Health and Welfare

All surface waters are considered appropriate to protect for incidental contact and ingestion by humans.

Wildlife

All surface waters are considered appropriate for the protection of wildlife that relies directly on the water to exist or rely on it to provide food for existence.

Fish and Aquatic Life

All surface waters are considered appropriate for the protection of fish and other aquatic life. Surface waters vary naturally with respect to factors like temperature, flow, habitat, and water chemistry. This variation allows different types of fish and aquatic life communities to be supported. Wisconsin currently recognizes the following Fish and Aquatic Life subcategories based on the water body's capacity to support a diverse and healthy fish community.

42 See State Administrative Code Chapter NR102 for full description.

The Fish and Aquatic Life Use Designation of a water body is legally recognized in Wisconsin Administrative Code. This designation is used to determine water quality criteria and effluent limits. A stream can obtain a codified designated use by applying formal stream classification procedures.[43] The current codified uses for individual Dane County Streams may be found by visiting WDNR Water Basin website and viewing the desired watershed and water body details.[44]

Assignment of designated uses for the protection of fish and aquatic life has been an iterative process dating back to the late 1960s. While the WDNR strives to maintain a contemporary list of designated uses, it cannot visit each stream, river, or lake very often. In fact, many of the designated uses that are included in the Wisconsin Administrative Code date back to the 1980s.

Current and Attainable Uses

Determining Fish and Aquatic Life subcategory is one of the first steps in managing water quality. In order to facilitate the determination of a designated use to reflect the most current understanding of stream/river ecology, the WDNR published updated guidance in 2004.[45] The informal guidance is used by biologists who monitor Wisconsin's stream and river communities. It provides a framework for the collection and assessment of field data to recommend which Fish and Aquatic Life subcategory a particular water or segment best fits.

- ***The "Current Use" is the fish and aquatic life community the WDNR biologists believe the water currently supports. This is not a formal designation; it is based on the current condition of the water.*** Current Fish and Aquatic Life Use determinations for Dane County streams are shown on Map 15, and the determinations for the FUDA study area streams are shown in more detail on Map 16.
- ***The "Attainable Use" is the use the WDNR biologists believe the stream could attain if "controllable" sources of impairment are managed.*** These actions include effluent requirements for point sources, and cost-effective and reasonable best management practices for nonpoint source pollution control. ***Beaver dams, low gradient streams, naturally occurring low flows, and land cover and land use are generally considered "uncontrollable" natural or cultural factors.*** The Attainable Use may be the same as the Current Use or it may be higher.

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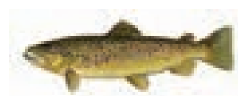
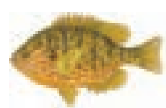
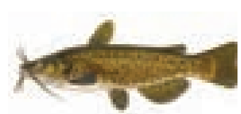
43 Classifications for water bodies are derived from the following factors:
- Streams classified and listed in NR 102 and NR 104 (*Note: all waters not officially codified in NR 102 or NR 104 are codified as Warm Water Sport Fish Community, which is the default classification and listed as "DEF").*
- Streams formally classified during the WPDES permitting process. These streams are surveyed and classified to provide the basis for the permit's effluent discharge limitations.
- Trout streams identified by reference in WDNR publication *Wisconsin Trout Streams*.
- ORW and ERW streams officially approved as such by the WDNR board and listed in NR 102.10 and NR 102.11. Officially, ORW/ERW water bodies are not fish and aquatic life use designations but are a separate category for the WDNR anti-degradation program. These water bodies receive a fish and aquatic life use classification for the purpose of determining water quality criteria and/or effluent discharge limitations.

44 http://dnr.wi.gov/water/basin/

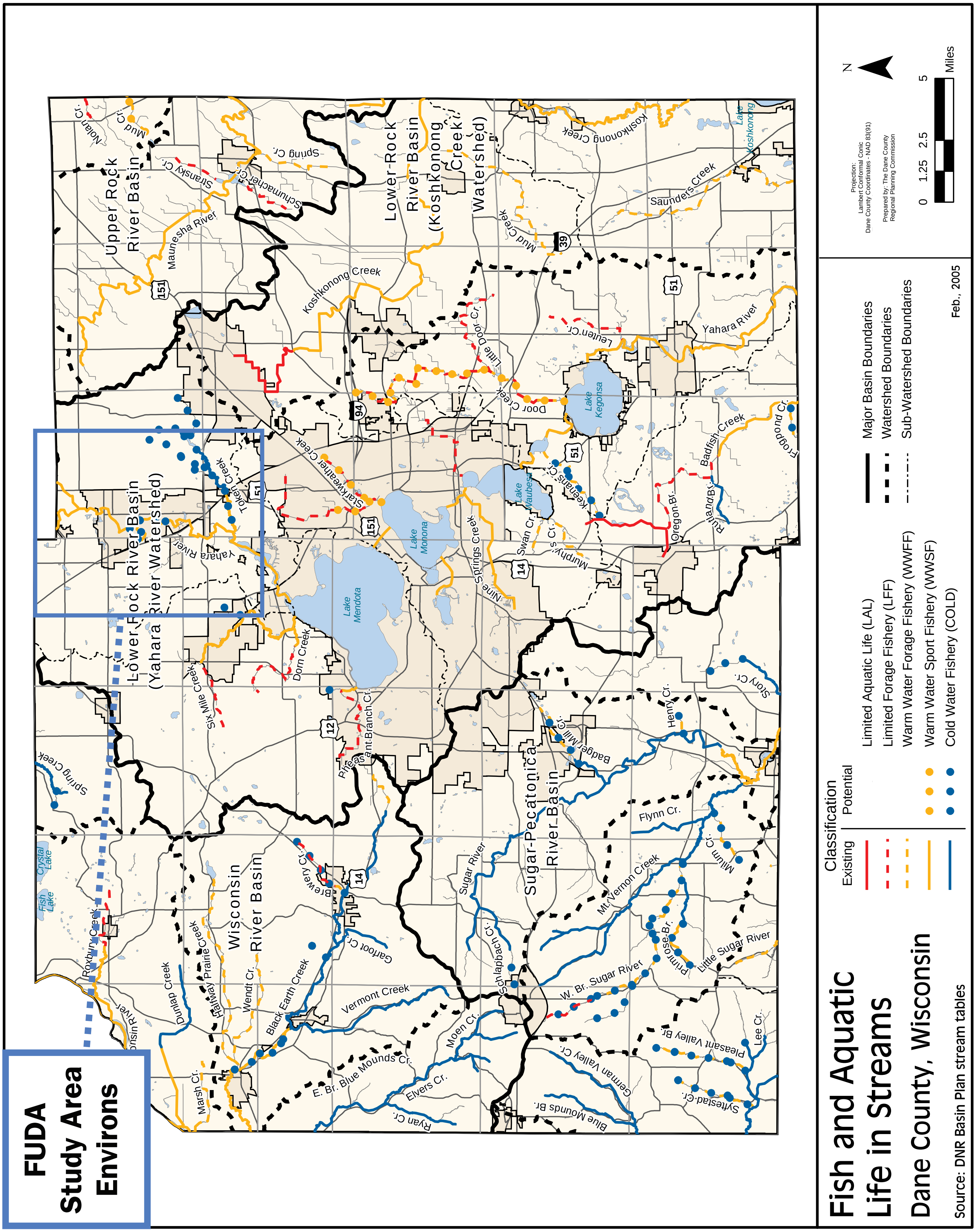
45 Guidelines for Designating Fish and Aquatic Life Uses for Wisconsin Surface Waters" (WDNR PUBL- WT-807-04).

Current and Attainable Uses are not formal designations. They are based on the current condition of the water or the condition that could be achieved through management plans or activities. ***They are not designed for, nor should they be used for, regulatory purposes.*** Note that the Current and Attainable Use determinations may actually be different than the codified Fish and Aquatic Life Use designations for some streams. This is because the Current/Attainable Use determinations are used for more informal fisheries management purposes, activities, and guidance; whereas the Codified Use designations are used for more formal or regulatory pollution control and permitting activities where there may be more significant legal and financial considerations.

Table 5
WDNR Fish and Other Aquatic Life Uses

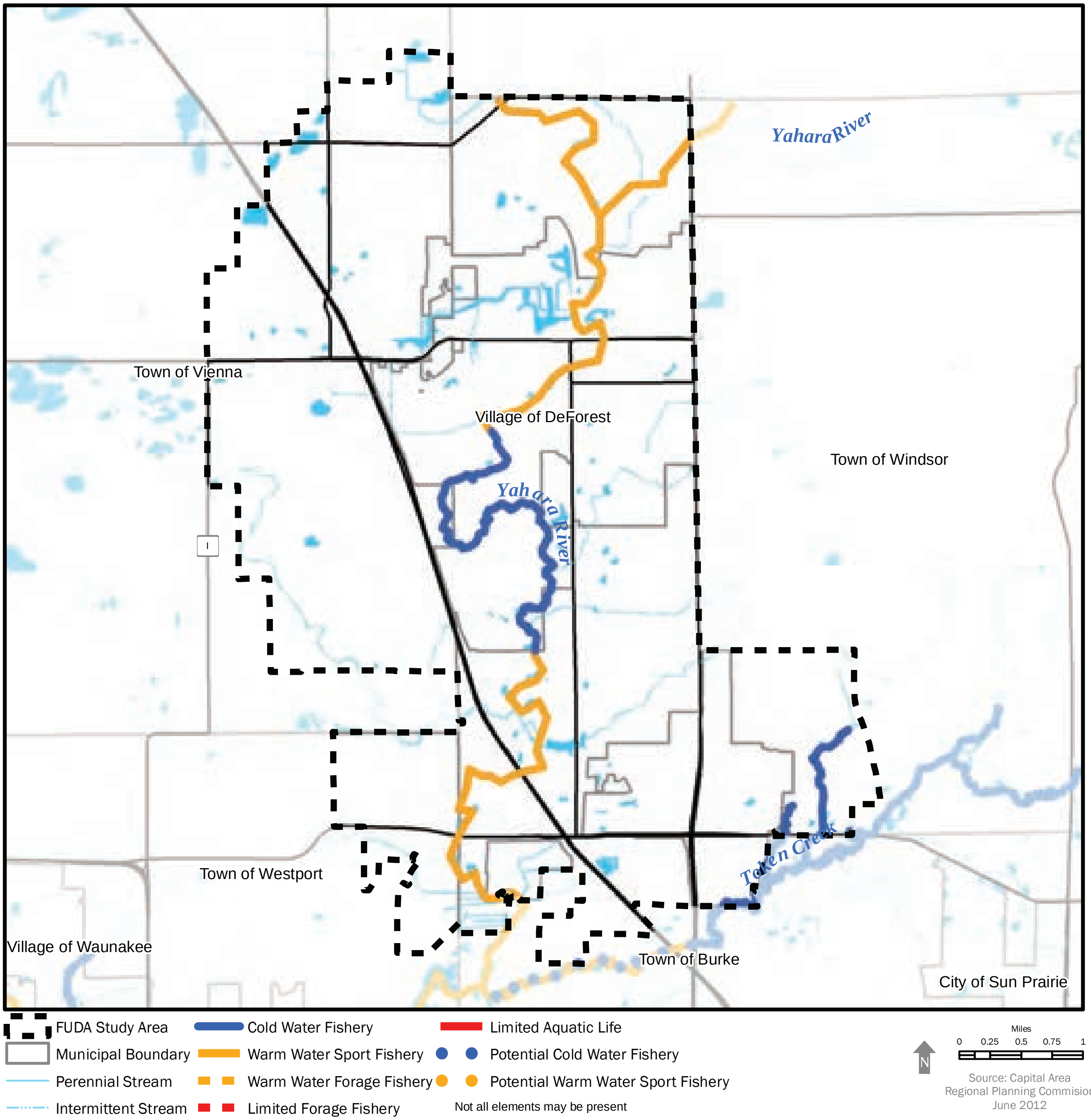
The Department has classified all surface waters into one of the fish and other aquatic life subcategories described below. Only those use subcategories identified in pars. (a) to (c) shall be considered suitable for the protection and propagation of a balanced fish and other aquatic life community as provided in federal water pollution control act amendments of 1972.	
(a) Cold Water Communities. This subcategory includes surface waters capable of supporting a community of cold water fish and other aquatic life, or serving as spawning area for cold water fish species.	
(b) Warm Water Sport Fish Communities. This subcategory includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning are for warm water sport fish.	
(c) Warm Water Forage Fish Communities. This subcategory includes surface waters capable of supporting an abundant diverse community of forage fish and other aquatic life.	
(d) Limited Forage Fish Communities. (Intermediate surface waters). This subcategory includes surface waters of limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of forage fish and other aquatic life.	
(e) Limited Aquatic Life. (Marginal surface waters). This subcategory includes surface waters of severely limited capacity and naturally poor water quality or habitat. These surface waters are capable of supporting only a limited community of aquatic life.	

Map 15: FUDA Study Area Environs - Fish and Aquatic Life in Streams



Map 16: DNR Fish and Aquatic Life Designations for Streams

North Yahara Study Area, Dane County, WI



Fish and Aquatic Life categories are based on the condition of the resource and the biological use the DNR believes the stream or stream segment could achieve through proper management of controllable pollution sources. Low gradient streams and naturally occurring low flows can not generally be controlled.

One indicator of stream water quality condition is the type of insects found living on rocks and other stream bottom materials. Certain species of insects will tolerate only undisturbed conditions with limited organic material, while others are able to survive in various types of habitat and water quality conditions. The Hilsenhoff Biotic Index or HBI indicates the degree of organic enrichment in a stream by the types of insects living there. Tolerance values are assigned to various species of insects and an overall score is calculated for the water body. The Index of Biotic Integrity (IBI) is another widely applied and effective tool using fish community data to assess the environmental quality of aquatic habitats (see Table 6).

Table 6
Biological Indicators

Water Quality Scale		
Hilsenhoff Biotic Index	**Water Quality Scale**	**Degree of Organic Pollution**
0.00 - 3.50	Excellent	Organic Pollution Unlikely
3.51 - 4.50	Very Good	Possible Slight Organic Pollution
4.51 - 5.50	Good	Some Organic Pollution Probable
5.51 - 6.50	Fair	Fairly Substantial Pollution Likely
6.51 - 7.50	Fairly Poor	Substantial Pollution Likely
7.51 - 8.50	Poor	Very Substantial Pollution Likely
8.51 - 10.00	Very Poor	Severe Organic Pollution Likely

Interpretation of IBI Scores		
Index of Biotic Integrity (IBI) Score	**Integrity Rating**	**Interpretation and Fish Community Attributes**
100 - 90	Excellent	Comparable to the best situations with the least human disturbance.
80 - 60	Good	Evidence for some environmental degradation and reduction in biotic integrity.
50 - 30	Fair	The stream reach has experienced moderate environmental degredation, and biotic integrity has been significantly reduced.
20 - 10	Poor	Major environmental degredation has occurred, and biotic integrity has been severely reduced.
0 or no score	Very Poor	Human disturbance and environmental degredation have decimated the natural fish assemblage.

B. Surface Water Features

Agricultural practices and historic urban development have either threatened or degraded receiving waters. Uncontrolled rainfall runoff from impervious surfaces in old urban areas can disrupt the natural hydrology of receiving surface water systems. Without infiltration and other stormwater management measures, as natural areas are converted to agriculture or urban development the ground/surface water balance shifts from a groundwater-dominated system to one dominated more and more by surface water runoff. This results in reductions in stream quality and transitions to more tolerant biological communities.

Since these impacts can be gradual and cumulative, it is important to minimize them in all cases where possible. One strategy promoted by the RPC for new development in the region since the mid-90s is to employ stormwater control measures and practices that maintain or otherwise mimic pre-development hydrologic conditions (i.e., the pre-development ground/surface water balance). For example, in addition to maintaining groundwater resources, stormwater management controls and practices that maintain pre-development infiltration and groundwater recharge also help reduce peak flow rates and volumes of stormwater runoff; resulting in less stream bank erosion, cutting and widening of channels and stream beds, and less pollutants being transported to our surface waters. The Village of DeForest has adopted a stormwater ordinance that requires such practices for new development. The Town of Windsor also requires such practices for some areas in its service are. ***Suitable buffers are also needed to protect our waters from surrounding land uses; in addition to providing necessary food, cover, and movement corridors for wildlife. More effort is needed to avoid impacts to these sensitive resources and instead direct future development to more suitable areas through thoughtful planning.*** Stormwater management strategies that maintain or restore pre-development hydrological conditions are particularly critical early on and throughout the development process. These strategies are described in detail in *Technical Appendix D* of the *Dane County Water Quality Plan.*[46]

46 Appendix D of the WQP: http://danedocs.countyofdane.com/webdocs/PDF/capd/2011_postings/WQP/WQP_Appn_D_Urban_Nonpoint_Source_Analysis_2011_web.pdf

1. Lake Mendota and Its Tributaries

The Yahara chain of lakes is the most prominent surface water feature that would be impacted from activities in the study area. Lake Mendota is the largest lake in the system. It is a large glacial lake with a surface area of 9,842 acres, a maximum depth of 82 feet, and an average depth of 42 feet. It is the largest and deepest lake of the four lakes in the "Yahara Chain of Lakes." The other lakes are Lakes Monona, Waubesa, and Kegonsa. The 232 mi^2 Lake Mendota watershed is largely rural. Approximately 20% of the watershed land area is urban or experiencing rapid urbanization (see Table 7). Approximately 12% is open water or wetland.

Issue:

Excess Nutrients

What has been done since late 1990s:

- Agricultural Best Management Practices (BMPs)
- Urban BMPs

What else can be done:

- Increase resources for agricultural BMP implementation.
- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.
- Investigate opportunities for capturing phosphorus and exporting it from the watershed.

Chain of Lakes

Table 7
Land Use in the Lake Mendota Watershed (2000)

	Dane Co. Acres	Columbia Co. Acres	Total Acres	Percent
Cropland	66,105	14,190	80,295	54
Grassland/Wildlife/Pasture	13,960	1,420	15,383	10
Woodland	1,800	198	1,998	1
Wetland	5,915	412	6,327	4
Open Water	11,108	60	11,168	8
Developed	29,304	117	29,421	20
Internally Drained	2,806	1,353	4,159	3
	130,998	17,753	148,751	100

Source: Lake Mendota Priority Watershed Plan. 2000

In 1847 a dam built on the Yahara River on the isthmus caused water levels of Lake Mendota to rise by about 5 feet, flooding its shoreline and submerging a large wetland complex at its headwaters (Cherokee Marsh). Tenney Park Locks further increased lake levels in 1912, creating the modern base lake water level. The fishery of Lake Mendota is excellent and diverse, containing both warm and coldwater species, rough fish, sport fish and forage fish; with the last accounts showing over 50 species present, including walleye, perch, panfish, bass, northern pike and hybrid musky. Cisco, a coldwater species, is also found in the lake. The lake serves as a major recreational resource for the Madison Metropolitan Area, providing residents and visitors with outstanding opportunities for fishing, swimming, boating, and other outdoor recreational activities.

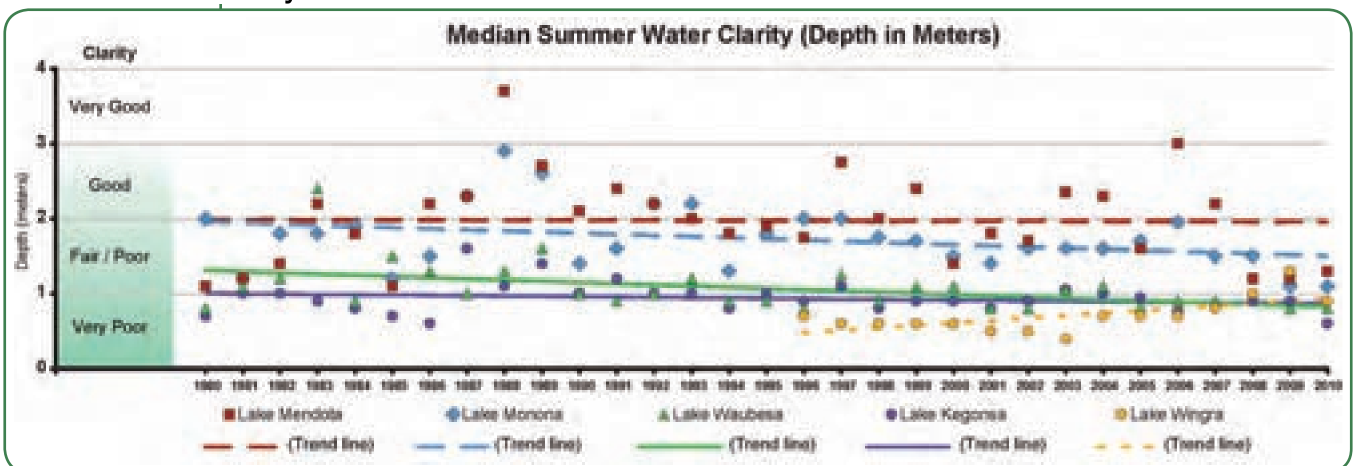
One of the principal water quality conditions of concern for Lake Mendota, however, is excessive blue-green algae (cyanobacteria) concentrations limit water clarity and negatively impacts recreational use. The primary pollutant supporting algal growth in Lake Mendota is the nutrient phosphorus. Like the other lakes in the Yahara chain, Lake Mendota is classified as being eutrophic or possessing relatively high fertility, characterized by having an overabundance of nuisance aquatic plant species. Lake Mendota is also impacted by the aquatic invasive species Eurasian water milfoil, which has a history of becoming dominant in eutrophic, nutrient-rich lakes.

The vast majority of the phosphorus entering Lake Mendota comes from the surrounding land area and is carried to the lake by tributary streams. The land use practices in the lake's tributary drainage area greatly influence the amount of phosphorus washed into the lake. Another source of phosphorus in Lake Mendota is from its high capacity for internal recycling of phosphorus buried in lake sediments. ***Phosphorus is often delivered to the lake attached to sediments. Increased sediment load is detrimental to lake ecology by reducing light penetration, inhibiting photosynthesis and impairing vegetation, and destroying fish and wildlife habitat.*** Tributaries draining primarily agricultural areas include Pheasant Branch Creek, Dorn Creek, Sixmile Creek, Yahara River and Token Creek. Drainage from considerably smaller urban tributaries include the Spring Harbor and Willow Creek storm sewers.

Records of algae blooms date back to at least 1882. Despite conventional understanding, nutrient levels and water quality conditions in the Yahara Lakes have improved since municipal and industrial wastewater was being discharged directly to them stopped. This was the result of diverting municipal wastewater around the Yahara Lakes to Badfish Creek – effectively bypassing the lakes by 1971. Efforts are now being directed towards reducing "nonpoint" or diffuse sources of nutrients washing off the land surface and into our surface waters. Various regulatory and voluntary measures have been, and are currently being pursued to improve the water quality of stormwater runoff from both agricultural and urban sources.

Low phosphorus concentrations in the lakes are correlated with years of low precipitation and runoff. In general, low flows to the lakes result in lower phosphorus concentrations, which are followed by low chlorophyll, which leads to improvement in water clarity. Lake Mendota has even dropped into the mesotrophic (moderately fertile) category such as in the drought year of 1988. ***This indicates that water quality improvement can be realized through nonpoint source phosphorus reductions and controls.***

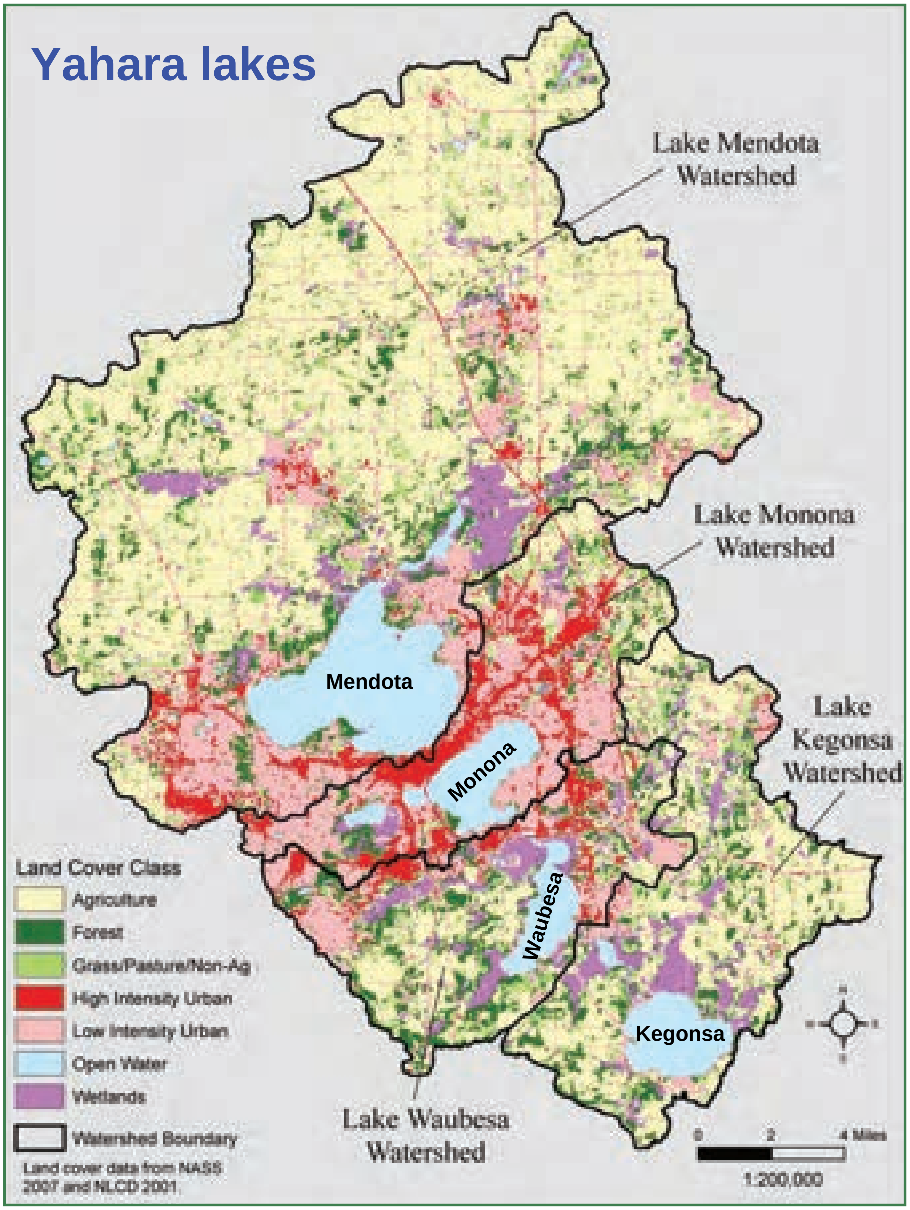
Figure 10
Summer Water Clarity in the Yahara Lakes



While highly variable, water clarity data since 1979 has shown no improvement in Lake Mendota (see Figure 10). Water clarity has declined in downstream lakes. Lake Wingra has improved, likely the result of carp removal in 2008. High population growth and regional development projections will require continued effort to maintain water clarity gains. Innovative approaches will be needed for protecting and sustaining this vital resource.

In 1993, the Yahara River-Lake Mendota watershed and the Pheasant Branch and Six Mile Creek watersheds were selected as a WDNR Nonpoint Source Pollution Abatement "Priority Watershed Project" (NR 120). The goal of the Lake Mendota Priority Watershed Project was to reduce phosphorus and sediment loading to Lake Mendota, the largest and furthest upstream of the Yahara chain of lakes. Approximately 77% of the watershed is agricultural or otherwise undeveloped.

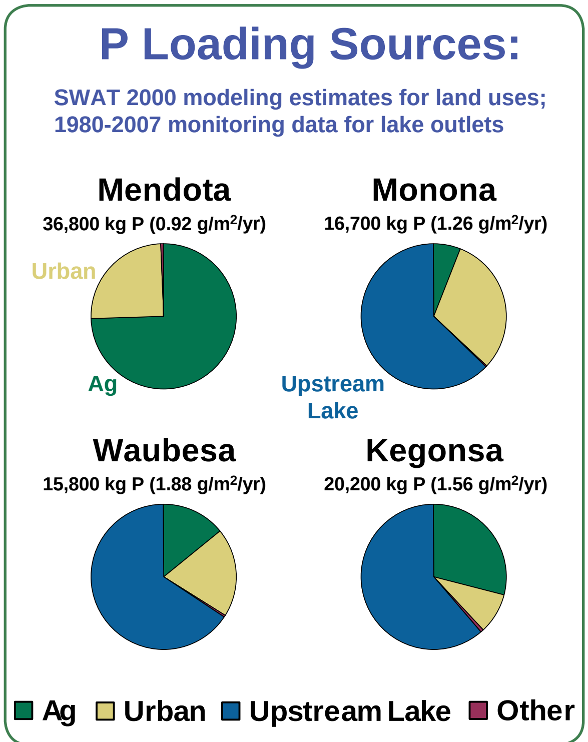
Map 17: Land Cover



Tom Simmons, WDNR

In 2000, modeling estimated that 81,000 pounds of phosphorus entered Lake Mendota annually (see Map 17 and Figure 11). ***Three-quarters of the total phosphorus load of Lake Mendota came from agricultural lands in the watershed.*** This has a cascading effect, since two-thirds of the phosphorus load to the downstream Yahara Lakes comes from the upstream lakes (indicated in blue). ***While the total rural area is greater than the urban area in the Mendota watershed, the amount of phosphorus delivered per unit area of land from construction erosion from urban lands was greater. However, this modeling pre-dates the current stormwater regulations in Dane County and the State of Wisconsin, which have significantly reduced the phosphorus discharge from urban areas.***

Figure 11
phosphorus Sources



Source: R. Lathrop & K. Kirsch, WDNR

Modeling associated with the Lake Mendota Priority Watershed Project[47] indicated that ***a 50% reduction in phosphorus loading (or a reduction of 4,800 tons in the sediment load) to the lake would reduce the number of potential algae bloom days.*** Since phosphorus is often bound to sediment particles, efforts to control sediment reduces phosphorus as well.

According to researchers, ***Lake Mendota water quality could improve relatively quickly if the amount of phosphorus flowing into the lake is significantly reduced.*** Likewise, phosphorus load reductions to Lake Mendota could produce cascading water quality improvements in the downstream Yahara Chain of Lakes as well.[48]

Since a majority of the phosphorus loading to Lake Mendota was found to originate from agricultural lands within the watershed, the priority watershed project was established to provide farmers financial cost-sharing for the installation of BMPs designed to reduce the amount of sediment and phosphorus leaving farm fields and barnyards. Implementation phase occurred between 1998 and 2009.

Sizable investment of public monies have been directed to water quality improvement in the Yahara system. Appendix A of this ECR lists the local project cost-share, not including staffing and other state funded projects. State funding for the construction of various retention and detention facilities in Madison, Middleton, Sun Prairie and DeForest is estimated to be approximately $3.7 million (Parsons 2011). Non-structural BMP measures were also promoted to reduce nutrient and sediment loading. These include the funding of municipal stormwater plans, additional street sweeping, enactment of an erosion control and storm water management ordinance by Dane County, among other projects. The principal goal is to assure that adequate erosion control and storm water management actions and facilities are utilized in developing areas to reduce direct discharges to surface waters by 80%, as well as reducing or controlling peak stormwater flows.

The water quality goal for Lake Mendota is to reduce the concentration of spring total phosphorus to less than 0.074 mg/L. Models indicate this concentration will result in a decrease in blue-green algae to less than 2 mg/L during the summer months. This concentration represents the threshold for algal blooms, identified by green water and surface scum. Given current annual phosphorus loading, the likelihood on any given summer day of a nuisance algae bloom occurring is 50%. With a 50% reduction in annual phosphorus loads to the lake, the likelihood of a nuisance algae bloom occurring is reduced to 20%. In years with high precipitation, with high runoff into the lake, nuisance algal blooms would be more likely that summer, even with the implementation of recommended best management practices (BMPs).

47 For the details of the Yahara-Mendota Priority Watershed project, see the project report at: http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/Lake_Mendota_Priority_Watershed_Project_1997.pdf
The Yahara-Monona Priority Watershed Report can be found at: http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/Yahara_Priority_Watershed_Plan_1992.pdf
48 For the details of the most recent research on phosphorus in the Yahara system, see http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/P_Loading_Yahara_Lathrop.pdf

More recently, Lake Mendota along with other tributary creeks have been included in the Rock River Total Maximum Daily Load (TMDL) project establishing necessary reductions in discharge of sediment and phosphorus.[49] ***These efforts are just beginning. Implementation measures and opportunities that are to be shared among the various agricultural and urban sources have not yet been defined.***

Issue:

High Lake Levels

What has been done:

- Peak rate control in urban areas since late 1990s
- Volume control in urban areas since 2004

What else can be done:

- Retrofit BMPs in older urban areas
- Restore wetlands, woodlands, prairies, and pastures in selected agricultural areas.

It is important to note that some of the sediment and nutrient load reductions to surface waters and the Yahara lakes could be negated if there is an increase in the frequency and intensity of spring and summer storms as projected by some climatologic models. Data from the Wisconsin Initiative on Climate Change Impacts (WICCI) show average annual precipitation has already increased between 4.5 to 7 inches in Dane County between 1950 and 2006.50 Projections suggest the average annual rainfall from 1980 to 2055 to increase an additional 1.5". The frequency of 3-inch rainfall events has increased over the last 10 years (Lathrop and Carpenter 2010). The WICCI projection is for 2 to 2.5 more rainfall events of 2" or greater per decade in Dane County from 1980 to 2055 (from 12 times per decade to 14 or 14.5 times per decade). Because most of the sediment and phosphorus discharged to Lake Mendota comes from agricultural land uses, the timing of the rainfall significantly influences phosphorus loading. August 2007, the wettest August on record with 15.18 inches of precipitation, resulted in a phosphorus loading of about 6,100 pounds at the USGS station at the Yahara River in Windsor. In comparison, June 2008, the wettest June on record with 10.93 inches of precipitation, resulted a phosphorus loading of about 22,100 pounds. Higher phosphorus loading with less precipitation is likely due to the timing of manure spreading and/or the changes in crop cover during the growing season. ***Additional urban and rural runoff management practices may be needed to improve water quality of Lake Mendota and the downstream Yahara lakes***. The National Oceanic and Atmospheric Administration's National Weather Service is in the process of updating the rainfall frequency data for Midwestern states, including Wisconsin. The result of this work is scheduled for publication in May 2012 and will be used to adjust the rainfall data used in stormwater modeling as necessary.

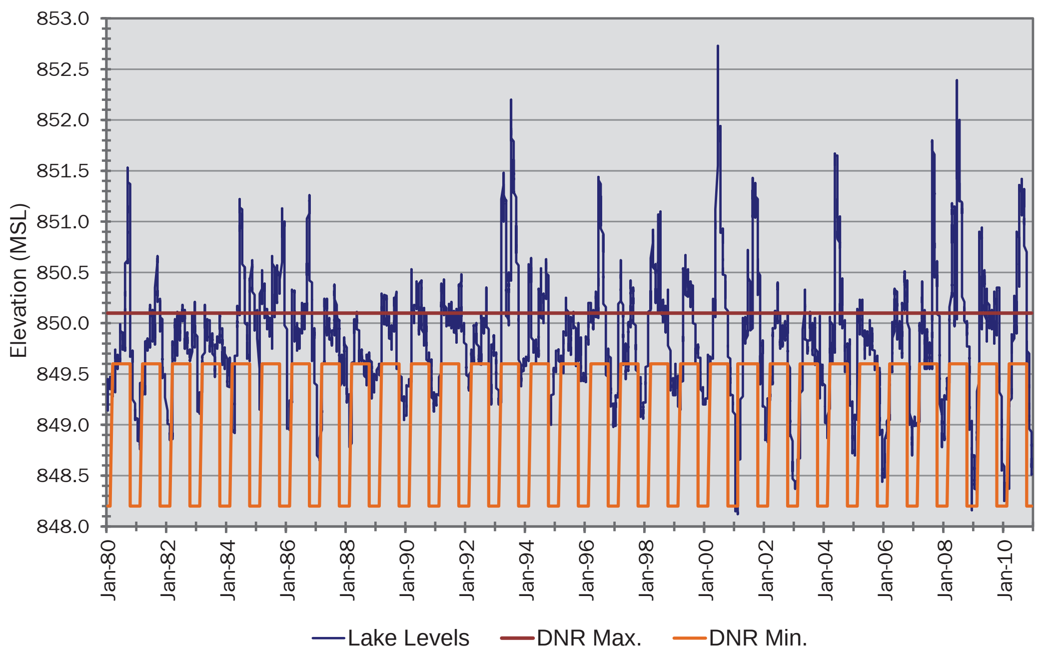
Agricultural operations with inadequate control of runoff and soil loss, and old urban areas with inadequate stormwater control have also increased the volumes of stormwater runoff, resulting in more frequent high lake levels and increased flooding. The lake levels for the Yahara Chain of Lakes, (Mendota, Monona, Waubesa and Kegonsa) are managed by Dane County according to the lake level orders established in 1979 by the WDNR. The orders require lake level coordination of the entire chain of lakes as an interconnected system. The target maximum water level for Lake Mendota is 850.10 feet. The 100-yr flood elevation is 852 feet. The target summer minimum water level for Lake Mendota is 849.6 feet from the first spring runoff after March 1st until October 30th.; whereupon it drops to 848.2 feet during the winter season. The persistent problem of high water levels on Lake Mendota is

49 For details of the Rock River TMDL , see http://dnr.wi.gov/org/water/wm/wqs/303d/rockrivertmdl/Final_Rock_River_TMDL_Report_with_Tables.pdf

50 WICCI. http://www.wicci.wisc.edu/resources/wicci_climate_change_maps.pdf

evidenced by the fact that there were 2,892 days when the lake level exceeded the target maximum water level between 1980 and 2011, or 26% (see Figure 12). The exceedances often last for months at a time. ***Since upstream communities contribute additional volumes of stormwater to the lakes, stormwater volume controls are a critical strategy in successfully addressing this problem – both for new as well as existing development. One promising strategy is to restore prior-converted wetlands, prairies, woodlands, or pastures in select areas of the watershed.*** Refer to page 116 for a more detailed discussion of wetland resources and opportunities in the study area.

Figure 12
Historic Lake Mendota Water Levels and DNR Lake Level Limits



Substantial financial resources have also contributed to a greater understanding of pollutant sources and sinks, including remediation and prevention strategies. ***It is important for new development projects to augment this progress through conscientious stewardship and elevated self-imposed standards of development, resource protection, and mitigation of adverse impacts on downstream areas.*** A major focus of the Lake Mendota Priority Watershed Project, and more recent efforts of the Yahara Lakes Legacy Partnership (YLLP) and Yahara Capital Lakes Environmental Assessment and Needs (CLEAN) project,[51] has been on continued sediment and phosphorus reductions from agriculture and urban sources, stormwater management, groundwater and wetland protection, and public education. ***Lake Mendota is also included in the Rock River Basin Total Maximum Daily Load (TMDL) project for USEPA-required reductions in sediment and phosphorus.*** These efforts are just beginning. Implementation measures among agricultural and urban sources have not yet been defined. There may also be opportunities for "nutrient trading" or pollutant reduction credits that could be exchanged among the various sources. Such trading opportunities are expected to result in more efficient and cost-effective pollutant reduction and remediation efforts overall.

51 For the details of the Yahara CLEAN project, see http://yaharawatershed.org/articles/CLEAN_Report_090910.pdf

As higher and higher treatment and control have become standard practices in new urban development, a diminishing return can be expected. Additional increments of water quality improvement can be achieved only at higher and higher cost. The same, or smaller, expenditures can instead be applied to improve agricultural conservation practices, resulting in capturing much larger pollution loads. This would require collaboration between urban areas and rural areas within the same watershed or sub-watershed.

Lake Restoration

Lake restoration technologies for the control of phosphorus can be separated into two categories, either controlling flows entering into lakes or diverting flows away from lakes. ***Some of these techniques may not be suitable-for all lakes in Dane County. Lake restoration should only be implemented after evaluation by experienced limnologists and by developing detailed restoration plans and with approval from the WDNR. Furthermore, because most of these restoration techniques are very expensive for large lakes such as the Yahara chain of lakes, they can only be undertaken where there are assurances that the sources of pollution have been removed. The expense of these undertakings also highlights the importance and cost-effectiveness of pollution prevention.*** Lake restoration techniques include hypolimnetic aeration, hypolimnetic withdrawal, artificial circulation, dilution, nutrient diversion, dredging and nutrient inactivation.

Issue:

Lake Restoration

- Restore lake ecosystems by:
  - o Controlling flow into lakes
  - o Diverting flows away from lakes
- Use ecological engineering through physical and chemical methods
- Control nutrient inputs before it enters lakes.

Before and after: Lake BelleView Restoration Project, Belleville WI

In hypolimnetic aeration, oxygen is pumped into the deep, nutrient enriched and oxygen depleted zone called the hypolimnion. This aeration maintains oxygen and limits phosphorus release from sediments while preventing water layer mixing (destratification). Hypolimnetic aeration has the added benefit of expanded habitat but is offset by expensive operation costs. It may also be difficult to aerate the hypolimnion without causing destratification and promoting algae blooms. Hypolimnetic withdrawal involves siphons that remove nutrient rich and low oxygen waters from the hypolimnion. However, this technique requires draining these areas into downstream waters, which will generate ecological problems elsewhere.

Artificial circulation is the installation of engineering devices including fountains, paddle-wheels and air diffusers which prevent stratification and increase aerobic habitat. These techniques are more suitable for small lakes and ponds.

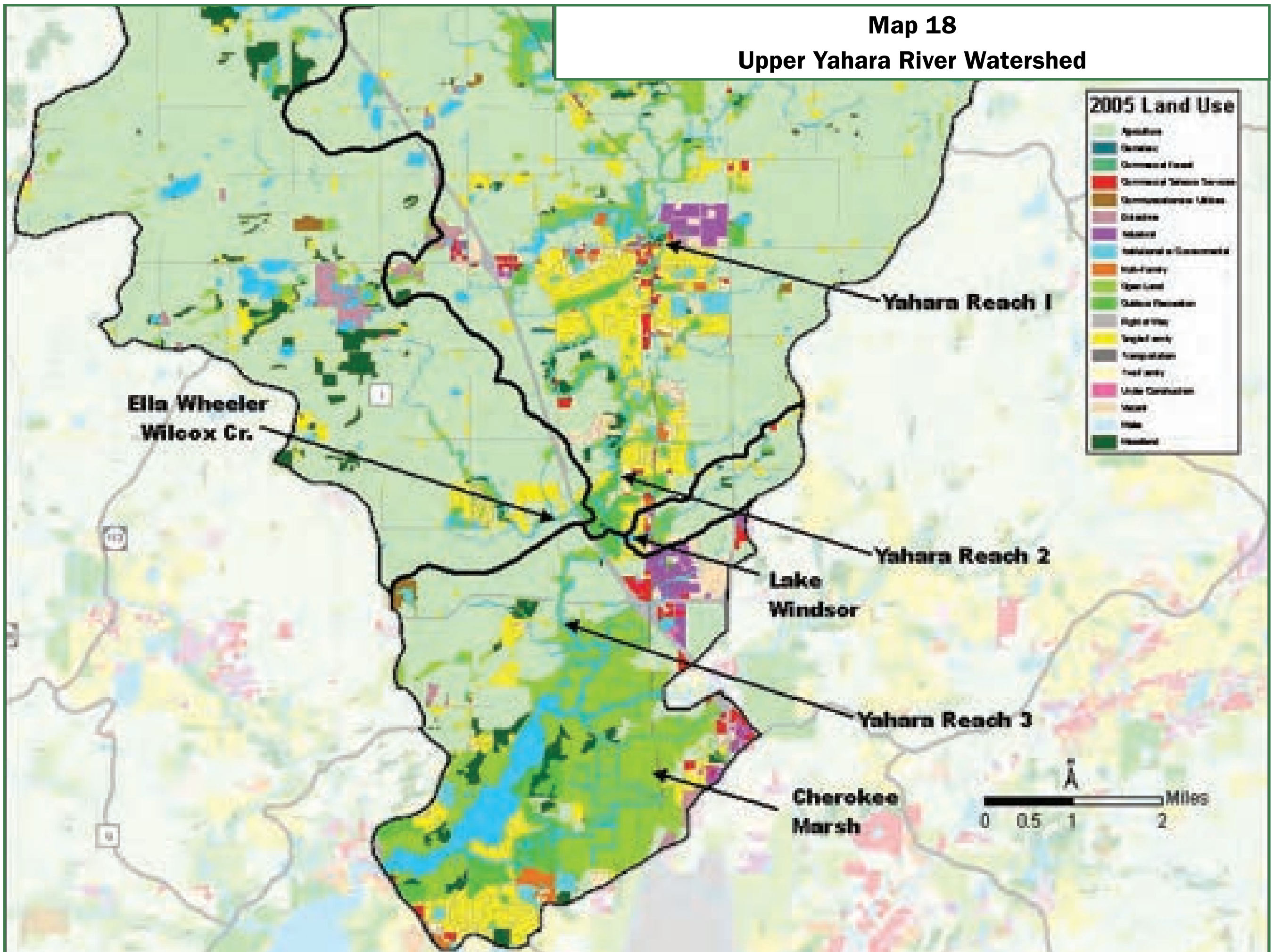
Dilution directs lower nutrient drainage waters into high nutrient lakes. This generates problems similar to hypolimnetic withdrawal and may use water that is scarce or expensive to acquire.

Nutrient diversion uses drainage channels to divert nutrient rich waters around lakes and into the downstream side of lakes. Such diversions may impair fish mobility, particularly for reproduction and is often difficult to find alternate diversion sites. It may be difficult to find new diversions for Madison area lakes considering this engineering has already been enacted for wastewater. Further diversion will also reduce the baseflow in the Yahara system, and this is already a concern due to the adverse impact of groundwater withdrawal.

Dredging uses heavy equipment to remove accumulated sediments. This may also remove nuisance aquatic vegetation, but also temporarily impair habitat. Dredging can be prohibitively expensive and may be most suitable for small lakes.

Nutrient inactivation is accomplished through addition of aluminum, calcium, or more rarely iron compounds. Lake projects typically use aluminum sulfate (alum) to chemically inactivate phosphorus. When added to lake water, the alum forms aluminum hydroxide which forms a flocculent which then precipitates out of the water column. This removes phosphorus and other suspended particles. As the flocculent settles on the lake floor, it forms an insoluble solid at low or zero dissolved oxygen. Nutrient removal efficiencies exceeding 90% are common. Nutrient inactivation effectiveness is determined by lake size and amount of alum applied. This treatment may last for eight years in small lakes and longer in deeper lakes. This method has been used successfully in several Wisconsin lakes in the 1970s. Despite these potential benefits, aluminum can become a toxic metal when water acidity drops below a pH of 6. Lake pH may change if acid rain is a problem. Observations of treated lakes with normal pH do not show any detrimental effects to invertebrates or fish.

There are multiple options may be available for lake restoration for Lake Mendota. Some of them may not be financially plausible because of the large size of the lake.



Map 18
Upper Yahara River Watershed

a. Upper Yahara River

The Upper Yahara River originates in the marshy areas of south central Columbia County and flows approximately 20 miles as a small meandering creek through the Town of Windsor and the Village of DeForest where it empties into the 2500 acre Cherokee Marsh and eventually Lake Mendota. The Upper Yahara subwatershed drains an area of approximately 28 square miles. The primary land use in this subwatershed is agriculture (64%), residential development (13%), transportation (12%) and wetlands (8%) (see Map 18).

The problems impacting water quality of the Yahara River include:

- sediment and nutrient loading from agricultural fields and barnyards
- channelized headwaters for agricultural production
- historic hydrologic modification and destruction of valuable wetlands
- areas of heavy instream aquatic plant growth
- elevated temperatures and periods of low dissolved oxygen
- lack of suitable habitat for aquatic organisms due to heavy sedimentation
- historic stormwater runoff from older urban areas
- historic loss of infiltration areas due to the increase of impervious surfaces
- reduction in water table levels and stream baseflows due to municipal well withdrawals

Measures taken since 1990s

What has been done since late 1990s:

- Implementation of agricultural best management practices (BMPs)
- Implementation of urban BMPs in areas of new development
- Adoption of stormwater volume control standards (100% stay-on) as part of the Village of DeForest stormwater ordinance

Additional measures that can benefit the health of the Upper Yahara River

- Increase financial resources for broader implementation of agricultural best management practices for water quality and runoff volume reduction
- Increase financial resources for broader implementation of retrofit urban best management practices in old urban areas for water quality and runoff volume reduction
- Restore wetlands, woodlands, prairies, and pastures in select areas for water quality improvement and runoff volume reduction
- Broad adoption of higher standards for both urban and agricultural non-point sources of pollution
- Capitalize on opportunities for capturing phosphorus within the watershed and exporting it

Three different reaches of the Yahara River are described below.

Reach 1 – Headwaters to CTH V

Land use in this part of the watershed is dominated by agriculture, both cash cropping and dairy farming, followed by residential development. Wetlands along this headwater stretch have been extensively drained and small feeder streams have been straightened. The loss of wetlands combined with heavy agriculture in this reach have resulted in large sediment and nutrient loads and loss of valuable fish habitat. Stormwater runoff from the developed areas in the Village of DeForest and the Town of Windsor is also a concern.

The current biological use of the fishery in this reach is identified as a Warmwater Sport Fishery (Map 16 and Table 5); however it is probably more reflective of a Warmwater Forage Fishery due in part to its low flows, elevated water temperatures, low dissolved oxygen levels, and lack of diverse habitat (Sorge 1996). Map 15 shows this in relation to other Dane County Streams. Watershed appraisal monitoring done in 1994-95 indicated a range from very good water quality conditions (HBI = 4.44) at the upper River Road crossing to fair water quality conditions (HBI = 5.90) at CTH V (Table 5). ***This section of the stream has very poor available habitat for aquatic organisms because most of the desirable substrate is embedded in fine sediments. Increasing buffered corridors adjacent to the stream would reduce the amount of sediment entering this section of the River.*** The average score for the five locations monitored was 4.91 indicating good water quality.[52]

Near Morrisonville in northern Dane County, an unnamed tributary to the Yahara River drains a predominantly agricultural area. Some wetlands lie in the drainage area but others have been drained. Intensive agriculture and polluted runoff have adversely affected the tributary's habitat.

52 The Hilsenhoff Biotic Index (Hilsenhoff, 1982) uses aquatic insects as biotic indicators of water quality. The Index is based on organisms' tolerances to low dissolved oxygen levels and is designed to evaluate the status of organic and nutrient pollution in streams. The Index of Biotic Integrity (Lyons 1992 and 1996) is another popular method.

Reach 2 – CTH V to Windsor Road

The primary land use in this part of the watershed is residential development, followed by agriculture. This reach flows through the Village of DeForest and the Town of Windsor, both of which are expanding their developed areas. ***Problems impacting water quality include:***

- ***Historic loss of infiltration areas and greater volumes of stormwater runoff from older urban areas***
- ***Sediment and nutrient loading from agricultural fields.***
- ***Areas of stream bank erosion due to bank failures***
- ***Turbidity***
- ***Historic loss of valuable wetlands***

The current biological use of the fishery for this reach of the River is Warmwater Sport Fishery, Map 16 and Table 5. Electrofishing surveys conducted in this reach in 2010 captured 24 different species of fish. Some of the unique species include central stoneroller, horneyhead chub, fantail darter, northern redbelly dace, and brook silverside. There were five different species of sport fish (bluegill, brown trout, largemouth bass, white bass, and white crappie), several tolerant forage fish, and some rough fish species. IBI fish monitoring conducted in 2007 indicated fair water quality, while instream habtitat was rated good. The WDNR noted some intolerant coldwater species were found in this reach. HBI monitoring done at sites upstream of Windsor Road between 1992 and 2000 indicated water quality ranging from good to poor as one goes upstream. With one exception, HBI scores between Windsor Road and DeForest have consistently indicated good to very good water quality conditions for the Yahara River at this reach.

This reach of river has the greatest potential for sustaining valuable populations of sport fish. The amount of available aquatic habitat in this reach is very good. This section of river contains large riffle areas with a mixture of gravel, cobble, and boulders. These riffle areas support excellent habitat for aquatic insects and fish, and provide great spawning habitat for several species of fish. Deep runs and pools also provide excellent cover and habitat for a wide variety of fish species.

The gradient and flow in this reach are also very good. The WDNR indicates the segment of the river from South Street in DeForest to Windsor Road as being a coldwater system (Johnson 2010) and therefore protected by Dane County thermal performance standards, Chapter 14.53(2)(f), Map 10.

Reach 3 – Windsor Road to Cherokee Marsh

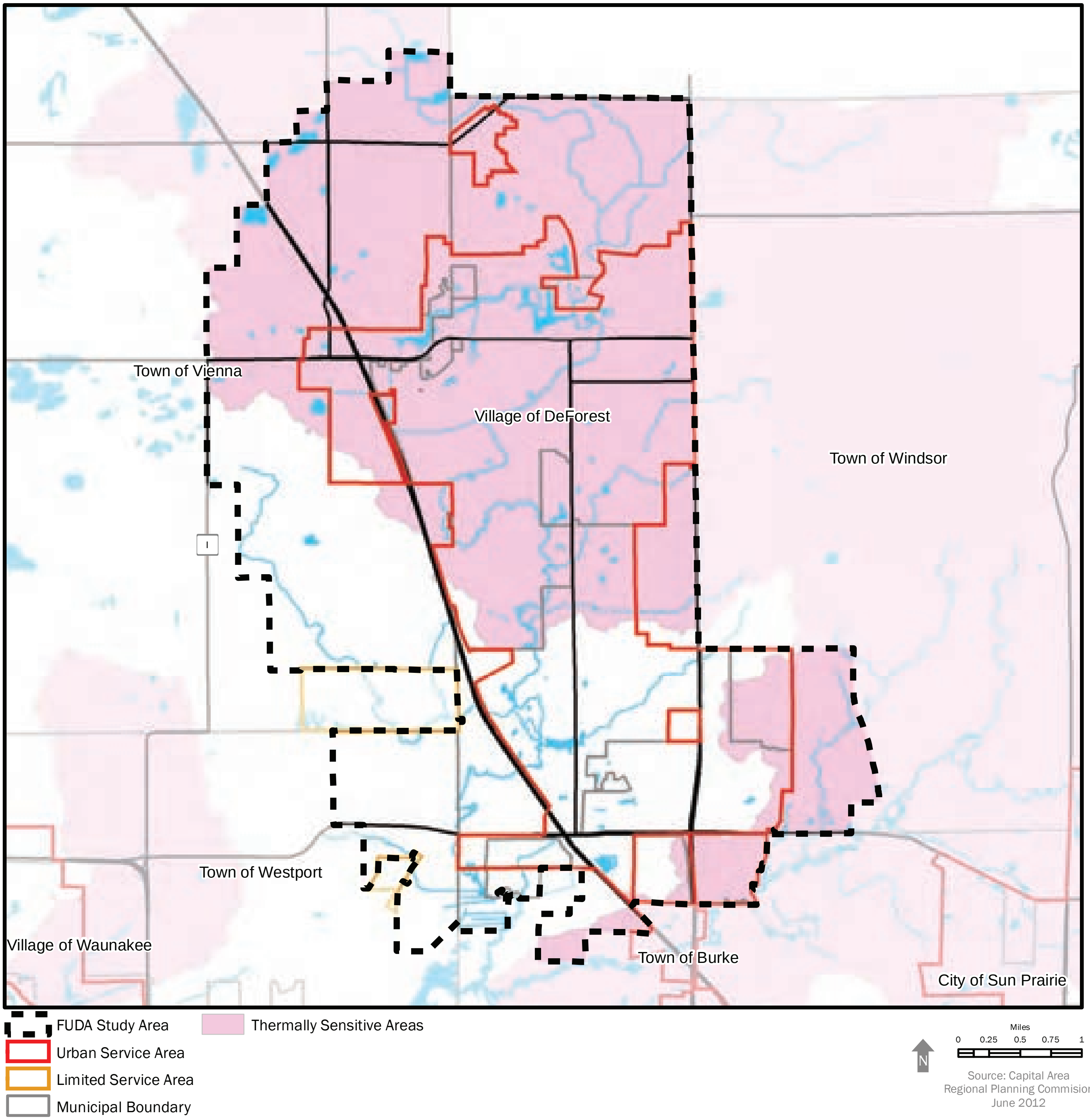
The primary land uses in this part of the watershed are agriculture, residential development, wetland, and grassland. ***The problems impacting water quality in this reach include:***

- ***Sediment and nutrient loading from agricultural fields and barnyards***
- ***Hydrologic modifications***
- ***Eroding stream banks***
- ***Turbidity***
- ***Debris jams***
- ***Elevated water temperatures and periods of low dissolved oxygen***
- ***Historic pollutant loadings associated with stormwater runoff from older urban areas***
- ***Heavy instream aquatic plant growth***
- ***Large populations of common carp***

The current biological us of the fishery in this reach is Warmwater Sport Fishery (WWSF). Historical fishery records show a wide diversity of warmwater species. They include some species that are present in the upper reaches, along with many that are commonly found in Lake Mendota. ***This reach plays an important role in providing spawning habitat for a wide variety of sport fish.*** Species such as northern pike, walleye, and white bass will use the lower reaches of the Yahara River and Cherokee Marsh on an annual basis. A wide range of wildlife species also use the lower reaches of the river along with the Cherokee Marsh. WDNR owns several parcels of land adjacent to the marsh known as Cherokee Marsh Fishery Area. This area provides public access for a wide range of recreational activities.

Map 19: Thermally Sensitive Areas

North Yahara Study Area, Dane County, WI



Thermally Sensitive Areas are areas within a watershed that drain to an existing or proposed Cold Water Community or Class I, II, or III Trout Stream, as designated by the Wisconsin Department of Natural Resources. These streams are capable of supporting coldwater fish and other aquatic life. Special thermal performance requirements have been established in Dane County Ordinance, Chapter 14.53(2)(f).

Issue:

Excess Nutrients, Sediment, and Temperature

Measures taken since 1990s

- Implementation of agricultural best management practices (BMPs)
- Implementation of urban BMPs in areas of new development
- Adoption of stormwater volume control standards (100% stay-on) as part of the Village of DeForest stormwater ordinance

Additional measures that can benefit the health of Lake Windsor

- Increase financial resources for broader implementation of agricultural best management practices for water quality and runoff volume reduction
- Increase financial resources for broader implementation of retrofit urban best management practices in old urban areas for water quality and runoff volume reduction
- Restore wetlands, woodlands, prairies, and pastures in select areas for water quality improvement and runoff volume reduction

b. Ella Wheeler Wilcox Creek

Ella Wheeler Wilcox Creek joins the Yahara River from the west just south of Windsor Road. Limited fishery data indicates many mottled sculpin, an intolerant coldwater species, and large brown trout. WDNR staff is planning to conduct more thorough monitoring of this small stream.

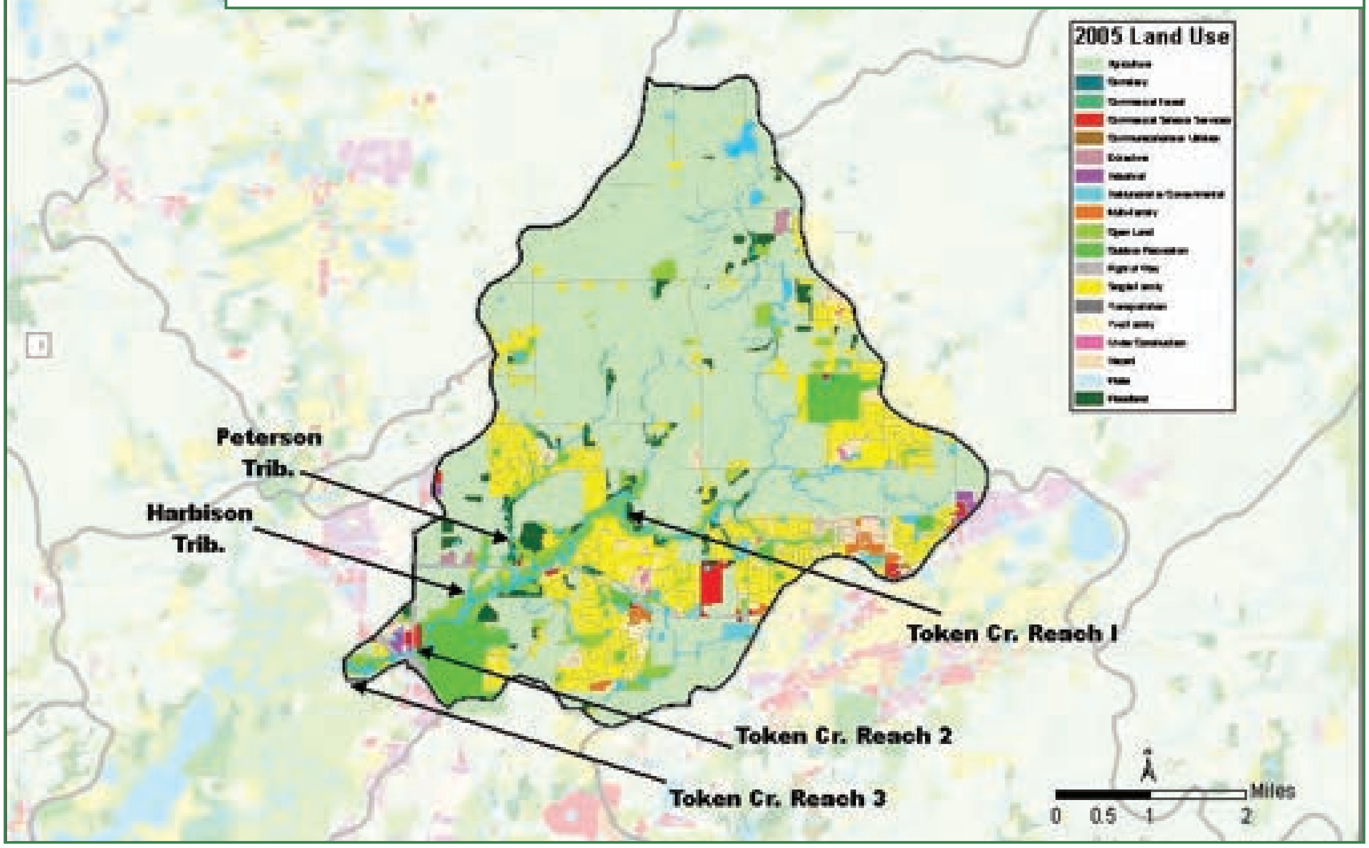
c. Lake Windsor

Lake Windsor is located in the Town of Windsor, sections 31 and 32. It is a drainage lake created by building a dam on an intermittent tributary to the Yahara River. The Windsor impoundment is nine acres in size, a maximum depth of six feet, and a drainage area of 778 acres. Its immediate drainage area is residential, but its drainage area also includes agricultural lands and parts of a Town of Windsor industrial park.

Lake Windsor is extremely fertile and turbid due to the tremendous amount of runoff generated by the surrounding agricultural lands. The ratio of the drainage basin to lake area is 86:1. The problems impacting water quality include sediment and phosphorus loading from surrounding agricultural fields being flushed into the impoundment, stormwater runoff from residential and transportation areas, internal phosphorus recycling from lake sediments, turbidity, nuisance algal blooms, winter/summer fish kills, and sediment suspension by carp. The lake's water quality problems are similar to that of other small, shallow impoundments in Southern Wisconsin and limits its fishery.

Historically, the impoundment was managed for trout but survival of fish was poor due to high summer temperatures and low oxygen conditions during ice cover. In response to landowner concerns of a fish kill in June 1984, an electrofishing survey conducted in the fall of 1985 found seven species of fish including bluegill, black bullhead, green sunfish, hybrid muskie, freshwater drum, common carp, and fathead minnows. The numbers of fish were low. The hybrid muskies had migrated up the Yahara River from Lake Mendota and had been caught by anglers and transplanted into the lake. Lake Windsor has a self-help volunteer that takes secchi disk recordings throughout the year. The results from this monitoring show that the lake is highly eutrophic (fertile). This is typical of most shallow impoundments in this region of the state. Overall water quality of this impoundment is poor, with an average secchi depth of 1.7 feet. ***Controlling and treating runoff is going to be a critical link in trying to improve water quality in this impoundment.***

Map 20
Token Creek Watershed



d. Token Creek

Token Creek is a spring-fed tributary to the Yahara river that originates in the Town of Windsor (T9N, R10E, Section 24). Token Creek is 10 miles in length and has a drainage area of 27.4 square miles located between the City of Sun Prairie and the Village of DeForest. Token Creek has a moderate gradient of 8.7 ft/mile. Token Creek has a diverse fishery containing warmwater, coldwater, forage fish, and rough fish species. This small watershed was probably a native brook trout fishery prior to European settlement but the construction of a dam and 44 acre millpond in the center of the watershed about 150 years ago limited the resource (since removed). ***Token Creek is a major contributor of flow to Lake Mendota, with flow of about 19 cubic feet per second (cfs) under baseflow conditions, representing over a quarter (27%) of the flow in the Yahara Chain of lakes measured at McFarland. Combined, Token Creek and the Yahara River contribute nearly half (41%) of the flow to the Yahara Chain of Lakes.***

The WDNR has identified the first three miles upstream of the Yahara River as a Warmwater Sport Fishery, with the potential of becoming a class III (i.e., stocked) trout stream, Map 16 and Table 5). The segment of stream from approximately USH 51 to Culver Springs is identified as a class II trout stream (exhibiting some natural reproduction). The remaining segment of stream is identified as being a class III trout stream with the potential of becoming a class II fishery.

Issue:

Excess Nutrients, Sediment, and Temperature

Measures taken since 1990s

- Implementation of agricultural best management practices (BMPs)
- Implementation of urban BMPs in areas of new development
- Adoption of stormwater volume control standards (100% stay-on) as part of the Village of DeForest stormwater ordinance
- Adoption of volume control by the City of Sun Prairie and Town of Windsor for recent development areas in the watershed
- Adoption of groundwater withdrawal mitigation measures by the City of Sun Prairie, Village of DeForest, and Town of Windsor for recent development areas in the watershed

Additional measures that can benefit the health of Lake Windsor

- Increase financial resources for broader implementation of agricultural best management practices for water quality and runoff volume reduction
- Increase financial resources for broader implementation of retrofit urban best management practices in old urban areas for water quality and runoff volume reduction
- Restore wetlands, woodlands, prairies, and pastures in select areas for water quality improvement and runoff volume reduction

Land use is dominated by agriculture (73%), followed by residential and transportation (11%), and wetlands (4%).

Problems impacting the water quality of Token Creek include:

- ***Sediment and nutrient loading from agricultural fields and barnyards***
- ***Historic hydrologic modification and destruction of wetlands***
- ***Historic urban stormwater runoff from older urban areas***
- ***Heavy instream aquatic plant growth***
- ***Elevated temperatures and periods of low dissolved oxygen***
- ***Sediment suspension by common carp***
- ***Lack of suitable habitat for aquatic organisms due to heavy sedimentation***
- ***Reduction in baseflow due to high capacity municipal well withdrawals***

Token Creek was placed on the state's 303(d) list of impaired waters in 1998. It was listed because of water quality impairments due to excessive sediment and suspended solids loading, and also because of the partially failed Token Creek millpond dam was an obstruction to fish passage.

In 2002 the EPA approved a Total Maximum Daily Load (TMDL) plan for Token Creek. Project goals included:

- ***Restoration of stream morphology and habitat***
- ***Managing and reducing sediment and other pollutant loading from agricultural land through the Lake Mendota Priority Watershed Plan***
- ***Managing stormwater discharges through the Lake Men dota Priority Watershed Plan and WDNR's stormwater discharge permit program***

The WDNR has added the goal of restoring a native brook trout fishery in the reach downstream of the Culver Springs. Brook trout are a very pollution intolerant coldwater sport fish. Restoration work on Token Creek to improve habitat and hydrologic functions include:

- ***Removing the berm around the Culver Springs (completed) allowing them to flow freely***
- ***Stream bank stabilization***
- ***Removal of pond sediment above the former dam location.***

The total sediment load capacity of the Creek has been established as being no greater than 746 tons per year. Projected 2020 annual loads have been estimated to be over double that amount or 1560 tons per year (estimated 1416 tons in 1996). Reductions in loading are specified in the TMDL and implemented through agricultural and urban best management practices. Token Creek is also included in the Rock River Basin Total Maximum Daily Load (TMDL) project for required reductions in sediment and phosphorus. These efforts are just beginning. Implementation measures among agricultural and urban sources have not yet been defined. There may also be opportunities for "nutrient trading" or pollutant reduction credits that could be bartered among the various sources. Such trading opportunities are expected to result in more efficient and cost-effective pollutant reduction and remediation efforts overall.

Relative to its drainage area, Token Creek has significantly more baseflow than most other streams in southern Wisconsin. Whereas the Yahara River watershed is about three times the size of the Token Creek watershed above USH 51, Token Creek has about twice the baseflow of the Yahara River (Figure 13). About half of the baseflow in Token Creek comes from a number of springs in the area of the former mill pond. The fact that baseflow in Token Creek is high compared to its drainage area suggests that groundwater flows into Token Creek from adjacent watersheds, such as the Yahara River Maunesha, and Koshkonong Creek watersheds. Compared to the surface watershed, the groundwater basin is believed to be considerably larger (Figure 14). This helps explain the relatively large amount of baseflow in Token Creek.

In 1992 the Token Creek dam partially failed and the drained millpond had become a shallow- to deep-water marsh. At least two significant springs became evident (Culver and Trout Pond Springs), identified by the two major tributaries rising to form clearly defined wetland/stream tracks leading to the Creek. The former millpond absorbed the coldwater springs, heating the water and degrading the Creek's fishery and water quality. The WDNR has been working with the Town of Windsor, Dane County, local conservation groups and residents to remove the dam and restore a high quality coldwater sport fishery here.

Figure 13
Comparison of the amount of water in Token Creek and Yahara River

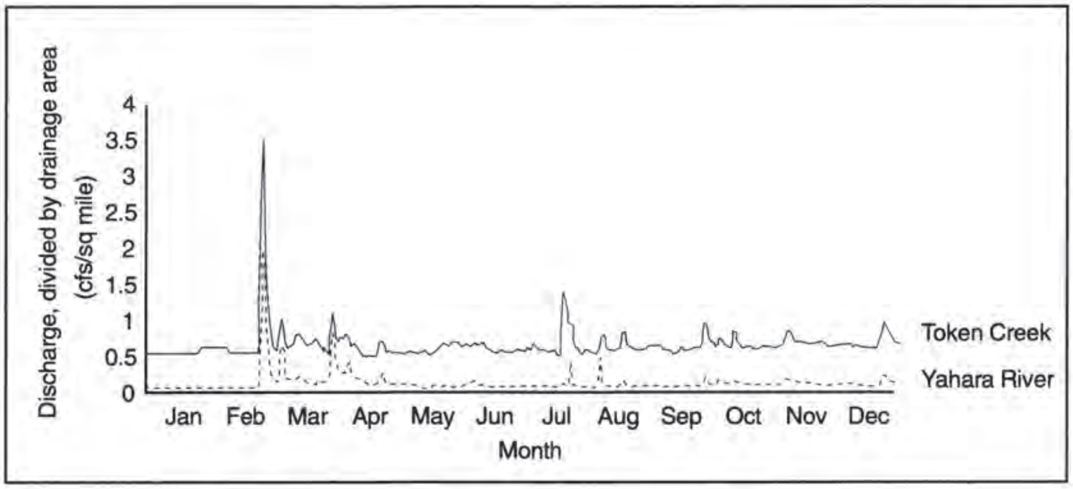
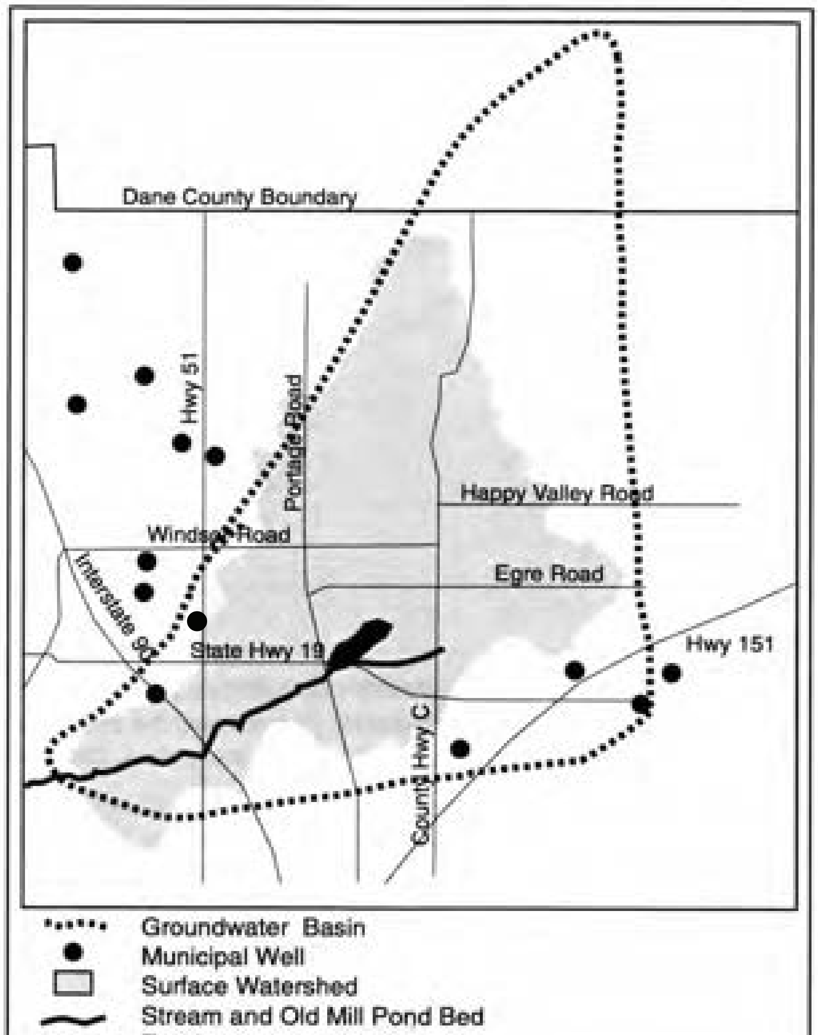


Figure 14
Token Creek watershed in relation to the groundwater basin.



Source: Water Resources Atlas for Token Creek, 1997

The natural springs in the Token Creek watershed are a unique resource, being one of the largest complexes in southern Wisconsin according to WDNR. The springs contribute water at a near constant volume and at uniform water quality and temperature supporting a Class III coldwater fishery. According to WDNR fishery biologists, the stream has the potential to support a naturally reproducing Class II coldwater fishery from its confluence with the Yahara River upstream to and including the former millpond – including brook trout, a highly sensitive species.

Trout streams are rare in the glaciated portions of Dane County. The quality of the fishery here is attributed to the relatively large baseflow discharges of groundwater to the stream. Because trout and other aquatic organisms typical of a coldwater system are intolerant to wide variations in their environment, the qualities that the springs provide are vital for a coldwater ecosystem to exist and thrive. In addition to serving as a source of water, the springs bring up clean sand and prevent accumulation of silt – critically important for trout reproduction. Biologists assert that preserving the springs is essential for maintaining the existing brown trout fishery and establishing a brook trout fishery at this location.

Token Creek has been the focus of significant public and private expenditures of funding and volunteer efforts directed at protecting and restoring this unique resource. In 1998 the WDNR and the Town of Windsor completed an acquisition of the Token Creek dam and surrounding reservoir for $1,400,000. This acquisition and subsequent dam removal is expected to enable the restoration of five to seven miles of brook trout stream in eastern Dane County. Removal of the dam is expected to allow the stream to find its original natural channel, improve the coldwater fishery, and provide a very valuable wetland complex. Because of its status as a trout stream, Token Creek is identified by WDNR as an Area of Special Natural Resources Interest. One of the things that make this project unique is that it is situated between the communities of Sun Prairie, DeForest, Windsor, and Burke. Conversely, if adequate measures are not taken these same communities' growth could limit restoration efforts by altering both surface and groundwater flow patterns (see page 162 - 164 of this report describing the natural resource impacts of urban development).

Issue:

Ecology of Headwaters to STH 113 – Reach 1

Habitat

- Stream to inter-marsh habitat, likely useful to birds and aquatic mammals

Species: Indices of Biotic Integrityl

- Invertebrates: fair to poor quality
- Fish: poor quality
- Riparian: open sedge meadows, some willow stands, reed canary grass. Well developed woodland riparian in upland areas.

Situated between various growing communities, the primary threat to Token Creek water quality is from uncontrolled urban stormwater runoff from impervious development and major roadways. Extraordinary stormwater management measures are needed to maintain or improve the hydroecology of the Creek. Maximizing stormwater infiltration opportunities in new developments as well as retrofitting existing development (where opportunities permit) will be needed to maintain and improve existing baseflow and thermal conditions in the Creek. These actions will protect this coldwater fishery. Recognizing this, the Village of DeForest has adopted a standard of no increase in stormwater runoff volume for all new development. This will reduce the likely impacts of proposed development and should address the potential impacts on the receiving waters by maintaining existing hydrologic conditions, which are critical to maintaining the health of the stream and the biological communities it supports. The City of Sun Prairie has also installed several stormwater measures in developing areas near the Creek to minimize pollutants reaching the stream and minimize adverse thermal impacts from urban runoff. In addition to what is currently being done, more effort will be needed to address historic impacts from older urban areas not covered by these measures.

Three different reaches of Token Creek are described below.

Reach 1 – Headwaters to Culver Springs

Land use is in this part of the watershed is dominated by agriculture, both cash cropping and dairy farming, and residential development. Housing development is occurring extensively in this area. ***Problems impacting water quality in this reach include sediment and nutrient loading from agricultural fields and barnyards, loss of habitat due to excessive sedimentation, historic loss of infiltration areas, and impacts to both water quality and water quantity resulting from historic stormwater runoff from older urban areas and municipal well water withdrawals.***

This section of stream is identified as being a class III (stocked) trout stream with the potential of becoming a class II fishery (supporting some natural reproduction). Priority watershed HBI appraisal monitoring of Token Creek done in 1994 and 1995 at four sites indicated a range of water quality conditions from very good (HBI = 4.30) to fairly poor (HBI = 7.49) depending on location. The monitoring was done prior to complete dam removal. Water quality conditions in Token Creek at CTH C improved significantly between 1994 and 2008 based on HBI scores. The HBI score at CTH C in 1994 was 7.44 (fairly poor water quality conditions), while the HBI score at the same site in 2008 was 4.92 indicating good water quality. Coldwater IBI monitoring upstream of the millpond and Culver Springs at CTH C in 1998 and 2000 indicated very poor biotic integrity conditions.

Reach 2 – Culver Springs to USH 51

The primary land use in this part of the watershed is very similar to that of the first reach, being dominated by agriculture and residential development. This segment has a large rural development component surrounding it. ***Factors that impair water quality include sediment and nutrient loading from agricultural and barnyard runoff, historic urban stormwater runoff from older urban areas, lack of habitat, suspension of sediment due to high common carp populations, turbidity, hydrologic modification and destruction of wetlands.***

The fish community is composed of a greater abundance and diversity including common carp, white sucker, green sunfish, bluegill, and even a few brown and brook trout. This is an unusual fish assemblage given that trout, particularly brook trout, are an intolerant species requiring low temperatures, high dissolved oxygen, and low levels of pollution. All other species found are highly tolerant species. Notes from site managers express the opinion that the trout are non-native and likely escapees from trout ponds. The high volume of cold spring water upwelling directly upstream in the former millpond area permits these fish to survive. It should be noted that the area of the former mill pond and immediately downstream is the only section of stream in which suitable substrate and gradient currently exist to allow for potential natural trout reproduction.

Macroinvertebrate samples indicate fair water quality (HBI = 5.7) in 1995 and was taken below the spillway of the former millpond. The millpond dam was found to be unsafe and was removed in 2005. Thus the area directly above the dam is existing as a shallow wetland, with a stream channel meandering through the former millpond. The aquatic life present below the millpond reflects an improvement in water quality. However, the available instream habitat is low, with a poor environment for aquatic organisms. In many areas sedimentation has covered most of the desirable substrate with over three feet of fine sediment.

Results of coldwater IBI monitoring in 2000 and 2001 upstream of Token Creek County Park indicated fair biotic integrity conditions for both years. Coldwater IBIs at STH 19 indicated poor biotic integrity conditions in 2000 and fair biotic integrity conditions in 2001. Coldwater IBI monitoring beginning just downstream of the dam site and continuing upsteam to the Culver Springs in 2006 showed a biotic integrity rating of good. ***These data coupled with the ongoing channel and habitat improvement indicates that Token Creek can sustain a viable coldwater fishery. The WDNR is attempting to establish a native brook trout fishery in the Culver Springs area.***

Reach 3 – USH 51 to the Confluence with the Yahara River

The primary land use in this part of the watershed is agricultural, followed by residential development and wetlands. Wetlands play a larger role in this reach, particularly as one gets closer to Cherokee Lake. Problems associated with degradation of water quality include sediment and nutrient loading from agricultural fields, nutrient loading from Cherokee Marsh, historic stormwater runoff from older urban areas, turbidity, high populations of common carp, and heavy instream sedimentation. Aquatic macrophytes (larger plants) are common and, in places, overly abundant.

The current biological use of the fishery is Warmwater Sport Fishery consisting of bluegill, largemouth bass, walleye, green sunfish, and some rough fish species (common carp and freshwater drum). Although the Yahara River and Lake Mendota serve as a reservoir for upstream migration of warmwater fishes, fisheries biologists believe that warmwater species are self-sustaining in this lower reach of Token Creek and that it has the potential to support coldwater species. ***The factors impairing the fisheries in this stretch include low gradient and high sediment/nutrient loading, extensive channeling and channel widening, high turbidity, low quality instream habitat, and temperature increases from proximity to Cherokee Marsh.***

Temperature Impacts

Because Token Creek is a coldwater resource, water temperatures are a particular concern. Token Creek and its tributaries show significant temperature change due to daily and seasonal variations. Seasonal fluctuations can be as high as 45°F. Daily fluctuations can also be significant with fluctuations as great as 23°F having been recorded. Fluctuations are much smaller in areas close to springs, which have a relatively constant temperature of about 50°F. The upper reaches of Token Creek and its tributaries east of CTH C are not fed by large springs so they are characterized by low flow volumes and low flow rates. The middle portion of Token Creek between CTH C and I-90/94 contains many springs which flow into Token Creek. The significant volume of water coming from these springs tends to lessen the degree of warming in the summer and cooling in the winter. Water temperatures in this portion of the stream range from 68°F in the summer to 46°F in late winter. ***In designating Fish and Aquatic Life Uses for Wisconsin Surface Waters (WDNR 2004), WDNR defines temperature as the maximum temperature during any year, usually in July or August. For Coldwater streams the maximum is 77°F. The Impairment Threshold is 73°F (WDNR 2010).*** There is no minimum temperature threshold.

In general, lower temperature surface waters tend to support intolerant plants and animals such as watercress and trout. Higher temperature surface waters drives off intolerant species giving rise to invasive carp and anaerobic bacteria. The relationship of temperature to dissolved oxygen is also very much related to the kinds of organisms living there. Oxygen is more soluble in lower temperature water. At 50°F water saturated with oxygen contains about 12 mg/L, while at 86°F water is saturated at only about 7 mg/L. Organisms that require high levels of oxygen are usually restricted to colder waters where more oxygen is available.

In addition, decomposition of excessive amounts of organic matter resulting from stormwater runoff can depress oxygen levels further by bacteria. The WDNR has established 6 mg/L dissolved oxygen as the minimum water quality criteria level for coldwater streams. Dissolved oxygen levels in Token Creek measured at USH 51 average 10 mg/L, with minimum levels averaging 9 mg/L.

Habitat Loss

In terms of habitat, the historic conversion of the Token Creek watershed from natural prairie and savanna vegetation to agricultural and urban land uses has altered the original stream channels. Comparisons between early surveyor's notes and present-day channel widths indicate that below the former Token Creek dam, the main branch of Token Creek has widened significantly (IES 1997). This increase shows that the channel cross sections have compensated to carry the increased water volumes. In addition to the widening trend, deep deposits of fine sediment across the stream bottoms indicate that the stream channel is also more shallow. The Pederson and Harbison tributaries do not show this widening trend, however. While these tributaries have not widened, their channels appear to have adapted to increased water volumes by cutting down vertically. These types of changes are expected in developed watersheds where width, depth, or both, increase as a result of increased flood magnitude, frequency and sediment load carried by the stream. ***These impacts can be mitigated or offset for new development through stormwater management practices that maintain pre-development hydrologic characteristics in streams. Previous development without adequate stormwater management practices would require retro-fitting to correct existing impacts.***

The shape and size of a stream cross section are a function of the streamflow, the sediment load, and how much the channel can erode. At higher flows the river has more energy, and thus is able to erode sediment from its banks and bed. At lower flows the river has very little energy and any sediment it is carrying is deposited on the banks and bed. Thus, higher flows associated with storms and spring snowmelt are responsible for shaping the channel. Large floods move more sediment and widen the channel more than small floods but they are also much less frequent. The smaller floods that occur every one to three years fill the channel and generally determine the channel size, or the bankfull capacity.

The ratio of the bankfull channel width to bankfull mean depth (width-to-depth ratio) affects water temperature and provides information on channel stability. With more exposed surface area, wide streams can heat up and cool down faster than narrow streams. Also, streamside vegetation cannot shade the surface of a wide stream. Wide, shallow streams also suggest active or past bank erosion and are generally less stable than narrow, deep streams. In the Token Creek watershed, surveyed stream sections have a relatively high width-to-depth ratio, confirming that their channels are wide, shallow and subject to bank erosion and water temperature variations. Although gravel streambeds have been observed in a few areas, the primary materials on stream banks and beds are fine-grained sediments. Silt deposit depths range from a few inches to several feet thick over sand and gravel. This information indicates that topsoil has eroded from uplands and washed down into the streams over time. The small particles in these channels now make the streams highly sensitive to erosion and prone to high turbidity during flows.

Pederson Tributary

Pederson Tributary originates in the Town of Windsor section 34 and flows south before entering Token Creek in the Town of Burke. The land use in this area is dominated by agriculture, residential development, and wetlands. ***Factors that impair water quality of this tributary include sediment and nutrient loading from agricultural fields, historic stormwater runoff from older urban areas and highways.*** The current biological use of the fishery is Coldwater. Fish species found in this tributary include brown trout, white sucker, and mottled sculpin. Macroinvertebrate samples indicate good water quality (HBI = 4.75). There was also an abundance of watercress *(Nasturtium spp.)* present. Watercress is a biological indicator of good water quality and high groundwater discharge.

Harbison Tributary

Harbison Tributary joins Token Creek approximately one mile east of the USH 51/STH 19 interchange. Baseflow is estimated to be approximately 2.0 cfs. The stream has a large spring complex (Pederson Springs >200 gpm) on the north side of STH 19 on property owned by Dane County. According to WDNR fisheries biologists, the stream contains natural populations of brown trout and likely brook trout as well, since the stocking of brook trout in the early to mid 2000s.

Four coldwater IBIs done in 2000 and 2001 all indicated good biotic integrity. This is consistent with the watershed HBI assessment monitoring of 1994 and 1995. WDNR has been doing habitat improvement projects including removal of a rough fish holding pond and stream bank work to improve instream and riparian habitat. A fish survey conducted in 2004 found good numbers of young-of-year brown trout (indicating natural populations) upstream of STH 19 as well as good nursery habitat. Downstream of STH 19 has more adult brown trout from 7-14 inches. ***This tributary is a valuable resource as both a source of cold water for Token Creek as well as a nursery source for reproduction of brown trout, which provides recruitment of fish for Token Creek.***

Because trout and other aquatic organisms typical of a coldwater ecosystem are intolerant to wide environmental variations, the qualities that the springs contribute are vital for a coldwater ecosystem to exist and thrive. In addition to serving as a source of water, the springs bring up clean sand and prevent accumulation of silt in areas of rapid upwelling, thereby providing critical spawning habitat.

Stream Restoration

Successful stream restoration projects require both scientific understanding and participant cooperation. A fine balance must be struck between the promotion of stream health and the desires and attitudes of landowners. Symptoms of poorly functioning streams are steep bank erosion, high sediment loading, and flooding. Modifications to streams such as rip-rap, channelization, bank armoring, levees and other flood and velocity control engineering only correct in-stream problems yet do not address large scale systemic problems. Maximizing stream restoration benefits occur when the watershed level is considered. This is accomplished through land management practices that hold water and slowly release water into streams.

> **Issue:**
>
> **Stream Restoration**
>
> - Maximize stream restoration benefits by considering watershed
>   - o Unify landowners to help
> - Streams need to remain dynamic
> - Stream restoration methods:
>   - o Modify land use (soft)
>   - o Modify stream itself (hard)

While restoration projects can occur in one locality, stream restoration requires coordination and negotiation with multiple landowners and jurisdictions in order to be successful. Efforts in stream restoration should be directed toward restoring processes that form, connect and sustain habitats. One challenge is to grant incentives to landowners with properties in stream headwaters, and who do not see the negative impacts of stream degradation, as compared to landowners downstream who most experience erosion and flooding.

Once landowner buy-in has been achieved, stream restoration projects should follow the five criteria for ecological success as described by Palmer et al. 2005, as follows:

1. ***a restoration goal or guiding vision that describes an ecologically healthy state that maintains dynamic properties within its regional context;***
2. ***undisturbed or recovered streams serving as restoration reference sites, specifically when historical data is lacking;***
3. ***using a design approach which uses empirical models that focus on ecological processes;***
4. ***using regional stream classification systems to guide restoration goals;***
5. ***using common sense to notice site details and remove obvious stressors (lack of riparian vegetation, unrestricted livestock).***

Successful restoration in streams requires dynamic qualities, not excessively imposed control leading to static conditions. River dynamics are often described as reaching an equilibrium that describes natural fluctuation around a character state. Stream70 restoration strategies often seek to correct flow regimes. Alterations in flow regimes have devastating impacts within riverine ecosystems. River flows determine flooding patterns, and it shapes the physical habitats of the river and the floodplain. Changes in flow negatively affects the distribution of organisms, impairs reproductive strategies of aquatic organisms, impairs habitat utilization and in stream connectivity. With these environmental changes, native organisms are quickly displaced by invasive species, which force their own changes on ecological structure and function.

In general, there are two categories of techniques used in stream restoration: non-structural or structural techniques:

Non-structural techniques use passive restoration; any restoration method that does not involve physical alteration of the environment and landscape oriented methods, changing land use through administrative or legislative means. Streams tend to be resilient ecosystems. If environmental stressors are identified and eliminated, sometimes streams will recover without active human intervention. Methods for non-structural stream restoration use fencing to exclude livestock, establishment of greenways, and conservation easements.

Structural techniques use active restoration, which does require modification to the environment. Structural techniques are divided again into two categories, those that use "soft engineering", which focuses on the use of on site natural materials such as alluvium and woody debris. This is contrasted against "hard engineering" which utilizes artificial materials like concrete, sheet piling and riprap. Physical manipulations intend to change stream sinuosity, gradient, substrate and sediment loading. As the amount of human intervention in stream restoration increases, the cost and immediate disruption to the system follows. However, physical manipulations may have more immediate results rather than potentially waiting years for streams to recover on their own.

The most likely areas within this FUDA study area that may require in-stream restoration or enhancement will be in higher order streams. Stream order is a ranking system. First order streams, have no other streams leading into them, and are headwaters of a larger stream ecosystems. The flow here is much less than higher order streams. The best means of protecting first order streams is through the use of vegetative riparian buffers (discussed on page 122.

A second order stream is the confluence of two first order streams, as is a third order stream a confluence of two second order streams. As stream order increases so does sinuosity and stream bank erosion until major confluences like the Mississippi River are formed. These middle order stream locations are most conducive to using hard engineering techniques. Major areas that should be thoroughly examined are the lower branches of streams before they drain into the lakes.

The extent of a stream restoration in urbanizing environments will be ultimately determined by social values. Restoring a stream to pre-settlement conditions may not be possible. Stream restorations in this context should be guided by determining what can be done to promote a dynamically variable environment, but constrained by site history and the need to protect property.

Cherokee Marsh

Cherokee Marsh is an extensive peat deposit along the Yahara River and Token Creek, north of Lake Mendota. Covering nearly six square miles, the continuous ***Cherokee complex is the largest wetland in Dane County and the major wetland in the Lake Mendota watershed. Abundant groundwater flow is from east to west toward the river, with local discharges appearing in several places to maintain good quality natural vegetation.***

Cherokee Marsh contains a diversity of plant communities including fens large and small; relic tamaracks, alders, and bog mats; various sedge meadows with and without shrubs or reed canary grass; ponds, shallow marsh, and some deep marsh; river flora, wet prairies, and willow swamp; upland oak, cherry, ash, and basswood forest; old fields; and numerous gradients between communities and between disturbed and undisturbed sites (Bedford and Zimmerman 1974). ***The rich flora and fauna includes many rare species.*** The less accessible central areas likely retain the condition and appearance of many of the Yahara basin marshes a century ago. The more accessible peripheral areas including river frontage, have in many places been converted to disturbance vegetation, such as reed canary grass or shrubs.

Issue:

Excess Nutrients and Sediment, Hydrologic Alteration

What has been done since late 1990s:

- Agricultural BMPs
- Urban BMPs

What else can be done:

- More resources for agricultural BMPs
- Retrofit BMPs in older urban areas
- Restoration of wetlands, woodlands, prairies, and pastures in selected agricultural areas.
- Hydrologic budget evaluation

Cherokee Marsh

Cherokee Marsh probably owes its preservation to the raising of the level of Lake Mendota by the Tenney Park Locks in 1912, making it more difficult to drain, and preventing peat fires during the 1930s. Raising the lake drowned some swamps and deep marsh but spared the fens which were originally well above lake level. Considerable damage has been caused by extensive ditching, which has dried out large portions of the marsh; dredging of tributary streams, Cherokee Lake, and the golf course including pumping the spoils into the wetland; planting and invasion of reed canary grass, woodlot and lowland grazing, and siltation from agricultural activities. Introduced carp have removed the wild rice and cause perpetually muddy water.

Major threats include municipal well withdrawals, and ditching of property still in private ownership. Hydrologic studies should be conducted and plans made to place future wells so as not to deplete Cherokee's groundwater supply. Lake Mendota's water quality as well as Cherokee's vegetation depend on adequate moisture to maintain the peat. Cherokee marsh is a major nutrient and flood storage for Lake Mendota. ***Further drainage would harm the lake by allowing the peat to oxidize; therefore neither ditching nor mining of essential groundwater should be allowed lest the peat dry out and oxidize, thereby releasing nutrients to the lake. Peripheral development must be guided to protect surface and groundwater supplies and quality, as well as provide a protective buffer zone.***

3. Wetlands

Over half of the wetlands in Dane County and the U.S. have been lost over the last century, including those in the North Yahara FUDA study area. Many of the wetlands that remain have been degraded. This has resulted in the loss of important wetland ecological functions and values, but also incurs socioeconomic costs. It has become increasingly recognized that all wetlands have value – particularly since there are fewer of them remaining. Significant advances have also been made in the science of wetland restoration, as well as public opinion and policies for protecting and restoring wetland acreage, diversity, structure and function.

Wetlands play a critical role in the hydrology of river basins. Wetlands are valuable for flood control, cleansing surface water of contaminants including sediment, heavy metals and pesticides, the organic peat permanently locking many chemicals; and providing important wildlife habitat, trophic support, movement corridors, and scenic qualities. As the North Yahara FUDA study area continues to be transformed from agricultural to urban land uses, retaining these wetland functions and values will remain important.

The Wisconsin Wetland Inventory (WWI) indicates that wetlands exist along streams, small lakes and marshy areas in the study area. Based on the hydrologic modifier codes for the WWI Map units, most of these wetlands appear similar from a hydrologic standpoint, with a modifier of "K" indicating standing water during much of the growing season. Wetlands in the study area include shallow marsh, sedge meadow, shrub carr, and occasionally forested wetlands.

Limited surveys have been conducted to assess the health and quality of these wetlands. Overall, there is a broad range of biological quality among the wetland sites depending on site specific factors. Generally, the quality of these wetlands depends on nearby land use, such as the intensity of agricultural activity (i.e. pasture, cultivated or mowed land, or those that have been ditched or drained); or urban development (such as polluted runoff or filled wetlands). Low disturbance wetlands feature native wet prairie and sedge meadow species. Medium and high disturbance wetlands are characterized by an abundance of reed canary grass or woody shrubs resulting from varying degrees of ditching or hydrologic alteration. Some have been affected by nutrient enrichment or sedimentation promoting more aggressive exotic plant species to displace native species.

As part of the natural resource inventory for the *Dane County Water Quality Plan,* a study of wetlands in Dane County was conducted by Bedford and Zimmerman in 1974. This study provided information for planning, and decision-making, and to also explore strategies for managing wetland resources in the county. The study was conducted on the premise that the information necessary to determine the type of wetland, its condition, and its value can be read from indicators seen in the field. The wetlands covered in the study included all of those known or suspected at the time to be of particular value, and these sections of the Bedford and Zimmerman report have been included in Appendix C of this ECR. ***The most valuable of these were studied in detail by the CARPC Restoration Ecologist in 2011. Wetlands that could not be visited are included in the areas labeled as being "Not Inventoried" on*** Map 21. More investigation is needed to evaluate and group these wetlands. Ephemeral or temporary ponds have also not been listed, even though they may provide critical life cycle habitat for some species, especially amphibians. Whereas some of the information contained in the *Wetlands of Dane County* is dated and needs to be re-visited, it provides valuable information, especially when combined with the significant progress that has been made in our understanding, appreciation, and management of these critical resources over the last 35 years.

While all wetlands have value, decisions must sometimes be made as to where specific approaches and efforts are best tailored or targeted. Except for Cherokee Marsh, based on more recent survey work, the majority of wetlands in the Northern FUDA study area appear to be Group IV or Group V wetlands, reflecting the significant historical agricultural influence in the area. More detailed wetland evaluations and restoration plans are needed to enhance the potential functions and values associated with these areas (see Wetland Restoration, below).

a. Wetland Groups

The information collected during the 1974 study was used to group wetlands into five categories. ***Wetlands are grouped based on their present or potential biological condition, scientific value, public use, extent of degradation, and immediate or long-range threats.*** While all wetlands have value, decisions must sometimes be made as to where specific approaches and efforts are best tailored or targeted.

Group I Wetlands are the best in the county and, in some cases, among the most valuable in southern Wisconsin (see "Map 21" on page 115). ***Cherokee Marsh is a good example within the study area. Although showing signs of disturbance they remain virtually intact.*** In addition to their wildlife value, water quality, and flood protection benefits, these sites also provide important reference sites for designing restoration projects in other areas. Every effort should be taken to protect them.

Group II Wetlands include many of the large peat deposits, which are particularly valuable for protecting the Yahara River and its chain of lakes. ***These include Waunakee Marsh, Pheasant Branch Marsh, Sixmile Creek and Dorn Creek wetlands.*** While the survey information may be somewhat dated, these wetlands still remain in very good condition. Most of the wetlands in this group are large or deep enough to have resilience. Alterations have not had a profound effect. These wetlands should receive the same protection as those in Group I, and it is certainly possible to improve or enhance their condition.

Group III Wetlands, although substantially altered, do in fact receive wildlife use, provide open space, and enhance the environment overall. While all reasonable efforts should be made to ensure their protection, ***enhancement may be especially important to improve one or more degraded functions such as flood protection, water quality, and wildlife habitat.***

Group IV Wetlands maintain some function or exist for temporary periods of time (such as protection from flooding or for migratory waterfowl use). Many of the Group IV Wetlands could not be surveyed during the original study because of limited resources. ***The fact that they can still be considered wetlands after many decades of drainage indicates that they are not well suited for agriculture. Their best use appears, then, to be enhanced or restored for one or more wetland values or functions – rather than continued attempts at drainage.*** The wetlands in the headwaters of Black Earth Creek downstream of USH 14 are a good example.

Group V Wetlands no longer exist or function as a wetland ecosystem. ***Ditching, draining, or filling has destroyed all functions and values.*** It may be possible, however, to restore them by reversing the action(s) that destroyed them in the first place. ***These areas present significant opportunities to restore wetland acreage that has been lost over the last century. The former Pheasant Branch wetlands are a good example of this and the Pheasant Branch Confluence Pond project as an excellent example of how these wetlands can be restored to serve important values and functions (e.g., flood control, water quality improvement, wildlife habitat, outdoor recreation and scenic beauty). Another good example is a Dane County wetland restoration project planned in the headwaters of Black Earth Creek immediately downstream of the Middleton business park.***

Wetlands should be protected regardless of their quality, because they are scarce in the landscape and because of the values and functions they do provide, no matter how small or degraded. ***Many degraded wetlands provide important flood protection benefits and open space corridors.*** Many sites, particularly those where native species remnants exist, have a high potential for restoration or enhancement. So too do those that have been ditched or drained, since it often possible to restore their natural hydrology by plugging ditches or breaking tile lines. In the end, the management strategy for each wetland will be as unique as the wetland itself, based on the site characteristics and available resources and opportunities. Because of the scarcity of remnant aquatic habitat, both aquatic and terrestrial endangered species are often found associated with wetland areas. Likewise, many ephemeral wetlands provide important breeding habitat for amphibians, which serve as food for other wildlife. Therefore, enhancing the quality and extent of wetland habitat in an area helps support and promote natural food webs, biotic health, and overall species diversity. This topic is discussed more fully in later sections.

Wetlands and former or converted wetlands pose significant constraints to development such as high water table levels, potential flooding, and poor soils. County and municipal zoning prohibits development in wetland areas of 2 acres or greater. Wetlands, regardless of size, are also regulated by other state and federal laws. Existing laws and regulations, however, do not always provide adequate protection. ***The best strategy is to avoid these areas completely and direct future development to better suited areas.*** In addition, existing laws and regulations largely ignore opportunities to restore some of the large wetland acreages (and associated functions and benefits) that have been lost over the last century. These remnant wetland acres should provide the basis or framework for carrying out an effective wetland resources protection and restoration strategy here, as in other watersheds throughout Dane County. Property tax law creates a disincentive for farmers who may be interested in wetland restoration by valuing wetlands higher than cropped farmland. ***Therefore, by restoring prior converted wetlands, farmers have to be prepared to pay higher property tax and lose income from reduced crop yields.***

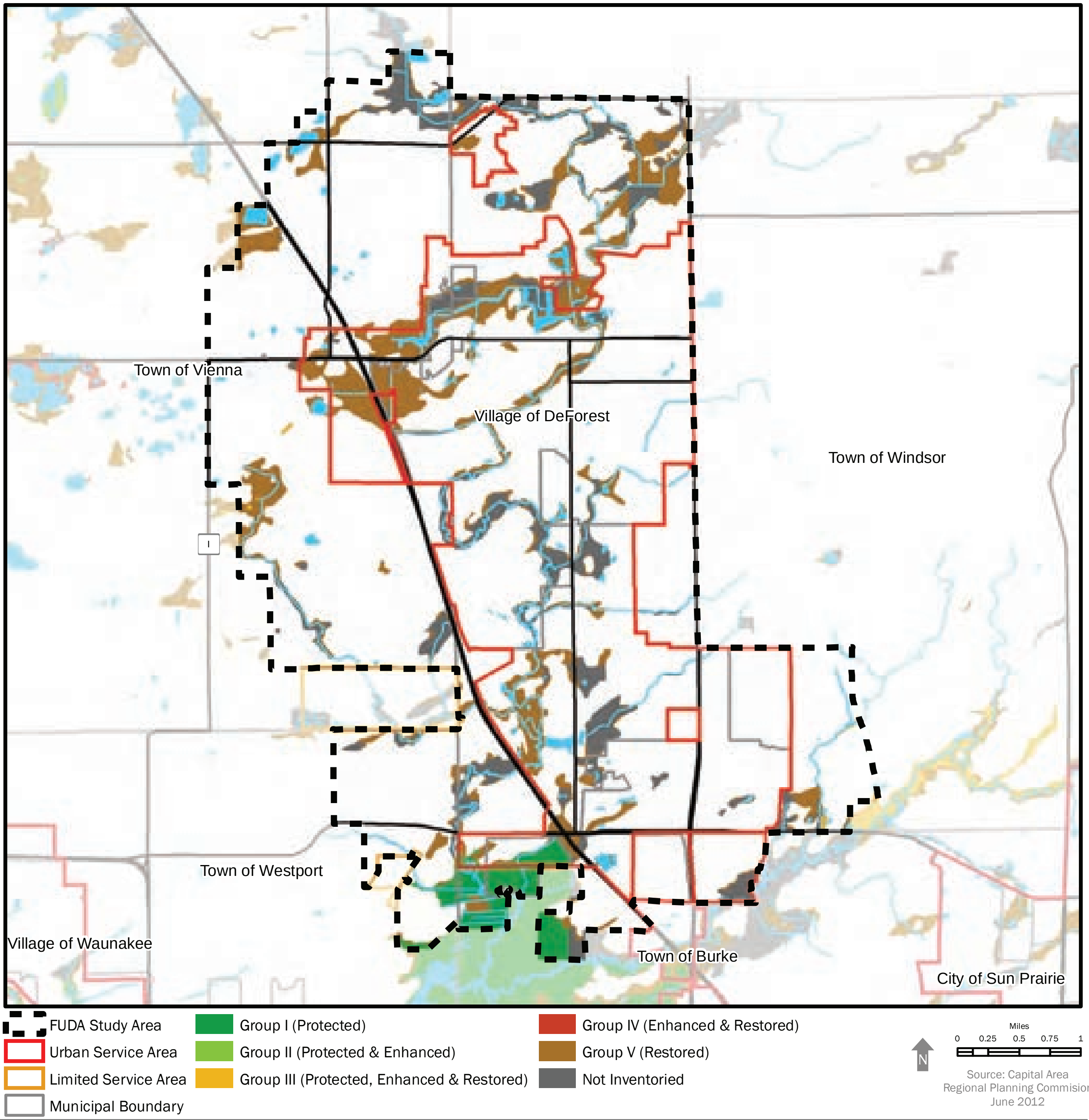
The Bedford and Zimmerman study is a particularly useful reference for those in the early stage of designing their own wetland restoration or enhancement projects. It is important to realize that as with all ecosystems, each wetland is unique. In the end the management strategy must be tailored for each unique wetland.. Wetland protection and restoration plans are routinely developed by consulting firms on behalf of their clients. There is also federal, state, and local funding available to promote these projects. The *Dane County Wetlands Resource Management Guide* (CARPC 2008) outlines a process and framework for developing successful wetland restoration and protection plans and projects in collaboration with public and private partners. In areas that have not been inventoried or information is significantly out of date, CARPC restoration ecologist/biologist can provide more current assessment, recommendations, and assistance especially during the more detailed and technical design work associated with particular development scenarios, plans, or projects.

Overall, wetlands provide very significant and valuable wildlife habitat, recreational opportunities, and water resource benefits and functions. Areas with hydric soils are a strong indicator of historic and potentially restorable wetlands. It is recommended that prior converted wetlands be restored whenever possible, and degraded wetlands be enhanced where opportunities permit. Existing wetlands should include a minimum buffer of 75-100 feet for water quality protection, and included in park and open space areas as Environmental Corridors.[53]

53 Environmental Corridors are continuous systems of open space in urban and urbanizing areas that include environmentally sensitive lands and natural resources requiring protection from disturbance and development (DCRPC 2004).

Map 21: Wetland Groups

North Yahara Study Area, Dane County, WI



Wetlands are grouped based on their present or potential biological condition, scientific value, public use, extent of degradation, and immediate or long-range threats. While all wetlands have value, decisions must sometimes be made as to where specific approaches and efforts are best tailored or targeted.

b. Wetland Restoration

As with all restoration activities, the goal is to create a self-sustaining, self-organizing ecosystem with similar ecological functions relative to historical or reference communities. ***For restoration to be successful, the ecological community will need to remain persistent, maintain ecological function after disturbances -- ecological resistance, and have the ability to return to its previous state after disturbance -- ecological resilience. There are three general approaches for wetland restoration. These are reestablishing hydrology consistent with historical patterns, control contaminants from entering into the wetland, and promoting native species while controlling invasive species.*** Like the stream restoration section described above, wetland restoration can be divided into two general categories, passive and active restoration. General passive techniques include eliminating grazing and mowing, which allows for the native vegetation to return. Active restoration techniques for wetlands include removing fill, changing site hydrology through changes in geomorphology (channel redirection), removal of invasive plant species with replacement by native species.

Issue:

Wetland Restoration

- Wetland restoration; three means
  - Hydrology
  - Contaminant control
  - Invasive species control
- Promote connectivity & consider the watershed
- Wetland restoration methods:
  - Modify land use (soft)
  - Modify wetland itself (hard)
- Seek governmental assistance for wetland restoration funding
- Altering land-use practices in adjacent agriculture can improve wetlands by reducing fertilizer inputs.

Wetland restoration occurs on a site by site basis. The potential role for wetland restoration within the watershed scale approach is usually not considered. This is largely due to limited resources and finding willing landowners who wish to participate. ***Restoring wetlands should be considered in a cumulative context, whereby more wetlands within a watershed are restored, the greater the influence on improving water quality. Considering landscape connectivity between wetlands is also important,*** not only for animal movement and dispersal but also for controlling the spread of invasive species.

There are multiple invasive species found in the wetlands of Dane County. The two most prolific invasive species of major concern are reed canary grass *(Phalaris arundinacea)* and hybrid cattails *(Typha angustifolia, T. x glauca).* To a lesser extent within wetlands, willows *(Salix spp.)* can be problematic as high density bush stands. Invasive species are problematic because they often form high density monotypic stands within the ecosystem which causes decreased species diversity, impairing food web interactions, and removing habitat. Invasive species affect ecosystem and watershed processes by altering erosion, runoff and depositional processes. There are multiple means of controlling these invasive species with specific strategies based upon degree of spread. Where there are smaller patches of invasive species, herbicide application and manual removal are known to be effective. However, when the invasive species tend to form large, monotypic stands that blanket the area, heavy machinery and controlled fires will be needed. Invasive species control as part of a restoration plan must be performed on adjacent sites, otherwise the invasive species will settle and colonize the site again. If urban development includes construction in areas with restorable wetland sites, it may be beneficial to use heavy equipment to remove extensive patches of invasive species (after receiving permission from WDNR).

Reed canary grass

There are several wetland restoration opportunities throughout the Northern FUDA study. First, generally dispersed throughout the study area in agricultural areas that are poorly drained and have hydric soils, yet persistently fail to produce cash crops. There are government programs designed to assist landowners in becoming natural resources stewards. Some of these programs include the Wildlife Habitat Incentive Program (WHIP), the Wetlands Reserve Program (WRP), and the Conservation Reserve and Conservation Reserve Enhancement Programs. If there are restorable wetlands within these agricultural areas that are not profitable for farmers, participation with these programs may give farmers the financial incentive to participate. ***Second, two large depressional wetlands were evaluated during site surveys of the FUDA area. These are in the northwest section of the FUDA study area near interstate 94.***[54] ***In both circumstances, they represent the largest depressional wetlands within this area. In both instances, the wetlands are surrounded by agriculture, found along roadsides and lack vegetative buffers.*** The most common plant found in these locations are cattails (Typha) yet are not dominated by hybrids. Also, these locations do have reed canary grass, but these populations reside in thin strips along the margins between cultivated land or roadways and the wetland. If these wetland areas were to be expanded, the general guidelines for restoring these areas is relatively inexpensive and includes the cessation of adjacent agriculture, plugging drainage ditches and breaking drainage tiles. Generally, after environmental stressors have been removed, wetland vegetation may return. If not, then a revegetation program will be needed. ***Third, there is a consistent problem of reed canary grass in wetland riparian areas.*** There have been multiple observations where there have been vast expanses of reed canary grass beyond the bounds of wooded riparian zones and ending before a corridor of upland trees or adjacent agriculture. In these locations, the native wetland community has been completely displaced by this invasive species. These expansive areas result in lowered plant community diversity and negative impacts on invertebrate diversity. These two factors may negative influences on organisms higher in the food web, yet current studies are inconsistent.

Wetland restoration should be considered on the landscape level. Interconnectivity between wetlands is important, not only for animal movement between patches, but also for the dispersal of plant propagules. If wetland restoration activities include the control of invasive species, then it is important to note if these invasive species exist in adjacent properties. If these organisms are not controlled, then they will return to the restoration site.

54 Town of Vienna sections 11 & 23

C. Open Space Corridors

An open space corridor is defined as water features and the riparian area of land that has contact with the water either through flooding or soil saturation, and can include upland areas in some cases (see Map 22 ***and*** Map 23***). An area of natural vegetation that protects the water from an adjacent agricultural or urban land use is called a buffer strip.*** Open space corridors promote important values for protecting water quality and habitat for fish and wildlife, as well as for recreational pursuits. In both the Yahara River and Token Creek watersheds the type and width of open space corridor varies greatly. For example, in the lower parts of the watershed in Token Creek County Park, extensive wetlands border the stream on both sides. Farther upstream and above the former mill pond site, the stream is bordered by hardwood forest species such as box elder and willow. The width of this forested band varies with each land owner. ***Most of the ephemeral and very small tributaries in the highest reaches of the watershed have very little or no protection provided by a riparian area. Potential opportunities may exist for establishing or expanding riparian buffers in these areas through pollutant trading between agricultural and urban sources involved in the Rock River TMDL project. However this aspect of the program has not yet been defined. Potential opportunities also exist through the Conservation Reserve Program and other voluntary cost-share/set-aside/nonpoint source control programs administered through the Dane County Land Conservation Department, based on landowner participation and support.***

Planning Considerations::

Potential Wetland Restoration Sites

- Consider opportunities to connect valuable natural resource areas into E-Ways for their recreational, educational, and environmental benefits.
- For example, the Environmental Corridors for the Yahara River and Token Creek and nearby prairie remnants and recharge areas could be expanded upon to showcase these significant natural resource features.

Although the amount of land in the riparian area constitutes only a small amount of the total land in the watershed, it has considerable value for both water quality and the overall life-cycle needs of organisms. Riparian areas link riverine and terrestrial systems and make each more ecologically productive. Riparian areas also serve as habitat for both terrestrial and aquatic species. Insects that emerge from riverine systems feed bird and bat populations. Nutrients from aquatic areas help to support vegetation in upland communities, and this vegetation in turn acts as a filter strip to help protect water quality and prevent upland sediment and associated pollutants from washing into the stream. Riparian areas enhance habitat in many other ways. For example, trees and shrubs along the river help shade the stream from the sun and keep the water temperatures low. Removal of vegetation from headwater streams in agricultural areas can therefore lead to temperature increases in the stream. Logs and branches that fall into the stream provide a suitable place for insect larvae, an important food source for fish. These logs, along with the vegetation that overhangs the stream channel, also provide hiding places and shelter. Fish use these places to rest, hide, and wait for prey. In addition, the leaf litter from trees and shrubs in riparian areas provides nourishment for insects and other stream organisms. Vegetation also provides stabilization for stream banks, with intermingling plant roots providing cohesion, providing drainage and reducing collapse, and buttressing soils from overland forces. Riparian trees dissipate the kinetic energy from floods and improve soil infiltration through increased soil porosity and improving the capillary action.

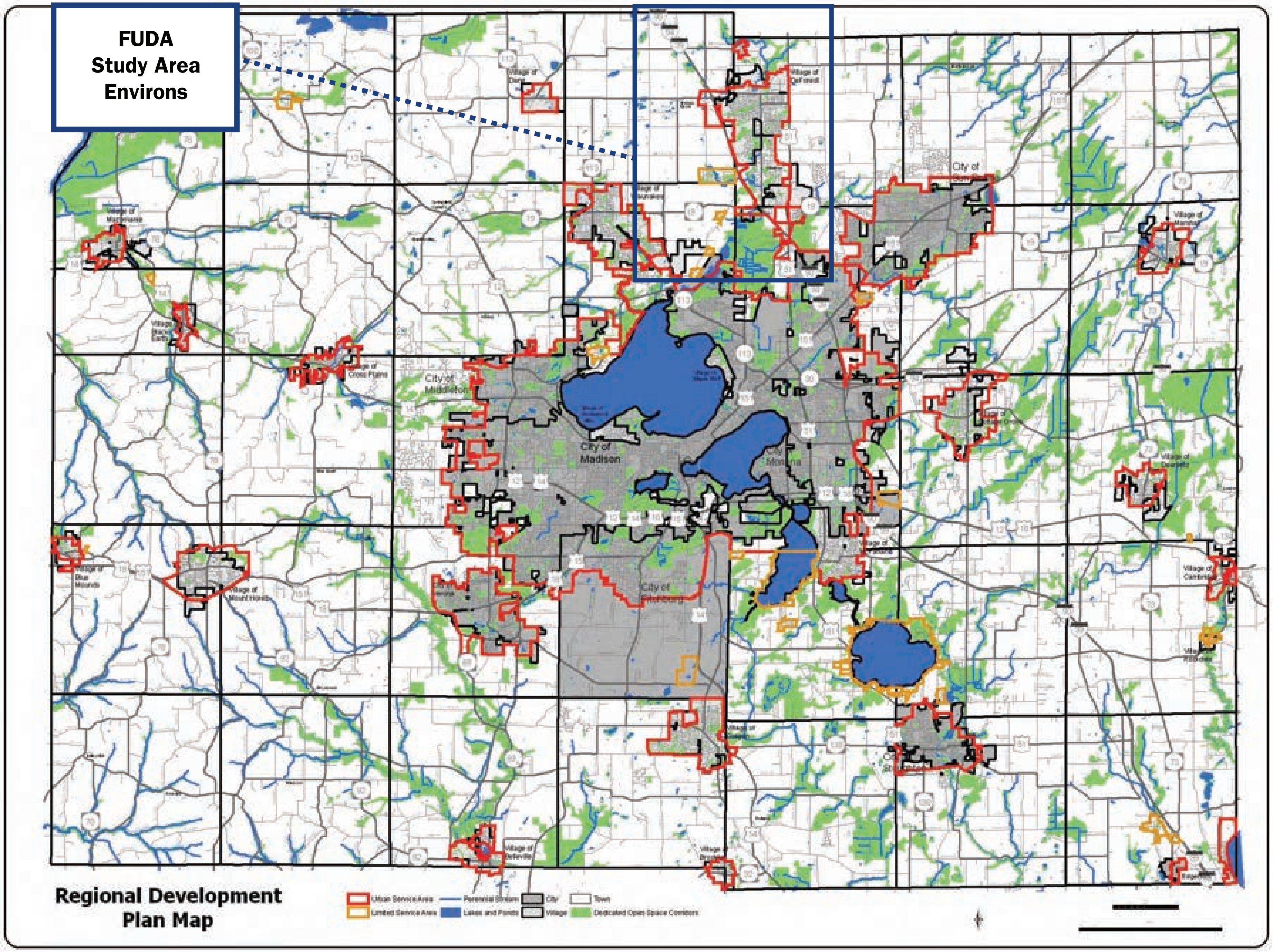
The Open Space Corridors shown on the Regional Development Plan Map (see Map 22) include two distinct components which together provide a continuous countywide network of open spaces and environmental resources considered to be most critical for protection:

Environmental Corridors within urban and limited service areas, provide the basis for a continuous open space system based on natural features and environmentally important lands such as streams, lakes, shorelands, floodplains, wetlands, steep slopes, woodlands, parks, and other publicly owned lands.

Resource Protection Areas in rural areas (outside urban and limited service area boundaries), are based primarily on floodplains, wetlands, and shoreland areas – lands protected through shoreland zoning and other regulations, along with publicly owned lands (e.g., parks). These areas face considerably less intensive development pressures than their urban counterpart.

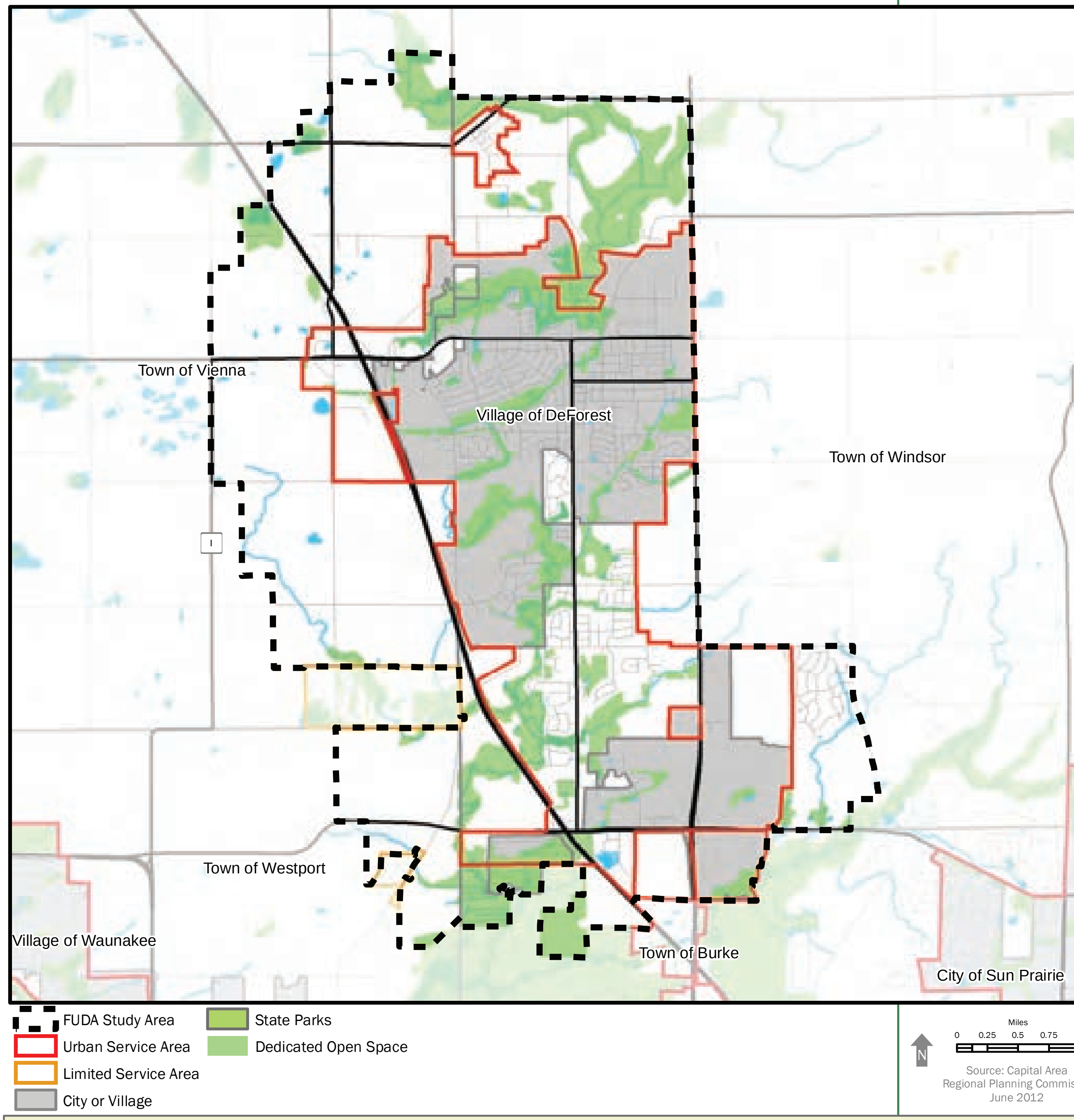
It is important to point out that Environmental Corridors were originally developed to protect sensitive aquatic features from urban development activities where the emphasis was largely directed to water quality concerns (e.g., providing a 75- to100-foot vegetative buffer). ***They were intended to provide a basic skeleton network of connected natural areas which would be expanded through local initiative. The 75-foot vegetative buffers are generally inadequate for protecting habitat, biodiversity, and ecosystem sustainability, which require 150- to 250-foot buffers.*** These concerns have emerged more recently. This is not a significant problem inasmuch as more needs to be done. FUDA planning offers the opportunity to capture and address these broader concerns. With this in mind, more information and discussion is provided in the section of this report dealing with the natural resource impacts from urban development, specifically as it relates to habitat loss and ecosystem health.

Map 22: FUDA Study Area Environs - Regional Development Plan Map



Map 23: Regional Development Plan Map (part)

North Yahara Study Area, Dane County, WI



Source: Capital Area Regional Planning Commision June 2012

Regional Development Plan

1. Riparian Areas and Their Restoration

The most effective approaches to addressing riparian restoration is to understand that within a riverine ecosystem, riparian areas shift and change as streams meander throughout time. ***Considerations for the establishment of buffers should include this meandering and expected change.***

Conserving riparian areas in upslope ecosystems, upstream systems in steep hills, is important for controlling sediment. These areas never achieve static equilibrium and lose sediments in episodic events, mostly during precipitation. Maintaining wide riparian vegetation in these steep areas will be essential for two reasons, (1) steeply sloped areas on the outside bends of stream meanders are not conducive to growing extensive vegetation, this suggests the importance of having wide riparian buffers to control flows through these areas, and (2) precipitation increases due to global climate change will likely make these areas more prone to erosion in the future.

Issue:

Riparian Restoration

- Riparian areas help control:
  - Overland water flows
  - Sediment inputs
- Riparian areas are important for:
  - Human population growth
  - Abating impacts from Global Climate Change
- Control for two major invasive species:
  - Willows & Cottonwoods
- Seek governmental assistance for wetland restoration funding
- Maximize riparian restoration benefits by considering watershed & habitat connectivity
  - Unify landowners to help

The North Yahara FUDA study area has multiple riparian sites where willows in bush form are present. If this species is allowed to propagate throughout riparian areas, it will reduce stream discharge rates. In southern France, pioneer trees such as willows, along the River Ouvèze, caused a reduction in the mean stream width to decrease by nearly half (from 92 m to 50 m). This change reduced the stream capacity to discharge flood waters, which eventually lead to devastating floods in 1992. ***Conversely, the presence of cottonwood trees, as noted in observations around the Waunakee Marsh area will have the opposite effect. Excessive woody debris inputs into streams will cause it to widen, resulting in warmer streams and the deposition of fine sediments.*** These fine sediments, in turn, remove the small interstitial spaces between river stones, that serve as macroinvertebrate refuge and reproductive sites for some fish.

It is important to consider ecological restoration of riparian areas, not only in an immediate context, but also with regard to future stressors caused by global climate change. Global climate change models predict increased severity and frequency of weather events. This will likely cause increased flooding and increased droughts. Considering ecological resilience, the ability for an ecosystem to rebound after an environmental stress and remain adaptable to future change, is important for designing ecological restoration plans. This is particularly important when considering restoration of riparian areas that often experience disturbances in hydrology and geomorphology. With global climate change and expanding human populations, it will be necessary to consider if current standards for riparian protection will be sufficient in future years. Research indicates that riparian vegetation are well adapted to these types of disturbances and may be more resilient than upland habitats. However, there are limits to ecological resilience and human activities interrupt ecological processes, often leading to impaired ecosystem function and colonization by invasive species. ***When possible, it may be prudent to expand buffers beyond 100 feet to increase resilience and redundancy in riparian ecosystems (for more detail on potential approaches see the concept of "core habitat" on*** page 150***.***

Riparian restoration shares with stream restoration the need for cooperation from multiple landowners in order to be effective. Restoration across private lands is important for maintaining connectivity, size and quality of riparian habitat. There are governmental funds available for riparian restoration. Many of these riparian programs are also under the same granting agency as wetlands. Some of these include the Wildlife Habitat Incentive Program (WHIP), the Conservation Reserve Program (CRP), and the Environmental Quality Incentives Program (EQIP). Riparian restoration in agricultural settings may be less interesting to full time farmers on larger plots than part time farmers with smaller plots. The Maryland Department of Natural Resources found higher landowner participation in the installation of forested buffers from small scale farmers who did not receive a majority of their income from agriculture. Farmers of larger tracts of land, who earned their income from agriculture, were more likely to install grass buffers instead of forested buffers.

Ultimately, despite the ability of riparian areas to control overland flows to streams and rivers, riparian conservation cannot be a substitute for good catchment management and land use practices. These areas can be further integrated into broader buffers for park and open space purposes which enhance wildlife habitat and support "core habitat" concepts outlined on page 151 ***.***

D. Groundwater

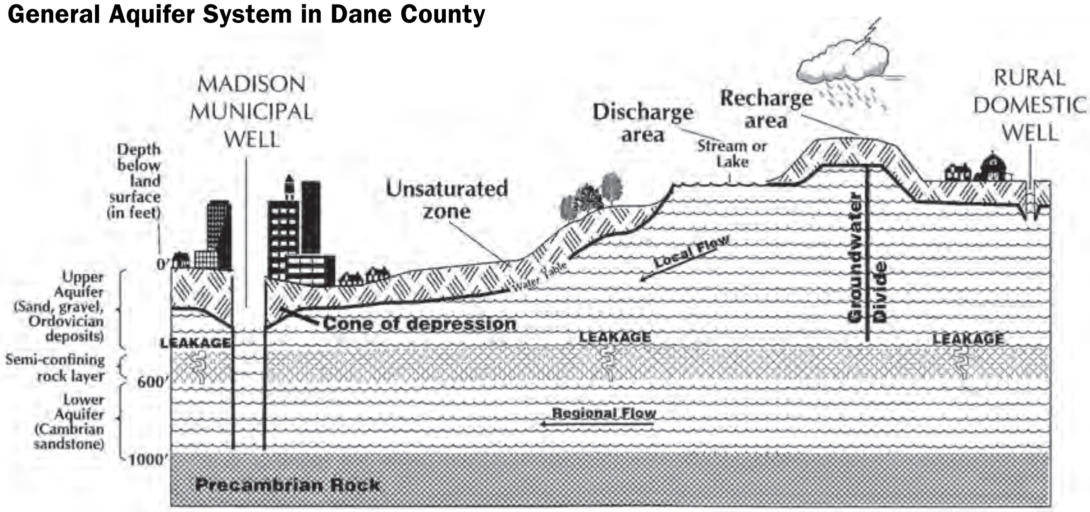
A substantial portion of precipitation that reaches the land surface evaporates. The remainder either infiltrates into the ground or flows downhill as surface runoff. The portion that infiltrates into the ground enters the groundwater system to provide our drinking water and also emerges as groundwater discharge to provide baseflow for streams, lakes, and wetlands. ***Surface water, shallow groundwater, and deep groundwater are closely interconnected. This groundwater/surface water balance can be upset by human activities affecting both the quantity and quality of our ground and surface water supplies. Almost all groundwater in Dane County originates as recharge occurring locally (Bradbury 1999). We are therefore directly responsible for the health of our ground and surface water resources.***

Planning Considerations:

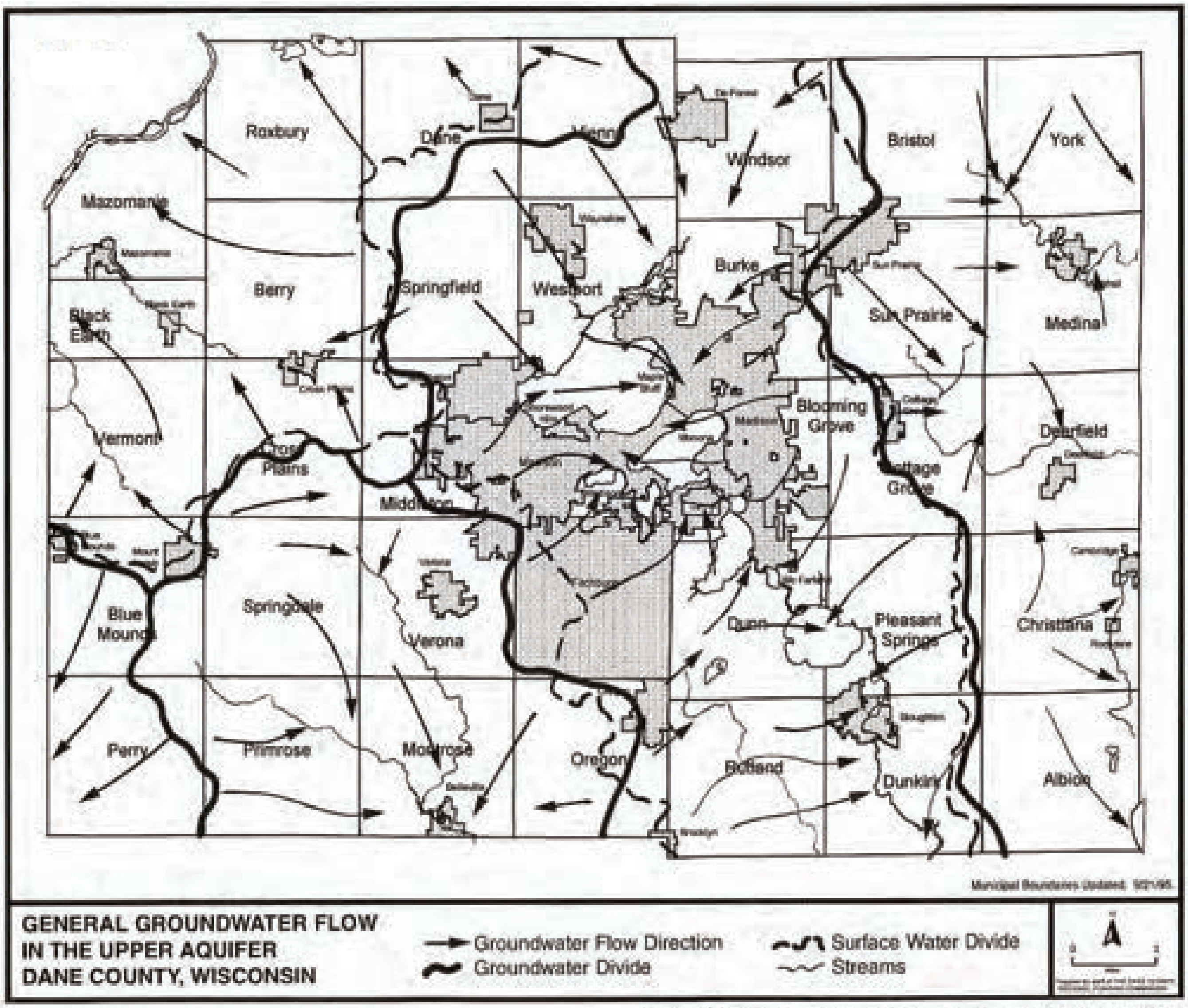
- Identify locations best suited for preservation for active and passive groundwater recharge.
- Use every opportunity to infiltrate rainfall runoff to recharge the groundwater.
- Locate future water wells outside of capture zones for springs.
- Increase water conservation with low flow fixtures and rainwater harvesting.

Most lakes and streams are discharge points for groundwater where the water table intersects the land surface. In general, the water table is a subdued reflection of the land topography (see Figure 15). The depth to groundwater ranges from zero at the fringes of lakes, streams, and wetlands to over 200 feet beneath the ridges in the driftless area. The shallow groundwater in Dane County forms several naturally occurring basins, analogous to but not entirely coincident with surface water basins (see Map 24). Shallow groundwater moves away from groundwater divides. Near major lakes, streams, and wetlands, shallow groundwater flows towards these surface water bodies. Note that groundwater and surface water divides do not necessarily coincide. There are various places in the county where shallow groundwater can move horizontally beneath topographic divides and opposite surface water flow. This is particularly evident where pumping from the Madison metropolitan area has expanded the groundwater divides, thereby capturing more water from the Sugar River watershed in the southwest and the Maunesha and Koshkonong watersheds in the northeast. ***High capacity municipal wells capture water from the deep aquifer often at the expense of smaller streams such as the Upper Yahara River and Token Creek.***

Figure 15
General Aquifer System in Dane County



Map 24. General Groundwater Flow

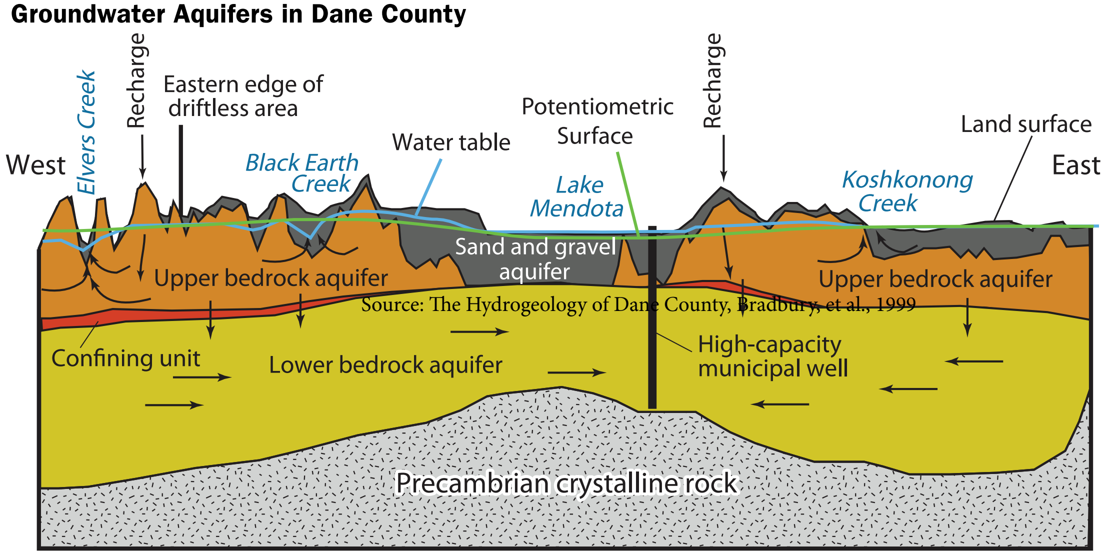


Source: Wisconsin Geological and Natural History Survey, 1995.

Groundwater in Dane County occurs in three aquifers, or useable layers of groundwater (see Figure 16):

1. ***The Sand and gravel aquifer that fills the buried bedrock valleys of the Upper Yahara River;***
2. ***The shallow sandstone and dolomite bedrock upper aquifer; and***
3. ***The deep Mt. Simon sandstone lower bedrock aquifer, underlying the Eau Claire shale aquitard (a confining layer).***

Figure 16
Groundwater Aquifers in Dane County



Note that the Eau Claire aquitard separating the shallow and deep aquifer systems in other areas of the county is largely absent beneath the Yahara Lakes and in the northeast portion of Dane County (see Map 25). ***This implies that shallow and deep aquifer systems are more directly connected where the confining layer is absent, and that the effects of high capacity municipal well water withdrawals can more easily propagate to the surface water systems. These effects include declines in water table levels and reductions in stream baseflow.*** Where the confining unit is present, direct or localized impacts to a particular stream by high capacity well withdrawals can be better absorbed by the deeper regional groundwater supply; by spreading the impact out among other surface water systems. Municipalities typically case new wells down into the deeper Mount Simon aquifer for a variety of reasons (both quantity and quality related).

Groundwater modeling and field studies by researchers suggests that streams and springs in the area are fed by both the shallow and deep aquifer systems (see Map 24 and Map 25) with contributing areas in the uplands. Map 26 and Map 27 show the upper and lower groundwater flow patterns separately to better distinguish these two aquifers. Note that termination of upper aquifer flow lines in the uplands in Map 26 indicate recharge to the lower aquifer in Map 27 Deep aquifer discharge to the upper aquifer near water bodies is not as readily apparent. With regard to the latter, general movement is southeast and east toward Lake Mendota.

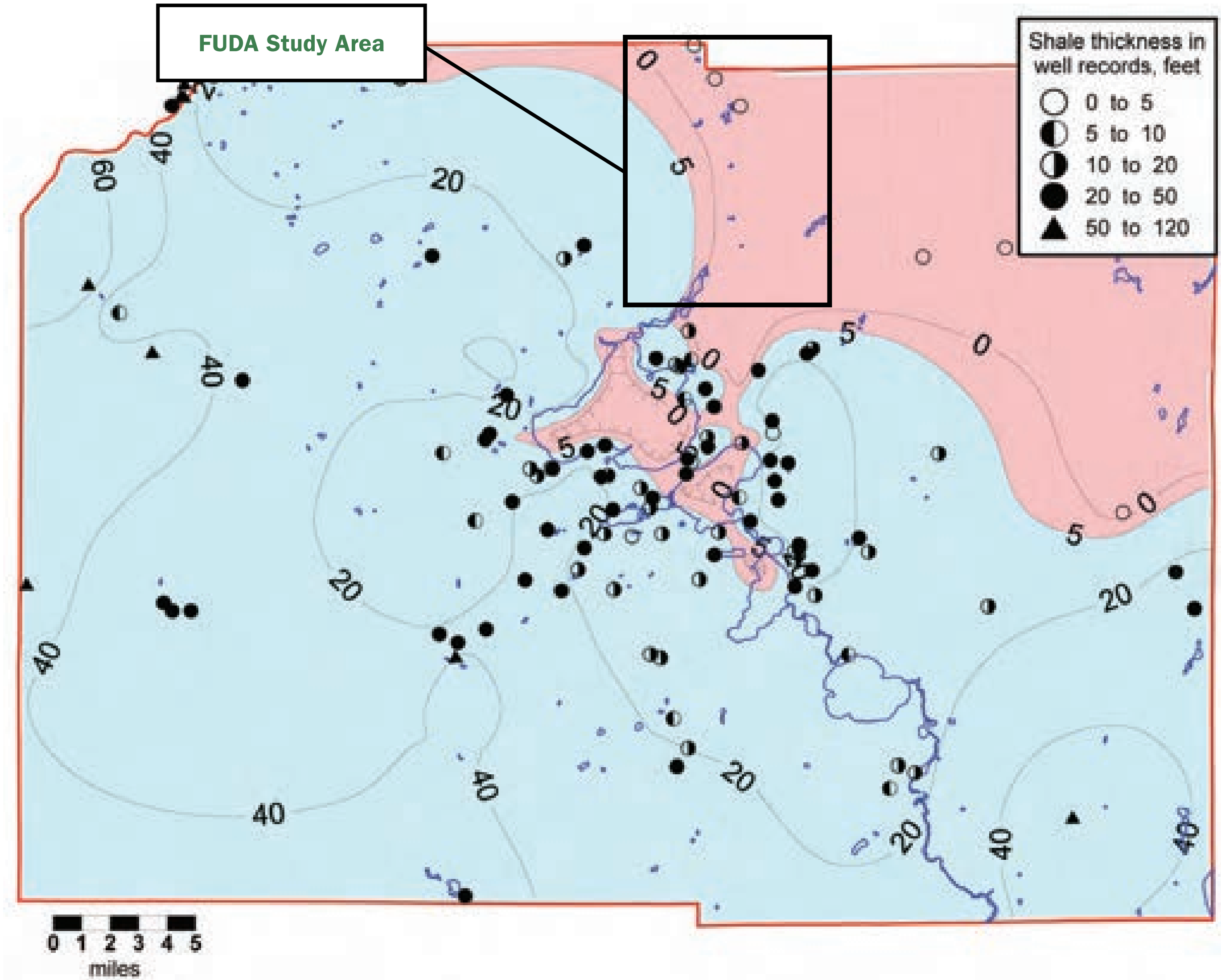
The Wisconsin Geological and Natural History Survey (WGNHS) has mapped several major springs in the Token Creek watershed (see Map 28):

- Pederson Springs (>200 gallons per minute (gpm)) on Harbison Tributary
- Trout Springs (785 gpm) and Culver Springs (2,700 gpm) near the site of the former millpond
- Two small springs: Big Hill Springs at the mouth of Pederson Tributary (10 gpm)
- An unnamed spring on Token Creek east of USH 51 (50 gpm)

There is only one documented spring (10 gpm) on the Yahara River between Morrisonville and DeForest.

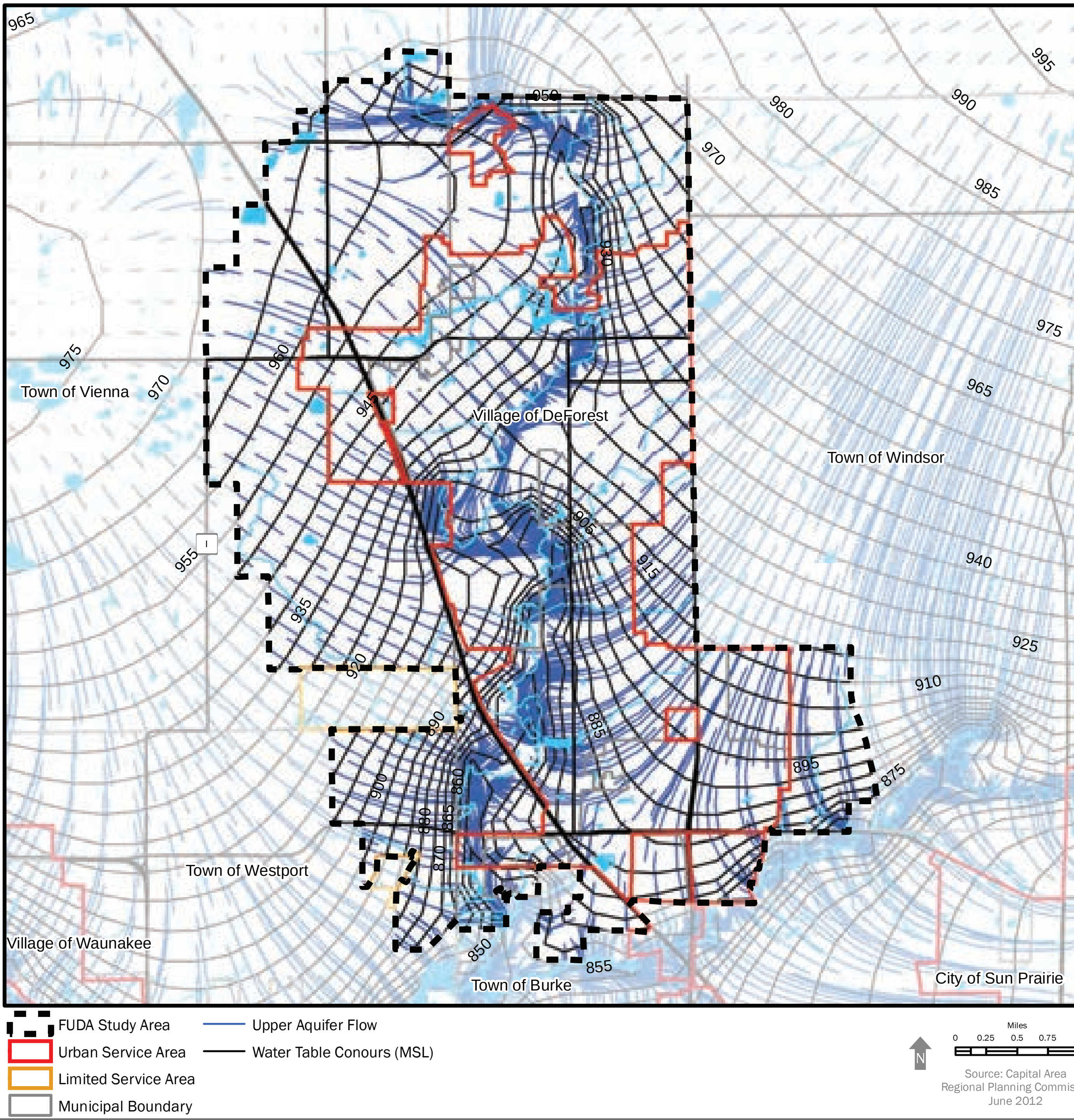
Culver Springs

Map 25: Lateral Extent of the Eau Claire Aquitard in Dane County (shaded red where less than 5 feet)



Map 26: Simulated Groundwater Flow (Upper Aquifer)

North Yahara Study Area, Dane County, WI

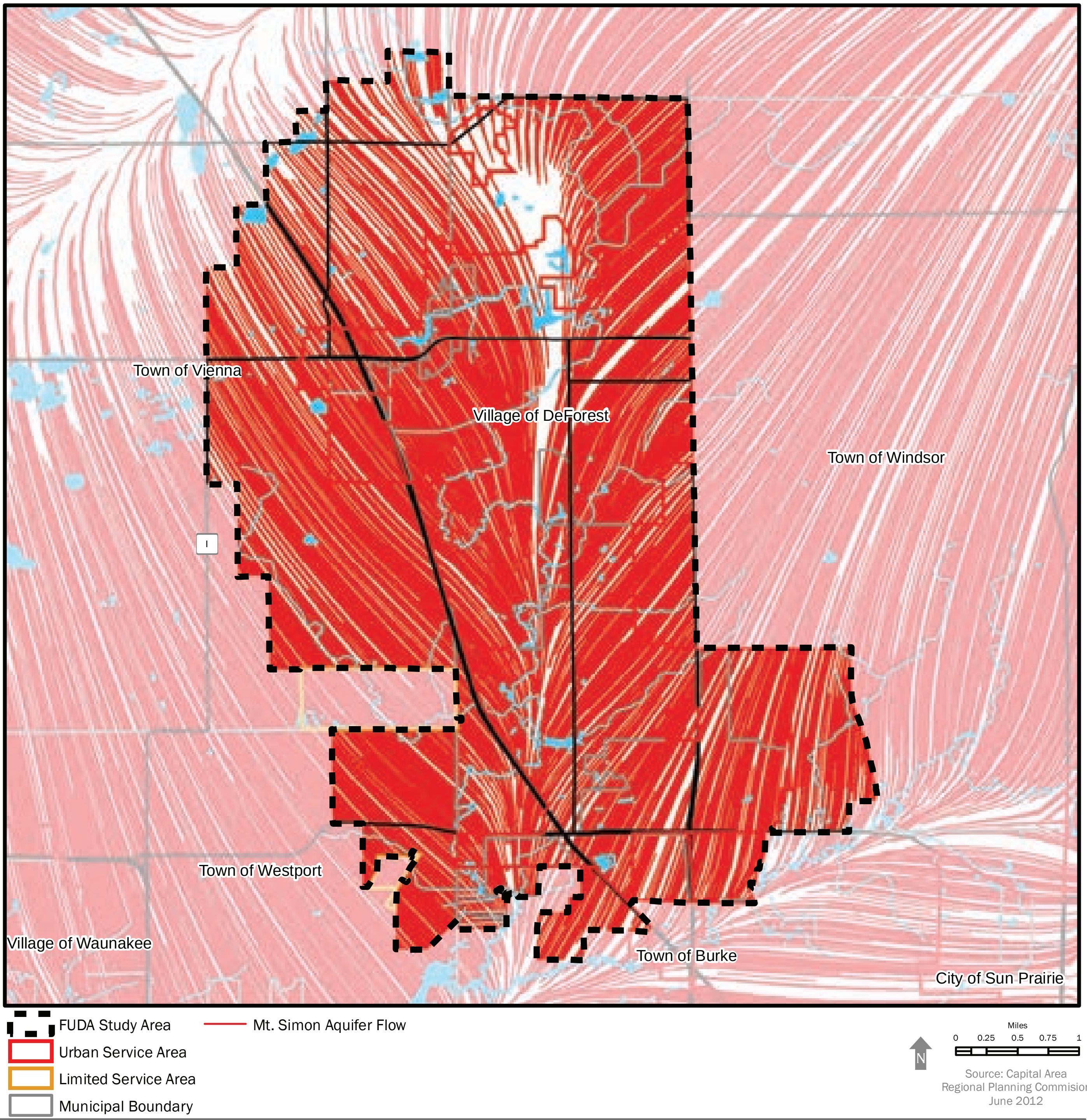


Similar to topographic contours, groundwater flows downhill or perpendicular to water table level contours. Abbreviated flow lines indicate recharge to the deeper Mt. Simon aquifer.

(Source: 2000 Regional Groundwater Model)

Map 27: Simulated Groundwater Flow (Mt. Simon)

North Yahara Study Area, Dane County, WI

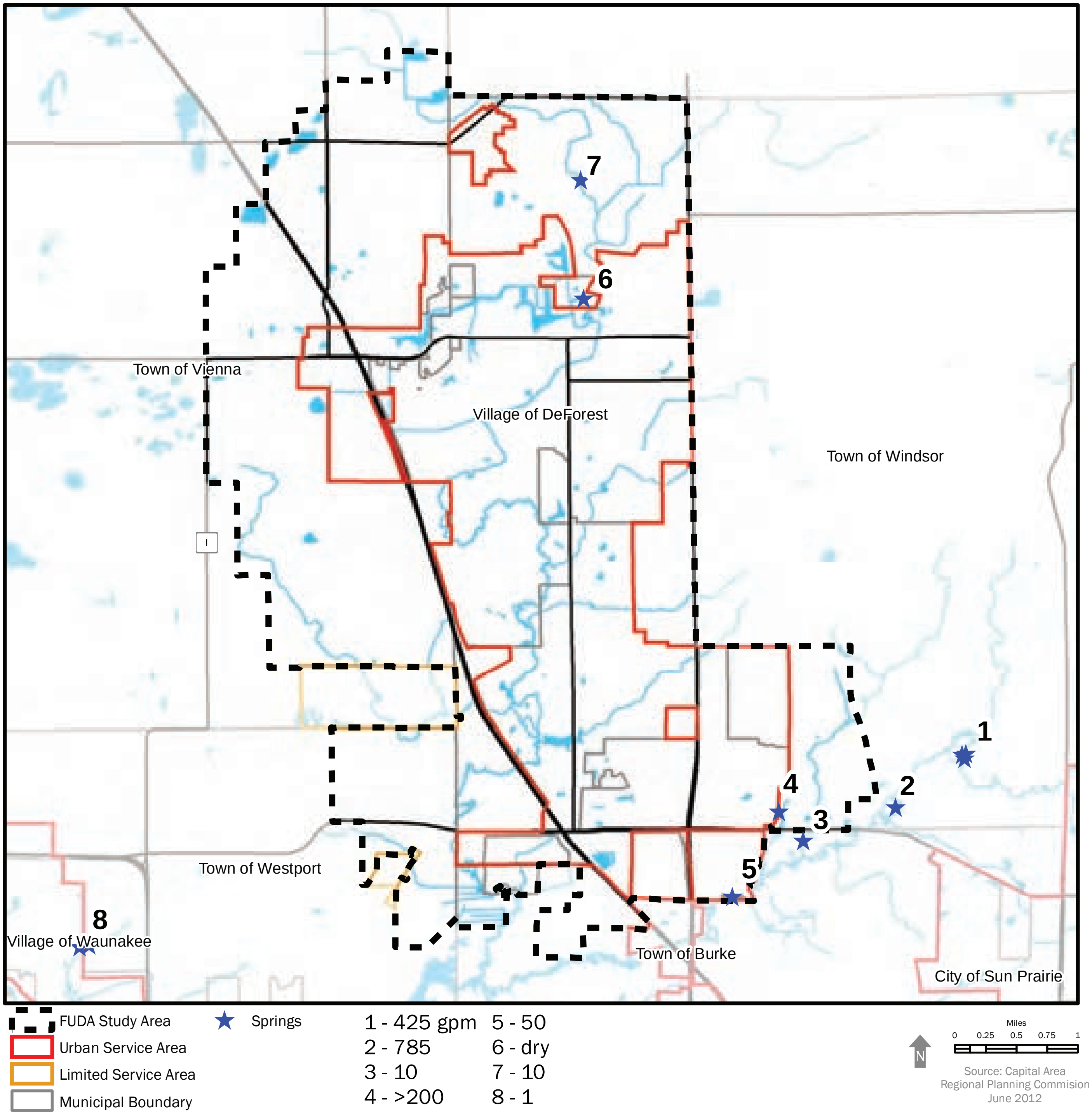


Deeper Mt. Simon aquifer flow indicates more regional groundwater movement.

(Source: 2000 Regional Groundwater Model)

Map 28: Springs

North Yahara Study Area, Dane County, WI



Springs indicate areas of visible groundwater flow to surface water features. Groundwater discharge to a stream along its length may not be as readily apparent except by measuring its baseflow (i.e., streamflow during prolonged dry-weather periods).
(Source: Wisconsin Geological and Natural History Survey)

1. Groundwater Quality

Groundwater supplies nearly all of the water for our domestic, commercial and industrial uses in the North Yahara FUDA study area as well as Dane County overall. Although there is a relatively unlimited groundwater supply for these purposes, it is especially important that the quality of groundwater be protected. Once groundwater becomes contaminated it is very expensive and difficult to return it back to its original condition. Groundwater is also very important for providing baseflow discharge to wetlands and streams, especially during periods of dry weather. ***Groundwater that is withdrawn and used in the North Yahara FUDA study area is for the most part recharged locally from infiltration of precipitation in the immediate area.***

In rural areas domestic water supplies are drawn from the upper sandstone and unconsolidated (glacial) aquifers (see Figure 16). In urban areas deep municipal wells draw water from the deep sandstone (Mt. Simon) aquifer. The shallow groundwater system is of primary importance in questions of groundwater quality. Shallow domestic wells are particularly at risk, compared to deeper municipal wells which are usually drilled to a depth of many hundreds of feet. Deeper municipal wells are also frequently tested. ***Since groundwater represents the source of nearly all our water supplies throughout the county, protection and management of the resource is a high priority.***

While groundwater quality is generally good, there have been localized instances of contamination from nearby pollution sources, particularly in the upper or shallow aquifer affecting shallow private wells. Water supply concerns relate to potential increases in nitrates, dissolved salts, and volatile organic compounds (VOCs), which could affect the deep aquifer from which most municipal water supplies are withdrawn.

Municipal well water quality is highly regulated. Public water supplies in DeForest and Windsor are regularly sampled and tested. The quality is generally quite high and safe for use. In addition, residents receive annual Consumer Confidence Reports from their municipal suppliers required by the Federal Safe Drinking Water Act and U.S. EPA. The reports provide consumers with clear, concise, and accurate information about the quality of their drinking water. Many communities have also defined wellhead protection areas and associated regulations to help protect their wells from contamination.

Map 29 shows the 5-, 50-, and 100-year zones of contribution for Northern FUDA communities' wells pumping at 2030 rates. These provide the technical basis for community Wellhead Protection Plans. DeForest is in the process of developing wellhead protection plans for its wells and Windsor is considering the prospects. Wellhead protection plans are developed to help guide development and prevent contamination of municipal wells.

2. Groundwater Quantity

a. Pumping and Diversion

Pumping or withdrawal of groundwater from one location and then discharging or diverting it to another location can significantly alter the local ground and surface water balance (e.g., MMSD diversion of wastewater to Badfish Creek, sentially short-circuiting the Yahara River system). ***As part of the Dane County Regional Hydrologic Study (DCRPC 2004) groundwater modeling was conducted to estimate the impacts of high capacity municipal well water withdrawals. These impacts can be particularly pronounced in urban areas where concentrated pumping of groundwater lowers the water table, reducing base flow contributions to streams and lakes.*** Figure 17 shows water table declines as a result of year 2000 pumping by as much as 65 feet on west side of the Madison metropolitan area, and by 45 feet on the east side. The fact that there are two cones of depression indicates that the Yahara Lakes are a significant source of water for groundwater supplies. Figure 18 shows the additional water table declines as a result of projected year 2030 pumping and diversion, concentrated primarily in the developing areas of the region.

Baseflows have been reduced by as much as 13% in Token Creek, and nearly half (45%) in the Yahara River measured at McFarland, compared to pre-development conditions (no wells pumping) (see Table 8). ***CARPC recommendations for new Urban Service Areas have encouraged water conservation and infiltration measures to help mitigate these reductions.***

Table 8

Simulated Stream Baseflows for Selected Streams in Dane County (cfs)

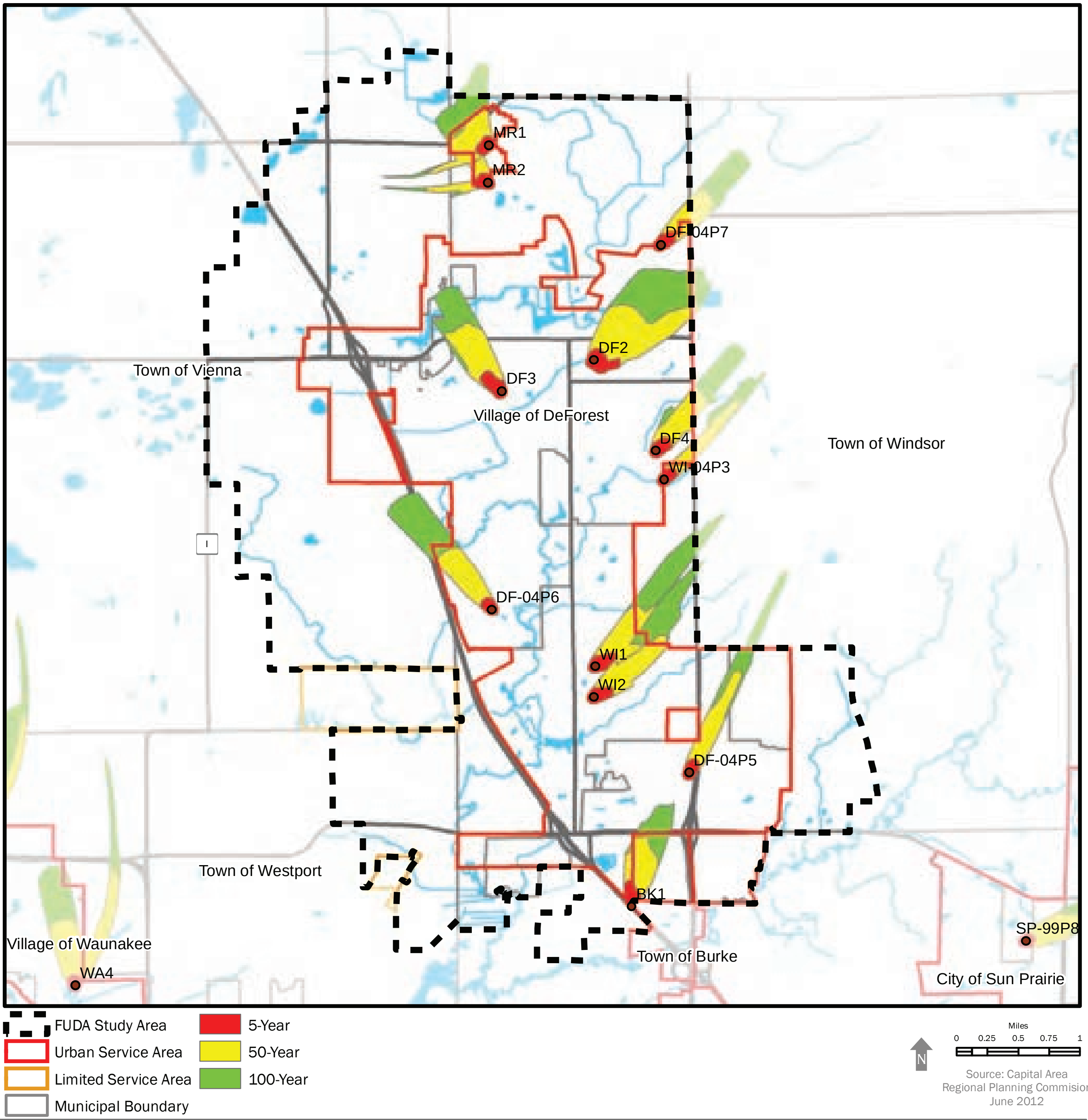
Station	Pre-Development cfs	2000 cfs (% reduction)	2030 cfs (% reduction)
Upper Black Earth Cr.	1.70	0.60 (65%)	0.19 (89%)
Pheasant Branch Cr.	2.20	0.85 (61%)	0.29 (87%)
Sixmile Cr.	4.46	3.40 (24%)	2.77 (38%)
Yahara R. @ McFarland	127.28	70.00 (45%)	54.21 (57%)

Source: DCRPC 2004

To better understand the degree of water quantity impacts to Token Creek and contributing springs as a result of municipal well withdrawals, additional groundwater modeling was conducted to assess the potential water quantity impacts of proposed new high-capacity wells for the Village of DeForest, without any mitigation measures being taken (see Figure 9). The maximum baseflow reduction (percent) would be 0.19 cfs at Harbison Branch (9.7 percent decline compared to no wells pumping), 1.05 cfs at Token Creek below Harbison Branch (4.8 percent decline), 1.10 cfs at Token Creek at I-94 (4.3 percent decline), and 0.24 cfs in the headwaters near Culver Springs (4.0 percent decline).

Map 29: Zones of Contribution for Municipal Wells

North Yahara Study Area, Dane County, WI



Zones of Contribution (ZOC) indicate the area contributing groundwater to a well for an assumed pumping rate and travel time. This simulation assumes projected 2030 pumping rates for communities based on 2030 population estimates spread evenly among both existing and planned wells. ZOCs provide the technical basis for communities in developing wellhead protection plans. (Source: 2000 Regional Groundwater Model)

Source: 2000 Regional Groundwater Model

Figure 17
Simulated drawdown at the water table, 1900-2000

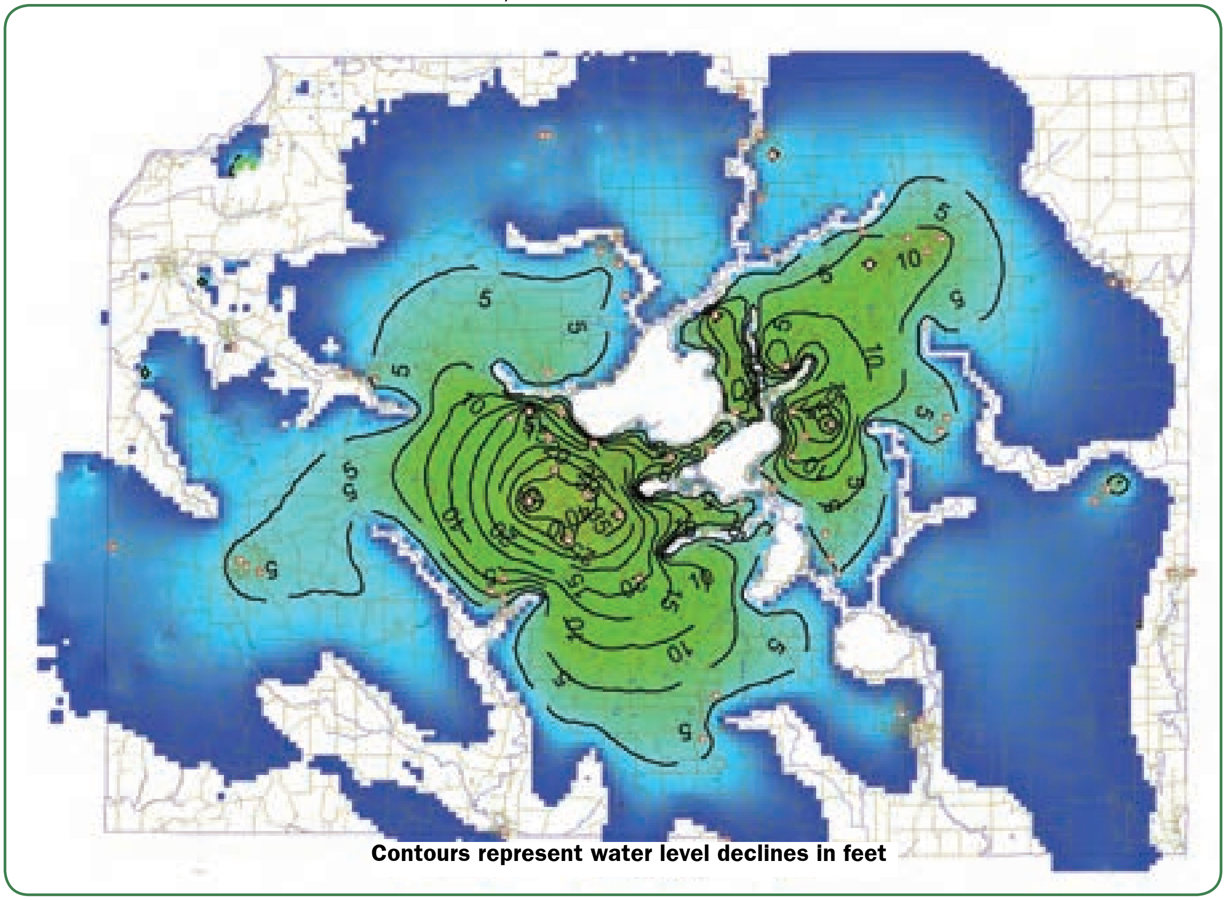


Figure 18
Simulated drawdown at the water table, 2000-2030

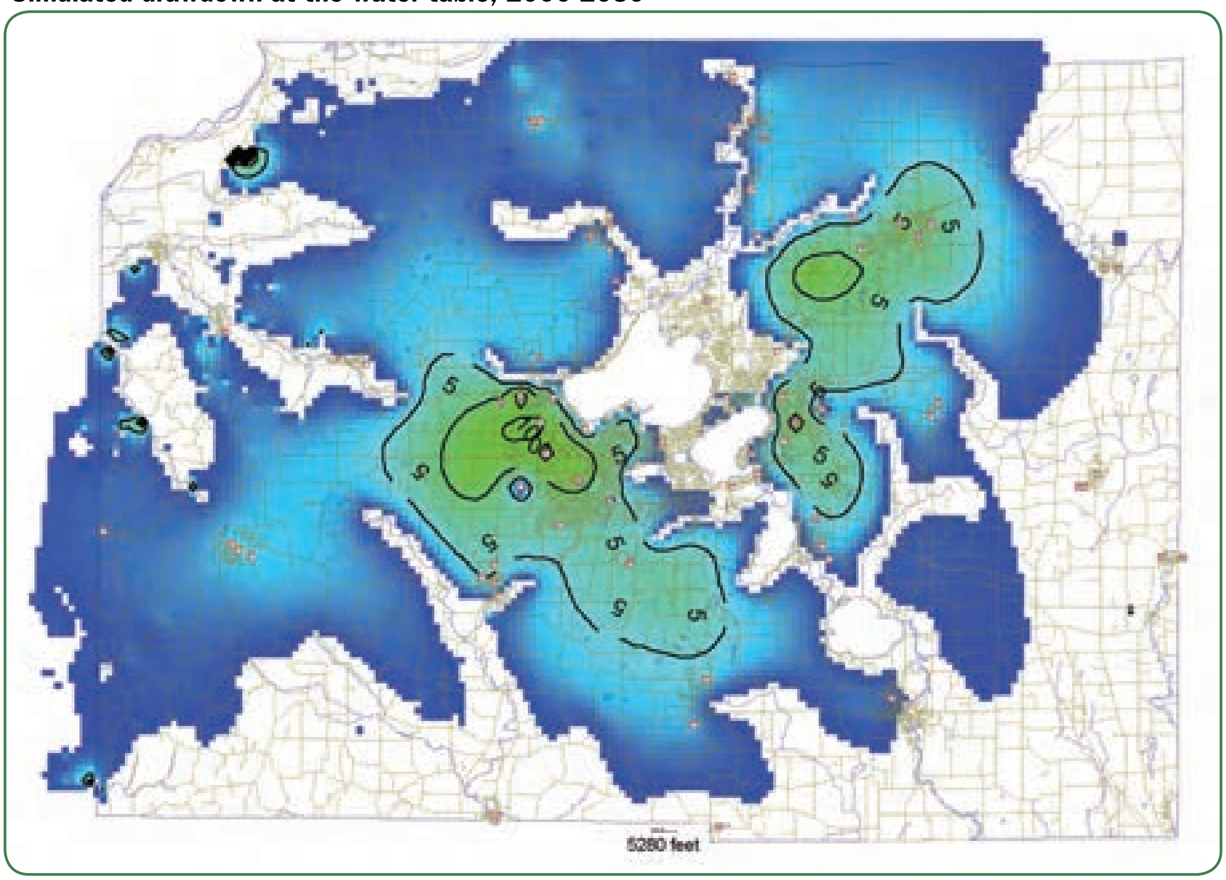


Table 9
Results of Model Simulations for Year 2009 and 2035 DeForest wells.

Location		Culver Spring (cfs)	Harbison Branch (cfs)	Token Cr. below Harbison Br. (cfs)	Token Cr. At I-94 (cfs)
Base Run (DeForest wells turned off)		6.00	1.96	21.83	23.09
2009 Pumping	Total	5.90	1.89	21.40	22.64
	change	-0.10 (1.7%)	-0.07 (3.6%)	-0.43 (4.6%)	-0.45 (1.9%)
2035 Pumping	Total	5.77	1.77	20.78	21.99
	change	-0.24 (4.0%)	-0.19 (9.7%)	-1.05 (4.8%)	-1.10 (4.3%)

Source: Ken Bradbury, WGHNS, memo dated 11/11/2010

Recognizing the cumulative impacts of well withdrawals on sensitive water resources, the Village of DeForest and the WDNR entered into a Memorandum of Understanding (MOU) in 2004 "Regarding the Use of New and Existing Wells and Their Impact on Token Creek and Other Area Surface Waters." In the MOU the Village agrees to take all reasonable management steps to limit the impacts of their well system on Token Creek. For example in accordance with the MOU, DeForest Well No. 5 will be used minimally on a daily basis and as needed for fire emergencies or system maintenance. The Village has developed a plan to limit the amount of water pumped from Well No.5 to 15 minutes per day (22,500 gpd) in 2015, 30 minutes per day (45,000 gpd) from 2020 through 2030 and 3 hours per day (270,000 gpd) in 2035. The other well in the south side supply area (Token Creek Well 1) would be pumped 0.144 mgd. Total projected 2035 withdrawal from the south supply area is estimated to be 0.414 mgd, as modeled above.

b. Groundwater Recharge Loss

One of the impacts of development is the expansion of urban areas and the increase in impervious areas covered by roads, roofs, and parking lots. ***The increase in impervious surfaces in the absence of active stormwater infiltration practices such as raingardens, results in substantial reduction in the natural groundwater recharge through the ground surface. In 2010 the Village of DeForest adopted a stormwater ordinance requiring new development to maintain pre-development stay-on volumes and groundwater recharge rates to address this impact.*** While there is no critical shortage of groundwater available for future supply needs, this clear and cold groundwater flowing from numerous springs, seeps, and baseflow discharge does provide an extremely important source of water for maintaining the health and well-being of our surface water resources. Map 30 shows natural groundwater recharge rates for the North Yahara FUDA study area.

Precipitation that soaks into the ground recharges groundwater supplies and discharges to streams keeping water temperatures low, and enhancing water oxygen levels. This favors habitat for fish and other sensitive aquatic species. Alternatively, precipitation that does not infiltrate into the ground typically runs off the land surface picking up pollutants along the way, requiring extensive stormwater quality treatment to protect surface water features. ***Additional runoff volumes, if not controlled, can also result in higher stream flows, and if allowed to continue and accumulate, can cause extensive stream bed and bank erosion and contribute to habitat damage.***

c. Relative Infiltration

A key modern stormwater management strategy for addressing the impacts of development is to infiltrate as much rainfall and snowmelt into the ground as possible, thereby reducing overland stormwater runoff and replenishing groundwater supplies. Map 31, Map 32, and Map 33 show various opportunities and strategies that can help minimize the impacts of future development as well as retrofit previously developed areas where opportunities permit.

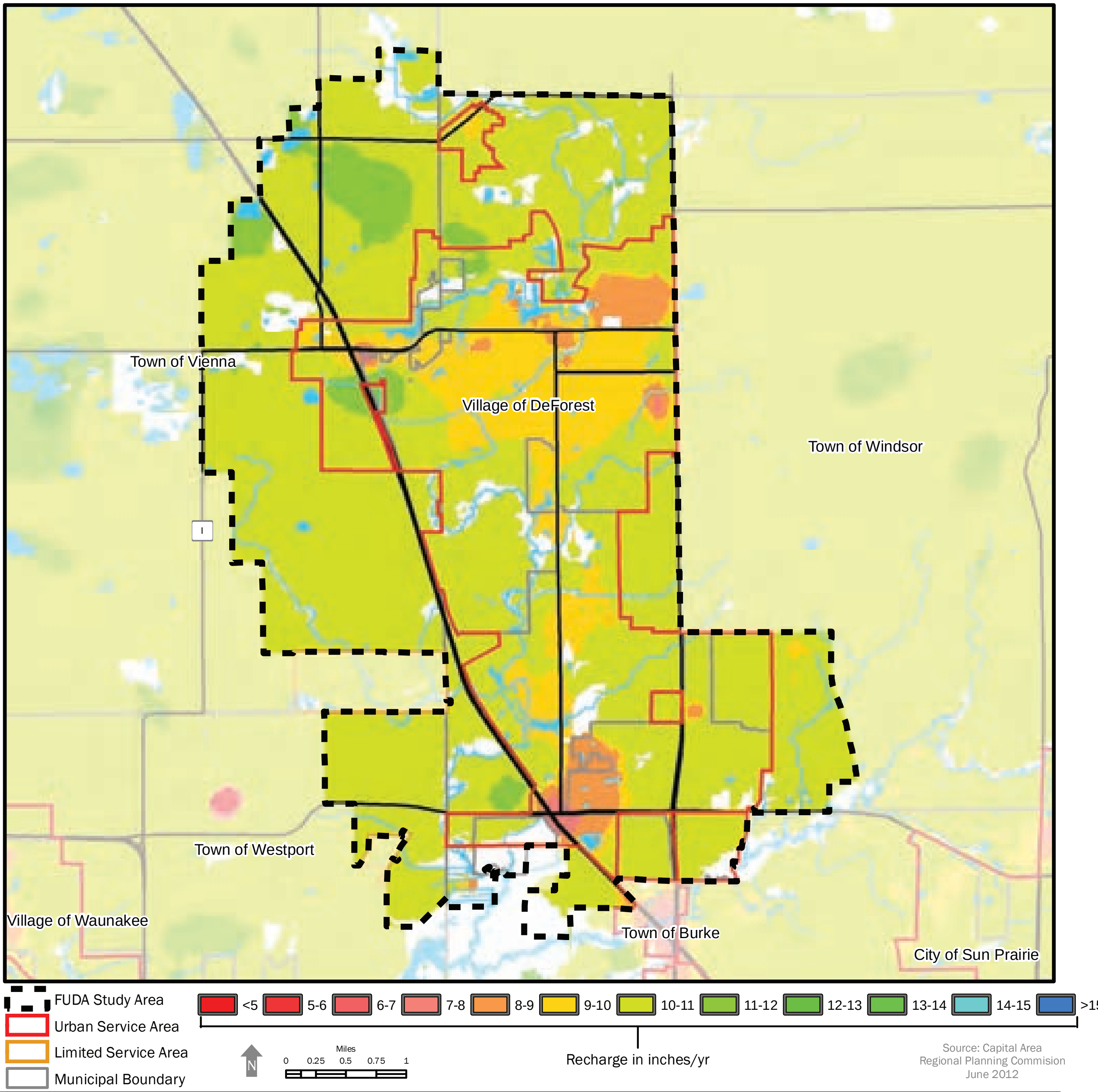
The distinction between infiltration and recharge should be clarified. Whereas all precipitation that reaches groundwater is infiltrated into the soil, not all infiltrated precipitation actually makes it all the way to recharging groundwater supplies. Some of it may be captured by plants and evaporated or transpired back into the atmosphere. The distinction is that infiltrating stormwater runoff into the soil can reduce the volumes of runoff washing over the land surface, but not all of the infiltrated stormwater will necessarily reach the groundwater. Groundwater recharge supplies baseflow discharge to area waters, sustaining them during dry weather conditions.

From an overall stormwater management perspective, areas with naturally high infiltration should be used to recharge the groundwater to the greatest extent practicable. Map 31 indicates generally medium infiltration areas within the North Yahara FUDA study area. Stormwater runoff generated in these areas could be reduced on site to some extent, such as through rain gardens and low impact design. Modeling by a researcher at UW-Madison provides important insight into the beneficial aspects of rain gardens. It has been theorized that over 90% of the annual runoff can be infiltrated into the ground by using a garden sized only 10% of the impervious area draining to it (see Figure 19). The optimum area ratio is between 10%-15% before experiencing a rate of diminishing return. In this manner, infiltration rates in rain gardens can be designed to exceed natural infiltration rates, helping to make up lost infiltration caused by past development and groundwater depression caused by well withdrawals. Stormwater runoff rates and volumes are lowered through infiltration practices, preventing damage to streams. Reducing runoff also results in reduced pollutant loads washing off the land surface into area waters. This is just one example of the many options available to promote greater infiltration of precipitation, both on-site and off-site.

Map 32 ***presents enhanced infiltration that could result from engineering practices tapping into deeper sand and gravel deposits. Significant opportunities exist within the study area. These may be prime locations for regional infiltration facilities*** that could be used for water recycling and to infiltrate stormwater generated in other parts of the watershed. These facilities would need to be adequately sized and located to accommodate the rates and volumes of stormwater generated by a proposed development. Groundwater quality protection measures should also be considered. For example, directing clean rooftop runoff to infiltration trenches and basins would be one way of dealing with this, as well as engineered soils (e.g., mixtures of sand, clay, and compost) to filter out pollutants, maintaining adequate separation distances to groundwater, along with a whole host of other engineering and conservation design practices. There may also be opportunities for retrofitting previously developed or re-developing areas.

Map 30: Groundwater Recharge

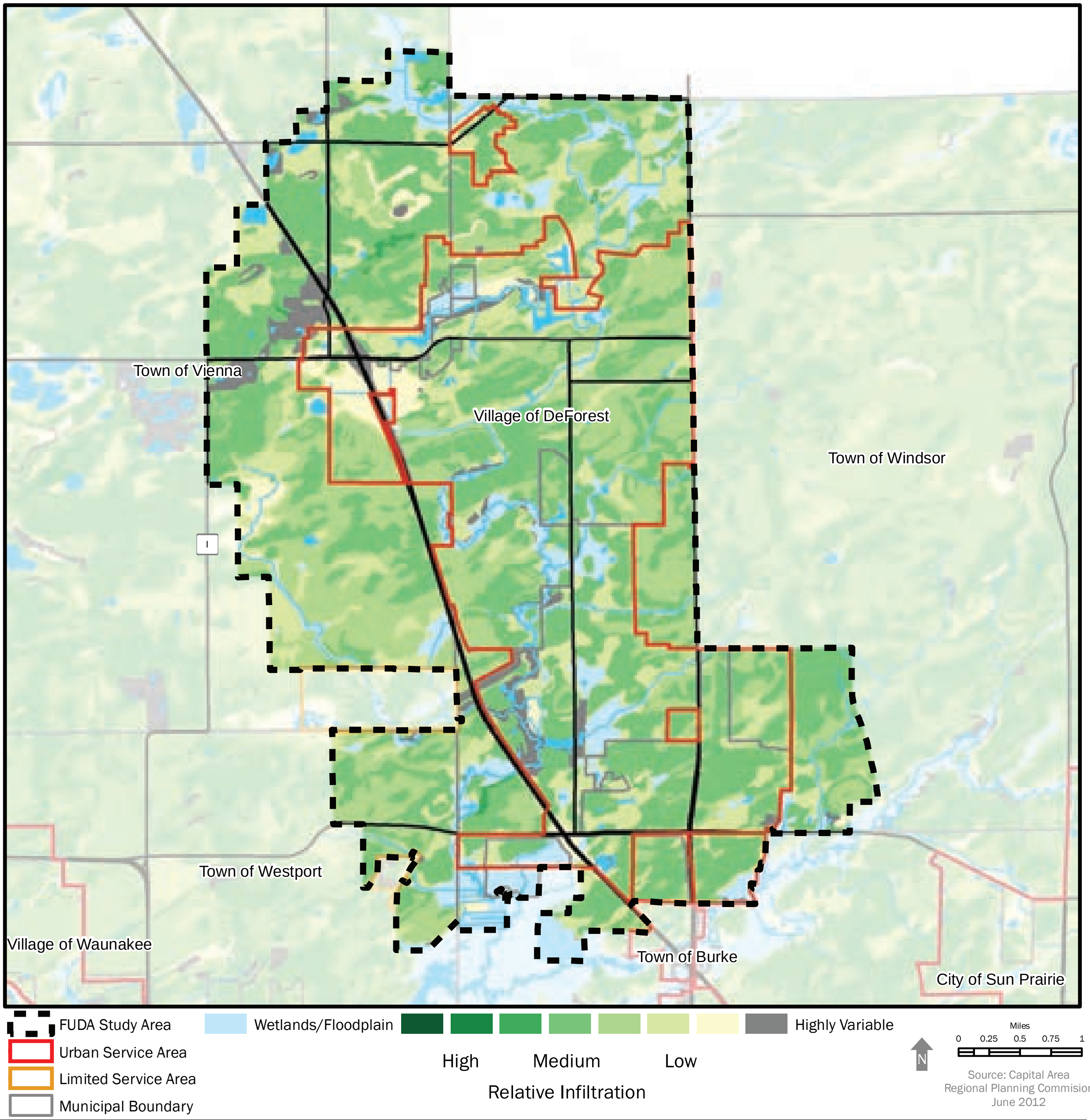
North Yahara Study Area, Dane County, WI



Precipitation that soaks into the ground and recharges the groundwater, eventually discharges to streams and other water bodies, helping keep water temperatures low and enhancing oxygen supplies. This favors habitat for fish and other sensitive aquatic species. Development without mitigation measures can disrupt the ground/surface water balance resulting in less recharge and more stormwater runoff.

Map 31: Relative Infiltration -- Natural Conditions

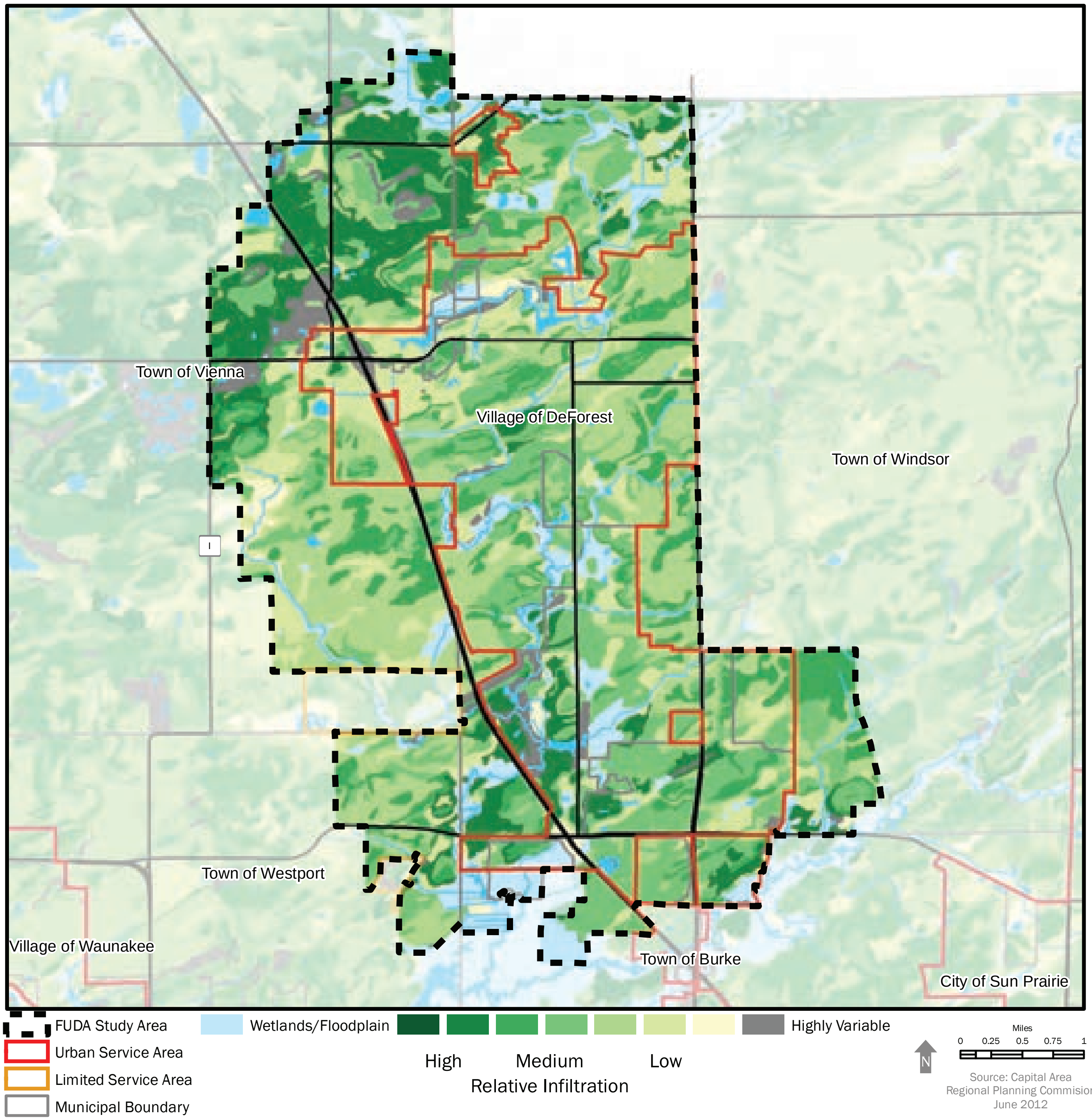
North Yahara Study Area, Dane County, WI



Areas with naturally high infiltration should be used to recharge the groundwater. They may also be prime locations for regional infiltration facilities that could be used for recycling treated water and to infiltrate stormwater generated in other parts of the watershed. Wetland and floodplain areas are generally not conducive to infiltration practices.

Map 32: Relative Infiltration -- Engineered Conditions

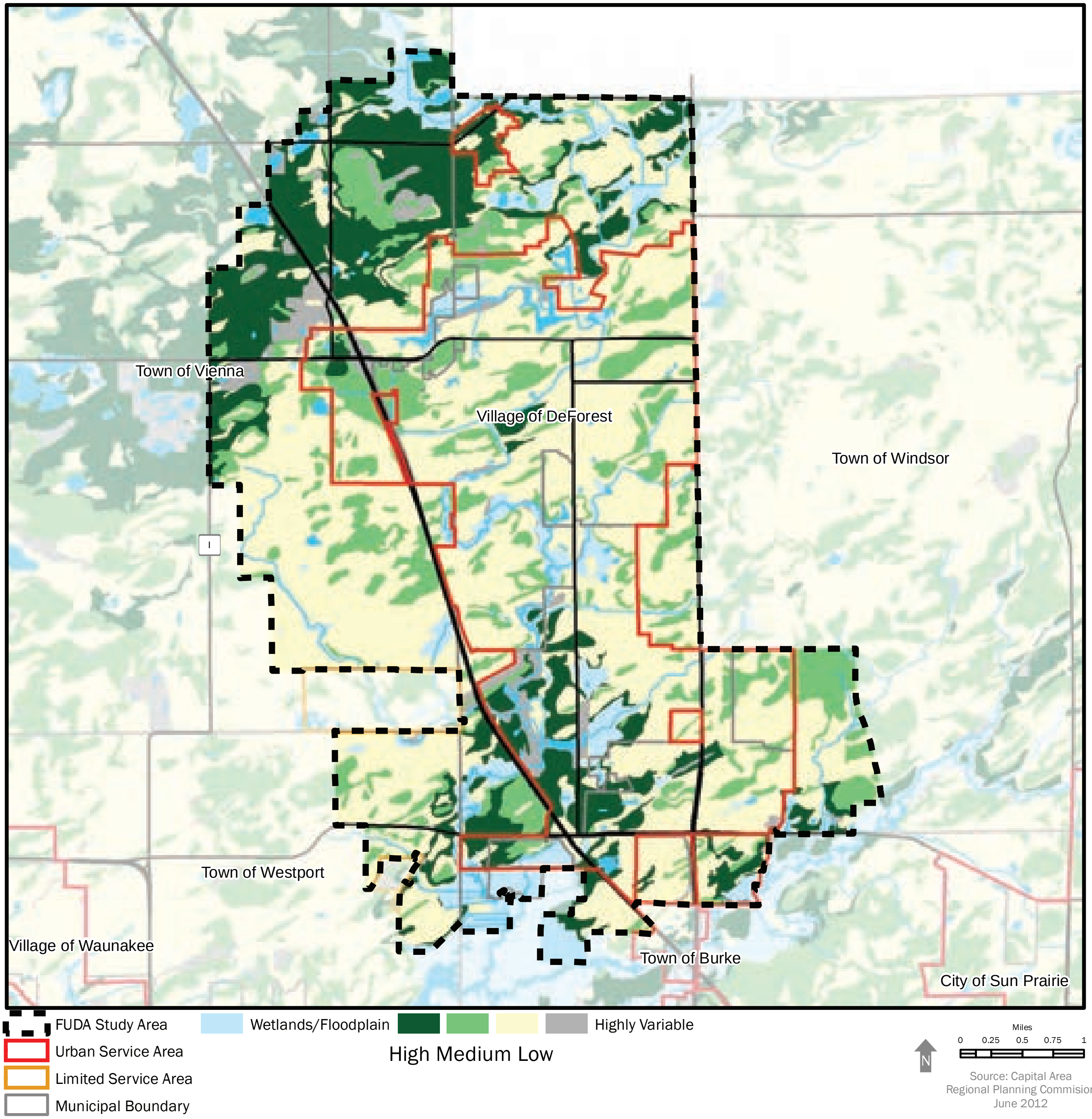
North Yahara Study Area, Dane County, WI



Infiltration can be enhanced through removal of shallow layers of low permeability soils and tapping into deeper sand and gravel deposits. The use of engineered soils can enhance natural infiltration and enhance the opportunities for infiltrating stormwater. There may also be enhanced opportunities or improvements that could be gained by retrofitting previously developed areas.

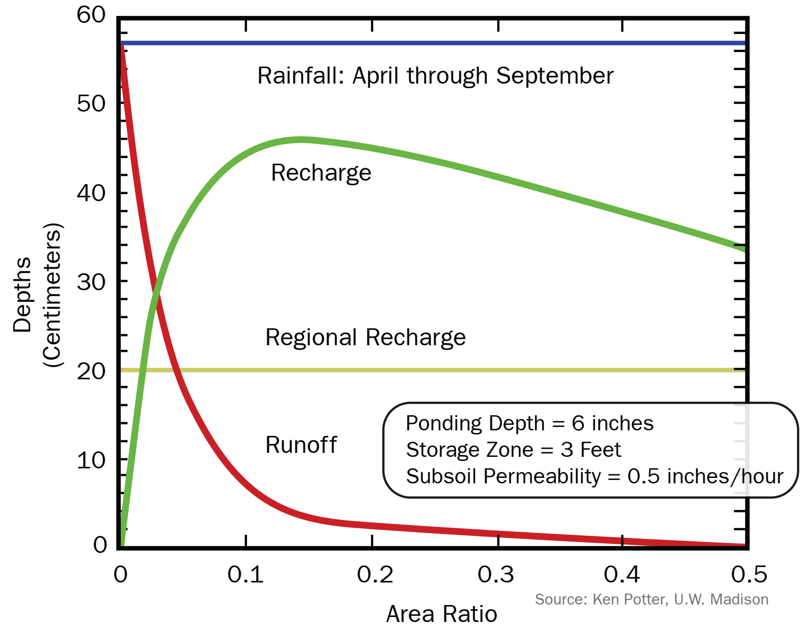
Map 33: Relative Infiltration -- Potential for Enhancement

North Yahara Study Area, Dane County, WI



This map indicates areas where infiltration enhancement potential may be the greatest. These areas show the greatest difference in scores between the natural and engineered states, highlighting opportunities where more permeable soils (e.g., sand and gravel deposits) may be present deeper in the soil column. These may be prime locations for regional stormwater facilities that could be used to infiltrate stormwater generated in other parts of the watershed.

Figure 19
Rain Garden Simulation



Source: Ken Potter, U.W. Madison

Map 33 ***shows where the potential for enhancing infiltration may be the greatest. These areas show the greatest improvement in infiltration capacity between the natural and engineered states.*** Overall, there are many opportunities for enhancing infiltration throughout the study area. The purpose of these maps is to highlight these areas as important elements of site design, so that they may be more fully utilized for water quality protection and groundwater recharge, early in the planning process. While the maps do not replace the need for more in-depth analysis for a particular site, they do provide a useful planning tool to encourage the incorporation of innovative stormwater management practices into more sustainable urban designs.

E. Endangered Resources

Before Europeans arrived, south central Wisconsin was mostly open country dominated by prairies and oak savannas (see Map 36). Grasses, wildflowers and widely scattered oaks were the principal vegetation. Low, poorly drained areas contained extensive marshes, sedge meadows, and wet prairies. For millennia, fire checked the growth of forests and kept the landscape open. Fires were probably ignited by native Americans or naturally occurring by lightning. Areas that burned often and contained few barriers to the spread of fire (such as lakes, rivers, and marshes) were usually treeless prairies, rich in grass and forb species. Areas that burned less frequently developed into oak savannas and woodlands. Like the prairie, these oak communities contained a high diversity of grass and forb species. Bur oaks and white oaks were the dominant trees in this landscape since their thick bark protected them from fire. Areas protected from fire, usually on the leeward sides of lakes and major rivers, developed into sugar maple-basswood forests.

Planning Considerations:

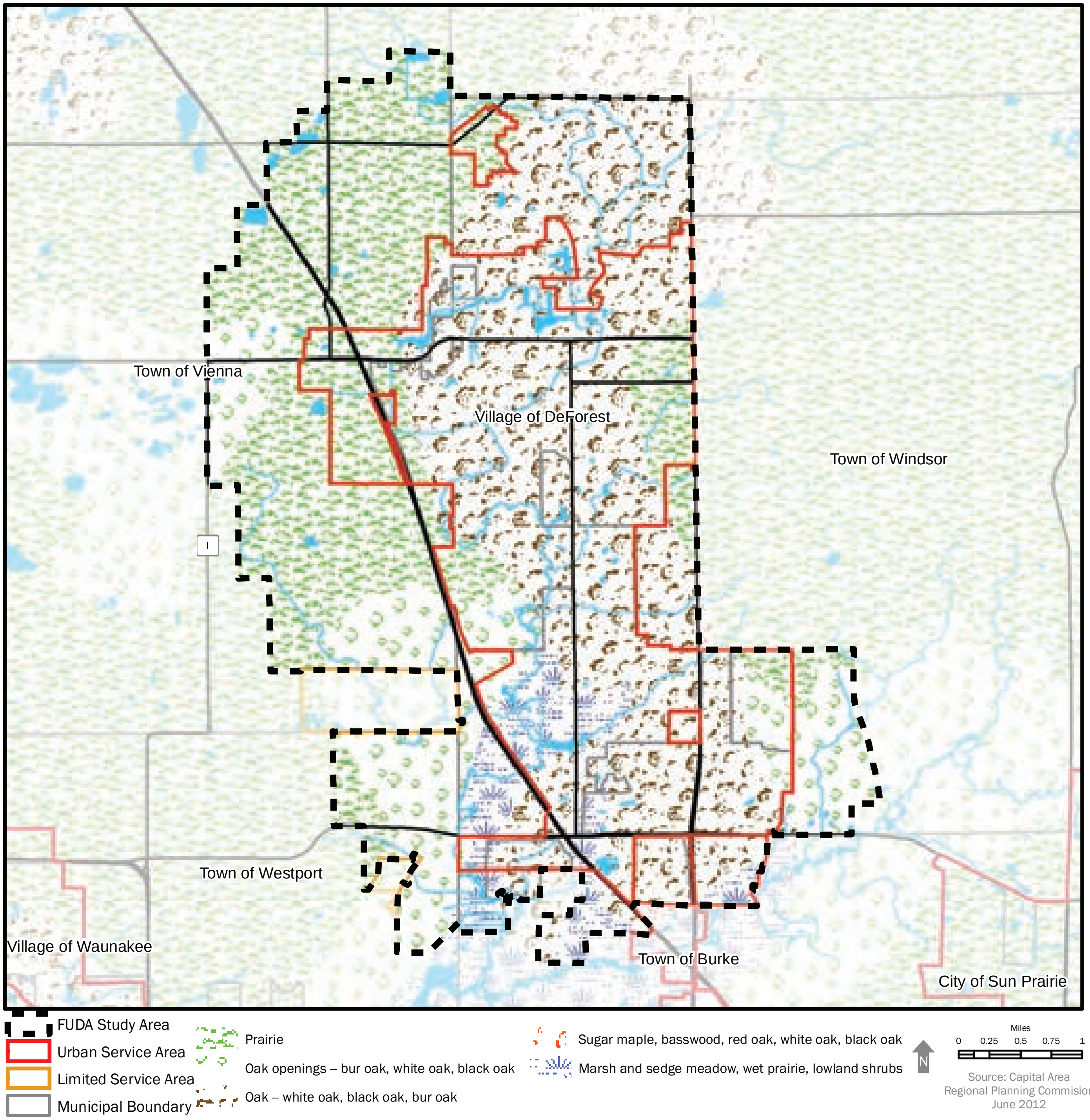
- Look for opportunities to protect habitat for threatened and endangered species in public parks and nature preserves.

Following European settlement, wildfires sharply diminished and eventually halted. No longer suppressed by fire, oak seedling sprouts grew rapidly and formed closed-canopy oak forests within a generation. Eventually fire-sensitive hardwoods, like maples, ashes, elms, and hickories began spreading and displacing oak trees. Lands that were prairies or savannas are now mostly wooded, farmed, or built upon. ***According to WDNR, only 0.5% of the original area covered by prairie and only 0.01% of the area covered by savanna in Wisconsin still exists (WDNR 1995). Ecosystems originally rich in plant and animal species have degraded through structural changes to habitat and subsequent loss of plant and animal species.*** This is the result of widespread clearing of land for agricultural production and urban development, stormwater runoff, drainage of wetlands, channelization of rivers and streams, invasion of exotic species, and extensive fragmentation of natural ecosystems. Only relatively recently have serious efforts been taken to protect and restore these resources. ***The North Yahara FUDA study area contains a diverse array of streams, wetlands, ponds, woodlands, and grassland habitats which give rise to numerous wildlife species, some of which may be either threatened or endangered.***

Plant community structure is the fundamental building blocks of ecological landscapes and determines zoological diversity and drives ecosystem function. Natural communities are valuable and vital component of sustaining biodiversity. Undisturbed communities allow for rare species, which often depend on specific habitat requirements. Rare species and unique natural communities are often good biological indicators of significant areas and ecological function. ***Termed "Endangered Resources," such resources indicate where particularly significant or vulnerable ecological areas exist. The presence of one or more rare species and natural communities is an indication of ecosystem health and importance. Such areas should prompt attention directed toward species conservation, management, and restoration needs.***

Map 34: Presettlement Vegetation

North Yahara Study Area, Dane County, WI



The presettlement vegetation cover data was digitized from a 1976 map created by Professor Robert Finley from land survey notes written in the mid-1800s when Wisconsin was first surveyed. This vegetation cover map can be used to identify regional changes in land cover since the time when the state was first surveyed. This data is not intended for landscape-scale analysis.

The WDNR Bureau of Endangered Resources (BER) maintains the Wisconsin Natural Heritage Inventory (NHI), a statewide database representing the known occurrences of rare species and natural communities. Map 35 shows generalized occurrences of endangered resources in the North Yahara FUDA study area. This information is confidential and is not subject to Wisconsin's open records law. Publication of the species locations cannot be made to resource managers, the NHI can determine the likely occurrence of rare species in areas affected by development or other land management activities. This information can be incorporated into development designs. ***It is important to note the NHI is not a complete catalogue of the locations of the state's rare species. Users must recognize that many areas of the state have not been inventoried, thus making distribution maps incomplete. Thus an "absence of evidence is not evidence of absence," nor does the presence of one occurrence imply that other occurrences have been surveyed for but not found.***
The typical screening review procedure entails querying the database for a particular area. The results list any know known occurrences in the search area and one mile buffer (two miles for aquatic species). If a known occurrence is found within the search area or buffer, then the search area is evaluated whether the habitat representing that particular species or community is present. If not, the species is not likely to exist. If it is, a field survey may be warranted to assess the suitability of the habitat and whether or not individual species may be present. Surveys are typically conducted during the season when the species can be most easily found and identified.

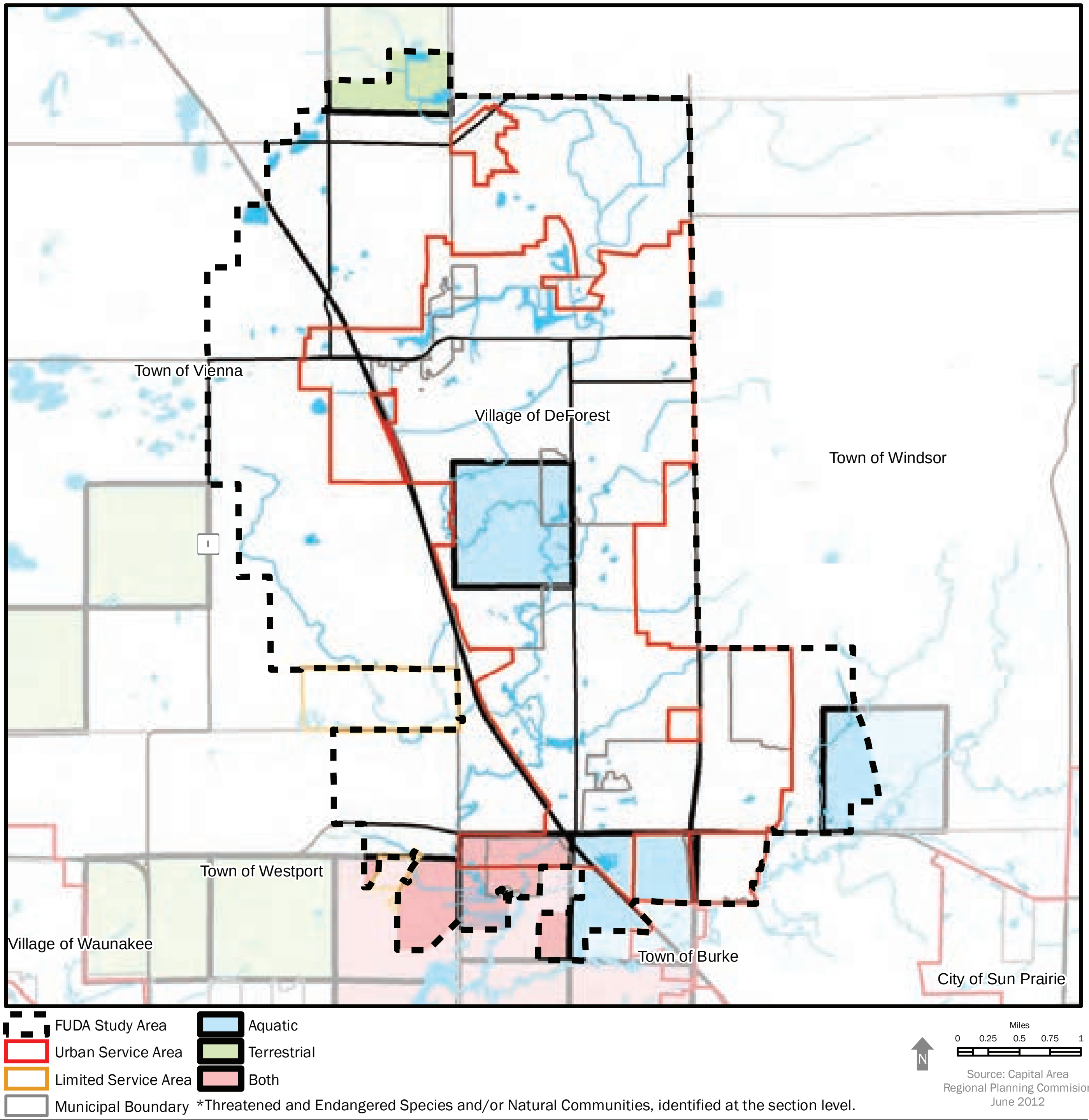
Since occurrences are generally site specific, the following information can be used as a guide in determining whether or not suitable habitat may exist in a particular area. If so, a more detailed review should be conducted by knowledgeable professionals and, depending on the occurrence, BER staff should be consulted for any specific actions that should be taken. Finding a threatened or endangered species doesn't necessarily mean that development cannot occur. Rather, prescribed management practices are available to avoid impact. Note that destruction of habitat is not an illegal activity, only taking or otherwise killing individual Threatened or Endangered species. The preferred approach, however, is to avoid habitat loss altogether.

Species listed in the NHI are categorized as one of the following:

1. **Threatened:** Any species which appears likely, within the foreseeable future, on the basis of scientific evidence to become "Endangered."
2. **Endangered:** Any species whose continued existence as a viable component of the state's wild animals or wild plants is determined by the WDNR to be in jeopardy on the basis of scientific evidence.
3. **Special Concern:** Any species whose population is suspected to be declining, but scientific evidence is insufficient to justify this assertion. Species of Special Concern could become threatened in time.
4. **Natural Community:** An identifiable assemblage of plant, fungal, and animal species living together in a particular area. The NHI Program tracks examples of Wisconsin's natural communities that are deemed significant because of their undisturbed condition, size, or for other reasons.

Map 35: Endangered Resources*

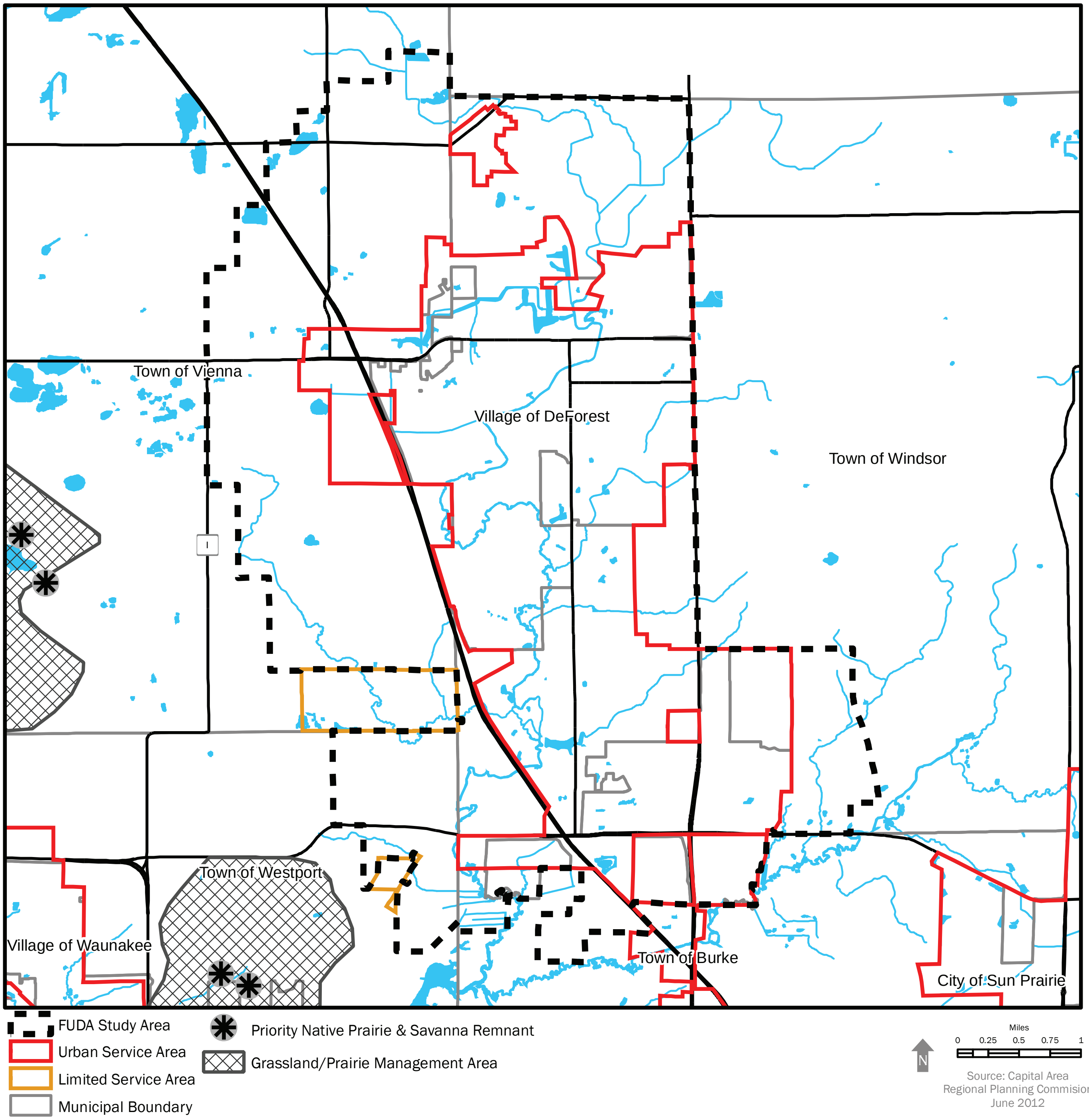
North Yahara Study Area, Dane County, WI



This map shows the generalized location of endangered species by the section in which they occur. More specific information is confidential and can be obtained by contacting CARPC or DNR Endangered Resources staff. Information is available to help minimize the impact of development for these species, largely depending on what is being planned.

Map 36: Prairies and Grasslands

North Yahara Study Area, Dane County, WI



Priority native prairie & savannah remnants and grassland/prairie management areas from Dane County Land and Water Resources Department

A screening review conducted by RPC staff identified endangered resource species shown in Table 10***. These species have the potential to occur in the FUDA study area if appropriate habitat exists.*** More detailed information concerning these species can be obtained from the WDNR Bureau of Endangered Resources reference site at: http://dnr.wi.gov/org/land/er/biodiversity/

Occurrences are site specific. CARPC staff should be consulted early on in the planning process with regard to specific plans and sites, and potential mitigation measures that may be needed. Where there is the possibility or likelihood that an endangered resource may be present, an Endangered Resources Review by WDNR may be necessary. The CARPC Restoration Ecologist can provide more current assessment, recommendations, and assistance especially during the more detailed and technical design work associated with particular development scenarios, plans, or projects.

Table 10
Endangered Resources in the North Yahara FUDA Study area

Endangered	Threatened	Special Concern	Natural Communities
Insects	**Birds**	**Mammals**	Dry Mesic Prairie
Red-Tailed Leaf Hopper	Henslow's Sparrow	Western Harvest Mouse	Mesic Prairie
Plants	**Plants**	**Fish**	Northern Wet Forest
Prairie Bush Clover	Prairie Parsley	American Eel	Shrub Carr
		Plants	Southern Dry Mesic Forest
		Flodman Thistle	Southern Sedge Meadow
		Glade Mallow	Wet Prairie
		Innocence	**State Natural Areas**
		Lesser Fringed Gentian	Empire Prairies
		One-lowered Broom Rape	Cherokee marsh

Source: WDNR Natural Heritage Inventory Database (12/2010)

F. Wildlife Resources and Biodiversity

While the importance of the protection of water resources from human activities such as agriculture and urban development is obvious, it is often less apparent that the terrestrial areas surrounding surface waters also serve as "core habitats" for many semi-aquatic species that depend on both aquatic and terrestrial environments to fulfill their life-cycle requirements (e.g., feeding, mating, nesting, and over-wintering). These in turn serve as food for higher level organisms and the circle of life continues. ***Scientists sometimes identify certain species as "umbrella species" in the hopes of saving a whole range of animals and plants in a given area and thereby maintaining overall biologic health and diversity (biodiversity).*** The idea is that by protecting an important umbrella species and preserving its habitat, various other species that depend on the same habit will also be protected.

Amphibians and reptiles (known collectively as herptiles) represent a crucial link between aquatic and land ecosystems. Herptiles play particularly important roles in food webs because they occupy a middle position as both predator and prey, and also because they constitute an enormous amount of the biomass in some aquatic and riparian ecosystems (see Figure 20). Development activities that cut too deeply into the base of these trophic pyramids can destabilize these systems, leading to diminished productivity, negative effects that cascade upwards to higher predators leading to eventual ecosystem collapse.[55]

Semlitsch and Bodie (2003) summarized literature on the use of core terrestrial habitats by amphibians and reptiles essential for carrying out their life-history functions (see Table 11). Using the minimum mean group (salamanders) provides a good reference point for establishing a minimum wildlife protection program. If the distances salamanders move from wetlands are assumed to be normally distributed (test of normality $W = 0.927$, $p = 0.2168$), then by definition the mean for adults of all salamander species combined represents a distance encompassing 50% of the population. Furthermore, a core habitat encompassing the majority of the population (95% confidence limits) would encompass a terrestrial habitat of 540 ft from a wetland edge (Semlisch 1997). This distance encompasses the minimum distances for nearly all herptile species in Table 11, except snakes and frogs (specifically) which are typically more motile.

55 Wisconsin DNR research shows that an average Green Frog population of 60-80 frogs per mile of waterfront can be expected in undeveloped areas. The population drops to zero where there are 40 homes per mile of waterfront. (personal communication with Gregg Breese, WDNR)

Semlitsch proposed stratified criteria that would include at least three terrestrial zones adjacent to core aquatic wetland habitats (see Figure 21):

1. ***Aquatic Buffer* – starting from the wetland edge, a first terrestrial zone would be restricted from use and designed to buffer the core aquatic habitat and protect water resources (100-200 ft.)**
2. ***Core Habitat* – a second terrestrial zone, overlapping the first, would encompass the core terrestrial habitat defined by the semi-aquatic focal-group (e.g., 540 ft. for salamanders, as above);**
3. ***Terrestrial Buffer* – a third zone, starting from the outward edge of the second zone, would buffer the core terrestrial habitat from edge effects and surrounding land use practices (e.g. 50 m or 160 ft.).**

Streams in Wisconsin are used less than ponds and wetlands for amphibian breeding, unless they possess similar amphibian breeding conditions; i.e., quiet water outside the stream channel or quiet backwaters (Hay 2008). A 300-foot buffer on both sides of the stream is recommended.

These areas are not intended to be restrictive to development or represent "no-build" zones. Instead, these areas are intended to highlight ecological connectivity and stewardship opportunities (e.g., open space and wildlife movement corridors, biofuels, community supported agriculture, etc.). ***More specifically, because of their critical nature and position in the landscape, these areas offer unique constraints and opportunities that need to be considered early on in the community's overall development and resource protection plans.***

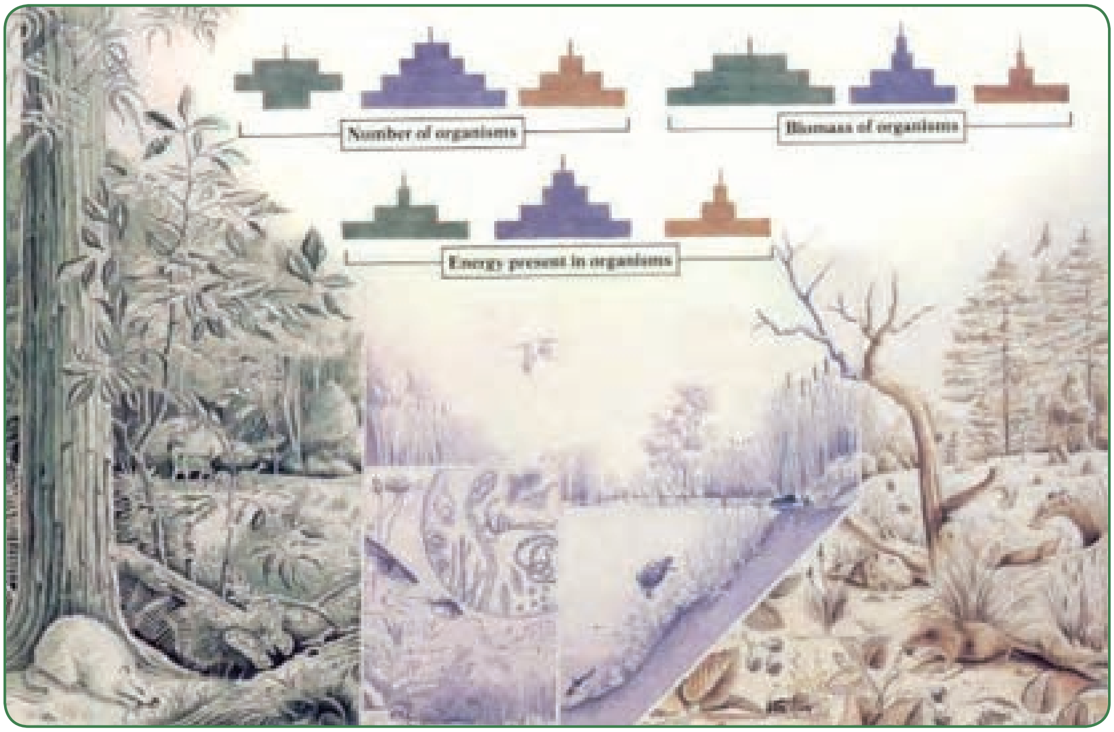
Table 11
Mean minimum and maximum core terrestrial habitat for amphibians and reptiles (Distance from wetland edges)

Group	Mean minimum (ft)	Mean maximum (ft)
Frogs	672	1207
Salamanders	384	715
Amphibians	522	951
Snakes	551	997
Turtles	403	941
Reptiles	417	948
Herptiles	466	948

Semlitsch and Bodie 2003

Stream corridors provide extremely valuable habitat as well as critical connecting corridors for a wide variety of wildlife species. Areas surrounding wetlands and ponds are also rich habitat areas. According to the Wisconsin WDNR Bureau of Endangered Resources (BER), ***90% of the occurrences of threatened and endangered species in Dane County are located within 300 feet of streams and 700 feet of wetlands or small ponds.*** The presence or likeli-

Figure 20
Trophic pyramids of numbers, biomass, and energy for a forest, a shallow pond, and an "old field."



hood of endangered species being present are themselves an indicator of the importance and potential ecological health and diversity these areas can support.

Researchers have also reported positive correlations between forest cover and amphibian and reptile populations in wetlands. ***These studies suggest the need to link terrestrial forest habitats adjacent to wetlands to sustain amphibian and reptile species.*** Map 37 shows a simple habitat classification based on the coincidence of two or more resource features (streams, wetlands, hydric soils, floodplains, and forestlands), including core habitat and wildlife corridors described above. It is probably not too surprising that core physical and biological components are mutually coincident.[56] In many cases these areas could be improved or enhanced by management activities that allow the land revert back to a more natural condition (passive restoration) and by more active management practices, such as active restoration of farmed wetlands, prairie restoration, and riparian re-vegetation.

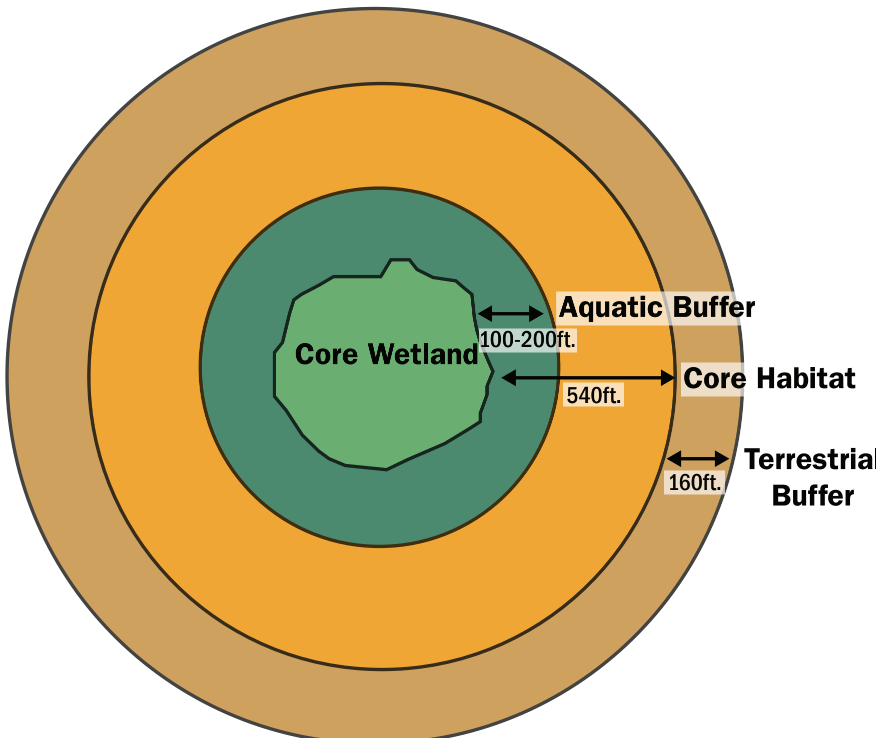
The overall conservation objective should be to direct development away from sensitive and critical resource areas. If that is not possible, it should be incumbent on planners to design developments to provide equal or greater natural resource protection. This may be accomplished by advanced conservation design techniques, restoration of other areas, or other means based on the type of development, site characteristics, opportunities, and options available.

56 Areas that stand out in red are based on WDNR wetlands being present but possessing little else in terms of the other habitat elements.

A resource-based approach to ecosystem management has proven to be a successful and comprehensive approach to resource conservation. ***A resource-based approach focuses on landscape patterns, manages these natural resource elements to collectively influence species assemblages in a positive direction. We should strive to limit the degree of isolation between existing habitat patches and optimize natural connectivity to allow for the dispersal and re-colonization of sensitive native species among patches. This goal is attainable by establishing habitat corridors, maintaining landscape attributes (e.g., patch size, shape, edge, etc.), and connecting "stepping stone patches" where possible.***

Figure 21

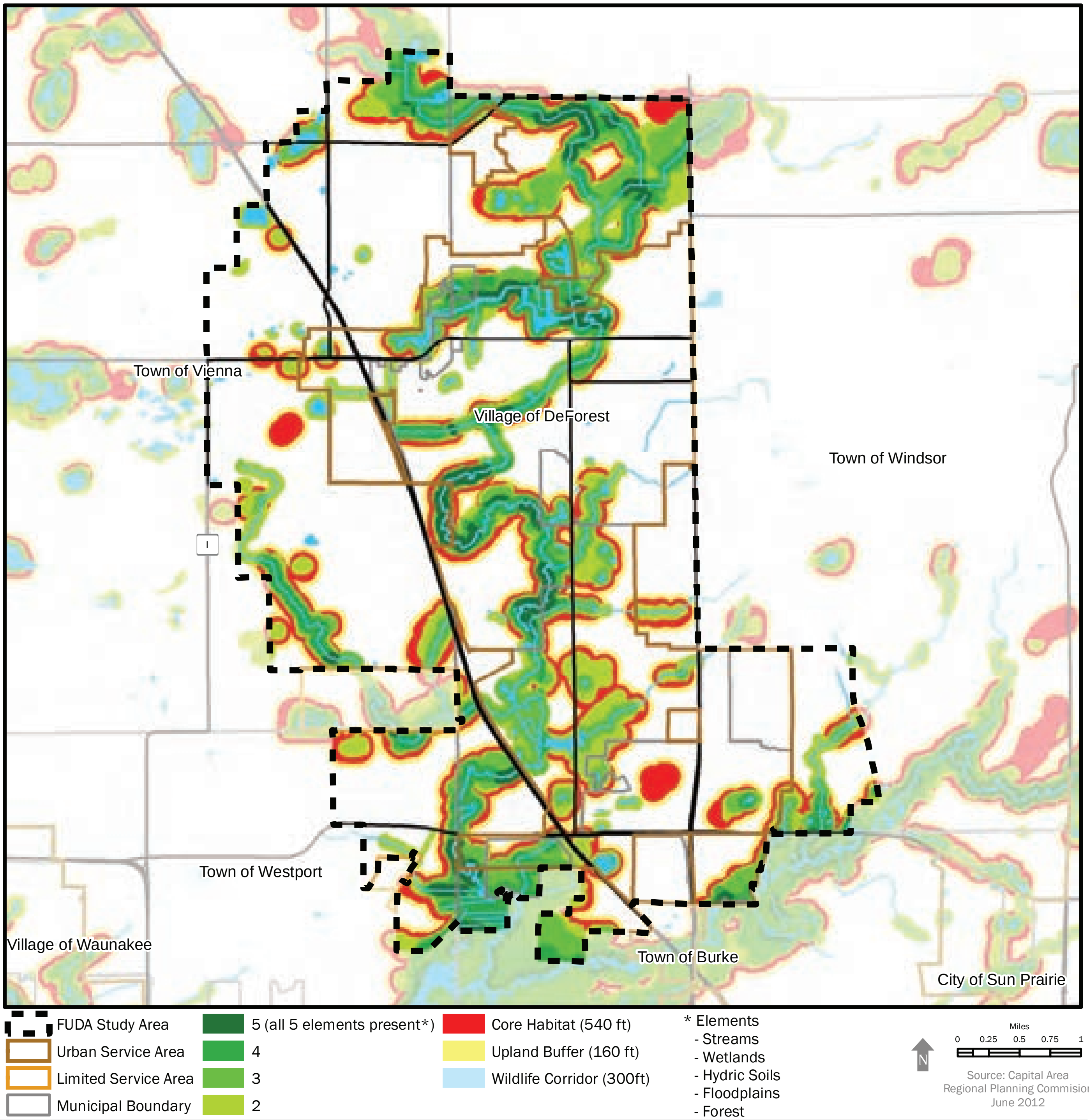
Zones of Protection for Semi-Aquatic Species



Source: Semlitsch 2001 & 2003

Map 37: Habitat Classification

North Yahara Study Area, Dane County, WI



This map shows a simple habitat classification system based on the coincidence of two or more aquatic resource features, including core habitat, wildlife corridor, and upland buffer as described in the literature. The overall objective is to avoid these sensitive natural areas and direct development to more suitable areas for it. These critical and sensitive natural areas can also be enhanced and improved by letting the land revert back to a more natural condition, enhancing biological diversity overall.

In general, most natural resource objectives can be accomplished within a corridor width of 300 feet from the edge of a stream and 700 feet from the edge of a wetland or small pond that is greater than two acres. Where there are groups of small wetlands, they should also be combined.

In circumstances where a 300 foot buffer may be considered burdensome for a community, there are alternatives that will allow for natural resources protection, create habitat, and produce a tradable commodity. For example, research into biodiversity and ecosystem functioning theory developed by David Tilman of the University of Minnesota suggests that planting high diversity tallgrass prairies may be a source for biofuels. When compared to other biofuel sources, tallgrass prairies are a better source than either corn ethanol or soybean biodiesel. These prairies produce 51% more energy per acre than other crops. Planting tallgrass prairies for biofuels also serve as better alternatives for low fertility soils than other crops intended for the same purpose, as they will have higher stand biomass. This resource may be collected using standard equipment and practices, and be regenerated every year, leading to a renewable resource. By potentially changing wider riparian areas to biofuel producing tallgrass prairies, communities may be able to promote multi-resource objectives. The limitations of this method will be the size of the converted area, historical landscape coverage, ability to conduct controlled burns that will not endanger infrastructure, and the ability of heavy machinery to access these locations. If the converted area is too small, it may not be economically viable to extract this resource. An experiment funded by the State of Minnesota and the United States Geological Survey is near completion at the Cedar Creek Ecosystem Science Reserve testing the relationship between biofuel production and water quality.[57] The results of this project will contribute greatly to implementation in local communities.

1. Ecological Restoration

Ecological restoration of natural resource areas may be necessary to maintain ecological functions and the services they provide, and to maintain our natural heritage for future generations. ***Designs for ecological restoration projects need to be tailored to each specific site, but share the following general characteristics and guidelines:***

- Comparatively, conservation and management of natural resource areas are far less expensive than attempting ecological restoration.
- If a restoration is to be successful, the causal factor leading to the ecosystem's degradation must be identified and removed or abated. If not, then a restoration project will not maintain cohesion, structure and emergent function and will be degraded again after restoration activities.
- When performing restoration, it is often not possible to restore or create an ecosystem that is an exact copy of a natural or idealized ecosystem state.
- Restoration of physical attributes within an ecosystem will not always result in positive biotic responses and will not always lead to the return of all species.

57 USGS, MN Water Science Center: Cedar Creek Biofuels Project (http://mn.water.usgs.gov/projects/cedarcreek/)

- Restoration will take time to mature. Depending upon the ecosystem, it may take a few years or several decades before restoration is mature. Successful restoration needs monitoring to determine if additional corrections are required.

- Restoration of ecosystems is complicated and not as easily manipulated as human engineered systems. It may not be possible to control for all aspects within a restoration project.

- Each restoration project will have its own unique challenges and specific approaches will be required to resolve those problems. Using a standard repeated approach (cook-book), without considering site specific problems, will likely not result in successful restorations.

- The ultimate goal of restoration is to create a self-organizing and self-sustaining system that no longer requires active human intervention. There may be instances when a complete restoration is not possible and long term management will be required to maintain ecosystems.

- Continually spending large sums of money, time and other resources will not solve ecological problems. Nor will waiting for advances in science and technology resolve degraded ecosystems. Application of current restoration methods is required now to preserve our quality of life and improve it for future generations.

2. Prairie Restoration

Prairie restoration is very much a site specific endeavor considering there are few prairies and oak savannas remaining in southern Wisconsin. The remaining prairies in southern Wisconsin have likely been preserved because soil depth to bedrock was too shallow, making these locations not conducive to farming. Restoration of grasslands and prairies will have positive benefits other than creating habitat for wildlife. Prairie roots promote rainwater penetration, reduce overland runoff and help to recharge groundwater.

As with other restoration projects, the development of a guiding image or ideal target community structure is important for developing a defined restoration goal. According to Packard (2005) there are ***six approaches to selecting a restoration goal: (1) Restore the original vegetation, (2) Restore the community now best expressed by the site, (3) Restore the rarest or highest priority community that is practicable, (4) Restore a variety of communities, (5) Restore as large as possible given site limits and (6) Restore the highest priority, best and easiest mix of communities possible for the site based on expert opinion.***

To preserve and restore these natural areas, the most important considerations is the reintroduction of fire regimes. Fire is a major regulating natural event for grassland, prairie and savanna ecosystems. The lack of fire in these ecosystems, itself, may be considered a disturbance. Without these events, grassland, prairie and oak savanna communities will inevitably change in composition to include fire-intolerant (e.g., brush/woody) species. The application of fires will remove these intolerant species and allow these native plants a competitive advantage. As fire regimes cease, the competitive advantage is given to non-prairie species. As these other species become established, they change the ecosystem properties and displace native species.

With many ecosystems, maintaining large areas is preferential to having smaller patches. Larger prairies are ecologically important for larger species, including prairie chickens, but are also deemed important for specific rare insects that require large areas, and consumable plants for their larval stages. On a practical perspective, it may not be possible to maintain large prairie areas given the economic interests of agriculture. Even with this condition, maintaining small prairies, wherever possible, will be beneficial. In some instances, maintaining prairies that are less than one thousand square feet may yield up to sixty different plant species and be habitat for countless insects and several bird species. It has been proposed that in an urban setting, that if one-tenth of lawns were to be replaced by "postage stamp" prairies, there would be a sizable reduction in the use of water, fertilizers, pesticides and reduced need to use powered lawnmowers.

There were two major prairies found within this FUDA study area[58] ***and both appear to be endangered by invasive species. The first site approximately 10 acres in size,*** located next to an adjacent riparian area and agricultural field, does show initial invasion by wild parsnip *(Pastinaca sativa)*. Wild parsnip is a particularly tenacious invasive species that is not regulated by fire or mowing. Applications of herbicide are only useful during the spring and can only effectively be applied manually without damaging other native plants. To remove this species, it may require manual digging that is made even more hazardous because this plant releases chemicals that cause chemical burns after exposure to sunlight (phyto-photodermatitis). Further, this species has seeds that are viable for up to four years. The best means of controlling this species is to prevent its invasion by early detection. As this species begins to invade, it propagates in a slow wave across the landscape. To maintain this valuable resource, control of this invasive species should begin as soon as possible. *At the second site, approximately 5 acres in size also adjacent to a stream, were stands of brush-form willow (Salix spp.)* on the opposite side of the road. Given that this site was a prairie riparian buffer, without proper management, it will likely be invaded by willow trees and the size of the prairie will shrink.

G. Parks and Open Space

Dane County plays a special role in the partnership among federal, state, and local units of government and private groups in meeting the outdoor recreational needs of residents and visitors. The *Dane County Parks and Open Space Plan* defines this role and recommends how Dane County can work as a partner with other governmental units and the private sector. Adoption of the Plan and acceptance by WDNR enables the county to participate in state and federal outdoor recreation grant programs. The Plan indicates various Natural Resource Areas, existing and proposed land and water trails, recreational parks, and forests, as the focus of these efforts in the study area (see Map 42), including:

58 Town of Windsor section 6

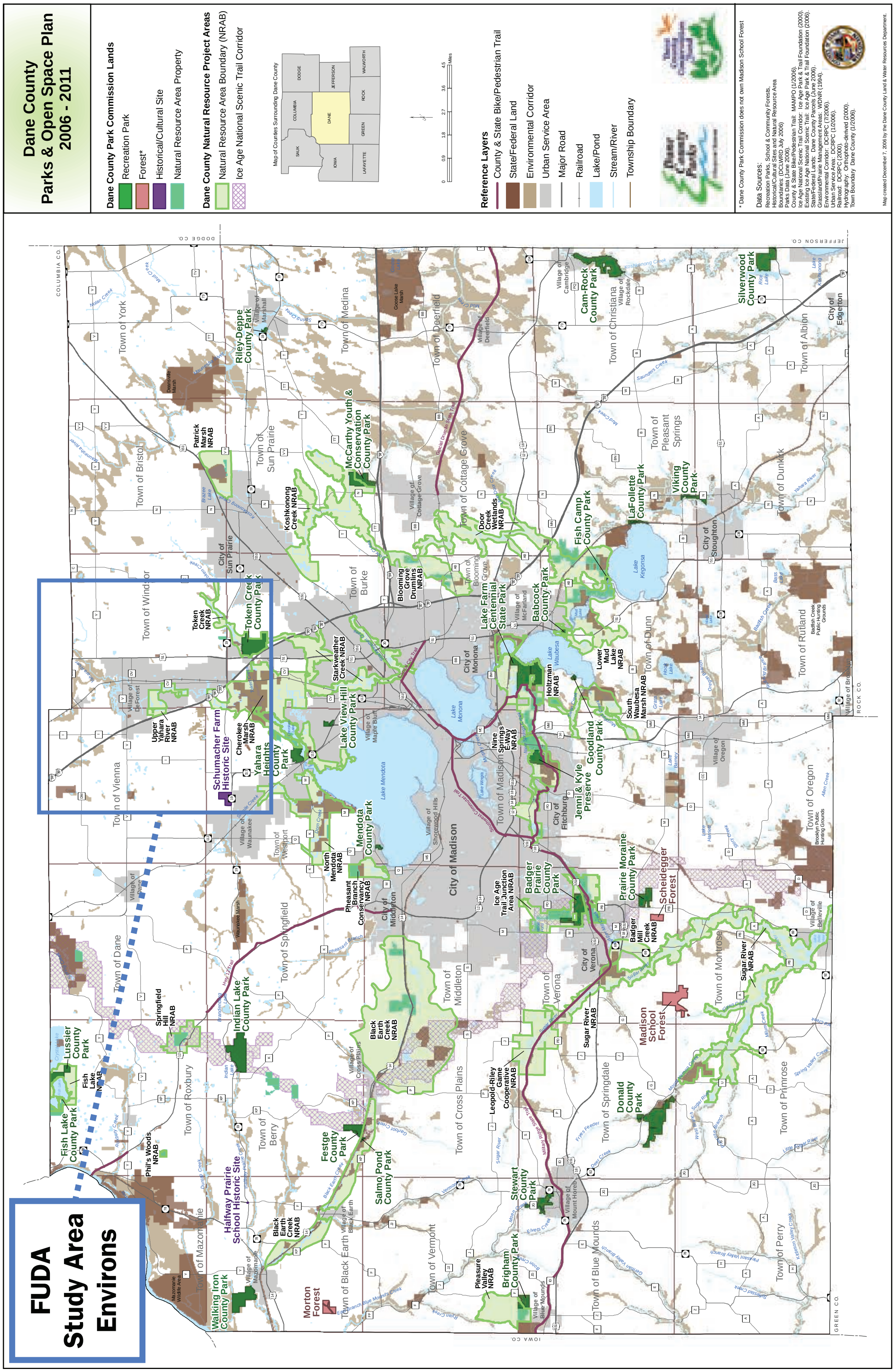
- Upper Yahara River Natural Resource Area
- Cherokee Marsh Natural Resource Area
- Token Creek Natural Resource Area
- Token Creek Park
- Proposed Token Creek Water-Based Trail
- Proposed Off-Road Bicycle/Pedestrian Trails
- Existing and proposed land and water trails
- Federal, state, and local areas

It is critically important that future land use plans consider and incorporate regional elements into designs. Dane County Parks staff should be consulted early on in development planning to promote opportunities, coordination, and avoid incompatible or potentially conflicting proposals. For example, Map 40 shows DeForest's Future Park and Recreation Facilities connecting urban, park, and open space areas.

The Village of DeForest has committed itself to the protection of natural resources and the development of infrastructure based on natural resources to benefit residents of the Village and the region, and to address the historical degradation of the Upper Yahara River. In 2011 the Village Released its updated Park and Open Space Plan, which includes recommendations to protect and enhance the community's natural resource base. In 2007 the Village conducted an ecological assessment of its conservation parks: Western Green, Veteran's, Bakke, and Northern Corridor Parks, traversing the Village along the Yahara River and has taken measures to upgrade the ecosystem functions of these parks in support of the health of the river. The Village's 2007 *Ecological Assessment and Management Plan* will further guide the Village management actions needed to preserve and enhance the diversity of plant and animal species in the parks. (118 acres). The Village has also completed a 2007 *Yahara River Large Woody Debris Inventory and Primer* to guide current and future stream restoration projects through the Village. In addition, the Village has begun Yahara riverbank restoration at the downtown Veteran's Park; prepared detailed ecological assessment for the Conservancy Place Yahara River Corridor and designated a "green" trail network; developed water trail access points for the Yahara River at the downtown Veteran's Park and Conservancy Place; and worked to identify options for natural community improvements that may potentially involve complete wetland restoration, with the potential to sell credits to developers (NR 350 Wetland Compensatory Mitigation), as well as less aggressive strategies for natural resource improvements.

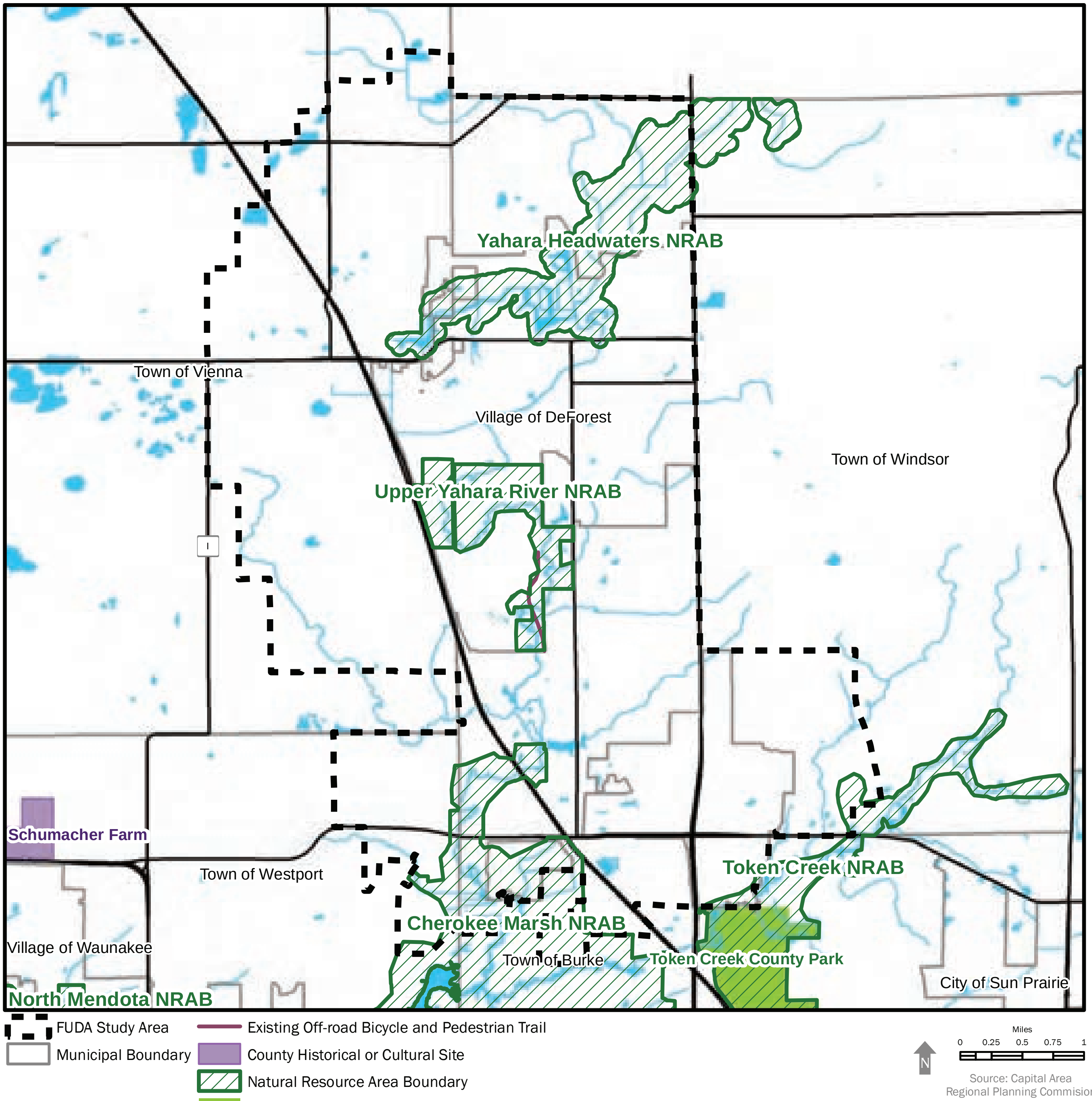
It should be noted that park and purchased conservation areas adversely impact town revenues and add to the cost of maintenance by the responsible park entity. Acquisition considerations for these areas should include revenue sharing measures or approaches to compensate the affected town for this loss of revenue, and to create programs that allow private ownership of buffer areas for agricultural uses that produce income while maintaining ecosystem services of a more natural land cover.

Map 38: FUDA Study Area Environs - Parks and Open Space Plan



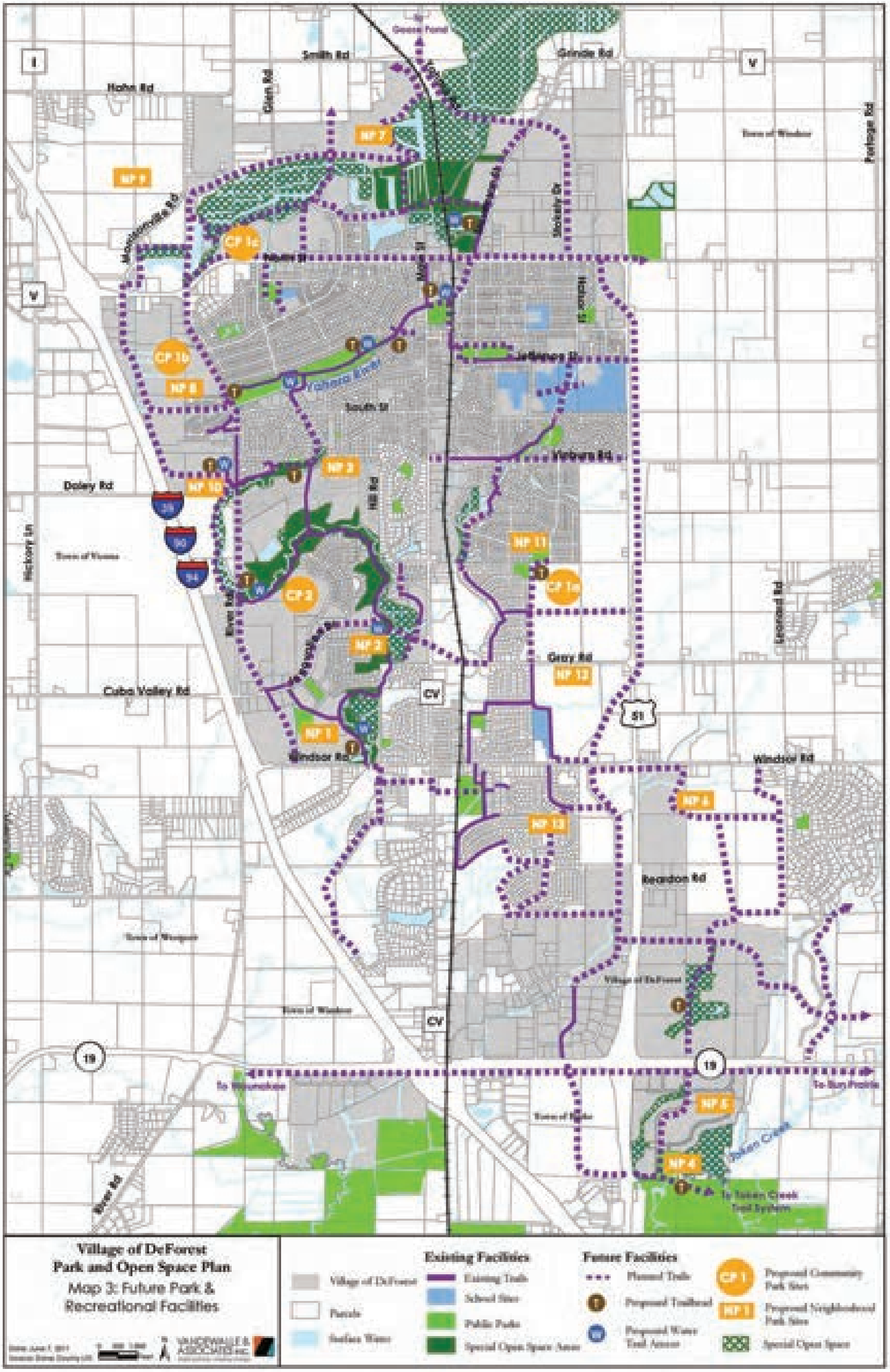
Map 39: Dane County Parks and Open Space Plan

North Yahara Study Area, Dane County, WI



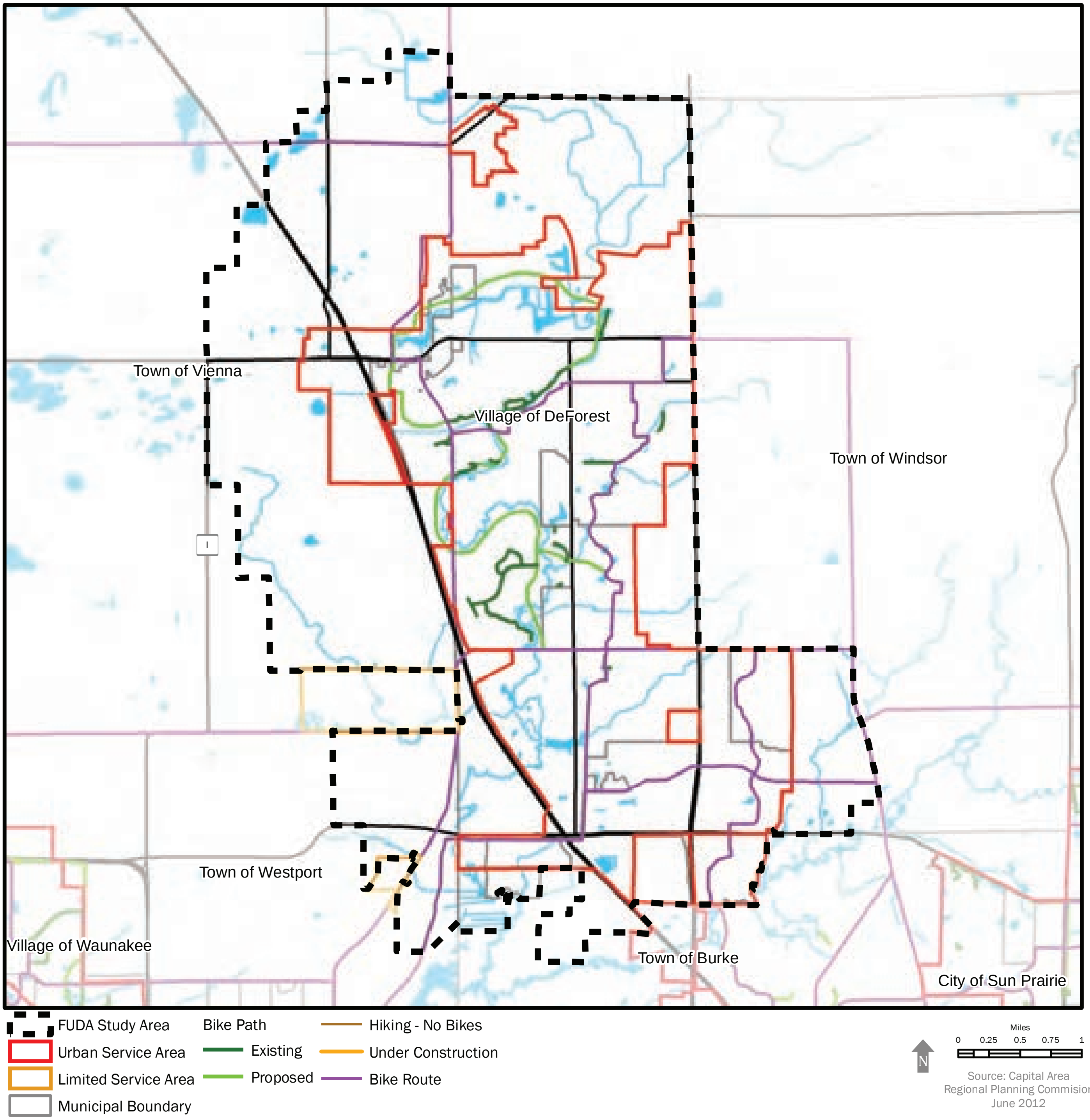
The Parks and Open Space Plan is coordinated by the Dane County Parks Departments located at 1 Fen Oak Dr #208 in Madison.
http://www.countyofdane.com/lwrd/parks/default.aspx
608-224-3730

Map 40: DeForest Park & Open Space Plan



Map 41: Bike Plan

North Yahara Study Area, Dane County, WI



Bike routes and paths including proposed paths are shown.

H. Natural Resource Impacts from Urban Development

Dane County is the second-largest metropolitan area and one of the fastest-growing counties in the state. By year 2030 almost 580,000 people are expected to reside in Dane County – an increase of almost 36% over current population. This urban growth and development must be properly planned and managed to mitigate the adverse impacts of urban development to protects the quality of our groundwater and surface water resources, the wildlife communities they support, and our everyday quality of life.

1. Hydrologic Impacts (Water Quantity and Quality)[59]

One of the most obvious manifestations of watershed development is the increase in impervious surfaces in the urban landscape. Urbanization reduces natural ground cover, replacing it with streets, rooftops, driveways, and parking lots. Figure 22 shows the progression of impervious surface area and the changes in the hydrologic regime if development progresses without mitigation. Because of compaction during the development process, turf and landscape areas can also affect the total runoff from built areas, unless this compaction is corrected through mitigation practices such as deep tilling and soil augmentation.[60]

Figure 23 shows typical pre-development and post-development hydrographs for a watershed that is being developed for urban land uses without any mitigation practices. As development progresses the stream hydrology changes from a more gradual and subdued groundwater-dominated system (solid line) to one dominated more and more by flashier surface water impacts (dashed line). The area below the hydrographs represents the volume of rainfall runoff. The increased peak flow and runoff volume resulting from development is significant because of the increased pollutant loading it can carry, as well as potential flooding and channel erosion problems it can cause downstream. In addition, as infiltration of precipitation is reduced by increased impervious cover, the volume of water available for baseflow in streams is similarly reduced. Infiltration and groundwater recharge of precipitation and subsequent discharge to streams and wetlands is critical in sustaining them during dry weather periods.

Urban land use without appropriate management practices can severely degrade aquatic ecosystems in various ways (see Table 12). Increased peak flows and runoff volumes increase the erosive force of the channel flows and can significantly upset the streambed and bank stability and the sediment load equilibrium that has established itself over time. Increased volumes and rates of runoff overload natural drainage systems that have adapted themselves to pre-development conditions. As the frequency of bankfull events increases with urbanization, the stream attempts to enlarge its cross section to reach a new equilibrium associated with the increased flows. Greater frequencies and durations of higher stormflows can result in channel incision, stream bank undercutting, increased stream bank erosion, sediment loading and transport along the streambed.

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59 Refer to the 2011 update of *Technical Appendix D: Urban Nonpoint Source Analysis* to the *Dane County Water Quality Plan* for a more complete discussion and analysis of these potential impacts and the performance standards and management practices that communities have or can put in place to mitigate them. Link here.

60 Deep tilling uses 4-foot steel shanks placed 4 feet apart on a bulldozer to till and break up the compacted ground after grading is completed. Soil augmentation incorporates composted mulch into the top 12-inch layer of the soil. Both practices serve to reverse the soil compaction that results from grading and other construction activities.

Figure 22
Hydrologic Effects of Urban Development and Impervious Cover

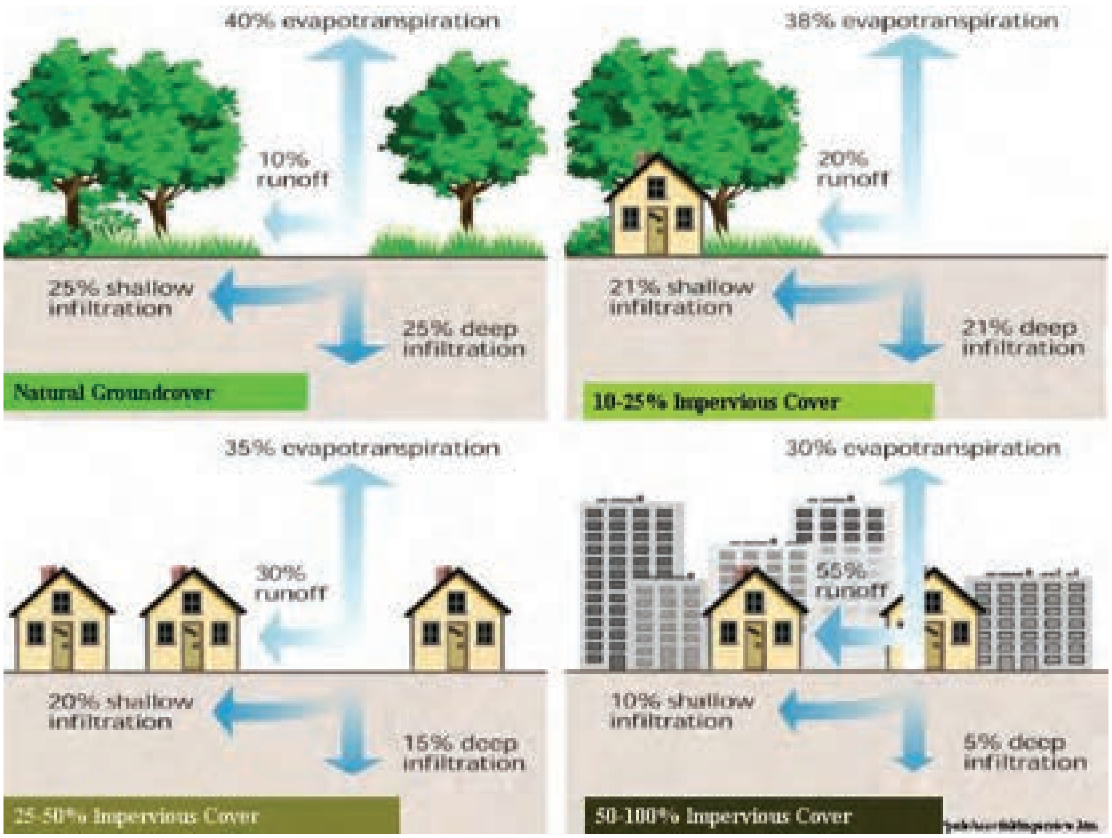
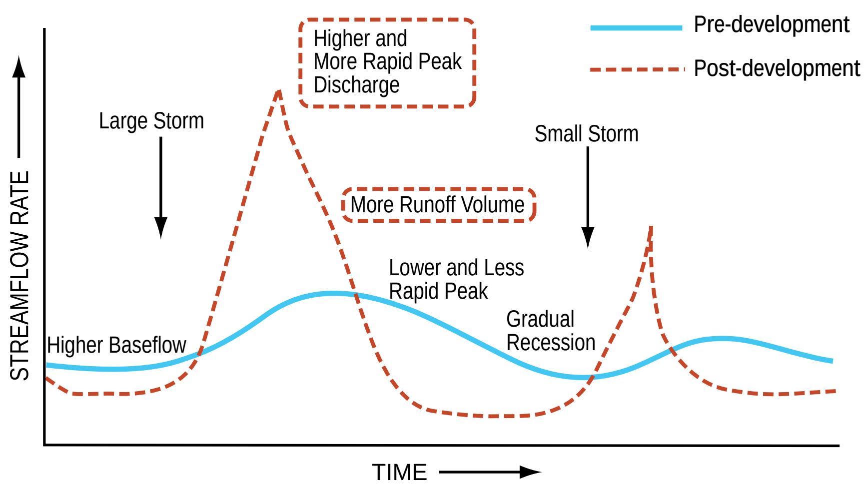


Figure 23
Changes in Stream Hydrology as a Result of Urbanization

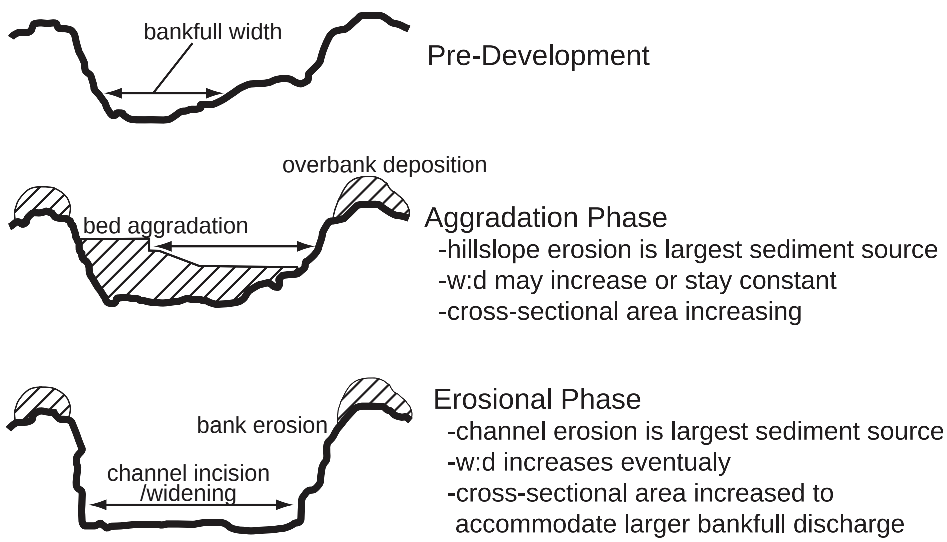


The results are wider, straighter, sediment-choked streams, greater water temperature fluctuations, as well as loss of riparian cover, shoreland, and aquatic habitat. The streambed is covered by sand and silt; and pollutant loading of other constituents (e.g., toxic materials, metals, and organics) is also increased. ***Research shows that by the time the water quality impacts become evident, the stream ecosystem has already largely been damaged by the water quantity impacts.***

The Village of DeForest has adopted an ordinance requiring a 100% pre-development stormwater volume control and groundwater recharge standard that is more stringent than that in NR 151 and Dane County Chapter 14. The challenge is in finding retrofit opportunities in existing development. The Village has spent substantial funds in recent years to upgrade and retrofit its stormwater management facilities and to improve water quality and has committed to fund future restoration and conservation activities.

The significance of hydrologic changes and pollutant loading associated with urban development that lacks mitigation practices is clear: strategies that maintain pre-development runoff volumes and mimic more natural flow conditions will reduce the frequencies of larger and more erosive flows resulting from that development. Also, since pollutant loading is a function of flow,[61] it stands to reason that reducing the volume of runoff will result in reduced pollutant loads as well. This is in addition to conventional practices that capture and treat the "first flush" of pollutants during runoff events. ***Overall, it is much easier to incorporate hydrologic protection measures early in the design before an area becomes developed than to address the problem after development.***

Figure 24
Changes in Stream Channel Geomorphology due to Urbanization



Source: NALMS 2007

Communities in our region have been working to mitigate these potential hydrologic impacts of urban development for over a decade. In the late 1980s the then Dane County Regional Planning Commission began requiring new urban service areas to provide peak runoff rate

61 Total pollution load is pollutant concentration multiplied by volume.

Table 12
Summary of the Potential Impacts of Urbanization on Aquatic Ecosystems

Environmental Concern	Potential Impact	Cause/Source
Increase in runoff-driven peak or bankfull stream flows	Degradation of aquatic habitat and/or loss of sensitive species	Increased stormwater runoff volume due to an increase in basin imperviousness
Increase in runoff-driven flooding frequency and duration	Degradation of aquatic habitat and/or loss of sensitive species	Increased stormwater runoff volume due to an increase in basin imperviousness
Increase in wetland water level fluctuations	Degradation of aquatic habitat and/or loss of sensitive species	Increased stormwater runoff due to an increase in basin imperviousness
Decrease in dry season baseflows	Reduced aquatic habitat and less water for human consumption, irrigation, or recreational use	Water withdrawals and/or less natural infiltration due to an increase in basin imperviousness
Streambank erosion and stream channel enlargement	Degradation of aquatic habitat and increased fine sediment production	Increase in stormwater runoff driven stream flow due to an increase in basin imperviousness
Stream channel modification due to hydrologic changes and human alteration	Degradation of aquatic habitat and increased fine sediment production	Increase in stormwater runoff driven stream flow and/or channel alterations such as levees and dikes
Streambed scour and incision	Degradation of aquatic habitat and loss of benthic organisms due to washout	Increase in stormwater runoff driven stream flow due to an increase in basin imperviousness
Excessive turbidity	Degradation of aquatic habitat and/or loss of sensitive species due to physiological and /or behavioral interference	Increase in stormwater runoff driven stream flow and subsequent streambank erosion due to an increase in basin imperviousness
Fine sediment deposition	Degradation of aquatic habitat and loss of benthic organisms due to fine sediment smothering	Increase in stormwater runoff driven stream flow and subsequent streambank erosion due to an increase in basin imperviousness
Sediment contamination	Degradation of aquatic habitat and/or loss of sensitive benthic species	Stormwater runoff pollutants
Loss of riparian integrity	Degradation of riparian habitat quality and quantity, as well as riparian corridor fragmentation	Human development encroachment and stream road crossings
Proliferation of exotic and invasive species	Displacement of natural species and de gradation of aquatic habitat	Encroachment of urban development
Elevated water temperature	Lethal and non-lethal stress to aquatic organisms reduced DO levels	Loss of riparian forest shade and direct runoff of high temperature stormwater from impervious surfaces
Low dissolved oxygen (DD) Levels	Lethal and non-lethal stress to aquatic organisms	Stormwater runoff containing fertilizers and wastewater treatment system effluent
Lake and estuary nutrient eutrophication	Degradation of aquatic habitat and low DO levels	Stormwater runoff containing fertilizers and wastewater treatment system effluent
Bacterial pollution	Human health (contact recreation and drinking water) concerns, increases in diseases to aquatic organisms, and degradation of shellfish harvest beds	Stormwater runoff containing livestock manure, pet waste, and wastewater treatment system effluent
Toxic chemical water pollution	Human health (contact recreation and drinking water) concerns, as well as bioaccumulation and toxicity to aquatic organisms	Stormwater runoff containing toxic metals, pesticides, herbicides, and industrial chemical contaminants
Reduced organic matter (OM) and large woody debris (LWD)	Degradation of aquatic habitat and loss of sensitive species	Loss or degradation of riparian forest and floodplain due to development encroachment
Decline in aquatic plant diversity	Alteration of natural food web structure and function	Cumulative impacts of urbanization
Decline in aquatic invertebrate diversity	Alteration of natural food web structure and function	Cumulative impacts of urbanization
Decline in amphibian diversity	Loss of ecologically important species	Cumulative impacts of urbanization
Decline in fish diversity and abundance	Loss of ecologically important species	Cumulative impacts of urbanization

Source: Fundamentals of Urban Runoff Management. NALMS 2007 control to pre-development levels and to remove sediment from stormwater runoff. Similar standards were adopted by Dane County and the State of Wisconsin in 2002. Infiltration requirements and volume control conditions were pioneered by the Dane County Regional Planning Commission in the mid 1990s. Infiltration requirements and volume control standards were adopted as part of the county-wide stormwater ordinance in 2004, and the standards for commercial areas were improved in 2011.

When properly planned, designed, constructed, and maintained, these standards and the management practices implemented to meet them can effectively mitigate the potential hydrologic impacts of new urban development. The primary sources of impacts to our water resources are agricultural nonpoint source pollution and urban nonpoint source pollution from development that was constructed before these standards were put in place.

2. Habitat Loss and Landscape Connectivity

Habitat loss or fragmentation is the process whereby contiguous natural areas are reduced in size and separated into discrete parcels due to land conversion for other uses, such as urban development or agricultural production. Because of the prime soils located here, agriculture has had a significant impact on wildlife habitat in Dane County. Due to draining and cropping practices over the last century, most remnant habitats can usually only be found in areas that are either too wet, steep, or stony to be effectively farmed. Also, as is too often the case in Dane County, where farmland has gained a toehold development is often apt to follow. That leaves relatively few areas in the county that have not already been farmed or developed. ***When habitat is destroyed, a patchwork of habitat fragments remains often resulting in patches that are isolated from one another. Since the potential for re-colonization of species is reduced, increased competition and local extinction (extirpation) can result.*** These remnant areas require protection, network re-connection and enhancement where possible.

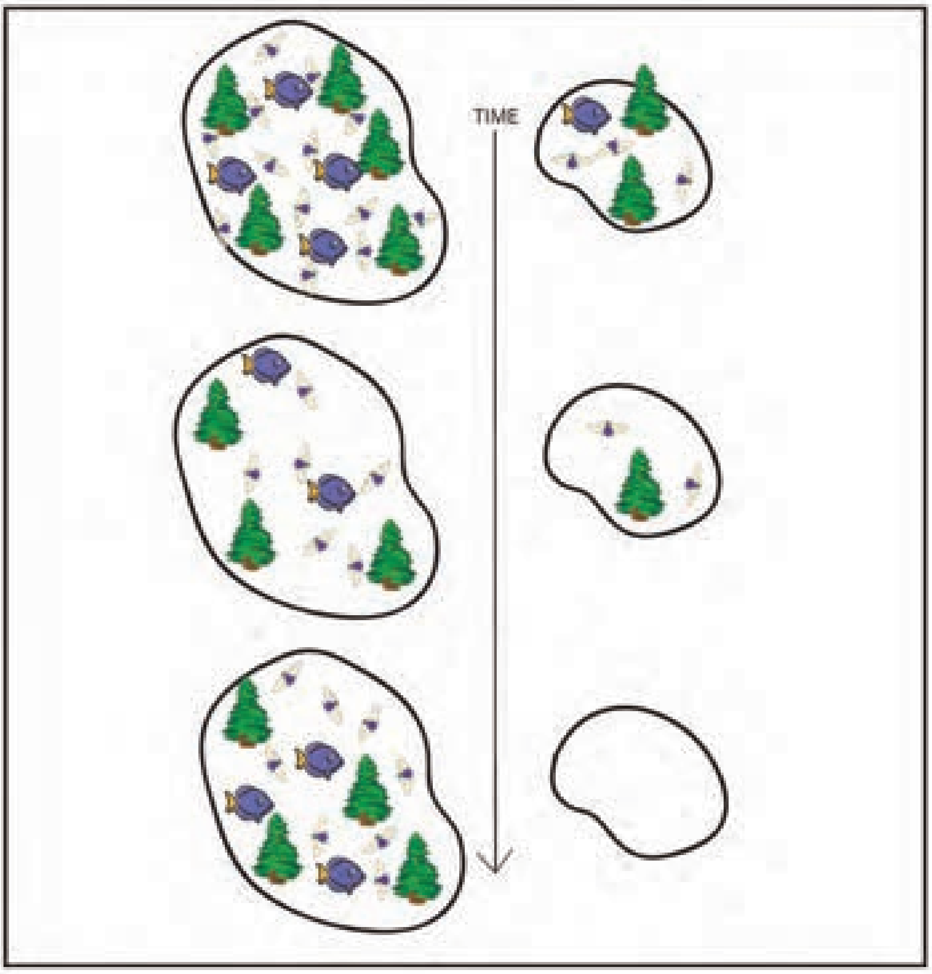
Planning Considerations:

- Establish Environmental Corridor widths sufficient enough to provide habitat needs of present species.
- Provide continuous corridors to provide habitat connectivity whenever possible.

Figure 25 ***shows the probability of a local species population being extirpated increases as habitat patch size decreases (right side of the diagram).*** Conversely, a larger patch generally supports a larger population size for a given species, making it less likely that the species will go locally extinct (left side of the diagram). ***Species viability and diversity are also enhanced by well-connected habitats.*** This is because small, isolated reserves are unlikely to maintain viable populations over the long-term. ***Wildlife Corridors are therefore recommended as a conservation measure to help counter the negative effects of habitat, loss, fragmentation, and patch isolation*** (see Figure 26). According to Noss (1997), ***landscape designs for maintaining habitat should be based on the following principles:***

- Species that are well distributed across a landscape have lower extinction risk
- Larger habitat patches with large populations are better than small patches with smaller populations
- Closer patches are better than distant patches

Figure 25
Patch Size and Local Extinction



The probability of a local species going extinct increases with decreasing habitat patch size. A larger patch generally supports a larger population size for a given species than a smaller patch, making it less likely that the species will go locally extinct in the larger patch.

Source: Environmental Law Institute 2003

- Contiguous patches are better than fragmented patches
- Connectivity of patches is better than isolated patches
- Stable populations fare better than fluctuating populations
- Peripheral populations perform poorly relative to core populations.

Figure 26
Wildlife Corridors

Source: Environmental Law Institute 2003

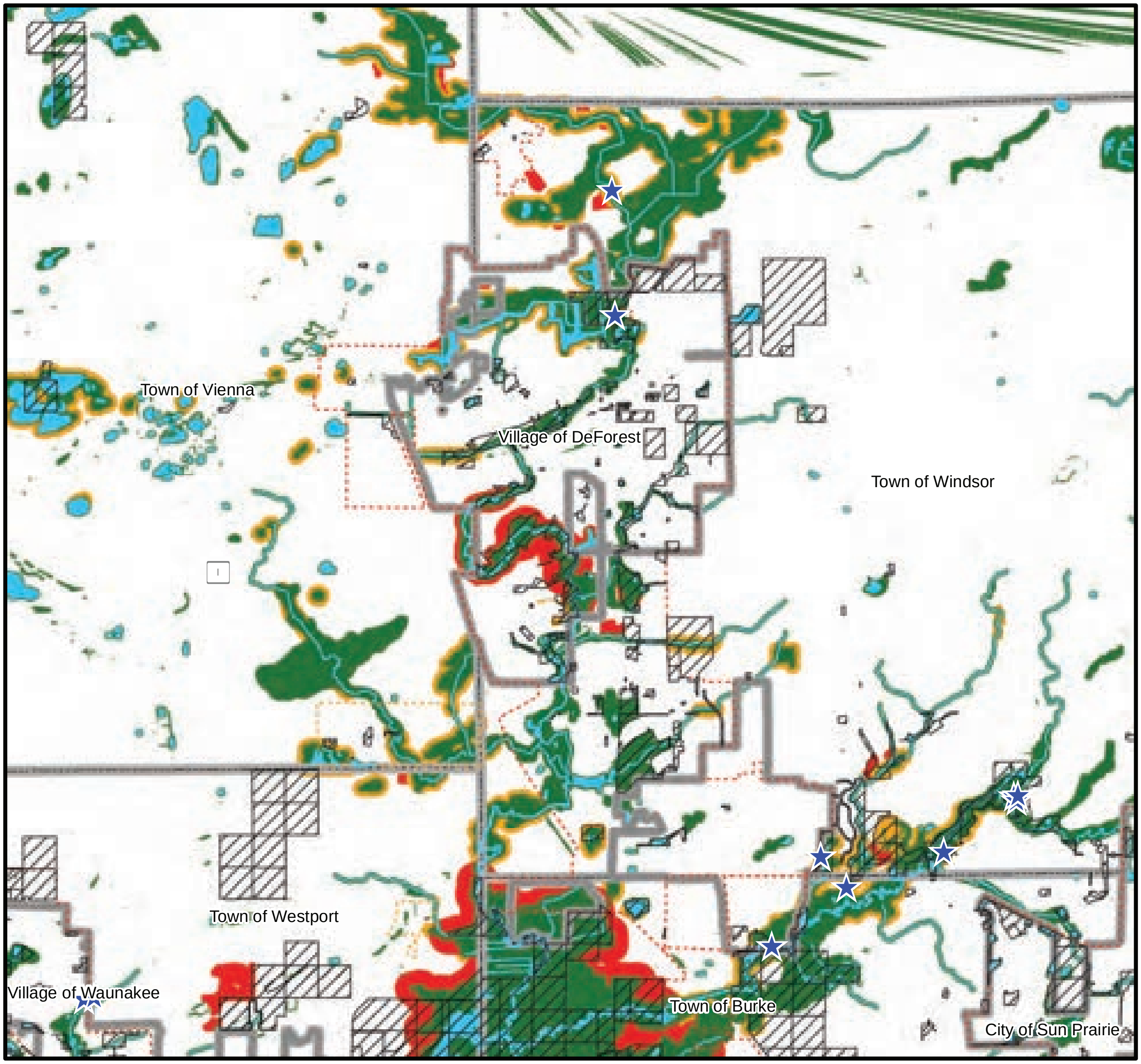
Protecting stepping stone patches or establishing a corridor can increase habitat connectivity, and improve species migration into extirpated habitat areas.

As the landscape is being considered for habitat, it is important to note that not all patches are always occupied by regional species. Due to ecological activities, species may naturally become extirpated. Maintaining a series of patches within a landscape is necessary for prey species to elude predators, refuge from contagious diseases and parasites, and providing re-colonization opportunities.

In general, most natural resource objectives can be accomplished within a corridor of 300 feet from the edge of a stream and 700 feet from the edge of a wetland or small pond (shown on Map 42***). This is the area where community stewardship activities will have the greatest beneficial effect.*** For example, this is the area suggested by leading ecologists for providing core habitat and a protective buffer for semi-aquatic amphibians and reptiles, which serve as umbrella species. By protecting umbrella species, other associated species may also be protected. Semi-aquatic species require both aquatic and terrestrial environments to fulfill their full life-cycle needs (e.g., breeding, hibernation, food, cover, etc.). Since amphibians and reptiles reside solidly in the middle of the food pyramid as both predators and prey, protecting core habitat for these umbrella species protects food, cover, and habitat for other associated species as well (i.e., other birds, mammals, fish, insects, and plants).

Map 42: Natural Resource Composit Map

North Yahara Study Area, Dane County WI



Government and Conservation Lands
Urban Service Area
Limited Service Area
Major Roadway
City or Village
Town
Open Water
Springs
Environmental Corridor Area
Optional Corridor Expansion
Optional Stewardship Area
Corridor Connectors * to be added*

N
Miles
0 0.25 0.5 0.75 1

Source: Capital Area Regional Planning Commision Feb 14th, 2012

Corridor areas are a no build area defined by existing standards for resource protection (NR 121) and adopted plans and policies. Optional Corridor Expansion Areas are high quality resources (wetlands, prairies, savannas & oak woodlands) that are recommended to be excluded from development. Optional Stewardship Areas are medium quality resources recommended to be protected through site design and review recommendations. Ranking criteria is based upon internal quality of natural resources, position in landscape, restoration feasibility and professional judgement.

I. Urban Development Strategies to Maintain and Improve Natural Resource Integrity

Various strategies have been presented below. These strategies can be implemented to minimize long-term impacts in a watershed undergoing urbanization.

1. Approach local issues from a regional watershed perspective

Watersheds and other natural features are not defined by political boundaries. Development impacts in one jurisdiction often spill over into other parts of the watershed. Planning at a watershed level is essential for streams and water bodies. Assessing the impact of each development, and the cumulative impact of development on a watershed scale is essential from a long-term hydrologic perspective. ***Criteria that balance high impact land uses such as residential, commercial, and industrial development with low impact land uses such as forests, wetlands, and grasslands are useful tools in the hands of regional and community land use planners and practitioners. Such criteria can be used to protect sensitive land uses such as wetlands, floodplains, woodlands, and the wildlife that depend on them, while also accommodating economic development that is important for the region.***

2. Direct development away from sensitive natural areas to better suited areas

Large naturally vegetated reserves surrounding our valuable water resources improves water quality by acting as a buffer and filtering out sediments and runoff that would otherwise enter these waters directly. Furthermore, acting as a sponge, these areas promote greater infiltration of the water into the ground, reducing runoff volumes and velocities, and concentrations of pollutants as the water that seeps through the ground is naturally filtered and released much more gradually. Natural resource reserves are particularly important as core habitat for wildlife. They also add to the natural scenic beauty of the landscape and provide an open space balance for the developed areas, increasing property values, outdoor recreation opportunities, and quality of life for residents and visitors alike.

3. Increase the efficient use of land resources through compact development patterns and optimizing the use of current urban areas through infill and re-development

The premature spreading out of urban land uses onto rural and other land areas is often inefficient and unnecessarily wasteful. Urban land uses moving out onto less-expensive land farther out from urban city centers do not typically account for the additional public costs or inefficiencies of providing the necessary infrastructure and services to serve that development (sewer, water, transportation, police, fire, etc.). After several decades of study in other areas around the country, it is apparent that unplanned or premature development imposes significant short-term and long-term costs on local governments, businesses, property owners, developers, as well as the environment.

4. Allow land use density transfers

Density transfers and TDRs can also be used in watershed planning. ***Density transfers allow developers and land owners to achieve the same overall density, therefore the same economic benefit, but concentrate the development in less sensitive portions of the site or the area.*** While overall density of the development is the same, it is concentrated in areas more suitable for it, thereby protecting more sensitive areas. Larger scale TDR programs provide a funding mechanism to compensate landowners located in sensitive "sending areas," directing the development potential of their land to more suitable "receiving areas." Landowners, developers, and the general public reap significant benefits by more efficient economic development activity.

5. Incorporate natural features into development design and apply conservation design principles

Incorporating the existing natural features of the site into the design of a development, rather than clearing the site completely and starting anew, reduces the impact that the development has on the natural state of a watershed. ***Encouraging conservation design principles in the layout for a new development is very effective in preserving the natural state of a watershed.*** Rather than the traditional individual plots and set back style, a clustered development with large passive open spaces is very effective. In many cases, clustered development leads to a dramatic cut in the cost of providing utilities and services – especially those related to transportation and imperviousness – as well as the significant and irreversible costs of natural resources depletion and impact which can be avoided.

6. Consider the long-term impacts when selecting a site

Because the amount of runoff generated by different land uses is a function of the hydrologic soil type and the land use, ***locating land uses based on the hydrologic soil type can in some cases significantly reduce the long-term impact of the development.*** For example, locating land uses that generate large amounts of clean rooftop runoff (e.g., commercial development) near soils that have naturally or potentially high infiltration rates can help reduce the hydrologic impact of the land use change.

7. Minimize impervious areas in design

Limiting road widths, parking spaces and other impervious surfaces to a minimum reduces their water quality and quantity impacts. Paying attention to design details and materials used in construction can add up. Using more permeable materials allows more water to seep into the ground. By looking into the design details that can be modified to minimize imperviousness, a great deal of success can be achieved. For example, utilizing a compact development pattern to reduce road lengths, minimizing overall disturbance of the natural features of the area, and reducing pavement and incorporating more greenspace are just some of the factors that can be considered.

8. Slow stormwater that runs off of the impervious areas and encourage infiltration

Stormwater basins and constructed wetlands reduce the risk of increased flooding due to increases in stormwater runoff rates. These basins retain stormwater and release it more gradually over a longer time period. Stormwater basins can be designed to be aesthetically pleasing and can potentially be used as the focus for open space or recreational facilities on a site. They can also be used for economic benefit by developers and realtors as many people enjoy living near water and are willing to pay higher prices for such plots. While stormwater basins are important for reducing peak flows, they do not solve the problem of increased runoff *volumes* due to development. An effective way to increase the amount of water that infiltrates into the ground instead of becoming runoff is by implementing effective infiltration control practices and measures. There is a wide variety of mitigation strategies to choose from depending on the characteristics of the site.[62]

9. Reduce Pollution Sources on all surfaces

The amounts of pollutants that get into stormwater can be reduced or prevented through good management practices at the source. Proper disposal of pet waste and reducing the use of fertilizers and pesticides in lawns, gardens, and other good "housekeeping" practices can significantly reduce the nutrients and chemicals in urban runoff.

62 Refer to the 2011 update of *Technical Appendix D: Urban Nonpoint Source Analysis* to the *Dane County Water Quality Plan* for a more complete discussion and analysis of these potential impacts and the performance standards and management practices that communities have or can put in place to mitigate them. Link here.

North Yahara

Future Urban Development Area Planning

Environmental Conditions Report

Chapter II. Agricultural Resources

Introduction

The DeForest, Vienna, and Windsor jurisdictions contain highly productive and economically valuable agricultural lands. The agricultural data in this chapter can inform their local decision-making and identify the agricultural lands that these community may preserve, maintain, or develop as part of the Future Urban Development Area (FUDA) planning and the Comprehensive planning processes.

Agriculture serves three general purposes:

1. Providing food, fiber, and fuel resources for use in the wildlife and human ecosystems, and human economic systems. Agricultural lands provide food, fiber, and fuel for life's most basic needs, adequate space for rural facilities and those which require large expanses of open land, and groundwater recharge.
2. Providing cultural resources for the community and region. Agriculture provides a community aesthetic and sense of place built throughout history that can educate citizens and provide them with recreational lands.
3. Supporting ecological systems. In supporting ecological systems, properly managed agricultural lands can be used to recycle nutrients, form soil, and provide some wildlife habitat. Additionally, properly managed agricultural lands can provide pervious land for infiltration of rainfall and snow melt, maintain water temperature and quality, and buffer noise.

Town of Vienna

The important functions and benefits provided by agricultural lands must be weighed when considering development, preservation, and other land use decisions.

The data in this chapter provides information for the 2000-2005 interval. Where available, 2008 data was also included. Comparable geographic data is not available for earlier periods. The information is from county-wide data sources including the Land Use Inventory, tax parcel assessments, and other data provided by the Wisconsin Department of Agriculture, Trade, and Consumer Protection. ***Data is provided for the local communities, the Moraine and Yahara River Valley physiographic sub-regions (explained further in the Ecological Services and Function section), and for Dane County as whole to provide sub-regional and regional contexts and comparison.***

This chapter of the environmental conditions report (ECR) covers the following agriculture related factors:

- Agricultural land area and land conservation
- Ecological services and functions on agricultural parcels
- Agricultural parcels and base farm tracts
- Agricultural contiguity and concentration
- Agricultural operation type (livestock, crop, and crop type)
- Tax parcel value assessment
- Soil quality (prime lands and Land Evaluation)
- Agricultural support services

Town of Vienna

A. Agricultural Land Area and Land Conversion

Agricultural production is one of the most significant land uses across the State. Dane County and the North Yahara FUDA territories are no different in this regard. Simultaneously, Dane County continues to experience one of the fastest population growth rates in the State. The land developed with buildings and infrastructure to accommodate population growth and movement is often taken out of agricultural production.

In year 2000, approximately 451,000 acres of land were categorized under agricultural land use in Dane County, nearly 100,000 acres fewer than categorized as agriculture in 1980.[66] Of the total area removed from agricultural uses since 1980, 37,000 acres were converted to developed uses, representing 37% of the total area removed, and 6.7% of the total area in agriculture in 1980. As of year 2005, 430,178 acres were dedicated to agricultural uses across Dane County.

Agricultural lands are generally in town jurisdictions with a few agricultural areas in cities and villages. The towns of Westport, Windsor, Burke, and Vienna directly boarder the jurisdictional limits of the Village of DeForest. Table 13***, and the corresponding*** Map 43***, show the breakdown of agricultural and developed lands in the study area.***

Table 13
Agricultural and Developed Land Area (acres)

Study Area Portion	Agricultural		Developed		All Other Land	
	2000	2005	2000	2005	2000	2005
T. Windsor	2,152	2,016	387	535	539	526
T. Westport	724	665	51	50	70	130
T. Burke	242	242	31	46	201	186
T. Vienna	3,455	3,477	410	473	447	363
V. DeForest	312	445	114	82	83	-
Regional Comparison						
Study area total	6,885	6,844	993	1,186	1,341	1,189
Yahara Rr. Valley	87,912	88,638	50,534	55,780	34,362	28,390
County	499,000	485,930	127,055	143,584	127,055	143,584

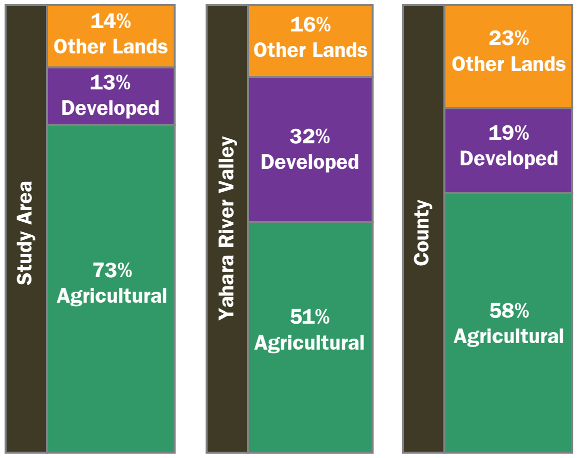
Source: CARPC Land Use Inventory

Windsor is bound by DeForest to the west; Burke, and the City of Sun Prairie to the south; and opens to Bristol and Colombia County to the east and north respectively. Windsor has a predominantly rural agricultural land use with rural housing intermixed. Rural subdivisions are scattered throughout the town with more concentrated urban development bordering the Village of DeForest. The Village of DeForest is broken into a north and a south portion, with urbanized areas of Windsor located in between.

As of 2005, 6,844 acres of agricultural lands were located in the study area (outside the urban service area), 40 less acres than were considered agriculture in 2000. Development

66 At the county level, about 95,500 acres of crop and pasture lands were converted to other uses between 1980 and 2000. Less than half of all crop and pasture acreage losses can be attributed to development, with approximately 37,000 acres developed. Thus, significant agricultural acreage is being transferred to land uses such as vacant/unused, environmental corridors, wetland restoration, or open space. See *FLM 1: Farmland Loss in Dane County* , CARPC, 2010. (http://danedocs.countyofdane.com/webdocs/PDF/capd/2010_postings/FLM_1.pdf).

Figure 27
Regional Land Use Comparison (2005)



acreage increased by more than this amount. The remaining increase is from (1) developing non-agricultural lands (e.g. open lands) or (2) lands converted out of agriculture before 2000 that acted as holding lands until development became feasible in the 2000-2005 interval. Note that lands are also lost to annexation. This is likely the case for Westport, where agriculture decreased while development acreage remain constant. In Windsor, 535 acres were developed, 1,948 were agricultural, and the remaining acres were dedicated to other land uses, such as public and open lands. The Town of Vienna accounts for a significant amount of agricultural lands in the study area, with 3,455 acres in 2000.

Agricultural land conversions are shown in magenta in Map 43. The map also shows agriculture present in Windsor and portions of DeForest in 1974, totaling 19,250 acres for the Village and the entire township.

These trends are in line with general historic changes dating back to 1980 and earlier. ***Overall, conversions out of agricultural use since 1980 indicate that roughly 3,700 acres in Windsor, 1,335 acres in Vienna, 2,770 acres in Burke and, 5,346 acres in Westport were converted out of the agricultural land use category.***[67]

The Village of DeForest had 312 acres of agricultural lands in 2000 and 445 acres in 2005. This increase is likely due to annexation of agricultural lands for urban development, cultivated until development is imminent. The decrease in developed land is likely due to changes in the Urban service area boundary, such that a portion of the developed acreage in 2000 were incorporated into the service area and were therefore not counted in 2005.

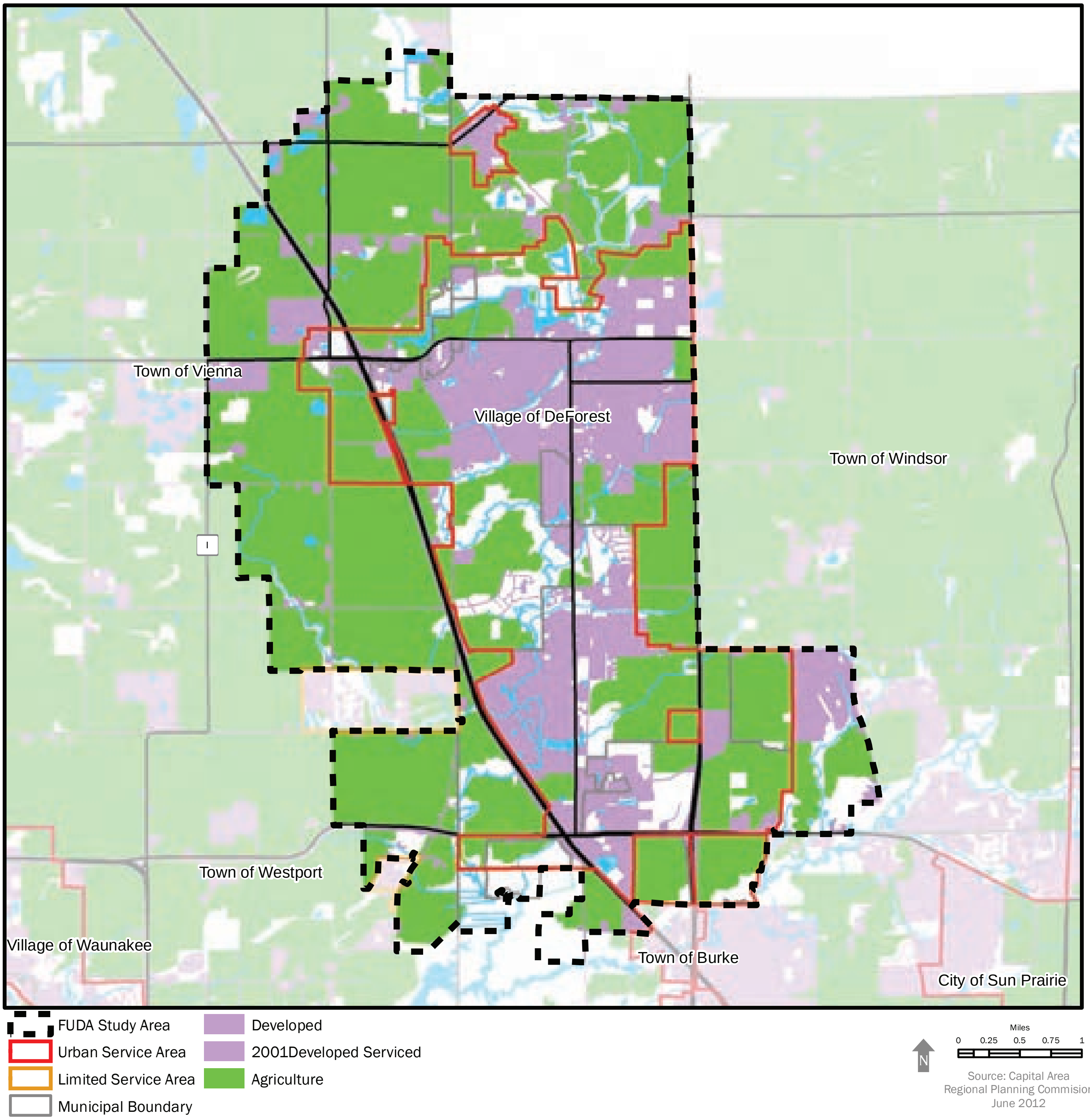
Agricultural lands in the Village of DeForest within the urban service area boundary are not included in Table 13, and are worth discussing for their potential as urban agriculture, development or ecological reserve. In 2005, DeForest had 1,645 agricultural acres inside and outside the urban service area, leaving 1,200 acres within the service area. Map 44 illustrates where these lands are located.

A significant portion of agricultural land in urban jurisdictions is likely intended for eventual development. Typically, land is annexed from a town because the landowner is seeking to develop the land with a more intense land use with public sewer and water services. This land can remain in agricultural production (typically leased out) to maintain lower agricultural use tax rates until development occurs. Alternatively, community gardens, community based farms, and certain agricultural lands can maintain or enhance their role in providing buffers between communities, other land uses, and natural resources. These lands (see Map 44) can be more specifically identified through the FUDA process.

67 A portion of the agricultural land that converted out of agricultural land use category were recategorized under their true land use as data collection advanced and became more refined. For example, farm ponds went from this category to the “water” category, or woodlands were delineated separately in 2005 accounting for a large increase in woodlands and a loss in agriculture. This may result in a decrease in agricultural land use acreage, yet the actual cultivated or pastured acreage may not change.

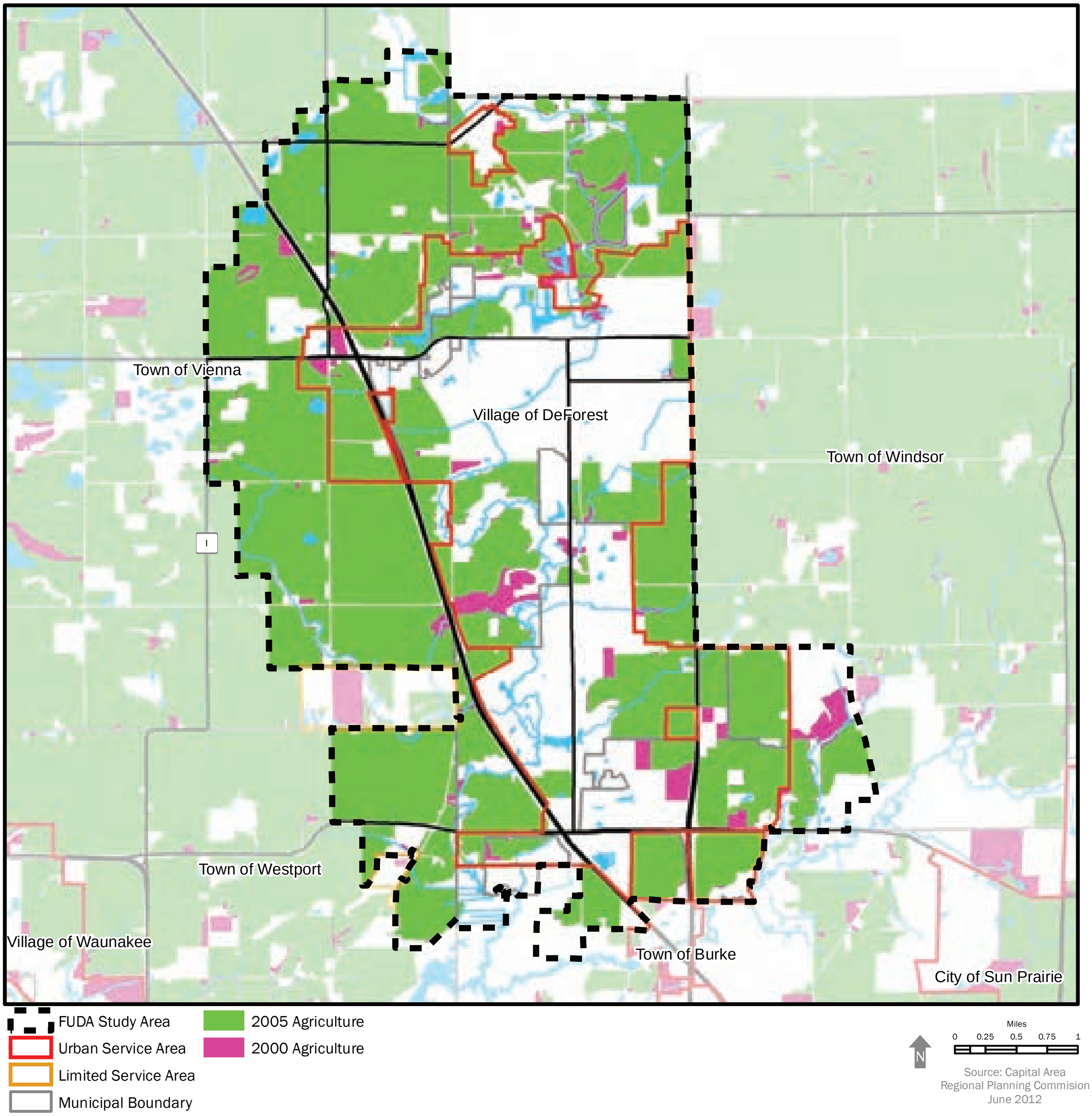
Map 43: Agricultural and Developed Lands - 2005

North Yahara Study Area, Dane County, WI



Map 44: Agricultural Land Conversion 2000-2005

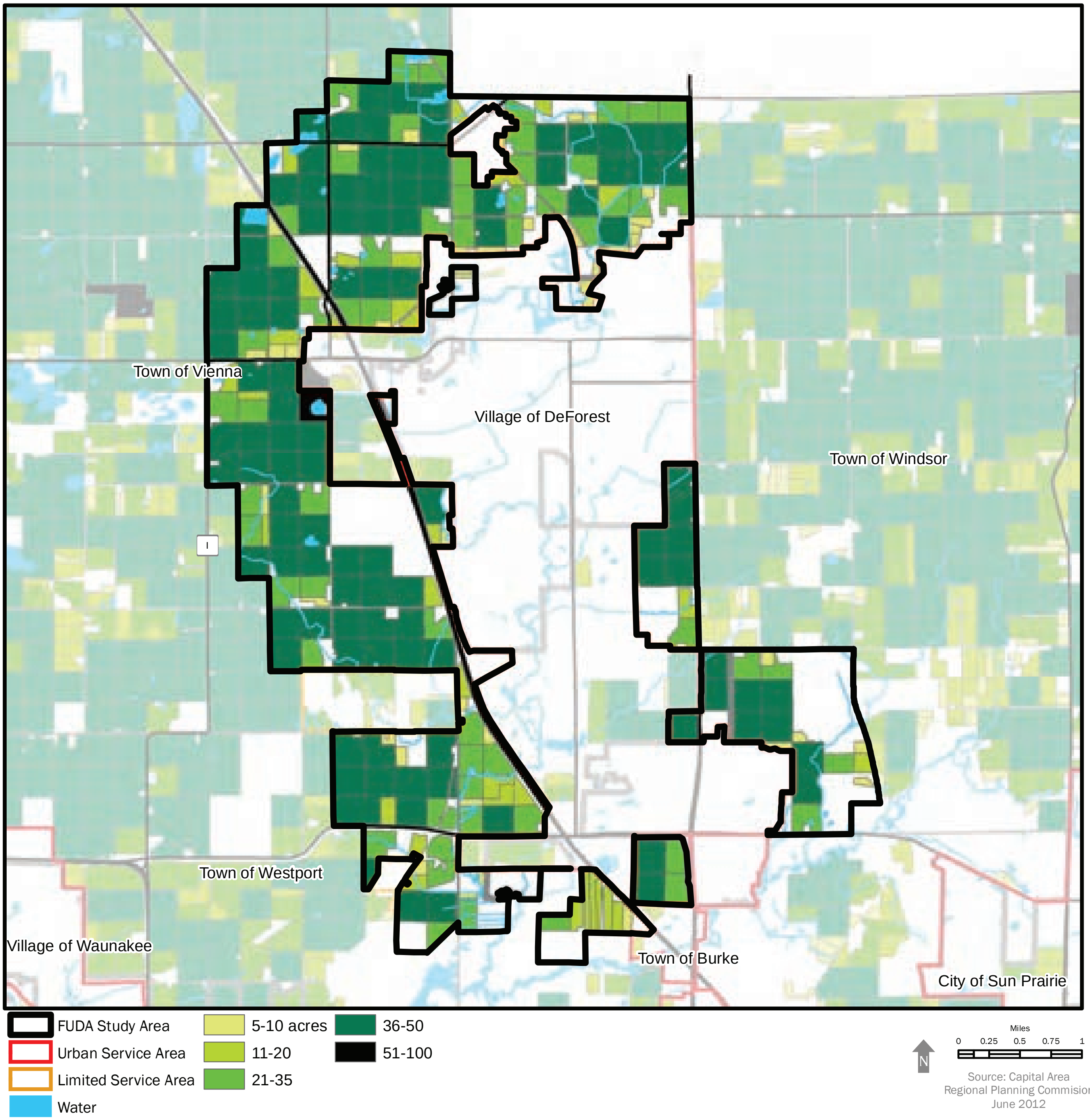
North Yahara Study Area, Dane County, WI



Source: Capital Area Regional Planning Commision June 2012

Map 45: Agricultural Parcels - 2005

North Yahara Study Area, Dane County, WI



Within the study area, the preatest portion of parcels were 36-100 acres in size. The largest parcel was 77 acres, in the year 2005. The median size was 34 acres and the mean was 28 acres.

B. Farmland and Farm Operation Characteristics

The following variables may be useful in planning for urban and rural development and agricultural preservation:

- Agricultural parcels and base farm tracts
- Agricultural contiguity and concentration
- Agricultural operation types (livestock, crop, and crop type)
- Tax parcel value assessment
- Soil quality (prime soils and Land Evaluation soils)
- Agricultural support services

1. Agricultural Parcels and Base Farm Tracts

Agricultural land is typically divided into parcels and often these parcels host other land uses in addition to farming, such as woodlands or water. Parcel acreages are larger than the area which is under active agricultural production. Still, parcels are important to examine because agricultural land is divided and sold by the parcel. Moreover, land use regulations occur at the parcel level and recommendations for agricultural land use will need to be useful at the parcel level as well as the regional level. Finally, parcels are the base unit for determining base farm tracts and contiguous blocks of agricultural land.

Applying the agricultural land use to tax parcel delineations reveals the number of agricultural parcels in the study area. Further analysis reveals parcel characteristics, such as size and ownership. These variables can begin to reveal the diversity of agricultural operations. Maintaining diversity in size and operation type can insulate the regional agricultural industry from severe market changes in any one sector, and can better support and encourage regional food systems. This diversity includes small and medium sized family farms and livestock operations that dominate the western portions of the County, and the potentially larger and contiguous operations in the east.

Town of Westport

Table 14 shows the number of parcels[68] in the study area. In 2005, agricultural land in the study area was divided into 253 parcels.[69] An increase in development potential between 2000 and 2008, resulted in numerous parcel divisions, and with the collapse of the housing market, many of the parcels remained in agricultural use through 2008. This is primarily the case in unserviced (unimproved) lands in DeForest, where parcel splits for residential subdivisions dramatically reduced the mean and median below previous data years. In town areas the number of parcels generally decreased, while maximum, mean, and median parcels sizes generally remained the same or slightly increased.

Parcel sizes typically follow zoning and regulatory standards, and do not necessarily reflect the farming operation or needs. The predominant agricultural parcel zoning standard across the county is 1 split for every 35 acres, with a few towns requiring larger split requirements of 40 to 75 acres. Parcel figures reflect the 1 split per 35 acres rule with a mean size of 28 and a median of 32. The largest parcel in the study area is 260 acres in the Town of Vienna.

Table 14
Agricultural Parcel Data (acres)

Study Area	2000				2005				2008			
	# Parcels	Median	Mean	Max.	# Parcels	Median	Mean	Max.	# Parcels	Median	Mean	Max.
T. Windsor	100	24	23	41	94	24	23	40	88	24	24	40
T. Westport	26	22	26	41	22	34	30	55	22	35	30	55
T. Burke	25	11	19	49	16	16	19	46	16	16	21	46
T. Vienna	133	36	29	41	117	37	35	261	118	37	33	261
V. DeForest	3	10	7	11	4	37	29	38	183	0.2	1.4	38
Regional Comparison												
Study area total	287	28	25	49	253	32	28	261	427	9	17	261
Yahara Rr. Valley	3,516	25	25	59	3,150	31	27	261	3,921	23	23	378
County	21,309	23	24	68	18,349	31	27	261	20,706	28	25	378

Source: CARPC Land Use Inventory

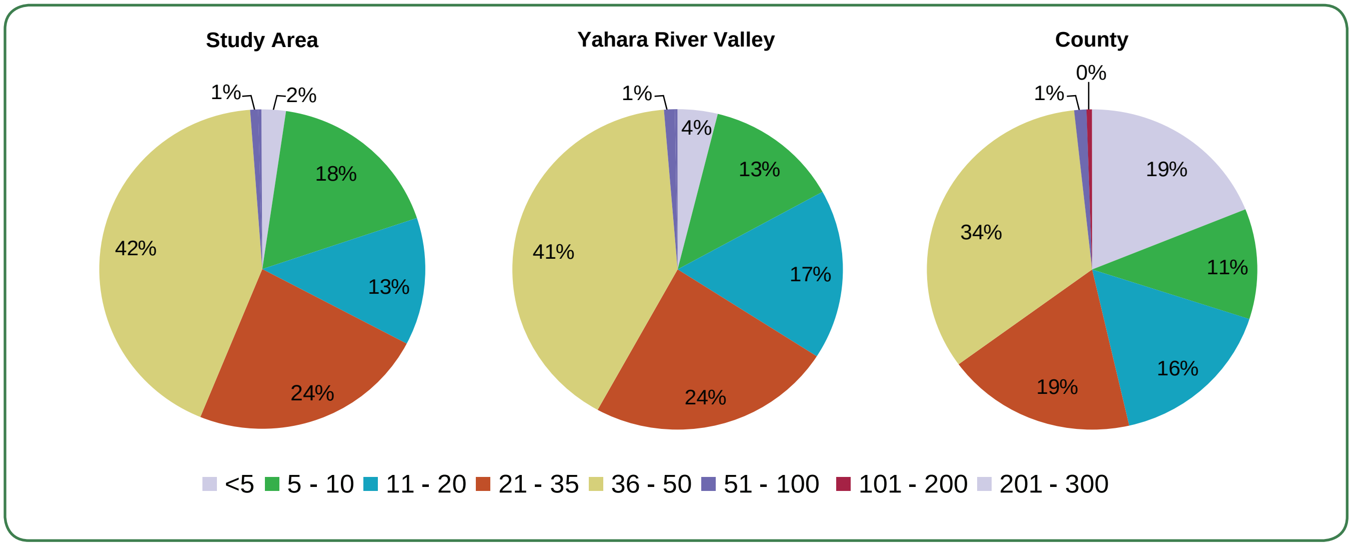
A look at the distribution of parcels in the study area, shown in Figure 28 and Figure 29 reveal the most common agricultural parcels to be 36-50 acres in size, with 42% of parcels in this range, occupying 59% of the agricultural acreage in the study area. Agricultural parcels of 35 acres (the typical zoning standard) or less account for more than half of the parcels, while accounting for 36% of agricultural land area. In Dane County and in the physiographic sub-regions larger parcels can be found up to 300 acres in size, though these parcels represent a relatively small percent of agricultural land.

68 Agricultural parcels are any privately owned 'rural' (as designated in the land use inventory) parcels 5 acres or larger. All parcels determined to be "ex-urban," "potential exurban," or "other" were removed from the agricultural parcel data set (see Appendix D for details).

69 Roads, water, parks, and other public lands are not counted in this figure.

Figure 28

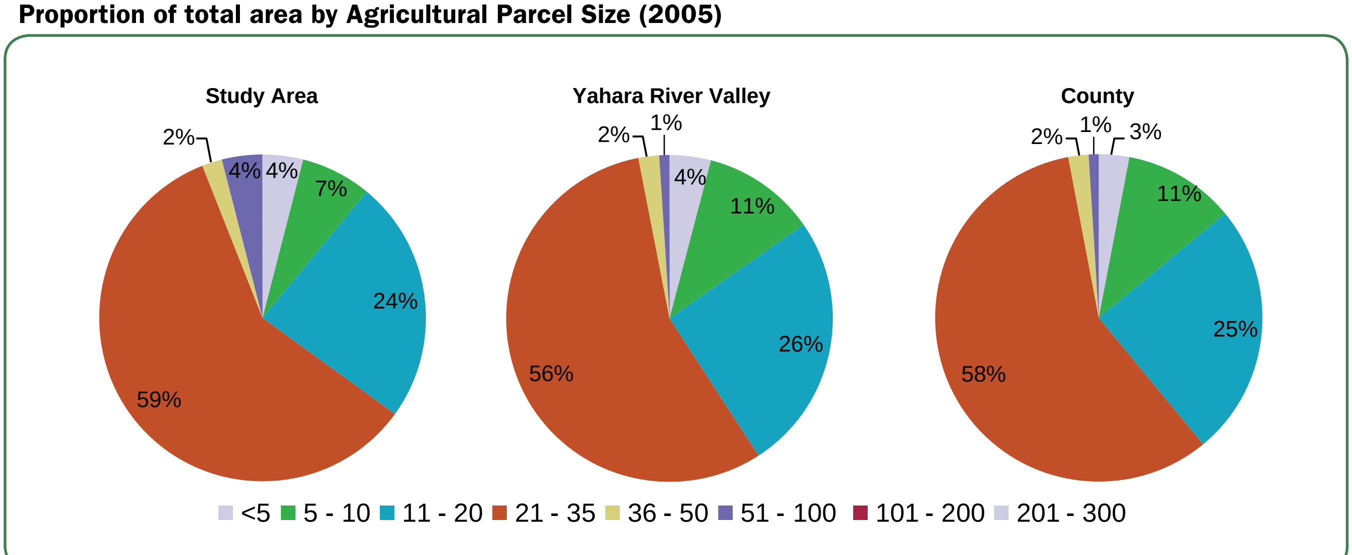
Distribution of Agricultural Parcels by Size (2005)



Town of Vienna

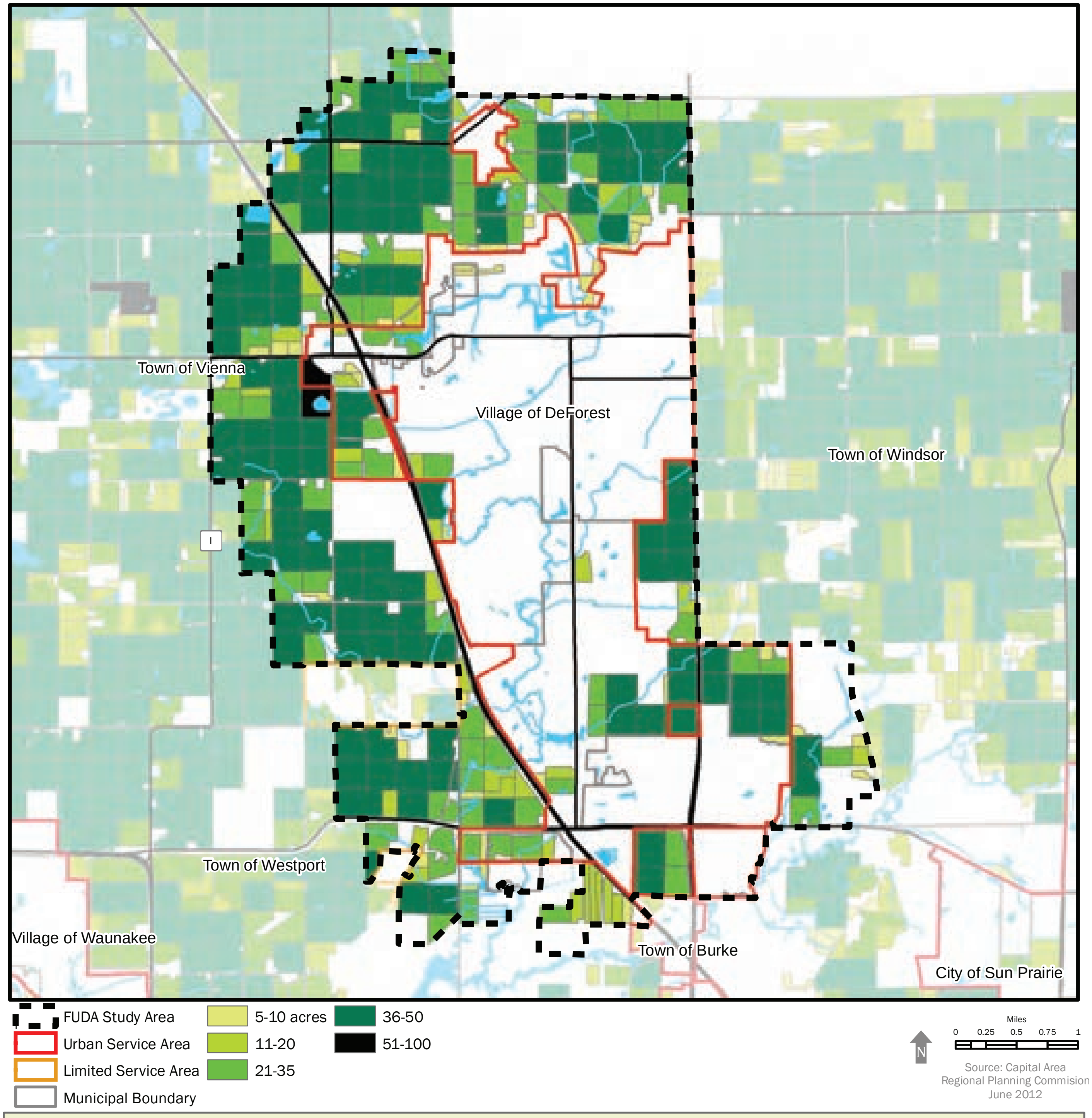
Figure 29

Proportion of total area by Agricultural Parcel Size (2005)



Map 46: Agricultural Parcels - 2005

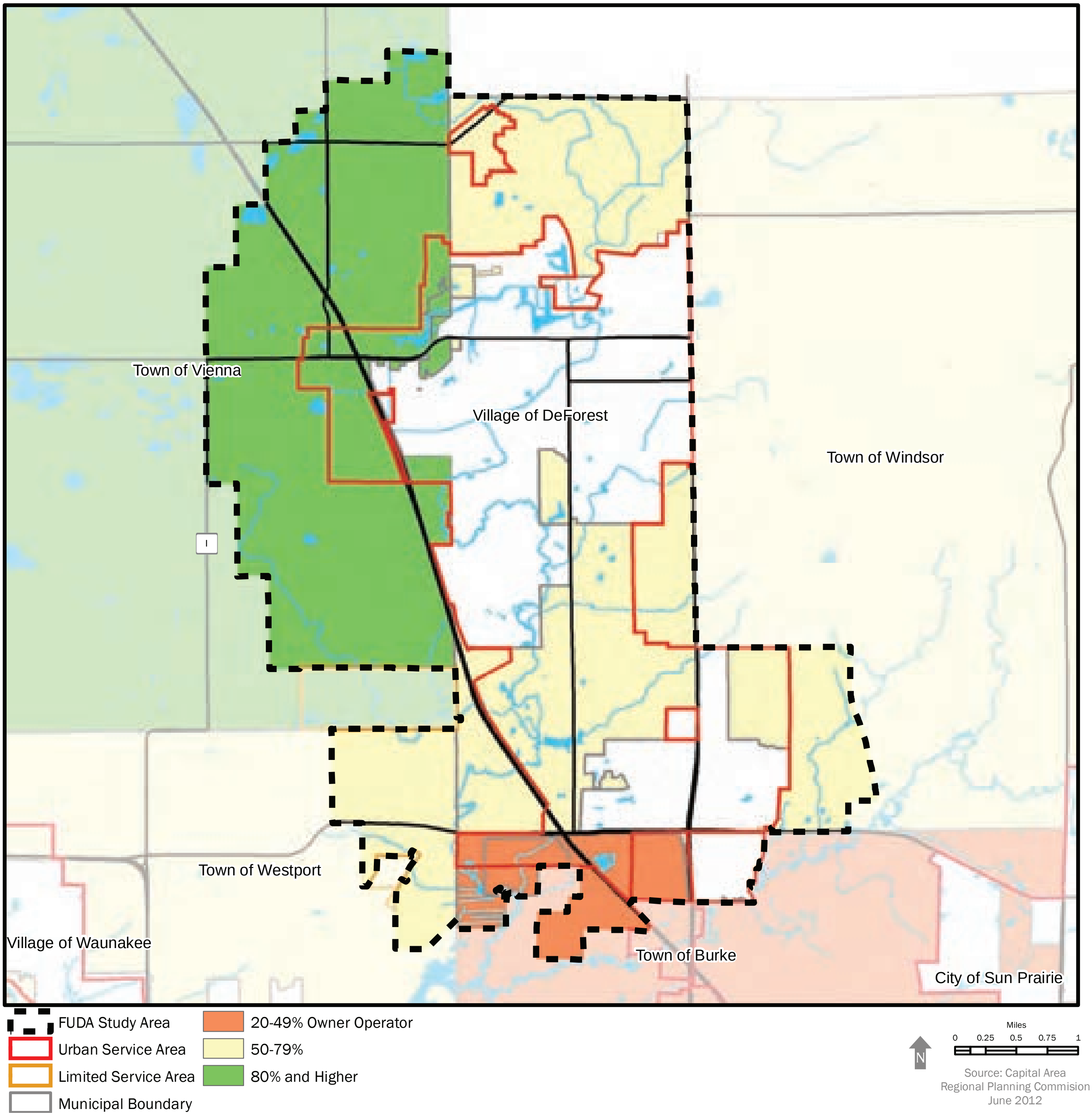
North Yahara Study Area, Dane County, WI



Within the study area, the preatest portion of parcels were 36-100 acres in size. The largest parcel was 77 acres, in the year 2005. The median size was 34 acres and the mean was 28 acres.

Map 47: Farmland Ownership (2008)

North Yahara Study Area, Dane County, WI



To determine the approximate number of farm operations and estimate their size, bordering parcels owned by the same landowner were combined into one unit called a base farm tract. Base farm tracts are shown in Map 48*.* Within the study area, there were 123 base farm tracts in year 2005, revealing that land owners typically hold more than one parcel for their farming operation.

The true number of farms, in business terms, is likely less than these figures because a base farm tract owner may not actually farm his or her own land. Instead the owner may lease out his or her land to an existing land owner or another individual for agricultural use.

As seen in the 'study area total' row in Table 15, the median tract size was 39 acres and the mean was 51 acres in 2005. This difference indicates that a few landowners own very large portions of the agricultural land. The largest base farm tract was 337 acres. This tract and the four next largest in the study area are located in the Town of Vienna.

The size distribution breakdown (fig. 30) for all base farm tracts shows that 40% of all tracts to be under 35 acres, with 20% of these falling between 5 and 10 acres in size. While these sizes have the highest quantity areas, tracts under 35 acres only comprise 10% of all agricultural land. The next largest contribution is from tracts 51 to 100 acres in size, which occupy 30% of agricultural land area, second only to tracts 100-200 acres for total land area.

Figure 30. Size Distribution of Base Farm Tracts (2005)

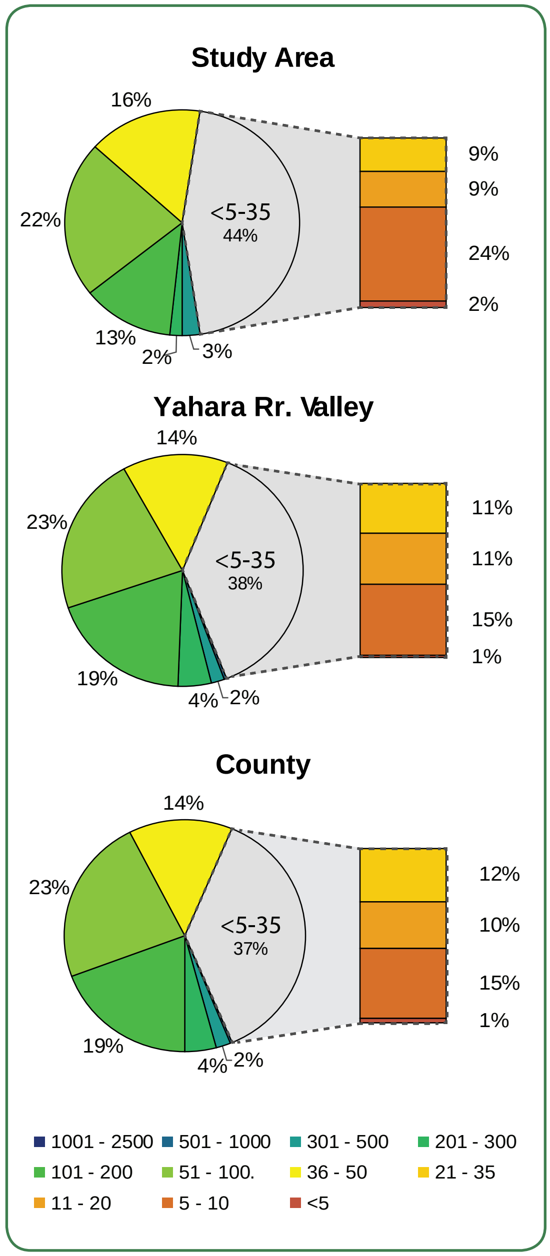
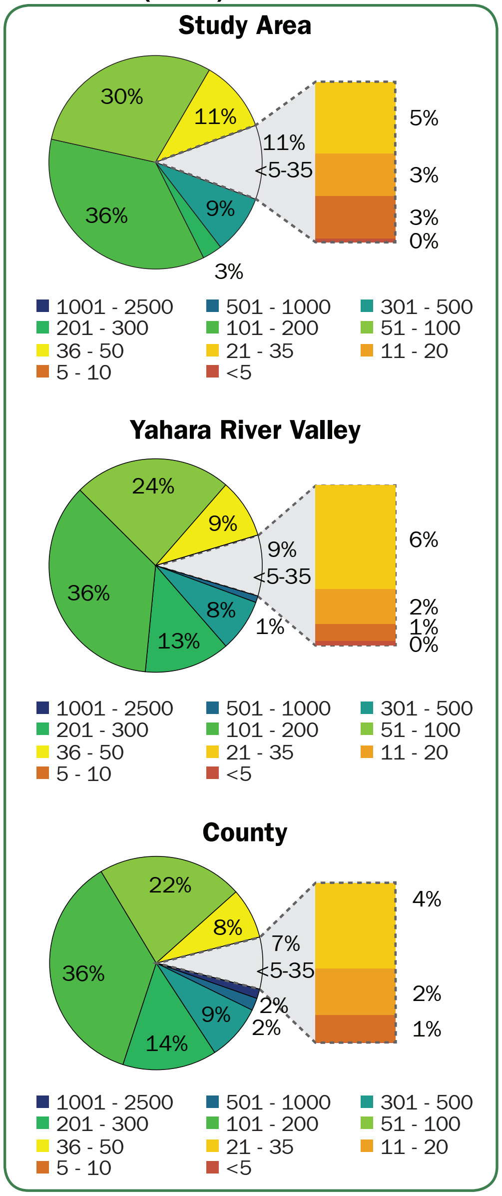


Table 15
Base Farm Tract Data (acres)

Study Area	2000				2005				2008			
	# Tracts	Median	Mean	Max.	# Tracts	Median	Mean	Max.	# Tracts	Median	Mean	Max.
Study area total	112	21	65	371	123	39	51	337	111	37	65	377
Sub-regions	1,287	54	79	822	1,331	47	74	639	1,416	40	75	753
County	6,586	50	78	1,723	6,761	45	74	1,666	6,961	42	75	1,811

Source: CARPC Land Use Inventory

Figure 31
Proportion of Total Area by Base Farm Tract Size (2005)

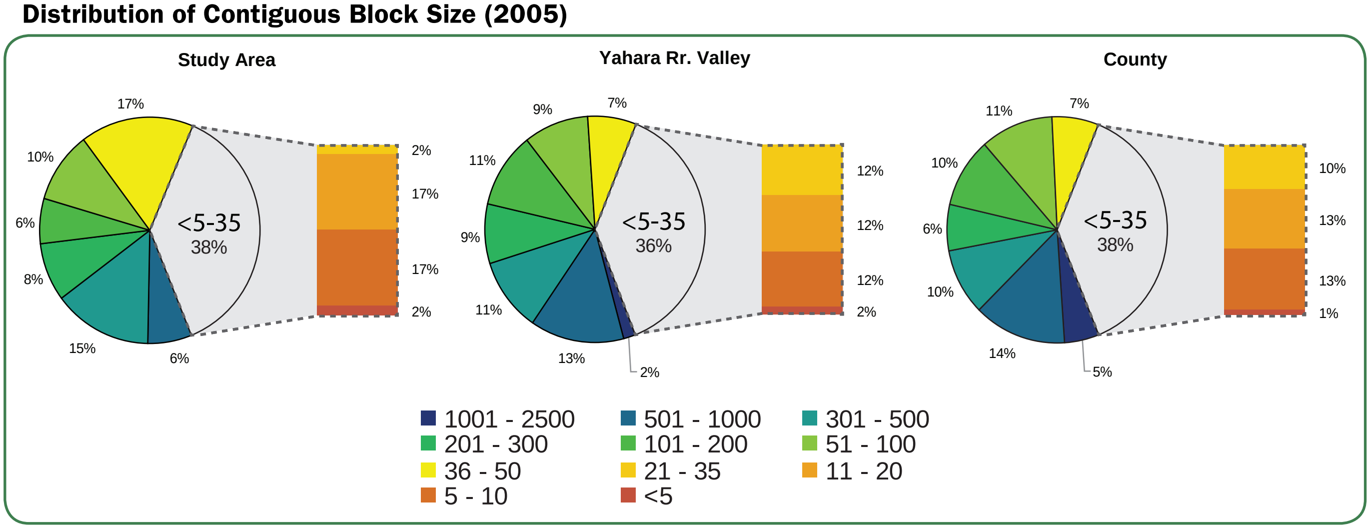


County-wide the breakdown of smaller sized tracts mirrors the study area. However, across the county, especially farther out from developing jurisdictions, much larger tracts of land exist. Also, note that some base farm tracts at the edge of the study area may also be connected to parcels outside the study area, and could therefore be part of a larger tract than accounted for in the table.

As mentioned above, a farmer may operate on land leased from a non-operator land owner. While specific data is not available for every parcel or operation (confidential records), the Department of Agriculture, Trade, and Consumer Protection (DATCP) provides summary information on owner-operators at the township level in broad ranges (Map 47). In the Town of Vienna, at least 80% of farms are worked by owner operators. Windsor and Westport have an owner-operator ratio of 50-79 percent. Lastly, the study area portion of the Burke has a ratio of 20%-49% owner-operator to non-owners operators.

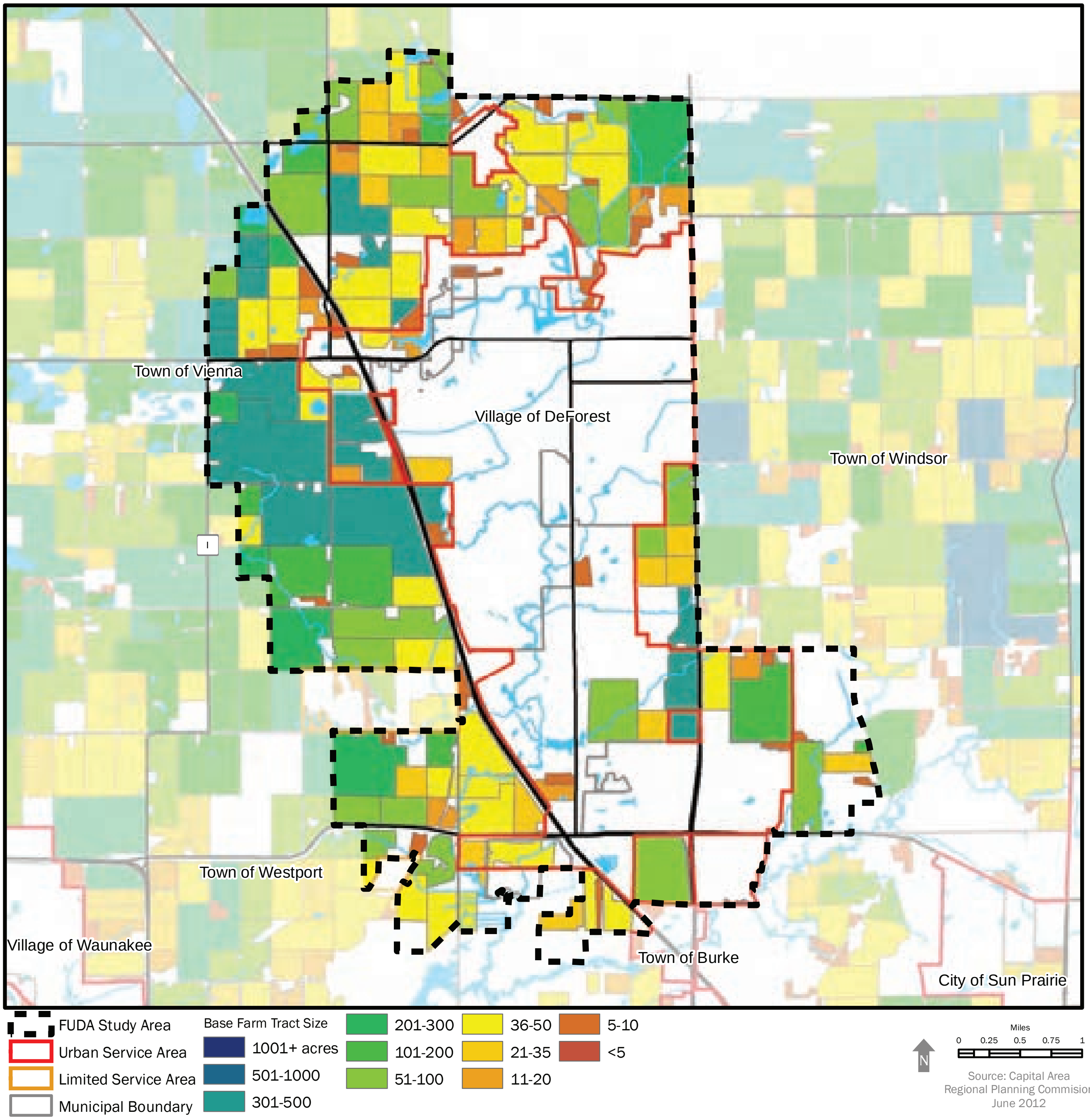
The lower ratio of owner-operators in a town indicates a higher likelihood that these lands will become available for development in the future, because the land owner is not directly using or investing in the land, and the existing farmer using the land might not be bound by long-term contracts.

Figure 32
Distribution of Contiguous Block Size (2005)



Map 48: Base Farm Tract Size - 2005

North Yahara Study Area, Dane County, WI



Within the study area, the largest portion of base farm tracts are 35 acres or less and more than half are 100 acres or less. The largest tract is 77 acres. The median size is 34 acres and a mean of 28 acres.

2. Agricultural Land Contiguity and Concentration

For agricultural operations to remain viable, a critical mass of relatively uninterrupted agricultural land may be necessary. This creates efficiency for businesses providing resources and services to farmers, and prevents conflicts with incompatible land uses, such as residential, that often lead to traffic conflicts on roads shared with large slow-moving farm vehicles, or complaints about farm noise and odor.

Contiguous agricultural blocks measure the current massing of agricultural parcels. The study area boasts large contiguous blocks of agricultural land and portions of large blocks primarily outside the study area, as shown in Map 49. Table 16 presents data for the area (note that the study area boundary crosses some block boundaries and many reduce some block sizes in the Figure 33).

Figure 33
Contiguous Blocks (acres) (2005)

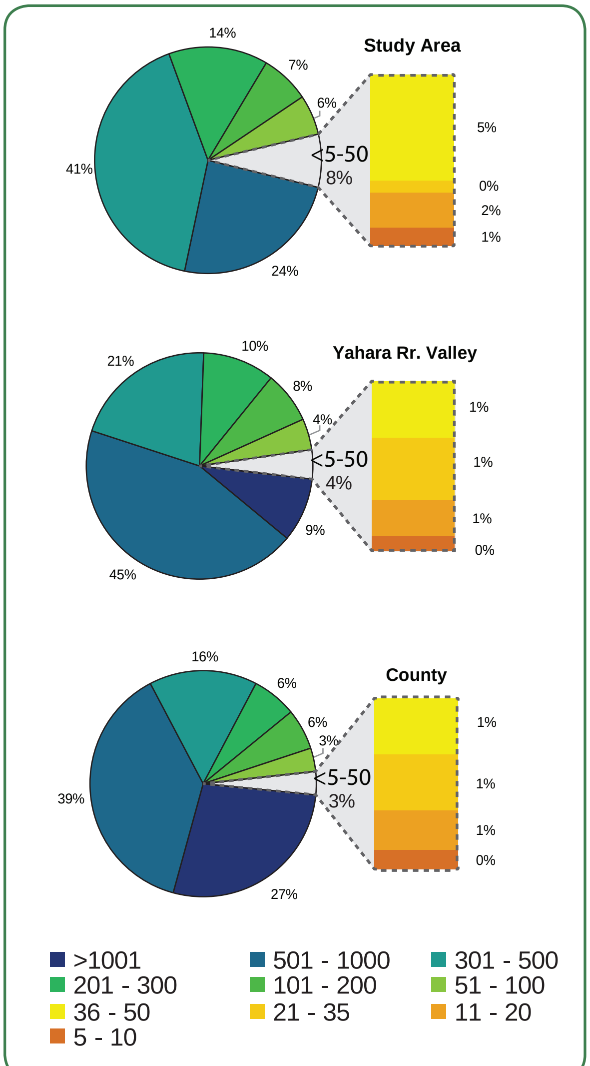


Table 16
Contiguous Blocks (acres)

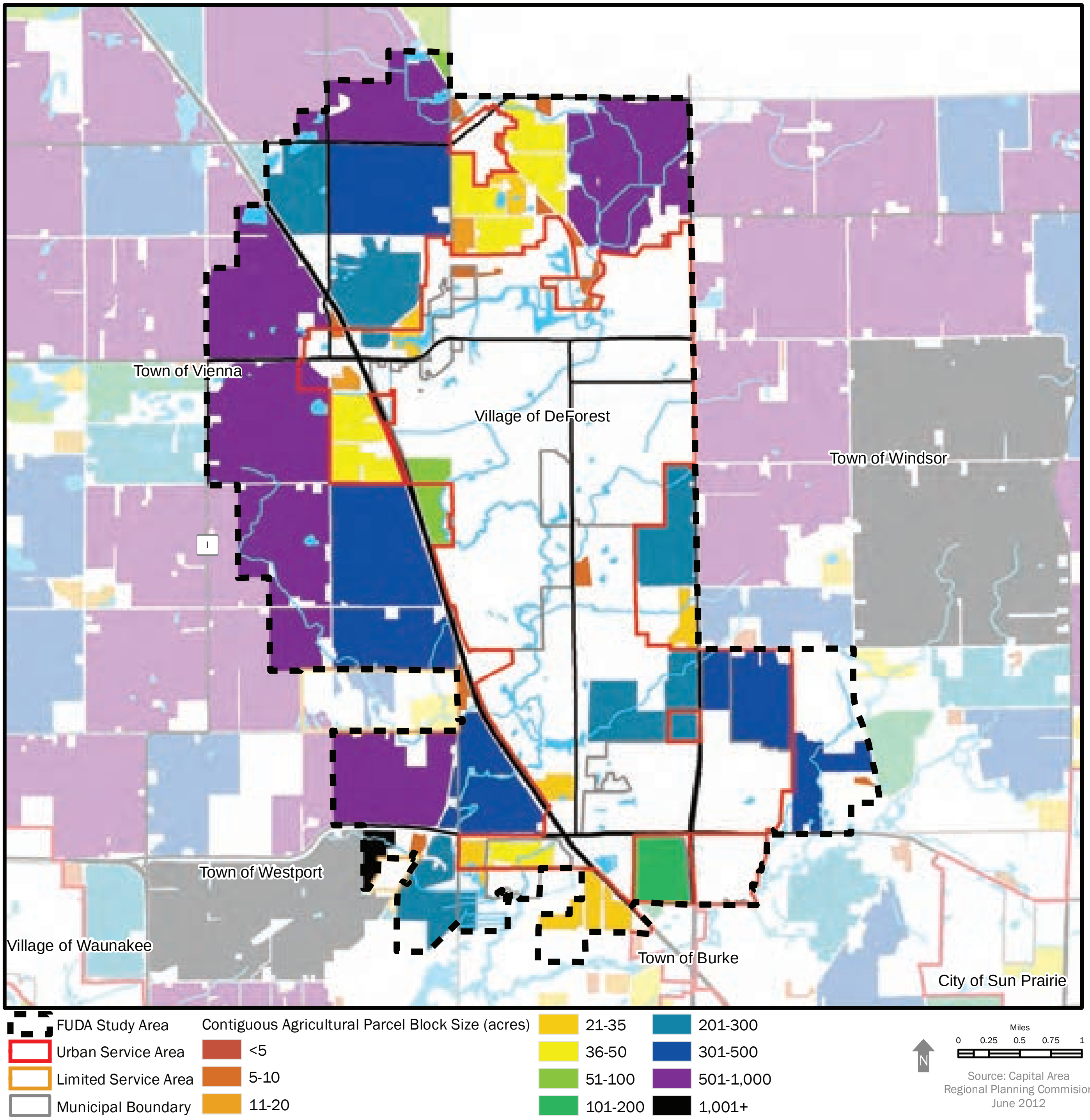
Regional Comparison	# Blocks	Median	Mean	Max.
Study area total				
2000	47	37	155	644
2005	48	13	146	638
2008	48	28	150	648
Yahara River Valley				
2000	471	94	228	1,650
2005	405	73	206	1,643
2008	498	66	222	1,644
County				
2000	1,857	88	275	3,764
2005	2,005	72	249	3,137
2008	1,893	69	275	3,955

Source: CARPC Land Use Inventory

Contiguous blocks: Touching agricultural parcels are grouped together to create contiguius blocks. Barriers (highways, large water bodies, steep slopes, or other land uses) break land into smaller pieces.

Map 49: Contiguous Agricultural Blocks - 2005

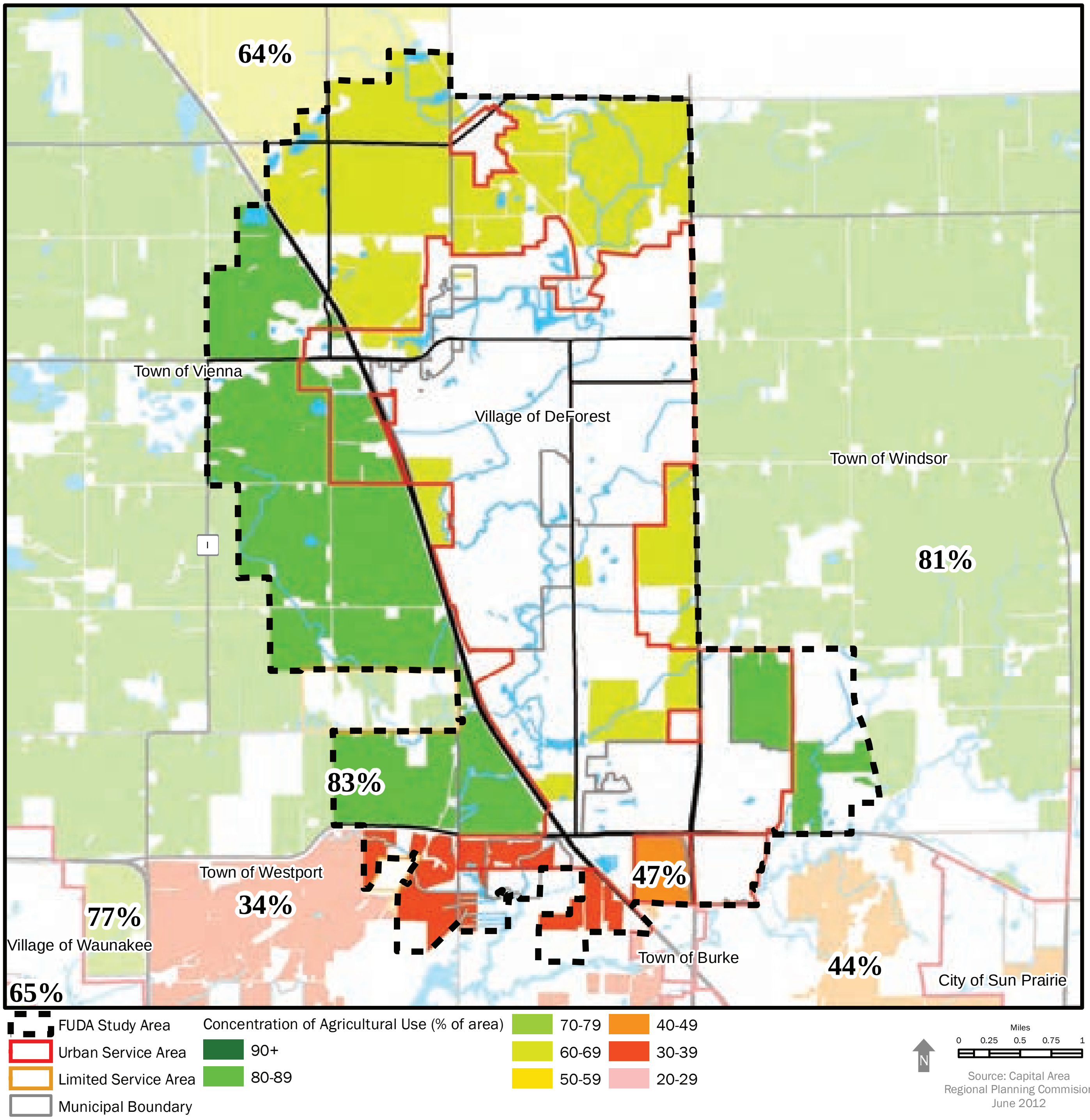
North Yahara Study Area, Dane County, WI



This analysis combines all touching agricultural parcels that are not separated by any roads, major water bodies, other non-agricultural devleopment, or steep slopes. One-hundred fifteen blocks existed in the study area in 2005. The largest was 1,286 acres. The median tract size is 108 acres and the mean is 279 acres.

Map 50: Concentration of Agricultural Use Between Major Roads - 2005

North Yahara Study Area, Dane County, WI



This analysis combines all agricultural parcels bound by major roads and caluclates the percentage of the land that is agriculture with that area. This anaysis was conducted to show contiguous agriculture without considering local roads a barrier to agricultural vitality.

In 2005, the study area had 48 contiguous blocks of agricultural land in the study area with an average size of 155 acres and a median of 37 acres . Within the study area only, the largest block is in the Windsor, south of County Road DM and west of Hwy 51, at 638 acres. Vienna hosts the second largest at 552 acres and the third largest at 515 acres.

Map 49 ***also indicates that agricultural lands within, near, or bordering urban areas and rural hamlets generally show increased fragmentation.*** This is especially observable outside the Morrisonville limited service area just north of DeForest and at the south end of DeForest in the Town of Burke.

The size distribution breakdown for study area blocks reveals that nearly 40% of the blocks are under 35 acres, most between 5 and 20 acres. This mirrors the block distribution in the sub-region and county, although these larger territories have more 21-35 acres block relative to the study land. The next largest interval in the study area is 35-50 acres and is much larger in the study area compared to the larger regions. Few blocks 501-1,000 acres in size are present in the study area than in the surrounding sub-region and county. The remaining intervals are similar in size across all of these.

While there are a large number of small acreage blocks, these blocks occupy less than 8% of the total land area in the study area. Blocks ranging from 301-500 acres occupy almost half of the land area and blocks over 201 account for almost 80% of the total land area. ***When study area tracts are connected to agricultural tracts outside of the study area, the Westport portion in the study area becomes part of one of the largest swaths of contiguous agricultural land in the general region. A few blocks in Vienna also join with neighboring parcels and move up to the 500-1,000 acres range from the 300-500 acre range.***

Larger contiguous blocks of agricultural lands maintain a critical mass that fosters a viable farming sector. These land masses are well suited for preservation in agricultural use. Smaller block, especially near developing areas, might infer where long-term farming may not be as viable. If smaller blocks are considered valuable for agricultural use or other uses, these areas may require special efforts to preserve, or to adopt practices to reduce the burden from expanding urban development on nearby farm operations, and maintain the economic viability of an isolated farm operation.

Another useful set of information comes from measuring the concentration of agriculture. Because many local and rural roads benefit agricultural operations, they are removed from the analysis as barriers. Instead, only major roads are considered barriers to agricultural concentration. The resulting concentrations of agricultural land use between major roads are shown in Map 50.

The highest agricultural concentrations are in Vienna west of US-90/94 and in Windsor to east of Hwy 51 with at least 80% agriculture. Windsor and Vienna between these two roads host a 64% concentration of agricultural land. To the south, Burke and Westport, the concentration of farmland relative to other land uses is less than 50%. Outside the study area and toward the northeastern Towns of Bristol and York agricultural concentration reach their highest in the county.

3. Agricultural Operation Types

Generally, these jurisdictions support significant crop and livestock production operations. The entire townships of Windsor and Vienna host 52-69 livestock premises, and Westport 35-51 hosts premises. The Town of Burke hosts 14-32 livestock premises, although none appear to be within the study area. Map 51 shows the location of some of these operations by type in 2010. Of the livestock operations, beef and horses operations dominate the study area with a few dairy sites in Vienna and in Windsor north of DeForest. A greater number of dairy operations are located outside the study area. Table 17 ***shows that 3,542 acres, were dedicated to pasture for livestock in the study area.***

The most common practices on cropland are shown in Table 17, Figure 34, and Map 52 based on data from the National Agricultural Statistics Survey (generally over-estimates). ***The most dominant crops are row crops including corn, soy, alfalfa, and others. Generally, these crops are dedicated to growing feed for livestock used in dairy and beef production.***

Table 17
Agricultural Land Cover 2005 (acres)*

Study Area Portion	Row Crops, Grains, Hay, or Seeds**						Pasture***		Fallow/Idle		Total
	Alfalfa		Corn		Soybeans						
T. Windsor	175	8%	872	39%	238	11%	869	39%	38	2%	2,221
T. Westport	43	6%	247	34%	188	26%	225	31%	5	1%	727
T. Burke	53	20%	102	38%	23	9%	89	33%	1	0.3%	270
T. Vienna	373	11%	1,410	40%	638	18%	1,021	29%	30	1%	3,550
V. DeForest	34	1%	40	1%	126	4%	111	3%	4	0.1%	321
Regional Comparison											
Study area total	677	10%	2,671	38%	1,213	17%	2,314	33%	78	1%	7,088
Yahara River Valley	18,040	2%	58,413	8%	29,767	4%	107,557	14%	7,065	3%	221,768
County	59,109	8%	155,971	20%	95,687	12%	305,726	40%	46,442	6%	766,655

Source: National Agricultural Statistics Survey

*** State specific crop and other crop lands are omitted from the table due to negligible presence in the study area. County wide 20,753 state specific crop acres and 22,910 other crop land acres exist.**
**** In the study area, other hay and grain, winter wheat and oats are negligible at 0 acres, 34 acres, and 47 acres respectively (all less than 1 percent of total) and are not included in this table, these values are factored into the pie charts under Row Crops. At the county level 19,667 acres were dedicated to other small grains and hay.**
***** May contain woodlands and CRP lands not used for pasture**

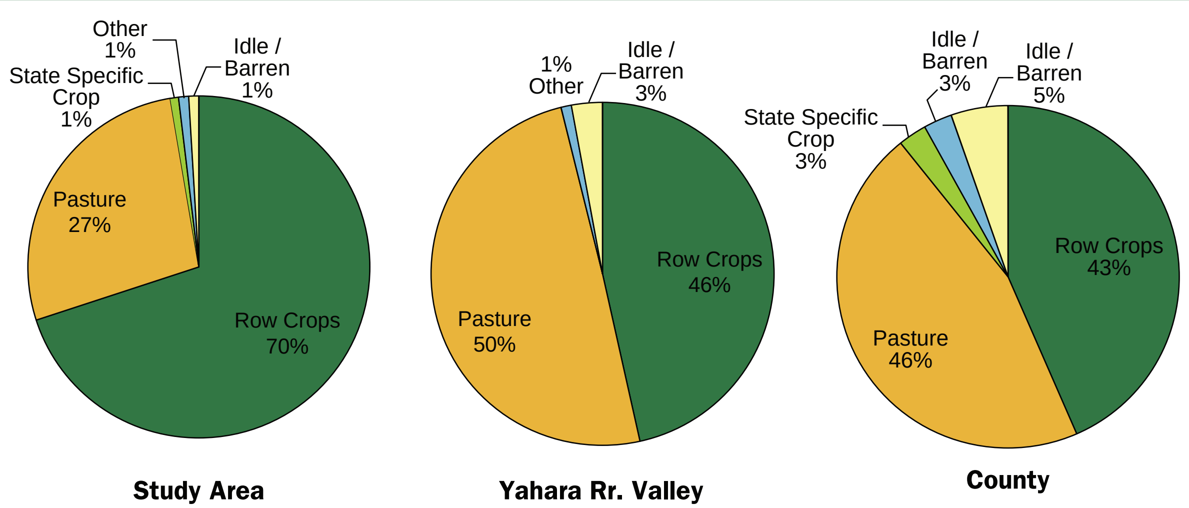
Town of Windsor

The Town of Westport has one commercial forest operation just outside the study area and close to Village of Waunakee. The Town of Vienna also one commercial forest operation just outside the northern most portion of the study area. Some forest lands are under the state Forest Land Management Program, noted in red hatched lines on Map 52.

Mineral extraction is also considered a rural use and is often grouped with agriculture because quarry sites are permitted under conditional use permits on agriculturally zoned parcels. Mineral extraction sites are considered a developed land use. Mineral resources provide economic opportunities and can adversely impact agricultural soils if the quarry is not restored with the original topsoil once the resources are extracted. Mineral resources are presented in greater details in the Natural Resources chapter (Chapter I) of this report.

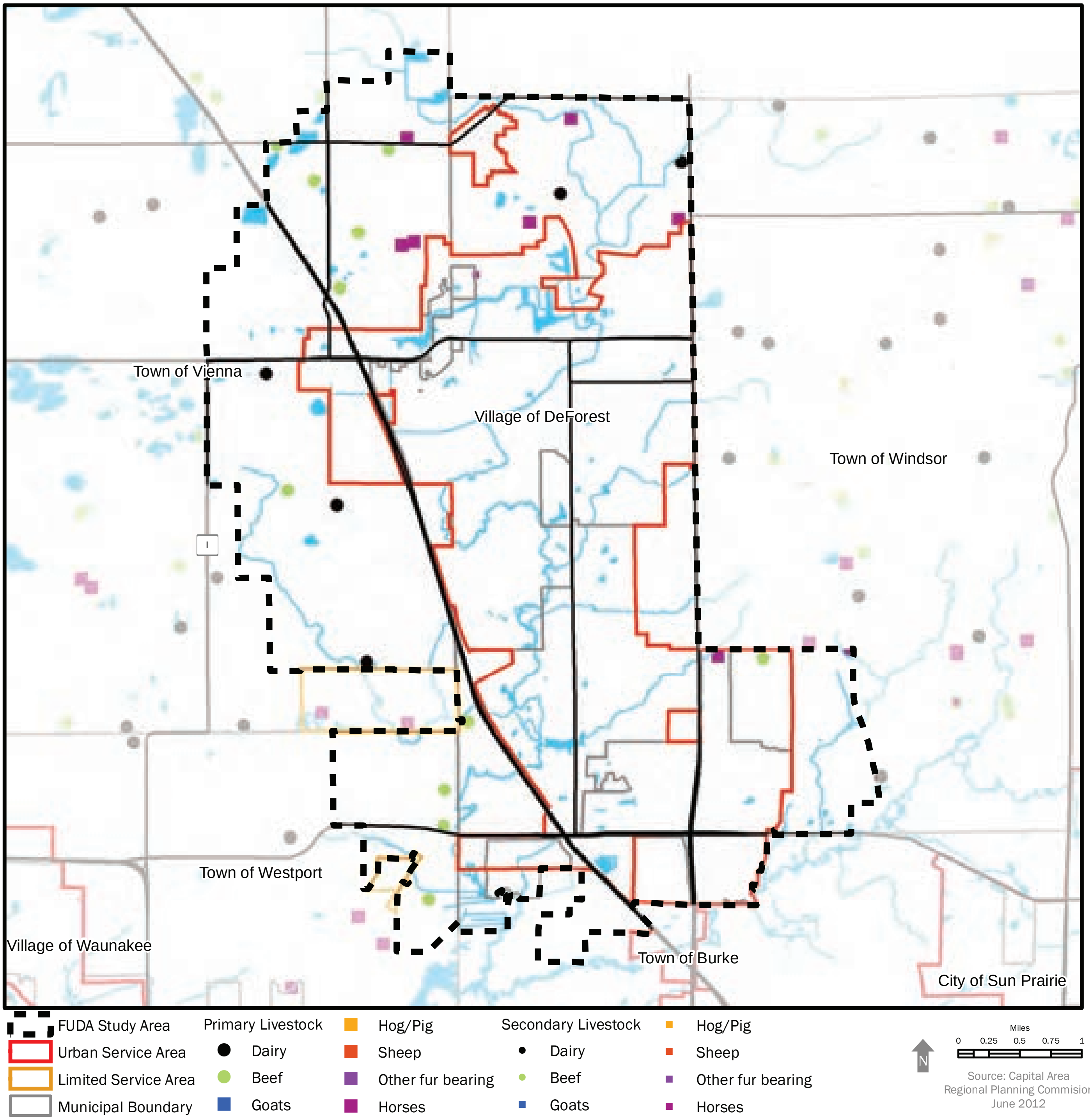
Compared to the Yahara River Valley sub-region and county, the study area hosts a significantly greater proportion of row crops and a significantly lesser proportion of pasture lands. Reflecting back on the open space corridor features of the study area, this difference can be attributed to the significantly greater prevalence of arable land, including some of the highest quality lands in the nation associated with the Arlington Prairie.

Figure 34
Crop Type (2005)



Map 51: Livestock Operations 2008/2010

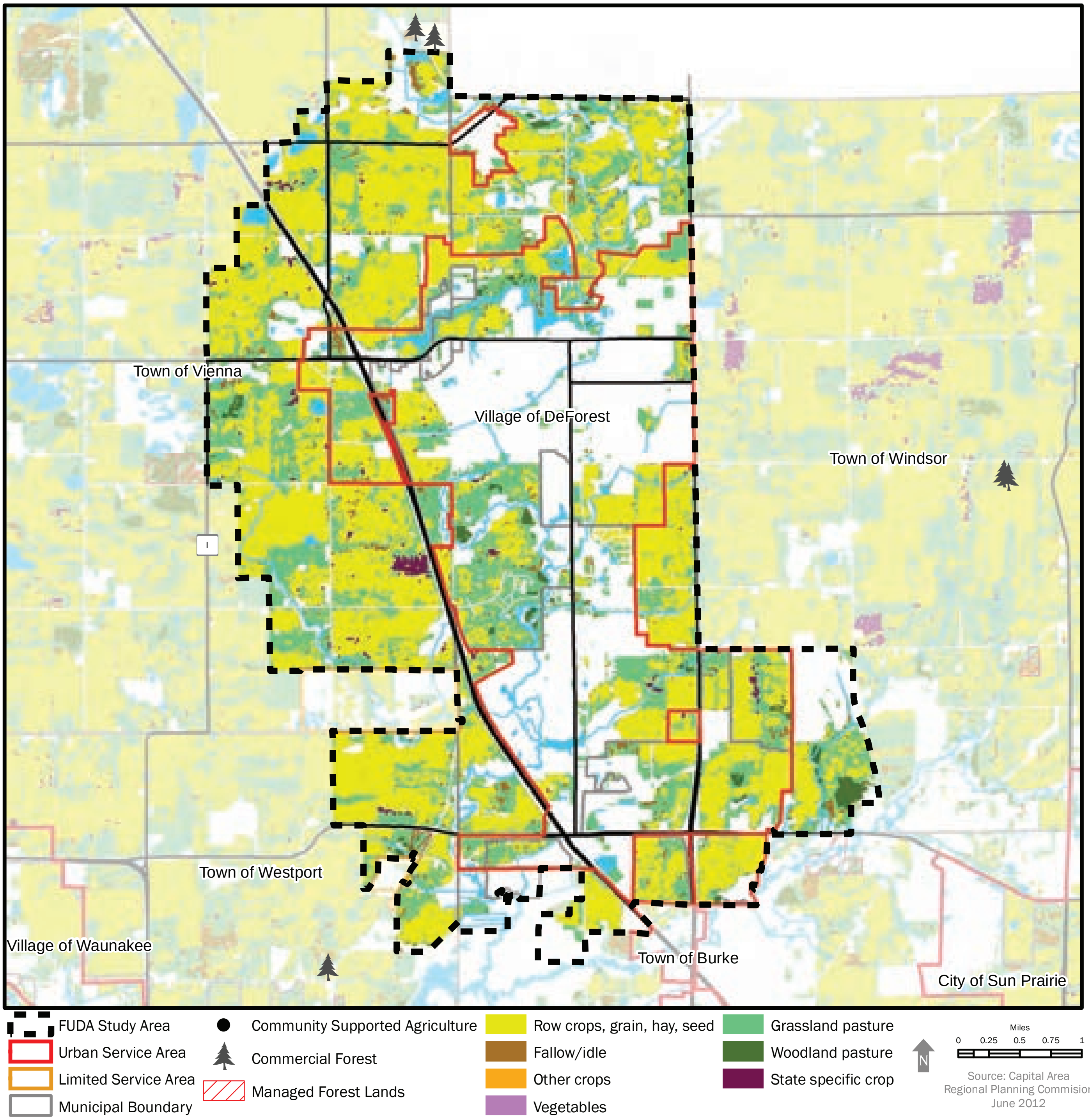
North Yahara Study Area, Dane County, WI



Beef and horse operations dominate the study area with a few dairy sites in Vienna and in Windsor north of DeForest. A greater number of dairy operations are located outside the study area.

Map 52: Crop Type - 2005

North Yahara Study Area, Dane County, WI



White spaces are non-agricultural lands. Row crops include corn, soybeans, oats, winter wheat, grains and alfalfa. Pasture categories are broad and contain open woodlands or grasslands that may not be used for pasturing (may include Conservation Resource Program lands).

4. Land Value Assessment

An examination of assessed land values can reveal areas experiencing high growth pressure and areas where assessment is influenced by agricultural preservation zoning. ***Supplementing this data with improvement assessment values may indicate investment factors that signify the intent to maintain the land in agricultural use and continue to support the viability of agricultural operations.*** Map 54 and Map 55 illustrate assessments of land value and improvements for all base farm tracts.

Table 18

Land Tax Assessment 2005 ($/per acre)

Study Area	Total ($)	Median	Mean	Max.
T. Windsor	2,569,400	29,197	7,800	118,300
T. Westport	701,100	31,868	9,900	173,600
T. Burke	844,100	56,273	7,900	624,900
T. Vienna	2,465,000	21,434	8,500	528,100
V. DeForest	0	0	0	0
Regional Comparison				
Study area total	6,579,600	27,415	8,500	624,900
Yahara River Valley	83,790,200	63,142	42,900	1,409,100
County	460,730,900	68,145	44,900	1,409,100

Source: Dane County Tax Assessor

Tracts with low land value assessment are typically dedicated to crop cultivation or pasture only, and may not generate a profit margin from land sales significant enough to promote converting the land to more intensive developed land uses at this time. Highly valued tracts can remain in agriculture, especially if they are tied to an agricultural improvement or facility that is also high value. A closer examination of the base farm tracts could reveal the agricultural economic vitality of a given area.

Town of Windsor

Town of Vienna

Parcels with high value agricultural improvements, such as large infrastructure investments for agricultural use (milking parlors, processing facilities, etc.), are potentially more likely to remain in agricultural use. Note that improvements are typically built structures and take arable land out of cultivation. Thus, preserving parcels with high value improvements alone is insufficient for food and fiber cultivation. Also note that some improvements on agricultural parcels may not be agriculturally related. A close examination of the improvements may be necessary to determine the likelihood of the conversion of surrounding land out of agricultural land use to development.

Table 19
Improvement Tax Assessment 2005 ($/per acre)

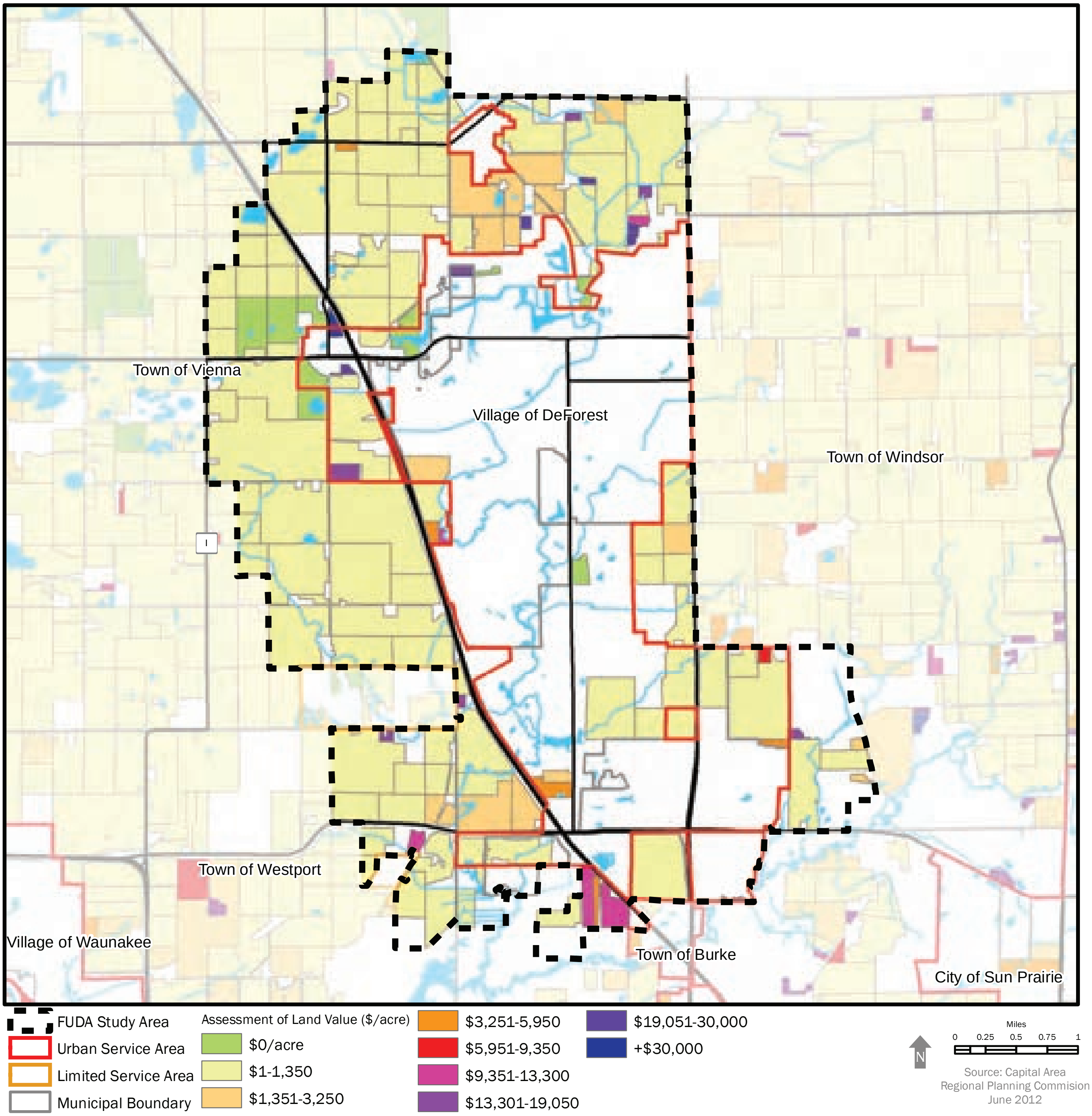
Study Area	Total ($)	Median	Mean	Max.
T. Windsor	3,998,700	45,439	0	300,800
T. Westport	961,900	43,722	0	195,900
T. Burke	1,083,000	72,200	0	858,100
T. Vienna	3,405,300	29,611	0	270,000
V. DeForest	0	0	0	0
Regional Comparison				
Study area total	9,448,900	39,370	0	858,100
Yahara River Valley	162,887,400	122,748	17,200	5,017,400
County	763,635,400	112,947	8,500	5,917,500

Source: Dane County Tax Assessor

Assessment figures are shown in Table 18 for land value and in Table 19 for improvement value. Some parcels have a very low assessment for both land and improvement values. For example, in Vienna, 27 tracts are assessed a zero dollars improvement value, 2 tracts at under $20/acre. The majority of the remainder are at least $500/acre and top out just under $20,000/acre. This is evident in the degree of difference between the median and mean assessment values and through a distribution analysis. The difference also reveals that a few very highly valued tracts raise the mean for the entire area.

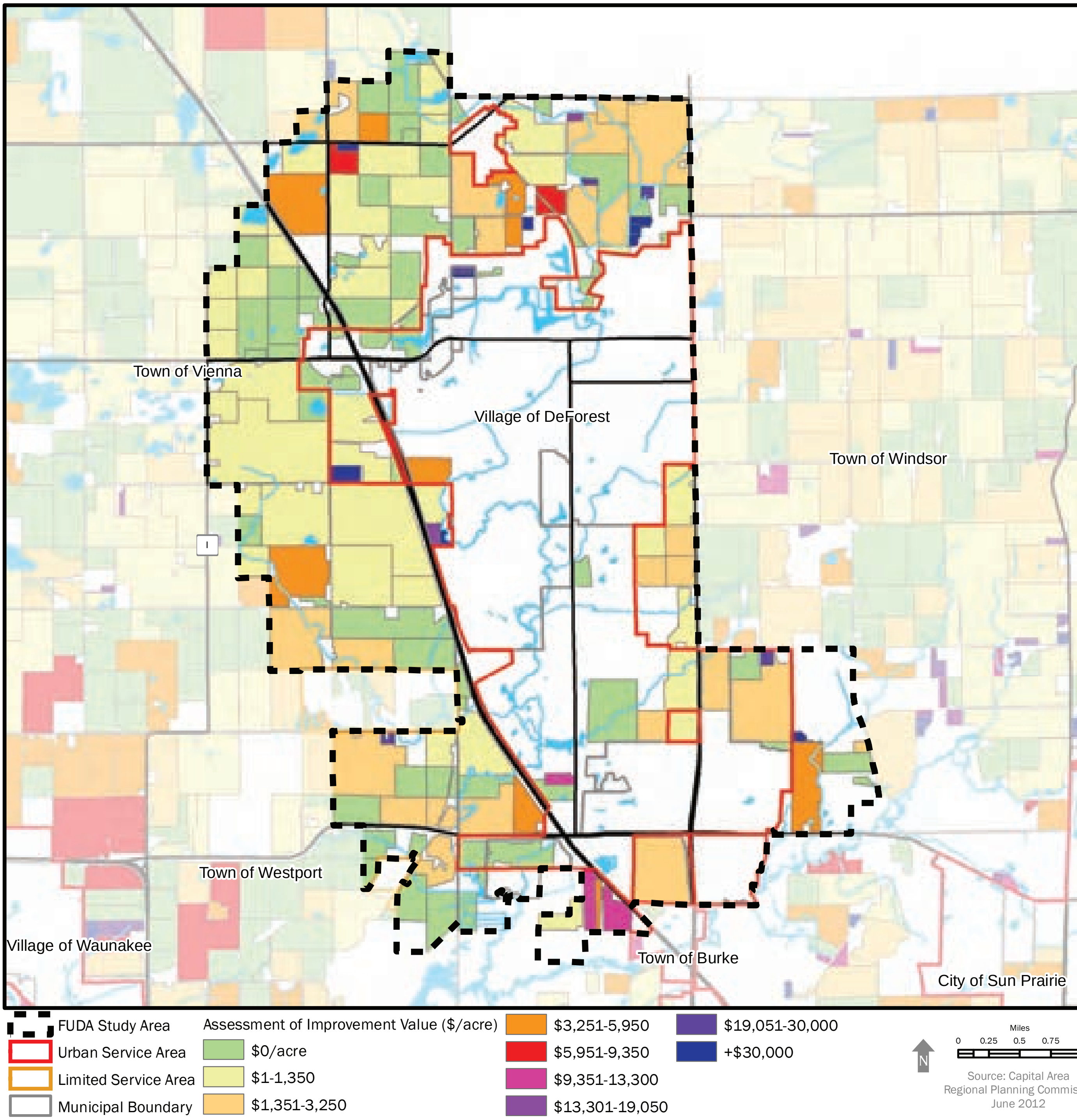
Map 53: Value Assessment of Land - 2005

North Yahara Study Area, Dane County, WI



Map 54: Value Assessment of Improvements - 2005

North Yahara Study Area, Dane County, WI



Source: Capital Area Regional Planning Commision June 2012

Prime Farmland and Land Evaluation Methods

Prime Farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses. A combination of factors are present in prime farmland: soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if it is treated and managed according to acceptable farming methods. In general, prime farmland has an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, an acceptable level of acidity or alkalinity, an acceptable content of salt or sodium, and few or no rocks. Prime soils are permeable to water and air. Prime farmland is not excessively eroded or saturated with water for long periods of time, and it either does not flood frequently during the growing season or is protected from flooding. Users of the lists of prime farmland map units should recognize that soil properties are only one of several criteria that are necessary. Other considerations include: Land use, frequency of flooding, irrigation, water table, and wind erodibility.

5. Soil Quality

Successful cultivation of crops depend significantly on soil quality. In Dane County, soil quality is referenced under two indicators, prime farmland and land evaluation. Communities within the study area use one or the other indicator. Land evaluation (LE) factors in prime farmland to determine soil classes, where Class I is the most preferred, and Class VIII is the least preferred agricultural soil.

Soil characteristics associated with high production agriculture are often also ideal for development. Special consideration is warranted when pursuing development in these areas to preserve high quality lands for food cultivation. This data also reveals where agriculture operations and facilities could locate without covering high quality cultivation soils and compromising cropland productivity. Table 20 provides summary information in Map 56 and Map 57.

Table 20
Prime Farmlands & Land Evaluation Classes 2005 (acres)

Study Area	Prime farmlands	LE Classes					
		Class I (Best)	Class II	Class III	Class IV	Class V	Classes VI-VIII
T. Windsor	1,548	1,047	807	87	413	112	562
T. Westport	432	2,156	648	108	598	46	528
T. Burke	315	37	207	0	30	10	185
T. Vienna	2,833	253	42	70	189	63	86
V. DeForest	193	109	123	18	95	3	161
Regional Comparison							
Study area total	5,321	3,602	1,826	284	1,324	233	1,521
Yahara River Valley	57,322	36,165	21,336	6,261	19,648	7,563	24,849
County	252,556	133,301	97,297	51,331	96,172	51,693	110,226

Source: Dane County Conservation

High quality soils are present in the study area and just north of the study area is Arlington Prairie, known as one of the highest quality and highest producing agricultural lands in the nation. Relative to the rest of the county, this land boasts a high concentration of prime farmlands and high LE class lands. In locations near the Yahara River, this quality is compromised slightly due to poorly drained soils.

6. Agricultural Support Services

All operations require various inputs and support systems to function and remain economically viable. Agricultural operations need land, input resources, and services required to support agricultural functions and the livelihood of farmers. Determining where existing services are located and the services they provide can help to identify areas that are well supported for continued farming, and reveal where additional agricultural support services may be warranted. ***The farming sector needs more than just good land for its viability, farm operators and employees are needed to maintain productivity. A threat to agricultural support services is a threat to agricultural production and, subsequently, to preserving agricultural operations.***

As seen in Map 57***, services are generally concentrated in urban areas. This highlights the important interdependence between rural and urban areas throughout the region and is one indication of the economic contribution of agricultural activities to the cities and villages.*** This data is not exhaustive of the agricultural services that are typically need. Other service, such as veterinary medicine, artificial insemination, and others are also important, and should be collected locally and incorporated into the existing data set.

Land Evaluation

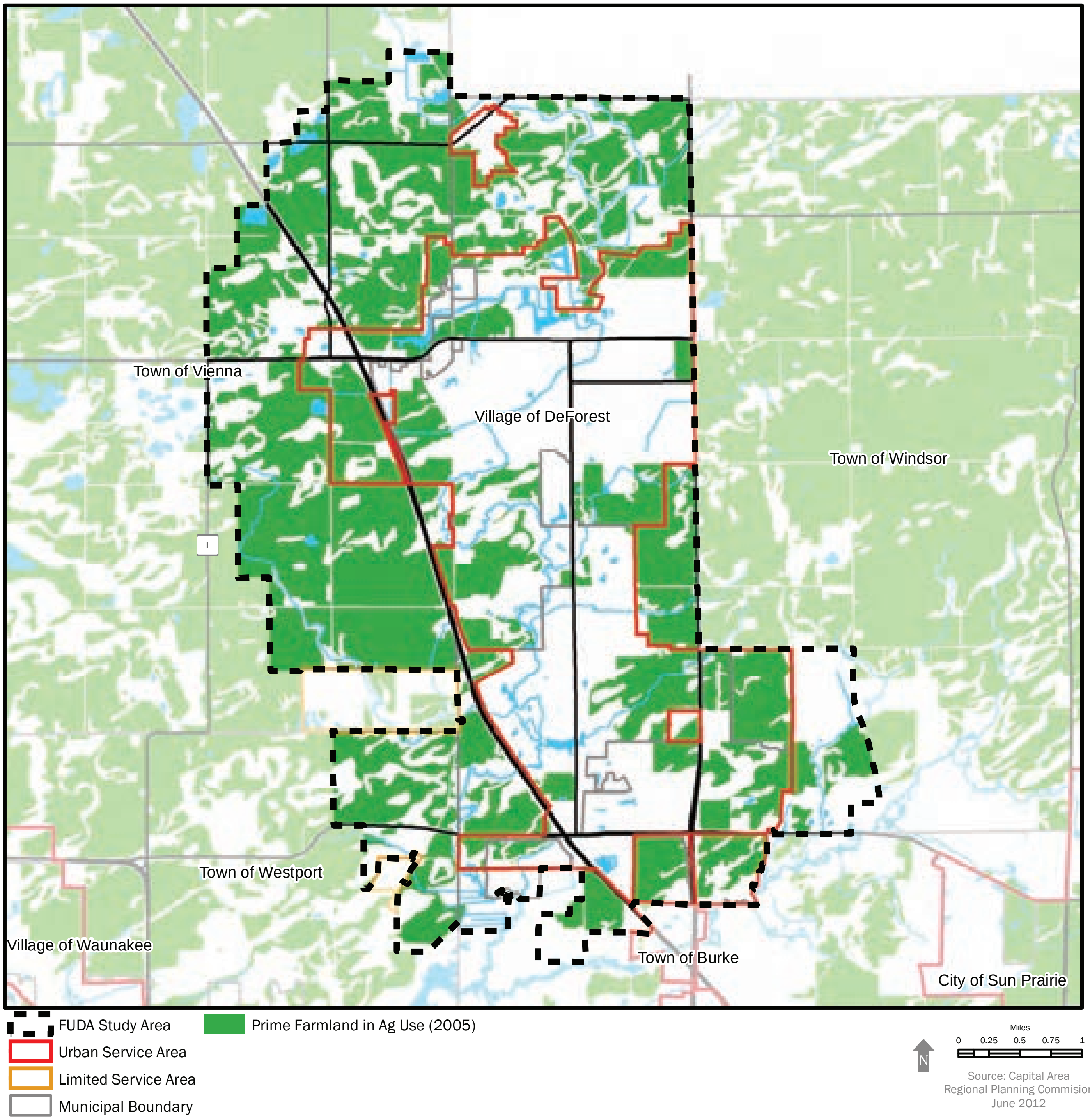
Land Evaluation is a component of the Dane County Land Evaluation Site Assessment (LESA) system and rates the soil-based qualities of a site for agricultural use. The factors used to determine agricultural Land Evaluation were developed by the Natural Resources Conservation Service (NRCS) with cooperation from the Dane County Land Conservation Department. The ratings were based on information from Land Evaluation and Site Assessment: A Guidebook for Rating Agricultural Lands, Second Edition, published by the Soil and Water Conservation Society (1996). Three factors were used to determine a numeric LE rating:

- **prime farmland (10%)**
- **soil productivity for corn (45%)**
- **land capability class (45%)**

Town of Vienna

Map 55: Prime Farmlands - 2005

North Yahara Study Area, Dane County, WI

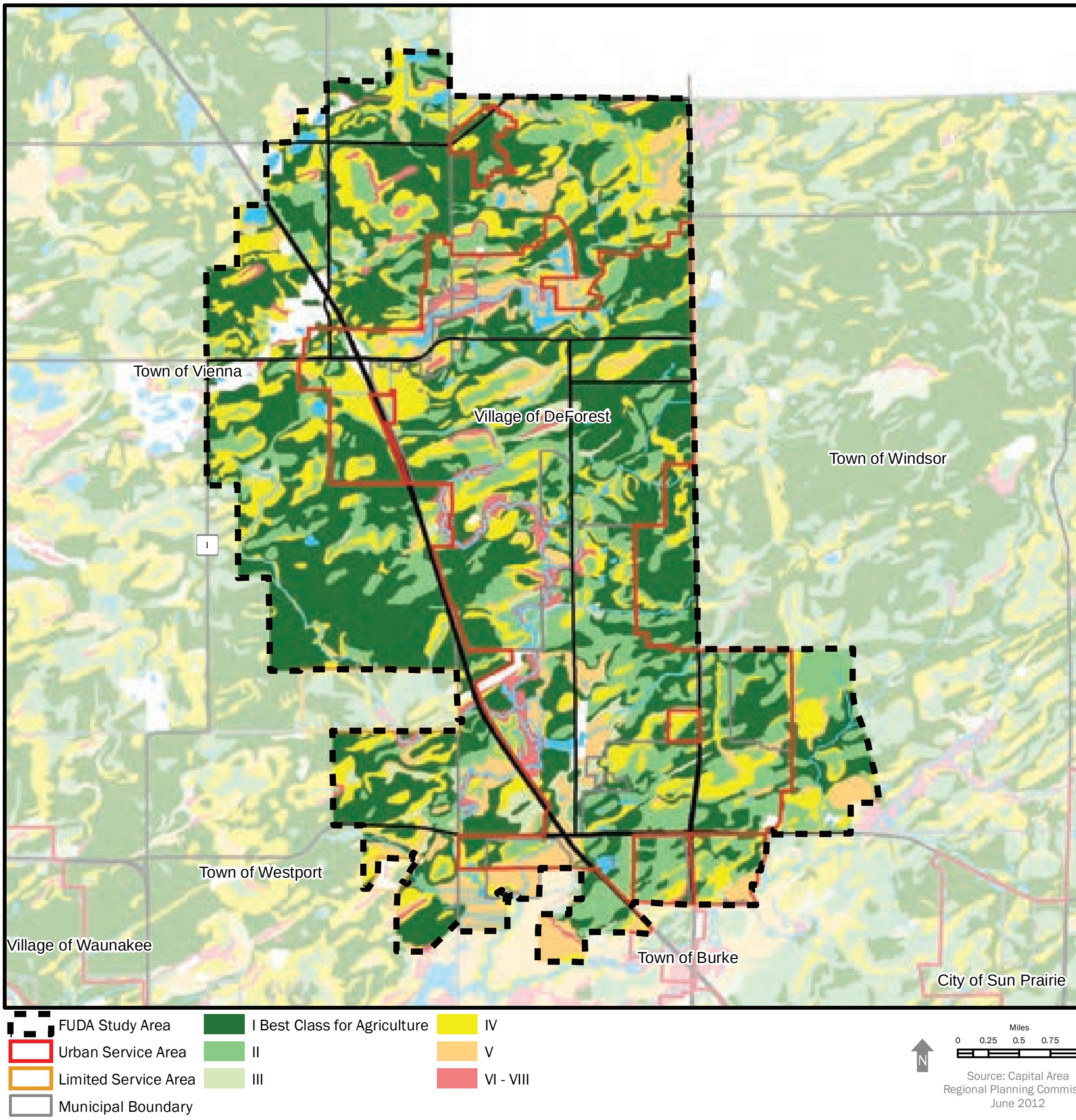


Source: Capital Area Regional Planning Commision June 2012

Prime farmland soils are located to the west of the Village of Waunakee and north of the City of Middleton primarily in the south eastern portions of the Town of Springfield and the south western portion of the Town of Westport. Another concentrated area is located between Highway I and the Village of Waunakee's north east border.

Map 56: Land Evaluation Classification - 2005

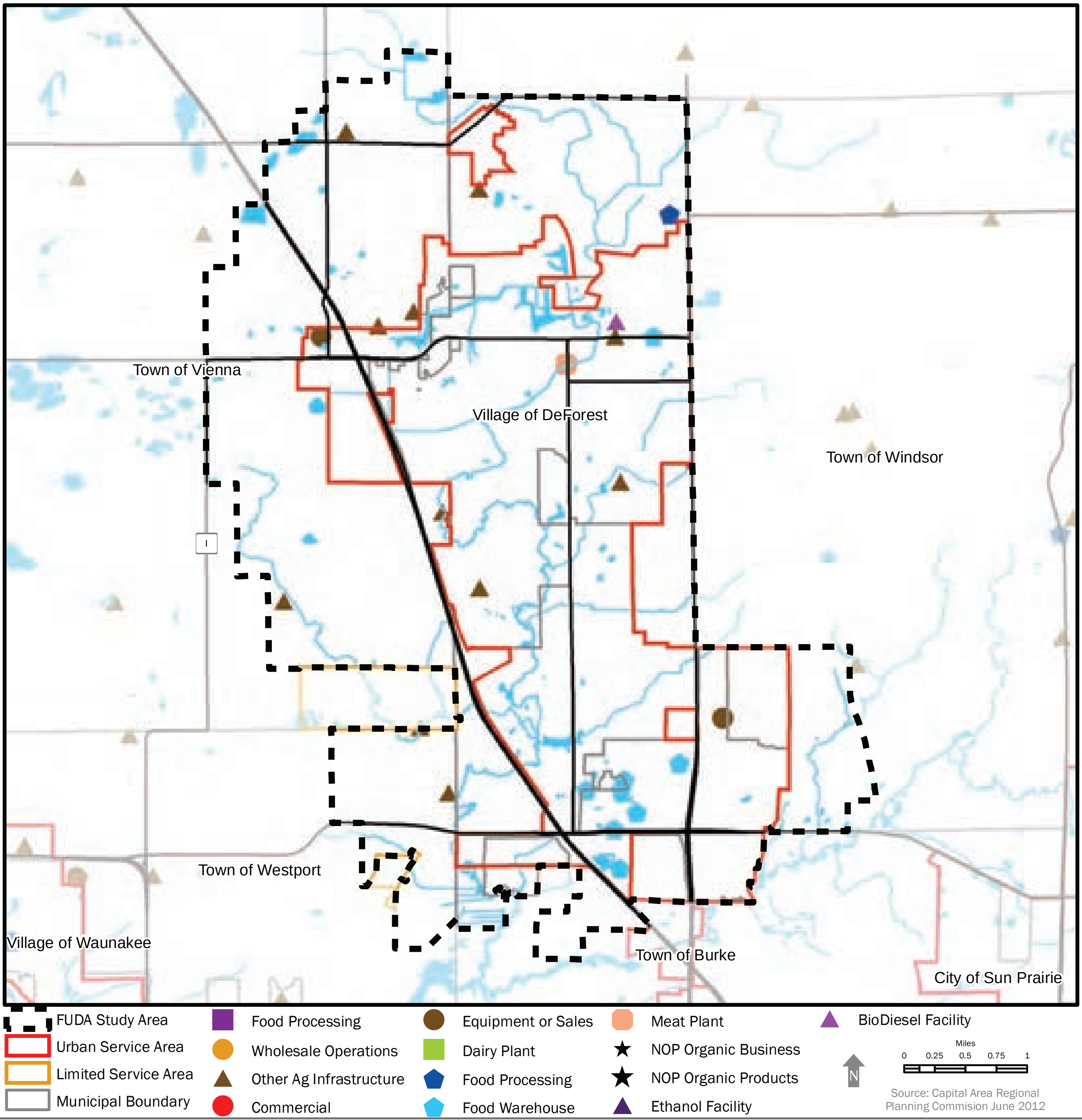
North Yahara Study Area, Dane County, WI



Source: Capital Area Regional Planning Commision
June 2012

Map 57: Agriculutral Support Services

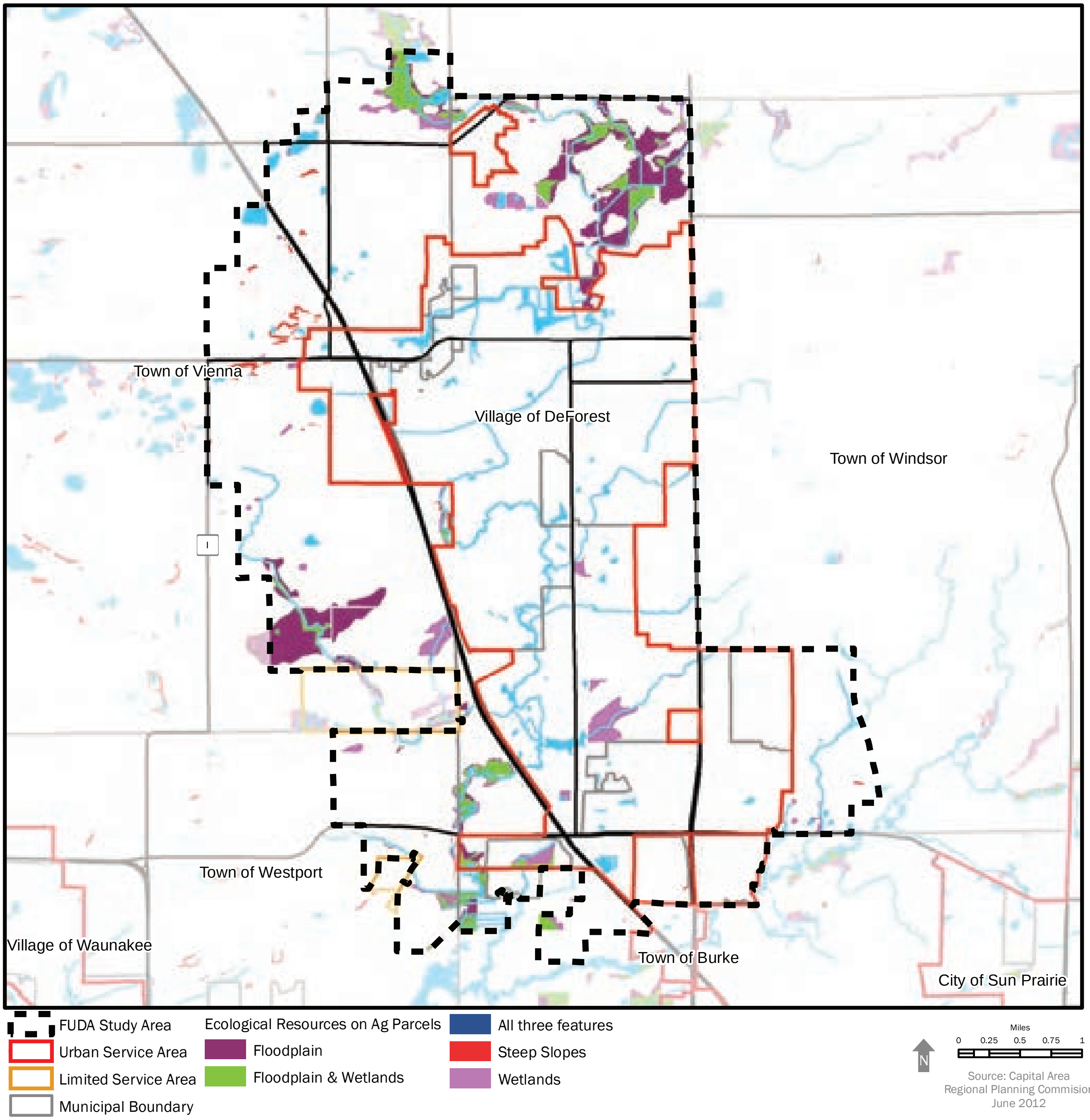
North Yahara Study Area, Dane County, WI



Data in this map comes from two different sources: Department of Agriculture, Trade and Consumer Protection and the Capital Area Regional Planning Commission's land use inventory for 2010. Where data is the same, data points from each set will overlap.

Map 58: Ecological Services and Functions - 2005

North Yahara Study Area, Dane County, WI



This map reveals where natural features providing ecological services and functions occur on agricultural parcels.

C. Ecological Services and Functions on Agricultural Parcels

Parcels hosting agricultural land and natural resource features can play a significant role in maintaining a certain level of environmental quality. Of the four physiographic areas in the region presented in the Natural Resources chapter, the study area covers two, the Moraine and the Yahara River Valley sub-regions. The Moraine sub-region, as referenced in the natural resources section, is the major drainage divide where the headwaters of many of the streams in the Wisconsin, Sugar and Rock River basins originate. The moraines are hilly with glacial till that deposited as the glaciers retreated. The Yahara River sub-region is where deep glacial deposits dammed up large valleys forming a chain of large lakes (Mendota, Monona, Waubesa, Kegonsa) and wetlands.

This analysis uses widely accepted criteria for establishing open space corridors, and includes former wetlands that have been drained for agriculture to determine where natural features occur on agricultural land parcels. Regional open space corridors are continuous systems of drainage ways and stream channels, floodplains, wetlands, steep slopes, and other natural resource features. These corridors maintain and protect the diverse pattern of exceptional natural features essential for preserving the quality of life in the region. ***Identifying Open Space Corridor features on agricultural parcels reveals lands with critical roles in improving and restoring the ecological services and functions the land can provide.*** These functions are described in detail in the Natural Resources Chapter (Chapter I) of this report.

Open Space Corridors

Open space corridors were developed and mapped in a general fashion and became a fundamental planning concept in the 1973 Dane County Land Use Plan. Open space corridors were further refined and mapped in the Dane County Water Quality Plan (1979) in urban and urbanizing areas as a component of sewer service area delineation. Open space corridors within a service area boundary were named environmental corridors. Open space corridors outside service area boundaries were called rural Resource Protections Areas and incorporated in town land use plans and the Farmland Preservation Plan as conservation and preservation areas.

It should be noted that many high-intensity agricultural practices can diminish the ecological services and functions these lands would otherwise provide. The *Dane County Water Quality Plan* includes stream, wetland, and groundwater inventories to identify these features. Taken over the past four decades, these inventories show degradation due to some historic and/or current agricultural practices, such as stream channel straightening, draining pothole wetlands, and dewatering isolated wetlands using drain tiles. Over-application of fertilizer and manure spreading, and changing land cover from forest and prairie to agriculture increase nutrient input into streams and lakes to unnaturally high levels. Historic land application of manure has left phosphorus concentrations ten times greater than crop uptake potential in some field soils. Excess phosphorus flows into surface water through overland flow or by shallow groundwater see page. Increased nitrogen levels are also present in the shallow groundwater from the over application of nitrogen fertilizer on farm fields. This nitrogen subsequently seeps into springs and streams. Additionally, livestock wading in waterways can cause bank erosion and degradation of water quality and habitat health. Finally, low commodity pricing encourages production maximization and planting in areas prone to soil erosion.

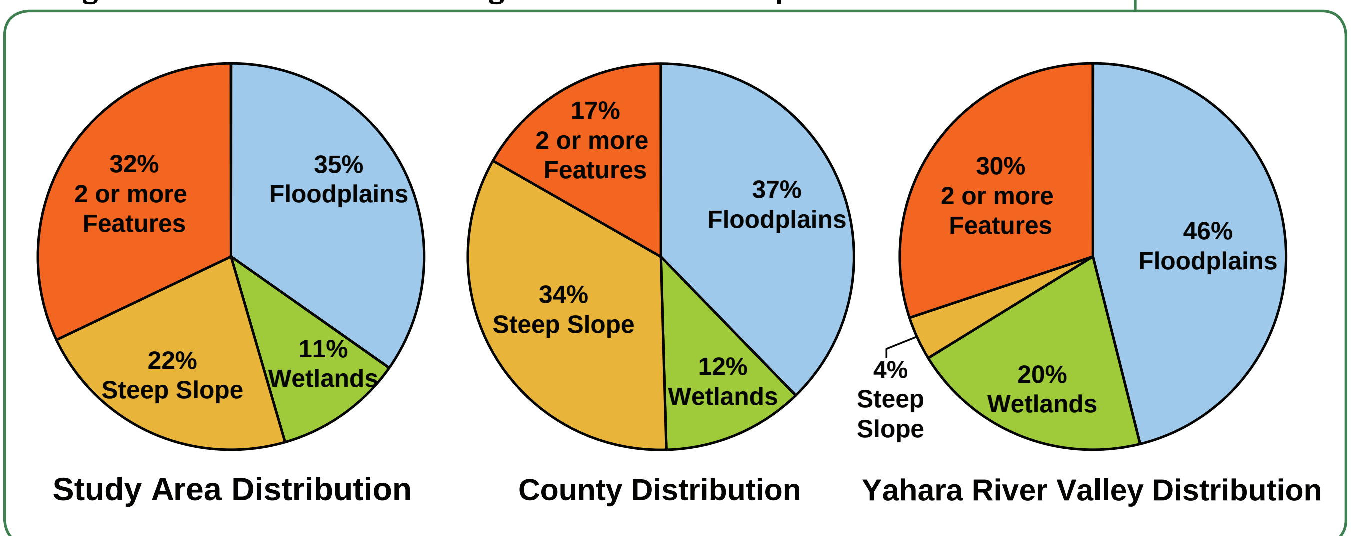
Farmers are dependent on environmental functions and resources for their livelihood, and implement conservation farming practices to reduce the adverse impacts of agricultural activities on natural resources. These practices include conservation tilling, improved nutrient management, and manure management. However, even with these practices, the historic impacts remain and inadvertent new impacts from current practices and products are discovered (such as atrazine contamination of the groundwater). Additionally, an emphasis on technology based remediation and mitigation typically increases the cost of production and encourage overproduction to disperse costs.

Table 21
Ecological Services and Functions on Agricultural Parcels (acres)

	Floodplain	Wetland	Steep Slope	Multiple	Total
Study area total	435	190	35	284	944
Sub-regions	3,148	972	2,030	2,905	9,055
County	34,002	10,648	30,406	15,082	90,137

As illustrated in Table 21 and Map 58, the study area hosts agricultural lands that include ecologically significant lands. Figure 35 illustrate the open space corridor acreage reflecting dominant ecological features in the study area compared to open space corridor acreage in the County and the Yahara River Valley sub-region. The study area is generally wet with floodplains and wetlands dominating the terrain, and roughly 30% of the land hosts both wetlands and floodplains in the same place. This differs greatly from the western territories of the county where steep slopes dominate the landscape. ***The lack of steep slopes in the study area and the territories that surround it make this land highly suitable for cultivating crops.***

Figure 35
Ecological Service and function Are Regional Distribution Comparison



To identify, enhance, and maintain ecological services and functions of agricultural land effectively, land management practices and the areal extent of these practices need to be considered together. The open space corridors[70] ***define a network of sensitive natural resource areas that can be augmented with additional conservation areas and practices.*** This approach can integrate various programs and policies to create a network of permanent agricultural and open space conservation areas which are protected from development. Supporting recommendations for low impact agricultural practices, conservation, and restoration of former wetlands and riparian zones for various locations in the study area can be provided based on ecosystem requirements and opportunities. In some upland areas, reforestation of agricultural lands could benefit hydrological systems and be a source for forest products. Other areas may be suited for integrated resource management, low-impact design, conservation design, agrarian design, and for accommodating multiple land uses and ecological services simultaneously.

This concept should be pursued with the idea that conservation areas would produce income for the land owner, and that restoration projects could be completed through pollutant trading opportunities. ***It should also be noted that some downstream mitigation goals for water quality improvement and flood control might be possibly achieved more cost-effectively through upstream conservation measures. Such opportunities should be evaluated as part of plan conceptualization in downstream areas.***

Adopted Agricultural Goals

Village of DeForest

- o Establish the DeForest area's unique identity through unifying the northern and southern portions of the Village, maintaining separation areas with other communities, and protecting surrounding agricultural land and natural resources corridors.
- o Preserve the agricultural character of the community and surrounding areas.

Town of Windsor

- o Maintain and protect the Town of Windsor's rural character and agricultural base.

Town of Vienna

- o Continue to maintain the Town's rural character through the preservation of agriculture.
- o Reduce and eliminate the potential for land use conflicts between farm and non-farm uses, as well as between farms.
- o Establish clear criteria for evaluating requests to rezone Exclusive Agricultural parcels.
- o Continue to maintain the Town's rural character through the preservation of agriculture and the discouraging of housing development that conflicts or could conflict with agriculture.
- o Reduce and eliminate the potential for land use conflicts between farm and residential uses.
- o Continue to maintain the Town's rural character through the selective location of light industrial or commercial uses that do not conflict with existing agricultural uses.
- o Promote compatibility between agricultural uses, commercial development efforts, natural areas and environmental corridors within the Town of Vienna as identified in this plan.

70 Map 23, page 121 shows these areas in the FUDA study area.

Groundwater recharge is one of the ecosystem functions of open and agricultural land that is often mentioned. The Natural Resources chapter (page 45) of this report outlines the regional groundwater susceptibilities of the region and the study area. The entire region provides groundwater recharge, and recharge alone does not provide a differentiating land characteristic for identifying preservation areas. ***High infiltration areas and zones of contribution have been identified on Map 31,*** page 139***; Map 32,*** page 140***; and Map 30,*** page 138 ***show important recharge areas that should be considered in planning and development decisions in the study area.***

D. Agricultural Considerations for FUDA Planning

Each community in the Study Area has an adopted Comprehensive Plan and/or is part of the *Dane County Farmland Preservation Plan* that presents background, goal, objective, policy, and program information.

Communities may want to incorporate the above information into their decision-making discussion. Some factors or characteristics maybe more important or useful than others to farmers and the local community. It is up to the local community to determine how to best use this information in decision-making processes that impact agricultural land within the larger context of regional preservation and development.

Communities differ in how they present and use information provided in existing plans, and use different language and criteria to determine related data. For example, to determine agricultural land quality the Town of Windsor utilizes the Land Evaluation system, and the Town of Vienna states “productive and tillable land.” The Town of Windsor and Village of DeForest have already undertaken this effort and aligning other jurisdictional plans in this way may prove beneficial in future land use discussions and agreements. Creating a common language for agricultural decision-making may prove useful when communities come together to jointly plan for growth and preservation.

An effective land management tool for agricultural land preservation is a boundary agreement between two jurisdictions. Boundary Agreements currently exist between DeForest and Windsor, DeForest and Vienna, and DeForest and Burke, City of Madison and City and Town of Sun Prairie. The DeForest-Windsor boundary agreement promises agricultural land preservation east of Highway 51 and north of Windsor Road for the next 30 years. DeForest could also establish a boundary agreements with the Town of Westport. Westport currently has boundary agreements with the City of Middleton and Village of Waunakee. Boundary agreements help to ease political tension, creates a more simple, predictable, and stable land management framework, and helps to direct growth to more appropriate locations.

In addition, town farmland preservation maps, in accordance with the State Farmland Preservation Act, designate lands as either “preservation,” “rural development,” or “transition areas.” These designations should be considered seriously when developing boundary agreements, and in pursuing rural development.

Town of Windsor

1. Agricultural Parcels and Farm Base Tracts

- Maintain diversity in size and operation type to better protect the regional agricultural industry from severe market changes in any one sector and will better support and encourage regional food systems.

2. Contiguity and Concentration

- •Maintain contiguous blocks of agricultural land to maintain the land mass that makes farming more viable and provides better protection for agricultural use. Direct urban growth away from contiguous blocks of agricultural land.
- Agricultural concentrations between major roads shows where agricultural land uses may be compromised by the prominence of other land uses. Agricultural lands in low concentration areas that are deemed valuable as agriculture preservation may be a priority for preservation efforts.

3. Support Services

- Maintain sufficient concentrations of agricultural lands to maintain the viability of support service businesses.
- Ensure adequate infrastructure to ensure support services remain accessible to the farming community.

4. Soil Quality

- Special consideration is warranted when pursuing development in these areas to preserve these lands for food cultivation dependent on soils.
- Arlington Prairie and the Northeastern portion of the study area boast the greatest amount of prime farmlands relative to the rest of the study area and might warranted special consideration in determining the direction and form of urban growth.

5. Ecological Services and Functions

- To identify, enhance, and maintain ecological services and functions of agricultural land effectively, land management practices and the areal extent of these practices need to be considered together. The open space corridors[71] define a network of sensitive natural resource areas that can be augmented with additional conservation areas and practices. This approach can integrate various programs and policies to create a network of permanent agricultural and open space conservation areas which are protected from development. Supporting recommendations for low impact agricultural practices, conservation, and restoration for various locations in the study area can be provided based on ecosystem requirements and opportunities. Other areas may be suited for integrated resource management and for accommodating multiple land uses and ecological services simultaneously.
- Former wetlands, since drained with underground drainage tiles and ditching, are also presented on the map to illustrate where wetland restoration could benefit ecological systems and water quality and quantity in downstream areas.
- In some upland areas, reforestation of agricultural lands could benefit ecological systems and water quality and quantity in downstream areas.
- Some conservation practices would greatly benefit from changes in state law and taxing policy. For example, wetlands are typically assessed at higher land values compared to farmland. Consequently, farmers not only lose cropland and income by restoring former wetlands, but also pay higher property taxes under current tax policy.
- Ecosystem service areas should be designed with the idea that the land owner would continue to benefit financially from the land. This can be either through sale of products from these conservation areas or through payments for the ecosystem service being provided.

The data in this section is provided to assist in decision-making processes to identify the agricultural lands that the community would preserve, maintain, or develop in the Future Urban Development Area Planning process. The data and subsequent decisions can be updated or incorporated into comprehensive and farmland preservation plans as the communities update them in the coming years. The variables with the most potential for making and measuring the impact of growth on farmland in the study area are contiguous blocks of agriculture and agricultural concentration. Other variable such as ecological services and functions, support services, land and improvement assessment values, and soil quality are best considered at the site level.

71 Map 23, page 121 shows these areas in the FUDA study area.

North Yahara

Future Urban Development Area Planning

Environmental Conditions Report

Chapter III Land Use, Demand and Supply

Introduction

The Land Demand and Supply chapter of the ECR provides information about the estimated future growth within the study area. This analysis compares projected future community growth against the supply of land in the study area to determine future land area needs.

This chapter includes three major components:

- ***Development Trends:*** This is an evaluation of observed trends in land development, including land use and densities.
- ***Land Demand:*** This component establishes baseline land demand estimates for urban and rural areas for the 25 year planning horizon, based on historic trends and the DOA approved CARPC methodology for growth projections.
- ***Land Supply:*** This component identifies land available to accommodate anticipated development through infill development and redevelopment, and through "greenfield" development in the FUDA study area (within and outside the urban service area).

urban: served by public sewer and water and other urban services, allowing higher urban densities.
rural: served by on-site waste treatment systems and private wells, generally requiring lower density development than urban areas.

The first two ECR chapters, provide inventories and assessments of natural and agricultural assets for the purpose of protecting important resources as development continues. This provides basis for locational decisions on how the communities may wish to accommodate future land demand.

All future development projections in this chapter follow CARPC's 25-year land demand methodology, which utilizes WI Department of Administration (DOA) growth projections. Because FUDA planning is a screening for future USA amendments, the land demand calculations need to follow NR 121 guidelines and methodology for growth projection. It is important to note that 25-year population projections will be updated every five years with FUDA updates.

Participating municipalities in the North Yahara Study Area anticipate future growth will exceed what is projected by the DOA and CARPC's land demand methodology. Because of this, development projections discussed in this chapter were not used for scenario planning. For more information, see the North Yahara FUDA Study Supplement C.

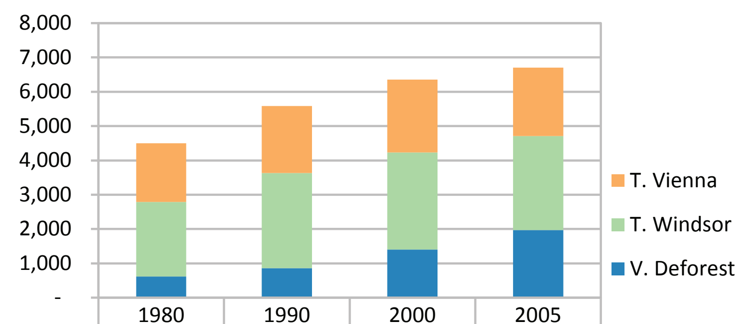
A. Development Trends

This section examines land use, population and housing data from 1970 (where available) to 2005[76] to identify development trends in the four communities participating in the North Mendota FUDA process. The past trends are used to establish base line projections for future land demand.

1. Total Development (Urban and Rural)

Within the study area, the Towns of Vienna and Windsor contain the most land while the Village of DeForest and the Town of Windsor contain the most development, both urban and rural (see Figure 36. From 1980 to 2005, the total developed area of these communities increased by approximately 50% (from 4,502 to 6,701 acres). The greatest growth during these years occurred in DeForest, accounting for 1,351 of the 2,199 acres of growth, or 61%, while the Town of Windsor grew by 565 acres, or 25% of total growth. (see Figure 36).

Figure 36
Developed and Undeveloped Land by FUDA Community - 2005



	1980	1990	2000	2005
T. Vienna	1,712	1,954	2,122	1,995
T. Windsor	2,171	2,766	2,831	2,736
V. Deforest	619	864	1,401	1,970

Source: U.S. Bureau of the Census and CARPC

2005 is the most recent land use inventory data available at the time of this writing. 2010 land use inventory data is scheduled to be widely available in the fall of 2012. Land use data comes from the regional Land Use Inventory conducted by CARPC on a decennial (and sometimes more frequently) basis, where aerial photographs and field observations are used to classify land uses, which are converted to Geographical Information System (GIS) digital layers.

Figure 37
Developed and Undeveloped Land in Study Area - 2005

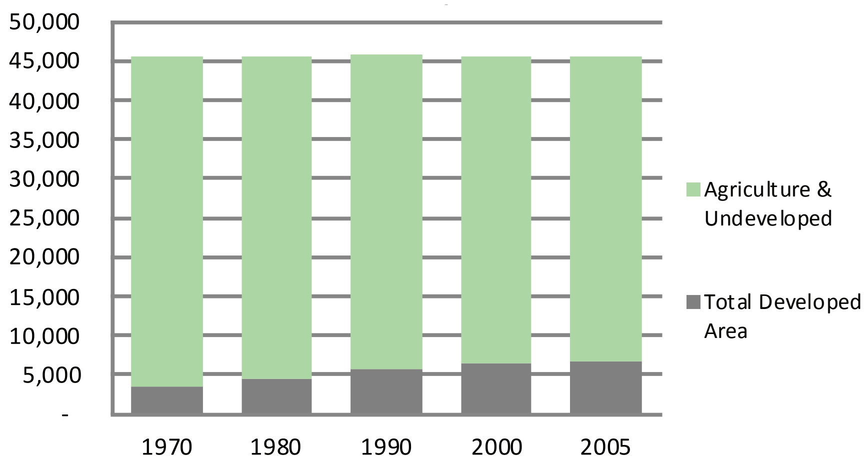
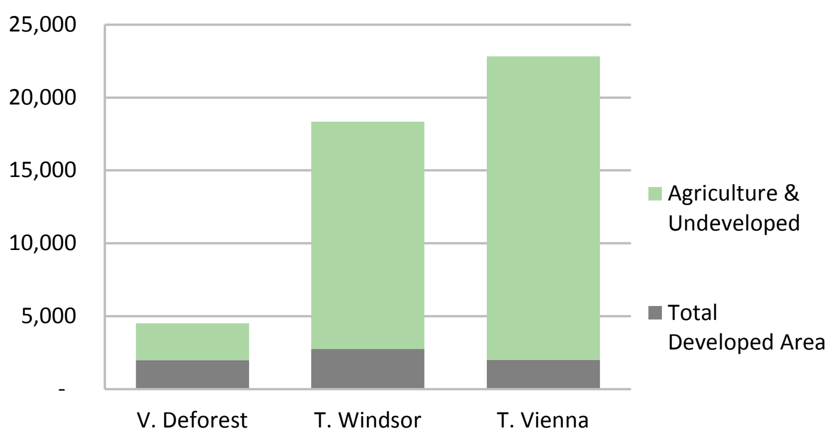


Figure 38
Developed Land by Community by Year



Categories of Developed Land Use

RESIDENTIAL
Single Family
Two Family
Multi Family
Farm Dwelling
Group Quarters
Mobile Home

INDUSTRIAL
Manufacturing
Wholesale
Extractive

TRANSPORTATION
Right of Way
Railroad

COMMUNICATION/UTILITIES
Generating Processing
Transmission
Waste Processing

COMMERCIAL RETAIL
General Repair & Maintenance
Transportation Related

COMMERCIAL SERVICES
Lodging

INSTITUTIONAL/GOVERMENTAL
Education
Administrative
Cemetery

2. Urban Service Area Land Use Trends

In Dane County, urban development occurs in Urban Service Areas (USAs) and rural development occurs outside of USAs. ***The FUDA area includes the Northern Urban Service Area, the DeForest portion of the Central USA (CUSA), the Morrisonville USA and the limited service areas (LSAs) of Westport, Windsor Prairie, and adjacent to Easy Street in Vienna.***

a. Urban Development Characterization

In Dane County, residential land uses occupy the largest share of urban land, as shown in Table 22. Residential land use represents between 37% and 43% of all land use across the county. Residential land uses includes single-family, multi-family (including duplexes), farm dwellings, group quarters and mobile homes (see text box on page 213). Single-family is the predominant housing form, comprising 76% of city and 86% of village residential land. Transportation is the second largest category of developed land use, comprising about a fourth of developed land uses. Road right-of-way is the largest portion of transportation land use (note that road right of way does not mean a road is present and the land may be in another use actively, such as agriculture).

County-wide, private employment is the fastest growing land use from 1990 to 2005. This category includes industrial, commercial, and communication and utilities (except public waste processing). The large growth in business parks accounted for a significant portion in this increase dispersing employment throughout the county. Outdoor recreation also grew significantly during this period, especially in small cities and villages.

Villages experienced the largest growth in all land use categories. Small cities also grew significantly. The City of Madison grew more slowly except in the private employment category.

Table 22
Developed Acres in Dane County - 2005 and Percent Change - 1990-2005

	DANE COUNTY			MADISON			SMALL CITIES			VILLAGES		
	2005		% change 1990-2005	2005		% change 1990-2005	2005		% change 1990-2005	2005		% change 1990-2005
	acres	%		acres	%		acres	%		acres	%	
Residential	56,552	40%	18%	13,502	37%	19%	8,663	43%	42%	6,902	44%	68%
Transportation	46,075	33%	23%	9,972	27%	21%	5,496	27%	65%	3,885	25%	75%
Private Employment	15,607	11%	51%	5,633	15%	56%	3,498	17%	38%	1,983	13%	224%
Outdoor Recreation	15,835	11%	43%	4,899	13%	32%	1,373	7%	121%	1,632	11%	159%
"Governmental Institutional"	6,254	4%	8%	2,429	7%	1%	1,352	7%	40%	1,113	7%	56%
Total Developed	140,323	100%		36,435	100%		20,382	100%		15,515	100%	

Source: Capital Area Regional Planning Commission

b. Urban Land Use in the North Mendota FUDA Area

The Village of DeForest comprises the largest portion of the urban development in the FUDA study area and has nearly twice the developed area as the Town of Windsor (urban) (Table 23). Residential and governmental uses in DeForest grew approximately equal with the average for all villages between 1990 and 2005. DeForest grew significantly faster than the village average in private employment, transportation and outdoor recreation categories. Annexation of a large commercial and industrial area in southern DeForest during this time period contributed significantly to these increases.

The Town of Windsor portion of the Northern Urban Service Area did not experience the rapid growth seen in DeForest. The growth rates observed in the Town are more similar to those seen in small cities, with more modest gains in residential, transportation and employment. The increase observed in outdoor recreation, 15%, was lower than the rates seen in Dane County, small cities and villages.

The urban area within the Town of Vienna's growth was primarily attributed to residential development, at a rate similar to that seen in the Town of Windsor. A small amount of private employment was also added during this time, however little development existed prior to 1990, resulting in a large percentage of growth.

Within Morrisonville, there was relatively little change over the 15 year period. An increase of 4.7 developed acres, or 5%, occurred within this time. Because of the limited size of the area and existing uses, small increases or decreases may have large percentage changes. Such is the case with private employment, which gained 4 acres, but shows a 59% increase.

The distribution of urban land uses in DeForest is similar to other villages with some exceptions. Residential (39% vs. 44%) and outdoor recreational (5% vs. 11%) are slightly lower, while private employment (24% vs. 13%) is significantly higher. Transportation and governmental values are identical. Urban Windsor also has similarities to all villages, with more residential (48%), recreation (22%) and less transportation (20%), private employment (10%) and governmental (2%).

Map 59 and Map 60 show the progression of land use change in the FUDA Communities from 1990 to 2005.

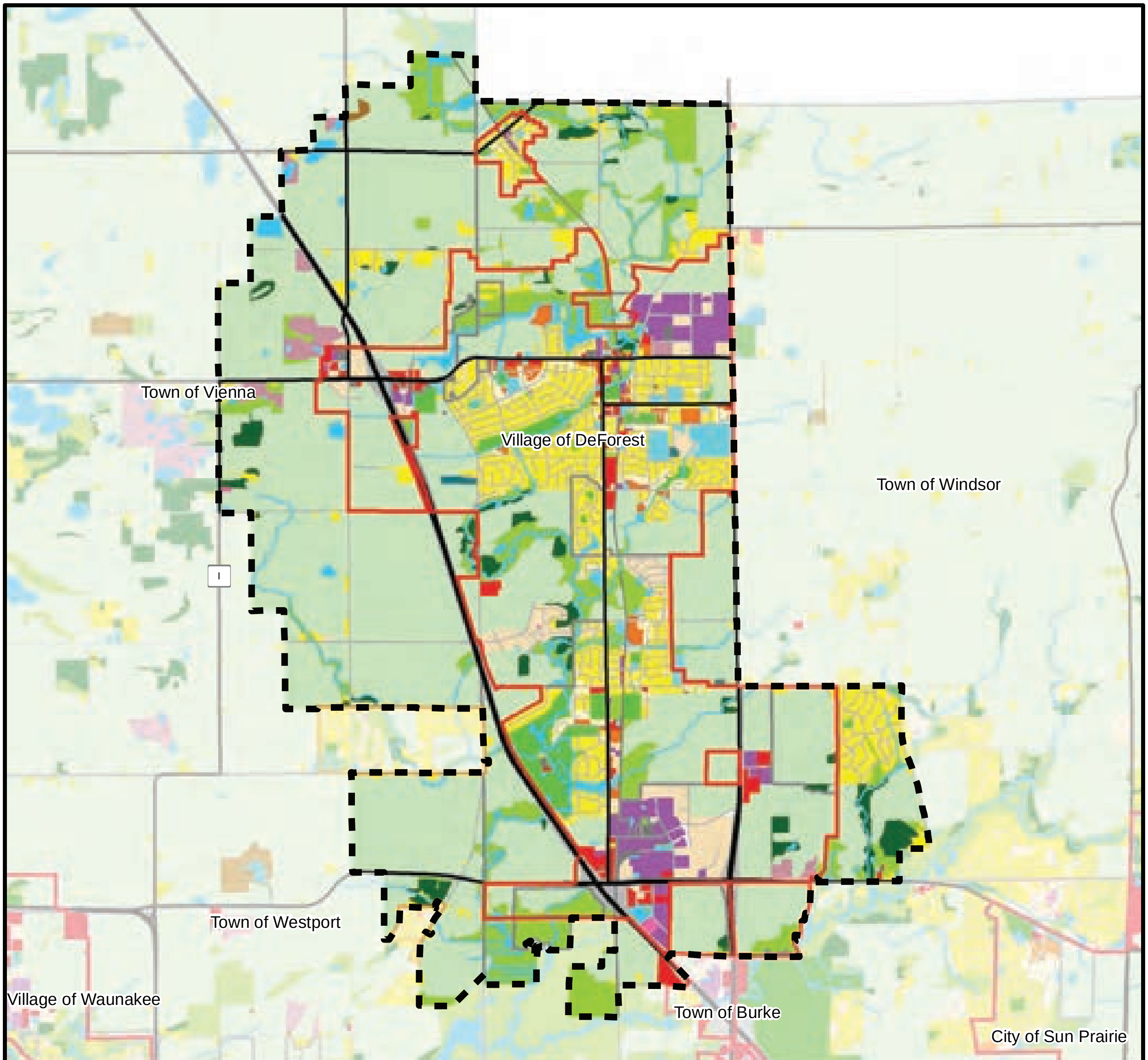
Table 23
North Yahara FUDA Developed Acres 2005 and Percent Change, 1990-200

	URBAN SERVICE AREAS											
	Northern USA									Morrisonville USA		
	DeForest			T. Windsor			T. Vienna			T. Windsor		
	2005		% change 1990-2005	2005		% change 1990-2005			% change 1990-2005	2005		% change 1990-2005
	acres	%		acres	%		acres	%		acres	%	
Residential	762	39%	72%	430	46%	37%	180	52%	44%	56	60%	-4%
Transportation	495	25%	237%	177	19%	53%	126	36%	89%	23	25%	15%
Private Employment	480	24%	520%	93	10%	39%	37	11%	80%	7	8%	59%
Outdoor Recreation	103	5%	244%	217	23%	15%	4	1%	8%	4	4%	0%
"Governmental Institutional"	128	7%	66%	13	1%	39%	0	0%	-	3	3%	-25%
Total	1,968	100%		930	100%		347	100%		93	100%	

Source: Capital Area Regional Planning Commission

Map 59: Land Use 2005

North Yahara Study Area, Dane County, WI



- FUDA Study Area
- Urban Service Area
- Limited Service Area
- Municipal Boundary
- Agriculture
- Cemetery
- Commercial Forest
- Commercial Sales or Services
- Communications or Utilities
- Extractive
- Industrial
- Institutional or Governmental
- Multi-Family
- Open Land
- Outdoor Recreation
- Right of Way
- Single Family
- Transportation
- Two Family
- Under Construction
- Vacant
- Water
- Woodland

Parcel based land use inventory for Dane County for the year 2005.

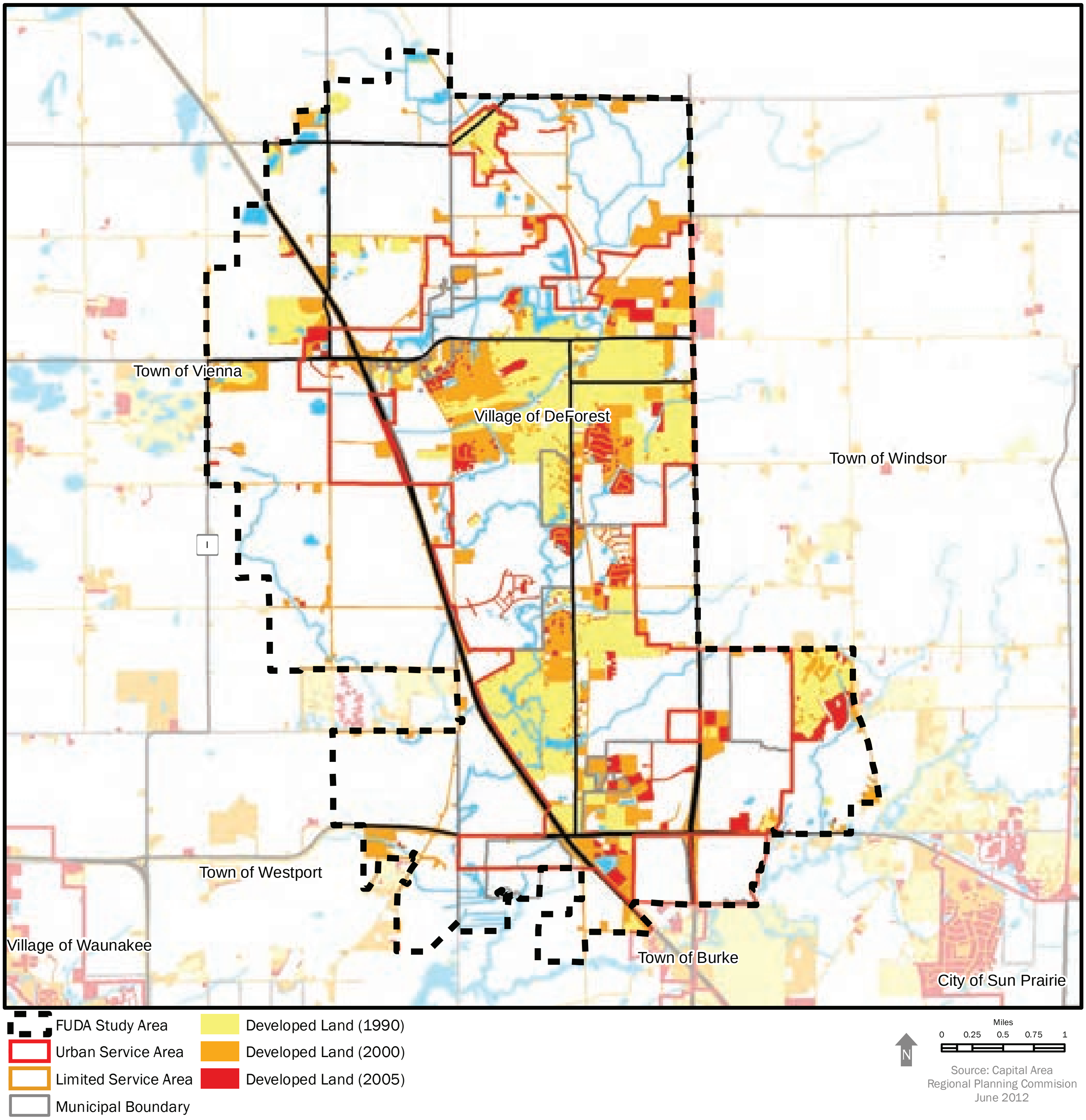
N

Miles
0 0.25 0.5 0.75 1

Source: Capital Area Regional Planning Commision
June 2012

Map 60: Land Use Changes: 1990-2005

North Yahara Study Area, Dane County, WI



Parcel based land use inventories for Dane County for the years 1990, 2000 and 2005.

c. Land Development Densities

Table 24 shows residential density trends in the Northern FUDA communities and comparative data for Dane County, City of Madison, small cities, villages, and towns from 1990 to 2005. DeForest saw a 12% increase of single family residential density, but an overall decrease in density due to a lowering of multi-family density. This is similar to the patterns displayed in other small cities and villages. The urban area within the Town of Windsor saw decreases in both single- and multi-family density but an overall increase in units per residential acre, showing an overall shift toward multi-family development. The rural area in Windsor saw decreases in single family and overall density, following the pattern of towns. Vienna, however, saw a significant increase in residential density between 1990 and 2005. Note that the decrease in Dane County town density may be attributable to a change in data methodology that occurred starting in 2000.[77]

Table 24

Residential Densities in FUDA Study Area and Comparative Data: 1990-2005

	Single Family	Multi-Family	Total Housing		Single Family	Multi-Family	Total Housing
V. DeForest				DANE COUNTY			
2005	3.78	6.71	4.32	2005	2.37	13.69	3.62
2000	3.85	5.93	4.23	2000	2.45	13.71	3.67
1990	3.39	7.42	4.62	1990	2.61	13.06	3.89
"% change: 1990-2005"	12%	-10%	-7%	"% change: 1990-2005"	-9%	5%	-7%
T. Windsor (Urban)				MADISON			
2005	2.13	7.52	2.93	2005	4.84	17.21	7.80
2000	2.04	6.70	2.54	2000	4.89	16.95	7.70
1990	2.16	7.99	2.68	1990	4.43	16.31	7.07
"% change: 1990-2005"	-2%	-6%	9%	"% change: 1990-2005"	9%	6%	10%
T. Windsor (Rural)				SMALL CITIES			
2005	0.78	2.31	0.78	2005	3.36	10.81	4.81
2000	0.77	2.31	0.78	2000	3.29	10.92	4.67
1990	1.42	3.33	1.43	1990	3.20	11.48	4.65
"% change: 1990-2005"	-45%	-31%	-45%	"% change: 1990-2005"	5%	-6%	4%
T. Vienna				VILLAGES			
2005	0.93	32.86	0.97	2005	3.31	8.12	3.94
2000	0.78	4.44	0.82	2000	3.31	7.84	3.88
1990	0.63	2.11	0.67	1990	3.13	9.27	3.76
"% change: 2000-2005"	46%	1458%	45%	"% change: 1990-2005"	6%	-12%	5%
				TOWNS			
				2005	0.98	10.88	1.15
				2000	1.06	11.58	1.24
				1990	1.28	5.85	1.47
				"% change: 1990-2005"	-23%	86%	-22%

Source: Capital Area Regional Planning Commission and U.S. Census.

77 In 2000, new data methodology was used when creating land use maps. The largest differences are seen in rural residential (single family) and transportation, which in 1990 were often integrated into other land use categories. For example, in 1990 a single family home on a large lot would often be classified entirely as open area, though the housing unit would be counted; in 2000, the area surrounding the house is classified as residential and the remainder of the parcel as open area. This results in inflated values for changes between these years.

Table 25 shows densities for the same jurisdictions and time period, measured by acres per thousand persons.[78] This measure generally shows more developed land per person overall and decreasing residential population per acres on residential land. Towns of Windsor and Vienna, and towns in Dane County, however, show increasing population per residential acres. ***The difference between these two measures of residential density can be explained by decreasing household size (persons per household). Although more homes are being built on each acre, the number of people on each acre is declining.***

Table 25

FUDA Area Densities and Comparative Data: Acres/ 1,000 Persons (1990-2005)

	Residential	Commercial	Industrial	Street ROW	Trans, Comm, Util	Gov, Inst	Recreational	Total Developed
V. DeForest								
2005	92.0	11.8	41.4	59.7	4.7	15.5	12.5	237
2000	87.4	8.1	17.7	45.2	3.1	14.5	14.0	190
1990	90.8	8.3	7.5	42.7	3.2	15.8	8.7	177
“% change: 90-05	1%	43%	454%	40%	48%	-2%	44%	34%
T. Windsor								
2005	253.9	10.7	11.6	144.9	10.3	6.4	45.0	483
2000	250.7	15.6	35.8	166.7	17.0	5.9	43.7	535
1990	325.6	17.5	25.4	165.6	12.9	4.7	46.2	598
“% change: 90-05	-22%	-39%	-54%	-12%	-20%	34%	-2%	-19%
T. Vienna								
2005	417.8	21.3	270.8	726.1	43.4	3.1	18.3	1,501
2000	440.9	14.1	400.2	739.9	24.3	1.5	19.0	1,640
1990	472.5	7.4	242.9	649.9	33.6	11.8	25.8	1,444
“% change: 90-05	-12%	188%	12%	12%	29%	-74%	-29%	4%
DANE COUNTY								
2005	123.4	16.1	16.8	91.7	11.6	12.1	34.6	306
2000	115.3	15.6	17.3	93.3	13.7	11.9	30.8	298
1990	130.8	12.9	14.1	91.6	14.4	12.8	30.2	307
“% change: 90-05	-6%	25%	19%	0%	-20%	-6%	14%	0%
MADISON								
2005	60.9	16.8	8.0	36.9	9.7	9.9	22.1	164
2000	58.5	16.7	7.1	35.1	11.6	9.6	19.4	158
1990	59.3	12.4	5.7	32.1	13.6	11.3	19.5	154
“% change: 90-05	3%	35%	40%	15%	-28%	-12%	13%	7%
SMALL CITIES								
2005	92.6	18.7	17.6	54.1	7.9	12.4	14.7	218
2000	90.9	16.6	16.8	53.0	7.9	13.5	13.8	213
1990	90.5	13.0	22.9	44.6	8.3	12.1	9.2	201
“% change: 90-05	2%	44%	-23%	21%	-5%	3%	59%	9%
VILLAGES								
2005	104.7	11.7	17.2	53.9	7.1	16.0	24.8	235
2000	98.9	10.3	15.7	44.5	8.9	15.0	21.2	215
1990	98.5	10.9	13.5	46.4	8.4	16.4	15.1	209
“% change: 90-05	6%	8%	27%	16%	-16%	-2%	64%	12%
TOWNS								
2005	356.4	14.9	40.6	326.8	25.4	14.6	102.8	882
2000	314.0	15.7	47.2	339.3	29.8	14.1	89.3	849
1990	395.0	15.3	29.6	336.8	26.7	15.7	91.5	911
“% change: 90-05	-10%	-2%	37%	-3%	-5%	-7%	12%	-3%

Source: Capital Area Regional Planning Commission and U.S. Census.

The FUDA communities generally followed trends established by small cities, villages and towns, seeing overall increases in developed land area per person for commercial, industrial, street right-of-way, and recreational categories. DeForest and Vienna saw increases in utilities, which counters trends seen for all villages and towns. The Town of Windsor saw

78 Increases in residential acres per thousands of persons shows decreases in density (more land developed per person), in contrast with dwelling units per acre, which shows increases in density as the number get larger.

decrease in many land use categories between 2000 and 2005, which is likely due to annexation of these uses.

Increasing land per person is consistent with an urbanizing region, where most growth is occurring on the edges of cities and villages, at lower density patterns than historical development, particularly for commercial land uses which often reflect single story buildings with large parking areas. Policies and market demand led to increases in houses per acre, but these increases were not sufficient to offset the declining household size.

B. Estimates of Land Demand

The purpose of FUDA planning is to protect vital natural resources, promote efficient development, and preserve farmland through cooperative planning for long-term growth. In order to achieve this purpose, estimates of the amount of long-term growth are required. Local communities need an estimate of how much growth is expected so they can plan accordingly.

Estimating growth is an imprecise exercise. The only solid data one can apply to the exercise is what has happened in the past. We know how much growth occurred in the recent past and it is reasonable to expect that growth will continue in the future for similar reasons: a relatively healthy metropolitan economy and high quality of life will continue to attract people. We can make educated guesses about how future decades will be different from the recent past. However, even the best economists cannot predict what our national growth will be a year from now with any significant degree of accuracy. Likewise, we cannot predict how changes over 25-years will be different from past changes with a significant degree of accuracy. ***Given these limitations, FUDA planning extrapolates current trends as a "baseline" from which to guide decision-making about what kind of future a community desires; and then to revisit and refine as necessary the projection on a regular basis as new information becomes available. This approach recognizes that local decision-making and policies largely determine the pace of community growth.***

The Wisconsin Department of Administration (DOA) provides 25-year population and housing projections for metro regions based on past trends in population growth and demographic factors including age distribution and household composition and formation. Metro projections are allocated among local jurisdictions based on past growth levels. DOA projections are extrapolations of recent trends, which are updated every five years to take into account recent growth.

FUDA planning uses DOA estimates of future population growth as the basis for future growth projections because CARPC is required, under Wisconsin Administrative Code (NR 121), to use DOA estimates. Starting with DOA estimates of year 2035 population, CARPC applies a DOA-approved methodology to estimate future housing units and the land area that these units will occupy. Estimates are adjusted based on input from local staff as to variables including the average number of people in each housing unit, and the average land area taken up by each housing unit (housing density). ***FUDA planning is intended to update estimates of growth every five years with new data as it becomes available. Therefore, the projection assumptions for each community are really only operative for the immediate upcoming 5-years.***

1. Methodology

Figure 39 shows the basic components of the methodology for projecting urban growth, or land demand. By CARPC's state-approved methodology, population projections from the Wisconsin Department of Administration provide the basis for projecting demand under the baseline projection included in this report. Population is divided by an estimate of persons per housing unit to generate numbers of housing units. Units are divided into single-family and multi-family (all types). Single-family and multi-family units are converted into land area (acres) with a units per residential acre estimation. Demand for non-residential land is estimated with per capita estimates (acres per 1,000 persons) based on trends observed in each municipality over the past 30 years.

Density values used to project land area demand for future single- and multi-family residential are based on current trends, existing plans and discussions with staff project team or steering committee members.

Figure 39
Land Demand Methodology Flow Chart

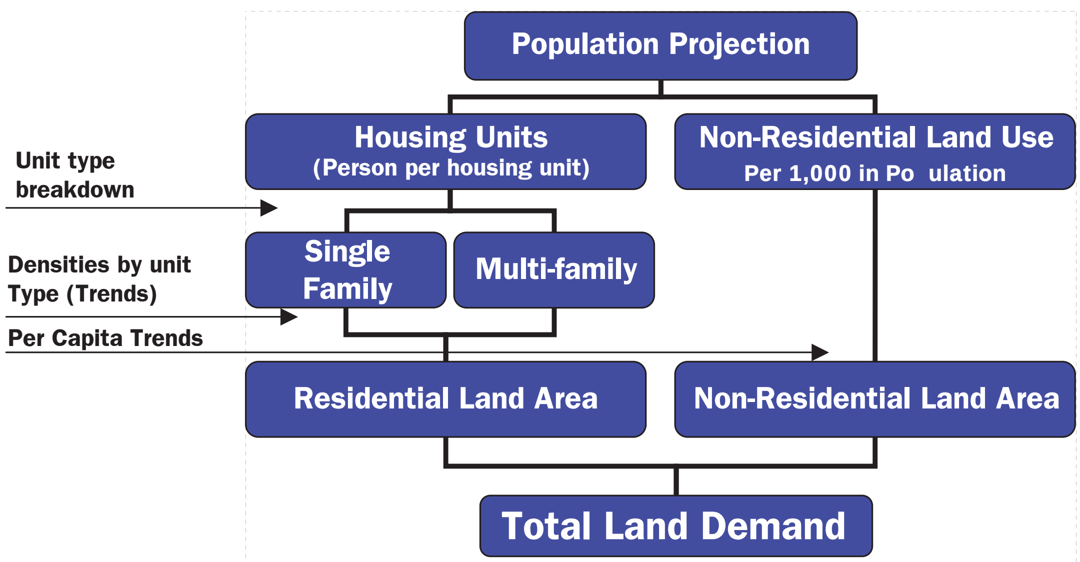


Table 26 through Table 28 show the projected urban land demand for the Village of DeForest and the urban portions of the Towns of Windsor and Vienna. These are created using CARPC's baseline protection methodology. All projections are based off land use, housing and population data from 1970 to 2005, and projections estimate changes from 2005 to 2035 (2005 is the most recent year that data exist for land use, housing and population). A prorated change from 2010 is shown and assumes equal distribution of development over time. Commercial, industrial, utilities, transportation, institutional and recreational land uses have been grouped under non-residential land.

Table 26

Village of DeForest Urban Land Demand Projection 2010-2035

Data Item	Est. 2005	Change 1970-2005	Projected 2035	Change 2005-2035	Est. Change 2010-2035
1) Total Population	8,288	6,377	14,361	6,073	5,061
Population Per Housing Unit	2.72		2.65		
2) Total Housing Units	3,289		5,382	2,093	1,744
% Single Family	71.7%		71.7%	0.0%	71.7%
% Multifamily Family	28.3%		28.3%	0.0%	28.3%
3) No. of Single Family Units	2,357		3,857	1,500	1,250
3) No. of Multifamily Units	932		1,525	593	494
4) Housing Area (Acres)	762	630	1,245	482	402
SF Residential Density (DU/Ac)	3.8				3.5
MF Residential Density (DU/Ac)	6.7				11.0
SF Area (Acres)	623	500	1,052	428	357
MF Area (Acres)	139	130	193	54	45
5) Non-Residential Land Use	1,206	1,047	2,065	859	716
Acres / 1,000 Persons	145	164			142
6) Total Developed Land (Ac)	1,968	1,677	3,310	1,342	1,118

Note: Estimated Change 2010-2035 is prorated and assumes equal distribution of development over time. Source: U.S. Bureau of the Census and CARPC

Table 27

Town of Windsor Land Demand Projection 2010-2035

Data Item	Est. 2005	Change 1970-2005	Projected 2035	Change 2005-2035	Est. Change 2010-2035	USA Change 2010-2035	Rural Change 2010-2035
1) Total Population	5,667	3,252	8,104	2,437	2,031		
Population Per Housing Unit	2.58		2.58				
2) Total Housing Units	2,187		3,127	940	784	467	317
% Single Family	82.4%			82.4%	82.4%	70.4%	100.0%
% Multifamily Family	17.6%			17.6%	17.6%	29.6%	0.0%
3) No. of Single Family Units	1,802		2,577	775	646	329	317
3) No. of Multifamily Units	385		551	166	138	138	0
4) Housing Area (Acres)	1,439	765	1,948	510	425	108	317
SF Residential Density (DU/Ac)	1.3			1.6	1.6	3.5	1.0
MF Residential Density (DU/Ac)	5.2			10.0	10.0	10.0	-
SF Area (Acres)	1364	728	1,857	493	411	94	317
MF Area (Acres)	75	36.8	91	17	14	14	0
5) Non-Residential Land Use	1,298	382	1,560	262	219	101	118
Acres / 1,000 Persons	229	118		108	108		
6) Total Developed Land (Ac)	2,736	1,147	3,508	772	643	208	435

Note: Estimated Change 2010-2035 is prorated and assumes equal distribution of development over time. Source: U.S. Bureau of the Census and CARPC

Table 28
Town of Vienna Land Demand Projection 2010-2035

Data Item	Est. 2005	Change 1970-2005	Projected 2035	Change 2005-2035	Est. Change 2010-2035	USA Change 2010-2035	Rural Change 2010-2035
1) Total Population	1,329	152	1,473	144	120		
Population Per Housing Unit	2.47		2.47	0.00	0		
2) Total Housing Units	537		595	58	48	18	30
% Single Family	95.7%			95.7%	95.7%	88.6%	100.0%
% Multifamily Family	4.3%			4.3%	4.3%	11.4%	0.0%
3) No. of Single Family Units	514		570	56	46	16	30
3) No. of Multifamily Units	23		25	2	2	2	0
4) Housing Area (Acres)	555	73	612	56	47	17	30
SF Residential Density (DU/Ac)	0.9			-1	1.0	1.0	1.0
MF Residential Density (DU/Ac)	32.9			-33	4.0	4.0	-
SF Area (Acres)	555	77	610	56	46	16	30
MF Area (Acres)	1	-4	1	1	1	1	0
5) Non-Residential Land Use	1,439	476	1,930	490	409	70	338
Acres / 1,000 Persons	1,083		1,310				
6) Total Developed Land (Ac)	1,995	549	2,541	547	456	87	369

Note: Estimated Change 2010-2035 is prorated and assumes equal distribution of development over time. Source: U.S. Bureau of the Census and CARPC

The Towns of Windsor and Vienna's land demand was subdivided into urban demand (projected inside the urban service areas) and rural demand by evaluating historic changes of various land uses categories (acreage) and whether they exist within a urban service area. The process used to divide urban from rural demand in each community is summarized in Figure 40.

Figure 40
Urban and rural Demand Methodology Flow Chart

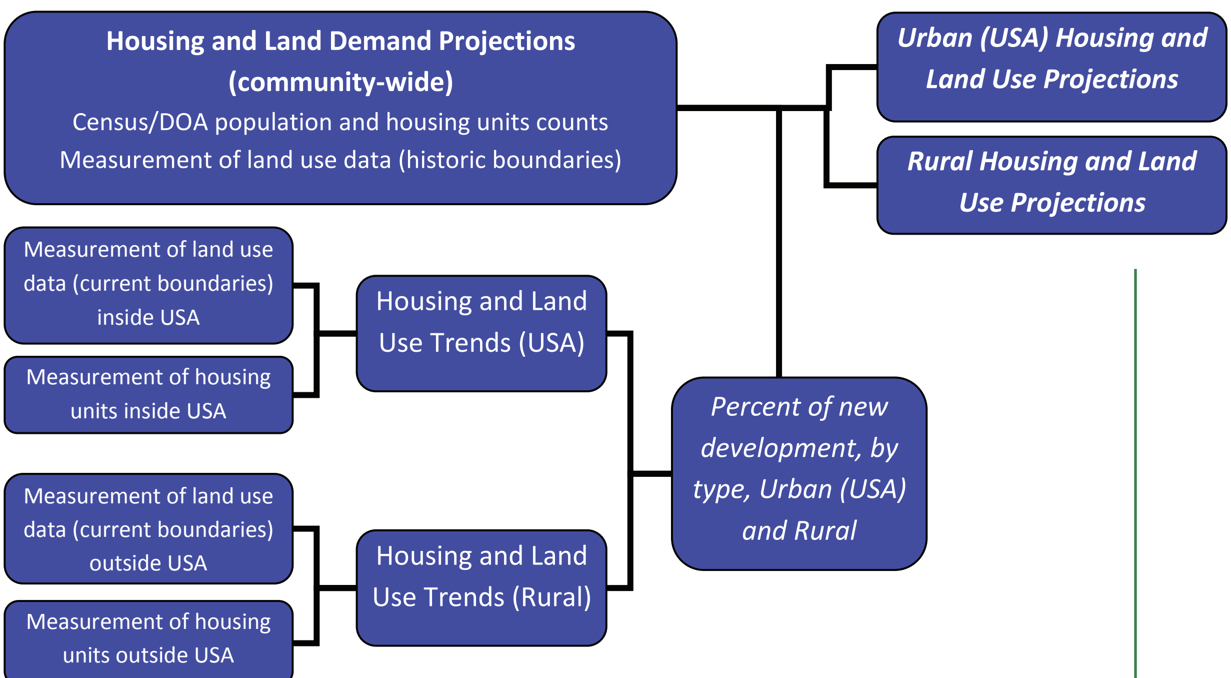


Table 29 indicates the total urban land demand projected for the FUDA area, which includes the Village of DeForest and the urban area of the Towns of Windsor and Vienna, between 2010 and 2035. The overall land demand anticipated is approximately 1,400 acres to accommodate growth anticipated during this time period. Residential land is a major driver of demand, and more than 2,200 dwelling units are anticipated at average densities of 3.4 and 10.7 units per acre for single family and multi-family respectively. Non-residential land demand accounts for 817 acres, or 63 percent of all land demand.

Table 29

Total Urban Area Land Demand Projection 2005-2035

	2005-2035	Est. Change 2010-2035
1) Total Population	NA	NA
Population Per Housing Unit		
2) Total Housing Units	2,675	2,229
% Single Family	71.5%	71.5%
% Multifamily Family	28.5%	28.5%
3) No. of Single Family Units	1,914	1,595
3) No. of Multifamily Units	761	634
4) Housing Area (Acres)	632	526
SF Residential Density (DU/Ac)	3.4	3.4
MF Residential Density (DU/Ac)	10.7	10.7
SF Area (Acres)	561	467
MF Area (Acres)	71	59
5) Non-Residential Land Use	1,064	887
Acres / 1,000 Persons	NA	NA
6) Total Developed Land (Ac)	1,696	1,413

C. Estimates of Land Supply

To accommodate 2010-2035 demand for urban development under CARPC's baseline projection, a minimum of 1,413 acres of developable land will be required. More or less land may actually be required, based on the uncertainties associated with projections and a variety of other factors.[79] To plan for this projected land demand, three categories of land supply within the FUDA Study Area are considered.

Infill: Development on land surrounded by developed uses on at least three sides (75% of perimeter) with public sewer and water available on adjacent parcels.

Redevelopment: Development on parcels with existing buildings that are replaced, added onto or substantially modified.

First, infill and redevelopment areas are assessed for their potential to accommodate projected demand. Second, developable land inside the current urban service areas is considered. Remaining demand, once infill/redevelopment potential has been estimated and developable land inside urban service area has been exhausted needs to be accommodated within the FUDA Study Area outside of existing USA boundaries. This process follows the concept that land inside the urban service area boundaries is generally prioritized for future development. However, USA expansions are often required prior to the development of all land within its boundary due to limiting factors within USAs such as landowners who are unwilling to sell or develop, or land access issues.

79 FUDA planning focuses on urban development that will take place within an urban service area (existing or future). Rural development that occurs outside of USAs is not the focus of FUDA planning.

1. Infill and Redevelopment

Like many communities, DeForest and Windsor encourage infill and redevelopment through existing plans. These include DeForest's downtown redevelopment plan and TIF plans, and BUILD plans addressing the Morrisonville and the Depot Street area in Windsor. This section identifies infill and redevelopment potential in areas that have been included in DeForest and Windsor's adopted local plans. Consideration of additional infill and redevelopment, not included in local plans, may be part of one or more alternatives developed for the scenario planning portion of FUDA.

Benefits of infill and redevelopment include more efficient use of existing infrastructure, improving property values, creating investment opportunities, and the potential to increase walkability and transit-friendliness by locating housing close to shopping and transit corridors. Infill and redevelopment, given the benefits, would be more commonplace but for the challenges public and private entities face when implementing these policies. Such challenges include multiple landowners, property assemblage, increased development costs (compared to greenfield sites) environmental contamination, and local resident opposition.

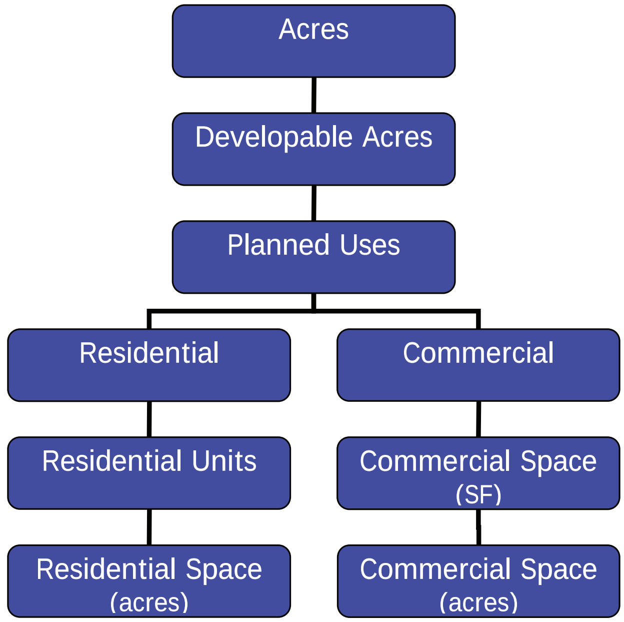
a. Infill and Redevelopment Assessment Methodology

Figure 40 displays the basic steps for determining infill/redevelopment potential. Using information from local plans, the number of acres identified for infill or redevelopment is determined. The portion of infill/redevelopment area that is planned for development (not including buildings that will be preserved) is determined, and the planned uses are identified. For example, a two-acre site may have an existing building with a footprint of half an acre. The planned redevelopment for the remaining 1.5 acres might be a three-story mixed-use building with commercial on the ground floor and residential above.

Redevelopment Assessment Methodology Example

DeForest Downtown sub-area 6 (see Figure 8) is a 1.3-acre site comprised of 3 parcels, one of which contains a duplex. The site is planned as a key redevelopment site, with a restaurant or entertainment use at a height of 1.5 to 3 stories. Open space is subtracted, with 20% of the site initially dedicated, leaving a buildable area of 38,000 square feet. The building program is ground-floor commercial with two levels of residential above and underground parking for residential users. The building size, and associated parking, was adjusted until the open space, building footprint and parking area filled the developable area. This resulted in an additional 15,100 square feet of commercial and 31 residential units (based on 1,000 sf average unit size). Based on the age and size of the existing buildings and the ratio of building to land value, the development was given a 50% chance of occurring within the next 25 years. If developed, the scenario would satisfy approximately 2 acres of demand. For land demand projections, only 1 acre is counted due to the 50% probability of redevelopment.

Figure 41
Infill and Redevelopment Assessment Methodology



Calculations are then made to determine the number of potential residential units and square feet of commercial space that could be accommodated on the site, given the need for parking and open space, and based on a number of assumptions (such as average unit size).

Because it is unlikely that all redevelopments would occur immediately, each site is assigned a redevelopment probability for the 25 year planning period, based on existing site characteristics. The number of projected units and square feet of commercial space for each site is then adjusted based on this percentage. Finally, residential units and commercial square feet are converted into acreage figures (based on assumptions of densities). The total acres of potential residential and commercial development is compared to projected 2010-2035 land demand to determine what portion of projected demand can be accommodated through infill and redevelopment.

b. Village of DeForest Infill and Redevelopment

The Village of DeForest has two areas that have been identified for potential redevelopment through existing plans. The first is the village's downtown areas, which was recently studied extensively in the 2009 Downtown Revitalization Strategy document. Parts of the downtown also overlap with one of two tax incremental financing districts (TID #1 and TID #6). The second area is located on Reardon Road, at the southern end of the village. Also in a tax increment district (TID #7), this area is focused on commercial and employment oriented uses.

DeForest Downtown

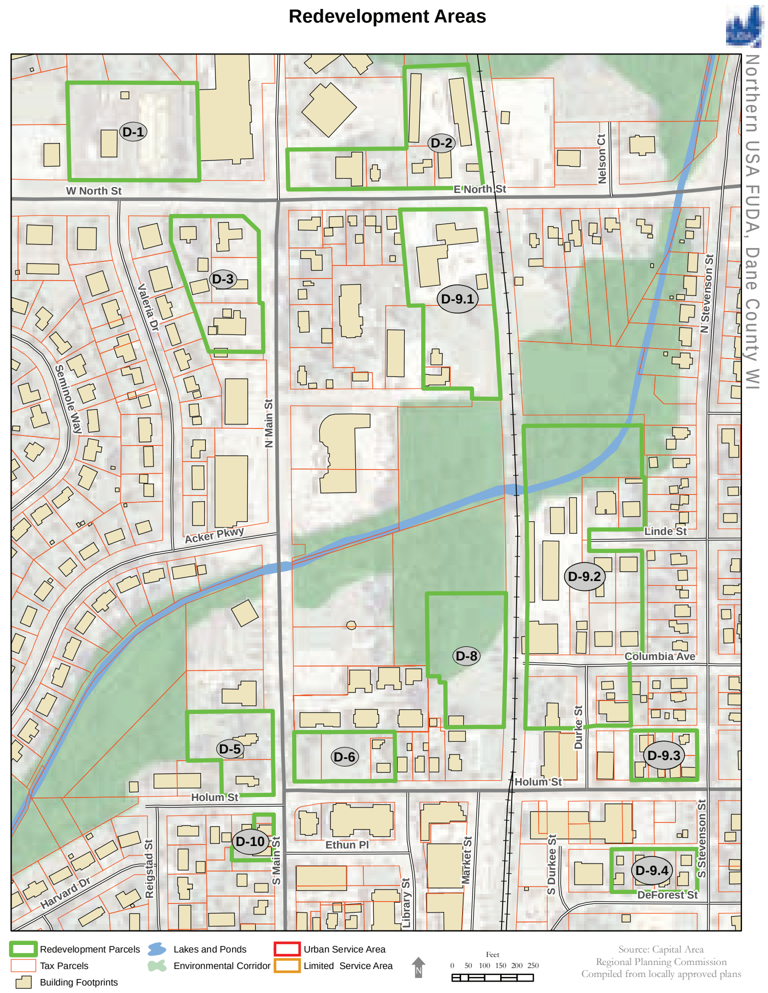
The Downtown Revitalization Strategy primarily focuses on parcels located on or in the vicinity of North, Main or Holum Streets in DeForest. This area contains a variety of uses; retail, office, residential, civic and industrial uses currently have a presence in the downtown.

One of the major goals of the Downtown Plan is to develop a mixture of uses that provides sustained opportunities for niche retail, neighborhood services, entertainment and housing. To accomplish this, sub-areas within the larger downtown were identified. The Commercial Redevelopment Crossroads at Main and North accommodates stand alone commercial while providing opportunities for gateways buildings. The Historic Downtown at Holum and Main seeks to foster an environment that encourages walkability and urban living.

The Village of DeForest's Downtown planning effort builds on the success of several recent developments in the downtown area, such as the Town Square mixed-use development as well as the new public library. The downtown also contains several historic buildings identified for preservation, including the Lyster House and the DeForest Railroad Depot.

Map 61

DeForest Redevelopment Area: Downtown



Redevelopment parcels were compiled by CARPC from approved local planning documents

The plan identified several sub-areas that called for varying degrees of reinvestment. Five sites within the downtown are identified for major redevelopment activity, including three sites for new 2-3 story mixed-use buildings and two sites allowing for expansion of adjacent commercial or community users. Numerous parcels have been identified for future improvements to the existing uses, either building façade or site, to continue the aesthetic improvements occurring in DeForest. Long-term redevelopment sites are called out, as well a potential future commuter rail stop connecting DeForest to Madison. DeForest and Windsor are located on a later phase line within the Transport 2020 study.

Table 30

Village of DeForest Downtown Redevelopment Area

Sub-Area	Developable Area (SF)	Existing Uses	Planned Uses	Potential Commercial Gain (sf)	Potential Residential Gain (units)
1	119,976	Bus barn (First Student/Laidlaw)	Redevelopment for office and/or parking	36,680	0
2	129,368	UW Health DeForest Clinic	Potential medical, office or multi-family	7,136	8
3	94,215	Retail, Auto Service, MF Residential	Gateway Commercial, bank (drive thru?)	5,265	13
5	56,675	Single Family Res.	Key Redevelopment, Ent. Rest, Service, 1.5-3 Stories	7,549	14
6	46,960	Two-Family Res., Vacant	Key Redevelopment Site, Diner, Niche Retail 1.5-3 stories	11,665	22
8	146,314	Vacant	Transit Stop and Associated Development	54,517	55
9.1	169,003	Manufacturing, Vacant	Long-term Redevelopment	8,094	67
9.2	274,112	Single Family Res, Apartments, Commercial	Long-term Redevelopment	8,474	46
9.3	32,356	Single Family Res, Retail, Office, Vacant	Long-term Redevelopment	402	5
9.4	34,848	Single Family Res	Long-term Redevelopment	8,468	14
10	11,224	Single Family Res, Restaurant	"Food/Entertainment (additional parking req.) "	255	-1
	1,115,051			148,504	243
		Land Demand Calculation Rates (FAR, Density)		0.25	11
		Acres		13.64	22.08

The sites that have been evaluated for redevelopment total 25.6 acres, of which 20.5 is considered to be developable after removing open space and site constraints. The development scenarios indicate the potential for 243 new residential units and 145,000 square feet of commercial space in the downtown (see Table 30). When evaluated cumulatively, these projects have an floor area ratio (FAR)[80] of 1.36 and an average density of 26 units per acre. A typical commercial FAR and the future multi-family density value is used to translate this back into acres to correspond with land demand calculations. These infill/redevelopment projects could accommodate a total of 35.7 acres of future land demand.

Reardon Road

The second area identified for redevelopment is a cluster of industrial parcels on Reardon Road at Hwy 51 in southern DeForest. Planned as part of TID #7, the seven parcels are a component a larger effort to establish a major office/research/commercial park that effectively utilizes its highly-visible locations and access from Hwy 51 and 19.

The parcels, totaling 38.6 acres, contain a mix of commercial service and industrial uses and are zoned Agricultural Business (AB) or Restricted or General Industrial (M-1 and M-2). While the FAR is lower, 0.1, this is not an atypical value for employment-oriented commercial or industrial development; unused land dedicated to future expansion is a common trait of business parks and this drives the overall FAR down (see Table 30). The overall improvement ratio of 2.04[81] also suggests the site is not necessarily underutilized.

80 Floor Area Ratio (FAR) is a measure of building intensity: the ratio between the total square foot of a building and the total square feet of the site. For example, a 100,000 square foot site with a 20,000 square foot, single-story building would have a FAR of 0.2. A FAR of less than 0.2 can be an indicator that a site is underutilized. FAR is one indicator that must be combined with other indicators and observations before conclusions can be drawn.

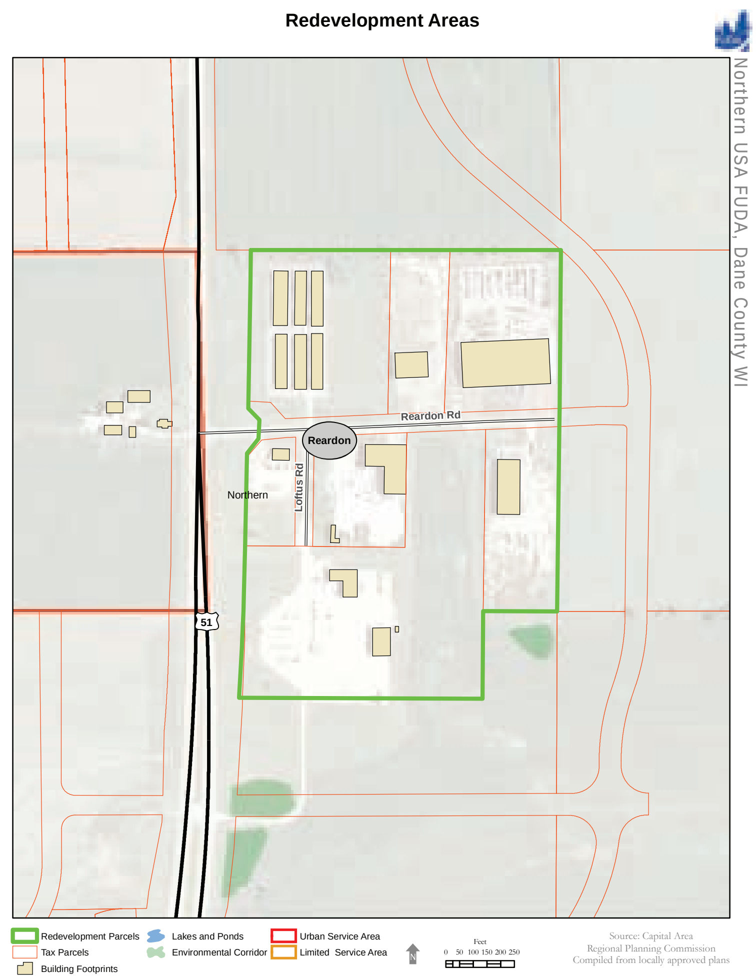
81 Improvement ratio is the ratio between the assessed value of the improvements (buildings) and the assessed value of the land. A site with land value of $100,000 and building value of $200,000 would have an improvement ratio of 2.0. Improvement ratios of 2.0 or higher generally indicate that sites are performing well in the market. Ratios of 1.5 or lower can indicate that a site is under-utilized. Improvement ratios are one indicator that need to be combined with other indicators and observations before conclusions can be made.

The Village supports the existing businesses and envisions this area as a long-term investment and redevelopment site, where some new development will occur as existing businesses transition to locations that better serve their needs or expand in place. The redevelopment/investment scenario created utilizes a mix of single- and two-story buildings, maintaining approximately 20 percent of the developable area for future expansion. This results in an additional 155,000 square feet of development and increases the FAR to approximately 0.36.

Between the Downtown and Reardon Road redevelopment areas, a total potential net increase of 303,099 commercial square feet and 243 residential units results. When using a typical commercial FAR of 0.25 and DeForest's future multi-family density value of 11 units per acres, the infill and redevelopment scenarios could accommodate approximately 50 acres of future land demand split between multi-family and commercial.

Map 62

DeForest Redevelopment Area: Reardon Road



Redevelopment parcels were compiled by CARPC from approved local planning documents

Table 31

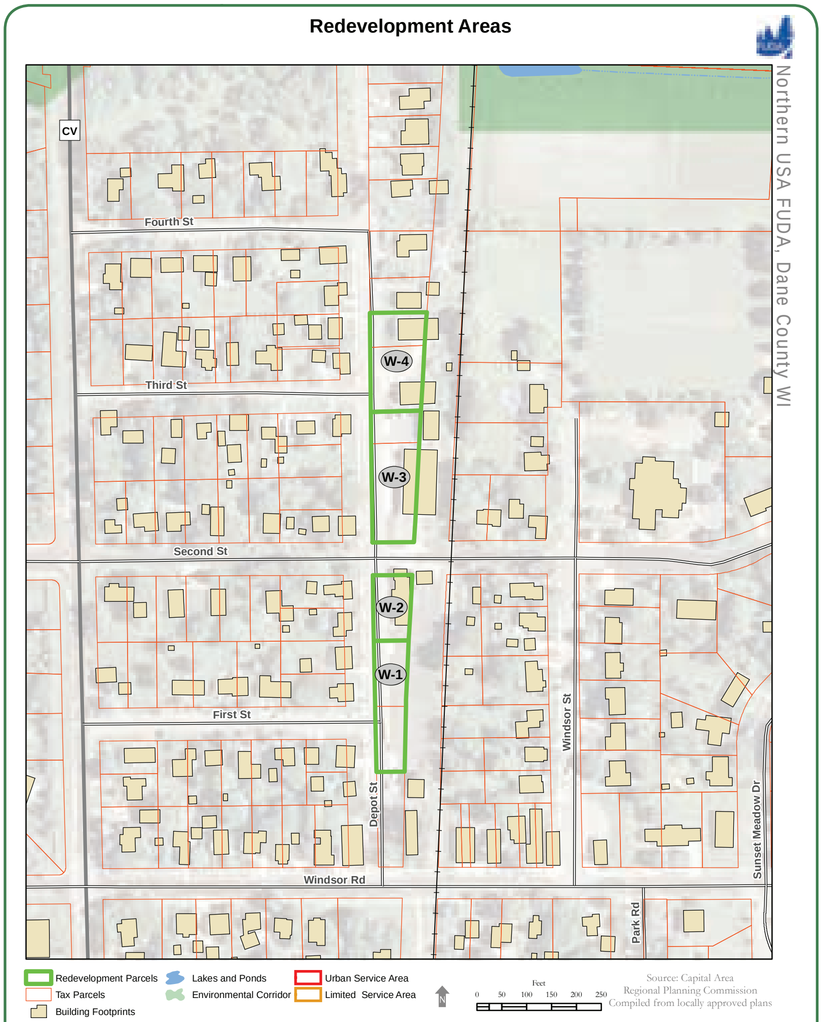
Village of DeForest Reardon Road Redevelopment Area

Sub-Area	Developable Area (SF)	Existing Uses	Planned Uses	Potential Commercial Gain (sf)	Potential Residential Gain (units)
Reardon	1,119,748	Industrial	Business PArk	154,595	0
		Land Demand Calculation Rates (FAR, Density)		0.25	11
		Acres		14.20	0.00

c. Town of Windsor Infill and Redevelopment

The Town of Windsor also has two areas that have been identified for potential redevelopment through existing plans. The Windsor Hamlet located on Windsor Road and CTH CV, and Morrisonville area were both studied through BUILD plans in 2003 and 2007, respectively. Each plan identified multiple development options for critical sites in the plan area.

Map 63
Town of Windsor Redevelopment Area: Windsor Hamlet



Redevelopment parcels were compiled by CARPC from approved local planning documents

Windsor Hamlet

The BUILD Windsor Hamlet plan's primary focus was to establish a development vision for parcels located on Depot Street, however the planning area is generally bound by CTH CV, Windsor Road, Fourth Street and the rail corridor. The area contains a mixture of uses, primarily commercial/light industrial on Depot Street and single family residential in the remainder of the study area.

The plan indicated that consumer commercial uses on Depot Street have diminished over time as travel patterns have shifted retail traffic away from this area, but residents have a desire for a small-scale retail restaurant or entertainment space. Smaller scale office and industrial buildings remain, with some utilization of the rail corridor by industrial users. At the time the plan was written, the buildings were generally sound and the corridor had an average FAR of 0.25. This information combined with a current improvement ratio of 2.2 would suggest the area is utilized but could support modest intensification (see Table 32).

Three alternative concepts are presented in the BUILD plan. The first recognizes the difficulty in redeveloping parcels to accommodate the same uses. This option (recommended by the plan) pursues site improvements that improve the appearance of the Depot Street area but does not affect the uses or intensity of the site. The second option preserves some commercial space while adding 10 townhomes and 3 single family homes north of Second Street. The final option removes the existing commercial south of Second Street and adds another 10 townhomes. The plan discusses the difficulty of marketing new residential abutting an active rail line and discourages residential as the exclusive use of the site.

Table 32
Town of Windsor Redevelopment Area: Windsor Hamlet

Sub-Area	Developable Area (SF)	Existing Uses	Windsor Hamlet BUILD Planned Uses	Potential Commercial Gain (sf)	Potential Residential Gain (units)
1	16,615	Vacant	Neighborhood Mixed Use	3,003	5
2	0	Depot Building	Neighborhood Mixed Use	0	0
3	24,304	Commercial Service, Storage Facility	Neighborhood Mixed Use	-343	2
4	21,347	Vacant and Commercial Service	Neighborhood Mixed Use	567	3
				3,228	10
			Land Demand Calculation Rates (FAR, Density)	0.25	10
			Acres	0.30	1.00

The redevelopment scenario for this exercise evaluates a slightly more aggressive and longer-term plan; the existing depot building remains but the surrounding buildings are replaced with mixed-use buildings with commercial spaces on the ground floor and residential units above. The commercial component could be office space or live-work studios. Retail may be possible but could face difficulties due to lack of visibility from Windsor Road. This approach results in the potential of 3,251 commercial square feet and 10 residential units, which translates to 1.3 acres in total land demand.

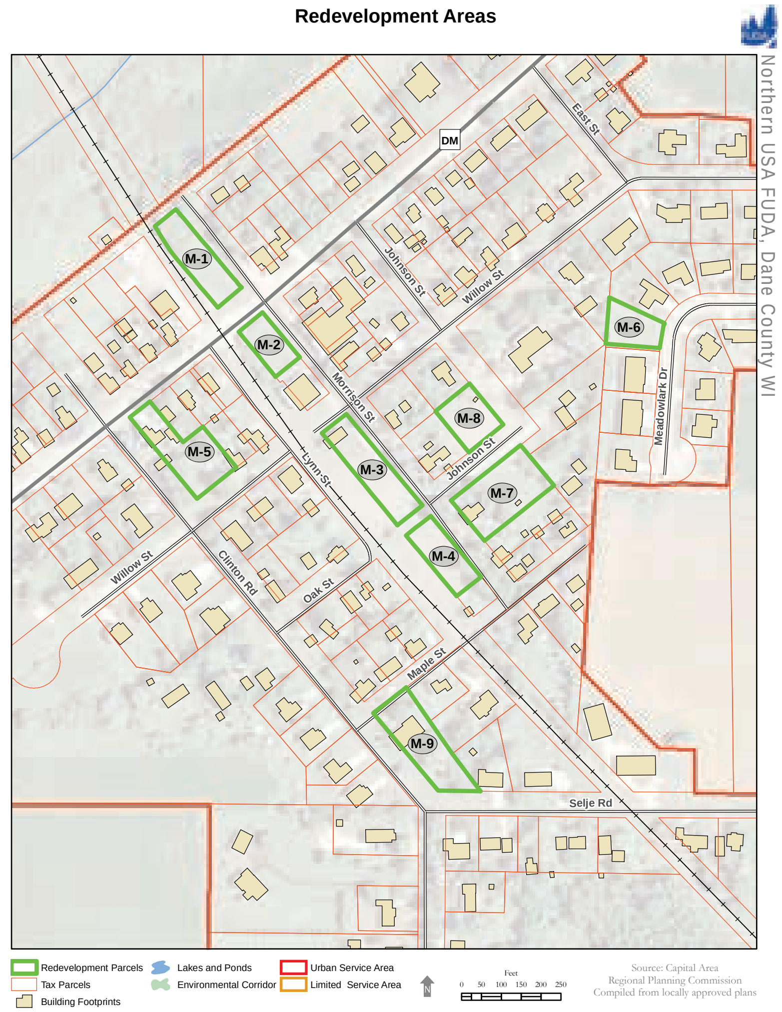
Morrisonville

The Morrisonville BUILD focuses on the parcels abutting the Canadian Pacific rail corridor, just south of CTH DM in northwest Windsor. Prior to the study, the Town of Windsor razed the Morrisonville Feed Mill, leaving three parcels vacant along the corridor. The plan sought to create a framework for a mixture of uses and housing types in a compact and pedestrian-oriented manner. Currently, Morrisonville is primarily single family housing with limited commercial development located near CTH DM and Morrison Street.

The plan provides four alternatives for development along the rail corridor; building sizes and uses in alternative 2 were selected to be used in the redevelopment scenario because they appeared the most market feasible for the Morrisonville context. This alternative called for a total of 11,600 square feet of commercial space and 6 duplex units on the three parcels, which total 1.4 acres (seeTable 33). In addition to the redevelopment parcels on the rail corridor, the plan identified scattered vacant sites that would be appropriate for residential development. When redevelopment probabilities were factored, the Morrisonville sites have the potential for approximately 7,000 square feet of commercial and 10 residential unit. These identified redevelopment opportunities could potentially offset 1.6 acres of land demand.

Map 64

Town of Windsor Redevelopment Area: Morrisonville



Redevelopment parcels were compiled by CARPC from approved local planning documents

Table 33

Town of Windsor Redevelopment Area: Morrisonville

Sub-Area	Developable Area (SF)	Existing Uses	Morrisonville BUILD Planned Use	Potential Commercial Gain (sf)	Potential Residential Gain (units)
M-1	19,809	Vacant	Commercial	8,700	0
M-2	11,429	Vacant	Commercial	2,492	0
M-3	23,728	Vacant building	Duplex Residential	-1,157	3
M-4	15,697	Vacant	Duplex and Stormwater area	0	2
M-5	16,935	Partial Lot, Vacant	None - Intensification with Duplex	-1,301	1
M-6	12,578	Vacant	None - Single Family	0	1
M-7	7,440	Single Family Res, Large lot	None - Intensification with Duplex	-921	1
M-8	14,868	Vacant - School owned Parcel	None - Intensification with Duplex	0	3
M-9	10,527	Vacant	None - Single Family	-944	0
				6,871	10
			Land Demand Calculation Rates (FAR, Density)	0.25	10
			Acres	0.63	1.00

e. Summary of Potential Infill and Redevelopment

Table 34 summarizes the potential impact infill and redevelopment efforts can have on the total urban land demand anticipated in the next 25 years.

Table 34
Potential Infill and Redevelopment and Urban Demand

	Prorated Demand (2010-2035)	Potential Redevelopment	Remaining Demand
Village of DeForest			
Residential (sf)	357	0	357
Residential (mf)	45	22	23
Commercial	331	28	304
All other catagorires	385	0	385
		50	1,068
Town of Windsor			
Residential (sf)	94	0	94
Residential (mf)	14	2	12
Commercial	35	1	34
All other catagorires	66	0	66
		3	1,068
Town of Vienna			
Residential (sf)	16	0	16
Residential (mf)	1	0	1
Commercial/Industrial	13	0	13
All other catagorires	57	0	57
		0	87
Total Demand Met Through Redevelopent		53	
Total Remaining Urban Demand			1,360

The redevelopment sections identified a potential capture of 24 acres of multi-family residential and 29 acres of commercial land, totaling 53 acres of redevelopment and infill. If this redevelopment potential is realized, it would account for 4% of the baseline projected land demand (2010-2035). This estimate of infill and redevelopment is based on existing plans in DeForest and Windsor. The potential for additional infill and redevelopment may exist in areas not yet planned and could be considered as an option in alternative development scenarios.

Other development will occur on “greenfield” sites within the developable portions of the existing urban service areas and potentially the FUDA Study Area outside currently outside the boundaries of the USAs.

2. Adequacy of Developable Land in the Existing Urban Service Area

The existing urban service areas in the FUDA communities were evaluated to determine the extent to which they contain sufficient developable land to meet the demand anticipated through 2035. This process identified land considered to be developable, and the planned future land use of these areas. For the purposes of this evaluation, land was considered developable if it is not developed and not considered undevelopable (including environmental corridors, floodplains, wetlands or slopes greater than 20%; woodlands within the Village of DeForest were also included as undevelopable because of an assertive preservation ordinance). The most recent land use data available is from 2005; as a result, this process uses developed land as of 2005 and development projections applicable to the time period between 2005 and 2035 shown in charts earlier in this report.[82]

Once developable areas were identified, they were compared to a multi-jurisdictional future land use plan compiled by the Madison Area Transportation Planning Board. Following this step, the quantity of planned and developable land for each community was arrived at by using current boundary agreements to estimate future municipal boundaries.

The analysis indicates that Village of DeForest had 1,479 acres of land considered developable in the Northern and Central urban service areas in 2005.[83] The baseline projection of urban land demand for DeForest between 2005 and 2035 is 1,342 acres, 113 acres less than the potential developable area. However, this value does not take into consideration planned land uses; for example, in the urban service areas, there are 272 acres more developable land planned for residential than projected demand. There are 147 acres estimated demand for industrial land than developable land planned to accommodate industrial uses. Within other land use categories, the analysis indicates DeForest has 338 acres more developable land planned for commercial than demand, and more demand than planned developable land for transportation (117 acres), institutional (100), recreational (87) and utilities (23).

The urban area of the Town of Windsor also had more land considered developable in urban service areas (Northern and Morrisonville) than projected urban demand. Similarly to DeForest, developable land planned for residential and commercial exceeded estimated demand and estimated demand exceeded planned developable land in all other categories. Within the urban service area, there is an estimated 145 acres of residential land beyond the estimated demand. Likewise, commercial includes 10 acres beyond estimated demand. Like DeForest, industrial and transportation have the largest shortfalls of 29 and 22 acres respectively.

The Town of Vienna contains an area of developable land (274 acres) inside the Northern urban service area planned primarily for industrial and commercial uses, though the Town's demand for these uses total 62 acres.

82 It is acknowledged that some development has occurred between 2005 and the present. This is accounted for by using 2005-2035 projections and indicates some of this projected demand has been satisfied.

83 This measurement uses future municipal boundaries identified in adopted intergovernmental agreements and current urban service area boundaries.

Table 35

Urban Developable Land, Planned Future Uses and Projected Future Demands

City of Middleton	NUSA Land Supply	CUSA Land Supply	Morrisonville Land Supply	Urban Land Demand	Potential Redevelopment	Supply in Excess of CARPC Projected Base-line Demand
Residential	675	57		482	22	272
Commercial	406	50		82	14	388
Industrial	156	0		316	13	(147)
Transportation	80	22		220		(117)
Utilities	0	0		23		(23)
Institutional	0	0		100		(100)
Parks and Recreation	32	0		119		(87)
	1,349	129		1,342	48	185
Village of Waunakee	**NUSA Land Supply**	**CUSA Land Supply**	**Morrisonville Land Supply**	**Urban Land Demand**	**Potential Redevelopment**	**Supply in Excess of CARPC Projected Base-line Demand**
Residential	253		19	129	2	145
Commercial	51		0	42	1	10
Industrial	3		0	32		(29)
Transportation	0		0	23		(22)
Utilities	0		0	2		(2)
Institutional	0		0	3		(3)
Parks and Recreation	2		0	19		(17)
	310	0	19	250	3	82
Town of Westport	**NUSA Land Supply**	**CUSA Land Supply**	**Morrisonville Land Supply**	**Urban Land Demand**	**Potential Redevelopment**	**Supply in Excess of CARPC Projected Base-line Demand**
Residential	19			20		(1)
Commercial	27			16		11
Industrial	228			46		183
Transportation	0			12		(12)
Utilities	0			10		(10)
Institutional	0			0		0
Parks and Recreation	0			0		0
	274			104	0	170

Source: CARPC and Madison Area Transportation Planning Board

Notes:

Land Use Category "Mixed Commercial/Residential" tabulated as 75% residential, 25% commercial

Redevelopment/Infill sites identified as vacant were adjusted to include only the portion of development above typical densities.

The analysis indicates transportation repeatedly has fewer acres of planned and developable land than projected demand acres. This is because communities generally only indicate major transportation improvements on future land use plans. Local roads, such as those constructed for residential subdivisions or business parks, are typically not accounted for separately, but included in the broader residential and industrial land use categories. The deficiency in this category will likely be satisfied with the other developments that occur during the FUDA time period. The outdoor recreation land use category also shows fewer acres planned than projected demand in DeForest and Windsor. Planned parks are often included in environmental corridors, and thus would be excluded from “developable” land in analysis. Similarly to roads, future parks may also be dedicated as an element of larger residential developments.

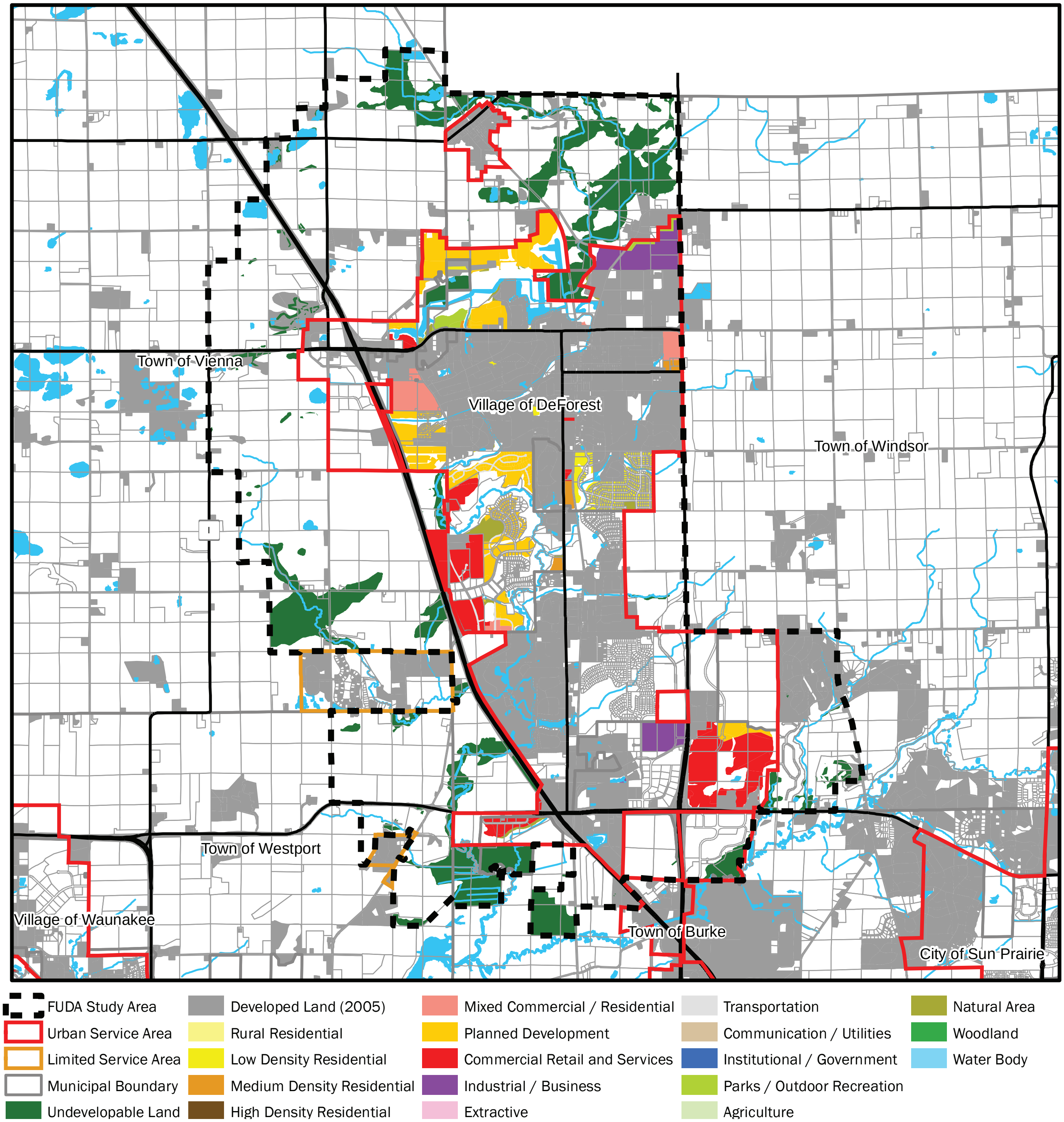
While all communities show an overall greater amount of developable land inside existing urban services area than baseline projected demands, this does not mean than urban service area expansions will not be necessary in the next 25 years.

Unmet demand in specific land use categories may require expansion of the USA. When developable land in one land use category exceeds the projected baseline demand, the additional supply of land should generally not be considered transferable to a different land use category (such as one with an insufficient supply of developable land) without a separate and specific land use planning effort which evaluates compatibility with adjacent uses, both existing and planned. For example, DeForest has baseline projected demand for industrial and institutional uses that exceeds developable land inside the USA planned for these, and more developable land planned for commercial and residential than projected demand. In this case, land planned for residential would likely be inappropriate for future industrial use and this may require USA expansion. Some of this industrial demand may shift to the planned industrial area in the Town of Vienna, which has a low projected demand and larger supply of developable land. Institutional demand however, such as schools, may be appropriate to develop in areas planned for future residential areas.

Unaccounted for demand that exceeds the baseline projection for a particular use also may require expansion of the USA. As previously discussed, baseline projections are based on historic trends in population, housing and land use. If communities experience rapid growth in the future, current baseline projections may not accurately reflect land demand.
Other factors may also limit the amount of developable land inside the existing urban service area that does development within the planning timeframe of the FUDA study. Property owners unwilling to develop, unforeseen environmental conditions, irregular or inaccessible parcels, or a variety of other reason may limit land development and create rationale for future urban service area expansions.

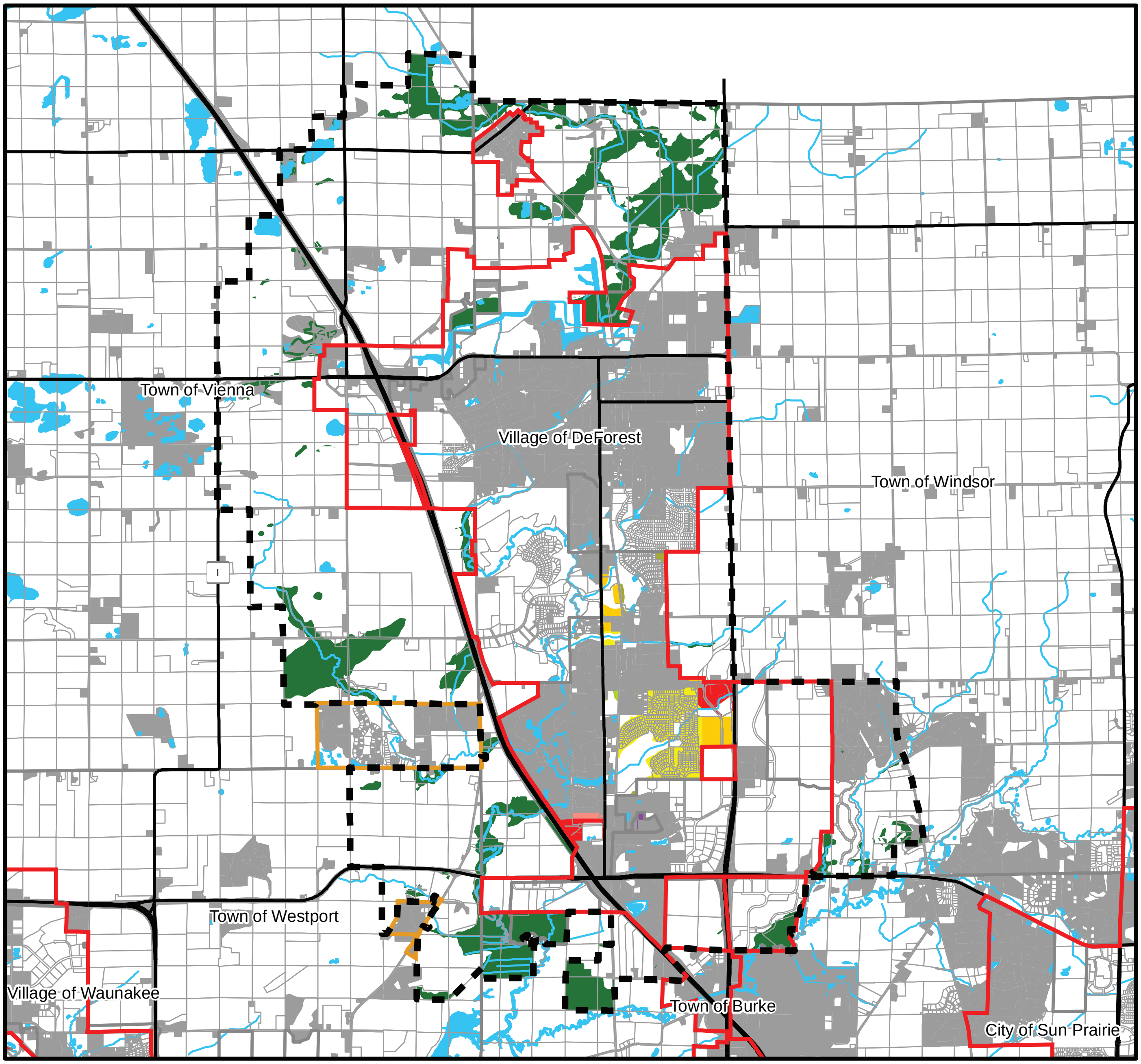
Map 65: Developable Land, Village of DeForest, FUDA Study Area

North Yahara Study Area, Dane County, WI



Map 66: Developable Land, Town of Windsor, FUDA Study Area

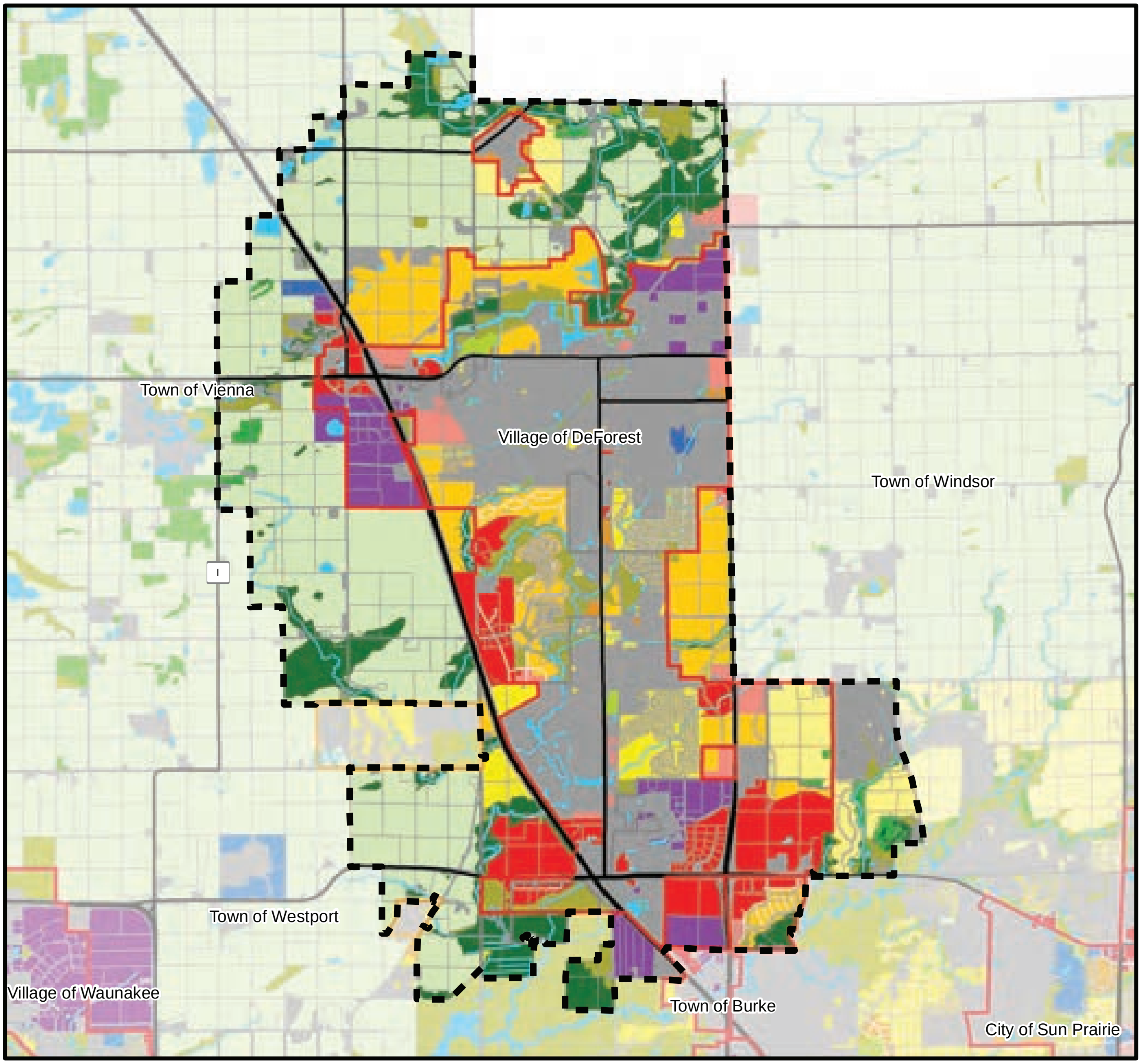
North Yahara Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Municipal Boundary
Undevelopable Land
Developed Land (2005)
Rural Residential
Low Density Residential
Medium Density Residential
High Density Residential
Mixed Commercial / Residential
Planned Development
Commercial Retail and Services
Industrial / Business
Extractive
Transportation
Communication / Utilities
Institutional / Government
Parks / Outdoor Recreation
Agriculture
Natural Area
Woodland
Water Body

Map 67: Developable Land in FUDA Study Area

North Yahara Study Area, Dane County, WI



FUDA Study Area
Urban Service Area
Limited Service Area
Municipal Boundary

Future Land Use
- Rural Residential
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Mixed Commercial / Residential
- Planned Development
- Commercial Retail and Services
- Industrial / Business
- Extractive
- Transportation
- Communication / Utilities
- Institutional / Government
- Parks / Outdoor Recreation
- Agriculture
- Natural Area
- Woodland
- Water Body
- Undevelopable Land
- Developed Land (2005)

D. Development Capacity of FUDA Study Area Outside the USAs

Urban development outside the 2011 urban service area boundaries (i.e. expansion of USA boundaries), and within the FUDA Study Area, may be attributed to urban growth from DeForest, Windsor and Vienna that cannot be accommodated within the 2011 USA boundary. Urban demand for land may also come from Sun Prairie as its growth extends into portions of the Town of Windsor, and from the towns of Westport and Burke.

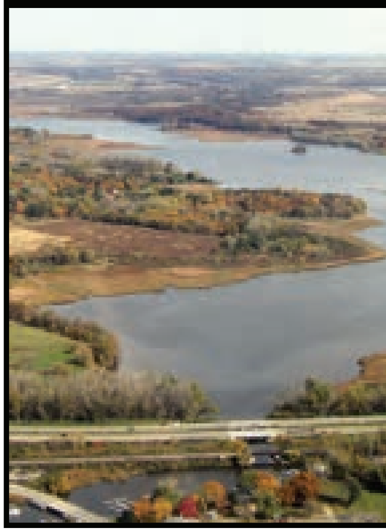
The land demands presented above represent the current trends, or baseline, scenario for the FUDA study area. The baseline scenario is based on Wisconsin Department of Administration (DOA) population projections and approved land demand estimation methodology, as required in NR 121. Any projection is, at best, an educated guess at what will happen in the future. The current trend scenario simply tells us what will happen if the development trends of recent decades continue into the future. However, just as past decades were not mere continuations of earlier periods, future decades will not be merely continuations of the past. Therefore, the purpose of extrapolating current trends is to inform future choices, not to constrain them. Continuation of historic trends gives us the baseline from which to make informed choices by considering alternative development scenarios based on community goals and different estimates of future growth. Comparing the costs and benefits of alternative scenarios to current trends, communities can make choices, plans and policies that best advance community goals.

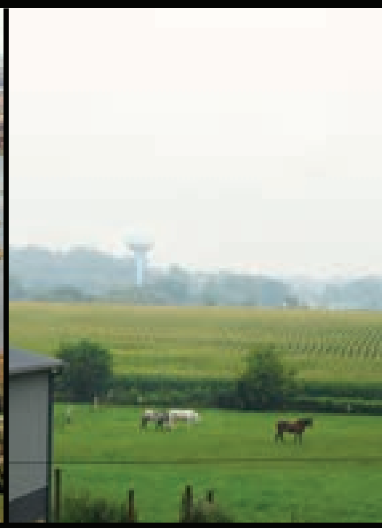
Such “scenario planning” (identifying and evaluating alternative development scenarios for the purpose of preparing a locally preferred scenario) is a part of the FUDA planning process. Alternative scenarios, based on community input, and selected by the local Steering Committee, will be evaluated based on factors such as land use, transportation, water and air quality.

North Yahara

Future Urban Development Area Planning

Environmental Conditions Report





Chapter IV Conclusions and Recommendations

A. Planning Consideration

The following provides recommendations on the kinds of natural resource conservation measures that should be considered for new development and re-development of existing areas. These considerations should be in the context of the broader agricultural and community development plans and objectives.

1. New Urban Development

Current Requirements

- Maintain at least 90% of the pre-development rainfall stay-on volume for all land uses. DeForest currently requires 100% control for new development.
- Maintain pre-development peak rainfall runoff rates for the 1, 2, and 10-year 24-hour design storms. Peak rainfall runoff rate control for the 100-year 24-hour design storm is also required in many communities, such as DeForest.
- Account for kettles, wetlands, and closed basins when determining pre-development peak rainfall runoff rates and stay-on volumes, when applicable.
- Reduce sediment in runoff by at least 80% compared to no controls.
- Provide oil and grease control for parking lots.
- Provide thermal control for runoff in thermally sensitive sub-watersheds (i.e. areas draining to coldwater streams).
- Install stormwater practices prior to other land disturbing activities and protect infiltration facilities from compaction and sedimentation during land development and construction.
- Ensure all stormwater management facilities are properly maintained and operated.
- All stormwater management facilities should be placed in Environmental Corridors and should be publicly managed, or have a perpetual legal maintenance agreement with the local municipality.
- Delineate detailed Environmental Corridors boundaries based on a field survey of wetland, stream, and floodplain resources reflecting adopted CARPC policies and criteria.

Planning Consideration

- Attempt to maintain 100% of the pre-development stay-on volume for all land uses, where not already required by local ordinances. DeForest currently requires 100% control for new development.
- Maintain the pre-development peak rainfall runoff rate for the 100-year, 24-hour design storm, where not already required by local ordinances.
- Maintain pre-development groundwater recharge rates.

- Conduct hydrologic analyses and planning to site municipal wells and conduct withdrawals so as not to adversely affect surface water resources. For example, the Village of DeForest and DNR have entered into a Memorandum of Understanding (MOU) "Regarding the Use of New and Existing Wells and Their Impact on Token Creek and Other Surface Waters."
- Provide additional groundwater recharge, water conservation measures, and/or return or recycling of treated effluent to mitigate the impacts of groundwater withdrawal from municipal wells where opportunities permit, and where groundwater induced flooding and groundwater quality concerns are not present.
- Restrict the lowest level of any structure to a minimum of one foot above the seasonal high water table, based on-site soil evaluations conducted in accordance with COMM 85.60. The on-site soil evaluations should be conducted wherever the NRCS Soil Survey of Dane County indicate seasonal zone of water saturation within 5 feet of the ground surface and hydric, very poorly drained, poorly drained, or somewhat poorly drained soils. Note that DeForest normally requires two-foot separation in new development.
- Conduct a functional assessment for all wetlands (e.g., Wisconsin or Minnesota DNR methodology).
- Maintain wetland hydrology (water level bounce and duration of inundation) within acceptable limits for wetland plant species and minimize the discharge of excess nutrients into the wetlands.
- Restore prior-converted and degraded wetlands to provide flood mitigation and improve water quality and wildlife habitat. Consider watershed level wetland enhancement/restoration opportunities when on-site opportunities are not present.
- Consider reforestation and prairie/grassland restoration to reduce stormwater runoff and to enhance infiltration and wildlife habitat where possible. Consider watershed level reforestation and enhancement opportunities when on-site opportunities are not present.
- Request a WDNR Bureau of Endangered Resources review for all projects where there is reason to suspect such species might be present (e.g., Natural Heritage Inventory screening) and that necessary measures be taken if species are found.
- Perform a field archaeology survey if there is reason to suspect artifacts might be present (e.g., wetland areas, local knowledge, etc.).
- Consult with Dane County Parks Department staff early in the development planning process to promote opportunities and coordination, as well as avoid incompatible or potentially conflicting proposals with the natural resource elements identified in the Dane County Parks and Open Space Plan.

2. Existing Urban Development

Current Requirements

- Reduce sediment from runoff in existing urban areas by at least 40% or as required by the TMDL for the watershed where applicable.
- Increase enforcement of construction site erosion control.

Planning Consideration

- Upgrade or retrofit stormwater management practices where opportunities/funding permit.
- Capitalize on converting traditional stromwater management and open space systems to green infrastructure systems.
- Prevent and remediate erosion from urban waterway banks.
- Capitalize on opportunities for urban stream, wetland, and buffer restoration and expansion.
- Capitalize on opportunities for urban reforestation and native plant landscaping.
- Harvest plants growing in existing urban wetlands to harvest captured phosphorus.
- Maintain and expand practices to reduce polluted stormwater runoff (i.e., "housekeeping activities") including street sweeping, road salt minimization and management, restrictions on lawn fertilizers, leaf collection, and community education to keep pet waste and other contaminants out of ground and surface waters.

3. Watershed Planning

Planning Consideration

- Promote active natural resource stewardship activities in sensitive wildlife and other resource areas (recommended 700 feet from significant WDNR wetlands and drainage lakes and 300 feet along streams).
- Work with other watershed communities (both urban and agricultural) in developing watershed management plans.
- Explore opportunities for nutrient trading between urban, agricultural, and point pollution sources associated with communities in the Rock River TMDL project establishing allowable levels of phosphorus and sediment being discharged to area waters.
- Engage in studies, assessments, designs, and implementation of the best and most economical practices for reducing pollutant sources in the community and the watershed.
- Conduct wetland evaluations and develop restoration plans to enhance the functions and values of wetlands.
- Promote and provide incentives for water conservation activities and practices such as green roofs, rain water collection and use for irrigation, gray water reuse, drought tolerant landscaping, and low flow plumbing fixtures as part of a comprehensive water supply planning and management program.

4. Agricultural Practices

Current Requirements

- Comply with the Agricultural Performance Standards and Prohibitions in NR 151:

  - No overflow of manure storage facilities.
  - No unconfined manure piles near waterbodies.
  - No direct runoff from feedlots or stored manure into state waters.
  - No trampled streambanks or shorelines from livestock.
  - Control cropland erosion to meet tolerable rates.
  - Build, modify or abandon manure storage facilities to accepted standards.
  - Divert clean runoff away from livestock and manure storage areas located near streams, rivers, lakes or areas susceptible to groundwater contamination.
  - Apply manure and other fertilizers according to an approved nutrient management plan

Planning Consideration

(in the context of nutrient trading and watershed runoff management – above)

- Maintain and expand farming practices that reduce phosphorus loads and runoff, including regular soil testing, nutrient management planning, alternative crop rotations, and perennial crops near streams and in highly erodible areas.
- Remove concentrated manure loadings from the watershed, using a range of strategies to capture and convert concentrated manure sources to nutrient and energy resources, and to allow nutrients to be exported from the watershed; discourage winter spreading; and change to low phosphorus animal feeds.
- Restore wetlands and natural buffers to capture sediments and filter runoff, especially along streams and creeks.
- Eliminate livestock grazing within wetlands and along stream banks (e.g., exclusionary fencing) to reduce the organic, sediment, and nutrient loading, as well as physical damage by livestock.

5. Agricultural Preservation Planning Consideration

Each community in the Study Area has an adopted Comprehensive Plan and/or is part of the *Dane County Farmland Preservation Plan* that presents background, goal, objective, policy, and program information.

Communities may want to incorporate the information provided in this report into their decision-making discussion. ***Some factors or characteristics maybe more important or useful than others to farmers and the local community and it is up to the local community to determine how to best use this information in decision-making processes impacting agricultural land within the large context of regional preservation and development.***

Communities differ in how they present and use information provided in existing plans. A simple example is that these communities use different language and criteria to determine related data. For example, to determine agricultural land quality the Town of Springfield utilizes the Land Evaluation system, and the Town of Vienna states "productive and tillable land." Creating a common language for agricultural decision-making may prove useful when communities come together to jointly plan for growth and preservation.

An effective land management tool for agricultural land preservation is a boundary agreement between two jurisdictions. Boundary Agreements are discussed in local comprehensive plans. Middleton/Springfield and Waunakee/Westport established boundary agreement, while Vienna could establish boundary agreements with the Villages of Waunakee and Dane. These boundary agreements help to ease political tension, creates a more simple, predictable, and stable land management framework, and help to direct growth to more appropriate areas.

In addition, town farmland preservation maps, in accordance with the State Farmland Preservation Act, designate lands as either "preservation," "rural development," or "transition areas." These designations should be considered seriously when developing boundary agreements and in pursuing rural development.

a. Agricultural Parcels and Farm Base Tracts

- Maintain diversity in size and operation type to better protect the regional agricultural industry from severe market changes in any one sector and will better support and encourage regional food systems.

b. Contiguity and Concentration

- Maintain contiguous blocks of agricultural land to maintain the land mass that makes farming more viable and provides better protection for agricultural use. Direct urban growth away from contiguous blocks of agricultural land.
- Agricultural concentrations between major roads shows where agricultural land uses may be compromised by the prominence of other land uses. Agricultural lands in low concentration areas that are deemed valuable as agriculture preservation may be a priority for preservation efforts.

c. Support Services

- Maintain sufficient concentrations of agricultural lands to maintain the viability of support service businesses.
- Ensure adequate infrastructure to ensure support services remain accessible to the farming community.

d. Soil Quality

- Special consideration is warranted when pursuing development in these areas to preserve these lands for food cultivation dependent on soils.
- Because of the variable terrain in the area and prominence of livestock based operations, soil quality is best considered at the site specific level. Large brush applications of prime farmlands as a priority criteria for preservation might significantly limit the potential of such a program and may work against the predominant and economically productive livestock operations in the region, especially farther to the west where prime soils are not as plentiful.

e. Ecological Services and Functions

- An effective approach to evaluating and maintaining ecological services and functions of agricultural land needs to address both the extent of the area under consideration and the relevant practices. Open space corridors define ecological areas that can be augmented with additional conservation areas and practices—agricultural and recreational. This approach could integrate various programs and policies to create a network of permanent agricultural and open space preservation areas. These areas could be protected from development and have supporting recommendations for improving agricultural practices, conservation, or restoration for different places in the study area. Other areas may be well suited for integrated resource management and host multiple land uses and services simultaneously.
- Former wetlands, which have been drained with underground drainage tiles, are also shown in the report to illustrate where wetland restoration could provide valuable ecological services in agricultural areas.
- In some upland areas, reforestation of agricultural lands could benefit ecological systems.
- Ecosystem service areas should be designed with the idea that the land owner would continue to benefit financially from the land. This can be either through sale of products from these conservation areas or through payments for the ecosystem service being provided.
- Some conservation practices would greatly benefit from changes in state law and taxing policy. For example, wetlands are typically assessed at higher land values compared to farmland. Consequently, farmers not only lose cropland and income by restoring former wetlands, but also pay higher property taxes under current tax policy.
- Ecosystem service areas should be designed with the idea that the land owner would continue to benefit financially from the land. This can be either through sale of products from these conservation areas or through payments for the ecosystem service being provided.

The data in this section can augment the decision-making processes to better inform what agricultural lands a community will preserve, maintain, or develop in the Future Urban Development Area Planning process. The data and subsequent decisions can be updated or incorporated into comprehensive and farmland preservation plans as the communities update them in the coming years. The variables with the most potential for making and measuring the impact of growth on farmland at the study area scale are contiguous blocks of agriculture and agricultural concentration. Other variable such as ecological services and functions, support services, tax assessment values, and soil quality are best considered at the site level.

Appendix A

Excerpts from the *Yahara - Mendota Priority Watershed Report*

Full report can be viewed at http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/Yahara_Priority_Watershed_Plan_1992.pdf

APPENDIX A
Yahara-Mendota Priority Watershed Report

Grantee Name (county or tribal government):	**Dane County Land and Water Resources Department**
Grant Number:	**YME-13000-N**
Priority Watershed Project Name:	**Yahara-Mendota Priority Lake Priority Watershed Project**
Grant Begin Date:	**November 12, 1987**
Grant Expiration Date:	**December 31, 2009**

<u>Final report contents:</u> The document listed in parentheses next to each report topic provides a source of information or data for that topic. If you require DNR financial data reports for this final grant report, contact the Priority Watershed Grant Manager, Jeff Soellner, at jeffrey.soellner@wisconsin.gov or (608) 267-7152.

1. **Introduction:** Introduce the program and the project.

The purpose of the project was to assess the nonpoint pollutants affecting water quality within Lake Mendota. Implementation of best management practices and educational activities to control polluted runoff were needed to meet water resource objectives to protect and enhance Lake Mendota and other lakes, streams, groundwater and wetlands in the watershed.

2. **Watershed Description:** Describe particular attributes of watershed and what factors accounted for it being chosen as a Priority Watershed. Describe the quality of the water prior to project implementation. Include/attach a map of the watershed/lake. (watershed plan)

232 square mile drainage basin located in the Lower Rock River Basin. Sediment and phosphorus were the primary pollutants of concern with delivery rates of 9,613 t/y and 72,275 lbs/y respectively based on inventory and modeling. Water quality conditions did vary amongst the eleven different subwatersheds. Primary concerns that were constant included sedimentation, nutrient loading, and some channelization. Generalized conditions were decreased water clarity and nuisance algae blooms and macrophyte growth. Secondary impacts were low dissolved oxygen and thermal loading.

3. **Accomplishments:** Describe or list the following:
   - Number of landowners/operators eligible for cost-sharing and easements (annual reports) : **567**
   - Number of eligible landowners contacted during the project (annual reports): **455**
   - Number of eligible landowners participating during the project (annual reports): **237**
   - BMPs that were installed (DNR or grantee CSA data)

     79 no. Barnyard Runoff Systems (Eaves, Sediment Basins & Roofs)
     10 no. Diversions
     58.1 ac Grassed Waterways
     3,105 ft Streambank Protection
     2 no. Terrace Systems
     8 no. Agricultural Sediment Basins/Grade Stabilization Structures
     12.8 miles Grassed Buffers along Surface Water
     18.8 ac Wetland Restoration

- Number of critical sites addressed compared to total number detected (annual reports)

Barnyards:
10 Critical Site Animal Lots were addressed of the 10 Critical Site Animal Lots detected in Dane County (one critical site lot added during watershed implementation).
Cropland:
80 Critical Site Crop Fields (54 landowners) were addressed of the 80 Critical Site Crop Fields identified in watershed plan.

➢ Major information and education activities during the project (annual reports)

1998:

Activity:	Objective:	Attendance:
Presentation of watershed plan	Inform Village Board of Deforest on program requirements	10
Construction site erosion control ordinance workshop	Inform builders, developers and engineers on ordinance	65
Presentation at Sauk County LCD	Use LMN as a case study for urban conservation	30
Presentation to Waunakee Village Board	Information on priority watershed requirements	10
Attend Waunakee Village Board Meeting	Provide technical background on construction site erosion control ordinance	10
County Watershed Tour	Tour Dane County Watersheds with Lakes & Watershed Commission	12
Wisconsin Association of Vocational Ag Instructors	Organized a urban and rural conservation program for ag teachers	35
Presentation to Middleton High School	Presentation to environmental conservation classes on LMN	65
Presentation to Middleton High School	Urban field trip showing effects of construction site erosion	65
Presentation to Environmental Science class at MATC	Inform students on LMN project goals	25
Teacher Training Workshop	Train area teachers on water quality testing procedures	77
Presentation to Middleton High School	Soils and habitat assessment field study with students	48
Project WET	Workshop for Deforest High School Teachers	24
Presentation to Oregon High School	Inform and educate students on stream ecology	56
Presentation to Friends of Pheasant Branch	Presentation on low input lawn care	34
Presentation to Sherman Ave. Neighborhood Assoc.	Presentation on Better Lawns and Gutters	11
Stormwater Stenciling	Teach 4-H youth leaders about stenciling program	22
1999:		
Nutrient Management Planning Workshop	Increase farmers knowledge of nutrient management planning	8
2000:		
Nutrient Management Planning Workshop	Increase farmers knowledge of nutrient management planning	13
Presentation at Danco Prairie FS field day	Inform farmers and consultants on nutrient management	10
Presentation to Deforest High School Ag Class	Educate ag students on conservation planning	15
Work with Middleton High School Envirothon Team	Inform students on landuse and its effects on environment	12
Presentation to local municipalities	Work with communities on implementation of erosion control and stormwater standards	100
2001:		
Presentation to Metro Grow Employees	Inform employees about nutrient management	20
North American Lake Management Society Bus Tour	Tour of conservation practices in LNM Watershed	20
2002:		
Citizen Based Monitoring began in the LMN Watershed	Staff worked with various citizen groups to train and assist in monitoring of water quality within the watershed.	
Workshop on development of nutrient management plans	Informed ag producers on the development and implementation of nutrient management plans	13
Developed two newsletters	Newsletter focused on watershed program	650
2004:		
Municipal Roundtable	Staff met with representatives of municipalities to discuss progress in updating erosion control ordinances.	

2006:		
Workshop on development of nutrient management plans	**Informed ag producers on the development and implementation of nutrient management plans**	**10**
2007:		
Workshop on development of nutrient management plans	**Informed ag producers on the development and implementation of nutrient management plans**	**10**
2009:		
Workshop on development of nutrient management plans	**Informed ag producers on the development and implementation of nutrient management plans**	**18**

- Water and soil conservation ordinances adopted during the project (annual reports)

1995: Dane County Construction Site Erosion Control Ordinance
2001: Dane County Stormwater and Erosion Control Ordinance
2002: Dane County Manure Storage Ordinance
2005: Dane County Winter Manure Spreading Ordinance

4. **Urban Nonpoint Source Project Component:** If the watershed plan had an urban component, list and describe the accomplishments and goals met, as applicable, such as storm water management plans and utilities developed, storm water and erosion control ordinances developed, structural BMPs designed and installed, etc. If available, list the associated pollutant load reduction information for the urban practices installed.

The Dane County LCD worked very closely with the municipalities of Madison, De Forest, Waunakee, Middleton, and Sun Prairie throughout the course of the project. In the late 90's, the DNR implemented new protocols for municipal funding basically creating a competitive format under the Urban Nonpoint Source grant program. Those communities were therefore on their own to apply for and implement urban initiatives.

Unique to this project was the urban critical sites criteria which was a first for Wisconsin's Priority Watershed Program. While NR 120 didn't recognize this aspect, staff worked exclusively with all five major municipalities implement the 7.5 t/a/y soil loss standard from construction sites. Additionally, this approach also lead to Dane County amending its' own stormwater and erosion control ordinance (Chapter 14) to include such standards county-wide.

Dane County provided $198,803 in funding through the Urban Water Quality Grant Program to assist municipalities in the installation of best management practices resulting in a reduction of 36.7 lbs of phosphorus from reaching Lake Mendota annually.

Attached is additional information (pages 7-12 of this report) , which will provide a more detailed analysis of accomplishments, related to urban components.

5. **Water Resource Evaluation:** Describe the water resource goals met and the percent of <u>applicable</u> pollutant load reduction and other goals reached. (annual reports)
   - Barnyard phosphorus:
     Reduced barnyard phosphorus runoff by 8923 lbs annually (72 % of project goal)
   - Upland sediment
     Reduced upland sediment loss to surface water through conservation planning by 4,034 tons/annually (38% of project goal)
   - Streambank/shoreline erosion
     Reduced streambank erosion by 93 tons annually (26% of project goal)
   - Gully erosion
   - **Reduced gully erosion by 1,606 tons annually (no project goal)**
   - Nutrient management acres
     Nutrient management plans were developed on 45% of cropland within watershed.
     The below table lists nutrient management plans reviewed by county staff within the watershed. Typical, nutrient management plans are funded for a three year period. (no project goal)

- Conservation plan acres
  89.6% of cropland within the watershed is farmed at or below tolerable soil loss levels.
- Wetland restoration
  18.8 acres of cropland have been restored to wetlands.

6. **Financial Evaluation:** Compare the cost-share grant amount to the total amount of money spent on BMPs, including urban BMPs. List the amount of money spent per BMP. (DNR or grantee accounting data)

Rural Projects:

The original watershed grant amount was $2,878,340 of which $776,083.72 was spent on the installation of best management practices. Below is a table listing the amount spent per practice.

	Practice	Units installed	Total Cost-share
C3	Diversion	2050 lin. ft.	$6,686.79
C5	Grassed Waterways	10.9 acres	$20,437.32
L1	Barnyard Runoff Management	17 sites	$143,725.71
L2	Manure Storage (Manure Transfer)	1 no	$13,201.92
LR	Roof for Barnyard Management	7 sites	$400,059.53
M2	Grade Stabilization Structure	4 no.	$19,501.57
M4	Agricultural Sediment Basins	4 no.	$19,312.01
M5	Nutrient Management	1,851.7 acres	$11,687.53
MR	Streambank Protection	2455 lin. ft.	$18,340.34
R6	Critical Area Seeding	0.2 acres	$350.00
513	Total Confinement of Livestock	1 site	$122,781.00
			$776,083.72

In addition to cost-share funds from the priority watershed program, county staff worked with producers within the watershed to enter into 195 Federal Environmental Quality Incentive Program (EQIP) contracts for $1,516,874 in cost share and incentive payments. Of this amount, $1,128,817 has been used to install best management practices within the watershed.

Urban Projects: (Funding from Urban Non-Point Source Program)

Municipality Name	**Name of Grant**	**Grant Cycle**	**Objective**	**Completion Date**	**Cost**
Urban SW Construction Grant					
City of Madison	Wexford Retention Retrofit	2000	Retrofit dry to wet pond	2000	$249,325
City of Middleton	Pheasant Branch Creek Stabilization Conservation Project	2006-2007	Erosion control and streambank stabilization	2008	$58,450
City of Middleton	Hwy 12 Catch Basin	2005-2006	Proprietary device installation	2006	$65,000
City of Middleton	Pheasant Branch Wet Pond	1997-2001	Wet pond construction	2001	$151,200
City of Sun Prairie	Token Creek Water Control	2000	SW Control	2000	$37,392
University of Wisconsin	Lot 34	2005-2006	Retrofit parking lot	2007	$150,000
University of Wisconsin	Angler's Cove Parking Lot	2003-2004	Retrofit parking lot	2004	$40,000
Village of Deforest	Industrial Park Pond	2000-2003	Wet pond construction	2003	$24,500
				Total:	$917,547
Storm Water Planning Grants					
City of Middleton	Storm Water Plan	2005-2006	Develop storm water mgmt plan	2007	$85,000
Village of DeForest	Storm Water Plan	2005-2006	Develop storm water mgmt plan	2007	$70,000
Village of Waunakee	Storm Water Plan	2006-2007	Update storm water mgmt plan	2007	$43,610

Village of Waunakee	Storm Water Plan	2000	SW Plan/ Erosion Control Ord.	2000	$43,574
Village of Maple Bluff	Storm Water Plan	2006-2007	Develop storm water mgmt plan	2007	$18,000
Village of Shorewood Hills	Storm Water Plan	2006-2007	Develop storm water mgmt plan	2007	$63,982
City of Sun Prairie	Storm Water Plan	2000-2001	SW Plan/ I&E/ Erosion Control Ord.	2001	$19,285
University of Wisconsin	Storm Water Plan	2002-2005	Develop storm water mgmt plan	2005	$96,430
				Total	$439,881

Evaluate the effectiveness of local assistance grant expenditures. (DATCP or grantee accounting data)

The local assistance grant was effective in assisting Dane County to fund staff to work on the watershed project. Staff were able to conduct outreach programs promoting the watershed and to assist landowners in the design and installation of conservation practices. The urban staff funded by the local assistance grant focused on the municipalities within the watershed assisting in updating of ordinances and improving construction site erosion inspections. The rural staff partnered with the Natural Resources Conservation Service in administering the federal Environmental Quality Incentive Program providing landowners an alternative cost share source for the installation of conservation practices.

A frustration with the local assistance grant was that funds did not increase over the years to cover the increase in salary costs.

7. **Summary and Conclusions:** Summarize the report and evaluate the overall success of the project.

The Yahara-Mendota Priority Lake Project spanned a time of changes in both the priority watershed program and agriculture. During the early years of the project, cost share funds available for installation of best management practices were limited. This resulted in project staff using the federal Environmental Quality Incentive Program (EQIP) as a cost share source. This resulted in over $1.2 million dollars of federal funds being used to install conservation practices. In agriculture, the farms transformed to larger, family corporations resulting in the concentration of livestock. Thus, best management practices typically installed (i.e. barnyard runoff systems) no longer solved the barnyard runoff resource concern. This resulted in Roofs for Barnyard Management being promoted as the best management practice to solve the resource concern from animal waste runoff.

Agricultural Summary:

- **42% of landowners/producers within the watershed installed or implemented a best management practice.**
- **All animal waste critical sites identified in the watershed plan were addressed.**
- **All cropland critical sites identified in the watershed plan were addressed.**
- **79 animal lots within the watershed have installed conservation practices or implemented management changes, which reduced animal waste runoff.**
- **155.9 ac of cropland has been seeded to grasses to establish buffers along surface water and wetlands. These buffers trap sediment and filter nutrients before runoff enters surface water. (Assuming an average width of 100-ft, this represents about 12.8 miles of surface water with grassed buffers installed).**
- **As part of Dane County winter spreading ordinance, staff worked with 29 livestock operations to develop winter spreading plans to minimize runoff from applications of liquid manure on frozen, snow covered or ice covered ground.**
- **Greater than 45% of the cropland acres in the watershed developed and updated nutrient management plans.**
- **Completed Farm Practices Inventory Survey (FPI) with producers to establish baseline data and trends. The same producers are being surveyed in 2010 to identify changes that have occurred as a result of the watershed project.**

Urban Summary

- **Municipal adoption of the 7.5 tons/acre construction site erosion control standard.**
- **Development and application of two interim BMPs including polymers and urban catchment basins.**
- **Identification and mapping of all urban outfalls.**
- **Provided municipalities with hydric soils maps for consideration when developing.**
- **Provided technical assistance and guidance when applying for Urban Non-point Source grants.**
- **Sun Prairie, Waunakee, and DeForest developed stormwater management plans.**
- **Developed and administered intergovernmental agreements for erosion control and stormwater plan review and inspections in DeForest, Waunakee, Middleton, and Sun Prairie.**
- **Developed criteria for urban critical sites, which was a first for the Wisconsin Priority Watershed Program.**

- **Provided administrative and technical support on all phases of erosion control and stormwater management initiatives to municipal partners.**
- **Watershed plan was impetus for further development and adoption of Dane County Chapter 14 Code of Ordinances Subchapter II, in 2002.**
- **Conducted two USEPA funded research projects evaluating effectiveness of erosion control practices.**
- **Dane County provided $198,803 in cost share funds to municipalities for the installation of best management practices at channel outfalls reducing 36.7 lbs of phosphorus from reaching Lake Mendota annually.**

Completed by: **Name (first mi. Last)**	Steven J Ottelien and Peter L Jopke
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Date Completed: (mo day yr)	April 30, 2010
Signature:	

Attachments: Map of the project
Photos of the project

DNR Copy distribution (3):

(1) 2 copies to Priority Watershed Grant Manager – Jeff Soellner, WI DNR CF/2, PO Box 7921, Madison, WI 53707-7921
(2) NPS Region Coordinator

The urban project goals include both sediment and phosphorus objectives. They were broken down into two categories to include existing and transitional areas. A third component (future) was also included but it is assumed that these future developments will be addressed by the new Dane County Erosion Control and Stormwater Management Ordinance (Chapter 14). Phosphorus objectives will be met in the following categories if the overall sediment objectives are satisfied.

Urban Project Goals- (Existing)
Sediment-40%
Phosphorus-20%

Urban Project Goals- (Transitional)
Sediment-80%
Phosphorus-60%

Existing Urban Areas-Management Needs & Alternatives

Management	***Status***	***Recommendation***
Increase street-sweeping frequencies to one time per week in areas identified as downtown commercial strip.	At this time, project staff do not know whether this alternative is being implemented	Visit with municipalities to review street-sweeping frequencies and areas targeted.
Increase and maintain street sweeping in other established urban areas to once every three weeks.	At this time, project staff do not know whether this alternative is being implemented	Visit with municipalities to review street-sweeping frequencies and areas targeted.
Construct and maintain urban catchment basins where there is direct discharge of stormwater to surface waters.	To date, it is estimated that three basins have been constructed in such areas.	Staff met with municipalities on various occasions to identify and prioritize locations. Municipalities indicated financial support as a limiting factor. Will continue to encourage pursuing Urban Nonpoint Source and Stormwater DNR Grants.
Direct runoff to buffer strips, porous pavement, infiltration trenches, and shallow depressions where sediment can be deposited and runoff reduced.	This recommendation is targeted for redevelopment. It is not known to what extent this is occurring although contracted municipalities have been addressing these issues where they can according to ec/sw plans reviewed by this office.	Continue to encourage this through the plan review process.
Adopt effective storm water management plans for each future development site.	All municipalities have stormwater management plans including Sun Prairie, Waunakee, and Deforest which prepared plans during the planning phase of this project.	The new Dane County EC/SW Ordinance will force compliance.

Transitional Urban Areas- Management Needs & Alternatives

Management	***Status***	***Recommendation***
Apply and enforce the 7.5 tons/acre construction site erosion control standard to all municipalities in the watershed.	All municipalities adopted this standard prior to the County Requirements in August 2002. The LCD has also contracted for plan review/inspection of construction sites in DeForest, Middleton, Waunakee, and Sun Prairie. Madison has hired an additional staff person and does this internally.	Continue to work with municipality in the watershed in this capacity.
Avoid development in areas with hydric soils.	LCD staff have provide municipality with maps indicating where hydric soils are located within their municipality boundaries.	Continue to work with municipality staff on the importance of not developing in these areas. Suggest alternatives and continue to recognize the value of these areas during the plan review process.
Reduce direct discharge coming from developing areas by 80%.	Direct discharges have been addressed during plan review. All plans within the municipalities having contracts are meeting this requirement.	Continue to address through the plan review process. Although LCD staff do not do this per contract requirements, suggestions are made per the approval letter.
Maintain peak stormwater flows to pre-development conditions for the 1,2 and 10-year 24-hour storm.	Peak flows are addressed for the 2 and 10-year storms only. With the exception of Sun Prairie, all municipality administer this through their own consulting firms or staff.	Continue to address through the plan review process. Although LCD staff do not do this per contract requirements, suggestions are made per the approval letter.

Urban Streambank Erosion

Urban streambanks are evaluated on a site-by-site basis. Currently, the North Fork of Pheasant Branch Creek is be reconfigured by the City of Middleton. As part of the development in that sub-watershed, the stream will be re-routed with a meandering pattern while strategically rip rapping certain segment. The South Fork of Pheasant Branch had a portion of its banks stabilized in 1997-1998. The Village of DeForest has been conducting annual stream clean-ups on the Yahara River but has not done any stabilization work. Finally, the City of Sun Prairie has undertaken an aggressive approach to minimizing thermal runoff into Token Creek. Although this was not an original goal of the Plan, all development in the Token Creek Watershed will include management practices for thermal pollutant reduction.

Pollution Prevention Practices

Pollution prevention practices are intended to remove pollutants at the source and prevent the need for treatment after they enter the water resource. Types of pollution prevention practices identified in the plan include:

- Reduce or eliminate the use of galvanized roof materials, which are sources of zinc in urban runoff.
- Immediate removal of pet wastes from urban areas, which can contribute bacteria to area surface waters.
- Control the use of herbicide and pesticide applications.
- Proper disposal of automobile fluids to keep them out of the stormsewer system.
- Removal of accumulated sediment, leaf material, and other debris from catch basins, streets, and parking lots. This can contribute nutrients to surface waters while inhibiting overall municipal maintenance.
- Control development and redevelopment through zoning which may influence the overall stormwater management impacting water quality, flooding, and habitat degradation.
- Minimize the use of de-icing compounds. Sodium chloride levels have shown an increase in groundwater resources.
- Control construction site erosion.
- Reduce the amount of motorized traffic.
- Reduce the areal extent of parking lots.

The above programs are best administered through the local municipality. Each municipality should be encouraged to address these issues. All of the prevention practices listed were part of the Information and Education strategies developed for this watershed. However, due to budget deficiencies and changes at the staff level, the information and education strategies have not been given a high priority with the exception of construction site erosion control and post development stormwater. From a priority standpoint, the project goals will have a higher likelihood of being met with the emphasis being placed on proper erosion control and stormwater management.

Urban Critical Sites

This watershed plan was the first in Wisconsin to include urban critical sites. Urban critical sites are all transitional areas that exceed 7.5 tons/acre/year in soil loss during the construction phase. The other critical site component includes areas of direct discharge into Lake Mendota or other surface waters that meet the following criteria: outfalls with a ratio of sediment (tons) to land area (acres) that is greater or equal to 0.2 and where best management practices are identified through a feasibility study.

Since all municipalities in the watershed area have adopted the 7.5 tons/acre/year soil loss rate and are actively administering it, there are no critical sites falling into that category. However, the second critical site component is not actively being targeted. Part of the reason is that there is no legal authority under NR 120 governing critical sites in urban areas. Secondly, although areas were initially identified during the inventory phase, no additional effort has been made to work with communities where the ratio is greater than 0.2.

Appendix B

Excerpts from the *Black Earth Creek Priority Watershed Report*

APPENDIX B
Black Earth Creek Priority Watershed Report

The following tables represent conservation efforts in the Black Earth Creek (BEC) watershed in Dane County through 1998. The pollutant load levels reflected in the tables represent levels achieved as of December 31, 1998. The percentages of reduction are for implemented practices only. The tables consist of the following sections:

- Pollutant Source-The type and source of the nonpoint source pollutant identified as a water quality impairment.
- Inventoried Load-The amount of phosphorus, sediment, or soil loss calculated at the inception of the project. Provides the baseline from which to derive pollutant reduction goals.
- Goals-The amount by which the project aims to reduce that pollutant by. Usually expressed as a percentage in watershed plans.
- Reduction-As of December 31,1998, the amount of nonpoint source pollution reduced.
- % Reduction of goal-As of December 31, 1998, the percentage of nonpoint source pollution reduced relating to project goals.
- % Reduction of total load-As of December 31, 1998, the percentage of nonpoint source pollution reduced based on the total inventoried load.

Black Earth Creek Priority Watershed

Watershed Black Earth Creek	Project Start 1989	Project End 2001		
Pollutant Source	Barnyard (Phosphorus)	Upland Sediment	Gully	Streambank
Inventoried Load	3,752 lb.	426,726 tons	11,800 tons	39,010 tons
Goals (Reduce By)	1,876 lb. (50%)	213,363 tons (50%)	5,900 tons (50%)	19,505 tons (50%)
*Reduction	3,198 lb.	327,499 tons	10,555 tons	32,756
% Reduction of goal	170%	153%	179%	140%
% Reduction of total load	85%	77%	89%	70%

**Represents local, county, state, and federal funding sources.*

There were approximately 300 contacts made with 108 of them signing contracts. The following quantify the practice type and number installed:

Practice	**Unit**
Barnyard Runoff System	88
Rock Crossing	36
Lunker Structures	625
Fencing	34,380ft.
Rip Rap	37,440
Shaping and Seeding	31,875

The BEC watershed was completed in the year 2001. The project has been very successful as can be seen by the pollutant load reduction. Pollutant reduction goals have been exceeded by 61% on average. As part of the nonpoint source redesign in 1998, the BEC watershed ranked first in the state. In total, $1,518,935.00 in cost-share has been provided through this watershed project since 1989.

Water Quality Improvements

A major indicator of the benefits of the project can be seen in the Brown Trout fishery of Black Earth Creek. The Wisconsin Department of Natural Resources (WDNR) has been conducting annual spring densities of the stream. The data has shown that since 1989, the responses to the Black Earth Creek Priority Watershed Project were very positive both by the fish and by fishermen. Trout densities increased from 200-500% depending on the pre-existing habitat in the area and how limited it was. Fishermen responded to the habitat improvement work in such numbers that local biologists could not fish some improved stretches for a season, due to the number of anglers. It is not uncommon to now see vehicles from Illinois, Michigan, Minnesota, and Missouri parked along the stream and Trout Unlimited has selected Black Earth Creek as one of the top 100 streams in the country. This rating is based on many tangibles, but it is one of the best because it has a wild brown trout population that is easily accessible by a large population of people. Local residents have really come to appreciate the resource and are much more protective of it, in large part because of the watershed project. During the summer of 1999, the fishery was featured on ESPN Outdoors as a top trout-fishing destination in the Midwest.

Appendix C

Excerpts from *the Wetlands of Dane County, Wisconsin*

Full report can be viewed at http://danedocs.countyofdane.com/webdocs/PDF/capd/2012_postings/Publications/Wetlands_of_Dane_County_DCRPC_1974.pdf

THE WETLANDS OF DANE COUNTY, WISCONSIN

1974

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for the

Dane County Regional Planning Commission

in cooperation with the

Wisconsin Department of Natural Resources

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PHEASANT BRANCH MARSH

Yahara River Valley Region

Priority Group II

Wetland Description

Pheasant Branch Marsh, in the Town of Middleton, is under consideration by the City of Middleton for a purchase and preservation program. It is part of the Lake Mendota watershed, and as such, its preservation is important in protecting the quality of the lakes.

This report describes Pheasant Branch Marsh as of the beginning of 1973. The marsh, with a lowland area of 311 acres, has a surface watershed of 1,400 acres. This does not necessarily coincide with sources of spring water, which are more difficult to determine. There is a good possibility at this time that a student at the University of Wisconsin will be making a hydrologic study of the region. This will be necessary to understand the action of the marsh on ground and surface water and vice versa. Counting the springs and streams entering the marsh does not give a sufficient picture of this action. However, it can be said that there is a continuous flow of water through the lowland basin, and that over half of the water appears to pass down open channels, rather than through stands of emergent vegetation. This may limit the capacity of the marsh to clean the water.

Six plant communities can be recognized in the area: upland old field; upland forest; lowland forest; sedge meadow-shrub carr, including sedges, grasses, and shrubs; shallow marsh, including mostly bur reed; and submerged aquatic plants in open water. At least some of the upland old field has been used in the past as cropland or orchard. This area provides winter weed seeds and cover for birds, a winter source of apples for deer, and bird nest sites in summer. The proximity of upland old field, lowland shrub areas, and open water at the springs has made Pheasant Branch an attractive area for small birds in winter. We have noted much higher numbers of wintering small birds here than in most other marshes.

On the west edge of the area, on the hillside next to Pheasant Branch Road is a small region of recent dumping whose winter ecology deserves brief mention. It will serve as an example to show that limited disturbance can add to the food web, provided plants are allowed to re-invade. Due to the dumping and earlier plowing, several weed species are found to be abundant here. These are pioneer species; that is, they require bare soil to start their growth, and in turn provide moisture and shade for other plant species to grow later. Especially notable for their seed crop are giant ragweed (Ambrosia trifida) and pigweed (Amaranthus sp., Chenopodium sp.). The seeds are being taken by large numbers of tree sparrows and mice (Microtus sp.). These in turn, especially the mice, provide food for various predators. Two owls, the great horned owl and the short-eared owl, have been seen in the area this winter. House cat tracks were seen in the weed area among the mouse tracks.

In winter, the only other heavy wildlife use is found in the open water channels. A large open channel is found in the center of the marsh, flowing southward from the largest spring. Here hundreds and sometimes thousands of ducks can be found. Recently a flock of 160 mallards and 4 black ducks was seen. Earl Loyster of the Department of Natural Resources has noted over 2,000 wintering ducks here on occasion.

The rest of the lowland, including the sedge-grass-shrub area, the black willow forest, and the large stands of bur reed, supports much more bird and animal life in the warmer seasons. During migration the open water is used by mallards, black ducks, shovelers, lesser scaup, wigeons, coots, blue-winged teal, green-winged teal, and wood ducks for rest and feeding.

The three lookout areas designated on the management map provide vantage points for observing without disturbing these ducks. The breeding season brings at least moderate numbers of the usual wetland nesting birds -- red-winged blackbirds, swamp sparrows, sora and Virginia rails, mallards, blue-winged teal, long-billed marsh wrens, short-billed marsh wrens, etc. -- along with a few representatives of species less commonly seen in Dane County. One immature male yellow-headed blackbird was seen, and a female harrier has been observed feeding in the area on several occasions.

The combination of lowland forest with shallow marsh and open water provides a suitable habitat for nesting wood ducks, as well as perches over water from which green herons and kingfishers can hunt. Dead and dying trees attract woodpeckers. The large stand of wild rice provides food for ducks, other birds, and muskrats. At least twenty-five muskrat houses were located in the marsh in 1972.

In spite of the heavy siltation which has occurred in the marsh, the diversity of submerged aquatic vegetation is good, not being limited to or dominated by two or three species. However, the almost complete dominance of bur reed in a large area north of the pond suggests that the silt deposits have diminished the diversity of emergent vegetation in that part of the marsh. Excessive duckweed choking the open water during late summer serves as a warning that eutrophication is occurring.

In addition to having an above average diversity of the more common native wetland flora, Pheasant Branch Marsh has several small patches of the less commonly occurring small yellow ladyslipper (Cyripedium parviflorum). We know of few other stations for this species in Dane County.

Management Considerations

It has been of interest recently to use marshes as settling basins to protect water quality downstream. This is a useful technique because (1) marshes store organic material, thus reducing the flow of nutrients into downstream lakes; and (2) marsh vegetation slows and breaks up water flow, causing finer silt to be dropped. These are both functions which an open holding pond cannot perform.

However, there is a serious drawback to looking at the pollution-siltation problem in this way. The number of marshes available in southern Wisconsin is increasingly limited. Each can clean the water effectively only if the rate of inflow of nutrients and silt is not too great. Further, the process places a load on the marsh itself, leading to eutrophication and filling with sediment. If the load is too great, the marsh ceases to be effective in protecting downstream waters, and ceases to be a healthy ecosystem itself.

For these reasons, we should turn the problem around, and use the marshes as indicators of land use problems, just as canaries are used to detect gas problems in mines. If the nutrient and silt load on the marshes is too great, it is the land practices upstream which must be altered. We can use a marsh, such as Pheasant Branch, as a warning system to let us know when to improve land practices. Further, by protecting a marsh such as this one, we automatically receive three benefits: lake protection, a healthy marsh, and the knowledge that the upland is being properly used also.

The following guidelines include some concepts which are not generally familiar, and certainly not in general use at this point. These techniques include buffer zones near the marsh, protection of springs, identification and protection of water sources above springs, erosion controls upstream, control of nutrient sources, settling areas above the marsh to control silt, and graded density development.

Buffer zones are necessary to a balanced wetland ecosystem. This is generally known by biologists and by some planners, but is rarely regarded as important in practice. This is, of course, due to our outdated land use system. In practice, edges of wetlands are dredged and filled, often with high density residential or even commercial or industrial development nearest the lowland. The values of a buffer zone include: (1) an upland breeding area for water-using animals, such as ducks and turtles; (2) a foraging and resting area for water-breeding animals, such as frogs and blackbirds; (3) an undisturbed transition zone between water and land, this being a region of heavy wildlife use; (4) protection of water quality; (5) protection against water level fluctuation; and (6) a large enough area available for home ranges to make it possible for a large number of bird and animal species to use the wetland.

Buffer zones can also be used for locating upstream water control areas, such as grassy silt-settling basins and ponds to catch sudden heavy runoff. Since most people are not confident about entering the low portions of a wetland, the existence of an upland buffer makes possible various types of low-intensity recreation, such as picnicking, hiking, nature instruction, and wildlife observation.

Springs, once abundant, are becoming less so in the Dane County area. This is due to several factors: increased pumping of ground water for city use, increased development of the land surface, which must cause at least some water to flow overland rather than entering the ground, lack of understanding, or even negligence. Three spring areas have been identified in the Pheasant Branch Marsh area to date. These provide a relatively clean steady water flow. With the improved protection of Pheasant Branch Creek, the marsh has the potential of being fed mostly by clean water. This, of course, requires that the springs themselves be purchased and protected. Further, the ground water recharge areas for the springs should be located. These must be protected if spring flow is to continue.

The results of erosion and nutrient inputs are now attracting public concern. However, much discussion still centers on cleaning up the results of bad management without attacking the sources. Water control should be practiced as far upstream as possible. Ideally , as soon as the raindrop hits the ground, its course should be properly managed. Only then will downstream cleanup become worthwhile. Pheasant Branch now provides an opportunity to demonstrate proper water control. Its watershed is small enough to handle. It is not too late to identify and correct problems.

Graded density development is perhaps a new concept. It is almost the reverse of present practice (see Figs. 15 and 16). A natural area, such as a wetland, is identified. An appropriate buffer zone is planned, including water control areas if necessary. In the ring of land nearest the buffer zone, and elsewhere on steep hills, is a zone of low density development only. This might include parks, schools, or very low density residential zoning. Light industrial zoning is appropriate if buildings are sparse and no toxic effluents enter the wetland. It should be an area of great scenic value, being nearest the natural area, and would have higher property value. The low density mentioned is definitely lower than that of most present residential (R1) developments. Strict attention should be paid to preserving natural amenities, such as scenery, trees, and natural land contours. Pavement should be at an absolute minimum. Strict controls should be placed on the amount of soil laid bare by construction, especially where hills are steep.

The second zone, moving away from the natural area, could be of greater density and include the same types of use. Attention should still be paid to protecting the land during and after construction, as it should everywhere. However, tight restrictions would not be quite as crucial as in the first zone. Further zones, if desired, could include increased use density, all the way to R-4 residential or heavy industrial. A further and very important consideration would be the placing of major travel, power, and sewer routes away from the natural area. Where reasonable, such natural areas would be connected by a green corridor system, as advocated by the Dane County Regional Planning Commission.

Future Use

Pheasant Branch Marsh, due to its size, diversity, location, and upland buffer zone, is an ideal area to develop for low-intensity recreation and for teaching. Purchase and management suggestions in this report are made with these uses in mind. The types of use available here are quite close to present uses in the University of Wisconsin Arboretum. Public pressure on the Arboretum serves to alert us that there is a definite and growing need, both for low-intensity recreation and for school and public outdoor education. The Arboretum guide system is in the process of expanding its size and coverage, and will become available for areas such as Pheasant Branch.

Some suggested uses of Pheasant Branch Marsh, by region, are:

1) Hiking on and off trails, nature study. A limited amount of walking off trails will not injure any existing values, since large numbers of people do not choose to enter the wetter areas. Suggested trail areas are: the hill along the west side (areas 8 and 4) with a loop into the willow forest (area 9) and a bridge or two across the new ditch; the wooded hillside on the east (area 5) using the present motorcycle trail, connecting with the lookout designated on the east hill (area 10) and extending southward to the County Road M ; on the north side, looping up over the prairie hill (area 17), down to the major spring (area 16), and into the sedge meadow west of it (area 2); possibly also west of Pheasant Branch Road (areas 3 and 7). These trails can be planned to connect if desired, making it possible to walk all of the way around. Exact locations of trails should be planned by a naturalist, so as to take best advantage of various features while doing a minimum of damage. It will be found that the forested lowland will not be usable during some times due to mosquitoes. However, the Arboretum, which also has this problem, has never sprayed and has had no complaints by hikers. Boardwalks in the wetter portions of the marsh may be found desirable in the future.

2) Canoeing. A canoe can enter the marsh from the lower part of the creek. This is a perfectly compatible use, and does not require further development of the area other than proper water quality management, as outlined elsewhere in this report.

3) Snowshoeing. It is relatively easy to get around in an old field or sedge meadow on snowshoes. One can go anywhere without doing damage.

4) Horseback riding. It may be desirable to allow horses on certain trails. However, horses should not enter the lower areas where they will sink into soft soil.

5) Picnicking. The hillside on the west (area 8) is excellent for this use, combining opportunities for hiking, relaxing, nature study, and an excellent view. Facilities could be placed with minimum disturbance to the area. Maintenance of a natural grassland would eliminate any need for mowing, and would be more esthetic. Another possible picnic area would be on the hillside north of the marsh (area 17).

6) Public school field trips, public tours. This would be much the same sort of program as is now used in the Arboretum. The combination of steep hills, springs, marsh, and lowland forest would be excellent for introducing groups to natural diversity. Facilities used would be the trail system and picnic areas noted above. A shelter would be necessary at times. The existing house north of the marsh might be considered for this.

7) Availability of parking. Three areas are suggested as suitable for access to trails and picnic areas. None are deep within the natural area. For the west hill (area 8), a flat spot on top of the hill across the road could be used. For the southeast (areas 5 and 10), a flat place exists near the County road (M) just east of the creek. For the prairie hill area along the north (areas 16, 17, and perhaps 14) parking could be located where the present private road meets Pheasant Branch Road.

Non-compatible uses: Certain uses are not consistent with maintaining this natural area, or with public interest. Some of these are:

1) Snowmobiling, motorcycling, use of all-terrain vehicles. These are damaging to the plant communities, scare wildlife, and diminish the experience of those who come for other types of enjoyment.

2) Motorboating and fishing. The open water area is too small and shallow for these uses, which can easily be pursued in other areas nearby. Dredging for these purposes is not in the best interest of marsh preservation.

3) Skating. Due to the presence of open water in cold weather, the City of Middleton should not encourage skating here. A large proportion of the available ice surface is not reliable.

4) Shooting and trapping. As this area becomes more used by the general public, shooting will be increasingly hazardous. Due to probable use as a nature study and perhaps research area, trapping should be done only by the proper authorities to meet specific needs, as in the Arboretum.

Another type of future use of eventual public benefit is the restoration of natural communities. The dry hillside on the north, now containing some prairie remnants, is ideal for such restoration. The upland and lowland forested areas each once had characteristic wildflowers, and both areas have been disturbed. The restoration of such plants and removal of the exotic pest honeysuckle can bring much pleasure to future hikers. The maintenance of open grassland areas and semi-open areas will aid in wildlife attraction, public enjoyment, school projects, and teaching opportunities. If not maintained, some of these areas will go to shrubs and eventually to trees. The right balance in each area should be sought.

In order to carry out and aid in the above uses of the Pheasant Branch area, which could in time become the Pheasant Branch Natural Area, it is hoped that a full-time naturalist could be hired to live on the site. The present house on the north side is ideally located for this, as well as for a small nature center-shelter. The duties of such a naturalist should include:

Conducting public tours on suitable weekends;

Working with teachers and the guide system to expedite school tours;

Establishing and maintaining the trail system, as suitable;

Maintaining open areas, semi-open areas, and edge, and coordinating volunteers in brush removal;

Carrying out prairie restoration and aiding in school projects in study and restoration of prairie;

Carrying out upland and lowland forest floor plant restoration and aiding in school projects;

Coordinating overall maintenance and restoration, working in other plant communities needing attention;

Collecting seasonal data on vegetation, wildlife, water cycles, public uses, etc., and making them available to interested parties;

Acting as troubleshooter for water problems, land misuse, public nuisances and other problems, and informing appropriate parties when necessary.

Pheasant Branch Marsh offers an excellent opportunity, one which is rapidly becoming scarcer, yet more in demand. It is the hope of the writers that this opportunity be used to the fullest extent possible.

PHEASANT BRANCH MARSH
VEGETATION AND LAND USE

MAP KEY

Emergent vegetation, mostly bur reed (*Sparganium eurycarpum*) in dense stand, wild rice (*Zizania aquatica*) in open water area.

Mixed emergent vegetation, including sedges.

Sedge meadow, much of it with tussock sedge (*Carex stricta*) dominant. Note grazed portions (see below).

Wetland shrubs, mostly willows (*Salix bebbiana* and *S. petiolaris*) and red-osier dogwood (*Cornus stolonifera*).

Wetland disturbance plants, especially reed canary (*Phalaris arundinacea*) and giant ragweed (*Ambrosia trifida*).

Old field.

Upland and lowland wooded areas.

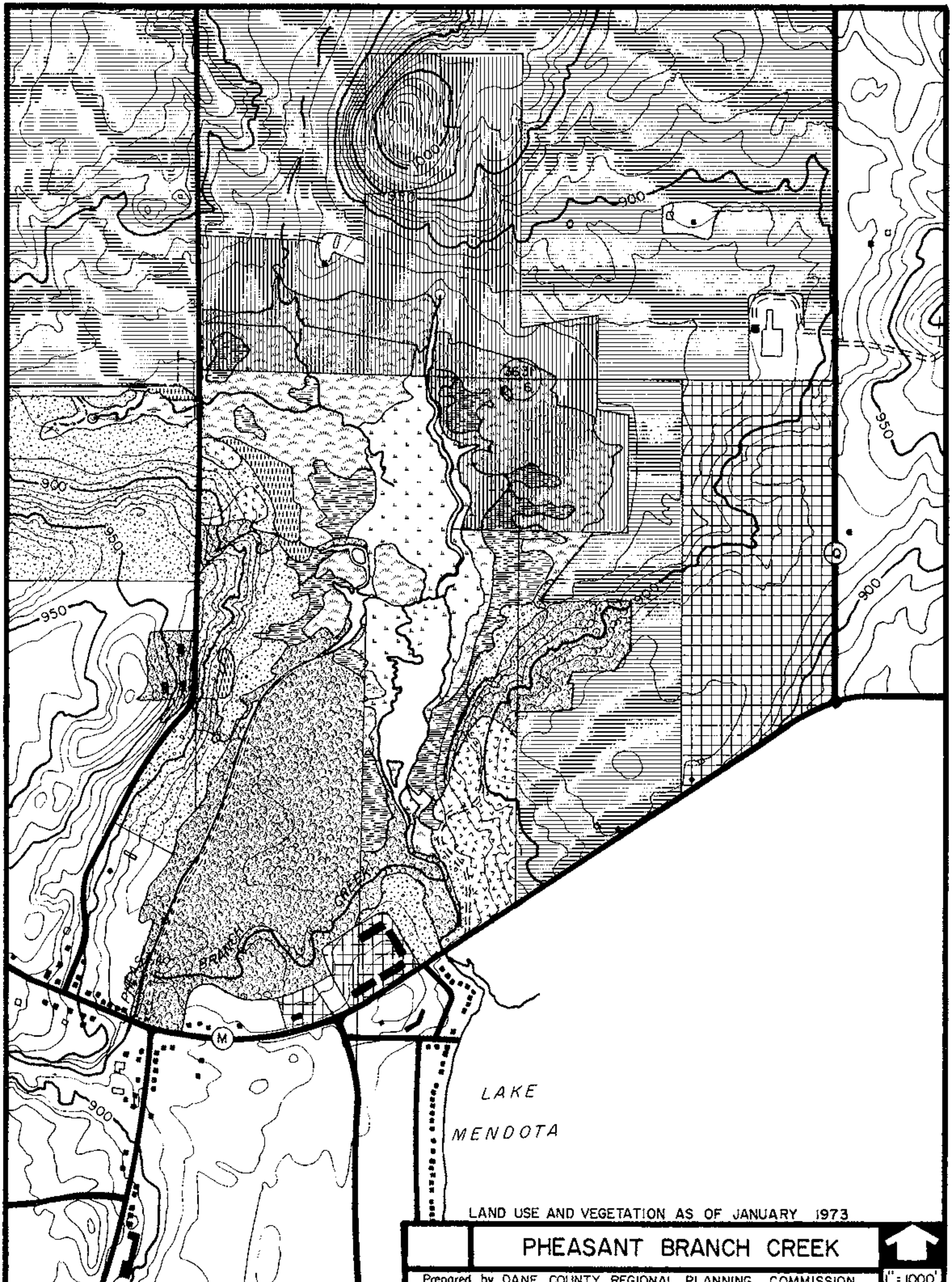
Grazed by cattle.

Cultivated.

Suburban development and construction areas.

Bulldozed (east side) and dump (west side) areas.

Spring.



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PHEASANT
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MENDOTA
LAND USE AND VEGETATION AS OF JANUARY 1973
PHEASANT BRANCH CREEK
Prepared by DANE COUNTY REGIONAL PLANNING COMMISSION
1" = 1000'

PHEASANT BRANCH MARSH

MANAGEMENT SUGGESTIONS

MAP KEY

Known winter wildlife use area.

Present extent of wildlife and natural vegetation area.

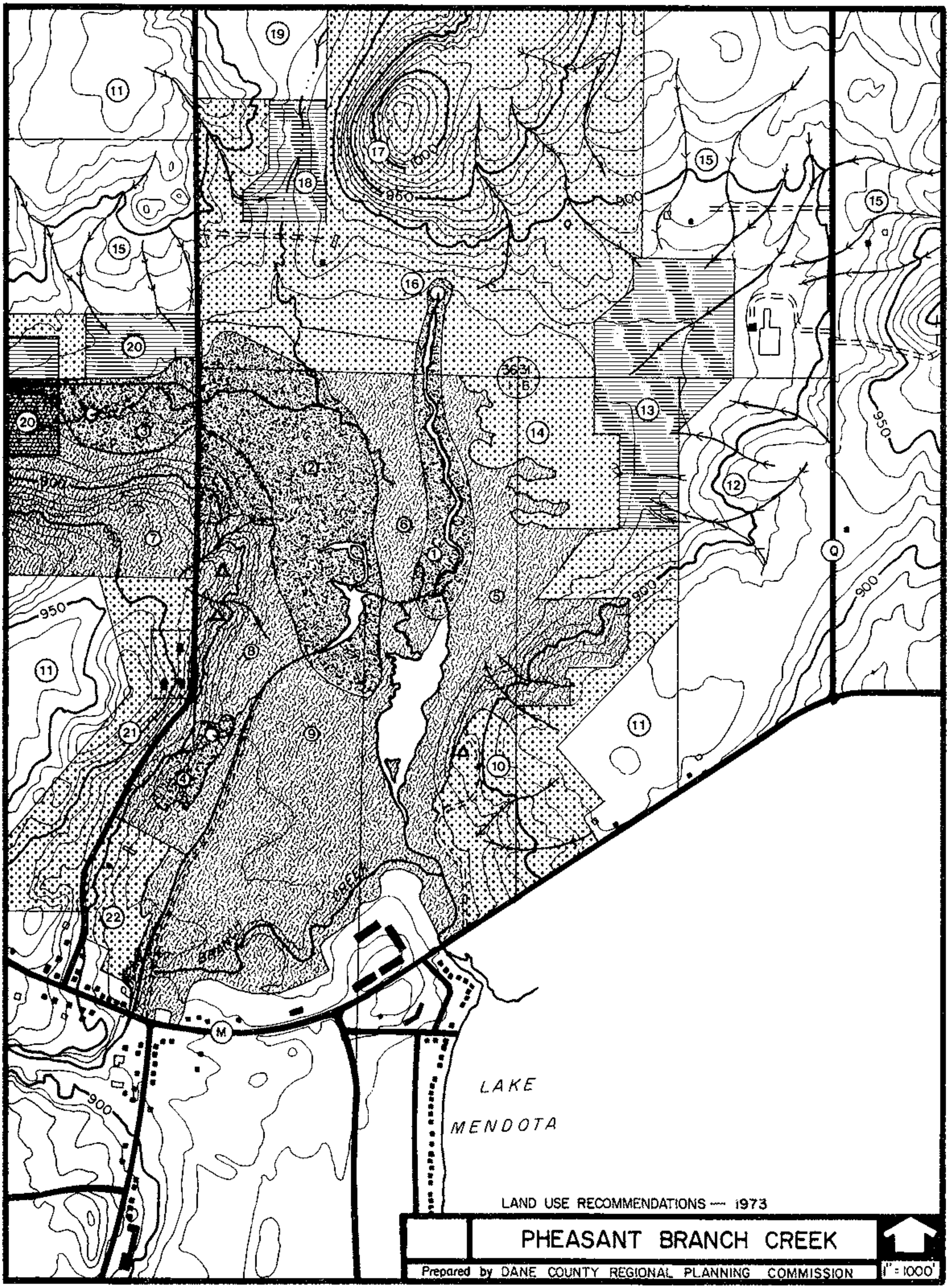
Buffer zone, additional to above.

Water collection and control area.

Limited development area.

Some patterns of surface flow toward marsh.

△ Wildlife and scenic observation point.


LAKE
MENDOTA
LAND USE RECOMMENDATIONS — 1973
PHEASANT BRANCH CREEK
Prepared by DANE COUNTY REGIONAL PLANNING COMMISSION
1" = 1000'

PHEASANT BRANCH MARSH
MANAGEMENT SUGGESTIONS

MAP EXPLANATION

Numbers in each category read roughly counterclockwise.

KNOWN WINTER WILDLIFE USE AREAS. These are areas of greatest winter wildlife density, and are considered high priority for purchase for protection and management.

1. Major spring-fed waterway. This remains open in winter, providing a wintering area for ducks numbering from several hundred to several thousand, and is, therefore, a high-priority purchase area.

2. Includes two ponds, one of which is partly open except in very cold weather. The combination of shrubs for cover, a weed patch for seed-eating small birds and mice, and open water makes this a major wildlife use area in winter. The presence of small birds and mice in turn attracts predators, such as hawks, owls, and foxes. This is a high-priority protection area.

3. Includes seepage-spring area, ditch, trees, shrubs, and other vegetative cover. Open water and cover together make this a wildlife use area. The presence of the spring and a major overland waterway entering the marsh also make it a high-priority purchase area.

4. Spring, shrubs, trees, and abandoned apple orchard. The orchard provides food for mammals, as evidenced by deer tracks. Its location close to the lowland woods make access to the orchard and spring easy for mammals. This is a high-priority purchase area for these reasons and because of the need to protect the spring as a water source.

OTHER WILDLIFE AND NATURAL VEGETATION AREAS. These are considered high priority for purchase, protection, and management, and are needed to protect the integrity of the whole marsh system. These areas contain natural vegetation as opposed to cropland, mowed, grazed, or other severely managed vegetation, and therefore support breeding wildlife and serve for the most part as reservoirs of native plant species. The open water is also included here. It receives heavy use as a feeding area by breeding wildlife and, especially, by migrating waterfowl.

5. Includes various types of marsh vegetation in lowland, oak-hickory forest on hill; high-priority purchase area.

6. Center of marsh, includes marsh vegetation in permanently standing water (except possibly during severe drought), areas of open water; high-priority purchase area.

7. High and low old field. This is former cropland, now useful for wildlife food and cover and as a buffer zone to protect the stream area. The northern half is a high-priority purchase area to provide undisturbed space for wildlife using the stream area, and to preserve water quality. The southern or upland half is also strongly recommended as part of the buffer zone. Possible future development should be very low density only, with strict erosion and runoff control.

8. Old field hillside. This long, narrow hill facing the marsh may be the most valuable portion of the upland area for wildlife use and observation. Its protection is essential also to maintaining water and vegetation quality in the lowland next to it (regions 2 and 9). The two triangles represent excellent wildlife and scenic observation locations. If managed to remain old field with scattered groups of shrubs and occasional trees, it will remain very useful, both for wildlife and for human recreation. This is a high-priority purchase area.

9. Lowland forest area, mostly black willow. Although disturbed, this is the only large lowland forest known to us in the Madison area. Its size, closeness to water, and remoteness from human activity make it valuable for wildlife. This is a high-priority purchase area.

BUFFER ZONES FOR FUTURE PLANNING, not now wildlife use areas. These are areas whose control or purchase is necessary to: (1) protect water quality in the marsh; (2) prevent intense human activity close to the wildlife areas; (3) protect scenic values; (4) make possible teaching and recreation areas; and (5) in one area, make possible rehabilitation of already existing marsh vegetation. The future use of these areas may vary from very low density development, such as placement of structures for homes or business, to open parklands. At all times, erosion and runoff control on hillsides should be a prime consideration.

10. Steep hillside close to and facing marsh. The portion of this in section 1, which is the steepest and closest to the marsh-wildlife area, has already been terraced for suburban development. It contains an excellent waterfowl observation point (triangle). This portion is a high-priority purchase area for public use and watershed protection. The portion in section 6 above the 900-foot contour is also recommended for purchase, but if developed, should be low density. There is a portion in section 6 which is below the 900-foot contour, now under cultivation, which should be purchased and added to the wildlife area.

14. Grazed sedge meadow. This is a high-priority purchase area for restoration. It is within the marsh basin, and extends across the northeastern and northern borders of the present wildlife use area (see vegetation map).

16. In addition to protecting sedge meadow south of this point, a buffer area is of high priority to protect this large spring. At present, use by cattle is causing serious erosion near the spring.

17. Steep hill, dry, with some prairie vegetation, possible recharge area for spring. The 16-17 area, lying in parts of sections 36 and 31, is shown as a buffer zone unit. This unit would make an excellent public use and teaching area. At a time when arboretums and public land recreation plans are popular, when city dwellers are casting about for outdoor recreation, and schools are emphasizing outdoor teaching, this area presents a rare opportunity. Upland, suitable for prairie restoration and teaching, hiking, and picnicking, is next to lowland and a spring, also suitable for hiking and teaching (see discussion of land use). Purchase of this area is strongly recommended for these purposes, as well as to enhance and protect the marsh. Meanwhile, negotiations to limit lowland grazing are strongly recommended.

21. Hillside buffer, separated from marsh by road. This area is recommended as an addition to the buffer zone by purchase, but if developed, should be very low density.

22. Partly residential, partly old-field. This is an area which need not be purchased, provided future use can be controlled. Its closeness to water and wildlife areas makes high-density development unsuitable.

WATER CONTROL AREAS. These are locations where deep or shallow basins may be necessary to collect future runoff if development increases it. It may turn out that no construction is necessary; however, purchase and maintenance of these as silt-collection areas is of high priority. They should be planted to dense grass whether shallow basins are constructed or not. In the event deep basins are later needed to collect rapid, heavy runoff and release it slowly, further construction plans can be pursued at these locations. However, control of runoff in development areas should make deep basins unnecessary.

13. Collection area for northeast and east. Note arrows indicating surface runoff patterns.

18. Collection area for north. A large flat basin exists north of region 19, now in use as cropland. The flow direction from this is not known, but it may drain naturally or artificially southward.

20. Two areas for collection from northwest and protection of stream. Note one area straddles the stream. It would be preferable to control the stream edges westward to its source, using native grasses or sedges near the stream, with erosion and runoff control on nearby slopes. A water collection area in the stream valley may be necessary, however.

LIMITED DEVELOPMENT AREAS. These are areas not explicitly needed as buffer zones, but which will have an influence on the marsh area. Low density development with control of erosion and runoff is the most intense suggested use. Open farmland would be preferable, with control of fertilizer runoff.

11. Hilltops (3 areas). The southeast, northwest, and southwest each have a hilltop area which could support low to moderate density development away from the marsh. Variable runoff problems exist; good planning is necessary.

12. Already developed. The northern half of this area is already causing runoff and scenic problems. The runoff affects a farmer's field (13), and will probably be piped into the sedge meadow (14), where it will continue to cause problems. Note the field in question is an area recommended as high priority for water collection. A slight backward slope will probably be necessary to avoid erosion within the collection area.

15. Slopes (3 areas). On the northeast and northwest are areas sloping directly toward the marsh where very low density to low density development is the <u>most</u> intensive use recommended. Water control should be strict.

19. Valley leading southward toward marsh. Low to moderate density development is the <u>most</u> intensive recommended, with strict water control to protect the stream feeding the marsh.

SIXMILE CREEK

Yahara River Valley Region
Priority Group II
Wetland Description

Sixmile Creek is one of the major stream systems supplying water to Lake Mendota. It drains low glaciated topography, including some wetland areas. Waunakee Marsh, discussed elsewhere in this report, is an especially important wetland in this system. Sixmile Creek itself is meandering, with wetland borders in many places. The landscape at the time of settlement was almost certainly open, with dry prairie on the uplands, wet prairie on the lowlands grading into sedge meadows along the creek edge. In some places there were probably shallow and deep marshes. Remnants of this native wetland vegetation are now scattered among larger regions of disturbance vegetation. Typical native streambank plants include glade mallow (*Napaea dioica*) and cup plant (*Silphium perfoliatum*). Much of the disturbance vegetation is reed canary grass (*Phalaris arundinacea*).

The upper portion of the creek, north of County Highway "M", still has areas of sedge meadow behind built-up stream banks. Much of this is grazed, but probably still functions as an important buffer zone protecting the stream and allowing a place for flood waters to spread out. South of Highway "M" the silt deposition is heavy. Bur reed (*Sparganium eurycarpum*), a silt indicator, is dominant here. In this region, there are disturbed remnants of sedge meadow, shallow marsh, and deep marsh. Near the mouth of the creek, along the edge of Lake Mendota, is sedge meadow with invading shrubs.

The condition of the creek itself reflects the load which has been placed on it by heavy agricultural and some urban land use in the area. The water is turbid with suspended silt, from the action of carp disturbing the bottom. Silt deposits are thick, up to two feet deep in places along the stream and several feet deep in the bay at its mouth. Stream banks are raw and unvegetated, cut by frequent floods. Debris of all kinds may be found in the stream, on the bottom, and on the banks, also attesting to the force of floods. Ditching upstream has increased the rate of runoff and erosion. The natural ability of the stream to hold and slowly release flood waters has been further decreased by land use along its banks. Heavy grazing has not only resulted in the loss of native vegetation, but in destabilization of the stream banks and fertilization of the water. Algal blooms and abundant attached algae indicate highly fertile water, from agriculture and from a cheese factory in Waunakee. The diversity of submerged aquatic plants is low. The areas sampled contained coontail (*Ceratophyllum demersum*) and water milfoil (*Myriophyllum* sp.) almost exclusively.

Although wildlife use of the creek system has undoubtedly declined, it is still important. Northern pike make an extensive run up the creek (Harold Meier, pers. comm.). Earl Loyster (pers. comm.) notes that they spawn in Waunakee Marsh. Waterfowl use is important during migration, especially at the confluence of Spring and Sixmile Creeks. Marsh birds are still present. The DNF lists fifteen species of fish for Sixmile Creek. Don Samuelsen has added 23 more by seining, making a total of 38. This list includes some important game species, e.g., northern pike, walleye, crappie, and largemouth bass.

Threats and Management

The Sixmile Creek area is in the path of suburban development. Unless careful planning is adhered to, this more intensive land use will result from a move that was intended to decrease the load on the Madison lakes and their associated watershed. The Waunakee area is now included in the Madison Metropolitan Sewerage System, which will decrease the nutrient load on Sixmile Creek and Lake Mendota. However, it could open this area up to increased development. The loss of this needed agricultural land would not result in the improvement of Sixmile Creek, because an increase in building and pavement coverage would increase overland runoff rates even further. Lawn fertilizers would be washed into the creek system, keeping it fertile. Population pressure would cause the loss of open space along the creek, with an attendant loss of wildlife use. Often under such circumstances, fill, pavement, buildings, and lawns extend right to the water's edge. Thus, Sixmile Creek, along with Spring Creek and the Upper Yahara River, urgently needs to be designated as a no-construction zone.

At the south end of Sixmile Creek, just north of its junction with Spring Creek, is a large region, perhaps as much as 80 acres, of shallow marsh and sedge meadow. Much of it is in a nearly undisturbed condition, so it still functions for flood control, for silt and nutrient control, as a wildlife area, and as open space. Most of it lies in a parcel of land which is at present offered for sale for development. There is no way intensive development can occur here without eliminating the above mentioned values and endangering the integrity of the creek system. Zoning is needed here, with a provision for graded density development. Filling of the marsh must be prevented.

Although Sixmile Creek is degraded, it is by no means beyond rehabilitation. Waterways and natural communities tend to repair themselves if the load is taken off of them. In this case, the enhancement of Sixmile Creek would bring a further benefit, a needed improvement in the water quality of Lake Mendota.

It is important to approach planning for an area under stress not by a delaying action, but by the establishment of positive goals. Our major recommendations are, therefore: (1) to control the human population density in the area, to protect both agricultural land and the watershed; and (2) to lessen the impact of agricultural activities on the watershed by instituting conservation practices. It is important to establish a buffer zone along the creek to slow runoff of water, soil, and fertilizer into it and to remove the impact of heavy stream bank grazing. The natural meanders must be protected, because they are crucial for slowing floods, especially since other land use practices at present tend to worsen flooding. Water should be held on the land as close as possible to where it fell as rain. Ditching should be stopped, and former wet areas restored. This means relinquishing some land to holding water after rainstorms rather than growing crops, but if the water is shunted quickly off the land, erosion of valuable soil increases and flood problems are merely compounded downstream. Water that runs off quickly is not available for seasonally restoring the water table. A further benefit of these protective programs should be the gradual re-establishment of natural diversity and improvement of wildlife use along the creek system.

PRELIMINARY LIST OF FISH SPECIES COLLECTED FROM SIXMILE CREEK

(Collections made by Don Samuelson and Barbara Bedford)

Amia calvai, Bowfin
Campostoma anomalum, Stoneroller
Catostomus commersoni (Lacepede), White sucker
Chrosomus erythrogaster (Rafinesque), Southern red-bellied dace
Cottus bairdii, Mottled sculpin
Cyprinus carpio L., Carp
Esox lucius L., Northern pike
Etheostoma exile (Girard), Iowa darter
Etheostoma flabellare, Fantail darter
Etheostoma nigrum (Raf.), Johnny darter
Eucalia inconstans (Kirtland), Brook stickleback
Fundulus diaphanus (Lesueur), Banded killifish
Ictalurus melas (Raf.), Black bullhead
Ictalurus natalis (Lesueur), Yellow bullhead
Ictalurus nebulosus (Lesueur), Brown bullhead
Labidesthes sicculus (Cope), Brook silverside
Lepisosteus osseus L., Long-nosed gar
Lepomis cyanellus (Raf.), Green sunfish
Lepomis gibbosus L., Pumpkinseed
Lepomis macrochirus (Raf.), Bluegill
Micropterus salmoides (Lacepede), Largemouth bass
Notemigonus crysoleucas (Mitchill), Golden shiner
Notropis atherinoides (Raf.), Emerald shiner
Notropis cornutus (Mitchill), Common shiner
Notropis hudsonius (Clinton), Spottail shiner
Noturus gyrinus (Mitchill), Tadpole madtom
Perca flavescens (Mitchill), Yellow perch
Percina caprodes (Raf.), Logperch
Percina maculata (Girard), Blackside darter
Pimephales notatus (Raf.), Bluntnose minnow
Pimephales promelas (Raf.), Fathead minnow
pomoxis annularis (Raf.), White crappie
Pomoxis nigromaculatus (Lesueur), Black crappie
Rhynicthys atuatulus, Blacknose dace
Semotilus margarita, Pearl dace
Stizostedion vitreum vitreum (Mitchill), Walleye
Umbra limi (Kirtland), Central mudminnow

Spring Creek already shows the effects of the silt and nutrient loads from the farms in the watershed. Much of this may come from the tributaries at the west end of the creek, where there is little buffering wetland vegetation, and cultivated areas are close to the water courses. To protect the creek and Lake Mendota as well, it is important to establish buffer zones here. Grass strips and perhaps small holding ponds would be helpful. The present practice of hurrying the water off the farmlands creates floods and other problems downstream.

In the event that this region does become heavily developed, it would be extremely important to have Spring Creek preserved intact. Its functions would then be flood control, wildlife area, and open space.

WAUNAKEE MARSH

Yahara River Valley Region

Priority Group II

Wetland Description

Waunakee Marsh is the largest and most important remaining wetland in the Sixmile Creek watershed. Its 1,043 acres of shallow marsh and sedge meadow buffer the creek and Lake Mendota against the effects of a highly agricultural watershed which has undergone extensive wetland drainage.

A major source of water for the marsh appears to be ground water seepage from the many springs all around the edge and from upwellings within the marsh itself. However, a large amount of surface water runoff, high in silt and nutrients, enters the marsh from surrounding croplands and drained, cultivated wetlands to the north. Cattle, which graze almost the entire southern edge, add more nutrients to the water. Yet, observations indicate that the quality of water leaving Waunakee Marsh is clearly better than that entering the marsh overland. For a discussion of the effects of the marsh on water quality, see pages 27-29.

Waunakee Marsh also acts as an important flood control device. In a watershed so extensively ditched as that of Sixmile Creek, water runs off the land at a rate too fast for the stream valley to handle in times of heavy rainfall. Flooding and bank erosion result, as observations downstream will verify. Without the marsh to slow and spread out some of the water, conditions downstream would be even worse.

The vegetation of Waunakee Marsh presents an interesting picture. Dominant plants are those of the shallow cattail marsh and sedge meadow. Yet it is not uncommon, when walking through the marsh, to slip suddenly through the plant roots and peat into water more than chest deep. Technically then, the water depth is that of the deep marsh. The plants apparently are floating on great chunks of peat over the water. The origins of this situation are not known, but a number of explanations are possible. It is conceivable that in an extremely dry period oxidation and subsequent subsidence of the peat occurred to the extent that when re-flooded, the peat did not entirely re-wet and floated up to the surface. Alternatively, the floating peat may be a remnant bog mat from a colder time. However, long-time residents of the area say that at one time they could cross the marsh in "low boots" and claim that the water level has been slowly rising since the Wisconsin River was dammed at Prairie du Sac (1914). The prevalence of sedge meadow plants and air photos which show the meanderings of an old stream through the marsh certainly suggest that water levels were much lower in the past. Further research is needed to answer the question.

Its large size and the presence of springs enhance the wildlife value of Waunakee Marsh. The size of the marsh permits species diversity and enough territory for the larger avian predators. Six springs and numerous seeps provide a year-round supply of clean water and wintering areas for waterfowl.

Although the low ratio of open water to vegetative cover precludes large numbers of nesting marsh birds and waterfowl, mallards and blue-winged teal breed here in moderate numbers. The more numerous species are those of the sedge meadow, shrub areas, and wetland edge: American bitterns, woodcock, short-billed marsh wrens, bobolinks, willow flycatchers, sora rails, and Virginia rails. Harriers, birds not often seen in Dane County, also nest here. Great horned owls and red-tailed hawks feed in the marsh and nest in adjacent woods. Sandhill cranes were observed in the area in August of 1972 and October of 1973.

Game species and fur-bearing animals which use Waunakee Marsh include deer, pheasant, muskrat, mink, and fox. Northern pike use the marsh as a spawning ground.

The Department of Natural Resources owns and manages 296.8 acres of Waunakee Marsh for fish and game.

Threats and Management

Poor land-use practices in the watershed and the draining of large areas of wetland north of Waunakee Marsh have overtaxed its filtering functions and portend further deterioration. An immediate management goal should be the development and implementation of an erosion control program to maintain soil and nutrients on the upland. Ideally, such a program would involve maximum use of conservation tillage practices: no tillage, minimum tillage, or mulch tillage. However, the following standard conservation practices are also effective in minimizing soil loss, especially when used in combination: (a) contour plowing; (b) planting cover crops in winter; (c) planting forage crops on slopes; (d) terracing; (e) contour strip crops, (f) crop rotations; (g) grassed waterways; (h) buffer strips of native vegetation around waterways; (i) streambank fencing; and (j) gravelled cattle crossings on streams.

In lieu of good upland management, the construction of settling basins may be necessary in crucial areas. Appropriate locations for water-control areas are suggested on the map (areas 15-19). These should be given high priority for acquisition.

Flooding has been mentioned as a management technique to open up more areas for waterfowl nesting. It is our concern that were flooding attempted, all that would result would be a further floating up of the peat. It would be advisable to experiment with raising water levels to restore deep-water marshes in smaller or lower priority areas before working with a wetland as large and valuable as Waunakee Marsh.

Addendum

In 1974, the wetland complex north and upstream of Waunakee Marsh was drained in such a way as to partially bypass the marsh. This is expected to result in an increased nutrient load on Lake Mendota (Gjestson, pers. comm.).

WAUNAKEE MARSH

MAP KEY

Shallow marsh, most of which seems to be floating (see discussion). Cattail is dominant. Also present are sawgrass sedge (*Carex lacustris*), *Carex aquatilis*, soft-stem bulrush (*Scirpus validus*), tussock sedge, tufted loosestrife (*Lysimachia thyrsiflora*), marsh dock (*Rumex orbiculatus*), and others. Variations are due primarily to greater or lesser presence of cattail. Occasional sedge or sedge-forb areas have no cattail. There is a strip of sedge meadow around the edges which is too narrow to indicate.

Area of heavy siltation. This shallow marsh has plant species characteristic of silt flow, especially bur reed and jewelweed. There is some cattail and arrowhead, with many muskrat houses.

Mixed wetland vegetation, mostly tussock sedge with sparse to medium cattail density, and scattered forbs.

Sedge meadow, mostly tussock sedge with sawgrass sedge, bluejoint grass, and sedge meadow forbs such as marsh milkweed (*Asclepias incarnata*), marsh thistle (*Cirsium muticum*), and marsh lousewort (*Pedicularis lanceolata*).

Grazed lowland, some native sedges but mostly European grasses on wet muck.

Marsh edge disturbance species. Basically this is a sedge meadow with invading European grasses, briar bushes (*Rubus* spp.), and tall forbs such as nettle, greater ragweed (*Ambrosia trifida*), saw-toothed sunflower (*Helianthus grosseserratus*), blue vervain (*Verbena hastata*), bull thistle (*Cirsium vulgare*), and Canada thistle (*Cirsium arvense*).

Shrubs, mostly willows (*Salix discolor*, *S. bebbii*, *S. petiolaris*, *S. interior*, *S. nigra*) and red-osier dogwood (*Cornus stolonifera*). Some meadowsweet (*Spiraea alba*), gray dogwood, and bog birch (*Betula* sp. [*sandbergii?*]).

Very disturbed or once cultivated sedge meadow. Reed canary grass is dominant, with marsh nettle, giant ragweed, saw-toothed sunflower, and scattered remnant wetland plants.

Old field.

Grazed old field.

Open woods. Note grazed areas.

Wooded areas. The young upland woods contain mainly white, black, and bur oaks (*Quercus alba*, *Q. velutina*, *Q. macrocarpa*), black cherry (*Prunus serotina*), and shagbark hickory (*Carya ovata*).

Spring.

General pattern of water flow within the marsh.

Drainage ditch or channeled stream.

All other land is under cultivation.

WAUNAKEE MARSH

MAP EXPLANATION

1) Row of black willow (Salix nigra) and quaking aspen, (Populus tremuloides) along an old drainage ditch.

2) Grazed sedge meadow and spring area. This is an entry point for farm runoff from the west and itself a nutrient source (in the form of animal wastes) for the marsh. The small area to the east shows disturbance due to increased silt load.

3) Small open water area surrounded by shrubs with sandbar willow (Salix interior), tussock sedge (Carex stricta), bluejoint grass (Calamagrostis canadensis), reed canary grass (Phalaris arundinacea), bur reed (Sparganium eurycarpum), and box elder (Acer negundo).

4) Large spring area, wintering area for waterfowl. The spring contains an unidentified lavender bacterium or alga. The area has received silt from the upland. Twelve carp were observed in the area on July 8, 1973.

5) Sedge meadow, grazed occasionally in dry years, but in good condition with scattered fen plants. Tussock sedge is dominant. Other species include the sedges Carex sartwellii, C. prairea, C. aquatilis, C. sterilis, and C. tetanica, as well as bog goldenrod (Solidago uliginosa), sage willow (Salix candida), cottongrass (Eriophorum angustifolium), marsh lousewort (Pedicularis canadensis), turtlehead (Chelone glabra), and four-flowered loosestrife (Lysimachia quadriflora).

6) Sedge meadow and shrub island.

7) A small area of clone-forming Carex aquatilis and a floating mat of Carex lacustris with scattered Carex lasiocarpa, the wiregrass sedge. This second area bounces just like a bog mat.

8) Small wooded island. The soil is oxidized peat and is never more than two feet above water level. The trees are mostly quaking aspen, some young oaks (Quercus spp.), box elder, with open forest shrubs such as gray dogwood (Cornus racemosa), red raspberry (Rubus idaeus), and American hazelnut (Corylus americana). A small bluejoint grass meadow is on the north side. Some low prairie plants, such as prairie dock (Silphium terebinthinaceum), are around the edge of the island.

9) This area disturbed near the road edge. There are patches of giant reed grass (Phragmites communis), and also some nettles (Urtica dioica), reed canary grass, bur reed, and tall composites. The water is about four inches deep.

10) Sedge and bluejoint meadow. Very tall tussocks (to two feet) of *Carex stricta* are largely taken over by bluejoint grass.

11) Sedge meadow along creek, which was grazed until 15 years ago, according to the landowner. Bluejoint grass and composites, especially Joe-Pye-weed (*Eupatorium maculatum*), are dominant.

12) Cattail sedge meadow, water to four inches deep. The meadow has received silt from adjacent cornfields. There is a higher presence of bur reed, bur marigold (*Bidens cernua*), and jewelweed (*Impatiens biflora*) than in other similar areas.

13) This once-cultivated sedge meadow is not so dominated by reed canary grass as is the large area north of the road. Rather, it is coming into a mixture of European grasses, weeds, and native wetland plants.

Sources of Overland Runoff and Proposed Water-Control Areas

14) Confluence of two large drainage ditch networks draining former wetlands to the north and northwest and emptying into Waunakee Marsh. A delta of siltation on the map indicates the area of most severe disturbance, where the silt deposit is several feet deep. A water control area here is recommended.

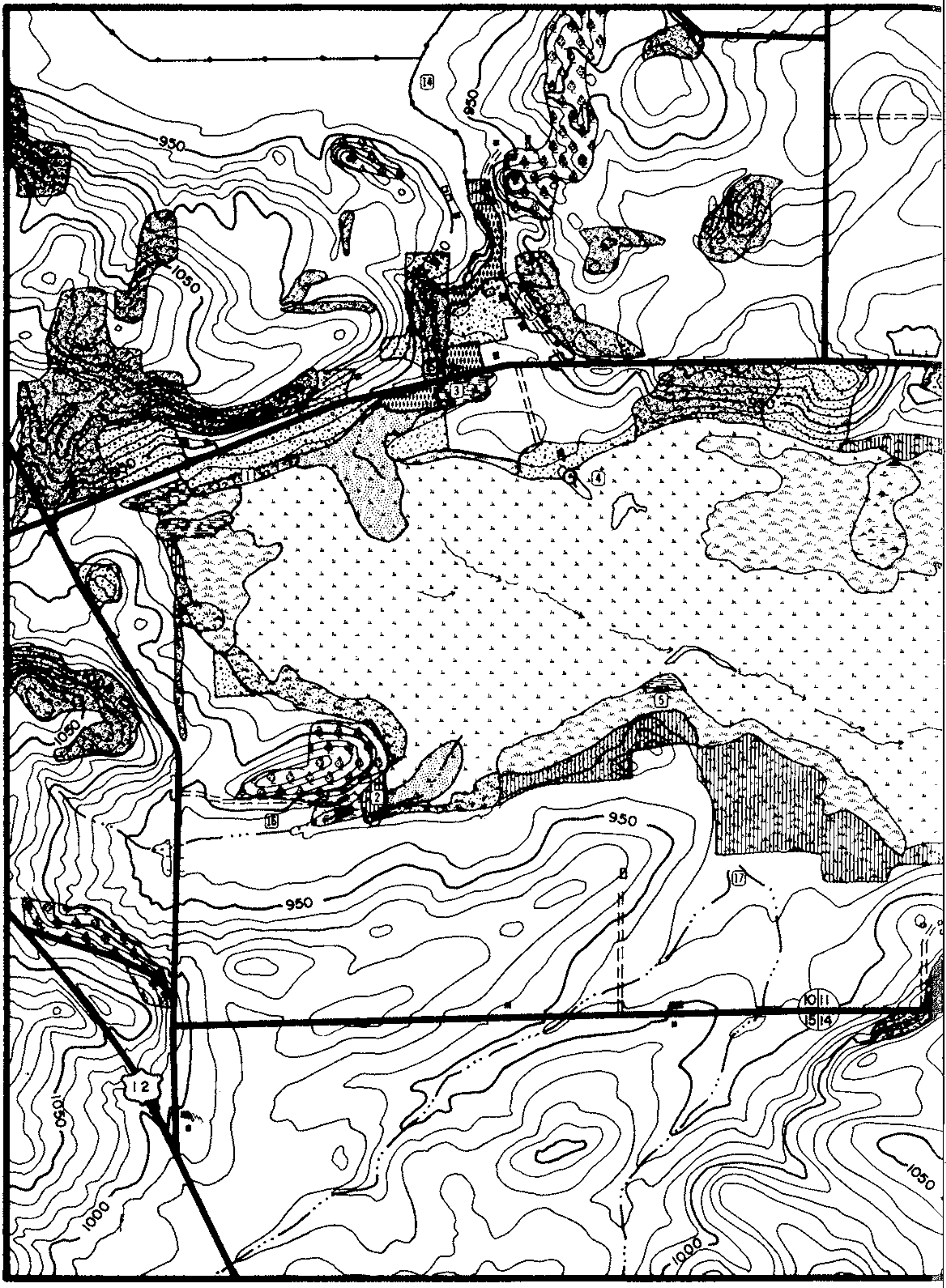
15) Old field, possible last resort for a ponding and silt-catching area.

16) Proposed water-control area. This drainageway, often too wet to cultivate, could serve to trap silt and nutrients from farmland to the west.

17) An intermittent stream feeding through cornfields into a grazed sedge meadow and then into the marsh. A water control area is recommended here.

18) Ditch carrying silty green-brown water into marsh. Cattle graze in the stream north of the road. An old field and disturbed sedge meadow area is on a slight ridge extending out into the marsh. This could serve as a water-control area.

19) Large area of ditched sedge meadow. Reed canary grass is dominant with scattered native wetland vegetation in wetter areas. The creek here still follows its natural meanders and its bank edges are still gradual. A suggested method of water control for this area might be to eliminate the ditches, thus forcing the water to spread out through the vegetation in order to filter out some of its nutrient and silt load.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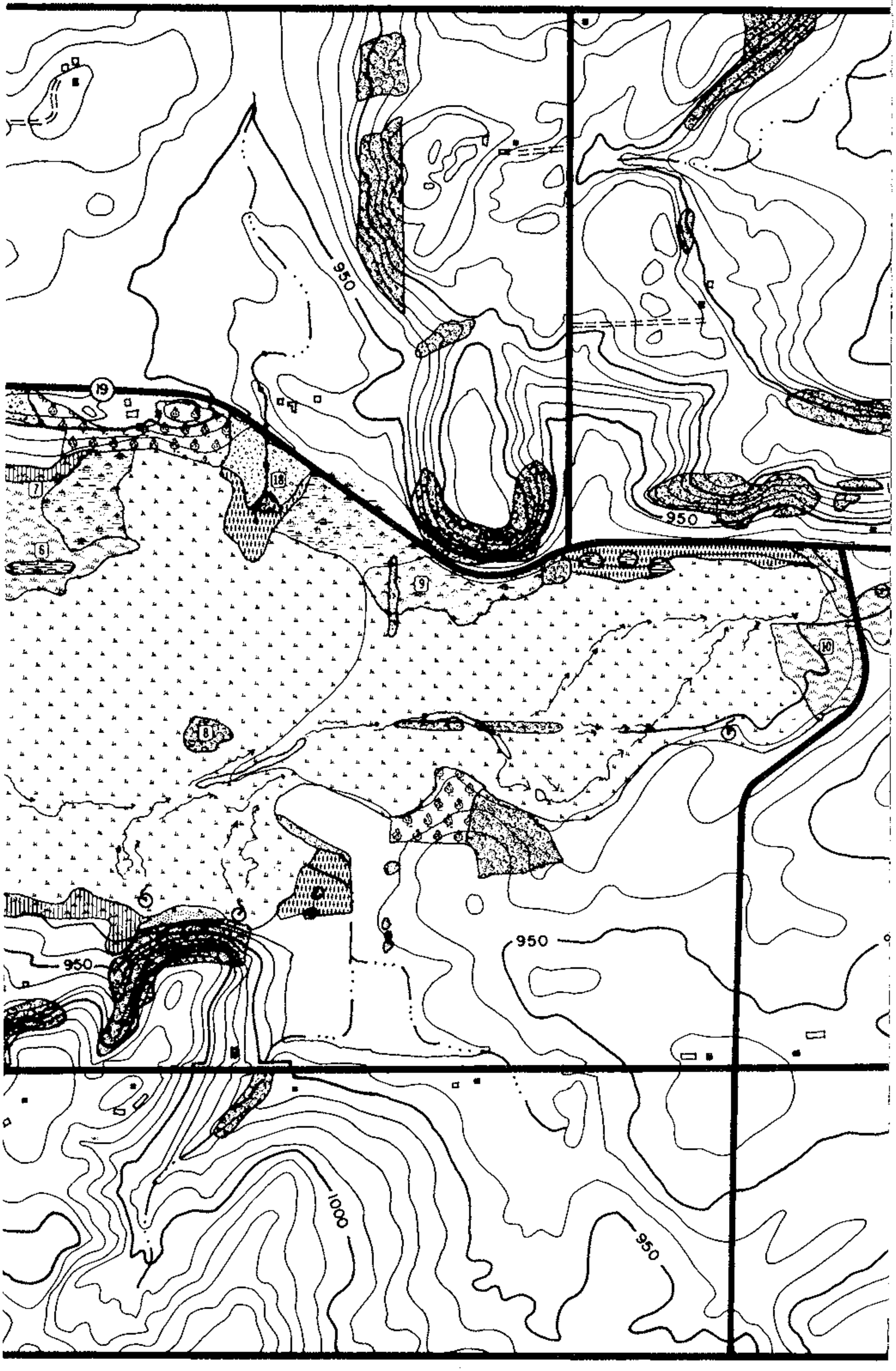

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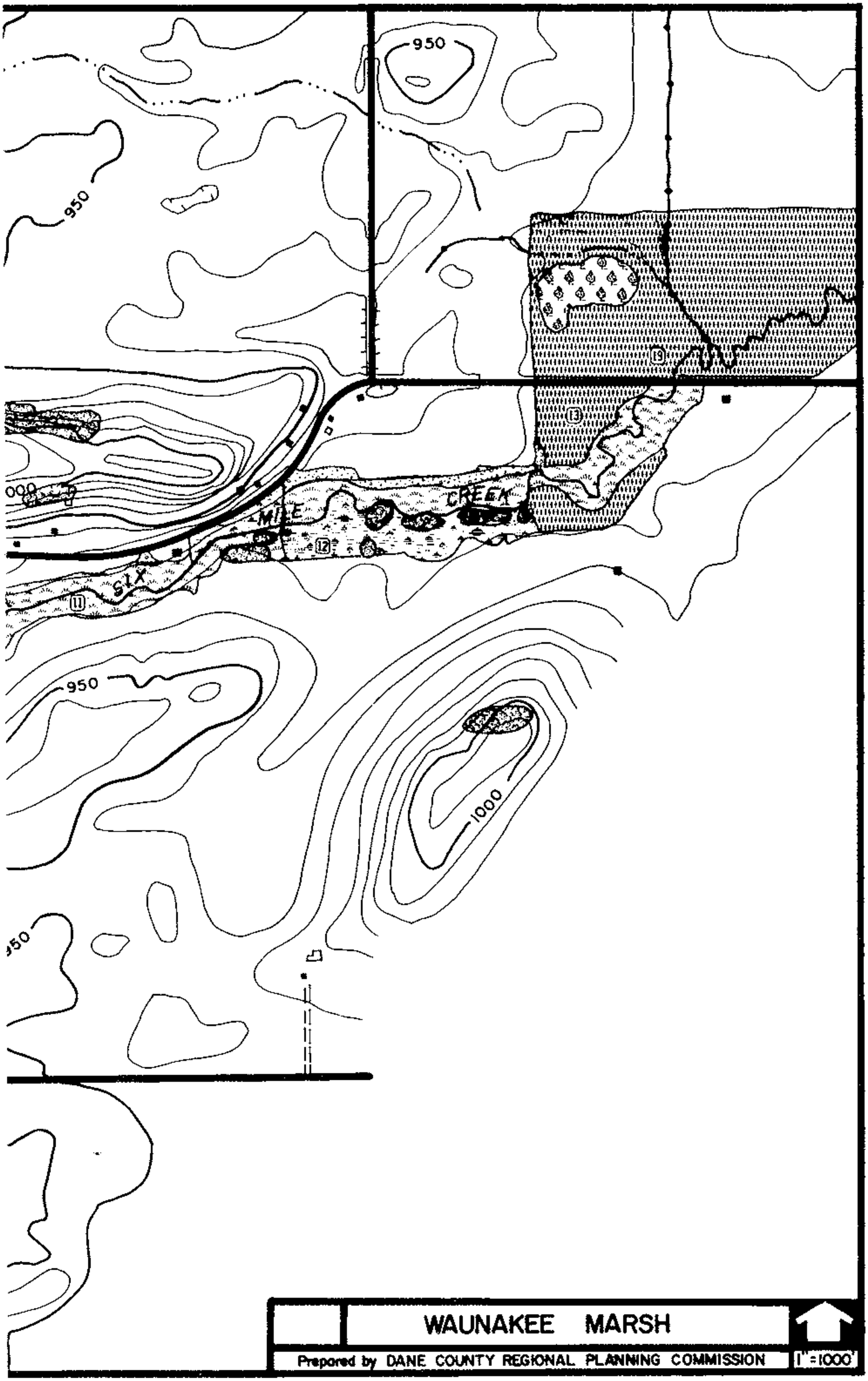

WAUNAKEE MARSH

Prepared by DANE COUNTY REGIONAL PLANNING COMMISSION

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