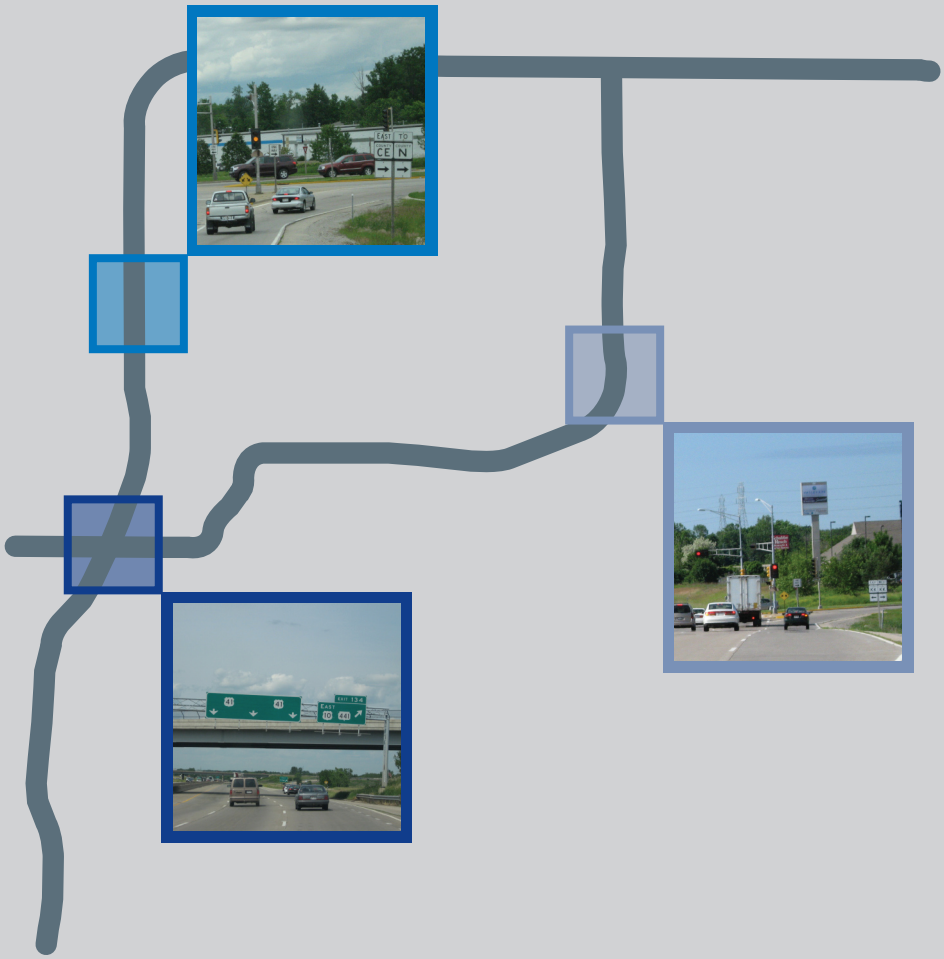

OPERATIONAL NEEDS ASSESSMENT

US 41 (Breezewood Lane to CTH U) and WIS 441

PRELIMINARY REPORT

FINAL

MARCH 2009

PREPARED FOR

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OPERATIONAL NEEDS ASSESSMENT

US 41 (Breezewood Lane to CTH U) and WIS 441

PRELIMINARY REPORT

March 2009

Winnebago, Outagamie, Calumet, and Brown Counties

WisDOT Project I.D. 1130-31-00

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Operational Needs Assessment
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APPENDICES – Volume 2 (bound separately)

INTRODUCTION

Study Location

This report describes the details of the Wisconsin Department of Transportation's operational needs assessment of US Highway 41 (US 41) and Wisconsin State Highway 441 (WIS 441). Project location maps have been provided in **Exhibit 1**. The subject highways are in WisDOT's Northeast Region in Northeastern Wisconsin, north of Lake Winnebago in Winnebago, Outagamie, Brown, and Calumet Counties. The study corridors pass through the following communities:

Winnebago County

- City of Appleton
- City of Menasha
- City of Neenah
- Town of Clayton
- Town of Menasha

Brown County

- Town of Lawrence
- Town of Wrightstown
- Village of Wrightstown

Calumet County

- City of Appleton
- Town of Harrison

Outagamie County

- City of Appleton
- City of Kaukauna
- Town of Buchanan
- Town of Grand Chute
- Town of Greenville
- Town of Kaukauna
- Town of Vandenbroek
- Village of Kimberly
- Village of Little Chute

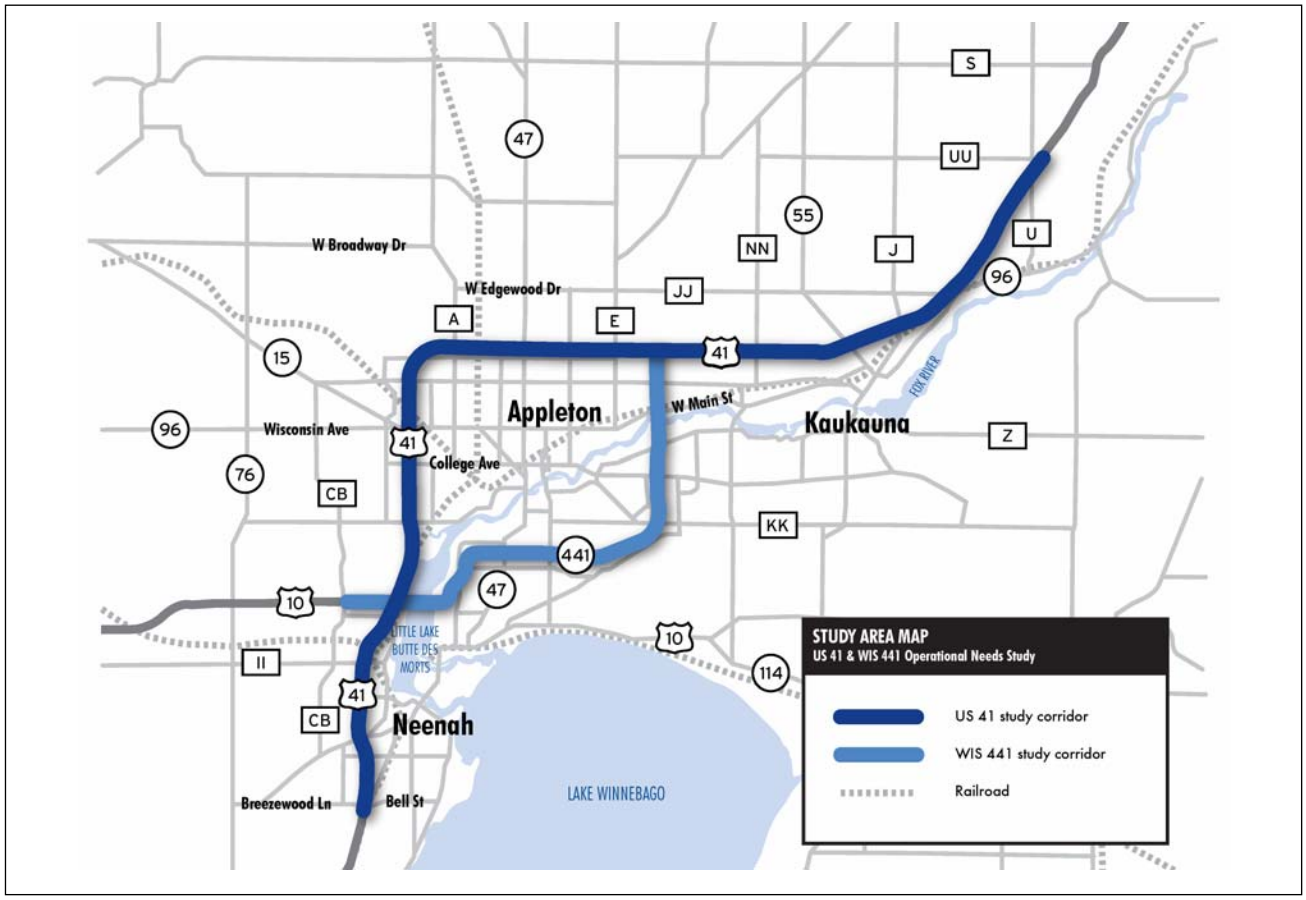
Study Segments

Figure 1 shows the study segments. All study highways are access-controlled freeways with no at-grade access and grade separated crossings. The study area has a combined total of 24 interchanges.

The US 41 study corridor includes the US 41 freeway from Breezewood Lane in the City of Neenah in Winnebago County to approximately one-half mile north of CTH U (County Line Rd.), near Apple Creek Road in the Town of Wrightstown located within Brown County. The US 41 study corridor is 25 miles long and includes 16 of the study interchanges.

The WIS 441 study corridor begins at the intersection of US 10 and CTH CB in the Town of Menasha located within Winnebago County and runs the entire length of WIS 441 to the northern US 41/WIS 441 interchange in the City of Appleton, Outagamie County. Approximately 1.25 miles of US 10 are included as shown in **Figure 1**.

Figure 1: Study Area Map



US 41 and WIS 441 are the primary arterial routes serving the Fox Cities area in north eastern Wisconsin. Both of these facilities are experiencing growing traffic volumes and safety concerns. This report contains the results of WisDOT's study of the existing operational and geometric characteristics of US 41 and WIS 441. Appendix B contains detailed descriptions of the data sources in addition to a detailed list of roadway segments and intersections evaluated.

Table 1 shows a list of the separate studies previously conducted that overlap segments of the US 41/WIS 441 Operational Needs Assessment.

Table 1: Studies That Overlap with the US 41/WIS 441 Project

Project ID	Description
1517-07-00	Tri- County Freeway Expansion, CTH CB- Oneida Street Winnebago county
1120-11-03	Northeast Region ITS Architecture & Traffic Management System Preliminary Engineering (Brown County)
1130-01-00	Northeast Region ITS Architecture & Traffic Management System Preliminary Engineering (Outagamie County)
1133-03-03	Northeast Region ITS Architecture & Traffic Management System Preliminary Engineering (Winnebago County)
1113-00-00	US 41 Interstate Conversion Study

Study Purpose

The purpose of the study is to:

- Analyze how traffic moves through the study area. Traffic movement volumes have been collected and signal timings reviewed.
- Determine where crashes are prevalent. Crash histories at key intersections have been analyzed and evaluated at intersections, interchanges, and roadway geometries.
- Determine when demand will exceed capacity. Future traffic volumes are forecasted and evaluated by HCS, Synchro and Paramics traffic simulation software.
- Determine what can be done to address problems. The improvement options and recommendations for short-term improvements will be tested by Paramics traffic simulation software.
- Provide information for the public. Paramics traffic simulations are suitable for public presentations to demonstrate predictions of traffic conditions in the future with and without improvements.

The main focus of this report is to analyze how traffic is moving throughout the study area. Another focus of this report is to identify and evaluate problem locations with high number of crashes and geometric deficiencies. Future work will be performed including forecasting future traffic volumes and using traffic simulation models to make recommendations for short term improvements in identified problem areas. The models will be suitable for use at Public Information Meetings (PIM) to help visually explain the purpose and importance of the recommended short term improvements.

PROJECT BACKGROUND

Route Importance and System Linkage

US 41 and WIS 441 are functionally classified as principal arterials. The routes are identified by WisDOT as part of a key multimodal intercity corridor called the "Fox Valley Corridor" running from Milwaukee to Green Bay.[1] US 41 and WIS 441 are major passenger and freight corridors linking Neenah, Menasha, Appleton, and Oshkosh to Fond du Lac and Milwaukee to the south and Green Bay to the north. They ultimately link to Chicago and points further south as well as to the upper peninsula of Michigan to the north. By serving the major manufacturing centers of Green Bay and the Fox Valley, US 41 and WIS 441 are critical to serving Wisconsin's travel patterns and supporting the state's economy.

National and Regional Importance

US 41 is a part of the National Highway System (NHS) (**Exhibit 1 – Sheet 3**). In this respect, its function is of state as well as national concern. The purpose of the NHS is to serve major population centers, international border crossings, ports, airports, public transportation facilities, and other intermodal transportation facilities and destinations, as well as to serve interstate and interregional travel. The NHS is expected to carry 40% of the nation's highway traffic, 75% of heavy truck traffic, and 80% of tourist traffic.

As a highway connecting major regions and economic centers, US 41 and WIS 441 are classified by the state as Corridors 2020 multi-lane backbone routes. WIS 441 is the only high-speed route crossing the Fox River system south of Green Bay, at Little Lake Butte des Morts and again east of Appleton, just south of the US 41/WIS 441 northern interchange.

Local Importance

Locally, the roadway connects the Fox Valley's manufacturing and other commerce to the rest of the state and beyond. The highway provides access to markets for freight, gets commuters to and from their jobs, and allows for tourist travel to and from recreation destinations. As such, the highways support the economic well being of the Fox Valley as a whole. There are no other comparable alternative major highways in the Fox Valley.

This lengthy corridor is adjacent to a wide variety of land uses under urban, suburban and rural landscapes. Land uses along US 41 on the north side of the study area are primarily commercial, industrial, agricultural, and some sizeable residential zones. On the west the uses are dominated by commercial and industrial including some large manufacturing facilities, malls and big box retail complexes, as well as Outagamie County Regional Airport. Nearby recreational uses include three golf courses and a major baseball stadium. There is also a cemetery and a quarry.

Land uses along WIS 441 include mainly urban uses such as single and multi-family residential, commercial and industrial. Additional uses include a cemetery, a park, and the University of Wisconsin-Fox Valley Campus.

[1] Connections 2030 Multimodal Maps. http://www.dot.wisconsin.gov/projects/state/2030-maps.htm#winn

Existing Environmental Constraints

A preliminary examination of the apparent environmental constraints present in the study area was conducted. A summary of the results is presented in **Appendix A**. The purpose of this preliminary review is to prepare for the necessary data and analyses associated with future National Environmental Policy Act (NEPA) study. **Appendix A** summarizes the study area's characteristics as related to a wide array of critical factors identified in WisDOT's environmental screening worksheets. This screening exercise is not a NEPA level analysis of potential environmental impacts; rather it is intended to assist WisDOT in identifying any "red flag" issues that they may encounter within the study area.

Factors that would be of concern depend on the type of improvements that may be proposed along the route. In future NEPA analyses, the physical and societal impacts of construction would be assessed as well as any secondary effects that may result from improving access to undeveloped lands. The findings suggest that there are no extraordinary or atypical resources of concern in the study corridor.

Between 1990 and 2000, the fastest growing municipalities in the study area were the Towns of Harrison (80.2%), located adjacently to the southeast of Appleton, and Greenville (79.8%) located in close proximity to the northwest of Appleton. Both towns are growing about eight times faster than the State of Wisconsin which grew at a rate of 9.6 percent during the same time period. The Town of Menasha and Town of Clayton also have had considerable population growth from 1990 and 2000 within the study area. The Town of Neenah on the other hand has lost population at a rate of -1.3 percent while the City of Appleton has only grown at a rate of 3.8 percent over the same ten year period. Wisconsin Department of Administration population projections indicate that that the Towns of Harrison and Greenville will continue to grow at the fastest rates; 132.7 percent and 74.0 percent respectively between the years 2000 and 2025. In comparison, the State of Wisconsin is expected to grow at a rate of 17 percent between 2000 and 2025, far less than the fastest growing municipalities in the corridor.

Given the population changes and the fact that much of the study corridor is located on the edge of urban development, the primary impacts of future capacity expansions or improvements to circulation would be related to growth and development. Local communities may choose to take advantage of increased accessibility by allowing or encouraging development of undeveloped lands that may be in agricultural production, open space, or that serve as wildlife habitat. Indirect and cumulative effects such as this will need further consideration at the time of NEPA review.

Wetlands and water bodies are not expected to be a major concern; however, there are some locations that encounter isolated wetlands and stream crossings. Major area water resources include Little Lake Butte des Morts and the Fox River, both part of the Lower Fox River Basin. Future environmental assessments will need to provide measures for erosion control and storm water runoff both during and post construction.

Crashes and Safety

Crash history was evaluated and analyzed throughout the entire study area. Results of the crash analysis are presented in **Appendix C**. This included analyzing data for crashes along the freeway mainline, ramp merge and diverge points, and ramp terminal intersections. Crashes were broken into two main categories: freeway mainline crashes and interchange area crashes. This information was then used to calculate crash rates and severity rates to determine any crash trends in the corridor as well as to pinpoint the locations with the highest crash problems.

Crash data along highways is updated and cataloged multiple times annually by WisDOT. The crash data for this study have been supplied by WisDOT, the UW-Madison Traffic Operations and Safety (TOPS) Lab, and the City of Appleton. Strand Associates Inc supplied additional crash data for the US 41 corridor in the project boundary. This data have been collected as part of the ongoing US 41 Interstate Conversion Study.

All crashes, excluding deer related crashes, were entered into a geographical information system (GIS). Crash locations were estimated on the GIS map using the initial crash direction, reference point numbers and distances, crash types, and crash locations. **Exhibit 2** provides a color-coded crash breakdown for the study corridor comparing the segments to the statewide average for this type of facility. The criterion for the breakdown was based on the statewide average for annual crash rates. This breakdown is different than the criteria used in **Appendix F** and **Appendix C** because it allows the exhibits to effectively display data which has limited variance.

This project relied on two methods of crash analyses. Method one is the comparison with the statewide average. This method of crash analysis was used in the locations where the corridor as a whole was evaluated and includes all crashes on the mainline as well as the interchange influence areas. The second method of crash analysis looks at each aspect of the corridor as an individual piece. In this method, crash rates were calculated for all merge, diverge, and ramp terminal intersection locations. The boundaries for these areas were based on the type of ramp that was being analyzed.

Crash data was further divided by year (2002-2006) and severity (property damage only, injury or fatality). Along the mainline, the crashes were also divided into different influence areas. An average crash rate and severity rate were calculated for each area and then broken into an annual crash rate and severity rate.

Annual average daily traffic (AADT) counts were extracted from WisDOT's 2004 statewide volume count. A sensitivity analysis on the volume count data relative to the individual segment crash analysis results was conducted due to uncertainty in the level of accuracy of the volume count data. The sensitivity analysis supported full confidence with all results obtained.

The most crash-prone areas along the mainline and at the intersections were determined through this analysis and through calculating the crash and severity rates at different points along the project corridor. It is important to consider the crash rate when examining the crash severity due to the variability that occurs with low crash locations. Corridor segments with the most five year crash totals are presented in **Table 2**, and merge and diverge crash results with the highest crash rate are provided in **Table 3**.

Table 2: Top Five Highest Crash Segments

Facility	Location	# of Crashes (5 yr total)	Crash Rate (HMVMT)
US 10	CTH CB to South US 41 Interchange	56	154
WIS 441	CTH P (Racine St.) to CTH AP (Midway Rd.)	70	86
US 41	CTH E (Ballard Rd.) to WIS 441	58	70
US 41	Main Street to CTH II (Winchester Rd.)	67	62
WIS 441	South US 41 Interchange to CTH P (Racine St.)	79	56

* State average crash rate = 56 HMVMT

Table 3: Top Four Merge/Diverge Crash Rates

Facility	Location	# of Crashes (5 yr total)	Crash Rate (HMVMT)
US 41	SB off-ramp at WIS 96(Wisconsin Ave.)	23	84
US 41	US 41 SB off-ramp to WIS 441 SB	25	102
WIS 441	CTH P (Racine St.) SB off-ramp	29	137
WIS 441	CTH AP (Midway Rd.) NB off-ramp	18	85

Multimodal Accommodations

An overview of the multimodal systems for the Fox Cities Regional Area as well as the US 41/WIS 441 corridor is located in **Appendix I**. This section outlines the existing accommodations for pedestrian/bicycle, transit, as well as the park and ride system within this area. In addition to outlining the existing programs and facilities that are present there is also information pertaining to current projects and studies that have to do with multimodal transportation.

EXISTING AND FUTURE TRAFFIC OPERATIONS

Existing and Future Traffic Volumes

The WisDOT Northeast Region Travel Demand Model (NE Region TDM) was used to analyze the US 41 and WIS 441 corridors. The year 2005 and year 2035 socio-economic (SE) data for the NE Region TDM was obtained from the existing metropolitan planning organizations (MPO) models for the urban areas of Green Bay, Appleton-Oshkosh and Fond du Lac. SE data from the Wisconsin Statewide Travel Demand Model was used for the rural zones. Meetings were then held with area municipalities to further refine the location of housing in the zones. Employment information for the rural zones was initially estimated using statewide model information, subdivided into each zone of the NE Region TDM, then verified and adjusted through local meetings. The SE data for year 2020 was interpolated from years 2005 and 2035. The roadway network used to establish vehicle travel was similarly developed by combining networks from the existing urban area models. The network for the remaining model area was developed from the Wisconsin Information System for Local Roads (WISLR) network. **Appendix D** outlines the steps taken to create the NE Region TDM.

Roadway traffic volumes were collected from information provided by WisDOT[2], as well as traffic volumes taken from recent projects completed within the study corridor and turning movement counts were collected. There is no specific base yet set because the data has come from multiple sources. This information was compared to the NE Region TDM to create balanced traffic volume data for the road segments and intersections in the study area. The daily mainline volumes used for this study are provided in **Table 4** and **Table 5.** Peak hour traffic volumes were then developed for use in the Paramics, Synchro, and HCS analysis. **Exhibit 6** includes maps detailing the daily volumes and peak hour volumes created for the study.

[2] Traffic count maps by county http://www.dot.wisconsin.gov/travel/counts/maps.htm

Table 4: Balanced Average Daily Traffic on WIS 441

WIS 441 Segment	Existing AADT (NB)	Existing AADT (SB)
West of CTH CB	7200	7200
CTH CB to US 41	11000	11200
US 41 to CTH P (Racine St.)	32800	32800
CTH P (Racine St.) to CTH AP (Midway Rd.)	23200	23200
CTH AP (Midway Rd.) to WIS 47 (Appleton Rd.)	22200	19300
WIS 47 (Appleton Rd.) to Oneida St.	23400	22500
Oneida St. to CTH KK (Calumet St.)	17700	16500
CTH KK (Calumet St.) to CTH CE (College Ave.)	21300	19500
CTH CE (College Ave.) to CTH OO (Northland Ave.)	21700	20800
CTH OO (Northland Ave.) to US 41	14100	13100

Table 5: Balanced Average Daily Traffic on US 41

US 41 Segment	Existing AADT (NB)	Existing AADT (SB)
Breezewood Ln. to WIS 14/CTH JJ (Winneconne Ave.)	35200	34700
WIS 14/CTH JJ (Winneconne Ave.) to Main St./Oakridge Rd.	37600	39300
Main St./Oakridge Rd. to CTH II (Winchester Rd.)	36500	42800
CTH II (Winchester Rd.) to US 10/WIS 441	44400	46400
US 10/WIS 441 to CTH BB (Prospect Ave.)	37500	36900
CTH BB (Prospect Ave.) to WIS 125/CTH CA (College Ave.)	37200	39100
WIS 125/CTH CA (College Ave.) to WIS 96 (Wisconsin Ave.)	33700	35200
WIS 96 (Wisconsin Ave.) to WIS 15/CTH OO (Northland Ave.)	29500	30100
WIS 15/CTH OO (Northland Ave.) to WIS 47 (Richmond St.)	29700	32500
WIS 47 (Richmond St.) to CTH E (Ballard Rd.)	27900	30200
CTH E (Ballard Rd.) to WIS 441	23600	23600
WIS 441 to CTH N (Freedom Rd.)	23600	23600
CTH N (Freedom Rd.) to WIS 55 (Delanglade St.)	23700	24200
WIS 55 (Delanglade St.) to CTH J (Lawe St.)	20000	20400
CTH J (Lawe St.) to CTH U (County Line Rd.)	19600	21700

Traffic volumes on US 41 were heaviest in both directions between Main Street/Oakridge Road in the City of Neenah and WIS 125/CTH CA (College Avenue) in the City of Appleton. For WIS 441, the heaviest traffic in both directions was at the Little Lake Butte des Morts structure between US 41 and CTH P (Racine Street) on the south end of the WIS 441 corridor.

Traffic Operations Analysis

Traffic micro-simulation modeling on the network was performed using Paramics. Paramics modeling simulates behavior of individual vehicles on the network with respect to road geometry, intersection control, congestion and interaction with other vehicles. The Paramics modeling uses base year travel demands and future year travel demands from the TP+/CUBE model to estimate the future travel demands on the transportation system. The Paramics sub-area network trip tables

for the AM and PM peak hours were extracted after the final traffic assignments. This process requires an input network, which was developed in CUBE through the use of the polygon tool and sub-area extraction. **Appendix E** details the process of creating the Paramics model and subsequent analysis.

Capacity and Level of Service

A capacity analysis of the existing roadway was completed to determine level of service (LOS) for the WIS 441 and US 41 corridor. Roadway LOS is the measure of a roadway's response to traffic demands, based on factors such as roadway geometry, travel speeds, peak hourly volume, and percent trucks. Capacity analysis along the US 41 corridor was not evaluated under this project because it has been evaluated under the US 41 Interstate Conversion Study.

The project corridor was broken up into feature categories that highlight specific areas of interest included mainline segments, merge/diverge locations, ramp terminals, and side road intersections. **Exhibit 3** has detailed maps showing the existing mainline level of service within the US 41 and WIS 441 project corridor. The feature categories were systematically graded from A to F based on the operating conditions for the specified segment of roadway. **Table 6** provides a description of each grade of LOS.

Table 6: Level of Service Grading System

LOS	Description
A	Unrestricted free flow, drivers virtually unaffected by others
B	Slightly restricted stable flow, slight restriction in speed and maneuverability
C	Moderately restricted stable flow, driver operation significantly affected by others
D	Heavily restricted flow, poor level of driver comfort and convenience
E	Unstable flow (approach flow > discharge flow), slow speeds and traffic backups
F	Forced flow, stop-go movements with long backups, max. driver frustration

* Source: Highway Capacity Manual

Highway Capacity Software (HCS) was used to analyze all free flowing movements in the corridor. The software is based on the Highway Capacity Manual (HCM) methodology. Specifically, the software evaluated the mainline segments as well as merge and diverge locations near interchange ramps. The software analyzes the input data and places a LOS letter grade to the evaluated roadway. Along with LOS, the program determines the traffic density to help quantify the traffic flow conditions and support the LOS value.

Intersections were analyzed with Synchro to determine intersection delay (in seconds) and evaluate the overall performance of the intersection. Using criteria from the Highway Capacity Manual, Synchro translates the delay into an LOS value for each approach and the intersection as a whole. Synchro is specifically designed to evaluate and optimize signalized and un-signalized intersections.

Four of the eighteen WIS 441 study segments and four of the thirty US 41 study segments experience a level of service of D. None of the study segments experience an existing LOS worse than D. **Table 7** presents the eight mainline segments which operate under heavily restricted flow.

Table 7: Existing Mainline Segments with LOS D or Worse

Corridor	Mainline Segment	Existing LOS	
		NB	SB
WIS 441	US 41 to CTH P (Racine St.)	C (D)	D (C)
WIS 441	CTH P (Racine St.) to CTH AP (Midway Rd.)	C (D)	C (C)
WIS 441	CTH AP (Midway Rd.) to WIS 47 (Appleton Rd.)	B (D)	C (B)
US 41	WIS 15 (Northland Ave.)to WIS 47 (Richmond St.)	C (D)	D (C)
US 41	WIS 47 (Richmond St.) to CTH E (Ballard Rd.)	C (D)	C (C)
US 41	CTH E (Ballard Rd.) to WIS 441	C (D)	C (C)

~ Legend: AM LOS (PM LOS) --- yellow is LOS D, orange is LOS E, & red is LOS F

Appendix H contains all data extracted from HCS and Synchro and also includes LOS ratings for the interchange intersections and merge and diverge locations. Along with existing conditions, each of the study areas was analyzed for 2020 and 2035 no-build conditions to estimate future traffic operations within the corridor.

Appendix H also presents peak hour factors (PHF) and truck percentages for both US 41 and WIS 441. The PHF is an indication of the level of traffic concentration within the peak hour. For example, a high PHF would indicate that the traffic is evenly distributed through all four of the 15 minutes segments within the peak hour. A lower PHF indicates that the traffic is primarily concentrated within one of the 15 minute segments. This data was used to calculate the existing LOS values and delay for both mainline and intersections.

EXISTING HIGHWAY CHARACTERISTICS

A deficiency analysis was completed for the WIS 441 corridor and results of the analysis are presented in **Appendix F**. As-built drawings obtained from WisDOT were reviewed to determine the deficiencies present on WIS 441. The analysis covered all aspects of the roadway including physical conditions, horizontal alignment, vertical alignment, vertical clearance, cross sections, ramp design, other geometric conditions, and structural conditions. These characteristics were evaluated using the latest update of the WisDOT *Facilities Development Manual* (FDM), the *2001 AASHTO Policy on Geometric Design of Highways and Streets* (GDHS), and the *2005 AASHTO Policy on Design Standards – Interstate System* (AASHTO IH Policy).

Much of WIS 441 was designed using FDM standards from 1990 or earlier American Association of State Highway and Transportation Officials (AASHTO) standards. Many of these standards have since been updated due to transportation safety research, economics, and changes in vehicle characteristics. The deficiency analysis identified substandard sections of the highway, problem areas in relation to crash prevalence and safety that could or could not be due to geometric deficiencies, and features of the roadway that only meet minimum standards and could be repaired with short-term improvements at a marginal cost.

The evaluation results are intended to serve as background information to develop possible roadway improvements or alternatives in the future. The analysis results will also be used to support decisions on planning and implementation of future roadway changes. Graphical analysis maps depicting mainline roadway conditions can be seen in **Exhibit 4**. Bridges and interchange analysis maps are included in **Exhibit 5**.

The rating system of GOOD, FAIR, or POOR is based on criteria identified by WisDOT. A list of the criteria used in the deficiency analysis is provided in **Appendix F**. A GOOD rating indicates that the feature is in good condition with respect to standards. A FAIR rating means that the feature is merely sufficient with respect to roadway standards. A POOR rating is an indication that the feature does not meet minimum allowable roadway standards.

Physical Conditions

Pavement condition of WIS 441 is generally FAIR to POOR. The worst pavement condition is found between CTH P (Racine Street) and CTH AP (Midway Road).

Horizontal Alignment

The mainline roadways demonstrate GOOD to POOR horizontal geometry throughout the corridor. Nine curves have radii too small for the required design speed. Additionally, three curves have superelevations that are too great for the roadway design speeds. These curves are rated POOR for these deficiencies.

In general, about one-quarter of the ramps include horizontal curves with substandard radii for the expected vehicle design speeds and current standard of 6% maximum superelevation. CTH AP (Midway Road) northbound on-ramp has a radius that produces a design speed of 45 mph. Generally, most of the remaining ramp curves rate GOOD or better, but have excessive or insufficient amount of superelevation that cause an overall FAIR rating. The superelevation issues on these ramps should not be a sole reason for reconstruction and should only be corrected if doing other work to these problematic locations corrects the ramp geometry.

The available horizontal stopping sight distance (SSD) did not meet current standards at the CTH P (Racine Street) southbound off-ramp and CTH P (Racine Street) northbound on-ramp.

Vertical Alignment

The mainline roadways currently meet standards for vertical geometry, with some exceptions. Those exceptions include areas where continuous grades were less than 0.3% grade or greater than 3% grade. The worst continuous grades were found in the northbound and southbound lanes just south of Oneida Street and in the northbound and southbound lanes just north of the Telulah Avenue overpass. There are an additional 21 vertical curves where the K-value for crest and sag curves does not meet the minimum standards for a 60 MPH speed. The vertical curves are rated POOR for these deficiencies.

Vertical alignments for ramps were categorized by GOOD, FAIR, and POOR ratings. POOR ratings involve ramp areas where continuous grades were less than 0.3% grade or greater than 5% grade and some ramp segments where the design speed for sag or crest curves exceeded the maximum safe speed for those curves. The only ramps not rated POOR were the CTH P (Racine Street) southbound on-ramp, the CTH KK (Calumet Street) southbound on-ramp, and the northbound WIS 441 to southbound US 41 exit ramp.

Vertical Clearance

All bridges on the WIS 441 corridor were categorized by GOOD, FAIR, and POOR ratings. The Telulah Avenue overpass (B-08-024), WIS 441 overpass at Tayco Street (B-70-068), the CTH P (Racine Street) bridge over WIS 441 (B-70-110), and the Carpenter Street pedestrian bridge (B-08-

033) are all substandard to the minimum vertical clearance requirement as stated by “FDM 11-35-1 Attachment 8,” and are rated POOR. There are 11 bridges within the WIS 441 corridor that have vertical clearances that are less than the desirable vertical clearance criteria are being given a FAIR rating. The remaining bridges exceed the desired vertical clearance criteria and are rated GOOD.

Cross Section

The mainline roadways demonstrate POOR cross-sectional features throughout the entire corridor. Each section of the roadway demonstrates a substandard shoulder width as stated in WisDOT FDM 11-35-1. Additionally, 6 of the 28 road segments had clear zone distances that were less than required.

The ramps generally include good cross-sectional features whenever rural cross-sections were used. Of the 32 total ramps, six were rated POOR: four having design speeds under 40 mph with urban, mountable curbs and gutters and deficient shoulder widths; two for having deficient shoulder widths only.

Ramp Design

Ramps were split between GOOD and POOR ratings. The ramps rated POOR have insufficient ramp length for acceleration or deceleration. The worst ramp for acceleration length is the northbound on-ramp at CTH P (Racine Street). All other ramps rated POOR have roughly three times as much distance as the CTH P (Racine Street) northbound on-ramp for acceleration or deceleration.

Two of the 32 ramps had FAIR ratings because their taper lengths were less than the minimum desired length.

When the ramp design rating is combined with horizontal geometry, vertical geometry, and cross-sectional feature ratings, only two ramps were rated FAIR and the rest were rated POOR.

Other Geometric Conditions

Evaluations of several other geometric conditions such as route continuity, lane balance, freeway guide signing, and interchange spacing were also conducted.

Both route continuity and lane balance were rated GOOD along the entire WIS 441 mainline.

Freeway guide signing is rated FAIR along the entire mainline. The on-ramp from northbound US 41 to southbound WIS 441 was the only location to receive a GOOD rating. One main problem with the signing is that exit signs are missing exit numbers. The other reoccurring problem is that there is not enough advanced exit signing for approximately two-thirds of the exits.

Interchange spacing was rated GOOD or FAIR for nearly all sections of the mainline. The only section with a POOR rating was between CTH OO (Northland Avenue) and the north US 41/WIS 441 northern interchange because the spacing between them was less than the required 1500 feet.

Structural Conditions

Condition of bridges along WIS 441 is generally GOOD. One bridge is in FAIR condition due to having a less than desired NBI rating for its substructure. There are four bridges rated as POOR

due to not meeting minimum requirements with respects to their load rating for which HS-20 is the minimum. These five bridges were built at least 10 years before any other bridges on the WIS 441 corridor. At the year 2020 it is predicted that the US 10/WIS 441 Bridge over Little Lake Butte des Morts will be in need of repairs including a possible deck replacement. These recommendations as well as rehabilitation recommendations for year 2035 are shown in **Appendix G**.

Summary

WIS 441 is generally in GOOD to FAIR condition after reviewing all aspects of the roadway. While most of the roadway does not require major improvements at this time, there are some areas that are in need of improvements to bring this the highway up to current standards.

Pavement along the roadway is generally in FAIR condition although there are problem areas that will need to be re-paved or patched to ensure a safe driving surface. Other general characteristics such as drainage, mainline access control, lane balance, and route continuity are all GOOD to FAIR. None of these characteristics need improvement at this time. Route signing is generally in FAIR condition but could use minor improvements to help drivers make clear decisions.

Bridges along WIS 441 are generally in GOOD condition with the exception of the few bridges built in the 1970's. These bridges do not have major deficiencies, but they do have some notable problems that may need to be addressed in the near future. These bridges will need improvements in either 2020 or 2035 to keep the roadway safe and fully operational. Vertical clearance for a few bridges should also be improved to meet minimum or desired standards thus avoiding damage to the superstructure.

The mainline of WIS 441 is generally in GOOD or FAIR condition. The main problems that need to be addressed are the shoulder widths along the entirety of the mainline and problems with the design speed of the roadway. There are problems with either deficient median or shoulder widths along the entire mainline. These problems can cause safety concerns for motorists that do not have enough space along the side of the road. Problems with design speed have made some horizontal curves along the mainline unsafe because the curve radii are too sharp for cars traveling at the roadway design speeds. The low design speed also causes problems with sight distance. Lowering of the posted speed could negate these problems.

The level of service (LOS) for the WIS 441 mainline is generally GOOD. This means there is no need for capacity expansion along the mainline at the current time but future growth of the area could lead to a need for capacity expansion in the future. Safety along the mainline is generally GOOD with regard to crash rates and crash severity and no major improvements to the mainline are needed at the current time.

Ramps along WIS 441 are also generally in GOOD or FAIR condition. The main problems include insufficient ramp lengths for acceleration or deceleration and some problems with vertical curvature. These issues will need to be addressed in the future for safety reasons.

Level of service for the ramps along WIS 441 is generally GOOD to FAIR. There are safety concerns for roughly half of the ramps due to high crash rates or high severity rates. Ramp termini are generally GOOD to FAIR with regard to safety.

A similar analysis for the US 41 corridor has been performed. This study is under WisDOT Project ID: 1113-00-00 and is entitled, "US 41 Interstate Conversion Study." It contains similar information to that which is contained under this "US 41/WIS 441 Operational Needs Assessment," but focuses mainly on the US 41 corridor.