

Exploring a New Interstate Corridor Between Eau Claire, WI and Rochester, MN through the Use of GIS

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Abstract

Eau Claire, WI and Rochester, MN are two cities approximately 94-96 miles apart. Through the use of GIS analysis a new interstate corridor was examined by exploring how a system may connect two growing communities and thereby benefiting local health and business economies. GIS Analysis was performed through the use of Digital Elevation Models (DEM's), land usage rasters, and protected land areas within the study area (Eau Claire, WI to Rochester, MN). Data were analyzed through raster analysis with potential corridor sites being located within a route in relation to cities with a population less than 10,000, slope less than or equal to 24°, and protected land areas. The outcome displays a “possibility” of potential sites for an interstate corridor and a pragmatic reality some cities and protected areas may be affected in both a positive and negative manner.

Introduction

The United States Interstate System arose out of the Federal-Aid Highway Act of 1956. Through the work of President Dwight D. Eisenhower, the Federal-Aid Highway Act became a reality on June 29, 1956. This act became known as the National System of Interstate and Defense Highways and in present day is referred to as the Interstate Highway System. The Federal Highway Administration created the transportation system to increase road safety, reduce road congestion, create growth in the economy, and defense of the United States of America (Weingroff, 2002).

As of 2011, there is no current straight line path from Rochester, MN to Eau Claire, WI. There are a series of state highways which create a route which takes approximately 2 hours for a traveler who wishes to travel from Eau Claire to

Rochester. The interstate corridor, as a concourse of transportation, is important due to its ability to create a “heightened accessibility to different areas through the streamlining of time-cost distance and distribution of population” (Lichter and Fuguitt, 1980). The creation of a transport system may aid the region it crosses in added mobility, productivity, and economic development.

The need for a streamlined road system has grown immensely over the last 55 years. Due to the age and condition of some current road structures, there is a need for construction of new road structures to replace aging road systems. Bessert (2009) explains WI State Highway 85, a main highway which connects Eau Claire and Pepin County, was first designated along its current route around 1920. Use of current road systems in place may be incorporated

or upgraded into the placement of a new corridor.

The study area is between Wisconsin and Minnesota (Figure 1). The City of Eau Claire is located in Eau Claire County. In Wisconsin, the study area includes the counties of Eau Claire, Trempealeau, Pepin, Dunn, and Buffalo. The City of Rochester is located in Olmsted County. The study areas of Minnesota include the counties of Olmsted, Winona, and Wabasha.



Figure 1. Counties in Wisconsin and Minnesota which are in a direct path of Eau Claire, WI and Rochester, MN.

While two bridge-crossings currently exist in the study area, new bridge crossings are explored within the study area. An outcome of the study is the location of potential new bridge sites between the two current bridges located in the study area. Currently, the only state to state bridges are located in the City of Wabasha (Wabasha County) and the City of Winona (Winona County) (Figure 2).

When exploring a new interstate corridor, one attribute to consider is that the majority of construction would take place in what is deemed the “Driftless Area” or “Driftless Zone.” This is an area in western Wisconsin and southeastern Minnesota that has a terrain which is extremely rocky, has many elevation levels, and is more like a

series of valleys which have sharp breaks and slopes between their sides and bottoms (Whitbeck, 1913; Zakrzewska, 1971).

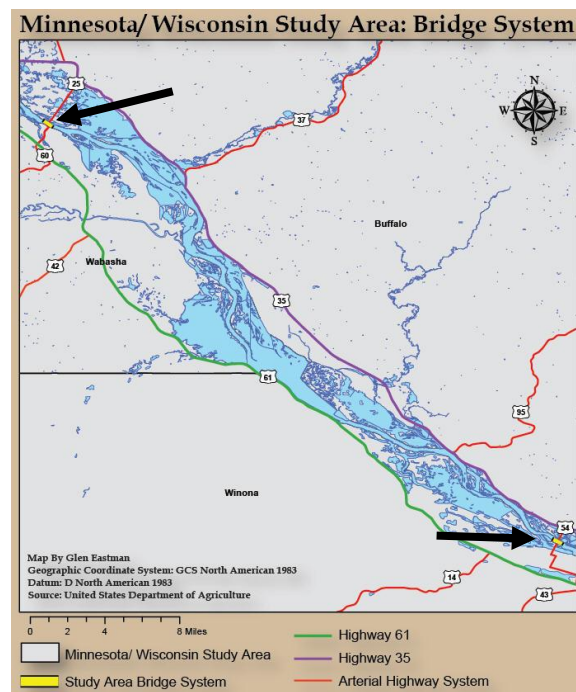


Figure 2. Current bridges located in Wabasha, MN and Winona, MN.

For the purpose of this study, economic impact, interchanges, and off ramp placement will not be evaluated. Cities within the study area, the majority having a population of 10,000 or less, may experience an economic impact due to the inception of a new interstate corridor. Historically, construction of an interstate has had an economic impact on cities which are currently developed or underdeveloped.

For example, creation of the I-43, connecting Beloit, WI to Green Bay, WI, afforded manufacturing employment to increase by about 30% within counties containing the corridor (NCHRP, 1996). It also may be noted land parcels near interchanges and off ramps tend to increase in value (Hoyt, 1960).

The objective for this analysis was to identify areas within the study area where a

new interstate corridor connecting the cities might be envisioned.

Methods

Data Acquisition

Vector base maps of Wisconsin and Minnesota were acquired from ESRI. Attributes for city population, highways, and water features were used and reprojected to a Geographic Coordinate System of GCS North American 1983 and a Datum of North American 1983. This coordinate system and datum were used to correspond with other datasets used in the study.

Several datasets were needed to complete this research. All raster datasets were produced with a spatial resolution of 30 meters. 2008 DEM datasets, from both Wisconsin and Minnesota, were acquired from the United States Geological Survey and merged to create the study area. Slope layers were derived from the DEM layers and were then clipped to the study area.

2008 Land Use Land Cover (LULC) datasets (30 meter resolution) were acquired from the United States Department of Agriculture. These layers were used for core analysis.

Land use files were subdivided into individual categories from sub categories and combined through the use of the raster calculator. The following aggregated categories were used for raster analysis – Developed, Wetlands, Forested, and Agricultural.

Protected land areas were acquired from the Data Basin Protected Areas Center and converted to raster data. Protected areas data was combined into one category though it is made up of public lands, parks, and

waters which have been preserved to conserve fish, wildlife, and plants.

Data Manipulation

DEMs were converted into slope to display a slope of 24° or less. Slope is defined as the grade of a highway (WSDOT, 2008). The grade of a highway is “a measure of its incline or slope and the amount of grade indicates how much the highway is inclined from the horizontal (Koth and Atkins, 2002).” Grades are a concern for vehicles carrying or pulling heavy loads through excessively high sloped terrain. If a grade is too steep, vehicle operators must use excessive braking when going downhill and vehicle operators going uphill have to slow down severely, possibly affecting traffic flow adversely (Reid, 2006).

The slope of 24° was chosen for two reasons. Due to the Driftless Area being comprised of weathered rock, a slope of 20° has been deemed by civil engineers as good for short distances. Excessive grades require more maintenance, and roads are harder to keep intact (Bureau of Land Management, 1985). Secondly, 95.58% of the study area has a slope less than or equal to 24°. Raster analysis was conducted with 6 classes. 24° became the acceptable mean due to covering distances of less than one mile for location of potential high maintenance areas.

Manipulation of Study Area

Due to natural topographic variations, the study area was divided up into two study areas for further evaluation. This was due to slope changes, which differ dramatically where Minnesota and Wisconsin is bordered by the Mississippi River (Figure 3).

MN/ WI Study Area Total Slope: Six Classes

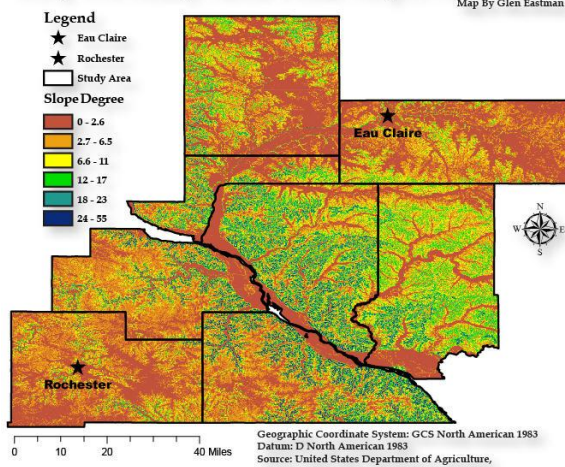


Figure 3. Slope of study area in Minnesota and Wisconsin showing Eau Claire WI, Rochester MN, and counties contained in the study area.

Current Wetlands, Protected Areas, Highway System and Cities with a population less than 10,000

MN/ WI Study Area: Wetlands, Protected Areas, Highways, and Cities

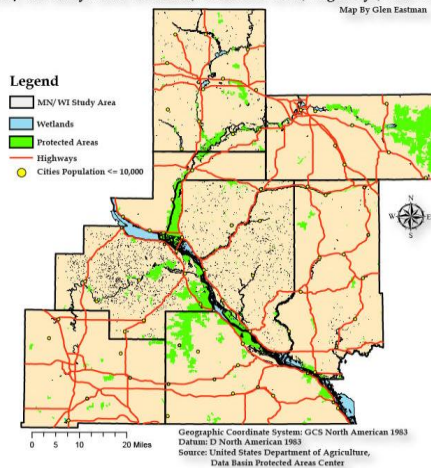


Figure 4. Study area with Wetlands, Protected Areas, Highways, and cities with a population less than 10,000.

Wetlands and protected areas were combined into one category due to their proximity and description within original datasets. Current wetlands and protected areas surrounded by highway systems and cities with a population less than 10,000 were used for analysis. It must be noted that

“cities” refers to towns, villages, and unincorporated communities. Current highways and city locations would eliminate areas for potential corridor locations (Figure 4).

Forested and Developed Areas

In the study, it was important to find out which lands were developed and which areas were forested. These land use types were queried with the purpose of identifying

MN/ WI Study Area: Forested, Highways, and Cities

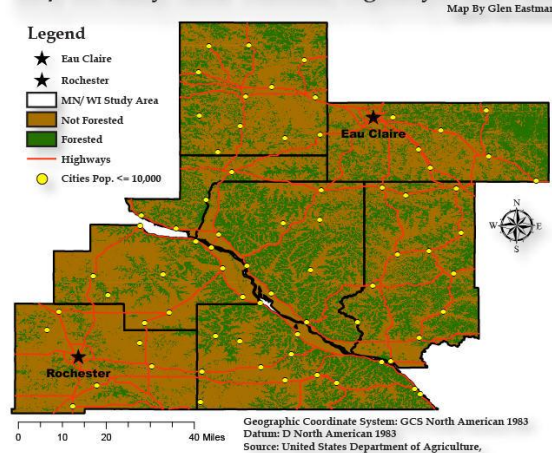


Figure 5. MN/ WI Study area and correlation of Forested, Non-Forested, Highways, and cities with a population less than 10,000.

potential land acquisition areas. Figure 5 displays LULC Forested areas of the study area. The areas were categorized into Deciduous Forest and Evergreen Forest.

Developed attribute data were originally classified within the LULC raster data with multiple features. Developed land refers to development that takes place when the parcel owner makes raw land suitable for residential or commercial use.

Developed features were defined in separate categories: Open Space, Low Intensity, Medium Intensity, and High Intensity. Through the use of the raster calculator, the Developed categories were combined into a single group defined as Developed (Figure 6).

MN/WI Study Area: Developed, Highways, and Cities

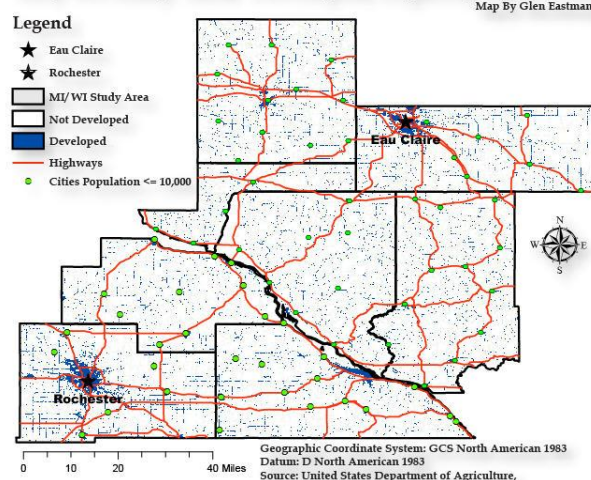


Figure 6. MN/WI Study Area: Developed, Non-Developed, Highways, and cities with a population less than 10,000.

Analysis

Study Area

The study area is based on five counties in Wisconsin and three counties of Minnesota. Analysis of this area was selected due to data availability, current highway system data, cities population statistics, and counties selected are all within a straight line path from Eau Claire to Rochester. The majority of the cities within the study area have a population of 10,000 or less. For the purpose of routing a corridor location, it is assumed there is not significant residential or commercial property which would limit potential corridor locations. Cities with a population less than 10,000 were chosen as a benchmark or a location as to which can be built around.

Results follow the methodology as if construction of the new interstate corridor was originating from Eau Claire, WI. The study area was subdivided into new categories: Wisconsin and Minnesota. Special attention is paid to Buffalo County (WI) and Wabasha County (MN), and Olmsted County (MN). Location of the

corridor site was based on avoiding as much of the wetlands, protected, and currently developed land as possible. Forested and agricultural regions were located for potential land acquisition and location of an interstate corridor.

Wisconsin Study Area

Developed, Wetlands, Protected, and Agricultural Areas

WI Study Area: Developed, Cities, Highways

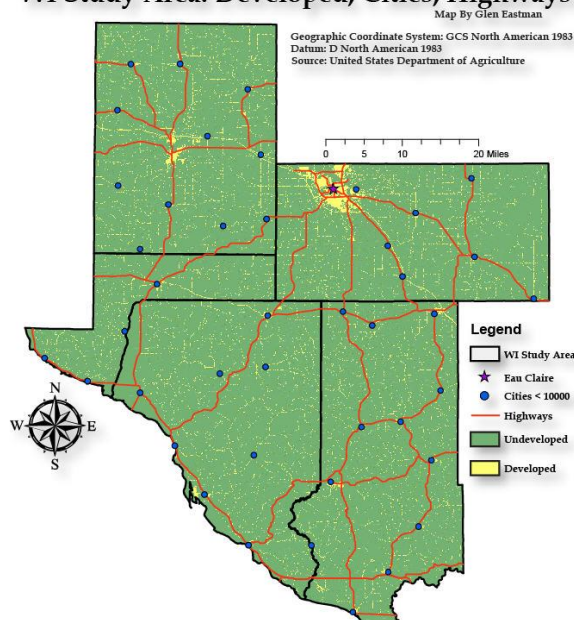


Figure 7. WI Study Area: Developed, Non-Developed, Highways, and Cities with a population less than 10,000.

Figure 7 displays developed areas in relation to cities with a population less than 10,000 and current highway system. Eau Claire has the highest area of development within a 4 mile radius of the city.

Outside of the City of Eau Claire and Eau Claire County, there is sparse development outside of other cities and highway locations. Creation of an interstate corridor could have an impact on cities that it might spur development. Lack of development would afford the establishment of a new interstate corridor in that there may

be less disruption in developed land use system currently intact.

Wisconsin Study Area: Protected & Wetlands

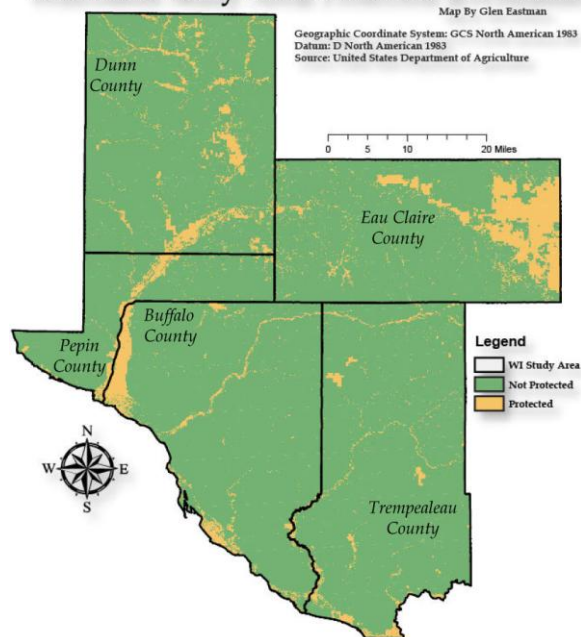


Figure 8. Protected and Wetland areas in Wisconsin study area.

Figure 8 illustrates wetlands and protected areas within the Wisconsin study area. There are few protected areas and wetlands existing through the majority of Eau Claire, Trempealeau, and Buffalo Counties. Protected areas and wetlands become prevalent towards southwestern Buffalo County. Creation of an interstate corridor is feasible through the majority of Buffalo County, though special attention must be paid to southwestern and southern regions of the county due to wetland and protected land being located in those areas. Agricultural land usage comprises 46.39 % in the Wisconsin study area. Figure 9 displays agricultural land use throughout the Wisconsin study region. Agricultural land might more easily be acquired for corridor development.

Agricultural is referred to as both LULC categories Pasture/Hay and Cultivated Crops. Construction of the

interstate corridor may inhibit agricultural land use in the study area.

Wisconsin Study Area: Agriculture

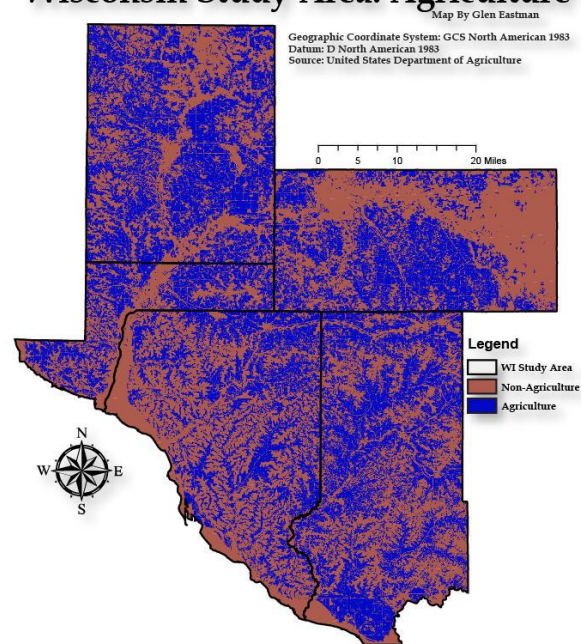


Figure 9. WI Study Area: Agricultural and Non-Agricultural land usage.

Slope

Isolation of areas with an appropriate slope of near 24° is prudent for location of a corridor site. Figure 10 shows Wisconsin study area of slope less than or equal to 24°. Figure 10 also displays Highways, Cities with a population less than 10,000, and current bridges. Cities potentially impacted by the path of a new corridor are listed in Figure 10 as a result of a crossing point being placed between the two current bridges.

Slope of less than or equal to 24° is evident throughout the southern region of Pepin, Buffalo, and Trempealeau counties in Wisconsin. Of the three counties, Buffalo County has the largest amount of slopes over 24°. A high slope is subject to intense scrutiny by the Wisconsin Department of Transportation (WSDOT). According to the

WSDOT Construction and Materials Manual, “exposed soil along the slope shall be protected from surface erosion and the stability of the excavation slopes shall be designed for site specific conditions which shall be shown and described in the working drawings (WSDOT, 2008).” Due to the high amount of slope over 24° not being totally avoided in the region, special attention must be paid to conditions which exist.

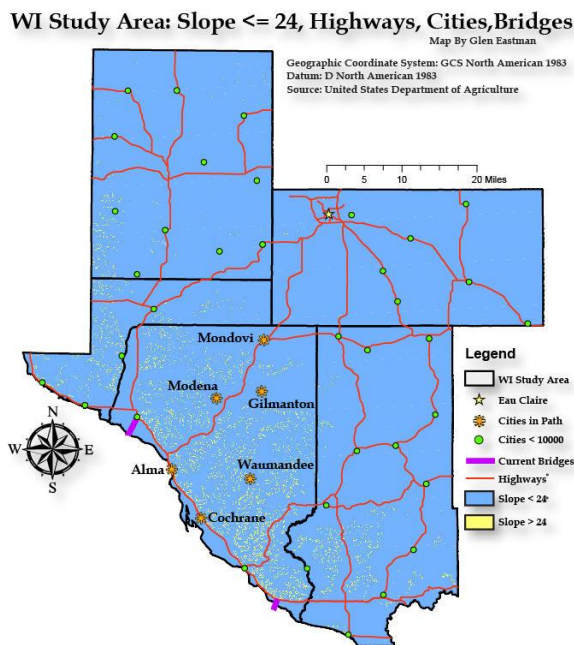


Figure 10. WI Study Area: Slope <= 24°, Highways, Cities with a population less than 10,000, and current bridges.

Buffalo County

Buffalo County, located within the Wisconsin study area, is the most likely location for an interstate corridor. This is most likely for a straight-line path it offers from Eau Claire WI to Rochester MN. Buffalo County is also where both bridges exist which allow traffic flow between Minnesota and Wisconsin.

Figure 11 displays Buffalo County as having bridges, 6 cities with a population of 10,000 or less, an arterial highway system, and majority of the county having a slope

under 24°. 14.99% of Buffalo County has a slope of over 24° but due to its sporadic nature, locations for a corridor may require minimal excavation. With the exception of Highway 95, located in the southeast portion of Buffalo County near Fountain City, all other highways and cities are located outside or on the periphery of slopes less than or equal to 24°.

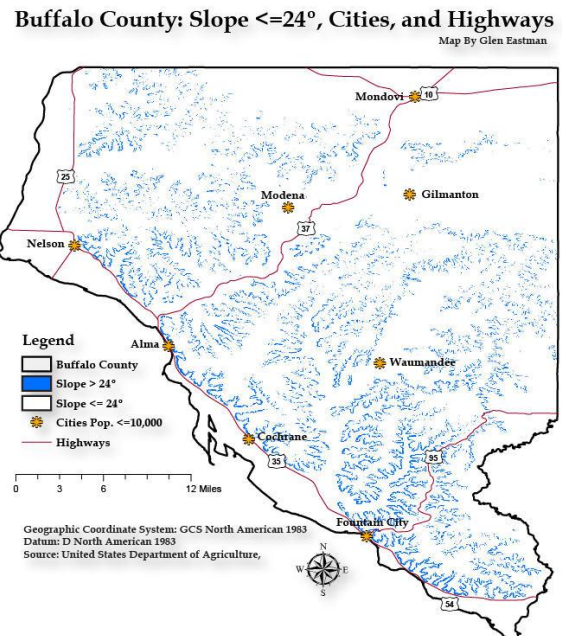


Figure 11. Buffalo County: Area of slope <= 24°, Highways, Cities with population less than 10,000.

Figure 12 displays Buffalo County with protected areas and wetlands. Two major protected areas are located in the western and south central regions of Buffalo County. These areas are surrounded by wetlands but some of which are within protected areas.

An important aspect is the south-central protected area, between the current bridges, located within Buffalo County. In order to keep a straight-lined path for an interstate corridor and avoid entering protected areas, evidence suggests a logical crossing point into Minnesota would be near the cities of Alma and Cochrane.

Buffalo County: Protected, Bridges, Highways, Wetlands, and Cities
Map By Glen Eastman

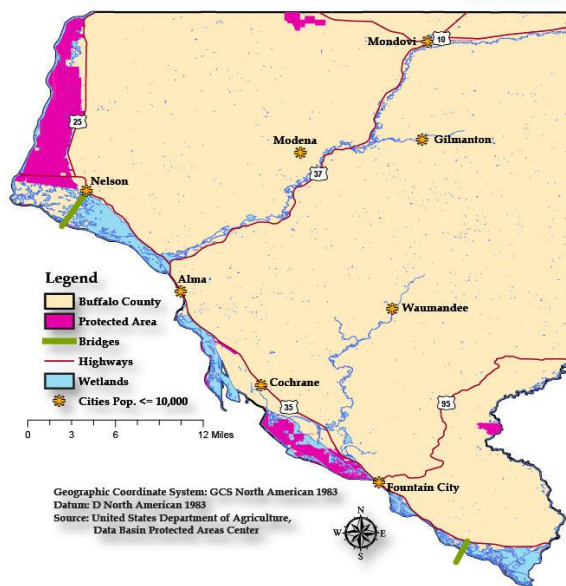


Figure 12. Buffalo County: Protected Areas, Bridges, Highways, and Cities with a population less than 10,000.

Minnesota

Wabasha County

Wabasha County (MN) borders Buffalo County (WI) to the west. Wabasha County has an extensive area of protected areas and wetlands. Location for a crossing point for an interstate corridor between Buffalo County and Wabasha County hinges on the amount and location of protected areas within Wabasha County.

Figure 13 illustrates an extensive protected areas region in the eastern portion of Wabasha County. Creation of a crossing location of the smallest portion of protected area would be critical in order to not disrupt the region. Special considerations would need to be made in construction of an interstate corridor crossing.

Potentially, some protected areas might have to be infringed upon or sacrificed to complete the project. The Minnesota Department of Natural Resources

would have to evaluate classifications in these areas.

Wabasha County: Protected Areas, Wetlands, Highways, Cities
Map By Glen Eastman

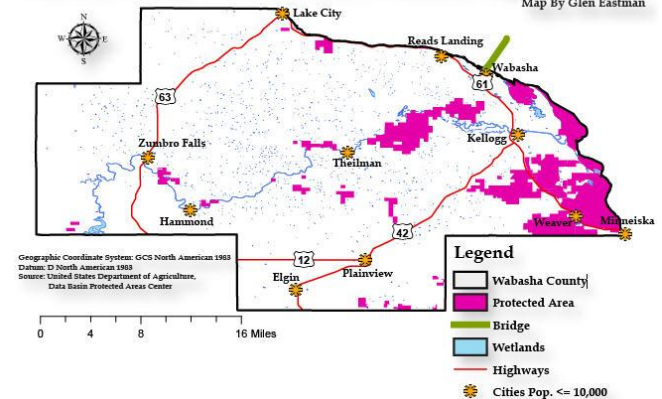


Figure13. Wabasha County: Protected Areas, Bridge, Highways, and Cities with a population less than 10,000.

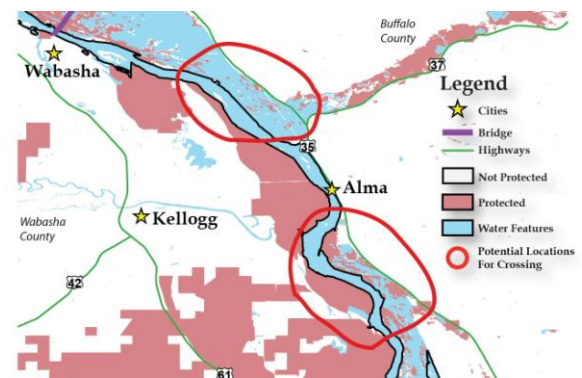


Figure 14. Buffalo/ Wabasha Study Area: Protected Areas, Bridge, Highways, Cities, and crossing location.

Crossing Location

Figure 14 demonstrates where potential crossing sites might be located. This displays two potential locations near Alma, WI. The northern site appears more likely when viewed in relation to protected areas in both Wabasha County and Buffalo County. Crossing of the Mississippi River would have to occur north of the Buffalo River. This may challenge the integrity of the overall study area by limiting options for the location of the corridor.

To maintain the integrity of a straight-line path, construction might best stay east of the Buffalo River. This would put the crossing point into the southern location identified in Figure 14. This would be possible but the bridge would have to be extensive as to not intrude upon protected areas located in the area.

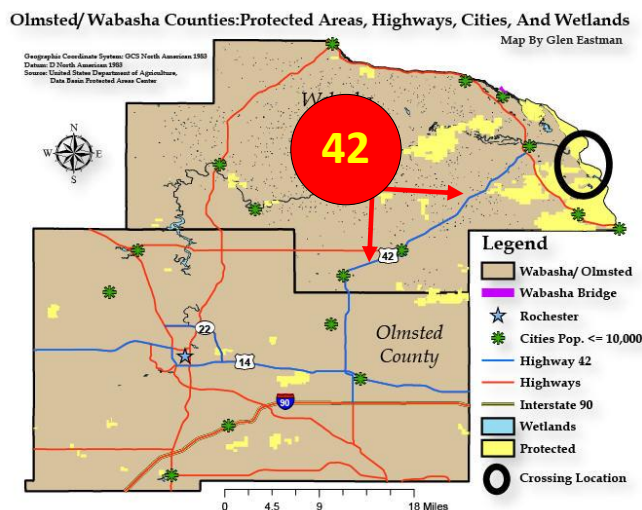


Figure 15. Olmsted/ Wabasha Study Area: Protected Areas, Bridge, Highways, Wetlands, and Cities with a population less than 10,000.

Olmsted/ Wabasha County

Figure 15 displays the crossing location in correlation to both Wabasha County and Olmsted County and protected areas of both counties. The location of an entry point into Rochester, while avoiding protected areas, is critical for a successful corridor to be envisioned. Minnesota Highway 42 is 4.21 miles from the suggested crossing site. There are very few protected areas to interfere with the construction of a corridor here. A corridor is feasible in a straight-line design is feasible and the potential for use of Minnesota Highway 42 (in Wabasha County) as an entry point into Olmsted County makes it attractive. Minnesota Highway 42 potentially could be upgraded to Interstate status depending on LULC.

Figure 16 displays minimal development outside of the Olmsted Study area. It is apparent there is minimal development along the Minnesota Highway 42 corridor within Wabasha County. In Olmsted County, other than a few areas, heavy development occurs on the periphery of Rochester.

Olmsted/Wabasha Counties: Developed Areas, Highways, and Cities

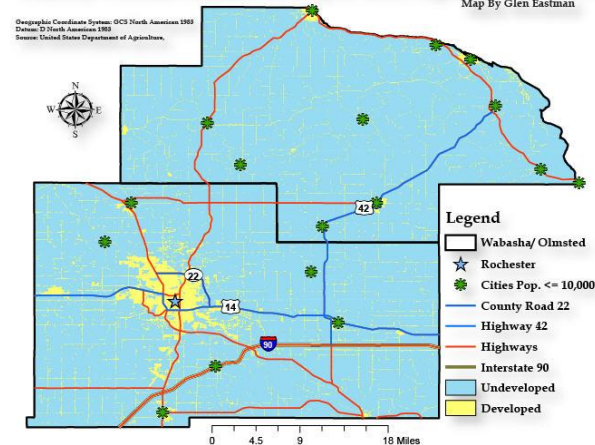


Figure 16. Olmsted/ Wabasha Study Area: Developed Areas, Undeveloped Areas, Highways, Rochester, Cities population under 10,000.

Olmsted/Wabasha Counties: Forested And Agricultural Areas

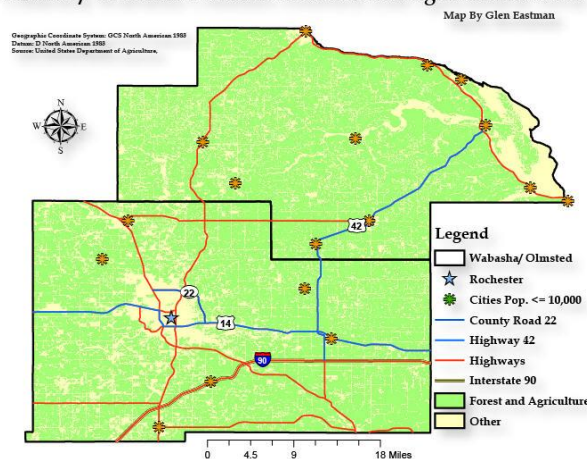


Figure 17. Olmsted/ Wabasha Study Area: Forested and Agricultural Areas, Non-Forested and Non-Agricultural Areas, Highways, Rochester, Cities population under 10,000.

In an effort to determine what land use exists and what would be affected by the construction of an interstate corridor, a

raster was created of both forest and agricultural areas (Figure 17). If land acquisition was necessary, the majority of Olmsted/ Wabasha study area, outside of developed and protected areas, consists of forest and agricultural land.

The study's findings could be used for land acquisition to construct a corridor from the point at which Minnesota Highway 42 turns south. In order to keep a straight line path, 13.21 miles of land would need to be acquired. A majority of the area occurs within Olmsted County connecting Highway 42 and County Road 22.

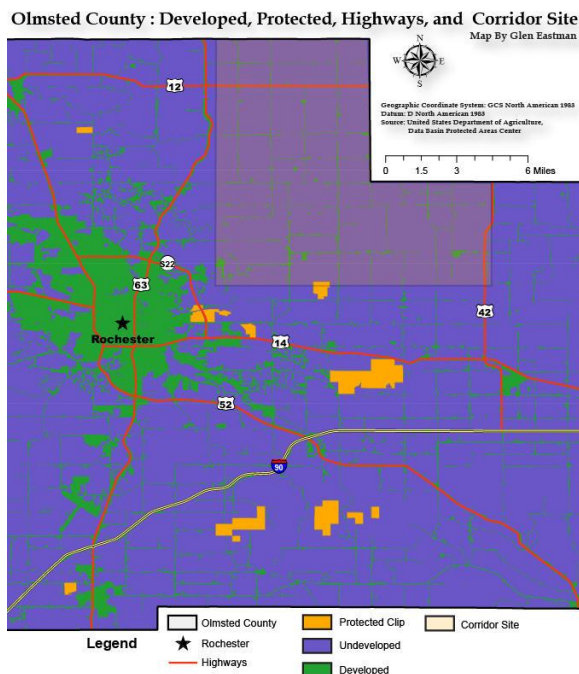


Figure 18. Olmsted County. Protected Areas, Developed Areas, Highways, and potential corridor location site.

Olmsted County

Due to the large amount of forest and agricultural land present, developed and protected areas would be the concern as to the placement of an interstate corridor. Results suggest the best entry into the Rochester area would likely be in the northeast.

Once entering Olmsted County, a decision would have to be made as to how to connect to the corridor to Rochester. Figure 18 displays the interstate corridor into Olmsted County. The map illustrates how the corridor site might enter from the northeast to the periphery of Minnesota County Road 22. A corridor location in this location would not infringe on many protected areas and potentially could aid in the growth of some development in the area. The suggested corridor location site ends 1.48 miles from Minnesota County Road 22.

Final Corridor Location

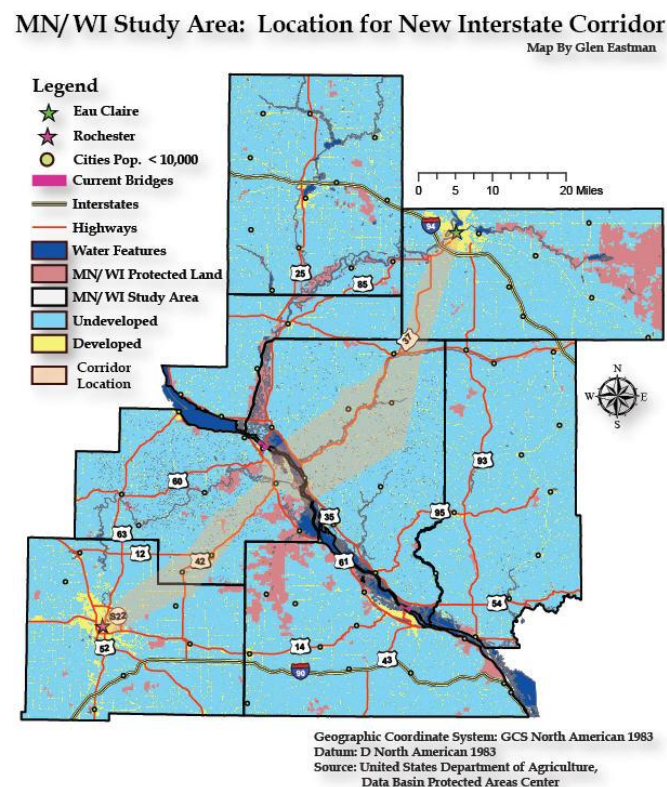


Figure 19. MN/WI Study Area: Locations for new Interstate Corridor.

The final corridor location site analysis and study have determined the final location for a potential location site. Visual and numerical findings suggest a corridor location capable of avoiding major conflict with developed and protected areas. Figure

19 displays a potential corridor location for a new interstate.

The corridor location would create a distance of 76.58 miles between Eau Claire and Rochester. This results in a lower distance by approximately 20 miles less than travel via existing roads.

Conclusions

The results of this study display potential for the creating of an interstate corridor from Eau Claire (WI) to Rochester (MN). Findings suggest it may be possible to create such a project. The crossing points for a new bridge were used as to not violate, or cause as little disruption as possible, to protected areas and wetlands of the study area.

This GIS model was effective in exploring several macro variables used in evaluating potential interstate route corridors. The study did not take into consideration residential streets or secondary highways due to their ability to be adjusted if an interstate corridor was developed.

Though Pepin, Dunn, and Trempealeau Counties were included for spatial reference, they were unexpected by the final selection.

Disclaimer

This study was a macro-scale, rudimentary exploration of several variables to outline potential locations for an interstate corridor system from Eau Claire (WI) to Rochester (MN). Results of the study may be delivered to civil engineers for evaluation of creation of such a project. No references to complete engineering codes or construction requirement specifications of roads or bridges were used, as this domain of knowledge is beyond the scope of this paper.

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