GOODHUE COUNTY ENVIRONMENTAL CONSTRAINTS LAND USE EVALUATION (ECLUE) MODEL

June 2009

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Executive Summary

As a Twin Cities collar county, Goodhue County is experiencing increasing development pressures. The county sits astride Lake Pepin to the east and the Hwy 52 corridor to the west – a desirable target for new development due to its proximity to Minneapolis-St. Paul and Rochester as well as to the "rural" qualities still present in the county. This pressure for urban growth combined with a steady interest by a segment of the population seeking to enjoy "rural living" has placed new pressures for change on the rural landscape. Goodhue County is currently undertaking a five-year evaluation of the Goodhue County Comprehensive Plan to ascertain progress in implementing the 2004 Plan Update and to consider new directions or new tools and methods necessary to best manage growth and change during the coming years.

Recognizing the unique situation of Goodhue County—situated between the expanding urban centers while retaining its agricultural heritage and rural character—County decision-makers have shown increasing concern about protecting the environment. They have the challenge *and* opportunity of managing growth and change and doing so in a manner appropriate for Goodhue County's environmentally sensitive and aesthetically beautiful landscape.

The Goodhue County Environmental Constraints Land Use Evaluation (ECLUE) Model was created to help support decision makers in this challenging work by providing easier access to information about environmental and other characteristics of Goodhue County. The land use model project was funded through a grant from the Minnesota Department of Natural Resources and was conducted by Goodhue County and 1000 Friends of Minnesota, a non-profit organization.

While land use models do not make decisions, a well-designed model can help support making *better* decisions by making appropriate information

clear and accessible. The results from the Goodhue County land use model highlight areas containing high quality natural resources, other potential resources, and those governed by zoning ordinances – all landscape features that are key considerations in making land use decisions.

Land use suitability models are a powerful means to illustrate and clarify what is occurring in the landscape, and so have been employed by planners, government staff and decision makers for many years. The model was developed in a cooperative manner with guidance and advice from a broad group including state, county and local government representatives, non-profit, environmental and other partners.

The model was created by combining geographic datasets that represent existing conditions or characteristics of Goodhue County, such as elevation, locations of lakes, streams and wetlands. The ECLUE Model developed for this project is a Geographic Information Systems (GIS) model that takes many sets of data representing geographic features in Goodhue County and then combines them. The model assigns a numerical value to each dataset based on its characteristics. These sets of information, or data layers, combined in a GIS model create an overall picture of natural resources and other characteristics in Goodhue County.

The data layers that comprise the final ECLUE Model are: high quality ecological areas; riparian habitat; bluff land; water features (rivers and lakes); streams; wetlands; sinkholes; sensitivity to groundwater pollution; geologic edges; steep slope & hydric soils; the Cannon River Wild & Scenic area; shoreland areas (around protected water features); floodplain areas; areas around bluff land; registered feedlots; aggregate resources; registered mining locations; prime agricultural soils; potential green corridor connectors; wind power potential; and publically-owned land.

To provide a clear understanding of the model results, the datasets were grouped into 3 categories or submodels: 1) Natural Resources; 2) Regulatory Factors; and 3) Additional Considerations. By doing this, the results of each submodel could be examined and interpreted more easily. For example, to ascertain where high value ecological areas are in Goodhue County, the natural resource model results are viewed. To learn where selected regulations apply, the regulatory submodel results can be viewed. Other factors that are important to land use decision can be determined from the Additional Considerations submodel results.

Together the submodels can be viewed as a total results layer. While data-dense, this layer could be used at either county or local level as an indicator for how many factors a land use decision could impact by and therefore could become a guide as to factors to be considered.

Each layer has an individual score, and when the layers are combined in the submodels, each submodel has a results layer and total score. The results of each submodel are then combined together into the overall results. The overall results layer has a total score made up of each combined submodel. The grouping of the datasets into submodels is provided in the figure below.

Submodels and data layers

Natural Resources	Regulatory	Additional Considerations
1. High Quality Ecological Areas	1. Steep Slope & Hydric Soils	1. Aggregate Resources
2. Riparian Habitat	2. Cannon River Wild & Scenic Area	2. Registered Mining Locations
3. Bluff Land	3. Shoreland Areas (around protected water features)	3. Prime Agricultural Soils
4. rivers and lakes	4. Floodplain Areas	4. Potential Green Corridors
5. Streams	5. Areas Around Bluff Land	5. Wind Power Potential
6. Wetlands	6. Registered Feedlots	6. Publically-owned Land
7. Sinkholes		
8. Sensitivity to Groundwater Pollution		
9. Geologic Edges		

The land use model results from this project will enable Goodhue County to evaluate their landscape and identify areas of rich ecological value vital to realizing the county's stated goal of natural resource preservation. Specifically, the model results could help inform and support decisions in Goodhue County in a number of ways including the revision of the comprehensive plan, evaluating county land use policies refining growth boundaries to consider significant natural resources and to evaluate land use at a sub parcel scale

Many landscape features can be impacted by a land use change. The Goodhue land use model offers an efficient and effective way to view and evaluate those landscape features. By providing a more complete picture, the land use model can help support the best outcome for critical choices that balance growth and change with preservation of rural character and natural resources in Goodhue County.

1.0 Introduction

As a Twin Cities collar county, Goodhue County is experiencing increasing development pressures. Recently the City of Red Wing, the largest city in the county, reported that their housing development is outpacing actual population growth by nearly 30 percent. The county sits astride Lake Pepin to the east and the Hwy 52 corridor to the west – a desirable target for new development due to its proximity to Minneapolis-St. Paul and Rochester as well as to the "rural" qualities still present in the county. This pressure for urban growth combined with a steady interest by a segment of the population seeking to enjoy "rural living" has placed new pressures for change on the rural landscape. Goodhue County is currently undertaking a five-year evaluation of the Goodhue County Comprehensive Plan to ascertain progress in implementing the 2004 Plan Update and to consider new directions or new tools and methods necessary to best manage growth and change during the coming years.

Recognizing the unique situation of Goodhue County—situated between the expanding urban centers while retaining its agricultural heritage and rural character—County decision-makers have shown increasing concern about protecting the environment. They have the challenge *and* opportunity of managing growth and change and doing so in a manner appropriate for Goodhue County's environmentally sensitive and aesthetically beautiful landscape.

1.1 Model Overview

The Goodhue County Environmental Constraints Land Use Evaluation (ECLUE) Model described in this report is intended to support decision makers in this challenging work by providing easier access to information about environmental and other characteristics of Goodhue County.

Land use models do not make decisions, but a well-designed model can help support making *better* decisions because appropriate information is available in a form that is more accessible and clear.

The land use model's primary intent is to highlight the best natural resources in Goodhue County; however, natural resources often must be considered by decision makers alongside other important factors in land use decisions such as zoning ordinances and other landscape features.

The model was created by combining geographic datasets that represent existing conditions or characteristics of Goodhue County, such as elevation, locations of lakes, streams and wetlands. These sets of information, or data layers, were combined in a Geographic Information Systems (GIS) model to create an overall picture of natural resources and other characteristics in Goodhue County.

The land use model results from this project will enable Goodhue County to evaluate their landscape and identify areas of rich ecological value vital to realizing the county's stated goal of natural resource preservation. Specifically, the model results could help inform and support decisions in Goodhue County in a number of ways including the revision of the comprehensive plan, evaluating county land use policies and refining growth boundaries around cities where significant natural resources have not been considered. In addition to these large scale uses, the model results could also be used at a smaller scale by local units of government to inform their land use decisions by providing an effective means of evaluating landscape characteristics at the municipality or parcel level scale.

The use of an analytical model provides an objective evaluation of current on-the-ground conditions and assists in understanding complex relationships of land features that may be impacted by land use change. An evaluation of this type can provide evidence of potential land use conflicts and may prove

valuable to support requests for additional assistance from conservation or development agencies and organizations.

1.2 Project Description

Goodhue County received a grant from the Minnesota Department of Natural Resources in May 2008. This grant was used to develop an Environmental Constraints Land Use Evaluation (ECLUE) Model for Goodhue County. To complete this project, Goodhue County partnered with 1000 Friends of Minnesota, a non-profit organization, who developed and delivered the technical model in collaboration with the County.

1.3 Document Organization

This report is organized into six sections, the first of which is this introductory section. The second section explains how the model was constructed. It describes the collaborative process of the model design as well as the technical approach to making that design into a GIS model. A complete description of all the model components and rationale for including them is provided in Section 3. Section 4 provides an overview of the model results and Section 5 explains anticipated uses of this model by Goodhue County and finally, Section 6 provides reference and resources related to this work. Appendices provide more detail about the geographic data used in the model, reports related to this model and meetings pertinent to the model development

2.0 Model Development

2.1 Introduction

The goal of the ECLUE Model was to create an overall picture of natural resource characteristics in Goodhue County and to highlight those at-risk natural areas that are the most sensitive to development. While the model's primary intent is to emphasize these areas, natural resources must often be considered in land use decisions alongside additional important factors such as zoning ordinances or other landscape features.

This section explains the process used to define model to meet these needs. The steps described here include the model development process, an overall model description, its construction in GIS, and its limitations.

2.2 Model Development Process

The work done to develop the land use model included reviewing existing land use models, seeking input from experts, decision makers and the public, and finally compiling these findings into a useable model.

2.2.1 Review of Land Use Models

Land use suitability models are a powerful means to illustrate and clarify what is occurring in the landscape, and so have been employed by planners, government staff and decision makers for many years.

This project reviewed GIS land use models, particularly those in done in Minnesota. A review of land use models, "*Employing a Suitability Model to Support Local Land-Use Decisions"* created by 1000 Friends of Minnesota and funded by the Minnesota Department of Natural Resources provided a context for this model as well as an overview of several model approaches. This document describes a range of models of varying complexity and provided a basis from which to determine the most appropriate approach for this project.

In particular, this project draws on land use model developed for Florence Township in Goodhue County. County staff recognized the value of the Florence Township model being scaled to the county level. As the land use sensitivity model did in Florence Township, there was significant interest in this ECLUE Model identifying the areas in County most sensitive to development, highlighting at-risk natural areas, slopes, stream banks, water quality, erosion risks, and most productive soils. The Florence model also highlighted the areas that are *least* sensitive to development; areas that would provide the most potential for appropriate future growth and change.

2.2.2 Input from Stakeholders

In addition, learning from previously conducted land use models, the model was developed in a cooperative manner with guidance and advice from a broad group including state, county and local government representatives, non-profit, environmental and other partners.

County staff, DNR and 1000 Friends of Minnesota staff held an initial meeting in August 2008 to discuss model goals and process. During this meeting, Goodhue County suggested an initial set of data inputs as a starting point for the project (see Appendix B). The meeting participants discussed a methodology for the project including technical and political considerations. Of particular importance was gaining input from additional stakeholders including local units of government, experts on particular model inputs (such as ecological data), and, as possible, the public.

1000 Friends of Minnesota of Minnesota constructed a prototype model that combined the initial layers suggested by Goodhue County. This model and its results were presented at a number of meetings by staff from Goodhue County, and/or 1000 Friends of Minnesota. These presentations (listed in Appendix C) reached a wide audience and provided feedback that was used to improve and refine the model. Two meetings were of particular importance and they were held on February 9, 2009 and on April 9, 2009. The February

9, 2009 discussion of the land use model was conducted as part of the regularly scheduled Goodhue County Planning Advisory Commission meeting. This group of planning officials was briefed on the project and a productive discussion followed on the model and the potential uses for its results. The feedback from the group was that the model results would be very useful for both county and local planning purposes. In addition, the officials asked questions about and had suggestions for data inputs. Most notably they requested the inclusion of agricultural soils which are an important resource in Goodhue County.

The second significant meeting was held on April 9, 2009. Several people attended this meeting entitled "Land Use Model Information sharing and gathering meeting." (See attendees and meeting notes in Appendix B.) The meeting started with a brainstorming exercise in which participants were asked, "What are the top considerations when planning for future lands uses in Goodhue County?" The results included characteristics that fell into the following categories: natural resources; agriculture; cultural/historical; economics; transportation and public services; and regulatory. The initial model, input data layers and preliminary results were then presented and a discussion followed. Based on the input from this meeting, several more datasets were considered for inclusion in the model. Those included wind power potential, historic and cultural landmarks, transportation, storm water; DNR forest model; prime agricultural soils and pollution hot spots.

Following these two key meetings, 1000 Friends of Minnesota had correspondence and meetings with Goodhue County staff and consulted experts such as DNR staff to ascertain feasibility of including datasets suggested at meetings. In some cases the data did not exist, or it was decided that the model results would not be usable or significantly changed by the inclusion of a suggested dataset. For example, data for pollution hot spots were not available. And while cultural and historic landmark data were available, it was decided the inclusion of that dataset in the model would not

ultimately benefit the models results in a usable way. However, some data were added to the model based on input from these meetings. For example, agricultural soils data were added, as was wind power potential data. In addition, the ecological inputs into the model were refined so as to better measure the *quality* of natural resources on the land. This included replacing simple datasets indicating the location of trees and other natural resources with more sophisticated data from the DNR that indicated not only identify where the natural resources are, but also provide a quality assessment of those resources.

Another key result of stakeholder input was the idea to break the model into separate parts, or submodels, which focused on the different goals for the model. For example, the goals of highlighting the best natural resources while also indicating the regulations that impact a particular area may combine together in such a way that neither is clear or apparent. This meant the results of the model may not have been effective and so would have been less useful to the decision maker. This realization resulted in a key change in how the model was constructed - it was decided to subset the model into three submodels: Natural Resources, Regulatory and Additional Considerations.

Overall, the model development process was shaped and improved by both input from a variety of stakeholders and also by the review of previous work on land use suitability models. The knowledge gained from this process was then shaped into the GIS model that is described in the following section.

2.3 Model Construction

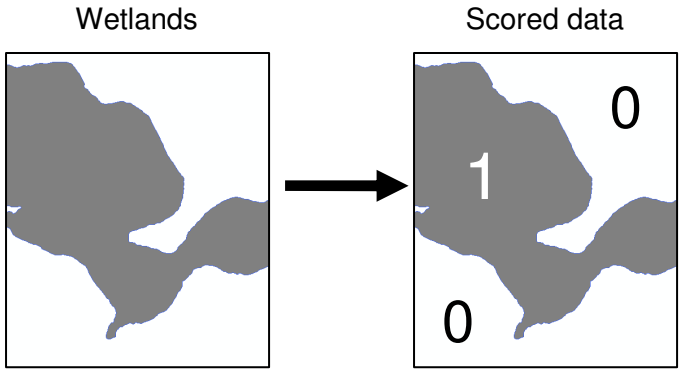
With the goals for the model decided, and the input of stakeholders collected, the remaining challenge was to construct and implement a model. In order to describe this process, a short background on how GIS models work is provided, followed by an overview of the GIS data inputs and then a

description of the Goodhue land use model. Finally the known limitations of the model are described.

2.3.1 Overview of GIS Models

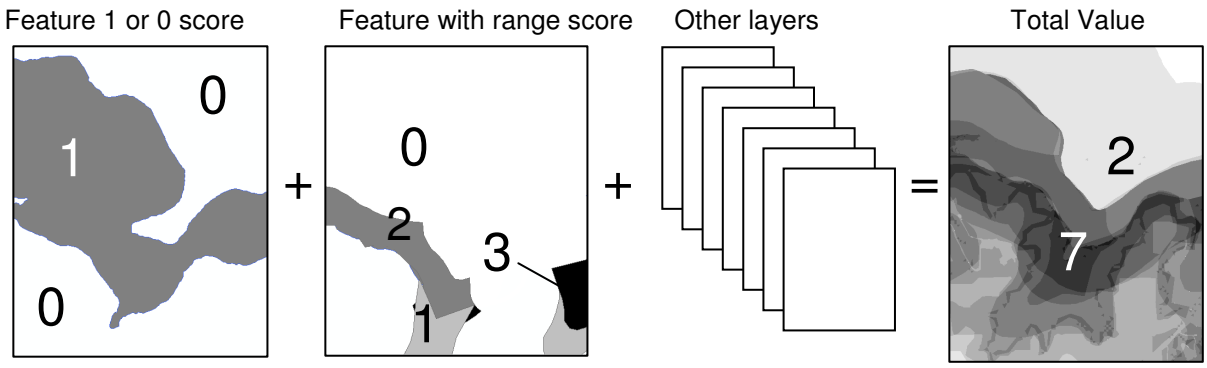
A model is a representation of the real world, and so a GIS model is a representation of geographic characteristics in the real world. In addition to creating a picture of existing conditions, a GIS model can add value by combining those characteristics in a meaningful way. This is the true value of a land suitability model – that it inputs *data* and it outputs usable *information*, thereby providing an effective tool for making decisions.

The ECLUE Model developed for this project is a Geographic Information Systems (GIS) model that takes many sets of data representing geographic features in Goodhue County and then combines them. The model assigns a numerical value to each dataset based on its characteristics. For example, to highlight areas of high ecological value, it is important to identify wetlands. To combine this data with other layers in a meaningful way, the areas that are wetlands are given a score of 1 and areas that do not include wetlands are given a score of 0. This is a binary representation of a characteristic – it either exists or not, as shown in the figure below.



In addition to applying a numerical score to data layers in a binary manner, it is also possible to score features on a range of values. For example, steep slopes are important to evaluate when considering natural resources. The data may be valued in the model as follows: areas with less than 20% slope

are scored as 0; slopes with 20%-30% slopes are scored as 1; and areas with 30% slope or greater are scored with a value of 2. These data layers with range scoring can be combined with binary-scored layers provided the values are within a reasonable enough range to provide an understandable output. A common manner for combining layers together is to simply add up the values geographically. This means that each individual layer's value will be added to all the other layers where they coincide at the same point on the landscape in the County. The results layer is the sum of all the input layers. The graphic below illustrates how this works.



In addition to assigning values based on the existence of features in the data, operations such as buffer measurements or sub-selections may also be included in the model. Together these map operations, scoring and combining of data layers is often called "cartographic modeling". Cartographic modeling is one of the strength of a GIS and a robust tool helpful in performing complex analysis.

The Goodhue land use model was built using ModelBuilder in the GIS software package, ArcMap. ModelBuilder is an application within ArcMap specifically designed to create, edit, and manage models. ModelBuilder allows datasets to be processed and combined in a replicable manner. For example, a model could be set up to buffer a feature such as a sinkhole by 100 feet before combining with other relevant data. This process itself is stored and reused allowing the sinkhole data to be replaced as necessary by an updated dataset without having to reprogram the model. The model also

serves as a record of the processing that has taken place. This allows the process used to produce the results to be reviewed, changed or updated as desired without having to revisit each process manually.

It was important to Goodhue County staff that the model could be altered, updated or expanded upon and the ModelBuilder provides an environment that is both scalable and flexible. The model developed for this project included 21 input layers, but each of those layers could be changed, or additional layers could be easily added.

2.3.2 GIS Data

With the overall goal of the model known – to highlight quality natural resources, key land use regulations and other features important to land use decisions – the remaining task was to identify and include datasets that accurately represented landscape characteristics to meet those goals.

At the project outset, Goodhue County staff had an initial idea of which data layers they wanted to include; this was used as a starting point. The original layers were: bluff land, shoreland (areas around protected waters), rivers, lakes and stream, sinkholes, floodplain, wetlands, important soils, sensitivity to groundwater pollution, forested areas, aggregate resources, natural resource inventory, Cannon River wild & scenic area, registered feedlots, registered mining locations, and potential green corridors. (See Appendix B for full documentation of original data input.)

The discussion of these datasets and other possibilities was included in all of the stakeholders meetings and much was done to ensure that the most appropriate datasets were selected. It was useful to leverage previous data collection investments. For example, the county has extensive elevation data, a new soil survey, a natural resource inventory and other current GIS data that was used to complete this analysis. In addition, the inclusion of datasets that were suggested by stakeholders required research or

collaboration with experts. For example, the desire to have a measure of natural resource quality in the model was facilitated by the input of subject matter experts from the DNR. The DNR provided not only a model input layer, but also a thorough explanation as to how it was created. With this and other expert input, a final set of data inputs were decided upon.

The data layers that comprise the final ECLUE Model are: high quality ecological areas; riparian habitat; bluff land; water features (rivers and lakes); streams; wetlands; sinkholes; sensitivity to groundwater pollution; geologic edges; steep slope & hydric soils; the Cannon River Wild & Scenic area; shoreland areas (around protected water features); floodplain areas; areas around bluff land; registered feedlots; aggregate resources; registered mining locations; prime agricultural soils; potential green corridor connectors; wind power potential; and publically-owned land.

These 21 data layers were selected to meet the goals of the model. Details about the datasets and their inclusion in the model are provided in Section 3 of this report.

With the datasets decided upon, the final decision about data was selection of a data storage method. The decision of whether to use data stored in raster or vector format is important when constructing a GIS model. Raster data represent geographic data stored as a uniform grid of cells where the value of a cell contains the value of the feature. Vector data represent geographic features as features as points, lines, and polygons and values are represented in associated tables. Either type of data can be used in a model. Generally, raster format may represent continuous features on the landscape better, such as elevation, whereas vector data better represents discrete features, such as zoning areas, roads or buildings.

Most of the source data layers for this model were stored as vector data and so the decision was made to run the model as a vector model to preserve the

accuracy in the source data. Vector data are more complex in structure and so take longer to combine together in a model process, but that factor was not considered to outweigh the benefits of having the original feature shapes preserved in the model output.

2.3.3 Land Use Model Description

With the datasets selected, the next step was to construct and implement a model that successfully combined these data inputs to achieve the model goals.

While it was clear that goals all intended to contribute towards making better land use decisions, they did at some level provide so much information that there was no clear message in the model output. For example, areas of wind power potential or aggregate resources may occur in the same location as a high quality natural resource area. While combining these layers together may result in a high score, the high score would not immediately explain which characteristics were present on the landscape. The results would have to be investigated to understand what a high number meant. Working with stakeholders and decision makers who would use the results, it was easy to see that unless the results were easier to understand, they may not be used or interpretation may be difficult, and so the model would not achieve its ultimate goal – to help inform land use decisions.

To provide a clear understanding of the model results, it was decided to group the datasets into 3 categories or submodels: 1) Natural Resources; 2) Regulatory Factors; and 3) Additional Considerations. By doing this, the results of each submodel could be examined and interpreted more easily. For example, to ascertain where high value ecological areas are in Goodhue County, the natural resource model results are viewed. To learn where selected regulations apply, the regulatory submodel results can be viewed. Other factors that are important to land use decision can be determined from the Additional Considerations submodel results.

Together the submodels can be viewed as a total results layer. While data-dense, this layer could be used at either county or local level as an indicator for how many factors a land use decision could impact by and therefore could become a guide as to factors to be considered.

Each layer has an individual score, and when the layers are combined in the submodels, each submodel has a results layer and total score. The results of each submodel are then combined together into the overall results. The overall results layer has a total score made up of each combined submodel.

The grouping of the datasets into submodels is provided in the figure below and an explanation of each layer and its scoring is provided in Section 3.

Submodels and data layers

Natural Resources	Regulatory	Additional Considerations
1. High Quality Ecological Areas 2. Riparian Habitat 3. Bluff Land 4. Rivers and Lakes 5. Streams 6. Wetlands 7. Sinkholes 8. Sensitivity to Groundwater Pollution 9. Geologic Edges	1. Steep Slope & Hydric Soils 2. Cannon River Wild & Scenic Area 3. Shoreland Areas (around protected water features) 4. Floodplain Areas 5. Areas Around Bluff Land 6. Registered Feedlots	1. Aggregate Resources 2. Registered Mining Locations 3. Prime Agricultural Soils 4. Potential Green Corridors 5. Wind Power Potential 6. Publically-owned Land

2.3.4 Model Limitations

As was stated at the beginning of this section, a model is simply a representation of the real world, and GIS models are representations of geographic characteristics in the real world. Model results, therefore, must be seen as a good, but not perfect, indicator of the truth on the ground.

The datasets selected for this model are considered the best available, but they vary in age and completeness, There could be geographic errors in the data meaning an area included for a characteristic may not exist on the ground, or conversely, a characteristic may be on the ground but not be included in the data and so the model. Additionally, the scale at which the data collected may be coarser than the scale at which the model results will be examine and used. Since GIS systems are "scaleless", meaning a user is able to zoom in very close on a map, often it is assumed that the data are accurate to that level – and that is not correct. It should be understood that precision of data does not indicate accuracy of data. In order for this GIS model to be most effective in the long run, it will need to be updated and maintained as conditions change or better data become available.

Additionally, the very selection of the datasets to include in the model will bias the results to indicate those datasets. This may be clear, but it is easy to overlook when examining results. For example, if a model includes several water features as inputs, then water features will be probably be scored and so highly apparent in the output. Much work has been done in the model to ensure a balanced approach to inclusion of data layers so as not to "load" the model results or "double count" for any one characteristic.

Overall the work done to create this model emphasized expert input and review with the hope of ensuring that the results are as accurate as possible. As with all model results, a common sense approach should be taken when using the results of the ECLUE Model. Land use decisions should be informed by, but not made solely upon, the results of this model. In land use decisions, there is no substitute for experienced decision makers, knowledgeable citizens and experts as well as on-the-ground investigation.

3.0 Model Description

3.1 Overview of Model

The land use model is composed of three submodels that reflect three different aspects of land use. The three submodels are 1) Natural Resources; 2) Regulatory; and 3) Additional Considerations.

The model results can be viewed as separate entities, or as a whole depending on the need of the decision maker or goal of a particular land use decision. For example, county-wide planning for natural resource preservation may benefit from using the natural resource model results, whereas at the local level, an application for parcel development may benefit from the review of results from the each submodel, or the combined submodels.

This section provides a detailed description of each submodel, each data layer and also provides their associated scoring. Where appropriate, information about GIS processing and/or data manipulations are described. Finally, a graphic overview is also provided of the geographic extent of each data layer grouped by submodels.

3.2 Natural Resources Submodel

3.2.1 Natural Resources Submodel Description

The purpose of this submodel is to highlight natural resources areas in Goodhue County. The data layers were selected because they indicate where natural resources exist, where sensitive natural features occur, and where areas of high quality habitat and significant ecological value are present. The hope is that the results from this model will clearly identify these resources, and that the scoring of can help prioritize protection of these important areas.

3.2.2 Natural Resources Submodel Layer Descriptions

Each of the natural resources layers is described below, including reasoning for including the layer. In addition, the GIS data source, quality and any known limitations of the data are provided. Metadata links, if available, are provided in Appendix A.

3.2.2.1 Ecological patches

The inclusion of an accurate and appropriate ecological data layer was considered essential for this model. The Minnesota Department of Natural Resources (DNR) offered to create an ecological dataset that identified areas, or patches, of significant ecological value. These patches were scored from 1-3 points based on their ecological quality.

The ecological data layer was created by combining 3 datasets: native plant communities from the Minnesota County Biological Survey (MCBS – considered the "best of the best"); native plant communities identified from the Minnesota Land Cover Classification System (MLCCS); and interior forest habitat.

Each of these inputs is described in detail in Appendix B, in "DNR Memo – Ecological Layer". Of particular interest is that DNR incorporated Goodhue County-created data into the process where possible. For example, the forest habitat is defined by a process that typically uses land cover data, but DNR incorporated Goodhue forest data that was derived locally from aerial photo interpretation. In addition, the MLCCS data includes The Goodhue County Natural Resource Inventory, an inventory of almost 60,000 acres within the Cannon, Zumbro and Mississippi and Lake Pepin Watersheds created with county funds and financial support from the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

The features in the ecological data set are given a score of 1-3 points based on the following criteria:

- 3 points if an area includes a MCBS native plant communities
- 2 points an area includes a MLCCS native community
- 1 point if an area is identified in ecological forest interior habitat model or mapped as a MLCCS non-native natural community.

If areas have more than one of the above criteria, the highest score supersedes the lower score. Similarly, if areas with two scores overlap, the areas are combined into one area and the new, larger polygon was given the score of the majority of the area score before they were joined.

3.2.2.2 Riparian habitat

A Riparian habitats layer was considered important to include in the model to identify areas near streams and rivers that would provide habitat to support plant and animal species as well as protect water resources. Preservation of riparian areas is important to support water quality, soil conservation, erosion prevention, to maintain or increase biodiversity and significant ecology and provide the space necessary for maintenance of an aquatic ecosystem.

This data set was constructed and delivered by the Minnesota DNR and was created by combining designated floodplains with flat areas and natural streams. Flat areas were considered to be those with slope of less than 1%. The floodplain areas were defined using the "FEMA" dataset, which is a digital representation of flood insurance rate maps (FIRMs) done by the Federal Emergency Management Agency (FEMA). Because FEMA is concerned with public health and safety and flood insurance, urban areas are included in this dataset, but those areas were not appropriate for this specific analysis. The urban areas were removed by taken out urban areas as defined by the 2001 National Land Cover Dataset (http://www.epa.gov/mrlc/nlcd-2001.html). ?? This last sentence is confusing but didn't want to edit as to not change the intent

Once the floodplains, flat areas and natural streams were combined, a buffer was then applied to extend the area out by 30 meters. The DNR provided

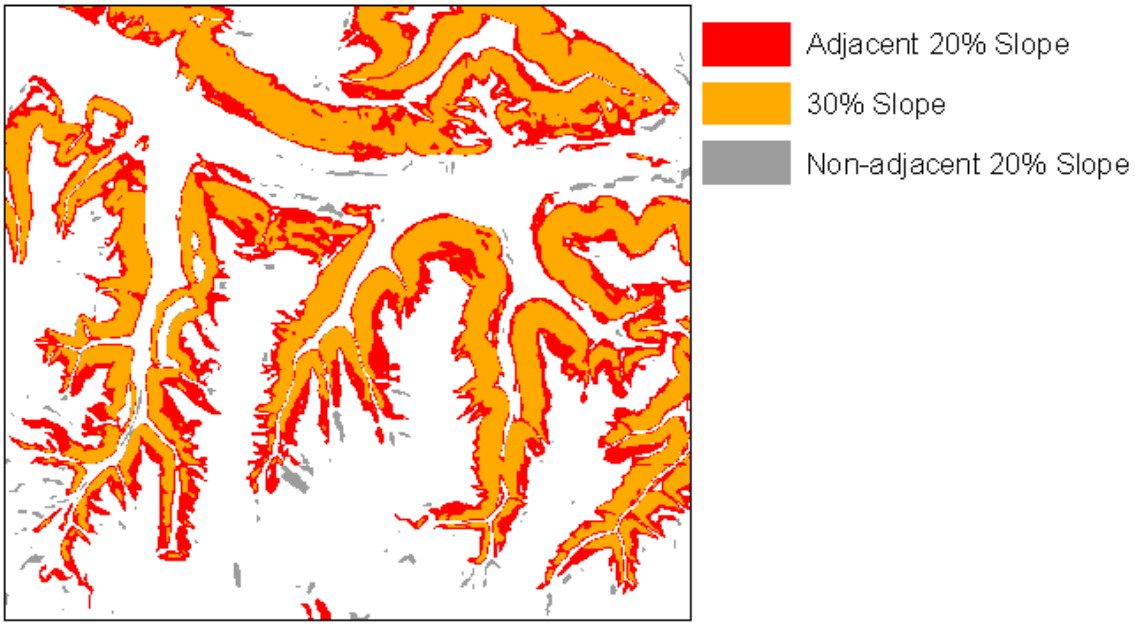
this dataset and no other processing was done for its inclusion in the model. The riparian habitat areas were given a value of 1 point in the model.

3.2.2.3 Bluff Lands

Bluff lands are one of Goodhue County's most scenic and culturally important features. In addition, they are natural resource features that are protected by ordinance. Bluff lands are susceptible to erosion and so are protected to prevent damage to easily disturbed areas at the top and bottom the bluff. In addition bluff land can be considered essential in the function of ecosystems because of the unique upland habitats it provides. In addition, protected bluff land provides corridors for species migration.

For the purpose of this model, bluff land was considered to be areas of 30% slope or greater *and* areas of 20% slope or greater that are *adjacent, or contiguous,* to the 30% slope areas. The graphic below illustrates these areas. The yellow shows areas of 30% or greater slope, generally considered to be a bluff face. These areas are given a value of 2 points. The red shows areas of 20% slope that are adjacent or contiguous to the 30% slope, generally referenced as the top and toe of the bluff, and so are included in the layer model. These areas are given a value of 1 point. The gray areas show 20% slope that is not adjacent and so excluded from this layer and like everywhere else in the county would have a value of 0 for bluff land.

Bluff Land Slope Example



The areas of 20% and 30% slope were derived by Goodhue County and based on highly precise and accurate 2ft contour Light Detection and Ranging (LIDAR)-based data. The data were preprocessed to identify the areas of 20% slope adjacent to 30% slope. The resulting layer was combined with the 30% slope and the scores were assigned to the data layer.

3.2.2.4 Water Features: Rivers and lakes

Lakes and rivers are water features that were included in the model as a natural resources layer. Lakes and rivers are essential to consider when looking at high quality ecological areas. They are habitats for plant and animal species and house the signature species of a region such as trout. They also provide necessary habitat for migratory species which travel through the area. Additionally, quality water resources serve as an important economic resource, drawing tourists and amenity focused development.

Lakes and rivers data were provided by Goodhue County and no additional processing was necessary to include them in the model. Rivers and lakes were given a value of 1 point in the model.

3.2.2.5 Water Features: Streams (with 50ft buffer)

Streams were included as an input in the natural resources submodel. Streams are connective habitat corridors for species such trout and they also are the backbone of the natural storm water infrastructure.

In addition to being valuable natural resources, streams are visible amenities that beautify the landscape and so increase the marketable value of land. Since the map data representing streams in the County are linear data, a buffer of 50 feet was applied to the streams to make them into an area. While not protected by ordinance, this buffer area around streams was considered important by the model stakeholders to include as a flag to decision makers when looking at land uses near streams.

Stream data were provided by Goodhue County and the model includes a step to buffer the streams by 50 feet. The areas defined were given a value of 1 in the model.

3.2.2.6 Wetlands

Wetlands are valuable natural resources that were considered in this model because they improve water quality; provide food and habitat for fish and wildlife; and provide flood control and shoreline erosion control. Because wetlands are a water holding system for storm water, they allow for groundwater recharge and filtration which slows runoff and reduces pollutants into fragile streams.

The wetlands data were created and provided by Goodhue County. The work done to create this wetlands data took into consideration topographic data in conjunction with other data sources including: aerial photos; National Wetland Inventory; artificial drainage maps; and hydric soils data. This wetlands dataset identifies land that is currently occupied by wetlands and areas that may be drained wetlands or areas that could be converted to wetlands. While the data layer treats "true" wetlands in the same way as

areas that may be currently be farmed, it was decided to include the entire dataset. All the wetlands (including drained areas) are given the same score of 1 if they are present and 0 if they are not.

3.2.2.7 Sinkholes (100ft buffer)

Sinkholes indicate active Karst geology which has major implications for building structures and for handling storm water in development. It was considered part of the natural resources model because sinkholes are an entry point for groundwater, and may also indicate unusual groundwater flow. Groundwater access points via sinkholes are areas extremely susceptible to pollution. For the purpose of this model, sinkholes are buffered by 100 feet and each resulting area is give 1 point for the model. The sinkhole data were provided by Goodhue County and were originally obtained from the Minnesota DNR's Geologic Atlas.

3.2.2.8 Sensitivity to Groundwater Pollution

Land use decision makers must often consider factors that may not be obviously visible on the landscape, but nonetheless very important. Sensitivity to groundwater pollution is one of those factors. On their website, the Minnesota DNR defines a sensitive area "as a geographic area characterized by natural features where there is significant risk of ground-water degradation from activities conducted at or near the land surface." The web site goes on to explain more about how and why a geologic rating system was created.

> The DNR has developed criteria and guidelines to assess sensitive areas to encourage a consistent approach to assessing geologic sensitivity in Minnesota (Geologic Sensitivity Workgroup, 1991). Assessments are based on the geologic and hydrogeologic factors that affect the ability of geologic materials to restrict the downward migration of contaminants to the ground water of interest. This approach is called geologic sensitivity.
> http://www.dnr.state.mn.us/waters/groundwater_section/mapping/sensitivity.html

The rating system created by the DNR rates areas on a 1-4 scale. In discussions with model stakeholders, it was decided to use this point system in the Goodhue land use model would place too much emphasis on this particular dataset. To remedy this, it was decided to modify the range for this layer to be a 1-2 range. The descriptions of the DNR ranges were examined and the stakeholders agreed on the following scoring:

Description of Groundwater pollution sensitivity	**Infiltration time**	**DNR score**	**Model Score**
Very high	Hours to months	4	2
High	Months to years	3	2
Moderate	Years to decade	2	1
Low	Decades to century	1	1

While the data were originally from the DNR Geologic Atlas, they were provided to 1000 Friends of Minnesota by Goodhue County. The score was added as part of the model processing.

It is interesting to note that Goodhue County in its entirety has some susceptibility to groundwater pollution with about half of it being high or very high sensitivity.

3.2.2.9 Geologic Edges

Geologic edges or formations are landscape features that are present in Goodhue County. They are areas of shale, siltstone and dolstone that underlie the Prairie du Chien and Jordan formations. Jeff Green of the DNR describes in an email memo (see Appendix C) that formations act in such a way that affects water movement, creating springs and water recharge. Consequently, concerns with geologic edges include their relationship to groundwater recharge, water contamination, bluff stability, and cold water for trout streams. Green states:

> Ground water recharge is can be impacted by surface activities such as road construction, water and sewer line trenching, housing development. Clearing of the forests can alter the natural hydrology of the hillslope and change the groundwater

> recharge and discharge patterns. Homes built on top of the shale and siltstone units of the St. Lawrence Edge may experience wet and flooding basements. To date, there is no special recognition or protection of this unique area. Only minimal protection is afforded to the upper bluffland drinking water recharge areas, the natural water purification system and cold-water sources for trout streams. Communities can adopt zoning regulations that guide development in these areas.
> DNR, 2009 – See Appendix C

While effects are not well documented nor fully understood, edges were considered important by stakeholders to include in the model. The areas where of geologic edges are present were given a score of 1. The data were provided by the Minnesota DNR.

3.2.3 Natural Resources Submodel Scoring

The nine natural resources submodel layers are listed in the following table. For seven of the layers the scoring is binary, meaning if the characteristic is present, the geographic area obtains a score of one, if the characteristic is not present, the area obtains a score of zero. For three layers, Bluff lands, Ecological patches and the Sensitivity to Groundwater Pollution layers, the scoring is a range of points 1-2, 1-3 and 1-2, respectively.

Natural Resources Submodel Scoring

Model Layer Description	**Score if criteria is *NOT* present**	**Score if criteria *IS* present**
Ecological patches	0	1 - 3
Riparian habitat	0	1
Bluff Land	0	1 - 2
Water Features: Rivers and lakes	0	1
Water Features: Streams (with 50ft buffer)	0	1
Wetlands	0	1
Sinkholes (100ft buffer)	0	1
Sensitivity to Groundwater Pollution	0	1 - 2
Geologic Edges	0	1
Total Minimum and Maximum Submodel points	***0***	***9 - 13***

Each layer of the model is added together and then the total points are calculated. The minimum number of points for an area in the results of the Natural Resources submodel is zero points, and the maximum is 13 points, however due to the potential for groundwater pollution present throughout the county no area received zero points

3.3 Regulatory Submodel

3.3.1 Regulatory Submodel Description

The purpose of the regulatory submodel is to provide decision makers with a quick view of whether or not selected Goodhue County land use zoning ordinances apply to a given area of land. Goodhue County has more ordinances than are included in this model, but County staff chose the included criteria for this model because these ordinances are often considered or examined in concert with natural resource evaluation. County staff selected six criteria to include in the regulatory submodel. Those criteria are: Hydric and Steep Slope Soils; the Cannon River Wild & Scenic Area; Floodplain District; Shoreland Areas; Areas within 30 feet of Bluff Land; and 1000 foot buffer around Registered Feedlots.

The ordinances and the selection of GIS data to represent those ordinances for each of the five criteria are provided in the following section. The next section provides a summary of how the layers are combined and scored.

3.3.2 Regulatory Model Layer Descriptions

Each of the regulatory layers is described below, including the Goodhue County zoning ordinance that forms the basis for the layer. In addition, the GIS data source, quality and any known limitations of the data are provided. Metadata links, if available, are provided in Appendix A.

3.3.2.1 Hydric and Steep Slopes Soils Data

Hydric and steep slope soils are important when considering land use decisions for different reasons and so are found in different areas of the zoning ordinances. In Goodhue County, these soils do not occupy the same areas, and so being mutually exclusive, it made sense to consider them as one layer in the model.

Hydric Soils

Hydric soils are defined as "soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part." (Goodhue County Zoning Ordinance, Article 10, Section 2, Subd. 54. (May 19, 2009)). Hydric Soils are a key indicator of wetlands and drained or potential wetlands, however, according to the Zoning Ordinance document definition, hydric soils must be present to indicate a wetland (Goodhue County Zoning Ordinance, Article 10, Section 2, Subd. 111. (May 19, 2009)). The reason for inclusion of hydric soils in the model was to highlight in the regulatory context both existing wetlands and those areas containing soil that indicates drained wetland, or potential wetlands. Goodhue County describes the importance of wetlands:

> Wetlands provide a valuable service by improving water quality, providing for flood water retention, reducing runoff, reducing stream sedimentation, and preserving wildlife habitat. For these reasons, Goodhue County intends by this Ordinance to establish a program that will protect, enhance, and conserve the wetlands of Goodhue County by implementing a policy calling for the replacement of all wetlands destroyed or diminished due to unavoidable activities.
> Goodhue County Zoning Ordinance, Article 32, Section 1. (May 19, 2009).

So the inclusion of this data not only indicates where current wetlands exist, but also indicates areas that have been drained and could potential be restored. Thee goals, explained in the purpose of the ordinance (which follows the 1991 Minnesota Wetland Conservation Act) are to:

> A. achieve no net loss in the quantity, quality, and biological diversity of Minnesota's existing wetlands;
> B. increase the quantity, quality, and biological diversity of Minnesota's wetlands by restoring or enhancing diminished or drained wetlands;
> C. avoid direct or indirect impacts from activities that destroy or diminish the quantity, quality, and biological diversity of wetlands; and
> D. replace wetland values where avoidance of activity is not feasible and prudent.
>
> Goodhue County Zoning Ordinance, Article 32, Section 2. (May 19, 2009).

The GIS data layer used to represent hydric soils in the land use model was provided by Goodhue County. County staff obtained the soils data from the National Resource Conservation Service (NRCS) which is part of the US Department of Agriculture, and subset it by soil type to include only hydric soils. Since the data layer only included hydric soils, no processing of the data was required for its inclusion in the model.

Steep Slope Soils

Steep slope soils are important to land use decisions because they define boundaries of areas that are protected under the Bluff Land Protection Ordinance. Bluff lands are considered historically and economically important in Goodhue County and the standards in the ordinance "set out to protect and preserve the sensitive physical features of the bluffs by regulating development, preventing erosion and controlling the cutting of timber on the slopes and tops of the bluffs." Goodhue County Zoning Ordinance, Article 12, Section 1. (May 19, 2009).

It is interesting to note that the areas protected under the bluff land protection ordinance defined by steep slope soils cover an area of land more than two times larger than the actual bluff land defined as 30% or greater slope. So the inclusion of steep slope soils in the ordinance is a means for protecting the important areas around bluff land, and so it follows that the inclusion of this layer in the model highlights those areas.

The GIS data layer used to represent steep slope soils in the land use model was provided by Goodhue County. County staff provided a data layer that only included steep slope soils, so no processing of the data was required for its inclusion in the model. County staff obtained the soils data from the National Resource Conservation Service (NRCS) which is part of the US Department of Agriculture, and subset it by soil type to include only steep slope soils. Since the data layer only included steep slope soils, no processing of the data was required for its inclusion in the model.

3.3.2.2 Cannon River Wild & Scenic Area

The Wild and Scenic River District ordinance was created to ensure land uses in the Cannon River district would be protected. The ordinance states its purpose is:

> To establish standards and criteria for uses in the Cannon River land use district shall be to protect and preserve existing natural, scenic, historical, scientific, and recreational values, to maintain proper relationships between various land use types, and to prohibit new residential, commercial, or industrial uses that are inconsistent with the State-Wide Standards and Criteria for Scenic and Recreational Rivers, 6105.0010 - 6105.0250 and 6105.1550 - 6105.1680.
>
> Goodhue County Zoning Ordinance, Article 12, Section 1. (May 19, 2009).

The inclusion of this area in a land use model will provide decision makers with a quick view of whether the specific rules governing this area need to be examined.

The GIS data layer used to represent Cannon River Wild and Scenic Area in the land use model was provided by Goodhue County. County staff provided a zoning layer and the Cannon River Wild and Scenic Area was subset from this.

3.3.2.3 Floodplain District

The floodplain district is included as a layer in the regulatory submodel because of the Floodplain District Zoning Ordinance. This purpose of this ordinance is to minimize losses due to inundation or flooding in known flood hazard areas. Goodhue County Zoning Ordinance, Article 31, Section 1. (May 19, 2009).

Currently in Goodhue County the geographic data used to define the floodplain district is geographic data based on Federal Emergency

Management Agency (FEMA) data. The "FEMA data" is a digital representation of flood insurance rate maps (FIRMs).

As part of the National Flood Insurance Program (NFIP), FEMA creates, manages and updates flood insurance rate maps. Many of these maps are older and do not reflect recent developments in floodplains. The FEMA flood maps are in the process of being updated to DFIRMs, or Digital Flood Insurance Rate maps. The new DFIRMS will include not just spatial data, but additional information such as graphics, text, shading, and other graphic data required to make a hardcopy FIRM printable product to FEMA standards and specifications.

The newer DFIRM dataset is not yet available for Goodhue County, so the older floodplain data from FEMA were included. While these may not reflect some newer development, or reflect more refined areas based better quality elevation data, it still remains the best available dataset. For the purpose of this model, it must be considered adequate in meeting the goal of highlighting areas of potential flood and inundation damage as indicated in the Ordinance. Since this model is built as a sum of parts, when the newer data becomes available, it can be replaced for the floodplain district layer

The FEMA GIS data layer used to represent the floodplain district in the land use model was provided by Goodhue County. County staff provided the dataset in a format that did not require any processing and so it was directly incorporated into the model.

3.3.2.4 Shoreland Areas

The inclusion of Shoreland areas are a reflection of the Shoreland Area Ordinance in Goodhue County. The Shoreland Ordinance standards are adopted for the purpose of

1. Regulating suitable uses of land surrounding protected waters.

2. Regulating the size of parcels, length of water frontage and alteration of shorelands of protected waters.
3. Regulating the location of sanitary facilities adjacent to protected waters.
4. Preservation of the natural vegetation, natural topography, and other natural resources to insure a high standard of environmental quality.

   Goodhue County Zoning Ordinance, Article 30, Section 1. (May 19, 2009).

The boundaries of shoreland district are established by buffer areas from protected waters are defined in the Goodhue ordinance and follow Minnesota regulations. For lake and rivers with a surface area of greater than 10 acres, the shoreland district is defined as a 1000 feet buffer area. For rivers and streams (draining an area greater than two (2) square miles), the shoreland district is defined as a 300 foot buffer.

The inclusion of the shoreland layer in the land use model will provide a means to identify the areas covered under the Shoreland ordinance.

Goodhue County staff provided a shoreland district GIS layer that contained the completed buffer analysis, and so it was ready to be used directly in the model without further processing.

3.3.2.5 Areas within 30 feet of Bluff Land

The inclusion of areas within 30 feet of bluff lands are an additional method to define the areas surrounding steep slope bluff lands in Goodhue County. These areas are protected under the Bluff Land Protection Ordinance because of their historical and economic importance in Goodhue County. As mentioned before, the standards in the ordinance "set out to protect and preserve the sensitive physical features of the bluffs" Goodhue County Zoning Ordinance, Article 12, Section 1. (May 19, 2009). This model layer is defined in Section 4 of the ordinance, "setback from top or toe of the bluff to

any structure in any district shall be no less than thirty (30) feet." Goodhue County Zoning Ordinance, Article 12, Section 4. (May 19, 2009).

The inclusion of areas within 30 feet of Bluff Land as a layer will indicate to the decision makers that this is an area that must be protected. The results layer will make it clear where these areas are.

The steep slopes or bluff land area dataset (30% slope or greater and 20% slope adjacent to 30% slope) provided by Goodhue County was used as a basis for this regulatory layer into the model. This model layer was created by buffering the bluff land areas by 30 feet. This layer was preprocessed for inclusion in the model because of the length of processing time.

3.3.2.6 Areas within 1000 feet of Registered Feedlots

The inclusion of a geographic layer in the model to represent an area around Registered Feedlots in Goodhue County directly supports one of the key intents of the Confined Registered Feedlot Ordinance, that, "Goodhue County supports conservation efforts and environmentally safe land use practices." Goodhue County Zoning Ordinance, Article 13, Section 1. (May 19, 2009). The Ordinance balances the needs by Goodhue County for livestock, poultry and other animals with the responsibility to make sure the operations do not have a negative environmental impact.

A minimum of a 1000 foot distance from a feedlot is required for residential and other development in Goodhue (Goodhue County Zoning Ordinance, Article 13, Section 8. (May 19, 2009)). Inclusion of the feedlot locations with a 1000 foot buffer will help identify how potential development plans could be impacted.

The GIS data layer for feed lots was provided by Goodhue County and is a point file. A point layer only provides one point on the land, whereas a feedlot may cover several acres. This may be a minor limitation of the

model; however, the 1000 foot buffer is sufficient for alerting decision makers to the general location of the feedlot area, and allowing more detailed study to take place as needed.

3.3.3 Regulatory Submodel Scoring

The six regulatory submodel layers are listed in the following table. For each the six regulatory layers the scoring is binary, meaning if the characteristic is present, the geographic area obtains a score of one, whereas if the characteristic is not present, the area obtains a score of zero.

Regulatory Submodel Scoring

Model Layer Description	**Score if criteria is *NOT* present**	**Score if criteria *IS* present**
Steep Slope and Hydric Soils	0	1
Cannon River Wild & Scenic Area	0	1
Shoreland Areas	0	1
Floodplain District	0	1
Areas within a 30 feet of Bluff Land	0	1
Areas within 1000 feet of Registered Feedlots	0	1
Total Minimum and Maximum Submodel points	***0***	***6***

Each layer of the model is added together and then the total points are calculated. The minimum number of points for an area in the results of the Regulatory submodel is zero points, and the maximum is six points. One point of interest in the construction of the model is that it was decided to keep the two soil layers as separate inputs, so the type of soil could be determined in the results layer. This means that technically, there are seven GIS input layers, but since the hydric and steep slope soils are geographically mutually exclusive, they appear and perform in the model as if they were one layer.

The final submodel in the land use model is named the "Additional Considerations" submodel and is described in the following section.

3.4 Additional Considerations Submodel

3.4.1 Additional Considerations Submodel Description

The purpose of this submodel is to highlight additional considerations that may be useful when evaluating land use decisions in Goodhue County. The layers included in this submodel are aggregate resources, mining locations, agricultural soils, wind power potential, potential greenway corridors and publically owned lands. These layers are scored and the results are combined to create the additional considerations results layer.

3.4.2 Additional Considerations Submodel Layer Descriptions

Each of the additional considerations layers is described below, including reasoning for including the layer. In addition, the GIS data source, quality and any known limitations of the data are provided. Metadata links, if available, are provided in Appendix A.

3.4.2.1 Aggregate Resources

Goodhue County has sand, gravel and limestone deposits, leading to significant mining in the area. While the economic opportunity for mining is strong, the potential for damage to the natural environment is high. For these reasons, Goodhue County considered it important to include in the model.

The data are originally from DNR Geologic Atlas, but were subset by Goodhue County for the purpose of this model. Two layers of aggregate resources were provided: 1) Bedrock aggregate resources (carbonate rock for cement and bituminous); and 2) Surficial aggregate resources (sand & gravel). These two layers were combined to create one data input for the model. If any of the aggregate resources were present in the resulting layer, the area was given a score of 1.

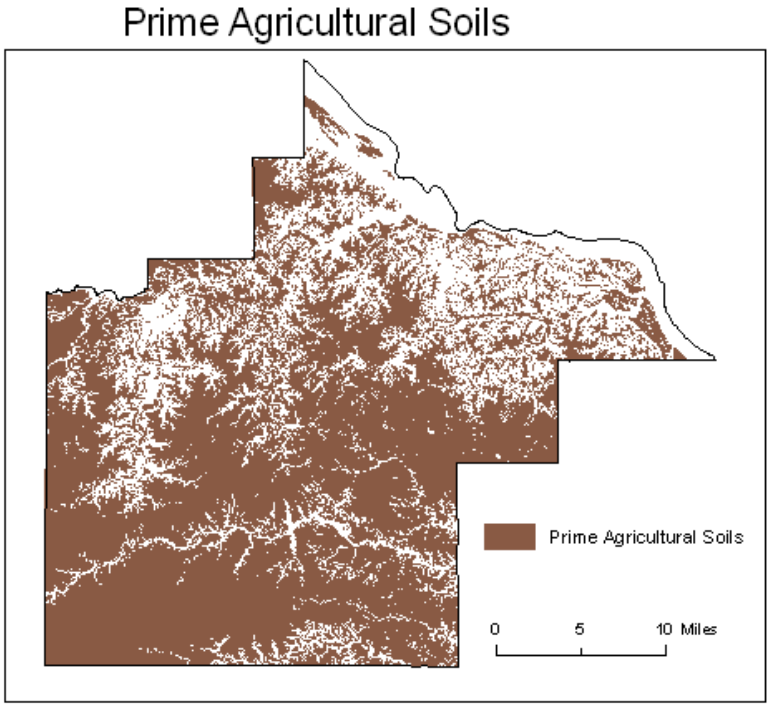
3.4.2.2 Registered Mining Locations

Goodhue County staff considers the locations of registered mining locations in their current land use planning decisions and so wanted to include this dataset in the model. The areas that depict the mines were created by Goodhue County and each mining location is given a score of 1.

3.4.2.3 Agricultural Soils

Agricultural soils were recommended for inclusion in the model by local and county government officials. Farming is important economically in Goodhue County, and land use decisions frequently involve land that is farmed, or could be farmed.

The GIS data layer used to represent prime agricultural soils in the land use model was provided by Goodhue County. County staff obtained the soils data from the National Resource Conservation Service (NRCS) which is part of the US Department of Agriculture, and subset it by soil type to include only prime agricultural soils. Prime agricultural soils cover much of the Goodhue County as shown in the map below.



3.4.2.4 Potential Green Corridors

The potential green corridors layer identifies the potential corridors between the ecological patches. The benefit of such a layer is that as land use changes in Goodhue County, it will be important not only to preserve natural resources, but to preserve connections between those areas of natural resources. These greenway connectors can be used by wildlife to move between natural areas. These corridors are also important pathways for movement of plant species.

The greenway connector layer was created by the Minnesota DNR using a methodology they have applied to create similar layer for other geographic areas. Specifically, the layer is generated using cost / distance analysis, where the shortest connection is selected through the best land cover types between the patches. Natural and semi-natural areas are the preferred route, followed by agriculture land, then areas with low imperviousness (little development). Connections through developed areas would be made if that was the only choice. Only patches within 3 kilometers of each other are connected. The generation of this layer is iterative, meaning the process used to create it is repeated several time to achieve the best result. The layer used in this model was run 6 times.

The DNR used the Goodhue County wetlands layer and other data inputs to generate this dataset. All the potential green corridor features in the layer were given a score of 1 for model compilation.

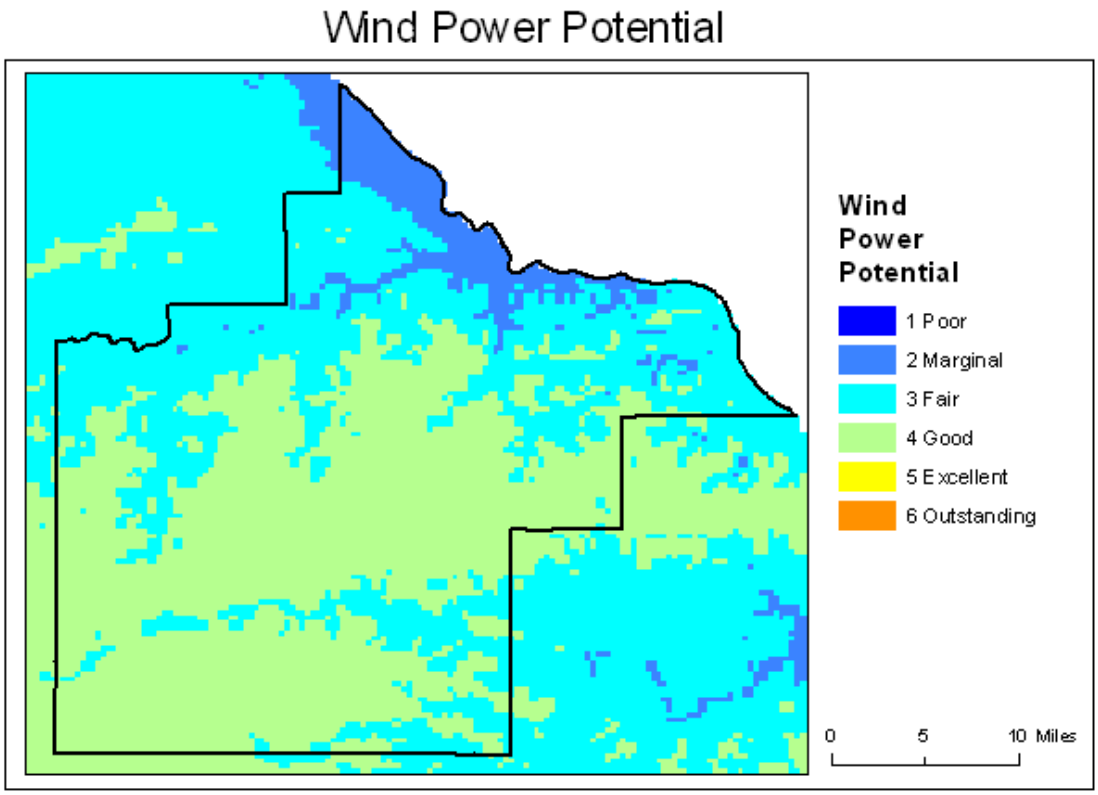
3.4.2.5 Wind Power Potential

Production of power using wind energy is becoming more prevalent and some wind generators have already been built in Goodhue County. Feedback at the public input meeting indicated that it would be useful to include this factor in the land use model.

Wind power potential is calculated by taking the average wind speed and applying a calculation to provide a measure of the potential. Wind speed data are available from the Minnesota Department of Commerce at the heights of 30 meters, 80 meters and 100 meters. (See: http://www.state.mn.us/portal/mn/jsp/content.do?contentid=536887066&contenttype=EDITORIAL&agency=Commerce.) Currently most commercial wind turbines are between 80-100m high and so for that reason, the wind speeds at 80 meters were considered.

In order to calculate the wind power potential from the average wind speed, the log wind profile formula available on Wikipedia was used (http://en.wikipedia.org/wiki/Log_wind_profile). This formula results in wind power potential. The standard classification for interpreting this potential used by the wind industry is via "wind power classes" which are a 1-7 range with 1 being "poor" and 7 being "excellent".

The 80 meter data reveals that Goodhue County wind power classes range from 2-4, meaning areas are marginal, fair and good (see map below). It was decided to include only the areas at level 4, or considered "good." These areas were given a score of 1 in the model, whereas the rest of the county was given 0 as a score.



3.4.2.6 Publically-owned land

Goodhue County staff consider publically owned lands in relation to their current land use planning decisions and so wanted to include this dataset in the model. The areas included as public lands include county, state, township and city-owned land in the county. The data were provided by Goodhue County and based on the parcel data. All of the land that is publically owned was given a score of 1 in the model.

3.4.3 Additional Considerations Submodel Scoring

The six additional considerations submodel layers are listed in the following table. For each the six additional considerations layers the scoring is binary, meaning if the characteristic is present, the geographic area obtains a score of one, whereas if the characteristic is not present, the area obtains a score of zero.

Regulatory Submodel Scoring

Model Layer Description	**Score if criteria is *NOT* present**	**Score if criteria *IS* present**
Aggregate Resources	0	1
Registered Mining Locations	0	1
Prime Agricultural Soils	0	1
Potential Green Corridors	0	1
Wind power potential	0	1
Publically-owned land	0	1
Total Minimum and Maximum Submodel points	***0***	***6***

Each layer of the model is added together and then the total points are calculated. The minimum number of points for an area in the results of the Additional Considerations submodel is zero points, and the maximum is six points.

3.5 Final ECLUE Model

The three submodels can be processed individually and viewed as stand alone products, but they can also be viewed as one combined product. The method used to do this simply combines the results from each of the submodels. The scoring of the results table is cumulative and the output results layer provides a summary of all the land use considerations in this model. A summary table provides the scoring for the combined submodels, after which a review of all the model inputs is provided in graphic format.

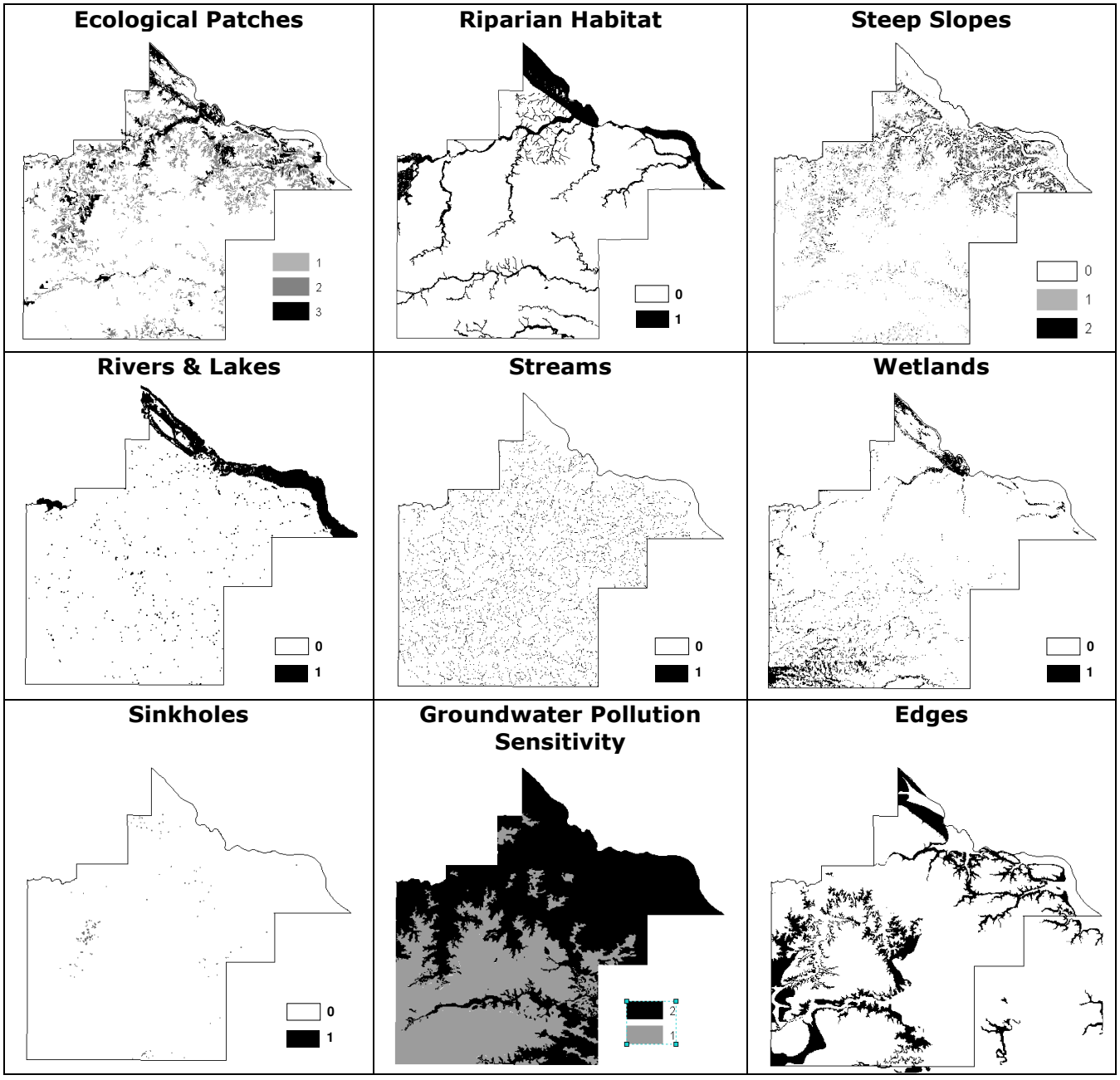
Final Scoring

Submodel Description	**Minimum Score**	**Maximum Score**
Natural Resources submodel	0	9 - 13
Regulatory submodel	0	6
Additional Considerations submodel	0	6
Final Model – total points	***0***	***21-25***

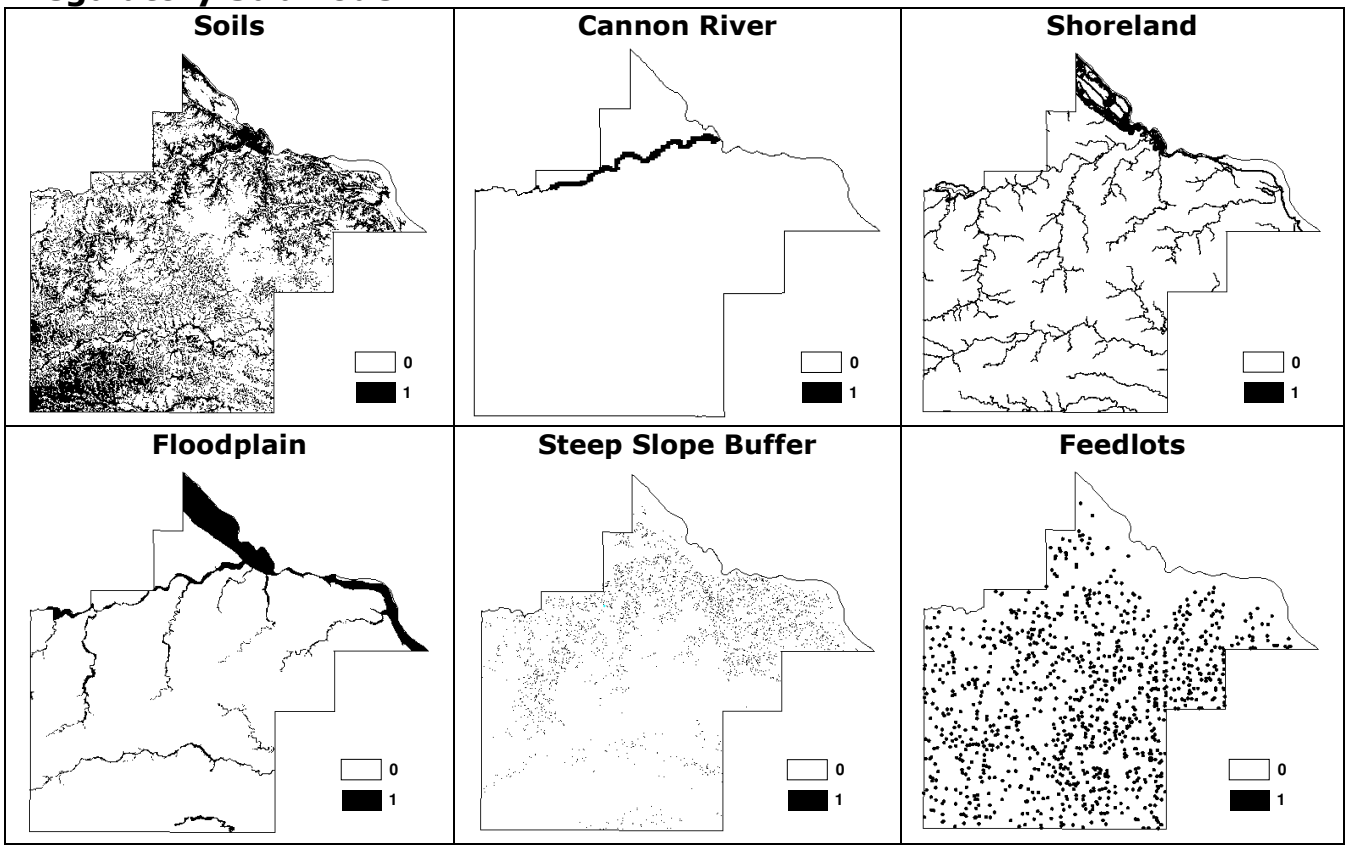
Each submodel is added together and then the total points are calculated. The minimum number of points for an area in the overall results is zero points, and the maximum is twenty five points.

The following section provides the model results showing each individual submodel and its results as well as the final combined model results.

Natural Resources Submodel

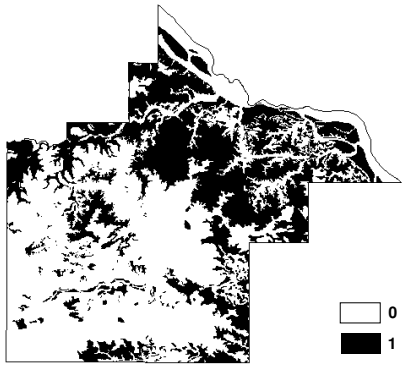


Regulatory Submodel

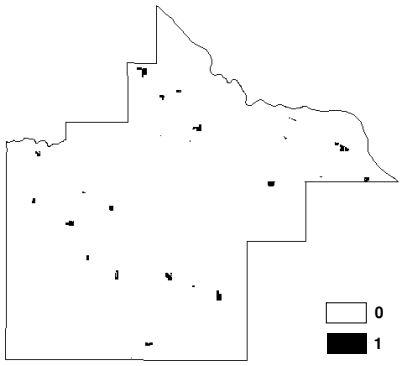


Additional Considerations

Aggregate

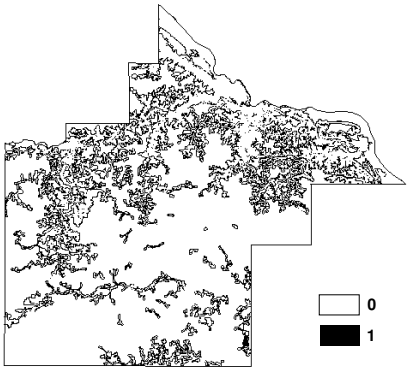


Mining Locations

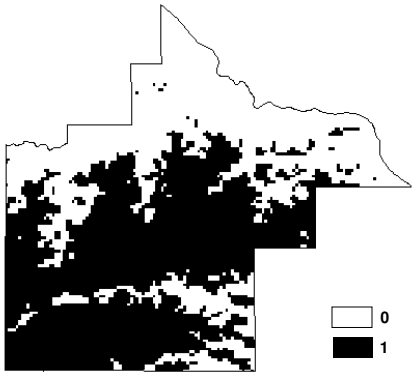


Soils (agricultural)

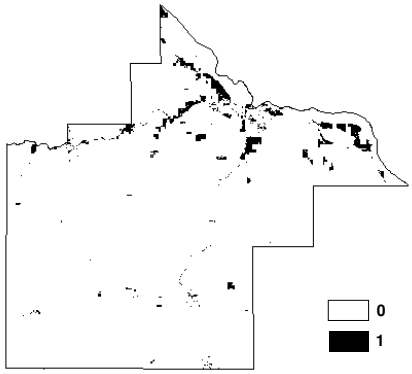
Potential Green Corridors



Wind Power Potential



Publically-Owned Lands



4.0 Model Results

The model results for each submodel and the combined results for the overall model are provided in this section. Taken as a whole, every part of Goodhue County is affected by one or more of the criteria found in the model. This speaks both to the abundance of resources present in Goodhue County, as well as to the need for mindful land use planning to protect these resources.

4.1 Natural Resource Submodel Results

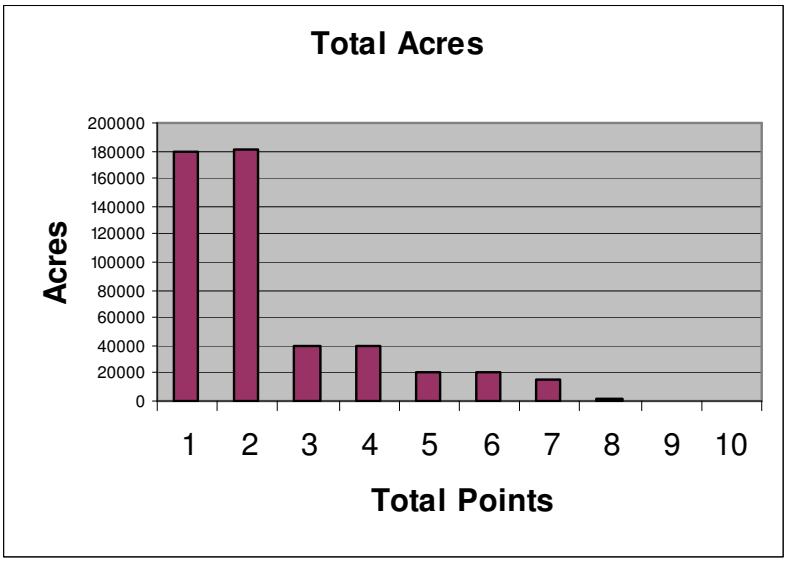
The natural resource model had the highest number of possible points of all the submodels; resulting in the largest point range in the results. The point range possible was 0-13, while the actual range result for this layer was 1-10. The figures below show the breakdown of acreage and percentage of the County included in each point value. For reference, the total area of Goodhue County is 499,082 acres, or about 780 square miles.

Natural Resource Points by Acreage

Natural Resource Points	Total Acres	% of Goodhue County
1	179500	35.97%
2	181092	36.29%
3	39595	7.93%
4	39394	7.89%
5	21350	4.28%
6	20552	4.12%
7	16229	3.25%
8	1777	0.36%
9	71	0.01%
10	0	0.00%

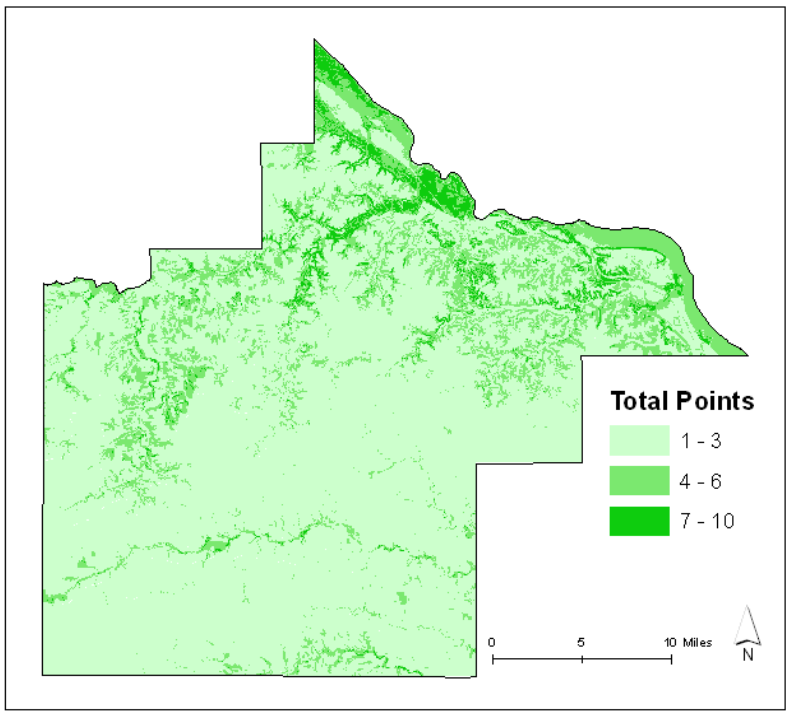
Total acreage numbers have been rounded to the nearest whole number and percentages to the nearest two decimal places, so acreage values of zero indicate less than one acre exists with that point value

The distribution of the acreage by point values is shown in the figure below.



The chart and table show that most of Goodhue County has a score of 1 or 2 points for natural resources factors. A smaller area of the County has a higher number of points. The map below provides a look at the distribution of the point values on the landscape. The map shows areas around water resources and bluff land areas have the highest points in the natural resources submodel.

Natural Resources Submodel Results



4.2 Regulatory Submodel Results

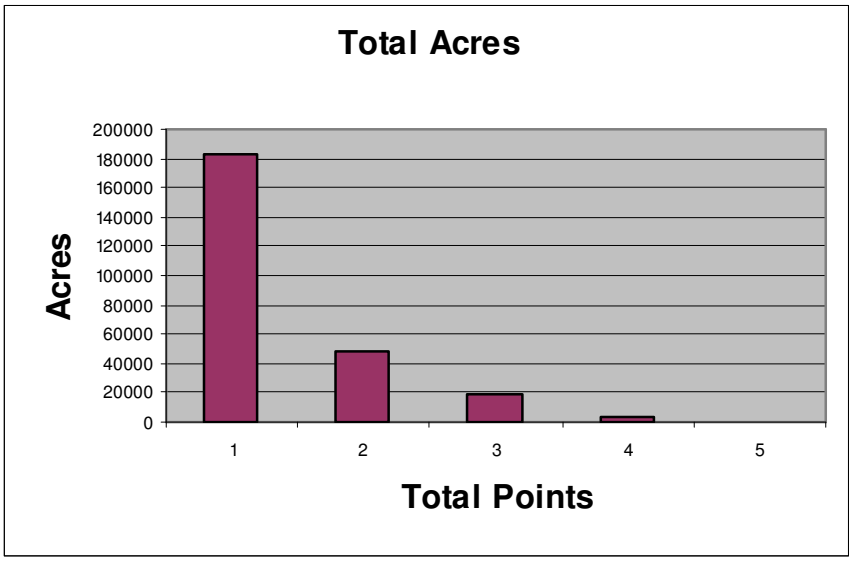
The regulatory model had a point range possible from 0-6, while the actual range result for this layer was 1-5. The figures below show the breakdown of acreage and percentage of the County included in each point value.

Regulatory Points by Acreage

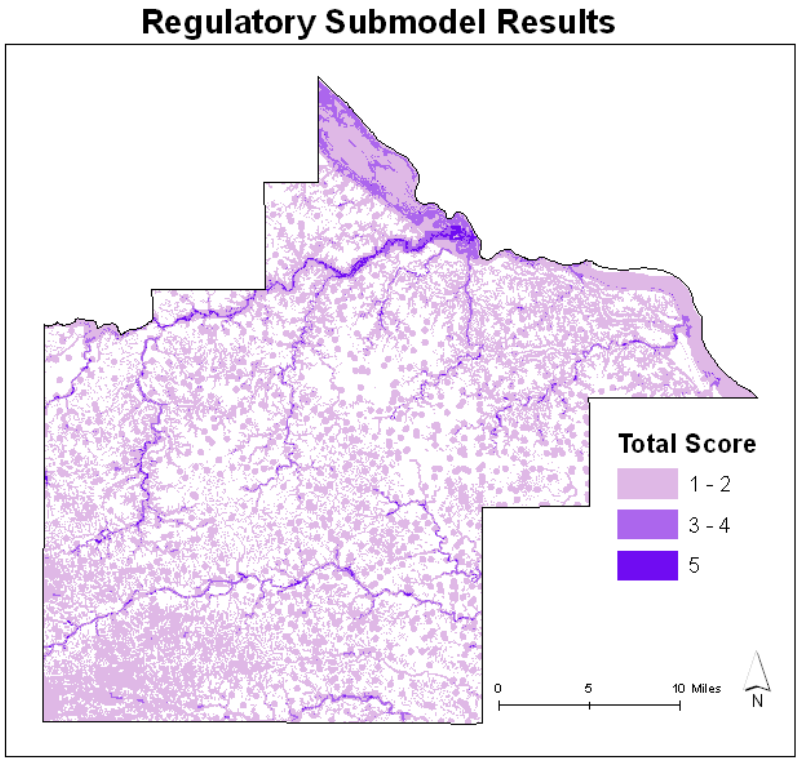
Regulatory Points	Total Acres	% of Goodhue County
1	182878	36.64%
2	48539	9.73%
3	19435	3.89%
4	2744	0.55%
5	60	0.01%

Total acreage numbers have been rounded to the nearest whole number and percentages to the nearest two decimal places, so acreage values of zero indicate less than one acre exists with that point value

The distribution of the acreage by point values is shown in the chart below.



Almost 37% of the County is impacted by one of the regulatory factors in the model, while another 12% of is impacted by two or more zoning regulations. The map of the distribution clearly shows the feedlot areas (point data with 1000 foot buffer identifiable as the round areas).



4.3 Additional considerations Submodel Results

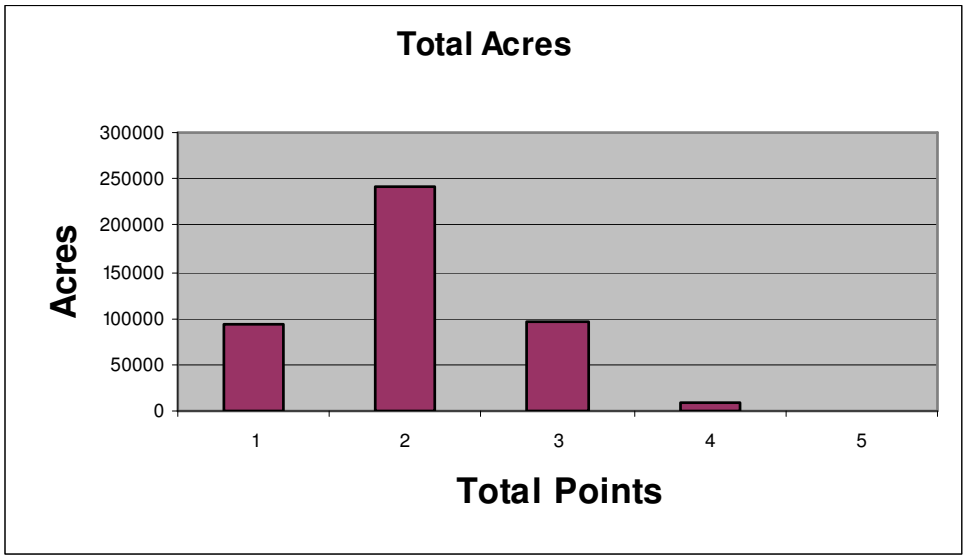
The additional considerations model had a point range possible was 0-6, while the actual range result was 1-5. The figures below show the breakdown of acreage and percentage of the County included in each point value.

Additional Considerations Points by Acreage

Additional Considerations Points	Total Acres	% of Goodhue County
1	6856	1.37%
2	94419	18.92%
3	240383	48.17%
4	97257	19.49%
5	9068	1.82%

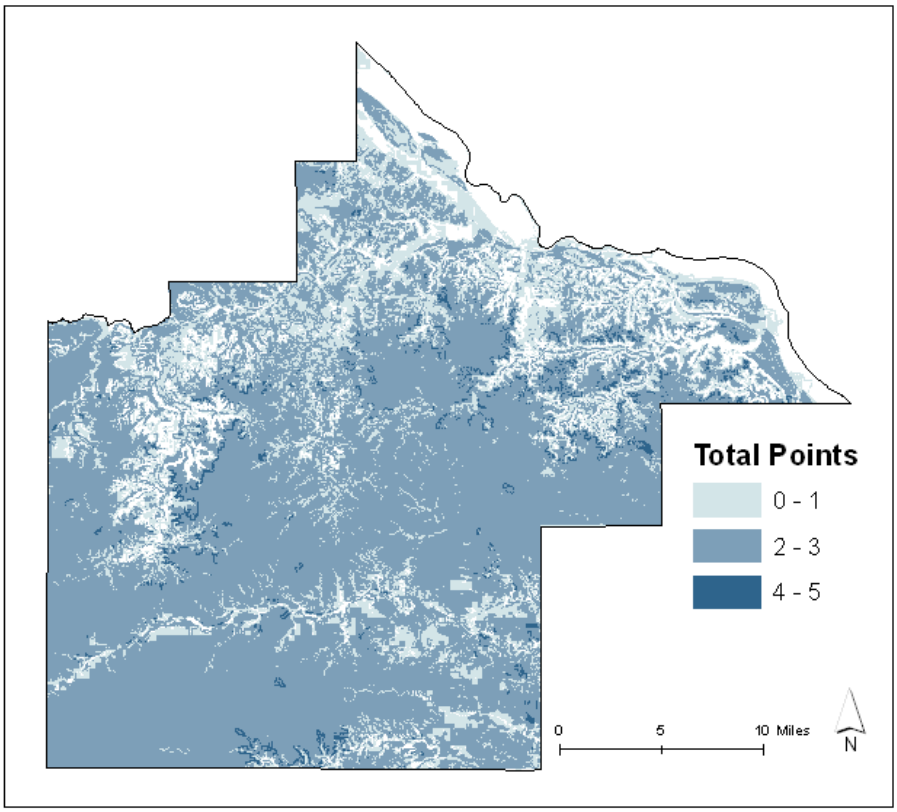
Total acreage numbers have been rounded to the nearest whole number and percentages to the nearest two decimal places, so acreage values of zero indicate less than one acre exists with that point value

The distribution of the acreage by point values is shown in the chart below.



Due to the nature of the inputs into the additional considerations submodel – wind power potential, agricultural soil, public land, etc., it is not surprising that there is no clear pattern on the landscape. Perhaps the areas that do have a higher number of points could be seen as "transition" areas between the steeper slope areas and the flatter areas of the County. Species are often attracted to these transition or edge areas as they lend the greatest amount of habitat diversity. The map below shows the distribution of the regulatory submodel results.

Additional Considerations Submodel Results



4.4 Overall Land Use model Results

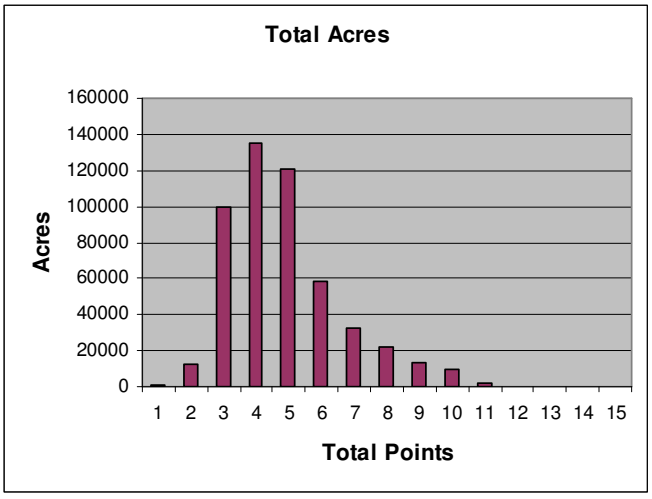
The overall model results, which combine the three submodels, have a possible point range of 0 to 25, while the actual range result for was 1-15. The figures below show the breakdown of acreage and percentage of the County included in each point value. For reference, the total area of Goodhue County is 499,082 acres, or about 780 square miles.

Additional Considerations Points by Acreage

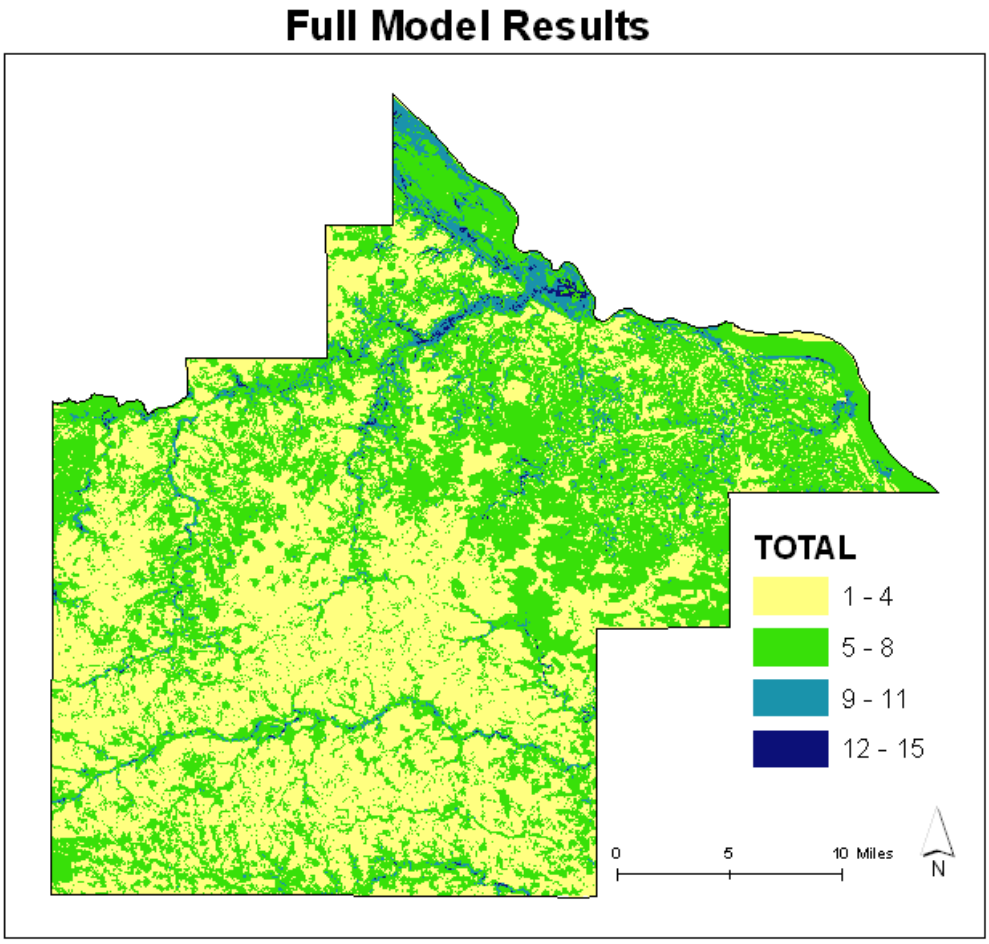
Additional Considerations Points	Total Acres	% of Goodhue County
1	915	0.18%
2	12151	2.43%
3	99590	19.95%
4	134963	27.04%
5	121069	24.26%
6	58171	11.66%
7	32168	6.45%
8	21572	4.32%
9	12952	2.60%
10	9133	1.83%
11	2285	0.46%
12	266	0.05%
13	29	0.01%
14	2	0.00%
15	0	0.00%

Total acreage numbers have been rounded to the nearest whole number and percentages to the nearest two decimal places, so acreage values of zero indicate less than one acre exists with that point value

The distribution of the acreage by point values is shown in the chart below.



It is interesting to note that the areas with point values between 11-15 account for less than 1% of the total County area. Even though small, these areas do have a significant number of land use factors.



4.5 Potential Uses for Model Results

The results of the Goodhue ECLUE provide a visual summary of the factors that may influence land use decisions on the landscape. Potential uses of these data are provided here, as well as recommendations for additional analysis of the results.

4.5.1 Using the data

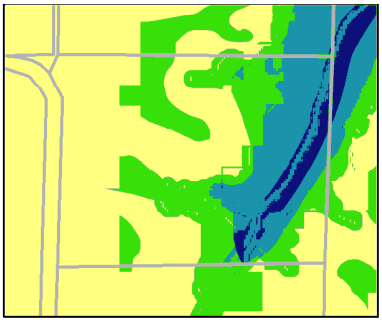
When presenting the data, it is of particular importance to use an appropriate symbology set. The use of different classification methods can greatly

impact how the data are understood. It is recommended that at the County-wide scale, a simple classification system of equal intervals is used, where points are grouped into sets of equal values. For example, 1-2, 3-4, 5-6. However, at a parcel level, having "hard breaks" between classes and colors may imply a distinct boundary on the landscape, when such a boundary may not exist.

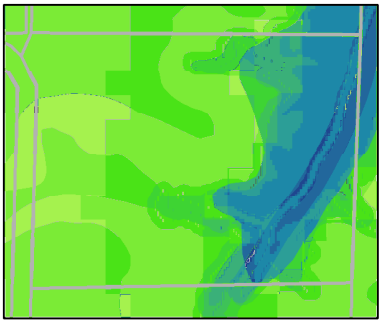
For parcel level analysis, using a symbol set that shows a gradual change in color may be more appropriate. In reality, the factors included in the model, such as elevation, soil type and riparian habitat do not change at a hard line on the ground, but continuously change over space. The hard line in the model results is a result of data collection and using GIS as a tool and this should be considered. An on the ground analysis will provide the most accurate and useful results; however, the model results can be a good indicator of which factors can be expected in that on the ground analysis.

The figure below provides an example of this. Each graphic shows the gray lines of parcel boundaries. The main parcel show is about 1500 feet in width. The top graphic shows the final model data with the points shown in four classifications, whereas the next graphic shows most of the point values each with their own color. Finally the lowest graphic shows a 2008 Aerial photograph for reference. It is clear that viewing the model results with more classifications shows the more subtle change across the landscape. However, there is still a wide difference in number of land use factors that exist when comparing the east and west sides of the parcel.

Parcel Level Results & Symbology



Model Results Total
- 1 - 4
- 5 - 8
- 9 - 11
- 12 - 15
- Parcels Boundaries



Model Results Total
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14 - 15
- Parcels Boundaries

- Parcels Boundaries

Aerial Photos: Farm Service Summer 2008

0 500 1,000 Feet

4.5.2 Future analysis of model results

This land use model provides a useful summary of features that exist on the landscape and so provides a quick way to view those features. The model results, however, could be used as a basis for future analysis. There are many possibilities, but a few are provided for consideration.

- How do the results from the natural resources model relate to areas that are protected by public ownership, easements and existing regulations?
- If the natural resource and regulatory model outputs are compared, how much of the high quality natural resource areas are already protected through regulatory means? Which areas in the county indicate high ecological value, yet remain unprotected through regulation?
- What is carrying capacity of feedlots? Number and type of animals would provide amount of land needed. What is carrying capacity of feedlots and animal waste? The number and type of animals could be used to calculate would provide amount of land needed to support a given number of animal units and their byproducts.

5.0 Model Uses

The results of the Goodhue County Environmental Constraints Land Use Evaluation (ECLUE) Model described in this report will be useful in several ways. The land use model is usable by Goodhue County for land use decisions, local units of government within Goodhue County and perhaps even a broader community of stakeholders who may be interested in the specific results in Goodhue County, or in the model itself. Each of these uses will be described below.

The results of the Goodhue County land use model will enable Goodhue County to evaluate their landscape and identify areas of rich ecological value vital to realizing the county's stated goal of natural resource preservation.

Specifically in Goodhue County, staff intend to use the model results to inform the 2009 update of the Goodhue County Comprehensive Plan, especially in planning for natural resource preservation. In addition, it may be used to evaluate county land use policies, and it is anticipated that it will contribute to the future land use map, detailing land use and zoning classifications. In addition, it will be used to revisit and refine the County's urban growth boundaries. Some city urban growth boundaries do not yet take account of the area's significant natural resources and this model will provide a starting point for that analysis and discussion.

In addition to these large scale uses of the model at the County level, the results could also be used at the small scale to inform local units of government of landscape characteristics or review land conditions at the parcel level. The model results can be shared with the local units of government via hard-copy maps, or through a free GIS-like browser such as ArcReader or Google Earth. This will enable local decision makers to not only use the results for their community and its decision. Also, providing the results to the local units of government will provide a means, or specific "model results language" with which to communicate with the County about

their area regarding land use, regulations and related issues. This will provide a way to involve local units of government more closely in county planning.

Another benefit of the land use model that may be more difficult to quantify, is that it provides a systematic means to view and evaluation the entire county based on the model layer inputs. Often, especially in localized land use decision, it is difficult to find a neutral perspective. The model will provide a more scientific and technical approach. The results, therefore, could be viewed as neutral or at minimum, an agreed upon base of data from which discussions on land uses discussions can begin, be informed and finally be decided. The model results will show that the natural resources, regulatory and other factors that are all important, and so illustrate the complexity that exists. By understanding the complexity of the landscape, hopefully, it follows an appropriate balance must be sought and observed in deciding on how to manage the need for natural resource protection, agricultural land use, agricultural related business, rural residential development and other competing factors.

In addition to local government, it would also be useful to provide access to the model results to the general public. Many citizens would like to help plan for the future of their communities. If citizens have the model results, they will be more informed and more able to understand County decision based on the model. While it may not be appropriate to provide all the information, because the GIS data, the model and results are complex, it would be useful to have some output products that provide key model results.

Another benefit of the model is that this type of analysis can help with future grant requests for special purpose projects such as land protection and securing additional partnerships.

Finally, this model may be of interest to other GIS or planning professionals from the perspective of learning from, or replicating the process used. It is recommended that the model be shared with colleagues in the field to support a better use of tools in decision making.

6.0 References and Resources

1000 Friends of Minnesota, *Employing a Suitability Model to Support Local Land-Use Decisions*, (Minnesota Department of Natural Resources).

Goodhue County Zoning Ordinances, May 19, 2009. http://www.co.goodhue.mn.us/departments/landuse/zoning/5-19-09ordinance-reduced.pdf.
Previous and more recent versions of zoning Ordinances can be accessed at: http://www.co.goodhue.mn.us/departments/landuse/zoning/

Knudsen, Beth J. "Land Use Suitability Analysis for Florence Township, Goodhue County, southeast Minnesota, U.S.A." *Department of Resource Analysis, Saint Mary's University of Minnesota, Winona, Minnesota 55987 and Minnesota Department of Natural Resources, Lake City, MN 55041.* Not dated.

NC Division of Costal Management, NC Center for Geographic Information and Analysis, *Land Suitability Analysis User Guide*, (2005).

Richardson, Bart, *Methodology for Conducting a GIS Ecological Assessment in Minnesota's East Central Landscape*, (DNR Central Region, St Paul, MN, 2005).

Ravalli County Planning Department, Geum Consulting, DTM Consulting, *Ravalli County Land Suitability Analysis: A Tool to assess development suitability based on Existing Infrastructure, Water resources, Wildlife, Working Lands, Open Lands, and Public Health and Safety in Ravalli County, Montana*, (2008).

Appendix A – Data Source & Scoring Overview Table

Geographic data layer	Score range	Data Supplier	Original data creator (if known)	Sources/related links
Natural Resources Submodel				
Ecological patches	1-3	MN DNR	MN DNR	http://deli.dnr.state.mn.us/metadata/mcbs_npcpy3.html http://www.dnr.state.mn.us/eco/mcbs/index.html http://deli.dnr.state.mn.us/metadata/lulc_mlccspy3.html http://files.dnr.state.mn.us/assistance/nrplanning/community/mlccs/factsheet.pdf http://www.dnr.state.mn.us/mlccs/index.html
Bluff Land	1-2	Goodhue County	Goodhue County	
Riparian habitat	1	MN DNR	MN DNR	http://www.epa.gov/mrlc/nlcd-2001.html
Water Features: Rivers and lakes	1	Goodhue County	Goodhue County	
Water Features: Streams	1	Goodhue County	Goodhue County	
Wetlands	1	Goodhue County	Goodhue County	
Sinkholes (100ft buffer)	1	Goodhue County	MN DNR	
Sensitivity to Groundwater Pollution	1-2	Goodhue County	MN DNR	
Edges	1	MN DNR	MN DNR	
Regulatory submodel				
Soils (steep slope & hydric)	1	Goodhue County	NRCS	http://soildatamart.nrcs.usda.gov/SSURGOMetadata.aspx
Cannon River Wild & Scenic	1	Goodhue County	Goodhue County & MN DNR	

Geographic data layer	Score range	Data Supplier	Original data creator (if known)	Sources/related links
Shoreland Areas	1	Goodhue County	MN DNR	
Floodplain District	1	Goodhue County	FEMA	http://www.fema.gov/hazard/map/q3.shtm
30 ft. buffer around Bluff Land	1	1000 Friends of Minnesota	Goodhue County	
Registered Feedlots	1	Goodhue County	Goodhue County	

Additional Considerations submodel

Aggregate Resources	0-1	Goodhue County	MN DNR Geologic Atlas	
Registered Mining Locations	0-1	Goodhue County	Goodhue County	
Soils (agricultural)	0-1	Goodhue County	NRCS	http://soildatamart.nrcs.usda.gov/SSURGOMetadata.aspx
Potential Green Corridors	0-1	MN DNR	MN DNR & Goodhue County data sources	
Wind power potential	0-1	The Nature Conservancy	MN Dept. of Commerce	http://en.wikipedia.org/wiki/Wind_profile_power_law http://en.wikipedia.org/wiki/Log_wind_profile http://www.state.mn.us/portal/mn/jsp/content.do?contentid=536887066&contenttype=EDITORIAL&agency=Commerce
Publically-owned land	0-1	Goodhue County		

Appendix B – Related Reports and Documents

Overview of Related Reports and Documents

Name of Document	Date of Document	Provided by	Full text included
Initial Data List Provided	August 2008	Goodhue County	Yes
Land Use Model Will Help Goodhue County Evaluate Environmental Resources, 1000 Friends of Minnesota Newsletter	November 2008	1000 Friends of Minnesota	Yes
Interim Report Memorandum	December 2008	Goodhue County	Yes
DNR Memo – Model Suggestions	May 2009	MN DNR	Yes
DNR Memo – Ecological Layer	May 2009	MN DNR	Yes
DNR Email – Geologic Edges	November 2005	MN DNR	Yes

Initial Data List Provided

9/23/2008

County GIS Data Layers to be incorporated into the Goodhue County Environmental Constraints Model - *Initial*

The following is a list of the data layers that Goodhue County would like incorporated into the Environmental Constraints Model.

*Data layers are maintained by Goodhue County unless otherwise noted.

**Data layers can be scored with a '1' or '0' unless otherwise noted to use a range of scores.

1. Bluff Land

a. Areas with a percentage slope of 30% or greater

2. Shoreland

a. Areas within 300ft of DNR protected streams or 1000ft of DNR protected lakes

3. Water Features

a. Lakes and streams

4. Sinkholes

a. Use a 100ft buffer polygon from each sinkhole

5. FEMA Floodplain

a. "Old" FEMA data. (New DFIRM data has not yet been finalized or approved.)

6. Wetlands

a. Existing or Possible Drained Wetland Areas (From Analysis project in '07 with SWCD)

7. Soils

a. Source: NRCS

b. Range (to be determined)

8. Sensitivity to Groundwater Pollution

a. Source: DNR

b. Range (Low=1, Med=2, High=3, Very High=4)

9. Forested Areas

10. Aggregate Resources

a. Source: DNR

11. Natural Resource Inventory

a. Range (to be determined)

12. Cannon River Wild & Scenic

a. Source: DNR (Incorporated into County's Zoning)

13. Registered Feedlots

a. Use a 1,000ft buffer polygon from each registered feedlot point

14. Registered Mining Locations

a. Range (to be determined)

15. Metro Greenways

a. Source: DNR (Marybeth Block)

Document last updated 9/23/2008

Goodhue County GIS Data – "Metadata"

***Data was sent to 1000 Friends on 9/23/2008 and included the following County datasets:*

- **FDLT05PY**

a. Point locations for registered feedlots from 2005. (We have a points layer for 2007 registered feedlots but it has not yet been QA/QC)

- **FEMAFWPY**

a. FEMA floodplain for Goodhue County

- **GWSLPY**

a. Groundwater Sensitivity to Pollution (DNR Geologic Atlas)

- **LUGC05PY**

a. General Land Use for Goodhue County including water coverage and forested areas. Information was digitized from the 2005 county imagery.

- **MUNBNDPY**

a. Municipal boundaries for Goodhue County

- **MINEGCPY**

a. Polygons digitized for registered mining areas within Goodhue County.

- **NRIPY**

a. Natural Resource Inventory data for Goodhue County. Digitized from the 1990 county imagery.

- **RSPGBGPY**

a. Bedrock aggregate resources (carbonate rock for cement and bituminous) (DNR Geologic Atlas)
b. This layer should be combined with the "RSPGSGPY" layer to make the 'aggregate resources' layer.

- **RSPGSGPY**

a. Surficial aggregate resources (sand & gravel) (DNR Geologic Atlas)
b. This layer should be combined with the "RSPGBGPY" layer to make the 'aggregate resources' layer.

- **SHPT**

a. Sinkhole locations (DNR Geologic Atlas)

- **SHRLNDPY**

a. Shoreland areas within Goodhue County which is 300ft from DNR protected streams and 1000ft from DNR protected lakes.

- **SLP30PY**

a. Areas with a percent slope of 30% or greater within Goodhue County. This layer was created from the County's 2ft contour data.

- **STRMGCLN**

a. Protected and Intermittent streams within Goodhue County.

- **WATRBDPY**

a. Water bodies within Goodhue County including lakes, ponds, etc.

- **WETLANDS_MERGE_070607**

a. Areas of existing or possible drained wetlands throughout Goodhue County. This dataset was created from a wetlands analysis project in 2007.

- **ZONEADDPY**

a. Additional zoning layer for Goodhue County which shows zoning for split parcels or areas not currently in the county's digital parcel layer. NOTE: This layer must ALWAYS be displayed on top of the "ZONEDGCPY" layer in order to correctly illustrate the zoning types. Included in this layer is the Cannon River Wild & Scenic designated areas.

- **ZONEDGCPY**

a. Goodhue County zoning designations by parcel. This layer must ALWAYS be displayed underneath the "ZONEADDPY" layer to properly show the zoning types.

1000 Friends of Minnesota Newsletter article
Land Use Model Will Help Goodhue County Evaluate Environmental Resources
November 2008

Goodhue County was awarded a DNR community conservation assistance grant to develop a land use model and in turn, Goodhue County partnered with 1000 Friends of Minnesota to develop the model.

The model will evaluate land in order to identify areas in Goodhue County that are most sensitive to development, highlighting at-risk natural areas including slopes, lakeshores and stream banks. In addition, important resources such as productive soils, trout streams and sand, gravel and limestone deposits will be included in the model.

The model will be developed using Geographic Information Systems (GIS) which allows different sets, or layers, of information to be combined into one map showing an inclusive picture of important resources and natural features. The map will include a rating, or score, that will indicate how resource-rich and ecologically sensitive different areas in the county are. The score also provides a standardize way to compare different areas across the county.

The results of this model will be used to inform decision makers in the 2009 update of the Goodhue County Comprehensive Plan and it is anticipated that the model will contribute to a future land use map, detailing land use and zoning classifications. In addition, Goodhue County expects to use this model to identify and prioritize areas for natural protection. The county will provide the map and model results to the public on their website.

1000 Friends of Minnesota has already started work on this model, and a public meeting to explain the project and invite input from township and city officials, and the general public was held in mid November.

One of the key benefits of using GIS for this model is that the process is documented, replicable and the method for the final result is transparent. This allows city and county officials and citizens to have a common understanding of where resources and natural features are. Having this common view of what is on the ground provides a common foundation from which important issues can be discussed, analyzed and resolved together. GIS models and resulting maps can help support more informed decisions about the future.

This project is a one of several currently in progress by the Technical Resource Center which is part of 1000 Friends of Minnesota's Growing by Design program. The Technical Resource Center offers expertise and solutions for communities and other non-profit agencies.

Interim Report Memorandum

December 22, 2008

TO: Sharon Pfeifer, Community Assistant Manager – Minnesota Department of Natural Resources

FROM: Michael A. Wozniak, AICP – Goodhue County Planner/Zoning Administrator

SUBJECT: 2008 Community Conservation Assistance Grant – Progress Report

Project Name: Environmental Constraints Land Use Evaluation (ECLUE) Model for Goodhue County

Grant Amount: $35,000.00

Project Terms and Deliverables

1. Create the ECLUE model that will:
   a. Assign a numerical value to land areas covering Goodhue County;
   b. Identify areas of high significant ecological values;
   c. Identify areas most sensitive to development and appropriate to enact conservation measures;
   d. Identify areas least sensitive to development.
   e. Highlight at-risk features.

2. Prepare a final report summarizing the project successes, challenges and outlining the technical protocol use to create the model.

Progress to date:

Goodhue County Land Use Management Department Staff and the staff of Project Sub-contractor 1000 Friend of Minnesota have made considerable progress towards developing the ECLUE model.

1. Project Updates have been provided to the Goodhue County Planning Advisory Commission which serves as the steering committee for the project at that body's regular October, November and December 2008 Meetings. It is anticipated that feedback on a "draft" version of the model will be solicited from the project steering committee during the January – February 2009 timeframe.

2. Public Information Meeting: A public informational meeting was held at the Zumbrota City Hall during the evening of November 13, 2008 to provide information about the ECLUE model project to local government officials and the general public. Information was also presented regarding another Goodhue County Planning Project: A Five-Year Evaluation of the 2004 Goodhue County Comprehensive Plan. Attached with this Progress Report is a copy of the PowerPoint presentation that was presented at the November 13, meeting. This meeting was attended by twenty-seven local government

officials, agency staff, or interested residents. Numerous questions were asked about the project and a variety of ideas were generated in regard to potential applications of the model.

3. ECLUE Model Development: The Goodhue Land Use model is a GIS vector model that combines 15 land use types into one output layer.

The input land use types are given a score and these individual layer scores are summed in the resulting output layer to provide a total score. This total score shows the cumulative ranking of each polygon for natural resources. The score highlights at-risk natural areas that may be sensitive to development or other land use change.

The input land use types are derived from one or more GIS input layers. The data layers and sources identified for inclusion in the model are listed below. Some layers have a simple binary of 1 or 0 for scoring, while other layers have a range of 1-4 applied. In addition to the total score, the output GIS layer contains each input types score, so that any polygon can be examined individually to understand how the total score was created.

Progress to date includes construction of a draft model incorporating most of the input layers identified. This draft model has been shared with Goodhue County Land Use staff. Remaining work includes collecting and processing remaining data layers and model refinement. Once the draft model is fully constructed the sub-contractor will seek advice on changes needed and weighting the data layers to accurately reflect county land use priorities through discussion with county staff, the Goodhue County Planning Advisory Commission, the County GIS User Group and other selected stakeholders. The working draft is a good start to begin soliciting input on further model refinement.

As the model is refined thought will also be given to the most useful output products, how can the model outcomes be most effectively shared with local governments to incorporate into their land use planning?

1 Bluff Land
a. Areas with a percentage slope of 30% or greater

2 Shoreland
a. Areas within 300ft of DNR protected streams or 1000ft of DNR protected lakes

3 Water Features
a. Lakes and streams

4 Sinkholes
a. Use a 100ft buffer polygon from each sinkhole

5 FEMA Floodplain
a. "Old" FEMA data. (New DFIRM data has not yet been finalized or approved.)

6 Wetlands

a. Existing or Possible Drained Wetland Areas

7 Soils
a. Source: NRCS
b. Range (to be determined)

8 Sensitivity to Groundwater Pollution
a. Source: DNR
b. Range (Low=1, Med=2, High=3, Very High=4)

9 Forested Areas

10 Aggregate Resources
a. Source: DNR

11 Natural Resource Inventory
a. Range (to be determined)

12 Cannon River Wild & Scenic
a. Source: DNR (Incorporated into County's Zoning)

13 Registered Feedlots
a. Use a 1,000ft buffer polygon from each registered feedlot point

14 Registered Mining Locations
a. Range (to be determined)

15 Metro Greenways
a. Source: DNR

4. Additional Input from local governments/agencies: Goodhue County Staff and 1000 Friends of Minnesota Staff are intending to solicit input on the ECLUE model through a County GIS Users Group and through direct meetings as may be necessary and appropriate during the January – March 2009 timeframe. The purpose of obtaining this input will be to ensure the final model offers the greatest utility to a wide variety of users while serving its primary purpose as a tool to protect and better manage natural resources within Goodhue County.

5. Additional Opportunities for Information/Input for the Public: Several public meetings have been scheduled as part of the Comprehensive Plan Evaluation Project to be held during the March – July 2009 Timeframe. Specifically meetings will be held on March 4, April 8, and May 6, 2009. One or more of these meetings may be utilized to update public official and the general public about the status of the project and to solicit feedback prior to completion of the project in June 2009.

6. A sub-contractor's agreement has been executed between Goodhue County and the 1000 Friends of Minnesota and the County is awaiting an invoice from 1000 Friends for sub- contracting work completed to date.

DNR Memo – Model Suggestions

Minnesota Department of Natural Resources

Central Region Community Assistance
1200 Warner Road, St. Paul MN 55106
651-259-5835

To: **Sally Wakefield & Alison Slaats, 1000 Friends of MN**
Michael Woznicak, Goodhue County

From: **Marybeth Block, DNR Community Assistance Specialist - Metro Region**

Cc: **Bart Richardson, DNR Central Region GIS Specialist**
Sharon Pfeifer, DNR Community Assistance Program Manager

The DNR Community Assistance Program respectfully offers the following suggestions regarding the data layers for the Environmental Constraints Land Use Model:

1) Incorporate an **ecological** layer that will have 3 levels (DNR will provide the layer):
    a. 3 points if polygon is mapped as a MCBS native plant communities (outstanding)
    b. 2 points if polygon is mapped as a MLCCS natural or native community (high quality)
    c. 1 point if the polygon is identified in ecological forest/habitat models (moderate quality)

    This layer will replace the Natural Resource Inventory, Forested Areas and Green Infrastructure layers. (If the Goodhue Forestry layer is retained we ask that it not be included in the ecological layer.)

2) The **Bluff Land** layer be expanded to include all areas with a slope of 20% or greater, buffered 200' (DNR has this layer) and given 2 points. Add an additional point to slopes 30% or greater.

3) **A Riparian** habitats layer (this would take the place of the FEMA layer in the scored portion of the model)
    a. FEMA floodplains with developed areas removed using land cover data
    b. Intersection of flat areas (>1%) and natural streams
    c. Combine FEMA and the flat areas and streams, and buffered out 30 meters

4) Remove hydric and steep **Soils** (assume these are captured in the county's wetland model and in #3 Bluff Land layer.) If desired add prime ag land.

5) **Groundwater** sensitivity layer be limited to 1 or 2 (for med or high) or replaced with a more refined layer if one exists.

6) Suggested model structure
    a. Natural Resources
        i. Ecological (scoring range 1-3 points based on quality)
        ii. Bluff Land (1 point)
        iii. Riparian (1 point)
        iv. Lakes & Rivers (1 point)

v. Streams with 50’ buffers
vi. Wetlands
vii. Geologic features (1 point for each feature for a 1-3 point range)
    1. sinkholes
    2. edges
    3. groundwater

b. Other Features (1 point for each feature for a 1-4 point range)
    i. Prime ag land
    ii. Aggregate resources
    iii. Registered Feedlots
    iv. Registered Mining Operations

c. Overlay Layers (not scored)
    i. FEMA
    ii. Shoreland
    iii. CR W&S
    iv. Greenways – DNR could provide a layer that delineates connections between ecological layers.

Please contact me with any questions or reactions to these comments. They are intended as suggestions and to provide perspective regarding DNR’s interpretation of the project deliverables:

1. Create the ECLUE model that will:
    a. Assign a numerical value to land areas covering Goodhue County;
    b. Identify areas of high significant ecological values;
    c. Identify areas most sensitive to development and appropriate to enact conservation measures;
    d. Identify areas least sensitive to development; and
    e. Highlight at-risk features.
2. Prepare a final report summarizing the project successes, challenges and outlining the technical protocol used to create the model.

With approximately 35 working days remaining I am confident that the County and 1,000 Friends will successfully complete the project.

DNR Memo – Ecological Layer

Minnesota Department of Natural Resources

Central Region Community Assistance
1200 Warner Road, St. Paul MN 55106
651-259-5835

To: **Alison Slaats, 1000 Friends of MN**

From: **Marybeth Block, DNR Community Assistance Specialist - Metro Region**
Bart Richardson, DNR Central Region GIS Specialist

RE: **Ecological layer** for the Goodhue Model Meta Data and Fact Sheets

d. 3 points if polygon is mapped as a **MCBS native plant communities**

e. 2 points if polygon is mapped as a **MLCCS native community**

f. 1 point if the polygon is identified in ecological **forest interior habitat** model or mapped as a **MLCCS non-native natural community**.

A. MCBS native plant communities:

Meta Data Overview and Link: http://deli.dnr.state.mn.us/metadata/mcbs_npcpy3.html

This data layer contains results of the Minnesota County Biological Survey (MCBS). It includes polygons representing the highest quality native plant communities remaining in surveyed counties. These native plant communities are important areas for conservation. Native plant communities (sometimes also referred to as "natural communities") are groups of native plants that interact with each other and their surrounding environment in ways not greatly altered by modern human activity or by introduced plant or animal species. These groups of native species form recognizable units, such as an oak forest, a prairie, or a marsh, that tend to repeat across the landscape and over time. Native plant communities are generally classified and described by considering vegetation, hydrology, land forms, soils, and natural disturbance regimes. The native plant community types and subtypes in this data layer are classified primarily by vegetation and major habitat features. Classification and inventory of native plant communities is an ongoing effort of the Natural Heritage and Nongame Research Program and the Minnesota County Biological Survey. The Minnesota County Biological Survey located higher quality native plant communities using aerial photo interpretation followed by field survey of selected sites. Areas that were not mapped as native plant community polygons primarily represent: 1) land where modern human activities such as farming, overgrazing, wetland drainage, recent logging and residential and commercial development have destroyed or greatly altered the natural vegetation; and 2) native plant community polygons that were below minimal size criteria. Note: some areas that were not mapped are important for conservation. They may include habitat for native plants and animals, corridors for animal movement, buffers surrounding high quality natural areas and open space, and target areas for restoration.

MCBS webpage link: **http://www.dnr.state.mn.us/eco/mcbs/index.html**

MLCCS native community: *This parameter has been slightly altered from the 4/13/09 memo – it now includes only all (type a-d quality) native communities.*

MLCCS Meta Data Overview and Link:
http://deli.dnr.state.mn.us/metadata/lulc_mlccspy3.html
Land cover data set based on the Minnesota Land Cover Classification System (MLCCS) coding scheme. This data was produced using a combination of aerial photograph interpretation and field surveys. There is a minimum mapping unit of 1 acre for natural vegetation and 2 acres for artificial cover types.

MLCCS Fact Sheet:
http://files.dnr.state.mn.us/assistance/nrplanning/community/mlccs/factsheet.pdf
MLCCS Website: http://www.dnr.state.mn.us/mlccs/index.html

Forest Interior Habitat Model *This parameter has been slightly altered from the 4/13/09 memo – it now includes MLCCS non-native natural communities*

Forest Interior Habitat Model used GAP land cover data (from 1992 landsat images) to predict suitable habitat for 5 species red-eyed vireo, wood thrush, scarlet tanager, ovenbird and eastern wood pewee. The model found forested area that fulfilled the size and shape parameters to sustain neo-tropical song birds.

This model could be updated using the Goodhue County Forest Layer or the MLCCS data or the USGS National Land Cover Dataset.

This layer is related to the Central Region RSEA (http://deli.dnr.state.mn.us/metadata.html?id=L390002900201), though is only one component of that larger analysis and is south of that extent.

Ecological Patches :

The combination of the above layers, with the highest score for a given area overwriting lower scores.

The RSEA were created with a similar process, but the overlapping areas were dissolved into one polygon. The new, larger polygon was given the score of the majority of the area score before the dissolve. This same process can be run for this project if Goodhue County wants it.

Greenways Layer: *This layer will be created if requested from the DNR.*

This layer would indentify the potential ecological corridors between the ecological patches. It would be generated using cost / distance analysis, finding the shortest connection through the best land cover types between the patches. Natural and semi-natural areas would be the preferred route, followed by agriculture land, then areas with low imperviousness (little development). Connections through developed areas would be made if that was the only choice. Only patches within 5 kilometers of each other would be connected.

The metro patches and greenways (corridors) are included in the data bundle as an example of this analysis.

DNR Email: Geologic Edge Data

From: Jeff Green
Date: 6/24/09
Subject: Re: St. Lawrence Edge

St. Lawrence-Franconia Edge

DEFINITION

The St. Lawrence and Franconia formations are layers of shale, siltstone and dolostone that underlie the Prairie du Chien and Jordan formations. The St. Lawrence and Franconia are closest to the surface at the base of the wooded hillsides that form the blufflands along the Mississippi River and its tributaries. In this part of the landscape these formations are zero to forty feet below the land surface. Water from the Prairie du Chien and Jordan formations and from the hilltop and side slopes moves down the hillside and discharges from springs and seeps from the St. Lawrence and Franconia. These springs form the trout streams that are tributary to the major rivers in southeastern Minnesota. There is some preliminary evidence to indicate that some of the water moving through the edge recharges the aquifer below the St. Lawrence and that this edge may remove nitrates in a manner similar to the Decorah Edge in Olmsted and Fillmore counties. The forests on the hillsides are a critical component of this landscape.

CONCERNS

The St. Lawrence Edge is prominent in the blufflands area. It is an emerging issue with concerns being raised about groundwater recharge, water contamination, bluff stability, and cold water for trout streams.

Ground water recharge is can be impacted by surface activities such as road construction, water and sewer line trenching, housing development. Clearing of the forests can alter the natural hydrology of the hillslope and change the groundwater recharge and discharge patterns. Homes built on top of the shale and siltstone units of the St. Lawrence Edge may experience wet and flooding basements. To date, there is no special recognition or protection of this unique area. Only minimal protection is afforded to the upper bluffland drinking water recharge areas, the natural water purification system and cold-water sources for trout streams. Communities can adopt zoning regulations that guide development in these areas.

Appendix C – Meeting Summaries

Overview of Meetings

Date	Meeting Topic	Location	Agenda/ Notes/Minutes Included?
August 16 2008	Project kick-off meeting	Redwing	Agenda
November 13	DNR, Goodhue County & 1000 Friends of Minnesota – project overview	St. Paul	N/A
December 4 1008	DNR & 1000 Friends of Minnesota – project review	St. Paul	N/A
February 9 2009	Model overview to Goodhue Planning Commission	Goodhue Co.	N/A
March 4, 2009	County Comprehensive Plan	Goodhue Co.	See note below
March 17 2009	DNR & 1000 Friends of Minnesota – project review	St. Paul	N/A
April 3 2009	DNR & 1000 Friends of Minnesota – project review	St. Paul	N/A
April 8 2009	County Comprehensive Plan	Goodhue Co.	See note below
April 9 2009	Goodhue Land Use Model Review	Red Wing	Minutes
May 6 2009	County Comprehensive Plan	Goodhue Co.	See note below
June 3 2009	County Comprehensive Plan	Goodhue Co.	See note below
June 19 2009	Final project review	St. Paul	N/A

County Comprehensive Plan Meetings
The land use model was discussed at public meetings held as part of our 5 year review of the County Comprehensive Plan. In addition to providing an explanation of the project, attendees were encouraged to provide feedback at the meeting or after the meeting.

County Planning Advisory Commission Meetings
Goodhue County staff provided project summary and updates to officials and Goodhue County staff at all regular Planning Commission Meetings beginning in September 2008 and continuing through the end of the project.

Goodhue County Land Use Evaluation Model Agenda
Design Meeting – August 16, 2008

Agenda – Discussion Outline

1. Review existing models overview
    - ❖ Design
    - ❖ Use

2. Model Technical Considerations
    - ❖ What do we want/need to measure
        - o Big issues in Goodhue (slopes, views, prime ag, aggregate, etc.)
        - o Data availability
        - o Analysis Unit/Cell Size
        - o Guided by ordinance, stricter than ordinance
        - o Meet Comprehensive Planning goals
        - o Outcome? Prioritize acquisition or site development? Other?
        - o Weighting – how and will the layers be weighted?

3. Political Considerations
    - ❖ Model Framing
        - o NR or Development focus
        - o Intended use – county wide or site specific analysis
        - o Current land-use review process – what is missing? How can/will model inform that process?
        - o Parcel boundaries – analytic or political?

    - ❖ Local Involvement – how to include
        - o Local government input
        - o Community input
        - o Experts/Stakeholders
        - o How much input will each have to the process and model design.

4. Action Timeline
    - ❖ County as requestor
        - o Sub-Contract with 1000 Friends of Minnesota
        - o County Board action needed – resolution?
        - o Timeline
        - o Related county activities
        - o County staff in-kind – how to include in proposal, how to quantify

Land Use Model Information sharing and gathering meeting
Goodhue County
April 9, 2009

Participants:
Sally Wakefield- 1000 Friends of Minnesota
Allison Slaats- 1000 Friends of Minnesota
Vanessa Morrell- 1000 Friends of Minnesota
Tracy Pooter- Wabasha County Planning and Zoning
Doug Sommer – Minneola Town board
Brain Peterson – City of Red Wing
Fred Mohn – Hay Creek Township
Don King – City of Zumbrota
Neil Jensen-
Kelly Moriarty – Goodhue County Land Use
Mike Wozniak – Goodhue County Land Use
Lisa Hanni – Goodhue County Land Use
Sarah Schrader – Goodhue City
Alan Laumeyer- Goodhue City
Marybeth Block- DNR
Kristen Eide-Tollefson – Florence Township

Agenda:
- Introduction
- Brainstorming
- Draft model presentation
- Discussion
- Wrap up

What are the top considerations when planning for future lands uses in Goodhue County?

Natural resources
- woodlands
- woodland protection and management
- bluff protection
- bluffs, steep slopes, new sheds, natural vegetation
- stream, riverside protection, water quality
- surface water quality
- water resources, wetlands, streams, rivers, watersheds
- water protection, rivers, groundwater
- riparian, new damns
- public open space, green space
- incremental loss of wildlife habitat
- what are potential uses of values of undeveloped lands in the county?
- Protection of agricultural land uses?

Agriculture
- Agricultural lands and soils
- Farming
- What is amount of tillable land and what number of feedlots can county sustain

Cultural/ historical

- cultural and historical locations
- population growth pressures
- how do you keep a rural identity?

Economics

- what are the values that pertain to our natural resources both dollars and green infrastructure functions?
- Cost of services, revenue

Transportation and public services

- future growth, residential, C/I w/ urban services
- approximate location to services/roads/work and shopping
- impact of storm water management systems
- how new development will effect infrastructure services
- transportation services, roads, rail, shipping, transit
- wind power
- public facilities, school services
- evaluation of property according to land use, how will model effect land value

Regulatory

- have you considered or are you considering possible carbon sequestration values
- would like a map for each township in the land use evaluation to help design in permitting and informing people as to why yes or no
- how can the model be used to protect areas from major infrastructure routes and projects
- regulation to control and manage land use
- what is the difference in approach between protection and mitigation

Are there other items that should be included in the model?

- for future: wind power locations
- prime farmland soils
- stormwater management
- damns and water retention areas
- DNR forest model
- Cultural and historical sites (identify like feedlots- points with buffer)
- Transportation routes and where greenways cross roads
- Rare and endangered animal and plat community locations
- Pollution hot spots

Are there any items that are being double counted?

- NRI layers and green infrastructure, bluffs, riparian
- FEMA floodplains maybe

Other notes:

- pull out 5 layers of NRI layer
- use gray infrastructure on top of NRI layer
- regulatory layers vs. natural layers, separate an use depending on needs
- trout streams and protected streams, need additional weight?
- Use model to identify pollution hot spots
- Use to identify issues for property sales and development proposals