Minnesota River Flood Mitigation Study

Final Report

Minnesota Department of Transportation

SEH No. MNTMD 115709

September 28, 2011



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Executive Summary

In February 2011, the Minnesota Department of Transportation (MnDOT) initiated the Minnesota River Flood Mitigation Study to investigate lower-cost, shorter-term ways to improve local and regional mobility during seasonal flooding in the Minnesota River Valley that can force closures of Trunk Highway 101 ("Highway 101") between the Cities of Chanhassen and Shakopee and Trunk Highway 41 ("Highway 41") in the City of Chaska. In particular, these river crossings have closed due to flooding six times between spring 1993 and spring 2011 with closure times varying from several days to several weeks. When Highways 101 and 41 are closed, the value of the additional time and miles traveled (using the Metropolitan Council's 2030 Regional Model to calculate the daily cost of closures) is \$670,000 per day in the year 2009 and is forecasted to be \$1,675,000 per day in the year 2030. While a long-term replacement solution has been identified for the Highway 41 river crossing, it will be decades before that crossing is replaced given current funding levels.

The purpose of this study is to identify a feasible design option at each river crossing that minimizes the risk of flooding without causing an increase in the 100-year floodplain elevation. The overall study approach has been built around the following major tasks: stakeholder and public involvement, traffic forecasting and analysis, historical flooding analysis, river modeling using computer aided hydrological analysis, design alternatives and analysis, impact assessment, and cost estimate preparation. The preferred concept at Highway 101 and 41 is described below and the key study findings are summarized in Table 1 (on the following page). It is anticipated that the proposed projects would follow a state-funded project development path.

The preferred concept at Highway 101 involves constructing a 3,080-foot land bridge within the existing MnDOT right-of-way. The proposed bridge width is fifty-six feet; this includes: twelve-foot travel lanes, eight-foot outside shoulders, and a twelve-foot trail with barrier separation from traffic. The existing bridge on the north end of the crossing (MnDOT Bridge No. 10007) would be removed for the construction of the land bridge. The existing road immediately north of the proposed land bridge would be raised to a minimum centerline elevation of 724.0 feet. With this land bridge, the roadway closure elevation for Highway 101 increases from 709.4 feet to 722.0 feet. The conceptual layout and proposed typical sections for the preferred concept are shown in Figure 3 at the end of this report.

The preferred concept at Highway 41 involves constructing a 1,350-foot land bridge within the existing MnDOT right-of-way. The proposed bridge width including concrete barriers is seventy-two feet (same as Bridge No. 70041 which was designed to carry traffic while under construction). The proposed bridge width includes: twelve-foot travel lanes, eight-foot outside shoulders, and a twelve-foot trail with barrier separation from traffic. Bridge No. 70041 (low steel = 716 feet) would be replaced to avoid concerns over carrying traffic while partially submerged. With this land bridge, the closure elevation for Highway 41, which is controlled by the low steel on Bridge No. 10012, increases from 714.6 feet to 719.6 feet. The conceptual layout and proposed typical sections for the preferred concept are shown in Figure 8 at the end of this report.

As this was a feasibility level study, further refinement of the concepts to a more developed design level should be undertaken to minimize any potential adverse impacts, while retaining the benefits of reduced frequency and reduced duration of roadway flooding and closure. Findings of this study will be used by MnDOT to pursue flood mitigation funding in the fall of 2011. Once a project is identified and programmed for implementation, it will move forward into the preliminary design and environmental documentation phase of project development.

Executive Summary (Continued)

E.S. Table 1 – Key Study Findings

Elements of Comparison	Proposed Land Bridge at Highway 101	Proposed Land Bridge at Highway 41	
Existing (2009) ADT ¹ (non-flood conditions)	20,400 vehicles per day	12,500 vehicles per day	
Forecast (2030) ADT (non-flood conditions)	24,700 vehicles per day	20,200 vehicles per day	
Current Closure Elevation ²	709.4 feet (Typically the first bridge to close and last to open with higher maintenance restoration costs than Highway 41)	714.6 feet (Typically the second bridge to close and opens before the Highway 101 river crossing)	
Proposed Closure Elevation ²	722.0 feet (Exceeds the 100-year flood water surface elevation)	719.6 feet (Approaches the 50-year flood water surface elevation of 720.3 feet)	
Proposed Bridge Width	56 feet with concrete barriers (Includes 12-foot travel lanes, 8-foot outside shoulders, and 12-foot trail with barrier separation from traffic)	72 feet with concrete barriers ³ (Includes 12-foot travel lanes, 8-foot outside shoulders, and 12-foot trail with barrier separation from traffic)	
Hydrodynamic Modeling Summary	The concepts reduced the flood elevations of the most frequent floods and increased conveyance for all events. There were no indications from the feasibility modeling to suggest that these concepts should not be further developed into workable solutions. For the proposed land bridge at Highway 41, the feasibility level modeling does show a small increase in stage for the 100- and 500-year events with the proposed alternative in place. However, with an informed design process, it may be possible to refine the design to minimize or even eliminate this increase.		
Wetland/Wildlife Opportunities	The concept of a land bridge is supported by the environmental review and permitting agencies since it would restore wetlands and wildlife movement within the corridor.		
Estimated Construction Cost w/ 20% Risk ⁴	\$27.7 million	\$17.0 million	
Benefit-Cost Ratio ⁵	3.81	3.06	
Staging and Constructability	Full Closure; 12-Month Duration	Constructed Under Traffic, Half at a Time; 18- Month Duration	
Community Input/Additional Considerations	The design of the preferred concept supports the planned effort to turn back Highway 101 to Carver County. The preferred concept would also provide an important connection with a state regional trail further linking the communities of Chanhassen and Shakopee.	The Trunk Highway 41 Minnesota River Crossing Tier I Draft Environmental Impact Statement (June 2007) identifies a long-term replacement solution at the Highway 41 crossing that addresses capacity issues and elevates the bridge out of the 100-year flood level.	

¹ Average Daily Traffic (ADT)

Mitigation Measures to Ease Congestion Prior to Implementation and/or During Construction

When the Highway 101 and 41 river crossings close, much of the traffic utilizes the U.S. Highway 169 and State Highway 25 Minnesota River crossings which cause a cascading effect of congestion that affects regional travel and costs travelers time and money. Although the U.S. Highway 169 river crossing is relatively new, it does not have sufficient capacity to efficiently handle the traffic detoured during flood-related closures at the Highway 101 and 41 river crossings. Highways 101 and 41 carry a combined average of 33,000 vehicle trips per day across the Minnesota River. As a part of this study effort, the study team identified measures to ease congestion at the U.S. Highway 169 river crossing to mitigate the impacts of detoured traffic resulting from flood-related closures. The temporary capacity improvement would involve restriping the northbound segment of Highway 169 to add a lane between Scott County Road 18 and Pioneer Trail (approximate) and restriping the southbound segment of Highway 169 to add a lane between Pioneer Trail (approximate) and Highway 101. It also includes minor bridge widening. The temporary capacity improvement is designed to be a recurring project and would need to be individually let each time that it is needed (for additional information, please see Appendix A).

² MnDOT closes these routes when flood waters reach an elevation of approximately two feet below the low road elevation at the crossing.

³ Same as Bridge No. 70041 which was designed to carry traffic while under construction.

⁴ Does not include project development/design costs.

⁵ A benefit-cost ratio greater than one, means that it is beneficial project.

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Minnesota River Flood Mitigation Study

Final Report

Prepared for the Minnesota Department of Transportation (MnDOT)

Introduction

Spring flooding frequently closes the Trunk Highway 101 ("Highway 101") and Trunk Highway 41 ("Highway 41") Minnesota River crossings, which has a detrimental effect on traffic in the region. In particular, these river crossings have closed due to flooding six times between spring 1993 and spring 2011 with closure times varying from several days to several weeks. These roadways carry a combined average of 33,000 vehicle trips per day across the Minnesota River. When these river crossings close, much of the traffic utilizes the U.S. Highway 169 ("Highway 169") and State Highway 25 Minnesota River crossings which cause a cascading effect of congestion that affects regional travel and costs travelers time and money. When Highways 101 and 41 are closed, the value of the additional time and miles traveled (using the Metropolitan Council's 2030 Regional Model to calculate the daily cost of closures) is:

- **\$670,000** per day (2009)
- **\$1,675,000** per day (2030)

While a long-term replacement solution has been identified for the Highway 41 river crossing (addressing capacity issues as well as elevating the bridge out of the 100-year flood level), it will be decades before that crossing is replaced given current funding levels. Given this context, the Minnesota Department of Transportation (MnDOT) initiated the following study in February 2011 to investigate lower-cost, shorter-term ways to improve local and regional mobility during seasonal flooding in the Minnesota River Valley that can force closures of Highways 101 and 41. The study effort also included the identification of measures to ease congestion at the Highway 169 river crossing since the crossing does not have sufficient capacity to efficiently handle the traffic detoured during flood-related closures at Highway 101 and 41 (for additional information, please see Appendix A). Overall, this report summarizes the range of alternatives for reducing flooding potential and effects on Highway 101 and Highway 41. Findings of this study will be used to pursue flood mitigation funding.

The study area (pictured on the following page) is located in the southwestern portion of the Twin Cities Metropolitan Area and encompasses portions of southeastern Carver County and north-central Scott County. Individual municipalities either partially or fully within the study area include the Cities of Carver, Chaska and Chanhassen and Dahlgren Township in Carver County, and the City of Shakopee, Jackson Township and Louisville Township in Scott County.



The study area includes floodplains associated with the Minnesota River, Chaska Creek and Bluff Creek. The Minnesota River is a tributary of the Mississippi River, approximately 332 miles long. The Minnesota River drains a watershed of nearly 17,000 square miles in Minnesota and about 2,000 square miles in South Dakota and Iowa. It flows through the study area and joins the Mississippi River south of the Twin Cities near historic Fort Snelling.

Study Approach and Strategy

The purpose of this section is to document the overall approach that has been followed in completing the Minnesota River Flood Mitigation Study. Key to this study has been balancing the various competing interests and tradeoffs. For instance, when raising a grade to avoid flooding impacts at a crossing location, river modeling has been performed to understand the potential flooding impacts associated with the additional fill in the floodplain. This has been an iterative process to find the right balance between costs, impacts and constructability.

The overall study approach is built around the following major tasks:

- Stakeholder and public involvement
- Traffic forecasting and analysis
- Historical flooding analysis
- River modeling using computer aided hydrological analysis
- Potential design alternatives and analysis
- Impact assessment and cost estimate preparation

Study Guidance and Public Involvement

The Minnesota River Flood Mitigation Study process included an extensive public and agency involvement program that was initiated at the beginning of the study. There were several elements to the involvement program, which are detailed below.

Study Management Team (SMT)

The SMT was formed to establish a communication link to constituents and elected officials regarding the study. SMT members include:

■ City of Bloomington

■ Hennepin County

MnDOT

Carver County

Jackson Township

Scott County

City of Chanhassen

Louisville Township

City of Shakopee

City of Chaska

Metropolitan Council

To date, the SMT has met six times. The SMT members have guided the study process, reviewed technical products, and served as a conduit between the study team and the organizations they represent.

Public and Agency Involvement Activities

Early Coordination with Environmental Review and Permitting Agencies

Three meetings were held with the following environmental review and permitting agencies during the months of April, May, and June.

- U.S. Army Corps of Engineers (USACE)
- U.S. Fish and Wildlife Service (USFWS)
- Minnesota Department of Natural Resources (DNR)

The purpose of these meetings was to share preliminary study findings with the agencies and to discuss the pros and cons of various flood mitigation options.

Public Open House Meeting

A public open house meeting was held on May 24, 2011 at the Chaska Community Center. Approximately thirty people attended the open house. The purpose of the meeting was to introduce the study to the public and gather input on study area issues and concerns. A public open house summary is included in Appendix B.

Study Newsletters

During the course of the study process, two newsletters were published to notify the public of the May 24th open house meeting and to provide study updates. Newsletters have been posted on the project's website and have been electronically distributed to the local units of government for dissemination. A final newsletter will be distributed upon completion of the study which will summarize the findings contained in this report.

Study Website

A study website was developed and maintained by MnDOT on the World Wide Web at http://dot.state.mn.us/metro/floodstudy. The site provided an additional means of distributing information and gathering input with an e-mail reply feature. Throughout the study process technical and public involvement materials have been provided to MnDOT for posting on the study website.

River Modeling Overview

The hydraulic model of the existing conditions, provided by MnDOT, included approximately thirty-five miles of the Minnesota River, reaching from the City of Carver to approximately 1.5 miles upstream of the confluence with the Mississippi River. This existing conditions model was used as the basis for the hydraulic analysis of the river crossings at Highway 41 and Highway 101.

The river modeling objectives of this study are to:

- Assess water surface elevation in the existing conditions and provide the necessary information for highway design;
- Assess the impact of different design alternatives for highway improvements on the frequency of flooding and road closures; and
- Develop a calibrated two-dimensional model of the Minnesota River in the Finite Element Surface Water Modeling System (FESWMS) modeling environment.

The two river models that were used to develop and evaluate possible design concepts at the Highway 101 and Highway 41 river crossings are described in greater detail in the following sub-sections.

Hydrologic Engineering Centers River Analysis System (HEC-RAS) Model

HEC-RAS version 4.1.0 software was used to perform the preliminary hydraulic analysis. HEC-RAS modeling was used for the initial screening to determine viable alternatives as well as to iterate various options for each of the alternatives using fill, land bridge, excavation, etc. to arrive at the optimal solution for each alternative.

The USACE HEC-RAS computer program is widely used in the preparation of studies and restudies for the National Flood Insurance Program (NFIP). The Federal Emergency Management Agency (FEMA) has adopted the guidance that hydraulic analyses for newly contracted studies and restudies of entire watersheds should be conducted using the HEC-RAS program.

Finite Element Surface Water Modeling System (FESWMS) Model

Two-dimensional modeling was used for the detailed evaluation of viable alternatives at Highway 101 and 41. The FESWMS model provides a much more detailed evaluation of alternatives and ensures that river flow conditions are taken into account. The data required to develop the model included bed elevations and features in the river and floodplain, satellite images and air photos, hydrological information, and the design drawings of the existing highways, bridge crossings, and other related infrastructure. The development of the FESWMS model, including grid generation, model setup, and model calibration is described in greater detail in Appendix C.

Traffic Modeling Overview

The Twin Cities Travel Demand Model (TCTDM) was used to develop traffic forecasts for all roadways in the project area. The calibration and validation of the existing regional model is described in the technical memorandum in Appendix D and was based on the daily volumes on the screen line crossing the bridges over the Minnesota River in the study area before the model was run for alternative evaluation. The programmed/planned improvements identified below were incorporated into the model assumptions. These roadways were assumed to be available (open) to traffic during flood events.

- Hennepin County proposes to raise the road profile of Flying Cloud Drive to an elevation of 720 feet in 2015 (100-year); this improvement will allow traffic to utilize Flying Cloud Drive during flood events.
- MnDOT is currently constructing a new interchange at State Highway 13/101 to replace the existing atgrade intersection. The elevation of eastbound Highway 101 near Eagle Creek is currently below the 50-year flood elevation. The project will raise the eastbound lanes so that they are above the 100-year floodplain elevation.

Daily vehicle miles traveled (VMT) and vehicle hours traveled (VHT) for all scenarios and possible closure combinations were calculated from the TCTDM model results for the entire metro area network. The TCTDM modeled years were 2015 and 2030. The different model scenarios include (all scenarios were completed with and without capacity improvements to Highway 169):

- No Build
- Highway101 Closure Only
- Highway 41 Closure Only
- Highway 101 and Highway 41 Closures

General Design Objectives

Since the Highway 101 and 41 river crossings are located below the 100-year flood level, the flood mitigation measures focus on elevating the roadway profile. For the river crossing improvements, it was desired to use recently built bridges, follow existing roadway alignments, and stay within existing right-of-way. As will be discussed in greater detail in the upcoming sections, the existing low points on the Highway 101 and 41 river crossings occur on the roadway segment, not on the channel bridges.

As part of the hydraulic modeling process for the Highway 101 and 41 river crossing improvements, the bridge low member elevations and freeboard above the water surface elevation will be evaluated. Bridges that do not have sufficient freeboard or that have low members contacted or inundated by floodwaters will be evaluated to determine if the situation is detrimental to the integrity of the bridge. Debris collection on the bridge and flow restriction at low members will also be considered in the evaluation. The feasibility of raising the bridge, along with the approach roadway, will be studied for those bridges where inundation may occur. All proposed bridges will need to include bicycle and pedestrian accommodations in accordance with Minnesota Statute 165.14.

The next two sections discuss the existing and proposed condition at the Highway 101 and 41 river crossings.

Highway 101 River Crossing Between the Cities of Chanhassen and Shakopee Existing Conditions

Highway 101 is a two-lane facility (county highway south of the river; state highway north of the river) that connects downtown Shakopee and Flying Cloud Drive. In Shakopee, Highway 101 tees into County Highway 69 at a signalized intersection; County Highway 69 connects to Highway 169 at an at-grade signalized intersection at the western edge of Shakopee. From its intersection with Flying Cloud Drive, Highway 101 continues north on a winding alignment up the river bluff, crossing the new State Highway 212 alignment in the vicinity of County Highway 18 and eventually connects to State Highway 5 in Chanhassen.

Structural Summaries of Existing Bridges

Highway 101 crosses the Minnesota River over two separate bridges along the length of a causeway. Bridge No. 70002 is located on the main channel along the south side of the floodway near the City of Shakopee. This bridge is an eight- span with seven prestressed concrete deck girder and a south approach cast-in-place slab span structure with center main spans of 108'0" and a total bridge length of 815'2". This bridge was built in 1992. The low member elevation of 721.9 feet is at the north end of the bridge. The deck is 78'9" wide and carries four through lanes and a southbound right turn lane. There is no provision for a trail on this bridge. The trail accommodation need is met on the Holmes Street Bridge (Bridge No. 4175; shown on Figure 3 at the end of this report) which is being rehabilitated to provide for a future trail connection between the Cities of Shakopee and Chanhassen. Records indicate that Bridge No. 70002 has a Sufficiency Rating of 82.0 in 2010 with some cracks, settlements and expansion joint seal deficiencies noted. The piers are solid concrete shafts founded on piling. The bridge underwater inspection was made in 2007. The bridge is not listed as being scour critical. This bridge has good lane capacity and should be able to provide service for an additional forty to sixty years of service.

The second bridge on Highway 101 is Bridge No. 10007 and is located on the north side of the floodway and carries intermittent flow. This is a five-span continuous steel deck girder comprised of 54-foot end spans and 66-foot long center spans for a total bridge length of 310'2". The low member elevation of approximately 710.8 feet is located at the north end of the bridge. This bridge was built in 1982 and provides a deck width of 59'10" comprised of two lanes with 11'5" shoulders and a 9'9" separated trail on the east side of the bridge. This bridge has a Sufficiency Rating of 81.0 with only minor deck cracks, spalls and joint leaks identified in the inspection report. Settlement of the approach slabs and roadway were noted in the report. No underwater inspection report was identified. The five pile bent piers are comprised of eight 16" diameter cast in place (CIP) piles and a concrete cap. Original plans indicate that they are in minimal depths of water during normal river stage. This bridge is in fair to good condition with no identified significant problems. It should be able to provide an additional forty to sixty years of service.

Recent Flooding Events and Impact to Road Users

In this stretch of the Minnesota River, Highway 101 is a primary transportation route which has been closed frequently in recent years due to flooding. MnDOT closes this route when flood waters reach an elevation of approximately two feet below the low road elevation at the crossing. Based on this policy, closure of Highway 101 takes place when the water level reaches an elevation of approximately 709.4 feet.

In 2011, Highway 101 was closed on March 23rd. Highway 101 reopened forty-three days later on May 5th. The number of days the Highway 101 crossing has been closed for each flooding event dating back to the 1965 flood is show in Table 1.

Table 1 - Days Highway 101 Crossing Closed During Flood Events 1965 - 2011

Flooding Event	(1) Highway 101 Days Closed
Spring 2011	43
Fall 2010	16
Spring 2010	27
Spring 2001	29
Spring 1997	18
Summer 1993	27
Spring 1969	17
Spring 1965	15

⁽¹⁾ Data for 2010 and 2011 were obtained from MnDOT. Data for 1993, 1997 and 2001 were obtained from the *Trunk Highway 41 Draft Environmental Impact Statement (DEIS)*. Data for 1965-1969 were estimated from historic hydrograph plots and assuming the road is closed for three days beyond the date when the water level dropped below the closure elevation to conduct maintenance and restoration work.

The 2009 Average Daily Traffic (ADT) using the bridge is 20,400 vehicles per day (vpd) with the projected 2030 demands to reach 24,700 vpd. When Highway 101 is closed, the value of the additional time and miles traveled (using the Metropolitan Council's 2030 Regional Model to calculate the daily cost of closures) is:

- **\$233,000 per day (2009)**
- **\$930,000 per day (2030)**

According to the *Trunk Highway 41 Minnesota River Crossing Tier I Draft Environmental Impact Statement (June 2007)*, the Highway 101 river crossing carries approximately eight percent truck traffic. During the peak commuting hour (4:00 to 5:00 p.m.), trucks made up seven percent of the traffic on Highway 101.

During a flood event, the MnDOT suggested detour route for southbound Highway 101 motorists is eastbound Highway 212 to southbound Interstate 494, to southbound Highway 169 to Highway 101. The route is reversed for northbound Highway 101 motorists.

Initial Screening to Determine Viable Alternatives (HEC-RAS Modeling Results)

As described in the River Modeling Overview section of this report, the study team used two river models (HEC-RAS and FESWMS) to develop and evaluate possible design concepts at the Highway 101 river crossing. This section describes the HEC-RAS modeling results for the Highway 101 river crossing and concludes with the identification of the preferred design concept. The two-dimensional (FESWMS) modeling results for the preferred design concept are discussed in the following section.

Prior to modeling the preferred concept, the bridge geometries for the existing structures at the Highway 101 crossing were updated based on construction drawings provided by MnDOT.

Initial modeling involved determining whether filling to raise the road profile could be a feasible method to minimize the risk of flooding at Highway 101 without causing a surcharge in the 100-year flood elevations. The Code of Federal Regulations requires that if fill is placed in the floodway, hydraulic analysis must show that this encroachment does not cause an increase in 100-year floodway water surface elevations. However, the amount of fill needed to raise the road to an elevation which would significantly reduce the road closure frequency at Highway 101 caused a significant increase in the 100-year floodway water surface elevations. Due to the magnitude of surcharge in the 100-year floodway water surface elevations, this increase in high water elevations could not be mitigated by the addition of active flow area at the existing bridges or by adding culverts in the areas of additional fill.

At the request of the SMT, the project team also looked at two additional options for raising the road profile using fill. One option involved the creation of upstream storage to reduce flows but this was determined to not be practical given the flat profile of the river. The second option consisted of conducting a Letter of Map Revision/Conditional Letter of Map Revision (LOMR/CLOMR) study to see if it was feasible to allow for some amount of stage increase. Given the amount of upstream impacts (approximately thirty miles), the number of affected properties would make for an unrealistic scenario. This option was determined to not be practical.

Since raising the road profile at Highway 101 using fill was not a feasible approach to reducing the frequency of road closure, the use of a land bridge was considered. Cross sections of the existing roadway taken every 100 feet were used to determine the amount of fill placed for construction of the existing roadway crossing. For the Highway 101 land bridge, this fill was removed from the cross section, thus introducing additional flow area.

For the Highway 101 river crossing, several iterations with varying road elevation, bridge length, pier width, pier spacing, and bridge deck depth were performed to select the optimum design. The proposed land bridge characteristics for the Highway 101 river crossing are described in Table 2.

Table 2 – Highway 101 Proposed Bridge Characteristics

Bridge Characteristics	Description	
Minimum Road Centerline Elevation	724.0 feet (NGVD 29)	
Bridge Length	3,080 feet 84 inches 100 feet 1.5 feet	
Bridge Deck Depth*		
Pier Spacing		
Pier Width		
*Depth includes road cross-section, structural elements of bridge and railing/bar		

Source: SEH, Inc.

The proposed land bridge has two vertical curves at 0.5 percent grade. The existing bridge on the north end of the crossing (MnDOT Bridge No. 10007) would be removed for the construction of this land bridge. The proposed land bridge and the existing road immediately north of the proposed land bridge would be raised to a minimum centerline elevation of 724.0 feet. With this land bridge, the roadway closure elevation for Highway 101 increases from 709.4 feet to 722.0 feet.

Table 3 shows the peak water surface elevations for the modeled flood events, which can be used to compare the flood frequency to roadway closure elevation. For Highway 101, the closure elevation (722.0 feet) is greater than the 100-year flood water surface elevation but not greater than the 500-year flood water surface elevation.

Table 3 – Peak Water Surface Elevations for Highway 101

Hydraulic Event	Existing Conditions Water Surface Elevation, Feet	Proposed Conditions Water Surface Elevation, Feet
10-Year Flood (10 Percent Annual Exceedence Event)	712.0	711.9
50-Year Flood (2 Percent Annual Exceedence Event)	718.4	718.3
100-Year Flood (1 Percent Annual Exceedence Event)	720.7	720.6
500-Year Flood (0.2 Percent Annual Exceedence Event)	726.0	726.0

Source: HEC-RAS Modeling. SEH, Inc.

The roadway crossing at Highway 101 has been closed due to risk of flooding several times in the past seventy-five years (see Figure 1 – Highway 101 Crossing Historical River Elevations at the end of this report). This figure shows that increasing the closure elevation as described above could significantly reduce the frequency of road closure at the Highway 101 river crossing. Figure 2 at the end of this report illustrates how increasing the closure elevation could significantly reduce the duration of road closure during 1993 flood event. Overall, the proposed land bridge at Highway 101 would significantly reduce the risk of flooding and the frequency and duration of roadway closure.

Description of the Preferred Concept at Highway 101

The proposed concept at Highway 101 consists of constructing a 3,080-foot land bridge within the existing MnDOT right-of-way (minimum 100-foot corridor). The proposed land bridge has two vertical curves at 0.5 percent grade. The existing road immediately north of the proposed land bridge would be raised to a minimum centerline elevation of 724.0 feet. The closure elevation is controlled by the low steel elevation of 722 feet on Shakopee Bridge No. 70002. The existing bridge on the north end of the crossing (Bridge No. 10007) would be removed for the construction of the land bridge.

The proposed bridge width is fifty-six feet; this includes: twelve-foot travel lanes, eight-foot outside shoulders, and a twelve-foot trail with barrier separation from traffic. The preferred concept is being defined as a two-lane section. The proposed roadway width is also fifty-six feet; this includes: twelve-foot travel lanes, eight-foot outside shoulders, and a ten-foot trail with guardrail separation from driving lanes. There are no design exceptions being proposed at this time. The conceptual layout and proposed typical sections for the preferred concept are shown in Figure 3 at the end of this report. The estimated construction cost for the preferred concept is \$27.7 million (for additional information, see Appendix E – Preliminary Cost Estimates).

It should also be noted that the segment of Highway101 in Carver County is planned to be turned back to the county. The preferred concept has been designed to support the turnback process of Highway 101 in Carver County. The turnback process has already occurred for the segment of Highway 101 in Scott County.

Two-Dimensional Hydrodynamic Model (FESWMS) Results for Preferred Concept

Model results illustrating flood extents, change in water surface elevation, velocity profiles, and changes in velocities for the Highway 101 alternative are shown in Figures 5.17 through 5.28 in the Hydrodynamic Modeling Report in Appendix C for the 10-year, 50-year, 100-year, and 500-year flood events.

Very little change in water surface elevation was seen with the proposed alternative in place for each of the modeled events. Water levels changed less than 0.1 foot downstream of the proposed road crossing. A decrease around 0.5 foot was seen upstream of the proposed crossing for the 10-year flow event. The 50-year and 100-year events showed a decrease in water surface elevations less than 0.1 foot and the 500-year event saw an increase in water surface elevation less than 0.1 foot for areas upstream of the proposed crossing. Areas of excavation along the road crossing show the greatest change in water surface elevation since some of these areas were not underwater in the existing conditions model. Table 4 gives the water surface elevation values immediately upstream and downstream of the Highway 101 road crossing (see Figure 2.1 in the Hydrodynamic Modeling Report in Appendix C for an illustration of the two-dimensional model domain). Model results show that the proposed road crossing at Highway 101 is not inundated during the 100-year flood event, but it is underwater during the 500-year event.

Table 4 – Peak Water Surface Elevation Upstream and Downstream of the Highway 101 Road Crossing

	WSE Upstream of Highway 101 (ft, NAVD88) Existing Alternative		WSE Downstream of Highway 101 (ft, NAVD88)	
Flow Event			Existing	Alternative
10-Year	712.5	712.0	711.9	711.9
50-Year	718.5	718.4	718.3	718.3
100-Year	720.8	720.8	720.6	720.6
500-Year	726.1	726.1	726.0	726.0

Source: Hydrodynamic Modeling for Minnesota River Crossing Feasibility Study Final Report. Prepared for MnDOT. Prepared by Short Elliott Hendrickson Inc. and W.F. Baird & Associates Ltd. September 23, 2011.

The initial evaluation of the proposed alternative does not appear to indicate there are any significant limitations with the feasibility level design. The proposed alternative reduced the flood elevations of the most frequent floods and increased conveyance for all events. There were no indications from the feasibility modeling to suggest the proposed alternative should not be further developed into a workable solution. No major redesign efforts of the road crossing should be needed. As this was a feasibility level study, further refinement of the alternative to a more developed design level should be undertaken to minimize any potential adverse impacts, while retaining the benefits of reduced frequency and reduced duration of roadway flooding and closure.

For additional information regarding the hydrodynamic modeling that was performed for this study, please see the report in Appendix C.

Cost Effectiveness

A benefit-cost analysis was completed for the preferred concept at Highway 101. The preliminary analysis indicates that the preferred concept at Highway 101 has a benefit-cost ratio greater than one (3.81), meaning that it is a beneficial project. The vehicle miles traveled and vehicle hours traveled benefits of the project are estimated to be greater than the costs associated with the construction of the project. For additional information regarding the benefit-cost analysis that was performed for this study, please see the technical memorandum in Appendix F.

Sensitive Resources in the Vicinity of Highway 101

The low-lying bottomlands along the river channel are a mix of forests, open wetland and forested wetlands. Existing vegetation on roadway slopes is undesirable box elder.

Parks and Recreation Areas

The river valley within the study area contains portions of the Minnesota Valley National Wildlife Refuge (MVNWR) and the Raguet Wildlife Management Area (WMA) (see Figure 4 – Highway 101 Park and Recreation Areas at the end of this report).

The MVNWR – Chaska Unit is located on the east side of Highway 101 and runs from the northeastern part of the City of Carver to the extreme southwest part of the City of Chaska. The MVNWR – Chaska Unit is about 600 acres in size. The MVNWR is owned by the U.S. Department of the Interior; the USFWS is responsible for its management. It was established in 1976 to preserve and protect wildlife and wildlife habitat and to provide opportunities for wildlife-oriented recreation and education. The MVNWR – Chaska Unit consists of marsh-edged lake surrounded by farmland and floodplain forest. The MVNWR is a largely undeveloped natural area with sites developed for hiking, biking and parking. Vehicle access and parking for the Chaska Unit of the MVNWR are provided at the south gate entrance and the trailhead is at Riverview Park in the City of Carver.

The DNR owns and is responsible for the management of the Raguet WMA. The management emphasis for this WMA is directed towards maintaining and improving habitat for wetland species. The 311-acre WMA is located on the west side of Highway 101in Carver County near the City of Shakopee. The WMA is entirely within the floodplain of the Minnesota River and contains floodplain forest, wetland areas and grassland. There is an access across the highway to the Minnesota River.

Since the preferred concept follows the existing roadway alignment and stays within existing MnDOT right-of-way, no impacts to these resources are anticipated. The concept of a land bridge is supported by the environmental review and permitting agencies since it would restore wetlands and wildlife movement within the corridor.

Wetlands

The proposed improvement would be required to comply with federal and state laws regarding wetlands; requiring mitigation if a permit is obtained for wetland fill. Approximately 0.52 acres of wetland fill would be required for the construction of the proposed land bridge. The excavation of the road embankment that is adjacent to existing wetlands would create approximately 8.61 acres of new wetland. Therefore the proposed improvement would not result in a net loss of wetland.

Wetland impact numbers were estimated based on National Wetland Inventory (NWI) mapping (see Figure 5 – Highway 101 NWI Wetlands at the end of this report), aerial photography and professional judgment, which provided a general indication of where wetlands may occur. The actual wetland impact amount would be determined by conducting a Routine Level 2 wetland delineation if the proposed improvement moves forward into preliminary/final design. The impact calculations were limited to wetlands within MnDOT right-of-way.

Additional Project Development and Design Considerations

Surface Water Drainage Improvement Needs

Improvement of the river crossing at Highway 101 would create the need for additional drainage system infrastructure for conveying and treating the runoff. The existing crossing essentially allows runoff to sheet flow off the roadway directly into the adjacent floodplain areas. Runoff from the existing bridge sections is also conveyed to the adjacent floodplain areas without specific treatment areas. In the improved condition, the additional impervious surface created at the crossing would trigger the need to provide treatment of the storm water runoff prior to discharging to the adjacent floodplain areas.

Treatment for the fill sections would remain sheet flow across the vegetated side slopes of the embankment and creation of a vegetated swale where grades and available right-of-way allow. Two approaches for providing treatment of the land bridge sections were developed for further consideration as the project moves forward. For the land bridge segments, the first approach would be to provide treatment at the low points along

the crossing as is typically done for project like this. The main challenge in this case is that the land available for treatment systems (e.g., a sedimentation pond) would be located in the floodplain and would continue to be subject to inundation during flood events. This location would create the need for ongoing maintenance to ensure proper function, including significant challenges for access and cleanout at the mid-point along the Highway 101 crossing concept. In addition, the frequency of flood inundation would almost certainly reduce the effectiveness of the basins to provide the desired water quality treatment.

The second approach for providing treatment would be to create treatment in the nearby urban or transportation corridor areas (e.g., local or MnDOT right-of-way, etc.) that would be sized to meet the level of treatment needed for the new impervious created as part of the river crossing. These treatment systems could be located outside the floodplain such that they would provide water quality treatment benefits even while a flooding event is occurring in the river.

Roadway Flood Damage Potential

With an increased roadway elevation the frequency and duration of overtopping will be lessened, therefore, the flood damage potential at the proposed crossing should be significantly lower. The most common mode of failure during flooding events is embankment sloughing along the roadway due primarily to scour from overtopping flows. This type of roadway damage will be eliminated in the area of the crossing where existing fill will be removed and replaced with the land bridge. SEH would recommend that riprap be placed along the downstream roadway embankments beyond the land bridge to help minimize damage from overtopping scour. Reducing the flood damage potential at the crossing will lead to lower time and costs for restoration after flooding events.

Staging and Constructability

Construction of the preferred concept is expected to take twelve months to complete and the crossing would be closed to traffic during construction. Existing businesses within the project area may experience negative short-term impacts during construction due to traffic disturbances/detours. MnDOT strives to maintain some form of access to businesses during construction except for short periods of time, which cannot be avoided. MnDOT does make every attempt to minimize negative business impacts from its highway construction, although it cannot prevent all of them. A construction staging plan would need to be developed during the final design phase of the project that would further assess potential traffic congestion and access-related impacts associated with construction.

Soils

Poor soils are known to exist within the study area. The proposed excavation of the road embankment will require additional subsurface information and geotechnical data. The geotechnical features that will affect the design and construction of the proposed land bridge should be investigated and evaluated during future phases of the project.

Environmental Review

It is anticipated that the proposed project would follow a state-funded project development path. State environmental review of the proposed improvement would be mandatory (required) since it exceeds the mandatory EAW threshold for the wetlands and public waters category (4410.4300, subpart 27.A). Excavation and/or fill into nearby public waters would exceed one acre, and therefore the mandatory EAW threshold.

Potential Permits

A number of permits will be required for improvements at the Highway 101 crossing. The following paragraphs summarize the key permits that will potentially be required for the improvement option.

Part 60.3(d)(3) of Chapter 44 of the Code of Federal Regulations "prohibits encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels ... during the occurrence of the base flood discharge". The hydraulic model prepared for this analysis shows that the proposed land bridge described herein did not cause an increase in peak water surface elevations during the 100-year flood event. Also, by removing fill at the Highway 101 crossing, the proposed land bridge would return the flow to a more natural state, which should minimize permitting challenges.

Several stormwater management permits will be required for improvements in the project area. The National Pollutant Discharge Elimination System / State Disposal System (NPDES/SDS) General Permit for Construction Activities (NPDES Permit) will be required as the project alternative would disturb greater than one acre of land and would create greater than one acre of new impervious surface. The primary requirements of the permit will be to establish protective measures to reduce the impacts of erosion and sediment control during construction and to install permanent water quality treatment practices for treating a water quality volume based on the extent of new impervious surfaces. The extent of treatment needed will need to be reevaluated during future phases of the project as the NPDES Permit is due for reissuance in 2013. Based on recent information from Minnesota Pollution Control Agency (MPCA) staff, the level of treatment required in the revised NPDES Permit is expected to increase significantly relative to the current requirements.

The Highway 101 crossing is located within the jurisdiction of the Lower Minnesota River Watershed District (LMRWD). The LMRWD currently does not have a permit program for projects in the District. Instead, LMRWD provides guidance and policy direction to municipalities and counties within the District relating to water quality requirements in local ordinances and codes, or within local surface water management plans. Therefore, the project may trigger local municipal and/or counties permits or approvals relating to stormwater management, shoreland management and related issues. As stated above, the extent of treatment needed will need to be re-evaluated during future phases of the project.

The DNR Waters Division oversees the administration of the Public Waters Work Permit Program which regulates water development activities below the ordinary high water level (OHWL) in public waters and public waters wetlands. This project will require a DNR Work in Public Waters Permit.

The Rivers and Harbors Act (Section 10) program regulates the placement of structures and/or work in, or affecting navigable waters of the Unites States including the Minnesota River. The USACE is the agency responsible for administering this program. Work outside of the main channel, but within wetlands, will require permits from the USACE under Section 404 of the Clean Water Act.

Wetlands that are above the OHWL will be regulated under the Minnesota Wetland Conservation Act, which will be administered by MnDOT.

Summary

Hydrodynamic modeling has determined that construction of a 3,080-foot land bridge raised to a minimum centerline elevation of 724.0 feet is a feasible method to minimize the risk of flooding at Highway 101 without causing an increase in the 100-year flood elevations (see Appendix G for a summary list of assumptions). With this land bridge, the roadway closure elevation for Highway 101 increases from 709.4 feet to 722.0 feet. The proposed land bridge at Highway 101 would significantly reduce the risk of flooding and the frequency and duration of roadway closure. Additional findings at this crossing are summarized in the Study Findings section of this report.

Highway 41 River Crossing in Chaska

Existing Conditions

Highway 41 is a two-lane facility that widens to four lanes through downtown Chaska. Highway 41 connects to Highway 169 and State Highway 212 at at-grade signalized intersections.

Structural Summaries of Existing Bridges

On Highway 41 over the Minnesota River there are two bridges and a causeway that comprise the crossing of the waterway. Bridge No. 10012 is located on the main channel along the north side of the floodway near the City of Chaska. This bridge is a four-span continuous steel deck girder bridge built in 2007. The total bridge length is 508 feet with a main channel span that is 170 feet long. The low member of the bridge is on the north end at elevation 719.62 feet. The deck is a total of 76'4" wide and provides for four lanes of traffic with 6'0" shoulders and a 12'0" trail separated by a barrier on the east side. Piers are solid concrete shafts supported on piling. The bridge management records indicate a Sufficiency Rating of 91.4 based on 2009 inspections. Only minor deck cracks, spalls and joint leaks were identified. Underwater inspections in 2008 found the piers in the channel to be in very good condition. This bridge has good lane capacity, provides for a trail, and because it is relatively new with no identified significant problems, should be able to provide an additional fifty to seventy-five years of service.

The second bridge on Highway 41 is located on a secondary channel on the south side of the floodway and carries intermittent flow. This bridge, No. 70041, is a prestressed concrete deck girder structure with three spans of approximately eighty-two feet giving a total bridge length of 294'8". The low member elevation is on the north end at elevation 715.95. It was built in 1998 and was constructed in stages to accommodate traffic and as such has an unsymmetrical 72'10" wide deck configuration with a 21'0" west shoulder, two 12'0" lanes centered on the causeway and a 33'6" east shoulder. There is no trail designated on this bridge. The bridge has a 2009 Sufficiency Rating of 81.0 with only minor deck cracks, spalls and joint leaks were identified in the inspection report. No underwater inspection report was identified. The two pile bent piers are comprised of nine 16" diameter CIP piles and a concrete cap. Original plans indicate that they are in five to six feet of water depth at normal water elevation of 700.0. This bridge has good lane capacity, provides for additional width for increased lane capacity, and because it is relatively new with no identified significant problems, should be able to provide an additional fifty to seventy-five years of service.

Recent Flooding Events and Impact to Road Users

In this stretch of the Minnesota River, Highway 41 is a primary transportation route which has been closed frequently in recent years due to flooding. MnDOT closes this route when flood waters reach an elevation of approximately two feet below the low road elevation at the crossing. Based on this policy, closure of Highway 41 takes place at approximately elevation 714.6 feet.

In 2011, Highway 41 was closed on March 23rd. Highway 41 reopened thirteen days later on April 5th. The number of days the Highway 41 has been closed for each flooding event dating back to the 1965 flood is shown in Table 5.

Table 5 – Days Highway 41 Crossing Closed During Flood Events 1965 - 2011

Flooding Event	(1) Highway 41 Days Closed
Spring 2011	13
Fall 2010	10
Spring 2010	22
Spring 2001	25
Spring 1997	10
Summer 1993	11
Spring 1969	15
Spring 1965	13

⁽¹⁾ Data for 2010 and 2011 were obtained from MnDOT. Data for 1993, 1997 and 2001 were obtained from the *Trunk Highway 41 Draft Environmental Impact Statement (DEIS)*. Data for 1965-1969 were estimated from historic hydrograph plots and assuming the road is closed for three days beyond the date when the water level dropped below the closure elevation to conduct maintenance and restoration work.

The 2009 ADT using the bridge is 12,500 vpd with the projected 2030 demands to reach 20,200 vpd. When Highway 41 is closed, the value of the additional time and miles traveled (using the Metropolitan Council's 2030 Regional Model to calculate the daily cost of closures) is:

- **\$302,000 per day (2009)**
- **\$653,000** per day (2030)

According to the *Trunk Highway 41 Minnesota River Crossing Tier I Draft Environmental Impact Statement (June 2007)*, the heavy commercial vehicle traffic on Highway 41 constitutes almost twenty percent of the current total daily traffic volume. During the peak commuting hour (4:00-5:00 p.m.), trucks made up thirteen percent of the traffic on Highway 41.

During a flood event, the MnDOT suggested detour route for the Highway 41 crossing is Highway 169, Interstate 494, and State Highway 212.

Initial Screening to Determine Viable Alternatives (HEC-RAS Modeling Results)

As described in the River Modeling Overview section of this report, the study team used two river models (HEC-RAS and FESWMS) to develop and evaluate possible design concepts at the Highway 41 river crossing. This section describes the HEC-RAS modeling results for the Highway 41 river crossing and concludes with the identification of the preferred design concept. The two-dimensional (FESWMS) modeling results for the preferred design concept are discussed in the following section.

Prior to modeling the preferred concept, the bridge geometries for the existing structures at the Highway 41 crossing were updated based on construction drawings provided by MnDOT.

Initial modeling involved determining whether filling to raise the road profile could be a feasible method to minimize the risk of flooding at Highway 41 without causing a surcharge in the 100-year flood elevations. The Code of Federal Regulations requires that if fill is placed in the floodway, hydraulic analysis must show that this encroachment does not cause an increase in 100-year floodway water surface elevations. However, the amount of fill needed to raise the road to an elevation which would significantly reduce the road closure frequency at Highway 41 caused a significant increase in the 100-year floodway water surface elevations. Due to the magnitude of surcharge in the 100-year floodway water surface elevations, this increase in high water elevations could not be mitigated by the addition of active flow area at the existing bridges or by adding culverts in the areas of additional fill.

At the request of the SMT, the project team also looked at two additional options for raising the road profile using fill. One option involved the creation of upstream storage to reduce flows but this was determined to not be practical given the flat profile of the river. The second option consisted of conducting a Letter of Map Revision/Conditional Letter of Map Revision (LOMR/CLOMR) study to see if it was feasible to allow for some amount of stage increase. Given the amount of upstream impacts (approximately thirty miles), the number of affected properties would make for an unrealistic scenario. This option was determined to not be practical.

Since raising the road profile at Highway 41 using fill was not a feasible approach to reducing the frequency of road closure, the use of a land bridge was considered. Cross sections of the existing roadway taken every 100 feet were used to determine the amount of fill placed for construction of the existing roadway crossing. For the Highway 41 land bridge, this fill was removed from the cross section, thus introducing additional flow area.

For the Highway 41 river crossing, several iterations with varying road elevation, bridge length, pier width, pier spacing, and bridge deck depth were performed to select the optimum design. The proposed land bridge characteristics for the Highway 41 river crossing are described in Table 6.

Table 6 – Highway 41 Proposed Bridge Characteristics

Bridge Characteristics	Description	
Minimum Road Centerline Elevation	722.5 feet (NGVD 29)	
Bridge Length	1,350 feet	
Bridge Deck Depth*	86 inches	
Pier Spacing	100 feet	
Pier Width	1.5 feet	
*Depth includes road cross-section, structural elements of bridge and railing		

Source: SEH, Inc.

The proposed land bridge has one vertical curve at 0.5 percent grade. With this land bridge, the closure elevation for Highway 41, which is controlled by the low steel on Bridge No. 10012, increases from 714.6 feet to 719.6 feet.

Table 7 shows the peak water surface elevations for the modeled flood events, which can be used to compare the flood frequency to roadway closure elevation. The closure elevation at Highway 41 (719.6 feet) is less than the 50-year flood water surface elevation, but higher than the existing closure elevation.

Table 7 – Peak Water Surface Elevations for Highway 41

Hydraulic Event	Existing Conditions Water Surface Elevation, Feet	Proposed Conditions Water Surface Elevation, Feet
10-Year Flood (10 Percent Annual Exceedence Event)	714.2	714.1
50-Year Flood (2 Percent Annual Exceedence Event)	720.3	720.2
100-Year Flood (1 Percent Annual Exceedence Event)	722.5	722.5
500-Year Flood (0.2 Percent Annual Exceedence Event)	727.7	727.6

Source: HEC-RAS Modeling. SEH, Inc.

The roadway crossing at Highway 41 has been closed due to risk of flooding several times in the past seventy-five years (see Figure 6 – Highway 41 Crossing Historical River Elevations at the end of this report). This figure shows that increasing the closure elevation as described above could reduce the frequency of road closure at the Highway 41 river crossing. Figure 7 at the end of this report illustrates how increasing the closure elevation could reduce the duration of road closure during 1993 flood event. Overall, the proposed

land bridge at Highway 41 would significantly reduce the risk of flooding and the frequency and duration of roadway closure.

Description of the Preferred Concept at Highway 41

The proposed concept at Highway 41 consists of constructing a 1,350-foot land bridge within the existing MnDOT right-of-way (minimum 150-foot corridor). Bridge No. 70041 (low steel = 716 feet) would be replaced to avoid concerns over carrying traffic while partially submerged. The proposed land bridge has one vertical curve at 0.5 percent grade. With this land bridge, the proposed closure elevation for Highway 41 increases from 714.6 feet (existing) to 719.6 feet. The proposed closure elevation is controlled by the low steel on Bridge No. 10012.

The proposed bridge width including concrete barriers is seventy-two feet (same as Bridge No. 70041 which was designed to carry traffic while under construction). The proposed bridge width includes: twelve-foot travel lanes, eight-foot outside shoulders, and a twelve-foot trail with barrier separation from traffic. The proposed roadway width is seventy-two feet; this includes: twelve-foot travel lanes, eight-foot outside shoulders, and a ten-foot trail with separation from driving lanes. There are no design exceptions being proposed at this time. The conceptual layout and proposed typical sections for the preferred concept are shown in Figure 8 at the end of this report. The estimated construction cost for the preferred concept is \$17.0 million (for additional information, see Appendix E – Preliminary Cost Estimates).

Two-Dimensional Hydrodynamic Model (FESWMS) Results for Preferred Concept

Model results illustrating flood extents, change in water surface elevation, velocity profiles, and changes in velocities for the Highway 41 alternative are shown in Figures 5.5 through 5.16 in the Hydrodynamic Modeling Report in Appendix C for the 10-year, 50-year, 100-year, and 500-year flood events.

For each of the alternatives, a change in water surface elevation was seen when compared to the existing conditions model. The only increase downstream of the crossing was seen for the 10-year event and was less than 0.3 foot of change. Decreases were seen downstream of the crossing for the other three events with all of the changes under 0.1 foot of change. Areas of excavation along the proposed crossing show the greatest change in water surface elevation since some of these areas were not underwater in the existing conditions model.

The 10- and 50-year events had a decrease of water surface elevation upstream of the road crossing, while the 100- and 500-year events result in an increase. At lower flows, the wider bridge opening allows considerably more water to pass through when compared to the existing conditions, which results in a drop in water surface elevation. The largest decrease in water surface elevation is seen during the 10-year event directly upstream of the proposed widening of Bridge No. 70041. Decreases in this location are up to one foot. At larger flows, the wider bridge opening is not large enough to maintain greater conveyance and the additional fill on the floodplain creates more of a backup for the flow resulting in a slight increase in water surface elevation. Table 8 gives the water surface elevations immediately upstream and downstream of the Highway 41 road crossing (see Figure 2.1 in the Hydrodynamic Modeling Report in Appendix C for an illustration of the two-dimensional model domain). Model results show that the proposed road crossing at Highway 41 is not inundated during the 50-year flood event, but it is mostly underwater during the 100-year event.

Modeled velocity profile plots compare the existing conditions to the proposed alternative conditions. All plots show an increase in velocities at the opening for the proposed replacement for Bridge No. 70041. The 10-year event shows a decrease in velocities at the existing Bridge No. 10012 with the proposed alternative in place. The 50-year, 100-year, and 500-year events all show an increase in velocities at Bridge No. 10012. These velocity increases are concentrated around the bridges and could potentially change bed scour or erosion patterns in these locations if this alternative were implemented. Refinements to the alternative and subsequent testing with the model could be used to optimize the design and minimize and constrain velocity changes within a defined range.

Table 8 – Peak Water Surface Elevation Upstream and Downstream of the Highway 41 Road Crossing

	WSE Upstream of Highway 41 (ft, NAVD88)			
Flow Event	Existing	Alternative	Existing	Alternative
10-Year	716.0	715.7	714.6	714.4
50-Year	720.8	720.7	720.2	720.2
100-Year	722.8	722.9	722.4	722.4
500-Year	727.7	727.8	727.6	727.6

Source: Hydrodynamic Modeling for Minnesota River Crossing Feasibility Study Final Report. Prepared for MnDOT. Prepared by Short Elliott Hendrickson Inc. and W.F. Baird & Associates Ltd. September 23, 2011.

This feasibility level two-dimensional modeling does show a small increase in stage for the 100- and 500-year events with the proposed alternative in place. However, with an informed design process, it may be possible to refine the design to minimize or even eliminate this increase.

Overall, the initial evaluation of the proposed alternative does not appear to indicate there are any significant limitations with the feasibility level design. The proposed alternative reduced the flood elevations of the most frequent floods and increased conveyance for all events. There were no indications from the feasibility modeling to suggest the proposed alternative should not be further developed into a workable solution. No major redesign efforts of the road crossing should be needed. As this was a feasibility level study, further refinement of the alternative to a more developed design level should be undertaken to minimize any potential adverse impacts (such as an increase in water surface elevation for high flow events), while retaining the benefits of reduced frequency and reduced duration of roadway flooding and closure.

For additional information regarding the hydrodynamic modeling that was performed for this study, please see the report in Appendix C.

Cost Effectiveness

A benefit-cost analysis was completed for the preferred concept at Highway 41. The preliminary analysis indicates that the preferred concept at Highway 41 has a benefit-cost ratio greater than one (3.06), meaning that it is a beneficial project. The vehicle miles traveled and vehicle hours traveled benefits of the project are estimated to be greater than the costs associated with the construction of the project. For additional information regarding the benefit-cost analysis that was performed for this study, please see the technical memorandum in Appendix F.

Sensitive Resources in the Vicinity of Highway 41

The low-lying bottomlands along the river channel are a mix of forests, open wetland and forested wetlands. Open meadow communities are dominated by reed canary grass. Existing vegetation on roadway slopes is undesirable box elder.

Parks and Recreation Areas

The river valley within the study area contains portions of both the Minnesota Valley National Wildlife Refuge (MVNWR) – Chaska Unit and the Minnesota Valley State Recreation Area (MVSRA) (see Figure 9 - Highway 41 Park and Recreation Areas at the end of this report).

The MVNWR – Chaska Unit is located on the west side of Highway 41 and runs from the northeastern part of the City of Carver to the extreme southwest part of the City of Chaska. The MVNWR – Chaska Unit is about 600 acres in size. The MVNWR is owned by the U.S. Department of the Interior; the USFWS is responsible for its management. It was established in 1976 to preserve and protect wildlife and wildlife habitat and to provide opportunities for wildlife-oriented recreation and education. The MVNWR – Chaska Unit consists of marsh-edged lake surrounded by farmland and floodplain forest. The MVNWR is a largely undeveloped

natural area with sites developed for hiking, biking and parking. Vehicle access and parking for the Chaska Unit of the MVNWR are provided at the south gate entrance and the trailhead is at Riverview Park in the City of Carver.

The portion of the MVSRA in the study area is in the Minnesota River valley and runs from the City of Carver on the south end through the City of Chanhassen on the north end, about four miles. The entire MVSRA is 5,490 acres. Highway 41 crosses over the MVSRA connecting the City of Shakopee with downtown Chaska. The MVSRA is owned by the DNR. The site was designated as a recreation area as was the trail in the late 1960s. The Minnesota Valley State Trail (MV Trail) is located within MVSRA. The MV Trail offers recreational opportunities for biking, hiking, snowmobiling, and horseback riding as well as wildlife observation and birdwatching. Vehicle access to the MVSRA and the MV Trail is provided from Highway 41 in the City of Chaska. The MVSRA is easily accessed by pedestrians and bicyclists via these routes as well. There are three boat launching facilities in the MVSRA.

Since the preferred concept follows the existing roadway alignment and stays within existing MnDOT right-of-way, no impacts to these resources are anticipated. The concept of a land bridge is supported by the environmental review and permitting agencies since it would restore wetlands and wildlife movement within the corridor.

Wetlands

The proposed improvement would be required to comply with federal and state laws regarding wetlands; requiring mitigation if a permit is obtained for wetland fill. Approximately 0.48 acres of wetland fill would be required for the construction of the proposed land bridge. The excavation of the road embankment that is adjacent to existing wetlands would create approximately 1.48 acres of new wetland. Therefore the proposed improvement would not result in a net loss of wetland.

Wetland impact numbers were estimated based on National Wetland Inventory (NWI) mapping (see Figure 10 - Highway 41 NWI Wetlands at the end of this report), aerial photography and professional judgment, which provided a general indication of where wetlands may occur. The actual wetland impact amount will be determined by conducting a Routine Level 2 wetland delineation if the proposed improvement moves forward into preliminary/final design. The impact calculations were limited to wetlands within MnDOT right-of-way.

Additional Project Development and Design Considerations

Surface Water Drainage Improvement Needs

Improvement of the river crossing at Highway 41 would create the need for additional drainage system infrastructure for conveying and treating the runoff. The existing crossing essentially allows runoff to sheet flow off the roadway directly into the adjacent floodplain areas. Runoff from the existing bridge sections is also conveyed to the adjacent floodplain areas without specific treatment areas. In the improved condition, the additional impervious surface created at either crossing would trigger the need to provide treatment of the storm water runoff prior to discharging to the adjacent floodplain areas.

Treatment for the fill sections would remain sheet flow across the vegetated side slopes of the embankment and creation of a vegetated swale where grades and available right-of-way allow. Two approaches for providing treatment of the land bridge sections were developed for further consideration as the project moves forward. For the land bridge segments, the first approach would be to provide treatment at the low points along the crossing as is typically done for project like this. The main challenge in this case is that the land available for treatment systems (e.g., a sedimentation pond) would be located in the floodplain and would continue to be subject to inundation during flood events. This location would create the need for ongoing maintenance to ensure proper function. In addition, the frequency of flood inundation would almost certainly reduce the effectiveness of the basins to provide the desired water quality treatment.

The second approach for providing treatment would be to create treatment in the nearby urban or transportation corridor areas (e.g., local or MnDOT right-of-way, etc.) that would be sized to meet the level of treatment needed for the new impervious created as part of the river crossing. These treatment systems could be located outside the floodplain such that they would provide water quality treatment benefits even while a flooding event is occurring in the river.

Roadway Flood Damage Potential

With an increased roadway elevation the frequency and duration of overtopping will be lessened, therefore, the flood damage potential at the proposed crossing should be significantly lower. The most common mode of failure during flooding events is embankment sloughing along the roadway due primarily to scour from overtopping flows. This type of roadway damage will be eliminated in the area of the crossing where existing fill will be removed and replaced with the land bridge. SEH would recommend that riprap be placed along the downstream roadway embankments beyond the land bridge to help minimize damage from overtopping scour. Reducing the flood damage potential at the crossing will lead to lower time and costs for restoration after flooding events.

Staging and Constructability

Construction of the preferred concept is expected to take eighteen months to complete. It would be constructed half at a time and would remain open to traffic during construction. No detours would be necessary during construction.

Soils

Poor soils are known to exist within the study area. The proposed excavation of the road embankment will require additional subsurface information and geotechnical data. The geotechnical features that will affect the design and construction of the proposed land bridge should be investigated and evaluated during future phases of the project.

Environmental Review

It is anticipated that the proposed project would follow a state-funded project development path. State environmental review of the proposed improvement would be mandatory (required) since it exceeds the mandatory EAW threshold for the wetlands and public waters category (4410.4300, subpart 27.A). Excavation and/or fill into nearby public waters would exceed one acre, and therefore the mandatory EAW threshold.

Potential Permits

A number of permits will be required for improvements at the Highway 41 crossing. The following paragraphs summarize the key permits that will potentially be required for the improvement option.

Part 60.3(d)(3) of Chapter 44 of the Code of Federal Regulations "prohibits encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels ... during the occurrence of the base flood discharge". The hydraulic model prepared for this analysis shows that the proposed land bridge described herein did not cause an increase in peak water surface elevations during the 100-year flood event. Also, by removing fill at the crossing, the proposed land bridge returns the flow to a more natural state, which should minimize permitting challenges.

Several stormwater management permits will be required for improvements in the project area. The National Pollutant Discharge Elimination System / State Disposal System (NPDES/SDS) General Permit for Construction Activities (NPDES Permit) will be required as the project alternative would disturb greater than one acre of land and would create greater than one acre of new impervious surface. The primary requirements

of the permit will be to establish protective measures to reduce the impacts of erosion and sediment control during construction and to install permanent water quality treatment practices for treating a water quality volume based on the extent of new impervious surfaces. The extent of treatment needed will need to be reevaluated during future phases of the project as the NPDES Permit is due for reissuance in 2013. Based on recent information from MPCA staff, the level of treatment required in the revised NPDES Permit is expected to increase significantly relative to the current requirements.

The Highway 41 crossing is located within the jurisdiction of the Lower Minnesota River Watershed District (LMRWD). The LMRWD currently does not have a permit program for projects in the District. Instead, LMRWD provides guidance and policy direction to municipalities and counties within the District relating to water quality requirements in local ordinances and codes, or within local surface water management plans. Therefore, the project may trigger local municipal and/or counties permits or approvals relating to stormwater management, shoreland management and related issues. As stated above, the extent of treatment needed will need to be re-evaluated during future phases of the project.

The DNR Waters Division oversees the administration of the Public Waters Work Permit Program which regulates water development activities below the ordinary high water level (OHWL) in public waters and public waters wetlands. This project will require a DNR Work in Public Waters Permit.

The Rivers and Harbors Act (Section 10) program regulates the placement of structures and/or work in, or affecting navigable waters of the Unites States including the Minnesota River. The USACE is the agency responsible for administering this program. Work outside of the main channel, but within wetlands, will require permits from the USACE under Section 404 of the Clean Water Act.

Wetlands that are above the OHWL will be regulated under the Minnesota Wetland Conservation Act, which will be administered by MnDOT.

Summary

Hydrodynamic modeling has determined that construction of a 1,350-foot land bridge raised to a minimum centerline elevation of 722.5 feet is a feasible method to minimize the risk of flooding at Highway 41 (see Appendix G for a summary list of assumptions). The proposed roadway closure elevation increases from 714.6 to 719.6 feet, which is less than the 50-year flood water surface elevation, but higher than the existing closure elevation.

The proposed land bridge at Highway 41 would reduce the risk of flooding and the frequency of roadway closure. With the larger bridge opening in place for the Highway 41 alternative, a larger volume of water is allowed to pass under the bridge. As a result, there is a decrease in water surface elevation upstream of the crossing. This also results in a decrease in velocity for frequent flood events such as the 10-year event. At higher flows the opening does not accommodate all the flow across the floodplain, and in combination with the additional fill, added to the crossing to increase the elevation of the road surface, the water is forced more quickly through the bridge openings. This creates an increase in velocities at the proposed bridges for flow events greater than or equal to the 50-year event. However, none of the velocities with the alternatives in place are as large as the velocities seen in the existing conditions for the 10-year event at the existing Bridge No. 10012. Since events the size of the 10-year flood and smaller occur more frequently than the 50-year event or greater, it is likely that the river channel will experience an overall decrease in frequency and duration of exposure to higher velocities throughout the course of time with the proposed alternative in place.

Additional findings at this crossing are summarized in the Study Findings section of this report.

Study Findings

This report summarizes the range of alternatives for reducing flooding potential and effects on Highways 101 and 41. Flood mitigation measures at the Highway 101 and 41 river crossings are focused on elevating the roadway profile (without solving capacity-related issues). Overall, there was agreement that all of the

improvements studied would provide benefit to the transportation system and are supported by the SMT members (see Appendix H for community support letters). Improvements to one corridor do not preclude or eliminate the need to make improvements on the other corridor.

The key study findings associated with the Highway 101 and Highway 41 river crossings are summarized below.

Highway 101 River Crossing

- The 2009 ADT using the Highway 101 river crossing is 20,400 vpd with the projected 2030 demands to reach 24,700 vpd (non-flood conditions).
- The preferred concept at Highway 101 involves constructing a 3,080-foot land bridge within the existing MnDOT right-of-way (minimum 100-foot corridor). The existing bridge on the north end of the crossing (Bridge No. 10007) would be removed for the construction of the land bridge. The conceptual layout and proposed typical sections for the preferred concept are shown in Figure 3 at the end of this report. The estimated construction cost is \$27.7 million.
- Highway 101 has a current closure elevation of 709.4 feet and is typically the first bridge to close and last to open with higher maintenance restoration costs than Highway 41. The proposed roadway closure elevation increases to 722.0 feet, which would be higher than the 100-year flood water surface elevation. The proposed land bridge at Highway 101 would significantly reduce the risk of flooding and the frequency and duration of roadway closure.
- The benefit-cost ratio of the proposed project at Highway 101 is 3.81 (a benefit-cost ratio greater than one, means that it is beneficial project).
- Construction is expected to take twelve months to complete and the crossing would be closed to traffic during construction. A construction staging plan would need to be developed during the final design phase of the project that will further assess potential traffic congestion impacts associated with construction.
- The design of the preferred concept supports the planned effort to turn back Highway 101 to Carver County.

Highway 41 River Crossing

- The 2009 ADT using the Highway 41 river crossing is 12,500 vpd with the projected 2030 demands to reach 20,200 vpd (non-flood conditions).
- The preferred concept at Highway 41 involves constructing a 1,350-land bridge within the existing MnDOT right-of-way (minimum 150-foot corridor). Bridge No. 70041 (low steel = 716 feet) would be replaced to avoid concerns over carrying traffic while partially submerged. The conceptual layout and proposed typical sections for the preferred concept are shown in Figure 8 at the end of this report. The estimated construction cost is \$17.0 million.
- Highway 41 has a current closure elevation of 714.6 feet and is typically the second bridge to close and opens before the Highway 101 river crossing. The proposed roadway closure elevation increases to 719.6 feet, which nearly achieves the 50-year flood water surface elevation of 720.3 feet. The proposed land bridge at Highway 41 would reduce the risk of flooding and the frequency and duration of roadway closure.
- Construction is expected to take eighteen months to complete. It would be constructed half at a time and would remain open to traffic during construction. No detours are necessary during construction.
- The benefit-cost ratio of the proposed project at Highway 41 is 3.06 (a benefit-cost ratio greater than one, means that it is beneficial project).

■ The *Trunk Highway 41 Minnesota River Crossing Tier I Draft Environmental Impact Statement* (June 2007) identifies a long-term replacement solution at the Highway 41 crossing that addresses capacity issues and elevates the bridge out of the 100-year flood level.

Mitigation Measures to Ease Congestion Prior to Implementation and/or During Construction

When Highway 101 and 41 river crossings close, much of the traffic utilizes the Highway 169 and State Highway 25 Minnesota River crossings which cause a cascading effect of congestion that affects regional travel and costs travelers time and money. Although the Highway 169 river crossing is relatively new, it does not have sufficient capacity to efficiently handle the traffic detoured during flood-related closures at the Highway 101 and 41 river crossings. Highways 101 and 41 carry a combined average of 33,000 vehicle trips per day across the Minnesota River. As a part of this study effort, the study team identified measures to ease congestion at the Highway 169 river crossing to mitigate the impacts of detoured traffic resulting from flood-related closures. The temporary capacity improvement would involve restriping the northbound segment of Highway 169 to add a lane between Scott County Road 18 and Pioneer Trail (approximate) and restriping the southbound segment of Highway 169 to add a lane between Pioneer Trail (approximate) and Highway 101. It also includes minor bridge widening. The temporary capacity improvement is designed to be a recurring project and would need to be individually let each time that it is needed (for additional information, please see Appendix A).

Next Steps

As this was a feasibility level study, further refinement of the concepts to a more developed design level should be undertaken to minimize any potential adverse impacts, while retaining the benefits of reduced frequency and reduced duration of roadway flooding and closure. Findings of this study will be used by MnDOT to pursue flood mitigation funding in the fall of 2011. Once a project is identified and programmed for implementation, it will move forward into the preliminary design and environmental documentation phase of project development.

List of Figures

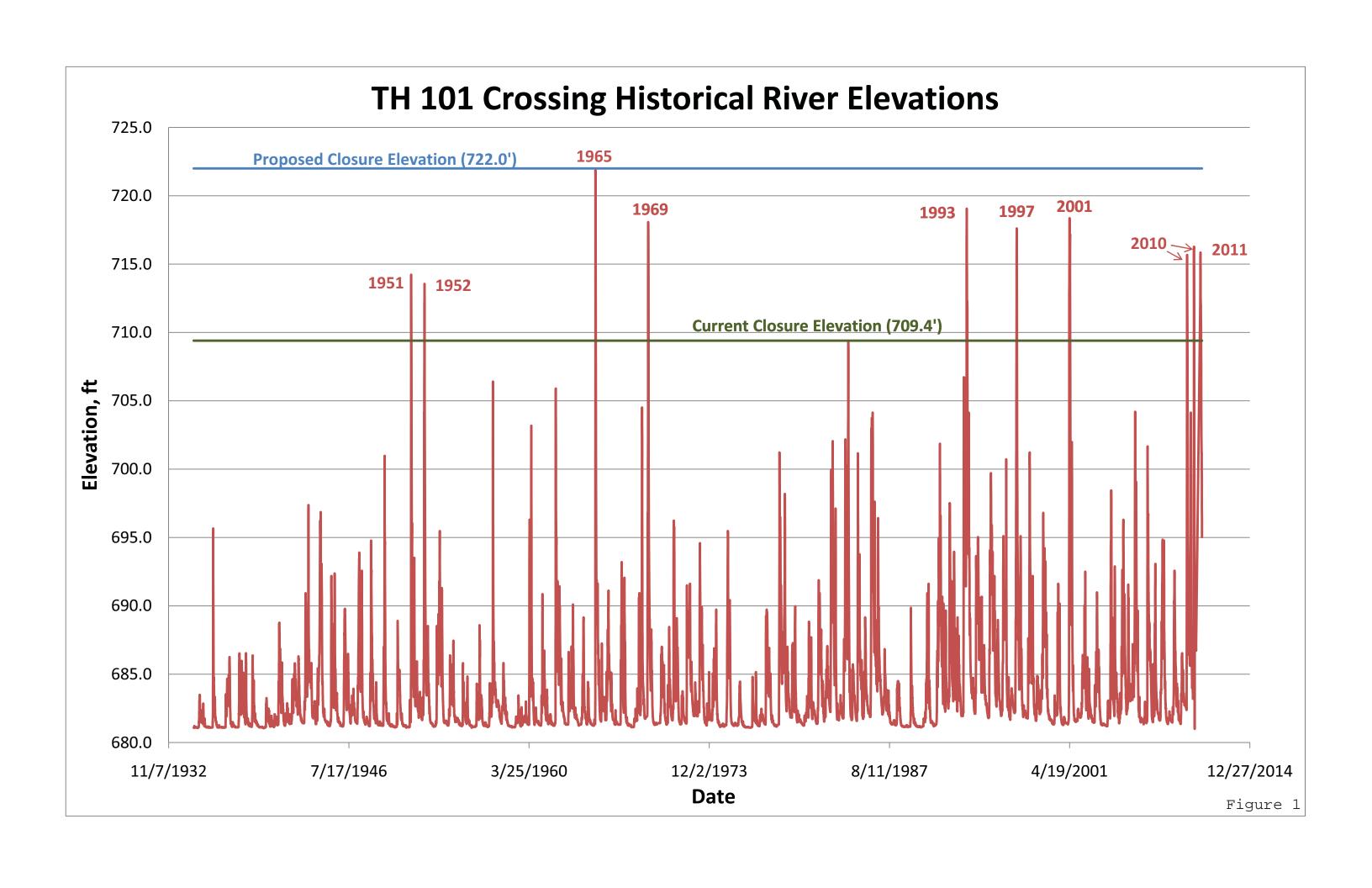
Figure 2 – Highway 101 Crossing, Summer 1993
Figure 3 – Highway 101 Preferred Bridge/Fill Option
Figure 4 – Highway 101 Park and Recreation Areas
Figure 5 – Highway 101 NWI Wetlands

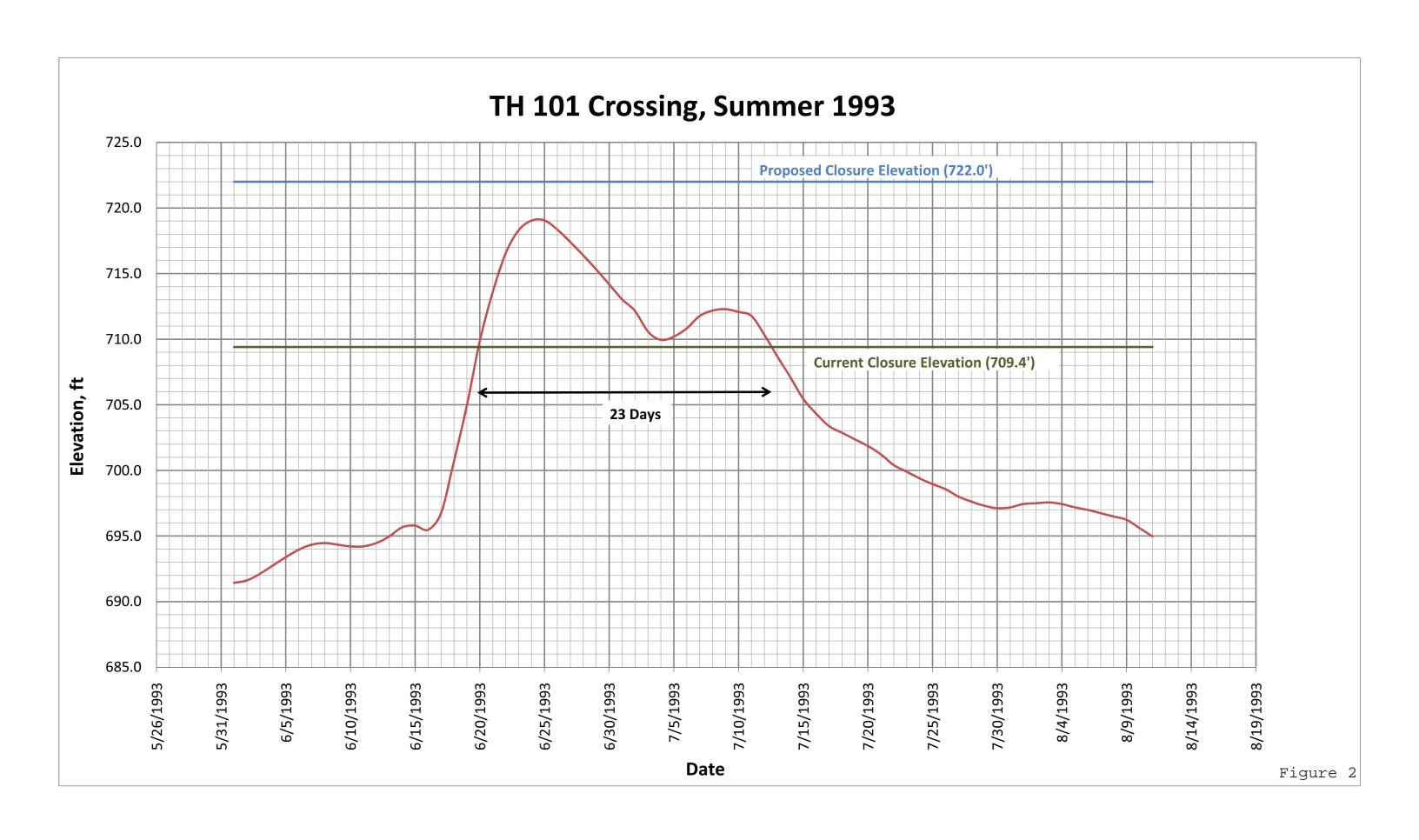
Figure 1 - Highway 101 Crossing Historical River Elevations

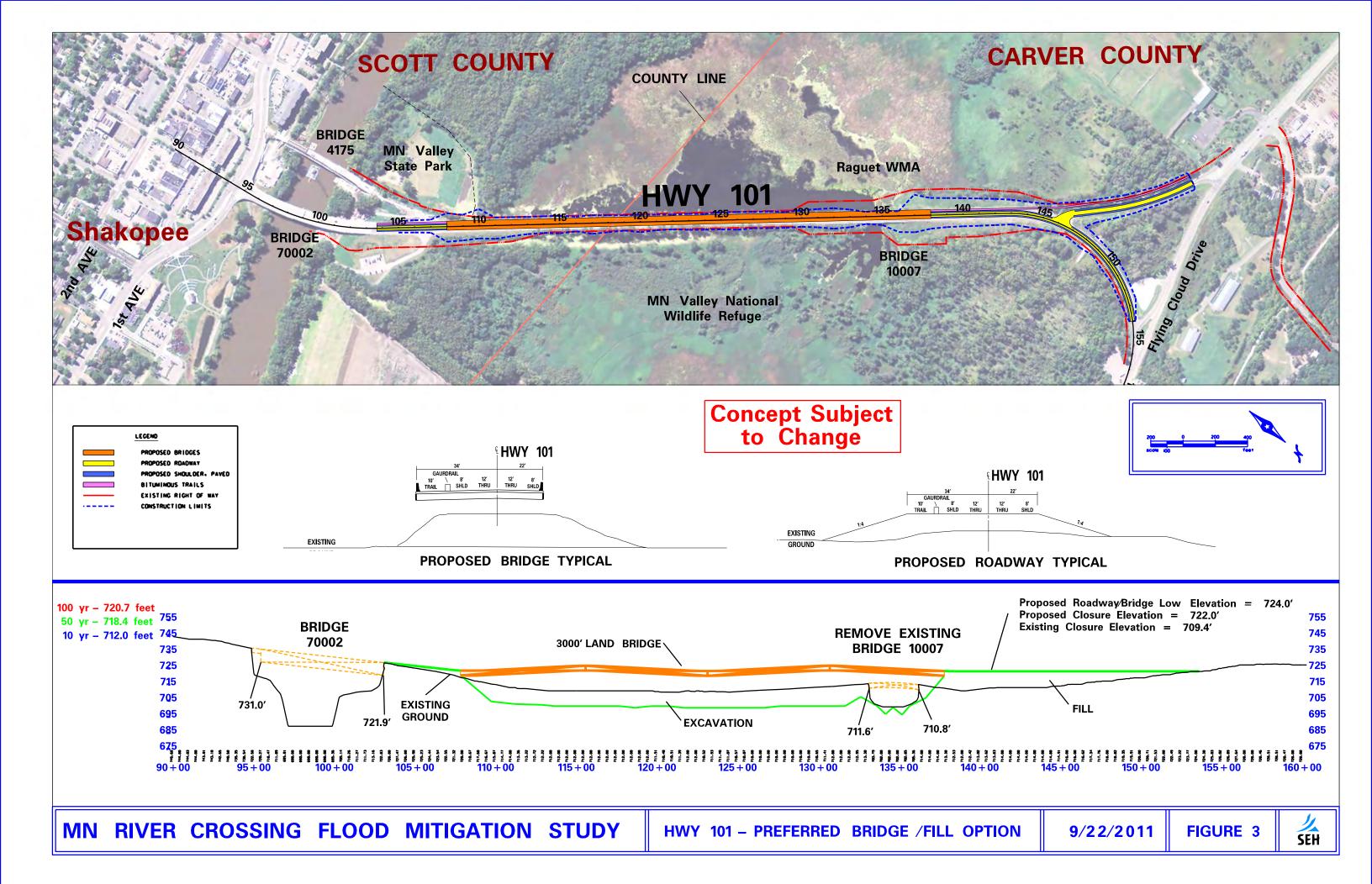
Figure 6 – Highway 41 Crossing Historical River Elevations Figure 7 – Highway 41 Crossing, Summer 1993

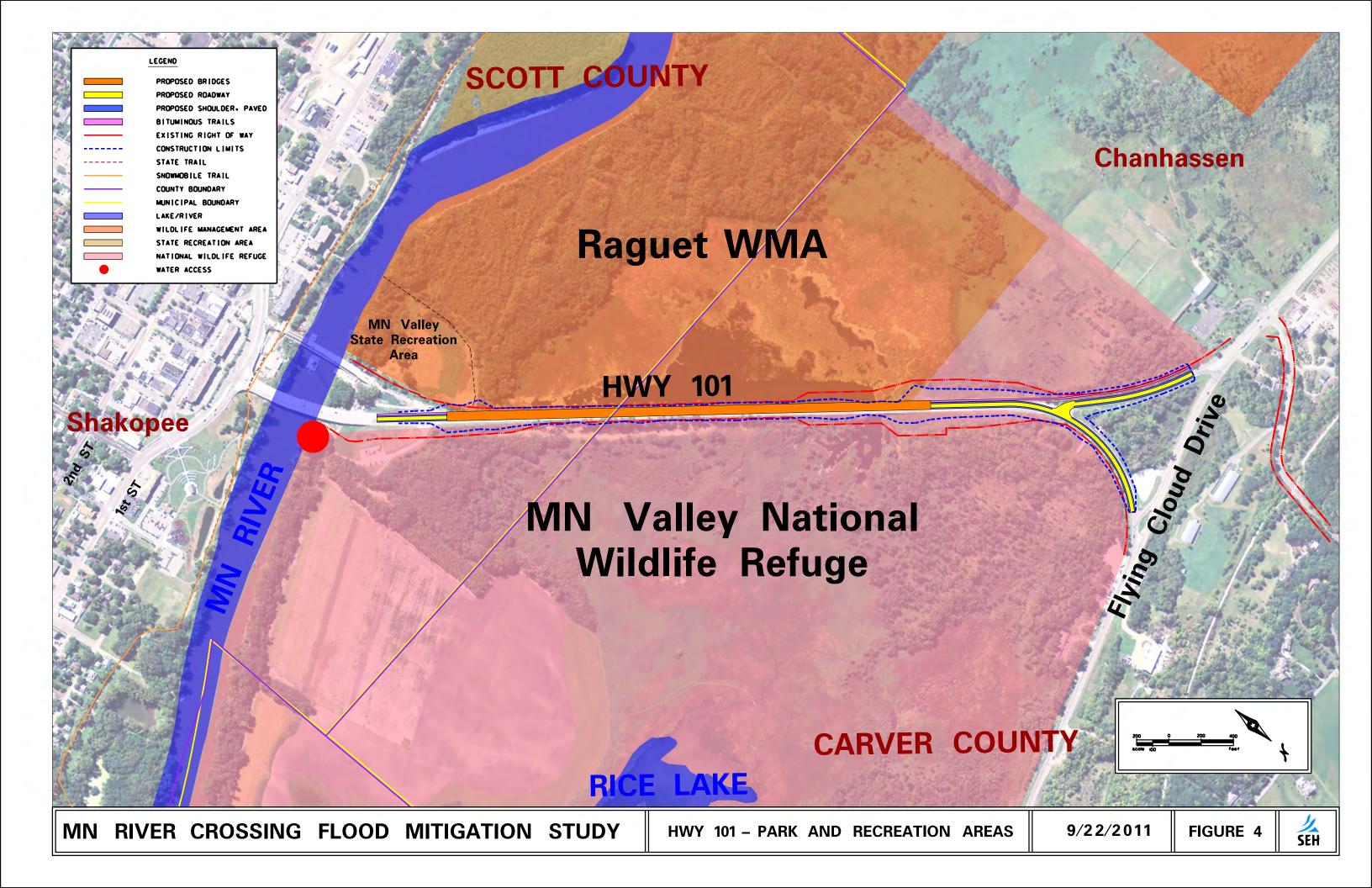
Figure 8 – Highway 41 Preferred Bridge/Fill Option

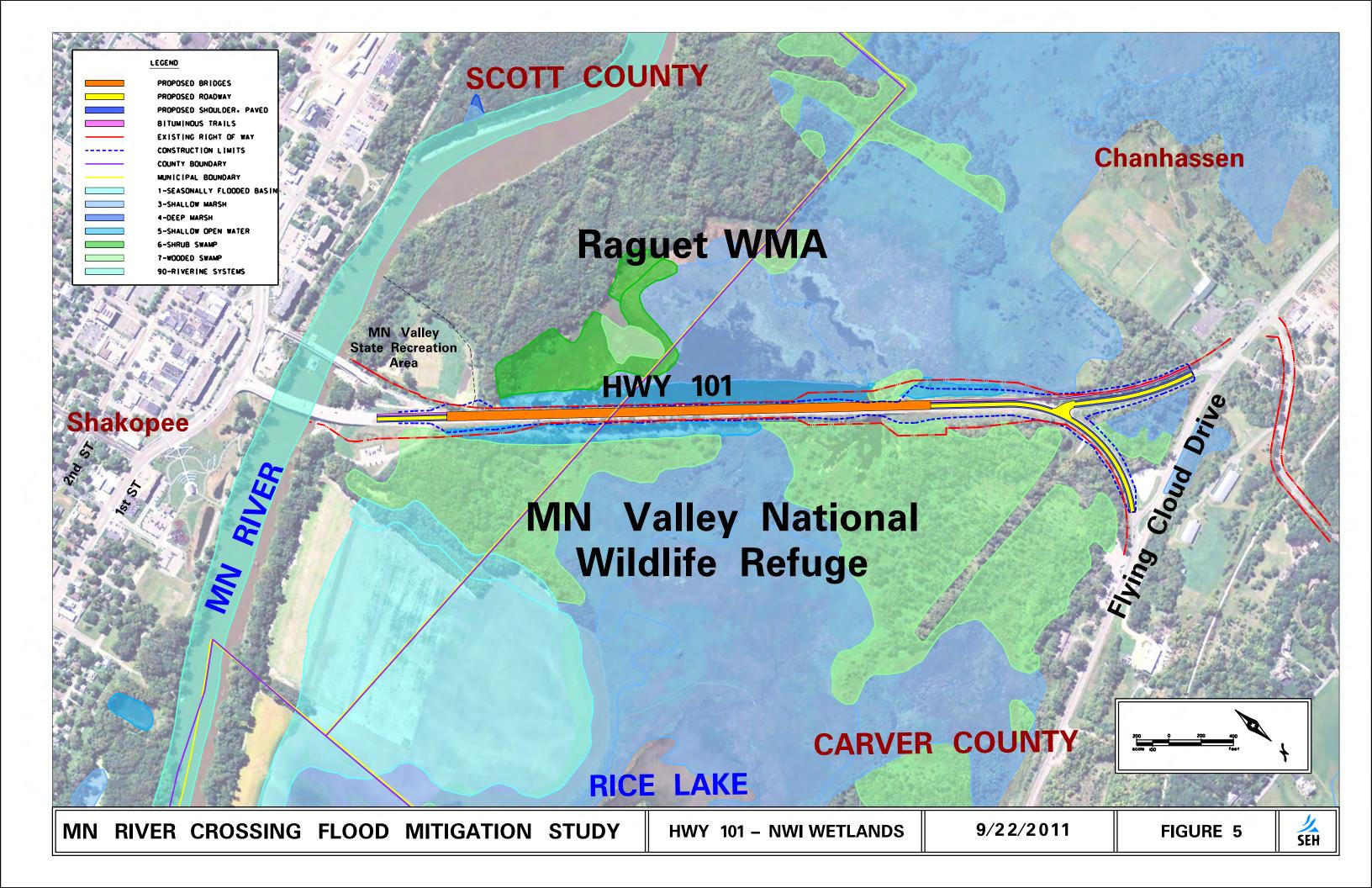
Figure 9 – Highway 41 Park and Recreation Areas
Figure 10 – Highway 41 NWI Wetlands

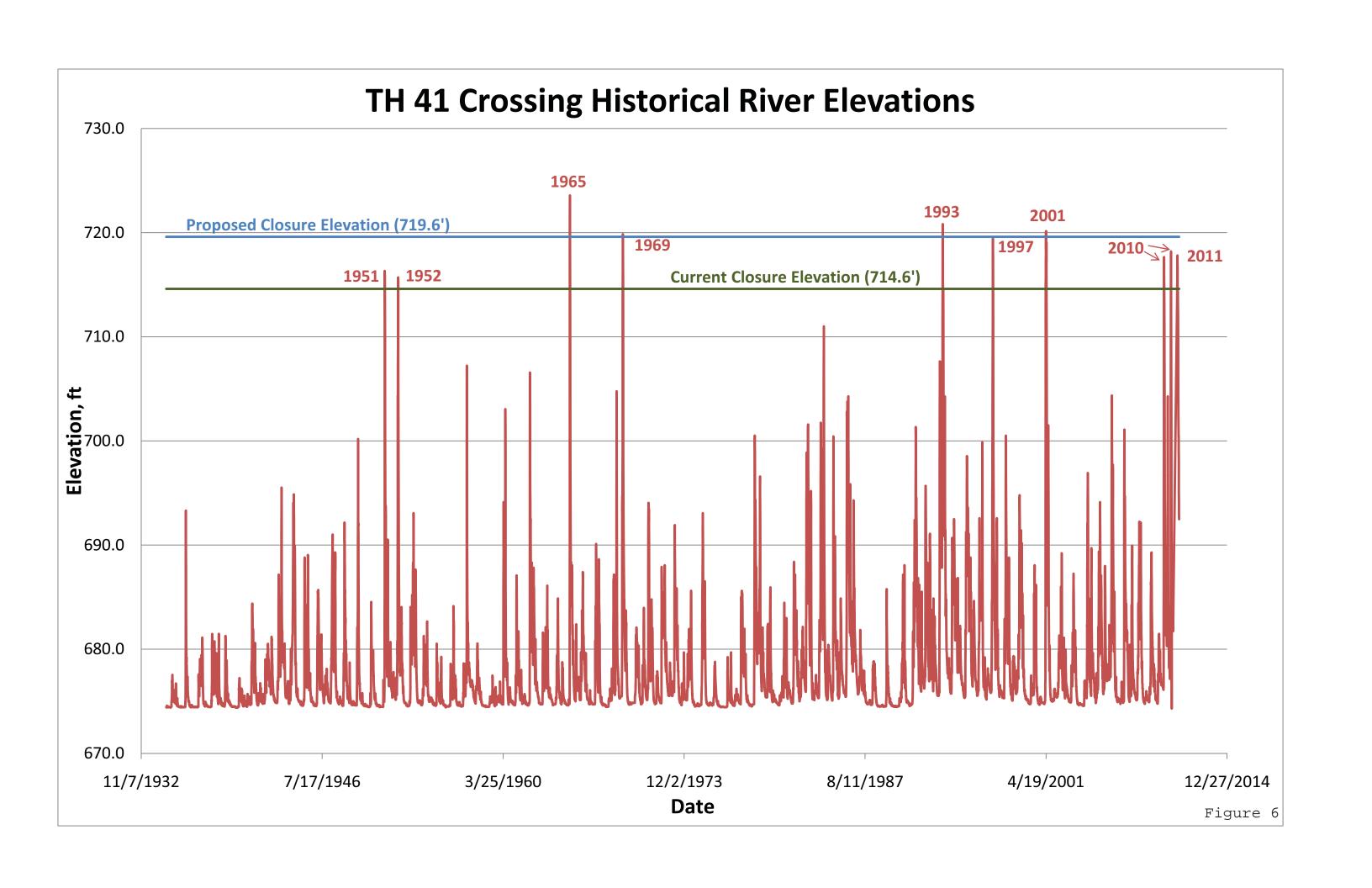


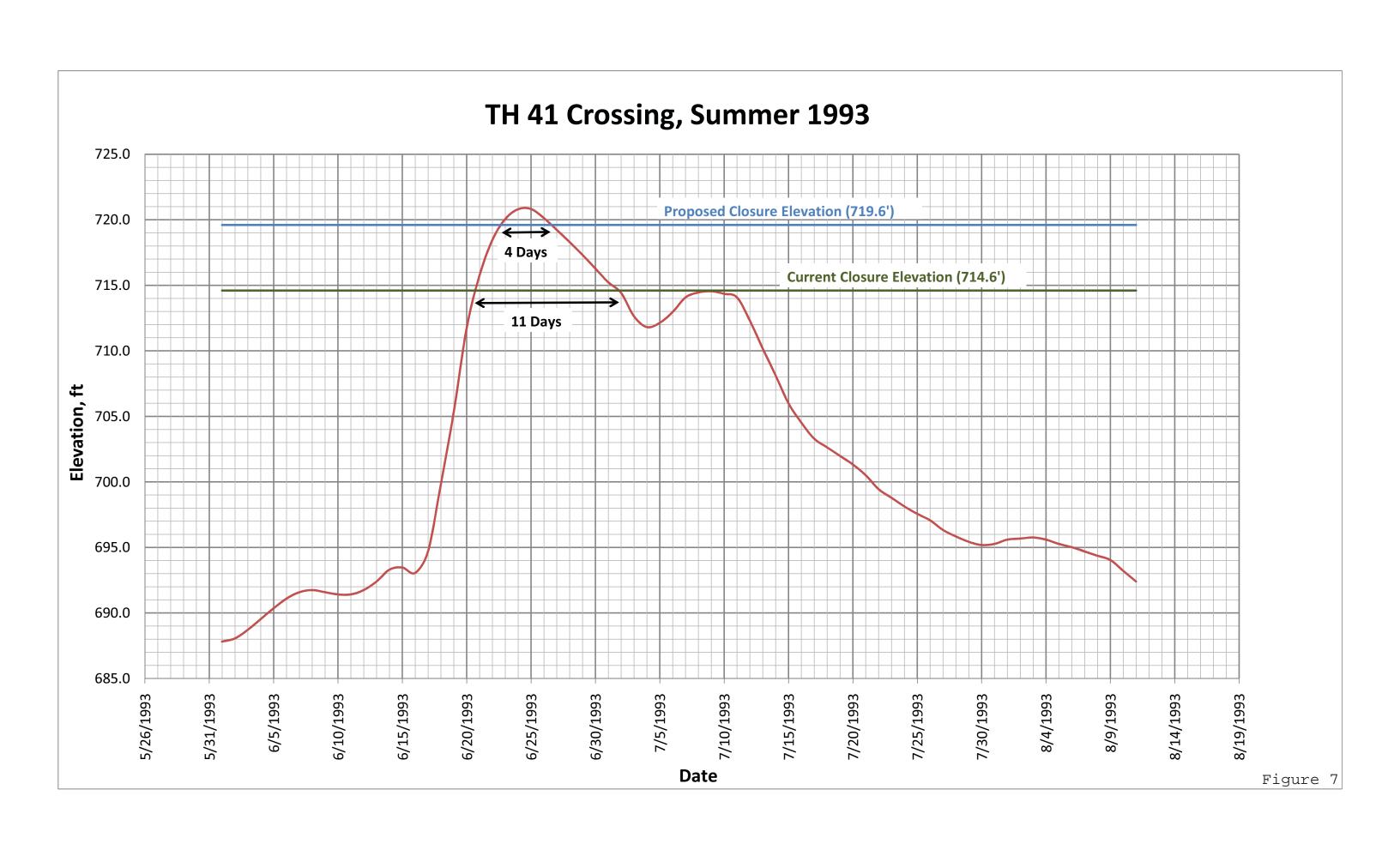


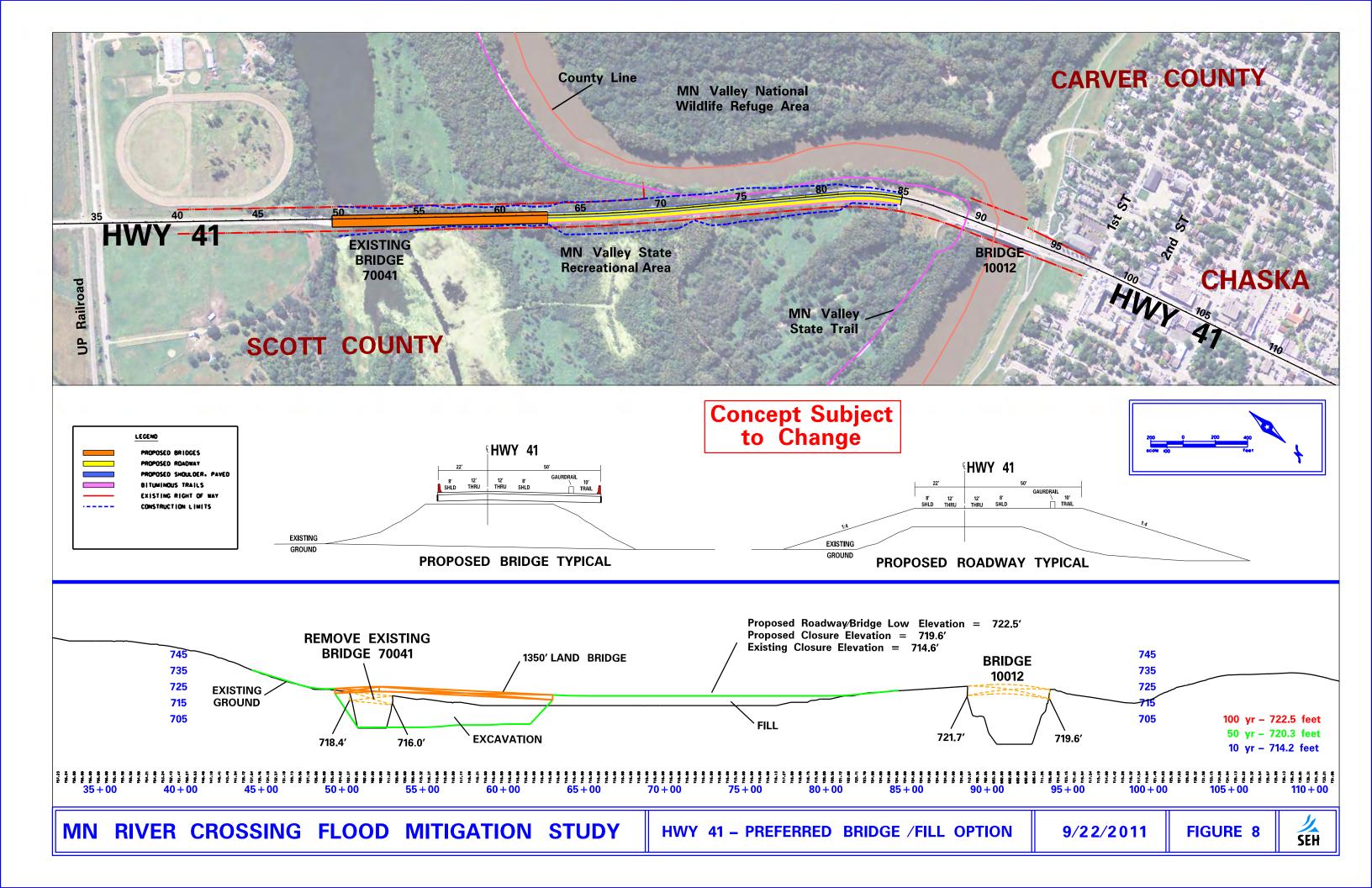


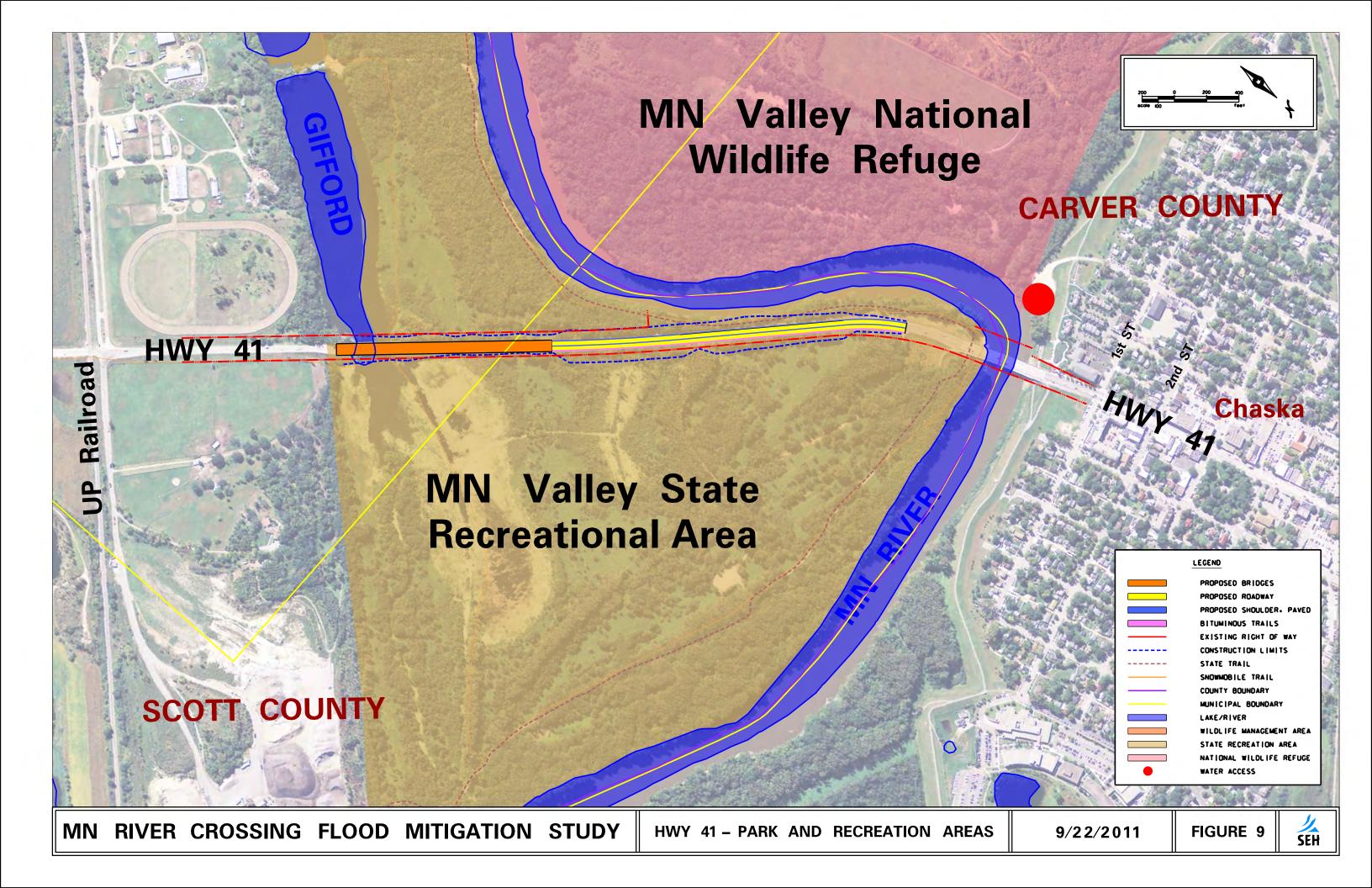


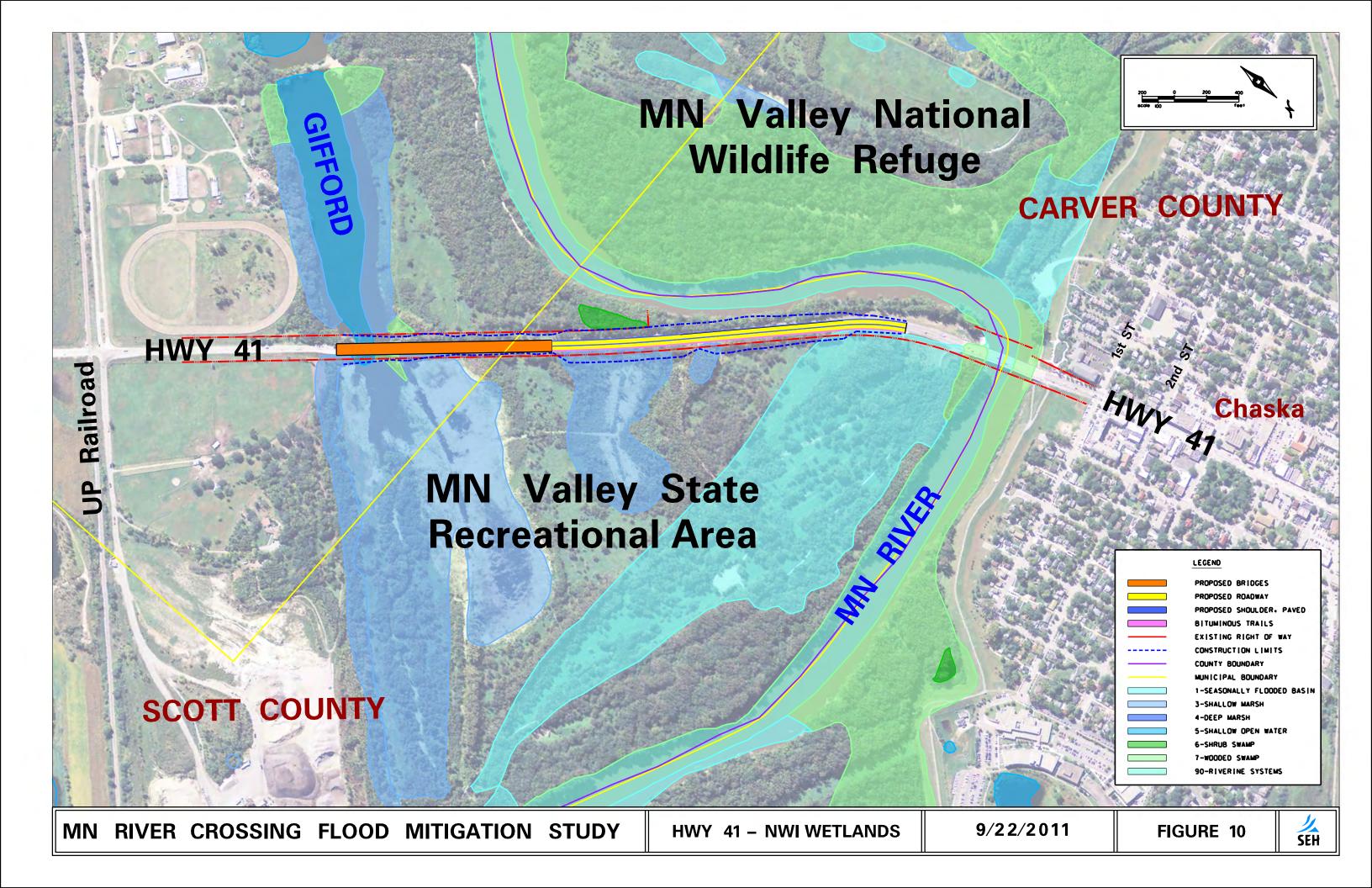












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Highway 169 River Crossing in Bloomington

Highway 169 River Crossing in Bloomington

Highway 169 operates with three or more lanes over the river in each direction to facilitate the junction of State Highway 13, County Highway 101 and County Highway 18 on the south end but with only two lanes each direction from Old Shakopee Road to the north. The four-lane segment serves nearly 80,000 ADT today with northbound AM and southbound PM peak hour flows operating near the capacity of the roadway. Improvements underway for the Highway 169/Interstate 494 interchange will eliminate an existing capacity constraint which will attract more trips to the Highway 169 corridor.

Although the Highway 169 river crossing is relatively new, it does not have sufficient capacity to efficiently handle the traffic detoured during closures at the Highway 41 and Highway 101 river crossings due to flood events. Since the Highway 169 river crossing is located above the 100-year flood level, the study team identified temporary and permanent measures to ease congestion and increase capacity.

Temporary Capacity Improvements to Ease Congestion

In response to the spring 2011 flood event which resulted in the closure of the Highway 101 and 41 river crossings, MnDOT completed a temporary restriping project to ease congestion within the Highway 169 corridor. The temporary restriping project created three narrow lanes with posted speed limits of 55 miles per hour or less along the restriped sections of Highway 169. The project restriped the northbound segment of Highway 169 to add a lane between Scott County Road 18 and Pioneer Trail (approximate) and restriped the southbound segment of Highway 169 to add a lane between Pioneer Trail (approximate) and Highway 101. Temporary signal modifications were also made at the Highwood Drive/Townline Avenue intersection in Bloomington and at the Highway 169/Interstate 494 interchange. The project also temporarily closed the ramp from Old Shakopee Road to northbound Highway 169; a detour directed motorists north on Bloomington Ferry Road. The spring 2011 restriping project was completed at a cost of \$426,000.

The temporary capacity improvement option proposed in this study is similar to this year's emergency project but would require more comprehensive upgrading to minimize design exceptions and pavement damage (as identified in Table 1).

Table 1 – Estimated Costs for Highway 169 Temporary Capacity Improvement

Item	Cost
Bridge Widening for Bridge No. 27694	\$81,000
Southbound Shoulder Upgrade	\$653,409
Total	\$734,409
Total w/ 20% Risk ¹	\$881,000
¹ Does not include project development/design costs.	

Source: SEH, Inc.

An additional cost estimated to be \$300,000, would be required for construction and maintenance purposes each time the project is implemented. The project would also need to be individually let each time that it is needed. The temporary capacity improvement alternative is designed to be a recurring project which could be implemented prior to or during construction of a river crossing improvement at Highway 101 and/or 41.

Permanent Capacity Improvements to Ease Congestion

Based on a request that was made at a Study Management Team meeting, the study team identified the costs associated with adding a permanent lane to the Highway 169 river crossing. Through bridge and roadway widening, this option would add a permanent lane between County Road 18 and Pioneer Trail. The permanent capacity improvement alternative would have higher costs (see Table 2) and a number of complex design and implementation issues would need to be resolved.

MNTMD-115709 Page 1

Table 2 – Estimated Costs for Highway 169 Permanent Capacity Improvement

Item	Cost
Widen Northbound River Bridge	\$14,040,000
Widen Southbound River Bridge	\$14,424,000
Widen Bridge No. 27694	\$501,660
Widen Bridge No. 27693	\$427,410
Widen Bridge No. 70519	\$621,750
Widen Bridge No. 70520	\$637,500
Widen Bridge No. 70521	\$298,440
Widen Bridge No. 70522	\$306,000
Widen Bridge No. 70523	\$746,100
Widen Bridge No. 70524	\$510,000
Widen Bridge No. 70528	\$360,000
Pavement Widening	\$2,768,939
Total	\$35,641,799
Total w/ 20% Risk ¹	\$42,770,000
¹ Does not include project development/design cost	s.

Source: SEH, Inc.

This alternative would provide congestion relief during both flood and non-flood events.

Cost Effectiveness

A benefit-cost analysis was completed for the temporary and permanent capacity improvement options at Highway 169. The preliminary analysis indicates that the temporary capacity improvement has a benefit-cost ratio of 19.11 and the permanent capacity improvement has a benefit-cost ratio of 15.15; a benefit-cost ratio greater than one means that it is a beneficial project. The vehicle miles traveled and vehicle hours traveled benefits of the project are estimated to be greater than the costs associated with the construction of the project. For additional information regarding the benefit-cost analysis that was performed for this study, please see the technical memorandum in Appendix F.

Summary

This appendix identifies temporary and permanent capacity improvements to ease congestion at the Highway 169 river crossing in the City of Bloomington. The Highway 169 river crossing was included as part of this study since it was not known at the outset whether a feasible solution could be identified at either the Highway 101 or 41 river crossing (that would minimize the risk of flooding without causing an increase in the 100-year flood elevation). Since feasible solutions have been identified at Highway 101 and 41 (see main body of the report), the temporary capacity improvement presented above should be considered as a possible traffic management strategy that could be used in the interim and/or during construction of one or both of the preferred concepts.

Appendix B

Public Open House Summary

Minnesota River Crossing Flood Mitigation Study Public Open House Meeting #1 May 24th, 2011



ATTENDANCE (MEETING SIGN-IN SHEET ENCLOSED)

• 32 individuals signed-in at the public open house meeting.

SUBMITTED COMMENT CARDS & E-MAIL RESPONSES (ENCLOSED)

- Four (4) comment cards were submitted during the public open house meeting.
- Three (3) e-mail responses were received after the public open house meeting.

CITY OF CHASKA LETTER (DATED JUNE 20, 2011; ENCLOSED)

 Supportive of Mn/DOT's efforts to address flood mitigation of Highway 41 through a plan that would raise the road and keep it at a two-lane section, but would not want to see this accomplished at the same time as creating the potential for increasing traffic capacity on Highway 41 through the city's downtown area.

CITY OF CHANHASSEN LETTER (DATED JUNE 27, 2011; ENCLOSED)

• Supportive of a <u>four-lane</u> design for Highway 101 to accommodate future growth.

SOUTHWEST METRO CHAMBER OF COMMERCE (DATED JUNE 27, 2011; ENCLOSED)

• Supportive of Mn/DOT's efforts to find a short-term solution to mitigate for seasonal flooding on Highway 41 and Highway 101.







	PLEASE PRINT
NAME	EMAIL ADDRESS (OPTIONAL)
Mark Syvertsen	Marksyvertsen@ courastinet
Leur Schwigs	\$ 25 Septem 14(0) ast, WET
Pat Heitzman	plheitzmand comcast, nat
Bruce Loney	Blonoy (Q. Ci, Shokapee, MN, WS
X em Thes	rabs@mvec.net
Sant Dealm	69 eglor & Consum MM. US
KORE HAIMFINGA	KOUNPNOON D. CHUNNASSEN. MN. US
Shannon Flecke	Sfiecker swpub.com
ERPO DAVIS	bdavis @ Co. Scott.mn.us
Su werman	bweetinian & co. carrer, mn. 45





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PI			(+. Surlong@		
	NAME	MARK Windschiff	1 odd Cornand Chof hanhisen	Ser	Son Contraction	CHRISTOPHEL SCHULZ			





Name:	Brad Table - Shakope Chamber Board Chair
Comments:	
	Down town Shakopee depends on 101 bein open
	Down town Shakopea depends on 101 being open and functional. 101 being closed 3 times in the last
	14 months (along with 1 ste Construction) has been
	denstating.
	This is a plan that will help DT Stall of Shakopea
	agnificantly. 4 lanes would be preferable for future but
	anything higher with reduced closure will benefit our
	anything higher with reduced closure will benefit our businesses and residents.
	thank you!



		100				

OF THANK	Books
Name:	Bruce Loney
Comments: _	
	CR 101 Alternative should consider or plan for
· .	- Future Improvents of the "Y" to 212
	- Possible MaDOT Turnbock Sul
	- Troil Connection to Holmes St. bridge
	- Con build bridge to bigher Elevotions
	- Consider more fill area to reduce Bridge hereth
:	a cost of project
	- More environment is restored with this obtainent he
	- Future TH Al bridge connection (212 +0 169) A
	- Use Fel Excountion Moterial For "Y" Rocenstruction





Name: DARYL R. BREN (brenvlvw @ hormail, COM)
Comments: While I lave IN Chaska because of CURRPENT RONDWX
I would reconnexed 41 upgrade over a 101 upgrade. There they 6.
between HOON VALLE GRAVEL PIT & LION'S TAP There is a
low spot that would require elevating As well as
UPGRADING 101. Havy 41 CAN CURPENTY CARRY MORE TRANS
Than 101. While Permis would be required, is it Possible
To Add AN additionA RIVER CHANNEL UNDER The
New Bridge to Allow More WATER to Plow under
New Bridge to ALLOW MORE WATER to FLOW under the pridge during flooding? THETERD OF LAND BRIDGE
AN ELEVATED RADWAY, Build IT 4 LANES WIDE SOIT STAG
OPEN DURING CONSTRUCTION AS WELL AS ALLOWING CAPS
AN ELEVATED RADWAY Build IT 4 LANES WIDE SOIT STAY CHEN DURING CONSTRUCTION AS WELL AS ALLOWING CAPS TO BE ON The Shoulder without Blocking TRAFFIC ADD TO PREVENT TRAFFIC THIS DURING ACCIONT PRINCIPLE.
Minnesota River Flood Mitigation Study
Public Open House Meeting May 24, 2011
OF TRUMERO
Name: GIND BUSINARO
Comments:
GETTEONE ASAC
THANK YOU

From: Mark Yost [mailto:m.yost@yahoo.com]

Sent: Sunday, May 22, 2011 9:40 AM

To: Gillach, James (DOT)
Subject: MN River Flooding

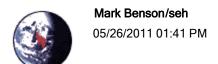
James,

I"m on travel this week and I can't make the meeting Tuesday evening in Chaska.

I'd like to cast a vote for building a bridge for CR 101. The stretch that floods out is not a navigable waterway. Elevate the road by about 10 feet and you're done. Problem solved.

One more thing. Please make it a four lane road with two lanes in each direction. Too often MNDOT spends all kinds of money on projects that are soon at capacity and then the public is stuck with it for the next 20 years. Let's think ahead and do it right.

Regards, Mark Yost



To -"Samuel Turrentine" <sturrentine@sehinc.com>

СС

bcc

Subject Fw: Comments from the Minnesota River Flood Mitigation Study Open House

From: "Gillach, James (DOT)" [james.gillach@state.mn.us]

Sent: 05/26/2011 01:21 PM EST

To: "Zschomler, Kristen (DOT)" <kristen.zschomler@state.mn.us>

Cc: "Langenbach, Diane (DOT)" <diane.langenbach@state.mn.us>; Mark Benson Subject: FW: Comments from the Minnesota River Flood Mitigation Study Open House

Flood study comment.

From: Kate and Jeremy Casper [mailto:kateandjeremycasper@gmail.com]

Sent: Thursday, May 26, 2011 12:40 PM

To: Gillach, James (DOT)

Subject: Comments from the Minnesota River Flood Mitigation Study Open House

Here are my comments regarding the Minnesota River flood mitigation study open house that was Tuesday at the Chaska Community Center.

- For the 101 crossing, what is the design speed that you are designing for? Since the road comes to a T intersection in Shakopee, it seems that the design speed would be based more on the speeds coming from the north. In looking at the 101 and old 212 intersection alternatives listed at http://www.dot.state.mn.us/metro/projects/chanhassen101/maps.html, it seems that the design speeds for 101 are between 35 and 50mph.
- For the 101 crossing, is there any plans for a trail along the bridge and the road? It would be nice to see a 10' or 12' trail along the north end of the bridge for the following reasons:
 - MnDOT is just about to complete the restoration of bridge 4175 (Holmes St bridge), which will serve as a river crossing for recreational uses.
 - Scott County is working on submitting a preferred route for the Scott County West Regional trail, with the northern part of the trail terminating at the 101 river crossing.
 - Scott County has received funding to complete the gap in the regional trail system between the Bloomington Ferry Bridge and Memorial Park in the City of Shakopee
 - The Mn River Bluffs LRT trail runs from Eden Prairie to Chaska just to the north of the river crossing.
 - The Mn River Valley State Trail runs from the 101 river crossing to the 41 river crossing
 - Funding could be available to assist in the development of a trail through the Legacy amendment and other funding sources
 - The 101 river crossing is already identified in the regional park plans as a regional trail route

The 101 river crossing represents the largest gap in the regional trail system in the area. In addition, during times of flooding, for people biking to work who need to cross the river, there is no alternative route. While the Bloomington Ferry pedestrian bridge may not flood, the approaches to the south flood. If the 101 crossing is closed, then the state trail between Shakopee and Chaska would be flooded as well. Even if 41 remains open and accessible to bikers, there isn't the connecting roads and trails that would be allow them to easily get to the areas in northern Scott County.

It would be optimal to have a trail on the north side since then it could then easily connect with the Holmes St bridge. If the issue of cost keeps on coming up, would it be possible to take the 44' width roadway and dedicate 10' of that to a trail and then reduce the shoulders to 5'.

- For both the crossings, will there be any plans for lighting along the stretches or at least would the bridges be built such that they could accommodate future lighting.
- For the 169 crossing, an improvement that can be made that isn't even necessarily flood related is to reduce eastbound Old Shakopee Rd to one lane under 169 and then also reducing the SB169 exit ramp from two left turn lanes to one. With the roadway reduced to one lane, then the exit ramp from NB169 to Old Shakopee Rd can have a dedicated lane for cars going eastbound onto Old Shakopee Rd. During peak rush hour times, cars can sometimes become staked up onto NB169 as the car have to stop and wait to make the right turn onto Old Shakopee.
- As much as I would like to see a permanent lane added to 169 between Pioneer and Co Rd 18, in terms of flood mitigation I think having 41 or 101 stay open longer would have more of an impact than a permanent lane.
- The 101 crossing should be design with the idea that it could be expanded to 4 lanes in the future as the current Mn River bridge is built to 4 lanes and the plan for 101 north of the river is to be 4 lanes.
- For 41, there isn't as much need for trails as the 1 regional trail in the area is on the north side of the river and the plan is to have it cross where the current UP rail bridge is.
- What would be the plan for actual construction, would a crossing need to be closed to allow for the improvements? Would the crossings allow the ability to construct the bridges next to the existing roadways or would the excavation of the current roadways have to happen before the construction can begin?

Thank you for taking the time to present this at the open house last Tuesday. I understand there a many pieces that go into coming with these plans especially since these crossings are also in environmentally sensitive areas. Regardless of the outcome, I am happy that MnDOT is taking the opportunity to look at these crossings.

-Jeremy J. Casper City of Shakopee resident kateandjeremycasper@gmail.com ----Original Message---From: Gillach, James (DOT)

Sent: Wednesday, June 08, 2011 9:06 AM

To: Zschomler, Kristen (DOT) Subject: FW: 169 ferry bridge

Hi Kristen - here's another comment for the MN River Flood Study.

----Original Message----

From: Henrik Nielsen [mailto:henrik.mn@comcast.net]

Sent: Tuesday, June 07, 2011 8:39 PM

To: *DOT InfolCom

Subject: 169 ferry bridge

To whom it might concern,

Adding an additional lane to the 169 was a blessing (during the flooding) and eliminated all congestions getting on to 169N from 18. Now that it is back to original lane configuration we have the congestion again. Yesterday it took over 20 minutes to get on 169 and cross the bridge. I strongly encourage Mn Dot to monitor this situation and to consider a permanent lane addition solution that has proven to work.

Best regards,

Henrik Nielsen Shakopee



June 20, 2011

Minnesota Department of Transportation Attn: Lynn Clarkowski MnDOT South Area Manager 1500 Co Rd B2 Roseville, Mn. 55113

RE: Formal Comments from May 24th TH 41 and 101 Open House

Dear Lynn:

I wanted to take this opportunity to thank you for scheduling the open house on May 24th to go over with local stakeholders the results of the initial work that MnDOT has completed on looking at short-term strategies for flood mitigation on Highway 41, 101 and 169. As you are aware, the communities of the Southwest Metro are significantly impacted each time TH 41 and 101 close for floods, causing issues both for businesses that rely on traffic from the river crossing, and for commuters that need to get to destinations on the opposite side of the Minnesota River. This has a significant economic impact for the surrounding communities, which is why we are pleased to see MnDOT putting a significant amount of time and effort into looking at this issue to identify potential short-term solutions until such time that a new River Crossing can be complete.

As staff, other Council Members, and I shared with you at the open house, we are very supportive of MnDOT's efforts to find a short-term solution to mitigate for seasonal flooding on both the Highway 41 and Highway 101 corridors. While we recognize that any short-term efforts would only protect the roadway to the 50-year flooding events, we do think that these efforts would have a significant impact on keeping the roadways open during many flooding events that they would normally be closed. As mentioned earlier, any amount of time we can keep Highways 41 and 101 open during flooding events has a very positive economic impact not only on our community, but other communities on both sides of the river.

While we are supportive of such mitigation efforts, we are supportive only under the following two conditions:

- > That the number of lanes (either permanent or temporary) do not increase from the current two-lane configuration south of the Minnesota River to avoid using this project to deal with any capacity building objectives
- That this solution does not take away from MnDOT's full effort to strive for a newly aligned Highway 41 corridor, as we have discussed in the RCIS process

As we discussed with you at the open house, the City of Chaska would be very concerned about the potential future impact of constructing a 4-lane section of road south of the existing Minnesota River Bridge. While you have indicated that under non-flood conditions this would remain a two-lane section of road, this could be re-striped during flooding conditions to increase capacity of traffic moving along TH 41. If it were possible to do this during non-flooding conditions, this would also leave open the possibility of this being permanently re-striped to a 4-lane section, as every other section of road between TH 169 and TH 212 is currently a 4-lane configuration. By constructing a 4-lane section of road, this project would have the ability of not only dealing with flood mitigation issues, but would also allow it to address capacity building objectives, even if that was not what the original intent of this project is. Increasing the capacity of traffic through our downtown would be detrimental to our historic downtown commercial corridor, which already suffers from a high percentage of regional commuter traffic, which often only congests our downtown without creating an economic benefit to our community. It should be noted, that if MnDOT felt that emergency pull-offs were necessary for this project, that we would suggest this over creating another additional lane for traffic.

A second concern that the City of Chaska would have if the road is built to a 4-lane section, is that this will potentially decrease the urgency of MnDOT to develop and build a permanent, newly aligned bridge. Not addressing current capacity issues on Highway 41 through downtown Chaska is not acceptable to our community, and we are concerned that the pressure to continue to address this permanent river crossing will be relieved if a significantly less expensive alternative exists by simply being able to re-stripe a raised section of Highway 41 to 4-lanes on the existing Highway 41 corridor. To Chaska, a four-lane section of TH 41 represents the "No Build" scenario for the future river crossing options.

The City of Chaska does think it is important to stay focused in this project on addressing only flood mitigation issues, and avoid any discussions of how to increase capacity on existing Highway 41 because of our concerns listed above. Highway 41 is already past a capacity that is good for our historic downtown commercial district, and would only become worse if capacity was increased on this roadway. The City of Chaska supports MnDOT's efforts to address flood mitigation of Highway 41 through a plan that would raise the road and keep it at a 2-lane section, but would not want to see this accomplished at the same time as creating the potential for increasing traffic capacity on Highway 41 through our downtown area.

We appreciate your willingness to take our comments, and would invite any questions you may have. You can reach City Administrator, Matt Podhradsky at 952-448-9200. He would be more than happy to discuss this letter with you in further detail.

Sincerely.

Mark Windschitl

Mayor



7700 Market Boulevard PO Box 147 Chanhassen, MN 55317

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Web Site

www.ci.chanhassen.mn.us

June 27, 2011

Ms. Lynn P. Clarkowski Mn/DOT Metro District South Area Manager Mn/DOT Metro District 1500 W. County Road B-2 Roseville, MN 55113

RE: Minnesota River Flood Mitigation Study - PW067E2

Dear Ms. Clarkowski:

The City of Chanhassen is in support of making improvements to the TH 101 Minnesota River crossing. The Minnesota River Flood Mitigation Study preliminary findings show the TH 101 river crossing is the best long-term cost benefit project and will have the most regional transportation benefit. Based on the preliminary finds of the Mitigation Study, the benefits are as follows:

- The TH 101 river crossing improvements have a better cost/benefit then the TH 41 River crossing proposed improvements.
- TH 101 currently carries and is anticipated to carry more traffic than TH 41.
- The future new Minnesota River Crossing will potentially address many of the transportation flooding issues at TH 41.
- TH 101 floods more frequently and stays closed longer than the TH 41 river crossing.
- The regional economic benefits will be greater since the corridor directly connects two communities.
- The project is compatible with the future turnback of TH 101 and turnback funds could potentially be leveraged as another funding source.
- Mn/DOT will be able to remove this corridor from its maintenance requirements once the turnback is complete.
- The investment that Mn/DOT has recently made to the historic bridge in Shakopee should be better utilized by constructing a pedestrian bridge with an improved TH 101 Minnesota River crossing to connect to the LRT Regional Trail and the local trial system on the Carver County side of the river.
- Hennepin County is planning to make improvements on Flying Cloud Drive to make it more flood proof in 2015. These improvements will benefit the TH 101 Minnesota River crossing.
- The length of time to construct TH 101 is shorter than the TH 41 improvements.

Improvements to this corridor are a high priority for the City of Chanhassen, as they would provide long-term benefit in the region and improve the states' trunk highway system. For these same reasons, the City also supports designing the TH 101 improvements to accommodate a 4- lane design in order to plan for future growth. I encourage you to continue to work with the city's engineering staff and others to ensure that the improvements made to the TH 101 Minnesota River provide the maximum long-term net benefit for all concerned.

Ms. Lynn Clarkowski June 27, 2011 Page 2

On behalf of the City of Chanhassen and its City Council, thank you for your continued assistance, and consideration of this letter expressing our support for the selection and funding of the proposed improvements to the TH 101 Minnesota River crossing.

Sincerely,

CITYOF CHANHASSEN

Tom Furlong Mayor



564 Bavaria Lane, Suite 100 | Chaska, MN 55318 | 952-448-5000

To: MNDot

From: Deb McMillan, SouthWest Metro Chamber of Commerce

On behalf of the SouthWest Metro Chamber of Commerce Business Members

RE: Flood Mitigation Project

Date: June 27, 2011

I am writing on behalf of the businesses in the SouthWest Metro area in support of a flood mitigation project for the SouthWest Metro area.

The SouthWest Metro Chamber of Commerce represents businesses in the Eastern Carver County communities of Chanhassen, Carver, Chaska and Victoria which have been significantly impacted by the recent flooding, shutting down main arteries in our regional transportation system and limited access to the area.

Though every business is not located next to the river, nearly every business has been impacted by the rising river and the subsequent closing of the roads resulting from the flooding. With large volumes of traffic being diverted to other crossings, businesses that depend on drive-by traffic find their business down as much as 70% during a significant flood event. Employees crossing the river to work each day experience significantly longer commute times as they are detoured to river crossings up to 20 miles out of the way. Additionally, suppliers and customers can be located on the opposite side of the river, making access to business difficult and inconvenient. The resulting loss of revenue and the increasing fuel costs, increased travel time and scheduling challenges create significant hardship for all during flood events. Of course, closed roads and detours also greatly impact emergency response time from police, fire and ambulance as well when minutes are critical.

Improvements to either the Highway 41 river crossing or the Highway 101 river crossing would benefit the businesses and residents in the SouthWest Metro region, making access to and from the region easier in the event of a flood. The SouthWest Metro Chamber strongly supports either improvement!

Thank you for your attention to this matter.

Appendix C

Hydrodynamic Modeling Report

Baird

engineering
lakes
design
rivers
science

oceans

watersheds construction

Hydrodynamic Modeling for Minnesota River Crossing Feasibility Study

September 23, 2011 11845.100









Hydrodynamic Modeling for Minnesota River Crossing Feasibility Study

Prepared for



The Minnesota Department of Transportation

Prepared by





For further information please contact Mark Riedel at (608) 273-0592

11845.100

This report was prepared by Short Elliott Hendrickson Inc. and W.F. Baird & Associates Ltd. for The Minnesota Department of Transportation. The material in it reflects the judgment of SEH and Baird & Associates in light of the information available at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. SEH and Baird & Associates accept no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

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EXECUTIVE SUMMARY

This report summarizes the results of a feasibility analysis to investigate possible bridge and highway alternatives that may reduce the frequency and duration of flooding related road closures on Highways 41 and 101. These critical transportation infrastructure assets are located within the Minnesota River Valley and are subject to frequent flooding. Consequently, changes to the existing structures have the potential to cause a corresponding change in flood regime, typically through a combination of changes in conveyance, water levels, and velocity. The feasibility level analyses conducted here serve as a screening tool to identify workable alternatives that warrant further consideration and development to support engineering level design.

The alternative bridge and highway crossings for Highway 41 and Highway 101 were predicted to reduce flooding of the transportation corridor by increasing conveyance for the more frequent flood events (e.g. the 10 and 50-year events) through the use of elevated land bridges and road grades. At the Highway 101 alternative, the increased conveyance was predicted to reduce velocity through the bridge structures. For the Highway 41 alternative, the elevated road grades were predicted to result in a decreased velocity (~4 ft/sec) at Bridge 10012 for the 10-year event and a slightly increased velocity (~4-5ft/sec) for all larger flow events. However, these velocities were still below what the existing system is experiencing under the 10-year event (~6 ft/sec).

In summary, the model results indicate the two preliminary alternatives reduced the flood elevations of the most frequent floods and increased conveyance for all events. There were no indications from the feasibility modeling to suggest the proposed alternatives should not be further developed into workable solutions. As this was a feasibility level study, further refinement of the alternatives to a more developed design should be undertaken to minimize any potential adverse impacts (such as an increase in water surface elevation for high flow events), while retaining the benefits of reduced frequency and duration of roadway flooding. Next steps would include partial engineering design (e.g. 50% design) of the alternatives using the existing models to iteratively inform and optimize the design process as modifications are made.

1.0 INTRODUCTION

S.E.H. Inc. (SEH) and W.F. Baird & Associates Ltd. (Baird) were retained by The Minnesota Department of Transportation (MNDOT) to develop a two-dimensional (2D) hydrodynamic model of the Minnesota River. This is part of a study analyzing the feasibility of highway improvement to reduce the frequency of road closures due to flooding along the Minnesota River. The objectives of the modeling study are to: a) assess water surface elevation in the existing conditions and provide the necessary information for highway design; b) assess the impact of different design alternatives for highway improvements on the frequency of flooding and road closures; and c) develop and deliver to MNDOT, a calibrated, 2D model of the Minnesota River in the FESWMS modeling environment.

2.0 DATA COLLECTION AND ANALYSIS

The data required to develop the model includes bed elevations and features in the river and floodplain, satellite images and air photos, hydrological information, and the design drawings of the existing highways, bridge crossings, and other related infrastructure. This section describes the data collected and the details of data processing.

2.1 GIS and Topographic Data

Topographic data on the floodplains and bathymetry data in the river bed are essential datasets for the model development. The actual survey and development of topographic and bathymetric data was conducted by other parties including MNDOT, the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (USACE), and cities and counties within the study area. The spatial extent of the data sets and model domain are illustrated in Figure 2.1. Independent quality control of these data was not a component of the scope of this study; hence, these data were only checked for consistency after obtaining them from the following sources:

• 2004 USACE and USGS HEC-RAS cross-sections
A HEC-RAS model of the lower Minnesota River was developed by the USACE and USGS in 2004. The cross-section survey data in the model can be used as the bathymetry in the river. The cross-sections in the HEC-RAS model were originally converted from an existing HEC-2 model of the river and were revised to include the updated channel topography from USACE sounding data (cross-sections 1 – 42) and the updated channel and overbank topography from USGS surveys conducted in 2000 (cross-sections 43-91) (USACE and USGS, 2004). The cross-sections were reviewed and compared with other data to provide a check of consistency. Through trial and error, the geographic coordinate systems referenced in the model were determined to be the horizontal Universal Transverse Mercator (UTM) in feet (ESRI linear unit of feet) and the vertical datum of NGVD29 in feet. Details on how this

dataset was processed in order to be used as bathymetry data for the 2D model are described in Section 3.2.2.

• 2007 USACE hydrographic survey

The USACE hydrographic survey was downloaded from the USACE GIS Center Data Repository (http://www.mvp.usace.army.mil/gis/default3.asp?location_id=70). The coverage of this dataset is outside of the model domain and was therefore not used to build the bathymetry for the model. However, this dataset was compared to the cross-sections in the HEC-RAS model to check consistency in development of the bathymetric model domain.

• 2006 LiDAR data

The LiDAR data provided by the client is a high-resolution element model (DEM) distributed by the Minnesota Department of Natural Resources Management Information Services Bureau (DNR-MIS). This dataset contains high resolution elevation data derived from LiDAR mass points. The cell size of this dataset is three meters. The geographic coordinate system to which the dataset is referred is UTM NAD83 in meters. The vertical datum to which the elevation is referred is NGVD88 in meters.

USDA/NRCS National Elevation Data (NED)

This dataset was downloaded from USDA/NRCS National Cartography & Geospatial Center. The NED is a seamless mosaic of best-available elevation data. One of the effects of the NED processing steps is a much-improved base of elevation data for calculating slope and hydrologic derivatives. The datasets are utilized by the scientific and resource management communities for global change research, hydrologic modeling, soils mapping, resource monitoring, mapping, and visualization applications. The cell size of this dataset is 10 meters. The geographic coordinate system referred by the dataset is UTM Zone 15 in meters, NAD83. The vertical datum for elevation is referenced to NAVD88. This dataset was used to build the bathymetry for all remaining areas that were not covered by the above datasets.

For consistency with the coordinate system used in the 2D model, all datasets were converted to the Minnesota State Plane South in feet and all elevations were converted to NAVD88. The difference between NAVD88 and NGVD29 is listed below in Table 2.1.

Table 2.1 Datum Shift between NAVD88 and NGVD29 in the Study Area*

<u> </u>		
antina	Datum Shift (ft)	
Location	(NAVD88 minus NGVD29)	
Minnesota River near Jordan, MN, USGS gage 05330000	0.131	
TH41	0.121	
TH101	0.141	
Dan Patch Line Rail Swing Bridge	0.190	

^{*} Conversion formula: height (NAVD 88) = height (NGVD 29) + datum shift (correction) value

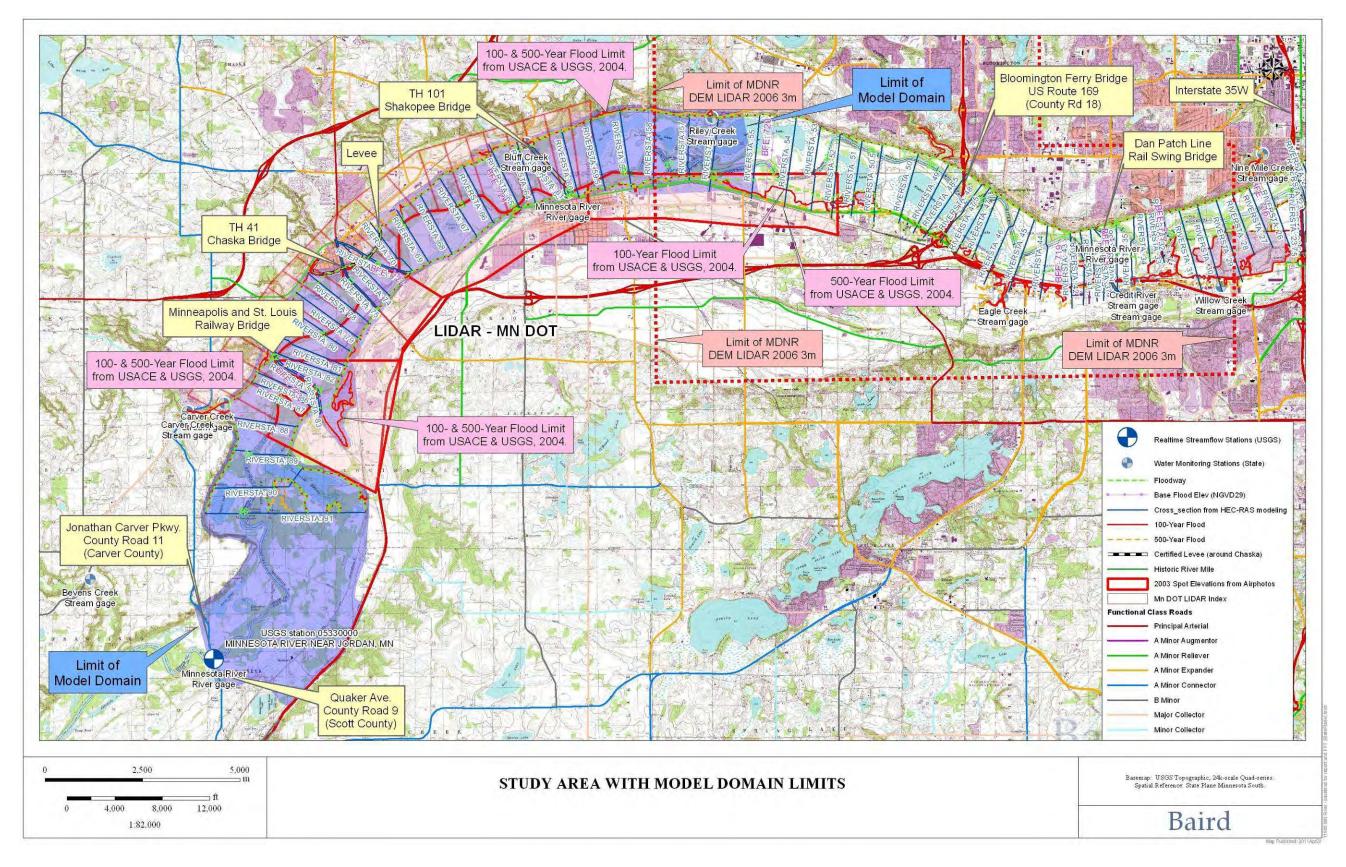


Figure 2.1 Basemap illustrating the coverage extents of the GIS and topographic datasets and the 2D model domain

2.2 Hydrological Data

The hydrological information in the lower Minnesota River was assembled to serve as boundary conditions for model calibration. There are two USGS gages within the study area of the Lower Minnesota River. The USGS gage station 05330920 Minnesota River at Fort Snelling State Park serves as the downstream boundary of the HEC-RAS model. The vertical datum for this gage is 680 feet above NGVD29. The other USGS gage station 05330000 Minnesota River near Jordan, MN is located on Quaker Avenue, Scott County Road 9. The datum of this gage is 690 feet above NGVD29. The gage serves as the upstream boundary for the 2D model (see Section 3.2.1 for further discussion). Figure 2.2 shows the locations of two gages.

In October 2001, the USACE revised the design flood discharge values at the gage near Jordan (USGS Gage 05330000) (USACE, 2001), as listed in Table 2.2. These revised discharge values were used for the model runs.

 1	0 0
Return period	Peak Discharge (cfs)
10 year	48,500
50 year	85,300
100 year	103,000
500 year	148,000

Table 2.2 The return period discharge at USGS gage near Jordan (0533000)

2.3 Field Surveys

The field survey for flow measurement was conducted by MNDOT during the flood event on March 28, 2011. The water surface elevation (WSE) and flow speed at the main river crossing (i.e. Bridge 10012, TH41) and at the overflow (i.e. Bridge 70041, TH41) were measured using an acoustic Doppler current profiler (ADCP). The locations of ADCP measurements are shown in Figure 2.2. According to the record at the USGS gage 0533000, the discharge of the Minnesota River that day was 72,300 cfs, which is approximately a 30-year return period flow. The WSE measured at the main river was 718.22 feet above NAVD88 (measured around 12:30 pm) and 717.82 feet above NAVD88 at the overflow (measured around 3:30 pm). The vertical average flow speeds measured at the main river and at the overflow are shown in Figures 2.3 and 2.4. These measured data were used to calibrate the 2D model.



Figure 2.2 Location of USGS gages used as boundary conditions in the 2D model and the HEC-RAS model, as well as ADCP measurement locations.

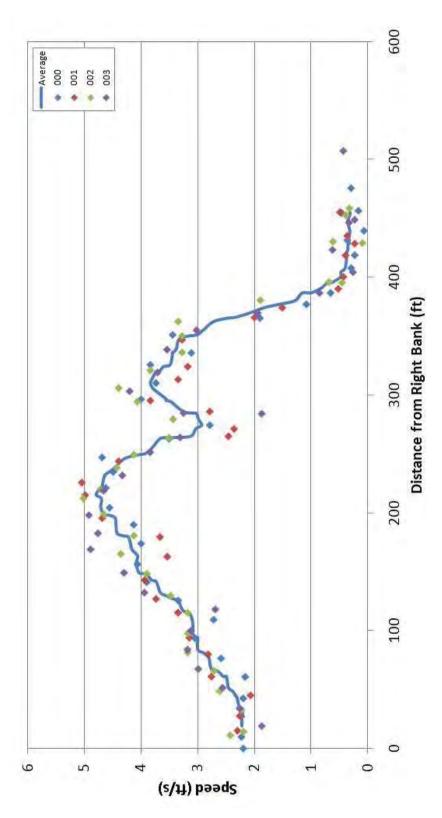


Figure 2.3 The measured flow speed at the downstream side of Bridge 10012, TH41

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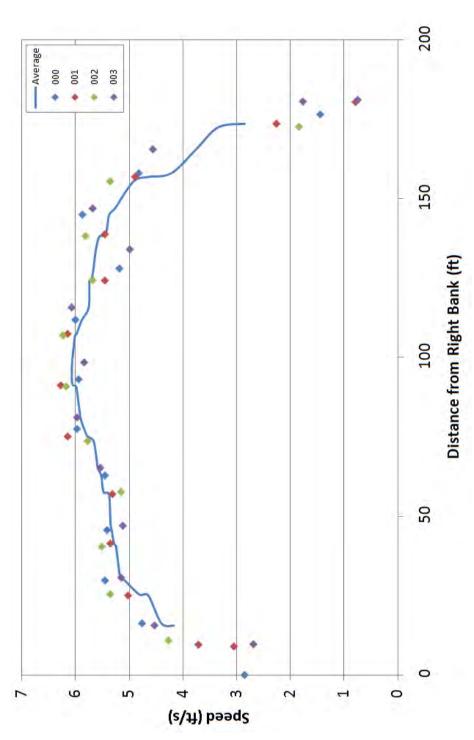


Figure 2.4 The measured flow speed at the downstream side of Bridge 70014, TH41

3.0 MODEL DEVELOPMENT

As specified by MNDOT, the Finite Element Surface Water Modeling System (FESWMS) was utilized for this study. This section describes the development of the FESWMS model, including grid generation, model setup, and model calibration.

3.1 FESWMS Model

The software package used in this study is the depth-averaged Flow and Sediment Transport Model (FST2DH) in the 2D horizontal plane, which is integrated into Surface-Water Modeling System (SMS). FST2DH is a hydrodynamic model that supports both super and subcritical flow analyses, including area wetting and drying. It was developed by Dr. Dave Froelich, P.E. in partnership with the Federal Highway Administration (FHWA). FST2DH applies the finite element method to solve steady-state and time-dependent systems of equations that describe 2D depth-averaged surface-water flow and sediment transport. FST2DH is specifically suited for highway river crossings where complex hydraulic conditions exist because conventional analyses based on one-dimensional flow calculations often cannot provide the needed level of solution detail at these types of locations. FST2DH also has the capability to simulate movement of non-cohesive sediment in rivers, estuaries, and coastal waters, which was not used in this study. The highlight features of FST2DH model capabilities are:

- General purpose 2D depth-averaged steady state and transient flow model;
- Accepts a wide variety of boundary conditions;
- Models several types of 1D flow control structures, such as weirs, culverts, and bridge openings;
- Represents flow resistance from bridge piers;
- Models pressure flow under bridge decks; and
- Coupled hydrodynamic/sediment transport analysis for modeling scour and deposition of non-cohesive sediments.

Version 3.22 of FST2DH was used for this model application. This version expands the capabilities of previous releases by adding or improving numerical simulation of the following phenomena: turbulence-induced shear stresses, wetting and drying of elements, pressure flow under bridge decks, flow resistance from bridge piers, local scour at bridge piers, bridge pier riprap sizing, flow over roadway embankments, flow through culverts, flow through gate structures, flow through drop-inlet spillways, and combined one-dimensional/two-dimensional flow and sediment transport.

3.2 Model Setup

3.2.1 Model Domain and Grid Generation

The model domain was developed to address the following important criteria:

- The model domain should cover the largest extent where flooding could potentially occur during extremely large flood events;
- The upstream open boundary should be located sufficiently far enough away from both highways so that the impact of highway improvement projects on water surface elevation is insignificant at the open boundaries; and
- The data should be available to setup the model and to control open boundaries.

The selected model domain is shown in Figure 3.1. The upstream open boundary was set at the USGS gage 05330000 Minnesota River near Jordan on Quaker Avenue, Scott County Road 9. This gage is about seven miles upstream of TH41. This reflects an upstream extension of the originally proposed model domain (from the existing HEC-RAS model) to facilitate greater control of the open boundary using data measured at the gage. These data are required for model calibration and the upstream extent of the HEC-RAS model was not located at a USGS gaging station. The downstream open boundary was set to three miles downstream from TH101 which corresponds to cross-section #55 in the HEC-RAS model. The downstream boundary from the HEC-RAS model (USGS gage 05330920) could not be reliably used because back-water effects from the Mississippi River during large flood events produced significant uncertainty in the water level and discharge records from this gage. The lateral extent of model domain was determined by the 500-year flood limits plus a 200 ft buffer. The model domain is about 14 miles long and 1.5 miles wide.

Numerous grid configurations were tested over the model domain to optimize model performance and facilitate model calibration. The original mesh systems were too large to allow for timely completion of model runs over such a large model domain. Consequently, a hybrid grid was generated using a combination of different mesh types to allow for greater model resolution and sensitivity within the river and at bridge crossings where flow would be more unstable, while allowing coarser mesh in overbank and backwater areas where flow would be more uniform. The grid was generated using SMS software as shown in Figure 3.2. There are about 35,000 nodes in total and about 10,000 finite elements which are combinations of 6-nodal triangles and 9-nodal quadrilaterals. The grid resolution in the main river is about 40 ft, 25 ft on highways, and about $100 \sim 400$ ft on the floodplain. The grid near the bridges was refined to more accurately simulate the currents near the bridges in detail. Figures 3.3 and 3.4 show the refined grid at TH41 and TH101, respectively.

Figure 3.1 Model domain and the interpolated bathymetry

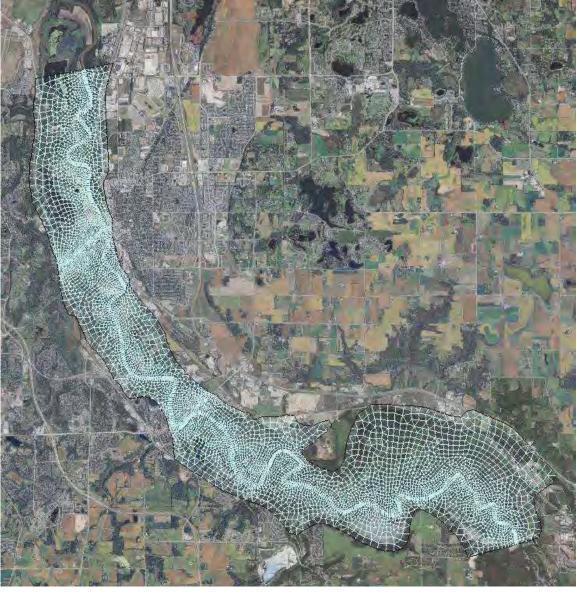


Figure 3.2 Finite element grid for the entire model domain

Figure 3.3 Refined finite element grid along TH41 - note, in this figure, only one-half of grid cells are shown for illustrative purposes. Actual model mesh is significantly finer (e.g. double the number of cells within the river channel)

Figure 3.4 Refined finite element grid along TH101- note, in this figure, only one-half of grid cells are shown for illustrative purposes. Actual model mesh is significantly finer (e.g. double the number of cells within the river channel)

3.2.2 Bathymetry

Bed elevation at each node was required for the model setup. The bathymetry is the essential dataset for model setup and has direct impact on the accuracy of model predictions. Therefore, the bathymetry elevation at each node was carefully evaluated to verify consistency. The following data sources were used to build the bed elevations:

• 2004 HEC-RAS model cross-sections

The bed elevations were extracted from the cross-sections used in the HEC-RAS model and mapped to the basemap. These cross-sections were compared with the other datasets such as LiDAR and NED data. It was found that many cross-sections do not match well with air photos and LiDAR data (see Figure 3.5). Therefore, the cross-sections were moved in the lateral direction to line the cross-sections up with the other datasets at the river banks. The cross-sections from HEC-RAS model are spaced coarsely in the longitudinal direction (about 200 ft \sim 300 ft). These data do not describe the river well, especially in river bends. Therefore, additional cross-sections were manually added between two cross-sections to better describe river bathymetry. The bathymetry in the river was used as the first dataset for model bathymetry interpolation. That is, any node located in the extent of river bathymetry was interpolated using this dataset.

2006 LiDAR data

The high resolution (three meter) LiDAR data were used as the second dataset to interpolate the bathymetry at the nodes. It is noted that the LiDAR data are not accurately representative of the bathymetry in the ponds or lakes on the floodplain. However, this does not have a significant impact on the accuracy of the model prediction for WSE since the existence of ponds or lakes will not change flood routing on the floodplains.

USDA/NRCS NED data

NED data was mainly used to interpolate the elevation at nodes where the above two datasets did not cover. One of these areas, for example, is the upper part of model domain beyond the upstream open boundary of the HEC-RAS model.

Using these three datasets, the bed elevation at each node was interpolated using the Natural Neighboring method. The interpolated bathymetry, shown in Figure 3.1, captures the variation of the river and bed elevation on the floodplain.

Additionally, four different land coverages, referred to as materials in the SMS program, were used to represent the various vegetation and surface types, i.e. river, highway, floodplain, and lakes. Each material has its own physical feature, such as bottom roughness, which is described fully in Section 3.3.

3.2.3 Boundary Conditions

Boundary conditions are required to control the boundaries of the model domain. There are two types of boundaries, land boundary and open boundary. The land boundary was dealt with as a wall with a no-slip boundary condition. Open boundaries were enforced by flow discharges or surface water levels. The lateral inflows from small tributaries to the model domain were not considered in the model since the flow discharge from these tributaries is very small compared to the flow in the Minnesota River. Additionally, there were no data available from these tributaries for model setup. Therefore, all lateral inflows inside the model domain were also dealt with as land boundaries.

There are two open boundaries in the model domain. At the upstream open boundary, the measured flow discharge at the USGS gage was used for the model calibration in the flood event on March 28, 2011. The revised discharge values, listed in Table 2.2, were used for the scenario runs under the existing and alternative conditions. At the downstream open boundary, the WSE extracted from the HEC-RAS model at cross-section #55 was used for both calibration and alternative runs.

3.3 Model Calibration

The developed model was first tested to check the stability of the model. The grid was locally adjusted as necessary to provide solution in areas of model instability. The model was then calibrated against the ADCP data and WSE measured at the downstream side of Bridge 10012 and Bridge 70041 TH41 on March 28, 2011. The flood event on that day is approximately a 30-year return period flow. In the model calibration, the Manning's roughness parameter was adjusted to make the model results fit best to the field measurement during the March 28th event. The final values of Manning's roughness are listed in Table 3.1. These values are almost the same as those used in the HEC-RAS model, except for the roughness in the floodplain and highway. Comparison of the model results with the field measurements are listed in Table 3.2. The difference between the WSE the model predicted and the physical measurement is less than 0.1 ft; both the FESWMS and the HEC-RAS model predicted the WSE at TH41 very well. Figures 3.6 and 3.7 show the comparison of flow vectors predicted by the model and measured in the field. The predicted flow velocity at the main river agrees well with the measurement, but the 2D model underpredicted the flow velocity at Bridge 70041. This may be a result of inaccurate bathymetry around the bridge or bridge opening.

Table 3.1 Manning's Roughness Used in FESWMS Model

Material Type	Manning's Roughness		
	FESWMS	HEC-RAS	
River	0.04	0.038 ~ 0.042	
Floodplain	0.065 ~ 0.15	0.055/0.065 ~ 0.15	
Highway	0.055	0.028	
Lake	0.04	-	

Table 3.2 Comparison of the Model Results with the Measurement

	1	Predicted by model		
Location	Measured	FESWMS	HEC-RAS	
Upstream Flow (cfs)	72,300	-	-	
Downstream WSE (ft)	718.0	-	-	
WSE at USGS Gage #0530000 (ft, NAVD88)	721.9	721.2	-	
WSE at Bridge 10012, TH41 (ft , NAVD88)	718.2	718.2	718.1	
Max. Flow Speed at Bridge 10012, TH41 (ft/s)	4.9	4.8	-	
Max. Flow Speed at Bridge 70041,TH41 (ft/s)	6.0	3.5	-	

Further model calibration was conducted by comparing the WSE predicted by the FESWMS model with the HEC-RAS model prediction. Four flow conditions were used for comparison between the two models, i.e. the 10-year, 50-year, 100-year, and 500-year flow events. Table 3.3 lists the flow conditions and WSE at the upstream open boundary and the predicted WSE at TH41 and TH101. The comparison of the model results are also plotted in Figure 3.8. The WSE predicted by the FESWMS model matches well with the HEC-RAS model for the flood events larger than a 50-year return period flow. But, FESWMS predicted the WSE slightly higher than the HEC-RAS model at TH41 for the flow events less than 50 years. According to the model calibration against the field measurements (see Table 3.2), the HEC-RAS model may slightly underpredict WSE at TH41 for flood events less than 50-years.

Table 3.3 Comparison of WSE Predicted by FESWMS and HEC-RAS Models on TH41 and TH101

Flow event US F	Flow conditions		Water Surface Elevation (ft, NAVD88)					
	US Flow DS WSE	TH41 (Bridge 10012)		TH101				
	(cfs)	(cfs) (ft)	HEC-RAS	FESWMS	Diff	HEC-RAS	FESWMS	Diff
10 yr	48,500	711.2	714.2	714.8	0.6	712.0	712.0	0.0
50 yr	85,300	717.8	720.3	720.2	0.0	718.4	718.3	-0.1
100 yr	103,000	720.2	722.5	722.4	-0.01	720.7	720.6	-0.1
500 yr	148,000	725.5	727.7	727.6	-0.2	726.0	726.0	0.0

Figure 3.9 shows the spatial distribution of flow speed and flow vectors simulated by the FESWMS model for the flood event on March 28, 2011. Figure 3.10 illustrates the predicted flood areas for the March 28th event. The flood areas reproduced by the model match well with the flood areas indicated in the photos taken of the highways at the time of flooding (Figure 3.11). This provides a qualitative check that the model is well calibrated and matched field observations.

In summary, the developed FESWMS model was well calibrated against the measured WSE and flow velocity. The difference of WSE between model prediction and field measurement is less than 0.1 feet. Both the FESWMS and the HEC-RAS model accurately predicted WSE at the highways in comparison to the field measurements. The WSE predicted by FESWMS matches well with the HEC-RAS model prediction for the flow events larger than 50-year return period flow. The HEC-RAS model may slightly underpredict water surface elevation at TH41 for the flood events less than 50 years.

Figure 3.5 Misalignment of cross-sections in HEC-RAS model with the base map - note cross section and bathymetric model are shifted north relative to the river location in the aerial image

Figure 3.6 Comparison of flow vectors predicted by the model and measured in field at downstream of Bridge 100012, TH41

Figure 3.7 Comparison of flow vectors predicted by the model and measured in field at downstream of Bridge 70014, TH41

♦ Hwy 41 (Bridge 10012, RAS 75)□ Hwy 101 (Bridge 70002, RAS 61)

Measurement at Hwy 41

FESWMS WSE (ft)

Figure 3.8 Comparison of water surface elevation predicted by FESWMS model with HEC-RAS model and measurement

Figure 3.9 Flow vectors simulated by the FESWMS model for the flood event on March 28, 2011

Figure 3.10 Flood extent simulated by the model for the flood event on March 28, 2011

Figure 3.11 Aerial photograph of TH41 looking northwest towards Chaska during the flood event on March 28, 2011

4.0 MODEL RUNS FOR EXISTING CONDITIONS

The calibrated model was run to simulate flooding for the flood events under the existing conditions. The model results provided the base for comparison to assess the impact of highway improvement alternatives on WSE. Four flow conditions, shown in Table 2.2, were simulated by the model.

Figures 4.1 through 4.4 show the flood extents under the existing condition for flow conditions during the 10-year, 50-year, 100-year, and 500-year events. The model results indicate that the existing Highway 41 is not flooded for the flow condition less than 10-year return period flow (i.e. 48,500 cfs). However, the calibration run shows that Highway 41 was flooded during the event of March 28, 2011, which is equal to approximately a 30-year return period flow. It is concluded that the existing Highway 41 starts to flood during flow conditions larger than about a 20-year return period flow. The model results show that the existing Highway 101 is flooded in the 10-year return period flow. It is noted that Flying Cloud Drive, on the north side of the Minnesota River downstream of TH101, is partially flooded during flow conditions of a 500-year return period flow (i.e. 148,000 cfs), as shown in Figure 4.5.

Figure 4.1 Flood extent produced by the model under the existing condition during a 10 year return period flood event

Figure 4.2 Flood extent produced by the model under the existing condition during a 50 year return period flood event

Figure 4.3 Flood extent produced by the model under the existing condition during a 100 year return period flood event

Figure 4.4 Flood extent produced by the model under the existing condition during a 500 year return period flood event

Figure 4.5 Part of Flying Cloud Drive flooded under the existing condition during a 500 year return period flood event

5.0 MODEL RUN RESULTS FOR ALTERNATIVES

Proposed river crossing alternatives for each highway were provided by SEH, Inc. (Figure 5.1 and Figure 5.2). The cross-section elevations from these plans were incorporated into the calibrated FESWMS model by adjusting node elevations along each of the river crossings. Two copies of the calibrated model were made so that each alternative could be analyzed separately.

Each of the proposed plans show areas of fill and excavation and each cross-section was altered accordingly. Neither of the alternative plans calls for realignment of the crossing, thus the model grid did not need to be changed. Bridge piers were also added to the models according to the spacing specified in the proposed alternatives. Pier width was 1.5 ft with a dimensionless drag coefficient of 0.64. Figure 5.3 and 5.4 show the resulting channel bathymetry along each of the crossings.

5.1 Highway 41 Alternative

Model results illustrating flood extents, change in WSE, velocity profiles, and changes in velocities for the Highway 41 alternative are shown in Figures 5.5 through 5.16 for the 10-year, 50-year, 100-year, and 500-year flood events.

For each of the alternatives, a change in WSE was seen when compared to the existing conditions model. The only increase downstream of the crossing was seen for the 10-year event and was less than 0.3 ft of change. Decreases were seen downstream of the crossing for the other three events with all of the changes under 0.1 ft of change. Areas of excavation along the proposed crossing show the greatest change in WSE since some of these areas were not underwater in the existing conditions model.

The 10 and 50-year events had a decrease of WSE upstream of the road crossing, while the 100 and 500-year events result in an increase. At lower flows, the wider bridge opening allows considerably more water to pass through when compared to the existing conditions, which results in a drop in WSE. The largest decrease in WSE is seen during the 10-year event directly upstream of the proposed widening of Bridge 70041. Decreases in this location are up to one foot. At larger flows, the wider bridge opening is not large enough to maintain greater conveyance and the additional fill on the floodplain creates more of a backup for the flow resulting in a slight increase in WSE. Table 5.1 gives the WSE immediately upstream and downstream of the TH41 road crossing. Model results show that the proposed road crossing at Highway 41 is not inundated during the 50-year flood event, but it is mostly underwater during the 100-year event.

Modeled velocity profile plots compare the existing conditions to the proposed alternative conditions. All plots show an increase in velocities at the opening for the proposed replacement for Bridge 70041. The 10-year event shows a decrease in velocities at the existing Bridge 10012 with the proposed alternative in place. The 50-year, 100-year, and 500-year events all show an increase in

velocities at Bridge 10012. These velocity increases are concentrated around the bridges and could potentially change bed scour or erosion patterns in these locations if this alternative were implemented. Refinements to the alternative and subsequent testing with the model could be used to optimize the design and minimize and constrain velocity changes within a defined range.

Table 5.1 Water surface elevations at the TH41 road crossing

Flow	WSE Upstream of TH41 (ft, NAVD88)		WSE Downstream of TH41 (ft, NAVD88)		
Event	Existing	Alternative	Existing	Alternative	
10 yr	716.0	715.7	714.6	714.4	
50 yr	720.8	720.7	720.2	720.2	
100 yr	722.8	722.9	722.4	722.4	
500 yr	727.7	727.8	727.6	727.6	

Figure 5.1 Proposed alternative river crossing for Highway 41 provided by SEH

Figure 5.2 Proposed alternative river crossing for Highway 101 provided by SEH

Figure 5.3 Proposed channel bathymetry at Highway 41 road crossing

Figure 5.4 Proposed channel bathymetry at Highway 101 road crossing

Figure 5.5 Change in water surface elevation with TH41 alternative for 10 year flood event

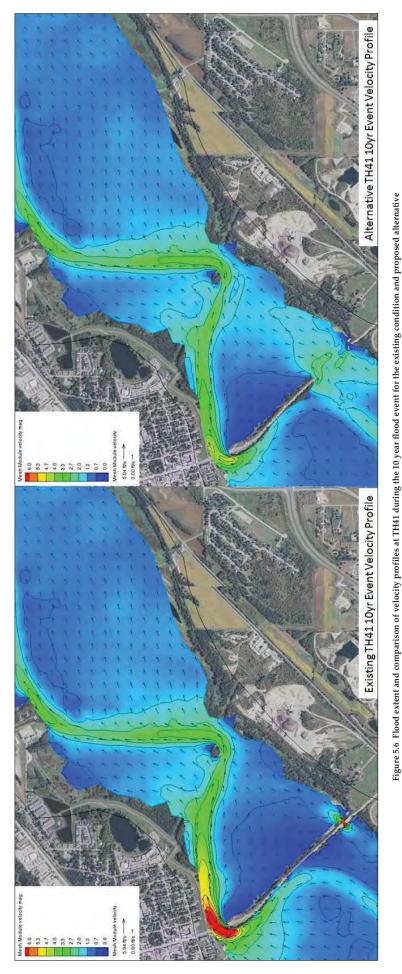


Figure 5.7 Change in velocity profile at TH41 during the 10 year flood event for the proposed alternative

Figure 5.8 Change in water surface elevation with TH41 alternative for 50 year flood event

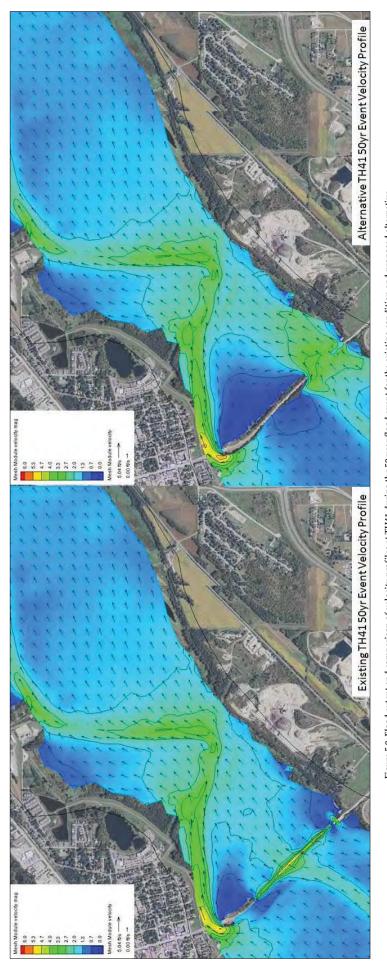


Figure 5.9 Flood extent and comparison of velocity profiles at TH41 during the 50 year flood event for the existing condition and proposed alternative

Figure 5.10 Change in velocity profile at TH41 during the 50 year flood event for the proposed alternative

Figure 5.11 Change in water surface elevation with TH41 alternative for 100 year flood event

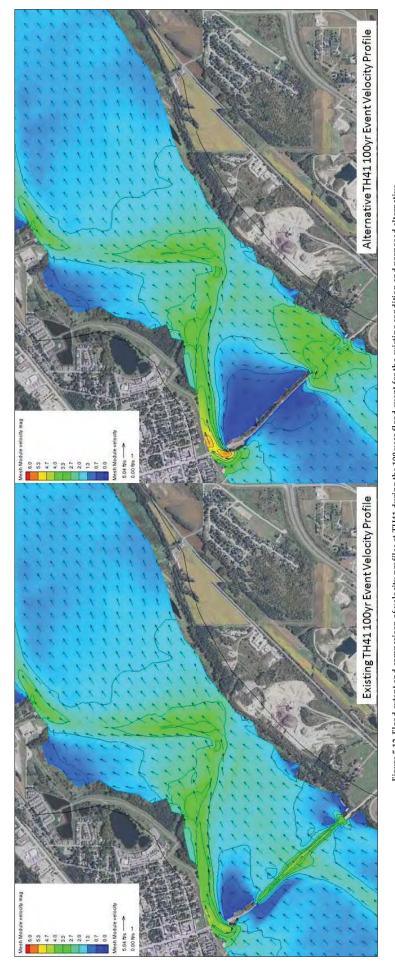


Figure 5.12 Flood extent and comparison of velocity profiles at TH41 during the 100 year flood event for the existing condition and proposed alternative

Figure 5.13 Change in velocity profile at TH41 during the 100 year flood event for the proposed alternative

Figure 5.14 Change in water surface elevation with TH41 alternative for 500 year flood event

Figure 5.15 Flood extent and comparison of velocity profiles at TH41 during the 100 year flood event for the existing condition and proposed alternative

Figure 5.16 Change in velocity profile at TH41 during the 500 year flood event for the proposed alternative

5.2 Highway 101 Alternative

Model results illustrating flood extents, change in WSE, velocity profiles, and changes in velocities for the Highway 101 alternative are shown in Figures 5.17 through 5.28 for the 10-year, 50-year, 100-year, and 500-year flood events.

Very little change in WSE was seen with the proposed alternative in place for each of the modeled events. Water levels changed less than 0.1 ft downstream of the proposed road crossing. A decrease around 0.5 ft was seen upstream of the proposed crossing for the 10-year flow event. The 50-year and 100-year events showed a decrease in WSE less than 0.1 ft and the 500-year event saw an increase in WSE less than 0.1 ft for areas upstream of the proposed crossing. Areas of excavation along the road crossing show the greatest change in WSE since some of these areas were not underwater in the existing conditions model. Table 5.2 gives the WSE values immediately upstream and downstream of the TH101 road crossing. Model results show that the proposed road crossing at Highway 101 is not inundated during the 100-year flood event, but it is underwater during the 500-year event.

Modeled velocity profile plots compare the existing conditions to the proposed alternative conditions. Decreased velocities are seen at each of the existing bridge locations for each flow event with the areas under the proposed land bridge showing a slight increase in velocities. The majority of these changes are less than 1 ft/s.

Table 5.2 Water surface elevations at the TH101 road crossing

Flow Event	WSE Upstream of T	ГН101 (ft, NAVD88)	WSE Downstream of TH101 (ft, NAVD88)				
	Existing	Alternative	Existing	Alternative			
10 yr	712.5	712.0	711.9	711.9			
50 yr	718.5	718.4	718.3	718.3			
100 yr	720.8	720.8	720.6	720.6			
500 yr	726.1	726.1	726.0	726.0			



Figure 5.17 Change in water surface elevation with TH101 alternative for 10 year flood event

Figure 5.18 Flood extent and comparison of velocity profiles at TH101 during the 10 year flood event for the existing condition and proposed alternative

Figure 5.19 Change in velocity profile at TH101 during the 10 year flood event for the proposed alternative

Figure 5.20 Change in water surface elevation with TH101 alternative for 50 year flood event

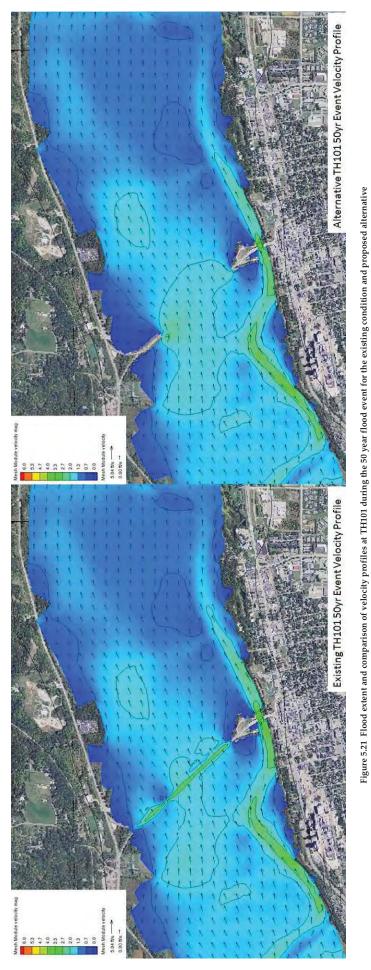


Figure 5.22 Change in velocity profile at TH101 during the 50 year flood event for the proposed alternative

Figure 5.23 Change in water surface elevation with TH101 alternative for 100 year flood event

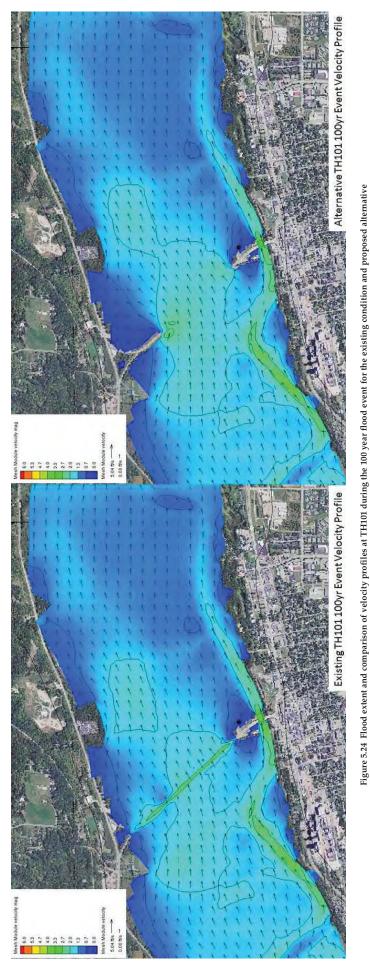


Figure 5.25 Change in velocity profile at TH101 during the 100 year flood event for the proposed alternative

Figure 5.26 Change in water surface elevation with TH101 alternative for 500 year flood event

Figure 5.27 Flood extent and comparison of velocity profiles at TH101 during the 500 year flood event for the existing condition and proposed alternative

Figure 5.28 Change in velocity profile at TH41 during the 500 year flood event for the proposed alternative

6.0 CONCLUSIONS

For flow conditions less than or equal to the 50-year return flow, the Highway 41 alternative was predicted to improve flow conveyance due to the widened opening where Bridge 70041 currently exists. This would reduce the risk of upstream flooding, as is suggested by the modeled decrease in WSE for flows of the 50-year return or less. The water level upstream of the Highway 41 alternative decreases about 1 ft for the 10-year return period flow. This alternative also causes a slight increase in WSE downstream of the road crossing. This increase is 0.3 ft or less and the impacted area extends downstream about 3500 ft.

For flow conditions larger than the 50-year return period, the Highway 41 alternative causes a slight increase in WSE of less than 0.2 ft. A decrease in WSE of less than 0.1 ft is created downstream. These results, in combination with the decrease in flood levels for the smaller discharge events, suggest the impact of the Highway 41 alternative on flood levels is not significant.

Modeling results show that the existing Highway 41 road crossing begins to flood at flow conditions larger than a 20-year return period. With the proposed alternative in place, flooding begins at flow events greater than the 50-year event. During the 100-year event, the WSE is just above the elevation of the road surface. With minor adjustments to the cut and fill areas across the proposed section and to the bridge design details, it may be possible to decrease the road overtopping frequency to a recurrence interval less than that of the 100-year event. This feasibility level modeling does show a small increase in stage for the 100 and 500-year events with the proposed alternative in place. However, with an informed design process, it may be possible to refine the design to minimize or even eliminate this increase.

With the larger bridge opening in place for the Highway 41 alternative, a larger volume of water is allowed to pass under the bridge. As a result, there is a decrease in WSE upstream of the crossing. This also results in a decrease in velocity for frequent flood events such as the 10-year event. At higher flows the opening does not accommodate all the flow across the floodplain, and in combination with the additional fill, added to the crossing to increase the elevation of the road surface, the water is forced more quickly through the bridge openings. This creates an increase in velocities at the proposed bridges for flow events greater than or equal to the 50-year event. However, none of the velocities with the alternatives in place are as large as the velocities seen in the existing conditions for the 10-year event at the existing Bridge 10012. Since events the size of the 10-year flood and smaller occur more frequently than the 50-year event or greater, it is likely that the river channel will experience an overall decrease in frequency and duration of exposure to higher velocities throughout the course of time with the proposed alternative in place.

There is, however, a significant increase in velocities at the proposed Bridge 70041 when compared to the existing conditions for all events larger than the 10-year event. This area experiences higher velocities over a larger area with the proposed alternative in place. Further study on the changes in

velocity in this area is suggested in order to more fully understand any potential impacts to the stability of the bridge structures and erosion of the river bed or banks.

Similar to the proposed Highway 41 alternative, the Highway 101 alternative improves flow conveyance in the river for flows less than or equal to the 100-year return event. This, in turn, decreases WSE and reduces the flood risk. The WSE upstream of the proposed road crossing decreases about 0.5 ft for the 10-year event. For flows greater than the 10-year event, the change in WSE is less than 0.1 ft which is not significant.

At Highway 101, the model shows the existing road crossing flooding at the 10-year return period flow. With the proposed alternatives, the highway would begin to flood at discharges larger than the 100-year flow event.

The Highway 101 alternative has no significant impacts on flow speeds for any of the flow events.

The initial evaluation of the proposed alternatives for each of the road crossings does not appear to indicate there are any significant limitations with the feasibility level design. Each alternative reduced the flood elevations of the most frequent floods and increased conveyance for all events. There were no indications from the feasibility modeling to suggest the proposed alternatives should not be further developed into workable solutions. No major redesign efforts of the road crossings should be needed. As this was a feasibility level study, further refinement of the alternatives to a more developed design should be undertaken to minimize any potential adverse impacts, while retaining the benefits of reduced frequency and duration of roadway flooding.

A DVD data archive accompanies the final report. This DVD contains a readme file fully detailing the contents of the disc and directs the user to the associated files of interest. Model versions of the calibration run, existing conditions, and proposed alternatives are included on the DVD, as well as a modeling log.

7.0 REFERENCES

USACE and USGS (2004). "Flood Plain Areas of The Lower Minnesota River." Technical report, provided by client.

USGS (2001). "Section 22 Study: Minnesota River Main Stem Hydrologic Analysis"

US DOT Federal Highway Administration (2003) "User's Manual for FESWMS FST2DH", Release 3, Publication No. FHWA-RD-03-053

Appendix D	Α	p	p	en	di	X	D
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Regional Model Traffic Analysis Technical Memorandum



TO: Minnesota River Crossing Study Management Team (SMT)

FROM: Haifeng Xiao, PE

DATE: May 9, 2011

RE: Minnesota River Crossing Feasibility Study,

Alternative Regional Model Analysis Results

SEH No. 115709

1. Introduction

The Minnesota River Crossing Feasibility Study area is located in the Minnesota River Valley in the southwest Twin Cities Metropolitan Area. Currently, there are five river crossings within the 14 miles of the study area, respectively at US 169 in Bloomington, TH 101 in Shakopee, TH 41 in Chaska, CR 9/CSAH 45 in Jordan and TH 25 in Belle Plaine. However, only the US 169 and TH 25 bridges are above the 100-year flood level. Historically, seasonal flooding has been a frequent problem in the study area. The TH 101, TH 41 and CR 9/CSAH 45 bridges often experience closures during the spring thaw period. In 2010, the TH 101 Bridge was closed for 43 days and the TH 41 Bridge was closed for 32 days due to flooding and they closed in 2011 as well. The bridge closures create serious traffic congestion in the southwest metro area. Historical data shows that the traffic demand on the US 169 Bridge increases significantly and exceeds its current capacity when the TH 101, TH 41 and CR 9 bridges are closed due to flooding.

The purpose of this study is to investigate the feasibility of implementing smaller scale projects and determine what capital improvements would be necessary to minimize roadway closures and/or add capacity due to flooding events for the existing river crossings and their approach roadways. A number of alternatives have been considered and evaluated including raising the existing bridges at TH 41 and TH 101 and adding temporary or permanent capacity to the existing bridge at U.S 169. One of the important evaluation criteria is B/C (Benefit/Cost) ratio analysis. The B/C calculations are largely based on the VMT (Vehicle Mile Travelled) and VHT (Vehicle Hour Travelled) outputs from the latest Twin Cities regional models.

This memorandum summarizes the regional modeling analysis methodology for different alternatives and their VMT and VHT results.

2. Modeling Methodology And Steps

The regional model analysis for the study was performed with the following steps:

1. The coding for the regional model networks were reviewed for accuracy. All the existing and future 2015 and 2030 model networks were refined to better represent actual roadway conditions for their years in the study area.

Minnesota River Crossing Feasibility Study, Alternative Regional Model Analysis Results May 9, 2011 Page 2

- 2. The refined existing 2009 model was run for the scenarios with and without the TH 101, TH 41 and CR 9/CSAH45 river crossings. The daily volume changes on major roadways from the regional model in the study area were compared against actual counts for model validation.
- 3. The coding for the I-494/US 169 interchange in the 2015 and 2030 network was modified to reflect the latest design.
- 4. All the socio-economic data in the regional model was reviewed and they remained unchanged for the analysis.
- 5. The base 2015 and 2030 regional models were run to obtain the VMTs and VHTs for the traffic travelled on the roadways within the Twin Cities seven-county metro area.
- 6. The 2015 and 2030 regional model networks were modified to reflect different build alternatives and were run to obtain their VMTs and VHTs.

3. Regional Model Network Refinement And Existing Model Results Validation

The highway network is an important input in any travel demand model. The latest regional model networks were reviewed and several refinements were made to the model networks to better represent the actual roadway conditions in the study area. The primary network refinements included:

- Add two links in the 2009, 2015 and 2030 model networks at the north end of the TH 25 Bridge.
 One link is for CSAH 40 between CASH 50 and TH 25 in Carver County which parallels the
 river and the other is for CSAH 53 between CASH 50 and TH 25 that connects Cologne and
 Belle Plaine.
- Modified the number of lanes from two to three for both directions of the US 169 Bridge in the 2009, 2015 and 2030 model networks. The capacities were modified accordingly.
- The 2015 and 2030 model network coding for the I-494/US 169 was modified to reflect the latest design.

The 2009 regional model was rerun for the scenarios with and without the TH 101, TH 41 and CR 9/CSAH45 bridge crossings. The model outputs on TH 212 and US 169 in the study area were compared against actual counts. The results are summarized in the Table 1 and graphically illustrated on the Figure 1 in the Appendix.

The table shows there are some differences between the regional model outputs and actual counts on the roadways for the scenarios. The differences are not uncommon in the forecasting process using the regional model and the model outputs may be adjusted to develop final daily forecasts. Nevertheless, the relative ratios of regional model outputs from bridge closure and open scenarios are generally in agreement with the actual counts, especially for US 169. Considering the fact that the VHTs and VMTs benefits for any Build Alternative are calculated based on the relative changes to the No Build Alternative, it is our understanding that the regional model is validated for this study purpose.

Table 1 Regional Model and Actual Daily Volumes Comparison for Bridge Open/Closure Scenarios

			201	O Actual Cou	ints	2009 Regional Model				
Freeway I	Location	Direction	Open* (3/3/2010)	Close* (3/31/2010)	ratio	Open*	Close*	ratio		
	South of	NB	38,430	43,156	1.12	44,110	51,365	1.16		
US 169	I-494	SB	38,850	40,647	1.05	44,031	48,395	1.10		
02 109	Mn River	NB	44,530	55,774	1.25	53,494	69,284	1.30		
	Bridge	SB	44,528	55,820	1.25	51,498	67,441	1.31		
	East of	EB	21,217	22,970	1.08	32,670	37,798	1.16		
US 212	TH 101	WB	22,237	23,791	1.07	32,978	39,487	1.20		
	East of	EB	16,495	17,621	1.07	22,176	25,577	1.15		
	TH 41	WB	16,632	17,608	1.06	22,730	26,485	1.17		

^{*}Bridges TH 101/TH41/CSAH 9 Concurently Close/Open

4. Build Alternatives and Results

A number of Build Alternatives were proposed for this study. The primary Build Alternatives are described as following:

- TH 101 Fix: Raising the TH 101 bridge and its approaching land bridge
- TH 41 Fix: Raising the TH 101 bridge and its approaching land bridge
- US 169 Temporary Fix: Restriping the US 169 bridge for a lane addition in both directions between CR 101 and Pioneer Trail
- US 169 Permanent Fix: Bridge and roadway widening for a lane addition in both directions between CR 18 and Pioneer Trail

The 2015 and 2030 regional models were run to obtain VMTs and VHTs for these primary alternatives and their combinations. The results are summarized in the Table 1 below. They will be used for B/C analysis, which is documented in a separate memorandum.

Figure 2 in the appendix illustrates the selected link analysis results for the bridges at TH 101 and TH 41 during 2030 PM peak hour from the regional model.

Figure 3-1 in the appendix illustrates the daily traffic pattern changes with and without the TH 101 bridge closure from the 2030 regional model runs.

Figure 3-2 in the appendix illustrates the daily traffic pattern changes with and without the TH 101 and TH 41 bridges closure from the 2030 regional model runs.

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Table 2 2015 and 2030 Regional Model VMTs and VHTs Results

Altornative*		2015		2030				
Alternative*	VMT	VHT	Speed(MPH)	VMT	VHT	Speed(MPH)		
Base	83,814,697	2,842,947	29.48	92,964,235	3,464,027	26.84		
TH 101 Closure	84,026,002	2,854,230	29.44	93,370,825	3,507,610	26.62		
TH 41 Closure	84,001,036	2,858,450	29.39	93,298,354	3,493,815	26.70		
TH 101&TH 41 Closure	84,443,197	2,878,447	29.34	93,917,735	3,538,927	26.54		
TH 101/TH 41/CR69/CR61 Closure	84,514,746	2,886,965	29.27	93,969,035	3,543,884	26.52		
US 169 Temp base	83,813,385	2,835,181	29.56	92,983,211	3,463,122	26.85		
US 169 Temp & TH 101 Closure	84,062,084	2,855,570	29.44	93,355,483	3,499,431	26.68		
US 169 Temp & TH 41 Closure	83,959,324	2,843,965	29.52	93,306,509	3,488,873	26.74		
US 169 Temp & TH 101&TH 41 Closure	84,445,948	2,869,646	29.57	93,875,758	3,519,720	26.67		
US 169 Permanent base	83,834,649	2,839,642	29.52	92,966,434	3,453,746	26.92		
US 169 Permanent & TH 101 Closure	84,065,019	2,852,980	29.47	93,323,576	3,488,740	26.75		
US 169 Permanent & TH 41 Closure	83,989,728	2,848,783	29.48	93,330,084	3,491,304	26.73		
US 169 Permanent & TH 101&TH 41 Closure	84,468,944	2,870,600	29.43	93,826,312	3,505,535	26.77		

^{*} CR 9/CSAH 45 Bridge Closed Concurrently for Any Bridge Closure Alternative

Minnesota River Crossing Feasibility Study, Alternative Regional Model Analysis Results May 9, 2011 Page 5

Appendix:

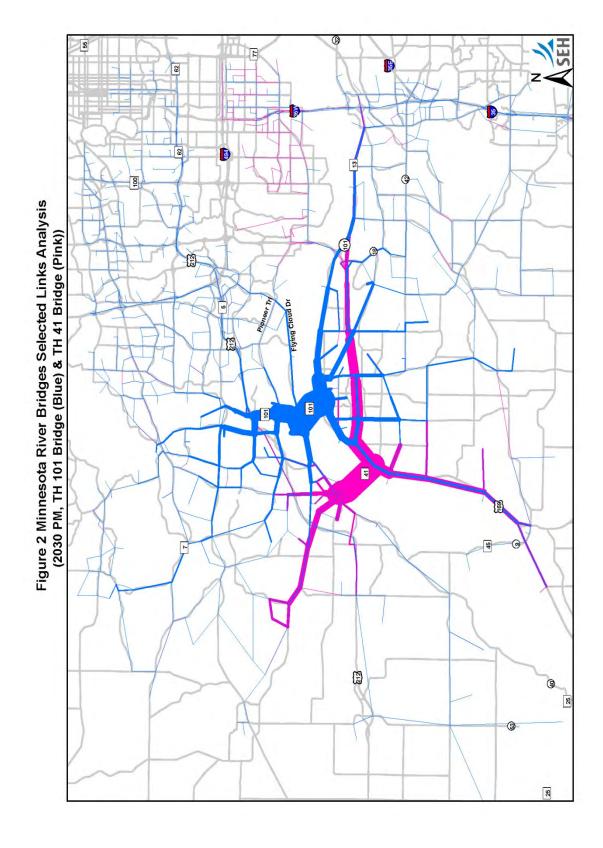
- Figure 1: Existing Daily Traffic Flow Changes due to TH 101&TH41 Bridges Closure
- Figure 2: Minnesota River Crossing Selected Links Analysis for TH 101 and TH 41 Bridges (2030 PM)
- Figure 3: Daily Traffic Flow Changes due to TH 101 Bridge Closure (2030 Regional Model)
- Figure 4: Daily Traffic Flow Changes due to TH 101 & TH41 Bridges Closure (2030 Regional Model)

00°,81 © 000,81 000,81 25,000 1.16 31,500 1.31 1.25 1.26 1.35 1.35 1.06 000,04 7.7 80.1 (2) D 0000 00611 96.0 30,500 9 30,500 19,200 Flying Cloud Dr 2,050 1,200 002,71 20.1 25,000 23,000 (Actual counts and regional model results comparison) 11,800 3.22 66'0 17.000 1,16 17,000 17,000 6,500 0.21 5,200 101 213 005.44 005.44 008.04 008.00 008.00 41 009'91 26'0 31,000 13,000 0000 29,000 19,100 86.0 11:500 11:30 0001 059 IL \$ 1.01 2,250 005 **169** 22,400 10,700 0050 3000 37.75 0.000 xx,xxx Actual 2009 ADT
x.xx 2009 Regional Model Ratio (Closure/Open)
x.xx March 2010 Actual Ratio (Closure/Open)
Bridge Closure 5,800 2.6 CR 9/CSAH 45 Bridge is concurrently closed 3,300 (3) 008:91 1,700 9,000 25 Legend Note:

Figure 1 Existing Daily Traffic Flow Changes Due to TH101&TH41 Bridges Closure

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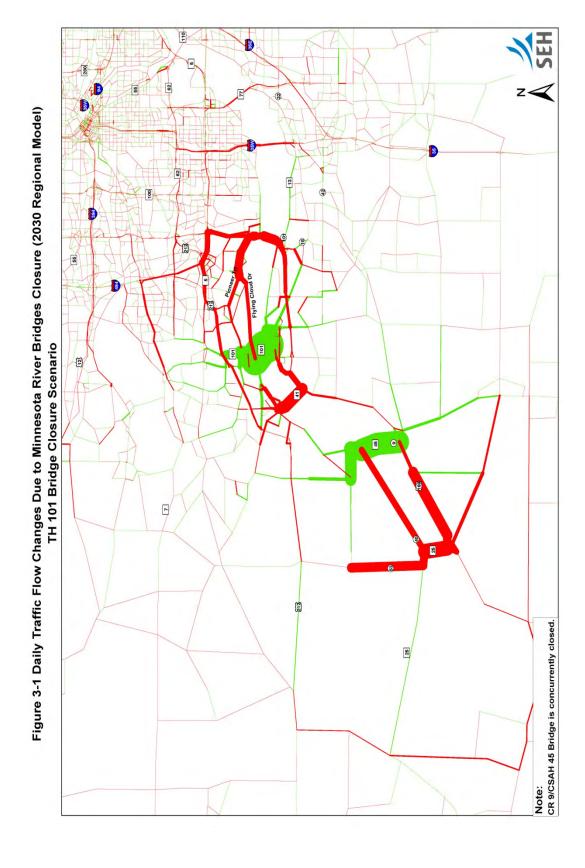
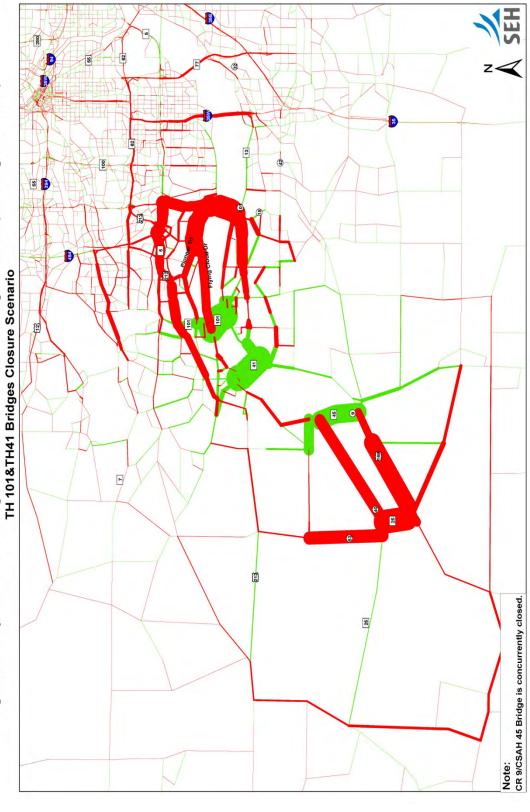


Figure 3-2 Daily Traffic Flow Changes Due to Minnesota River Bridges Closure (2030 Regional Model)



Appendix E

Preliminary Cost Estimates

	Land	l Bridge		Gra	ding		Surf	acing		Subb	ase/Base								
		100' pier																	
		spacing					8" Pavement (ma	ain and shoulder)	Ag	gregate	Select	t Granular			Erosion	Signing/			
		Cost	Volume cut		Volume fill				Volume	Cost	Volume	Cost				Striping/ Traffic		Other/	TOTAL w/20%
Roadway	Area (sqft)	(\$120/sqft)	(cuyd)	Cost (\$2/cuyd)	(cuyd)	Cost (\$1/cuyd)	Volume (sqyd)	Cost (\$32)	(cuyd)	(\$20/cuyd)	(cuyd)	(\$12/cuyd)	Drainage	Mobilization	Establishment	Control	Removals	Misc	Risk
TH 41	97,200	\$11,664,000	54,660	\$109,320	84,400	\$84,400	22,000	\$704,000	4,900	\$98,000	14,650	\$175,800	\$50,000	\$350,000	\$130,000	\$250,000	\$250,000	\$275,000	\$16,968,624
																			i
TH 101	168,000	\$20,160,000	43,050	\$86,100	48,400	\$48,400	16,500	\$528,000	3,700	\$74,000	11,000	\$132,000	\$50,000	\$600,000	\$200,000	\$400,000	\$400,000	\$425,000	\$27,724,200

Medium risk factor 20% from SEH based on level of detail at this early stage Land Bridge - 100' pier spacing \$120/sq ft from SEH Structural Engineer, Jeff Johnson

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Benefit-Cost Analysis Technical Memorandum

TO: John Wilson

FROM: Graham Johnson, PE

DATE: August 30, 2011

RE: MN River Crossing Study Benefit-Cost Analysis

SEH No. AMNTMD 115709

PURPOSE

This memorandum documents the methodology and results of a screening level, benefit-cost analysis for the build alternatives developed as part of the Minnesota River Flood Mitigation Study.

There are three closely spaced river crossings in the southwest metro; TH 41, TH 101 and US 169. During a flood event year, the crossing at TH 41 and TH 101 will typically close due to the rising river water. When the two river crossings close, much of the traffic utilizes the US 169 river crossing. This shift causes a cascading effect of congestion that affects both regional travel and costs travelers time and money. Figure 1, below, shows the location and proximity of the three river crossings.

Figure 1 Location Map



For the study, four separate build alternatives were analyzed and compared to the No Build alternative. The alternatives are listed below:

- 1. No Build do nothing alternative
- 2. TH 41 Bridge Improvement reconstruct the river crossing to a new elevation
- 3. TH 101 Bridge Improvement reconstruct the river crossing to a new elevation
- 4. US 169 Temporary Improvements temporary capacity improvements to ease congestion when TH 101 and/or TH 41 are closed (similar to 2011 improvement)
- 5. US 169 Permanent Improvements permanent capacity improvements to ease congestion when TH 101 and/or TH 41 are closed

The US 169 Bridge is the only river crossing, of those under study, which does not close during a flood event. This crossing handles the majority of the displaced traffic when one or both the other crossings are closed. There are two proposed alternatives for this structure. The first alternative is to construct and remove temporary capacity improvements only during flood events. This was completed during the spring 2011 flood event at a cost of \$426,000. The second alternative is construct permanent capacity improvements along US 169 that will provide congestion relief during both flood and non-flood events.

The TH 101 Bridge has a current closure elevation of 709.4' and is typically the first bridge to close and last to open. The 2009 ADT using the bridge is 20,400 vehicles per day (vpd) with the projected 2030 demands to reach 24,700 vpd. The proposed mitigation for this bridge is to construct a new 3,000 foot long bridge that will have a closure elevation of 722'. This new bridge elevation is higher than the 50-year flood elevation of 719' and the structure should not close up to and during that flood year under this alternative. The typical maintenance cost to close and reopen this river crossing is \$73,500 per flood event (this cost was provided by Mn/DOT Metro Maintenance based on 2010/2011 flood closure costs associated with closing, restoring and reopening the roadway).

The TH 41 Bridge has a current closure elevation of 714.6' and is typically the second bridge to close and opens before the TH 101 Bridge. The 2009 ADT using the bridge is 12,500 vehicles per day (vpd) with the projected 2030 demands to reach 20,200 vpd. The proposed mitigation for this bridge is to construct a new 1,350 foot long bridge that will have a closure elevation of 719.6'. This new bridge elevation is not completely higher than the 50-year flood elevation of 721', though the structure should stay open longer during a flood year under this alternative than the No Build. The typical maintenance cost to close and reopen this river crossing is \$71,070 per flood event (this cost was provided by Mn/DOT Metro Maintenance based on 2010/2011 flood closure costs associated with closing, restoring and reopening the roadway).

Table 1 represents the previous 6-flood events that have occurred in the past 20-years.

Table 1. Flood Event Closure Days											
Bridge	1993	1997	2001	2010 Spring	2010 Fall	2011	Average				
TH 101	27	18	29	27	16	43	26.7				
TH 41	11	10	25	22	10	13	15.2				
TH 41*	5	0	5	0	0	0	1.7				

*TH 41 Closure days above new bridge closure elevation of 719.6'

With 6 flood events during the last 20-years, this analysis will assume there will be 6 flood events during this 20-year analysis. The average closure days from Table 1 will be used for the assumed flood event years in the VMT and VHT calculations.

The purpose of a benefit-cost analysis is to express the effects of an investment into a common measure, (dollars). This allows for the fact that the benefits of a project are often accrued over a long period of time, while the initial investment is incurred during the initial years of the project.

In this analysis approach, any quantified benefits that are greater than or equal to the quantified costs (benefit-to-cost ratio greater than one) represents an economically viable project.

BENEFIT-COST METHODOLOGY

The monetary benefit for the project is quantified in terms of reduced vehicle miles traveled (VMT) and vehicle hours traveled (VHT) over the analysis period between the No-Build and the Build alternatives. The costs include construction, bridges and structures, right-of-way, and engineering/project delivery costs. Remaining capital values of these roadway features at the end of the analysis period are subtracted from the total cost of the project.

The screening level of this analysis did not take into account crash reductions or general operating and maintenance costs. It did take into account the different maintenance costs due to the bridge closures and temporary mitigations provided during a flood event.

The results of the analysis provide input for evaluating the overall benefit of the proposed improvements to the area. Due to the planning level of detail in the calculations, the magnitude of the value is not as important as the value being greater or less than one.

General Assumptions

- All monetary values are discounted to the 2011 analysis year. Inflation is not included.
- The 20-year benefit period is based on a 2015 day-of-opening through the year 2035.
- Yearly Build and No-Build benefits are calculated based on linear interpolation over the 20-year analysis period.
- Longer travel times and rerouting of trips during construction years are not included.
- Preliminary cost estimates were completed using cost per square foot for bridges and unit costs for grading, base and pavement. An appropriate risk factor given the early stage in the project development process was also used.
- The number of days per year used in the analysis was 365; based on the flood closure events spanning over weeks at a time.

Specific Assumptions

Table 2 Specific Assumptions (Mn/DOT)

Crash Costs	Mn/DOT Standard Values
Fatal Type K	\$7,200,000
Injury Type A	\$420,000
Injury Type B	\$138,000
Injury Type C	\$92,000
Property Damage Only	\$12,000
Operating Costs (Vehicle Miles Traveled)	
Automobile (per mile)	\$0.32
Heavy Vehicle (per mile)	\$0.95
Automobile percent	95.0%
Heavy Vehicle percent	5.0%
Time Costs (Vehicle Hours Traveled)	
Automobile (per occupant use vehicle occupancy to adjust)	\$13.93
Heavy Commercial (per hour, assume avg occupancy = 1.0)	\$17.51
Capital Cost Estimate – see Preliminary Cost Estimate	
Component Service Life (years)	
Program Development and Delivery	0 years
Right-of-way, per acre	100 years
Major Structure	60 years
Grading and Drainage	50 years
Sub-base and Base	40 years
Surface	25 years
Analysis Period for Roadway projects	20 years
Discount Rate (annual)	2.7%

Source: Mn/DOT Office of Capital Programs and Performance Measures, August 2011

Traffic Assumptions

As part of the Minnesota River Crossing Study, the Twin Cities Travel Demand Model (TCTDM) was used to develop traffic forecasts for all roadways in the project area. For each alternative and flood closure event, a separate model was created to include both local and regional trip rerouting. Below are the traffic assumptions used in the VMT and VHT calculations for all alternatives:

- Daily VMT and VHT for all scenarios and possible closure combinations were calculated from the TCTDM model results for the entire metro area network. The TCTDM modeled years were 2015 and 2030; this information was extrapolated out to the 2035 design year. The different model scenarios include (all scenarios were completed with and without capacity improvements to US 169):
 - o No Build
 - o TH 101 Closure Only
 - o TH 41 Closure Only
 - o TH 101 and TH 41 Closures
- Yearly values for each alternative were calculated based on a non-flood event and a flood event year.
 - o For non-flood event years, the calculations only use the No Build VMT and VHT data. So there is no potential benefit for days the roadway would normally be open. The only exception is for the permanent capacity improvements on US 169, for this a separate non-flood event yearly value was calculated.
 - o For flood event years, the average number of days of closure (Table 1) was used in conjunction with the remaining days in the year to compile a yearly VMT and VHT. The

daily values for each closure scenario were combined with the No Build scenario daily values to create a yearly VMT and VHT value.

- Yearly values for each alternative, for both non-flood event and flood event years were carried forward and interpolated for the 20-year analysis.
- The VMT and VHT information for a flood event year would replace the information in the non-flood event. This ensures that the only benefit occurs during the flood event year.
- Six flood events are assumed to occur during the 20-year analysis (based on historical data). The years for the assumed flood events are 2016, 2020, 2024, 2028, and 2035.
- In order to better compare the permanent US 169 capacity improvement scenario to the other alternatives; this alternative was analyzed under two separate circumstances. The first only provides the capacity improvement during the flood event years, making it comparable to the other alternatives. The second provides the capacity improvements to every day of every year.

Table 3.1 represents the resulting VMT and VHT values for all alternatives for the year of opening and the design year during a non-flood event year.

Table 3.1 Non-Flood Event Yearly VMT and VHT

ITEM	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
2015 VMT	30,613,318,079	30,613,318,079	30,613,318,079	30,613,318,079	30,613,318,079	30,620,605,547
2035 VMT	35,069,143,085	35,069,143,085	35,069,143,085	35,069,143,085	35,069,143,085	35,067,784,842
2015 VHT	1,038,386,392	1,038,386,392	1,038,386,392	1,038,386,392	1,038,386,392	1,037,179,241
2035 VHT	1,340,852,352	1,340,852,352	1,340,852,352	1,340,852,352	1,340,852,352	1,336,247,889

Table 3.2 represents the resulting VMT and VHT values for all alternatives for the year of opening and the design year during a flood event year.

Table 3.2 Flood Event Yearly VMT and VHT

ITEM	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
2015 VMT	30,625,301,287	30,619,669,154	30,616,150,432	30,625,758,045	30,626,141,337	30,632,896,086
2035 VMT	35,090,707,329	35,082,740,327	35,074,970,446	35,089,469,099	35,087,849,989	35,086,591,034
2015 VHT	1,039,055,746	1,038,728,817	1,038,622,037	1,038,937,381	1,038,922,097	1,037,803,189
2035 VHT	1,342,815,480	1,342,360,750	1,341,377,507	1,342,340,261	1,341,893,945	1,337,626,071

BENEFIT-COST ANALYSIS RESULTS

Table 4, below, summarizes the results of the benefit-cost analysis for the Minnesota River Crossing Study.

Table 4 Summary of Benefit-Cost Analysis

Scenario	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
VMT & VHT Benefit	\$41,875,950	\$84,652,558	\$19,574,548	\$33,495,932	\$556,319,350
Operating and Maintenance Benefit	\$294,274	\$301,661	(\$1,748,405)	\$0	\$0
Total Benefit	\$42,170,224	\$84,954,220	\$17,826,143	\$33,495,932	\$556,319,350
Total Costs (Present Value)	\$19,107,520	\$31,244,500	\$1,057,409	\$51,323,799	\$51,323,799
Remaining Capital Value	\$5,330,295	\$8,935,863	\$124,677	\$14,601,837	\$14,601,837
Total Cost - RCV	\$13,777,225	\$22,308,637	\$932,732	\$36,721,962	\$36,721,962
Benefit-Cost Ratio	3.06	3.81	19.11	0.91	15.15

The preliminary analysis indicates that all build options have a benefit-cost ratio greater than one, meaning that they are beneficial projects. The only exception is the permanent US 169 improvement under the flood event years only. The VMT and VHT benefits of the project are estimated to be greater than the costs associated with the construction of the project.

At this level of analysis, the magnitude of the benefit-cost ratio is not as important as the overall finding that the ratio is greater than one. Further refinements to the VMT and VHT values are possible using different traffic models and methods. However, this basic analysis indicates that all proposed project are economically valuable.

It should be noted that the analysis only compares a single alternative to No-Build. It is possible that more than one alternative would be built in the future and the collective benefit-cost is not represented on the table since it is not additive.

See attached tables for more detail.

COST EFFECTIVENESS POLICY

The Minnesota Statewide Transportation Plan established a cost-effectiveness policy for Mn/DOT as outlined in Technical Memorandum No. 04-05-IM-01 and dated December 7, 2004. The cost-effectiveness evaluation is a three-step process: (1) benefit-cost analysis; (2) best value assessment; and (3) social, environmental, and community goals and business impacts. The benefit-cost analysis described above meets the requirements described in Step 1 of the policy. No further analysis is necessary under the stipulations of the cost-effectiveness policy since the project results in a benefit-cost ratio greater than one.

gtj Attachments Tables A1 through A10

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Benefit Cost

Table A1 Summary

ITEM	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
Operating Benefit (VMT)	\$ 12,640,484	\$ 22,486,454	\$ 289,880	\$ 937,922	\$ (13,589,792)
Travel Time Benefit (VHT)	\$ 29,235,467	\$ 62,166,105	\$ 19,284,668	\$ 32,558,010	\$ 569,909,142
Crash Benefit (Not Analyzed)			· ·	· ·	· •
Operating and Maintenance Benefit	\$ 294,274	\$ 301,661	\$ (1,748,405)	· •	· ·
Total Benefit	\$ 42,170,224	\$ 84,954,220	\$ 17,826,143	\$ 33,495,932	\$ 556,319,350
Major Structures (Bridge)	\$ 11,664,000	\$ 20,160,000	\$ 81,000	\$ 32,872,860	\$ 32,872,860
Grading/Drainage	\$ 243,720	\$ 184,500			
Surfacing	\$ 704,000	\$ 528,000	\$ 653,409	\$ 2,768,939	\$ 2,768,939
Subbase/Base	\$ 273,800	\$ 206,000			
Right of Way			· ·		· •
Risk Factor (20%)	\$ 2,828,000	\$ 4,621,000	\$ 147,000	\$ 7,128,000	\$ 7,128,000
Engineering (20%)	\$ 3,394,000	\$ 5,545,000	\$ 176,000	\$ 8,554,000	\$ 8,554,000
Total Cost	\$ 19,107,520	\$ 31,244,500	\$ 1,057,409	\$ 51,323,799	\$ 51,323,799
Project Salvage Value	\$ 5,330,295	\$ 8,935,863	\$ 124,677	\$ 14,601,837	\$ 14,601,837
(Total Cost - Salvage Value)	\$ 13,777,225	\$ 22,308,637	\$ 932,732	\$ 36,721,962	\$ 36,721,962
Benefit-Cost Ratio	3.06	3.81	19.11	0.91	15.15

NOTE: TH 169 Permanent Improvement is broken into two scenarios. The first, Flood Event Capacity Only, only accounts for the increased capacity only during flood events to make it more comparable to the TH 41 and TH 101 options. The second scenario, Year Round Capacity, includes the capacity improvements for every day of the 20-yr analysis.

8/30/2011 SEH, Inc.

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Benefit Cost Table A2 Itemized Costs (2011)

ITEM	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
Computed Items:					
Major Structures (Bridge)	\$ 11,664,000	\$ 20,160,000	\$ 81,000	\$ 32,872,860	\$ 32,872,860
Grading/Drainage	\$ 243,720	\$ 184,500	\$	\$	
Surfacing	\$ 704,000	\$ 528,000	\$ 653,409	\$ 2,768,939	\$ 2,768,939
Subbase/Base	\$ 273,800	\$ 206,000	\$	\$	
Mobilization	\$ 350,000	000'009 \$			
Erosion Control	\$ 130,000	\$ 200,000			
Signing/Striping	\$ 250,000	\$ 400,000			
Removals	\$ 250,000	\$ 400,000			
Miscellaneous	\$ 275,000	\$ 425,000			
Right of Way	· &	- \$	\$	-	•
Risk Factor (20%)	\$ 2,828,000	\$ 4,621,000	\$ 147,000	\$ 7,128,000	\$ 7,128,000
Engineering (20%)	\$ 3,394,000	\$ 5,545,000	\$ 176,000	\$ 8,554,000	\$ 8,554,000
TOTAL COST	\$ 20,362,520	\$ 33,269,500	\$ 1,057,409	\$ 51,323,799	\$ 51,323,799

Benefit Cost

Table A3

Assumptions Used in the Benefit-Cost Study

Alternatives

Base Condition	No Build
Build Option 1	TH 41 Bridge Improvement
Build Option 2	TH 101 Bridge Improvement
Build Option 3	TH 169 Temporary Improvement
Build Option 4	TH 169 Permanent Improvement (Flood Event Capacity Only)
Build Option 5	TH 169 Permanent Improvement (Year Round Capacity)

Analysis Timeframe

Existing Year	2011
Duration of Benefit Cost Analysis (years)	20
Year of Opening	2015
Design Year	2035
Days Per Year	365.25

Operating Costs

Estimating change in travel costs (Vehicle Miles of Travel)		
	Automobile (per mile) (1) \$	0.32
	Heavy Vehicle (per mile) (1)	0.95

Time Costs

Estimating change in time costs (Vehicle Hours of Travel)		
	Automobile (per occupant use vehicle occupancy to adjust) (1) \$	13.93
	Heavy Commercial (per hour, assume avg occupancy = 1.0) (1) \$	17.51

Vehicle Occupancy

All Auto Trips (Urban Areas Daily) (2)	1.46
Percent automobiles (3)	95.00%
Percent heavy vehicles (3)	5.00%

Component Service Life (years) (1)

Component Service Life (years)	
Engineering	0
Right-of-Way	100
Bridge	60
Mass Grading and Drainage	50
Base	40
Surface	25
Signal System	20

Depreciation Method	Discount Rate (annual)
Sinking Fund	2.7%

NOTES

- (1) MnDOT Office of Investment Management recommended value
- (2) 2001 / 2002 National Household Travel Survey (NHTS)

(3) MnDOT 2006 Traffic Flow Maps

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Benefit Cost Table A4 Salvage Values

Service Life	Remaining Capitol Value Factor	ltem (2011 Dollars)	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
50	75.0%	Grading and Drainage	\$ 243,720	\$ 184,500	· •		· •
40	63.0%	Subbase/Base	\$ 273,800	\$ 206,000	· •	· \$	- 9
25	26.0%	Surfacing	\$ 704,000	\$ 528,000	\$ 653,409	\$ 2,768,939	\$ 2,768,939
		Construction SV	\$ 538,324	\$ 405,435	\$ 169,886	\$ 719,924	\$ 719,924
09	82.0%	Major Structures	\$ 11,664,000	\$ 20,160,000	\$ 81,000	\$ 32,872,860	\$ 32,872,860
		Major Structures	\$ 9,564,480	\$ 16,531,200	\$ 66,420	\$ 26,955,745	\$ 26,955,745
100	95.0%	Right of Way		- \$	- \$	· •	
		R/W SV	- \$	- \$	- \$	- \$	- \$
		Other Costs	\$ 7,477,000	\$ 12,191,000	\$ 323,000	\$ 15,682,000	\$ 15,682,000
	1						
	1	TOTAL COST	\$ 20,362,520	\$ 33,269,500	\$ 1,057,409	\$ 51,323,799	\$ 51,323,799
		TOTAL SV yr 2035	\$ 10,102,804	\$ 16,936,635	\$ 236,306	\$ 27,675,669	\$ 27,675,669
		PV SALVAGE VALUE yr 2011	\$ 5,330,295	\$ 8,935,863	\$ 124,677	\$ 14,601,837	\$ 14,601,837

Benefit Cost Table A5A Daily VMT / VHT

Table 5A.1 - Minnesota River Crossin	ng - 20 Year Historical	Days of Road Closure	es				20-Year Average
Bridge	1993	1997	2001	Spring - 2010	Fall - 2010	2011	3.33
TH 41 (total days)	11	10	25	22	10	13	15.2
Days above Build Elevation*	5	0	5	0	0	0	1.7
TH 101 (total days)	27	18	29	27	16	43	26.7
Days above Build Elevation**	0	0	0	0	0	0	0.0

Notes: *TH 41 Build Elevation for closure is 719.6"; this elevation has been surpassed in the 1993 and 2001 floods.

Table 5A.2 - Flood Event Assumptions

Description	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
Days Per Year	365.25	365.25	365.25	365.25	365.25	365.25
Non-Flood Days (Total)	338.55	338.55	350.05	338.55	338.55	338.55
Flood Days (Total)	26.70	26.70	15.20	26.70	26.70	26.70
Days of Separate Roadway Closures	3					
TH 101 Only	11.5	25.0	0	11.5	11.5	11.5
TH 101 & TH 41	15.2	1.7	0	15.2	15.2	15.2
TH 41 Only	0	0	15.2	0	0	0

Table 5A.3 - Non-Flood Event Day (No Closures)

Daily Value	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
2015 VMT	83,814,697	83,814,697	83,814,697	83,814,697	83,814,697	83,834,649
2030 VMT	92,964,235	92,964,235	92,964,235	92,964,235	92,964,235	92,966,434
2015 VHT	2,842,947	2,842,947	2,842,947	2,842,947	2,842,947	2,839,642
2030 VHT	3,464,027	3,464,027	3,464,027	3,464,027	3,464,027	3,453,746

Table 5A.4 - Flood Event Day, TH 101 Closed (TH 41 remains Open)

Table SA.4 - Hood Event Day, TH	101 010000 (111 41 10	mamo opem,				
Daily Value	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
2015 VMT	84,026,002	84,026,002		84,062,084	84,065,019	84,065,019
2030 VMT	93,370,825	93,370,825		93,355,483	93,323,576	93,323,576
2015 VHT	2,854,230	2,854,230		2,855,570	2,852,980	2,852,980
2030 VHT	3,507,610	3,507,610		3,499,431	3,488,740	3,488,740

Table 5A.5 - Flood Event Day, TH 101 and TH 41 Closed

Daily Value	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
2015 VMT	84,443,197	84,443,197		84,445,948	84,468,944	84,468,944
2030 VMT	93,917,735	93,917,735		93,875,758	93,826,312	93,826,312
2015 VHT	2,878,447	2,878,447		2,869,646	2,870,600	2,870,600
2030 VHT	3,538,927	3,538,927		3,519,720	3,505,535	3,505,535

Table 5A.6 - Flood Event Day, TH 41 Closed (TH 101 remains Open)

Daily Value	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
2015 VMT			84,001,036	83,959,324	83,989,728	83,989,728
2030 VMT			93,298,354	93,306,509	93,330,084	93,330,084
2015 VHT			2,858,450	2,843,965	2,848,783	2,848,783
2030 VHT			3,493,815	3,488,873	3,491,304	3,491,304

Table 5A.7 - Results in Yearly VMT & VHT based on a Flood Event Year

rubic orar recounts in really viii	a viii bacca oii a i	lood Event real				
Yearly Value	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
2015 VMT	30,625,301,287	30,619,669,154	30,616,150,432	30,625,758,045	30,626,141,337	30,632,896,086
2030 VMT	33,974,355,819	33,966,972,534	33,960,265,443	33,973,541,335	33,972,422,826	33,973,167,297
2015 VHT	1,039,055,746	1,038,728,817	1,038,622,037	1,038,937,381	1,038,922,097	1,037,803,189
2030 VHT	1,266,875,546	1,266,452,767	1,265,688,639	1,266,489,541	1,266,150,983	1,262,670,350

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 $^{^{\}star\star}$ TH 101 Build Elevation for closure is 722'; this elevation has not been surpassed in the last 20 years.

Benefit Cost

Table A5B
Yearly VMT / VHT

Table 5B.1 - Non-Flood Event Years

TH 169 Permanent Improvement (Year Round Capacity)	30,620,605,547	33,955,990,019	35,067,784,842	1,037,179,241	1.261.480.727
	30,62	33,9	35,0	1,03	1,26
TH 169 Permanent Improvement (Flood Event Capacity Only)	30,613,318,079	33,955,186,834	35,069,143,085	1,038,386,392	1,265,235,862
TH 169 Temporary Improvement	30,613,318,079	33,955,186,834	35,069,143,085	1,038,386,392	1,265,235,862
TH 101 Bridge Improvement	30,613,318,079	33,955,186,834	35,069,143,085	1,038,386,392	1,265,235,862
TH 41 Bridge Improvement	30,613,318,079	33,955,186,834	35,069,143,085 35,069,143,085 35,069,143,085	1,038,386,392	1,265,235,862
No Build	30,613,318,079	33,955,186,834	35,069,143,085	1,038,386,392	1,265,235,862
ITEM	2015 VMT	2030 VMT	2035 VMT	2015 VHT	2030 VHT

NOTES: This table provides the VMT/VHT calculations for the Non-flood event years. If a scenario has no capacity improvement, during a non-flood year, there will be no change in traffic values. Daily values are pulled from table 5B.3 and multiplied by 365 days/year. 2015 and 2030 numbers were obtained from the Twin Cities Regional Model, 2035 numbers were calculated on a straight line growth.

Table 5B.2 - Flood Event Years

ITEM	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
2015 VMT	30,625,301,287	30,625,301,287 30,619,669,154	30,616,150,432 30,625,758,045	30,625,758,045	30,626,141,337	30,632,896,086
2030 VMT	33,974,355,819	33,966,972,534	33,960,265,443	33,973,541,335	33,972,422,826	33,973,167,297
2035 VMT	35,090,707,329	35,090,707,329 35,082,740,327	35,074,970,446 35,089,469,099	35,089,469,099	35,087,849,989	35,086,591,034
2015 VHT	1,039,055,746	1,038,728,817	1,038,622,037	1,038,937,381	1,038,922,097	1,037,803,189
2030 VHT	1,266,875,546	1,266,452,767	1,265,688,639	1,266,489,541	1,266,150,983	1,262,670,350
2035 VHT	1,342,815,480	1,342,815,480 1,342,360,750	1,341,377,507	1,342,340,261	1,341,893,945	1,337,626,071

NOTES: This table provides the VMT/VHT calculations for the Flood event years. Yearly values are pulled from table 5B.7 and are the result of using the flood assumptions from Table 5B.2 and Daily values from Tables 5.3 to 5B.6. 2015 and 2030 numbers were obtained from the Twin Cities Regional Model, 2035 numbers were calculated on a straight line growth.

TH 168 TH 168 Permanent Improvement (Frod Event (Capacity) Charles) TH 45 Birdge (TH 101 Birdge (Yearly VMT (Only Non-Flood Event Years)	n-Flood Event Year	(s)				Yearly VMT (Only I	Yearly VMT (Only Flood Event Years)				Ö	mbined Yearly Vehi	Combined Yearly Vehicle Miles Traveled (VMT)	VMT)	
30.6816.180.779 30.682.646.547 30.682.942.807 30.682.646.547 30.682.942.807 30.682.646.547 30.682.942.807 30.682.646.3207<	No Build TH 41 Bridge Improvement	TH 41 Bridge Improvement		TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Canacity Only)	TH 169 Permanent Improvement (Year Round Capacity)	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
31,085,005,580 31,086,323,477 31,073,040,2172 31,085,323,477 31,073,040,272 31,085,323,477 31,073,040,272 31,085,323,477 31,073,040,272 31,085,323,477 31,073,040,272 31,085,323,477 31,073,040,272 31,085,323,477 31,073,040,272 31,085,323,477 31,085,323,486,327 31,085,323,477 31,085,323,486,327 31,085,323,477 31,085,323,477 31,085,323,477 31,085,323,477 31,085,323,477 31,085,323,477 31,085,323,477 31,085,323,477 31,085,323,477 31,085,323,477 32,085,4	30,613,318,079 30,613,318,079	30,613,318,079		30,613,318,079	30,613,318,079	30,613,318,079	30,620,605,547	30,625,301,287	30,619,669,154	30,616,150,432	30,625,758,045	30,626,141,337	30,632,896,086	30,613,318,079	30,613,318,079	30,613,318,079	30,613,318,079	30,613,318,079	30,620,605,547
31,026,000.580 31,026,00.580 31,026,022.477 31,026,0212.477 31,026,0212.477 31,026,0212.477 31,026,0212.477 31,026,0212.477 31,026,0212.477 31,026,0212.477 31,026,0212.477 31,026,0212.477 31,026,0212.277 32,026,0212.27	30,836,109,330 30,836,109,330	30,836,109,330		30,836,109,330	30,836,109,330	30,836,109,330	30,842,964,512	30,849,170,749	30,843,140,267	30,839,233,050	30,849,565,596	30,849,867,932	30,856,195,361	30,849,170,749	30,843,140,267	30,839,233,050	30,849,565,596	30,849,867,932	30,856,195,361
31,281,681,830 31,281,681,830 31,281,681,830 31,281,682,442 31,286,906,674 31,286,086,581 31,586,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,594,483,080 31,744,734,143 31,596,085,581 31,594,294,581 31,544,684,582 32,544,584,584 32,544,544,584 32,544,544,584 32,544,544,544 32,544,544,444,544 32,544,544,444,544 33,544,544,444,544 33,544,544,444,544 33,544,544,444,444,544 34,444,544,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644 34,444,644,644	31,058,900,580 31,058,900,580	31,058,900,58	٦	31,058,900,580	31,058,900,580	31,058,900,580	31,065,323,477	31,073,040,212	31,066,611,379	31,062,315,669	31,073,373,147	31,073,594,528	31,079,494,635	31,058,900,580	31,058,900,580	31,058,900,580	31,058,900,580	31,058,900,580	31,065,323,477
31,527,274,333 31,527,274,33 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,333 31,527,274,	31,281,691,830 31,281,691,830	31,281,691,83	2	31,281,691,830	31,281,691,830	31,281,691,830	31,287,682,442	31,296,909,674	31,290,082,491	31,285,398,287	31,297,180,698	31,297,321,123	31,302,793,909	31,281,691,830	31,281,691,830	31,281,691,830	31,281,691,830	31,281,691,830	31,287,682,442
31,727,24331 31,727,24331 31,727,24331 31,727,24331 31,724,743341 31,744,74341 31,820,065,681 31,600,065,681 31,647,78,356 31,844,78,356 31,844,78,356 31,844,78,356 31,844,78,356 31,848,000 32,172,866,831 32,172,866,831 32,172,866,831 32,177,78,78,786 32,177,78,78,78 31,848,78,356 32,142,747,74,341 31,848,78,366 32,142,747,74,341 32,142,747,74,341 32,142,747,74,341 32,177,72,87,69 32,142,747,74,341 32,142,747,74,341 32,142,747,74,341 32,142,747,74,341 32,142,747,74,341 32,142,747,74,341 32,142,747,74,341 32,142,747,74,341 32,147,74,341 <td< td=""><th>31,504,483,080 31,504,483,080</th><td>31,504,483,08</td><td>8</td><td>31,504,483,080</td><td>31,504,483,080</td><td>31,504,483,080</td><td>31,510,041,406</td><td>31,520,779,137</td><td>31,513,553,604</td><td>31,508,480,905</td><td>31,520,988,249</td><td>31,521,047,719</td><td>31,526,093,184</td><td>31,504,483,080</td><td>31,504,483,080</td><td>31,504,483,080</td><td>31,504,483,080</td><td>31,504,483,080</td><td>31,510,041,406</td></td<>	31,504,483,080 31,504,483,080	31,504,483,08	8	31,504,483,080	31,504,483,080	31,504,483,080	31,510,041,406	31,520,779,137	31,513,553,604	31,508,480,905	31,520,988,249	31,521,047,719	31,526,093,184	31,504,483,080	31,504,483,080	31,504,483,080	31,504,483,080	31,504,483,080	31,510,041,406
317.2.866.581 31.950.066.581 31.950.066.581 131.954.759.335 31.956.180.02 31.956.065.581 31.77.850.02 31.956.177.1850.02 31.956.177.1850.02 31.956.177.1850.02 32.956.950.	31,727,274,331 31,727,274,331	31,727,274,3	31	31,727,274,331	31,727,274,331	31,727,274,331	31,732,400,371	31,744,648,599	31,737,024,716	31,731,563,524	31,744,795,800	31,744,774,314	31,749,392,458	31,744,648,599	31,737,024,716	31,731,563,524	31,744,795,800	31,744,774,314	31,749,392,458
32,172,856,831 32,172,856,831 32,172,856,831 32,177,18,301 32,192,856,841 32,177,728,750 32,182,410,902 32,182,2155,650 32,2356,648,002 32,235	31,950,065,581 31,950,065,581	31,950,065,5	84	31,950,065,581	31,950,065,581	31,950,065,581	31,954,759,336	31,968,518,062	31,960,495,829	31,954,646,142	31,968,603,351	31,968,500,909	31,972,691,732	31,950,065,581	31,950,065,581	31,950,065,581	31,950,065,581	31,950,065,581	31,954,759,336
22,286,648,002 32,286,648,002 32,286,648,002 32,286,648,002 32,286,648,002 32,286,648,002 32,286,648,002 32,286,648,002 32,286,648,002 32,286,641,002 32,286,	32,172,856,831 32,172,856,831	32,172,856,8	31	32,172,856,831	32,172,856,831	32,172,856,831	32,177,118,301	32,192,387,524	32,183,966,941	32,177,728,760	32,192,410,902	32,192,227,505	32,195,991,007	32,172,856,831	32,172,856,831	32,172,856,831	32,172,856,831	32,172,856,831	32,177,118,301
2.2.6.16.428.332 2.2.6.16.126.449 22.6.16.126.449 22.6.16.126.449 22.6.16.126.449 22.6.16.126.449 22.6.16.126.149 22.6.126.14	32,395,648,082 32,395,648,082	32,395,648,0	82	32,395,648,082	32,395,648,082	32,395,648,082	32,399,477,265	32,416,256,987	32,407,438,053	32,400,811,379	32,416,218,453	32,415,954,100	32,419,290,281	32,395,648,082	32,395,648,082	32,395,648,082	32,395,648,082	32,395,648,082	32,399,477,265
32.26.41,200.562 32.26.41,200.562 32.26.41,200.562 32.26.41,200.562 32.26.41,200.562 32.26.41,200.562 32.26.41,200.562 32.26.41,200.562 32.26.41,200.562 32.26.41,200.562 32.26.41,200.562 33.26.561,200.562 33.2	32,618,439,332 32,618,439,332	32,618,439,3	32	32,618,439,332	32,618,439,332	32,618,439,332	32,621,836,230	32,640,126,449	32,630,909,166	32,623,893,997	32,640,026,004	32,639,680,696	32,642,589,555	32,640,126,449	32,630,909,166	32,623,893,997	32,640,026,004	32,639,680,696	32,642,589,555
33.0864,021.833 33.0864,021.833 33.0864,021.833 33.086.6554,160 33.087.886.374 33.077.8851.380 33.070.0852.34 33.087.613.887 33.087.133.887 33.0	32,841,230,582 32,841,230,582	32,841,230,5	82	32,841,230,582	32,841,230,582	32,841,230,582	32,844,195,195	32,863,995,912	32,854,380,278	32,846,976,615	32,863,833,555	32,863,407,291	32,865,888,830	32,841,230,582	32,841,230,582	32,841,230,582	32,841,230,582	32,841,230,582	32,844,195,195
33.266.613.083 33.266.613.083 33.266.613.083 33.286	33,064,021,833 33,064,021,833	33,064,021,8	33	33,064,021,833	33,064,021,833	33,064,021,833	33,066,554,160	33,087,865,374	33,077,851,390	33,070,059,234	33,087,641,106	33,087,133,887	33,089,188,104	33,064,021,833	33,064,021,833	33,064,021,833	33,064,021,833	33,064,021,833	33,066,554,160
33,503,506,604,333 33,506,604,333 33,506,604,339 33,513,510,604,339 33,513,510,604,339 33,513,510,605,339 33,723,536,510,539 33,723,510,510,510,510,510,510,510,510,510,510	33,286,813,083 33,286,813,083	33,286,813,0	983	33,286,813,083	33,286,813,083	33,286,813,083	33,288,913,124	33,311,734,837	33,301,322,503	33,293,141,852	33,311,448,657	33,310,860,482	33,312,487,378	33,286,813,083	33,286,813,083	33,286,813,083	33,286,813,083	33,286,813,083	33,288,913,124
33,722,305,683 33,732,305,683 33,732,305,683 33,733,631,054 33,753,631,054 33,753,631,054 33,753,631,054 33,753,631,054 33,753,631,054 33,753,631,054 33,753,631,054 33,753,631,054 33,753,631,054 34,751,054 34,	33,509,604,333 33,509,604,333	33,509,604,3	333	33,509,604,333	33,509,604,333	33,509,604,333	33,511,272,089	33,535,604,299	33,524,793,615	33,516,224,470	33,535,256,208	33,534,587,078	33,535,786,653	33,535,604,299	33,524,793,615	33,516,224,470	33,535,256,208	33,534,587,078	33,535,786,653
33.965.166.834 33.955.166.834 33.955.186.834 33.955	33,732,395,583 33,732,395,583	33,732,395,5	83	33,732,395,583	33,732,395,583	33,732,395,583	33,733,631,054	33,759,473,762	33,748,264,728	33,739,307,089	33,759,063,759	33,758,313,673	33,759,085,927	33,732,395,583	33,732,395,583	33,732,395,583	33,732,395,583	33,732,395,583	33,733,631,054
34.177.978.004 34.177.978.004 34.177.978.004 34.177.978.004 34.178.348.303 34.207.272.887 34.198.206.302 34.108.472.325 34.206.678.869 34.205.768.804 34.207.078.334 34.400.776.348 34.4010.77	33,955,186,834 33,955,186,834	33,955,186,8	334	33,955,186,834	33,955,186,834	33,955,186,834	33,955,990,019	33,983,343,224	33,971,735,840	33,962,389,707	33,982,871,310	33,982,040,269	33,982,385,201	33,955,186,834	33,955,186,834	33,955,186,834	33,955,186,834	33,955,186,834	33,955,990,019
34,400,769,334 34,400,769,344 34,400	34,177,978,084 34,177,978,084	34,177,978,0	384	34,177,978,084	34,177,978,084	34,177,978,084	34,178,348,983	34,207,212,687	34,195,206,952	34,185,472,325	34,206,678,861	34,205,766,864	34,205,684,476	34,177,978,084	34,177,978,084	34,177,978,084	34,177,978,084	34,177,978,084	34,178,348,983
34,623,560,585 34,623,60,585 34,623,660,585 94,623,086,913 34,654,951,672 34,642,149,177 34,631,637,562 34,642,393,963 34,653,220,085 34,642,578 34,845,351,835 34,845,425,878 34,878,821,074 34,885,620,230,30 34,845,725,181 34,878,101,514 34,878,946,851	34,400,769,334 34,400,769,334	34,400,769	,334	34,400,769,334	34,400,769,334	34,400,769,334	34,400,707,948	34,431,082,149	34,418,678,065	34,408,554,944	34,430,486,412	34,429,493,460	34,428,983,750	34,431,082,149	34,418,678,065	34,408,554,944	34,430,486,412	34,429,493,460	34,428,983,750
34,846,351,835 34,846,351,835 34,846,351,835 34,845,425,878 34,845,826,078 34,846,620,290 34,854,720,181 34,876,346,651	34,623,560,585 34,623,560	34,623,560	585	34,623,560,585	34,623,560,585	34,623,560,585	34,623,066,913	34,654,951,612	34,642,149,177	34,631,637,562	34,654,293,963	34,653,220,055	34,652,283,024	34,623,560,585	34,623,560,585	34,623,560,585	34,623,560,585	34,623,560,585	34,623,066,913
	34,846,351,835 34,846,351	34,846,351	,835	34,846,351,835	34,846,351,835	34,846,351,835	34,845,425,878	34,878,821,074	34,865,620,290	34,854,720,181	34,878,101,514	34,876,946,651	34,875,582,299	34,846,351,835	34,846,351,835	34,846,351,835	34,846,351,835	34,846,351,835	34,845,425,878
35,069,143,085 35,069,143,085 35,069,143,085 35,069,143,085 35,067,784,842 35,090,707,329 35,082,740,327 35,074,46 35,089,469,099 35,087,849,989	35,069,143,085 35,069,143,085	35,069,143	3,085	35,069,143,085	35,069,143,085	35,069,143,085	35,067,784,842	35,090,707,329	35,082,740,327	35,074,970,446	35,089,469,099	35,087,849,989	35,086,591,034	35,090,707,329	35,082,740,327	35,074,970,446	35,089,469,099	35,087,849,989	35,086,591,034

_			VMT Annual Operating Cost	perating Cost					Operati	Operating Benefit				ā	Present Value Operating Benefit (2011 dollars)	ng Benefit (2011	dollars)		
Year	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event	TH 169 Permanent Improvement (Year Round Canacity)	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event	TH 169 Permanent Improvement (Year Round	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvemen	TH 169 Permanent Improvement (Flood Event		TH 169 Permanent Improvement (Year Round Canacity)
2015																			
2016	\$ 10,843,483,518	\$ 10,841,363,804	\$ 10,839,990,417	\$ 10,843,622,307	\$ 10,843,728,578	\$ 10,845,952,669 \$. 69	\$ 2,119,715	5 \$ 3,493,101	(138,789)	\$ (245,060)	\$ (2,469,151)	•	\$ 1,855,347	7 \$ 3,057,447	\$ (121,479)	69	(214,496) \$	(2,161,202
2017	\$ 10,917,203,554	\$ 10,917,203,554	\$ 10,917,203,554	\$ 10,917,203,554	\$ 10,917,203,554	\$ 10,919,461,202 \$. 69	•	69	•	•	\$ (2,257,648)	•	•	69	\$	69	69	(1,924,126
2018	\$ 10,995,514,678	\$ 10,995,514,678	\$ 10,995,514,678 \$ 10,995,514,678 \$ 10,995,514,678	\$ 10,995,514,678	\$ 10,995,514,678	\$ 10,995,514,678 \$ 10,997,620,378	- \$	- \$. \$	- \$	- \$	\$ (2,105,700)	- \$	- \$	•	\$	\$	-	(1,747,444
2019	\$ 11,073,825,803		\$ 11,073,825,803 \$ 11,073,825,803	\$ 11,073,825,803		\$ 11,073,825,803 \$ 11,075,779,554 \$	- \$	- \$. \$	\$	- \$	\$ (1,953,752)	- \$. \$	•	\$	\$	-	(1,578,722
2020	\$ 11,158,243,983	\$ 11,158,243,983 \$ 11,155,564,188	\$ 11,153,644,579 \$ 11,158,295,724	\$ 11,158,295,724	\$ 11,158,288,171	\$ 11,158,288,171 \$ 11,159,911,449	. 69	\$ 2,679,795	5 \$ 4,599,404	4 \$ (51,741)	\$ (44,189)	\$ (1,667,466)	•	\$ 2,108,471	3,618,825	\$	40,710) \$	(34,768) \$	(1,311,968
2021	\$ 11,230,448,052	\$ 11,230,448,052	\$ 11,230,448,052	\$ 11,230,448,052	\$ 11,230,448,052	\$ 11,232,097,907	- 49	•	49	•	•	\$ (1,649,855)	•	•	9	\$	69	φ, '	(1,263,983
2022	\$ 11,308,759,176	\$ 11,308,759,176 \$ 11,308,759,176 \$ 11,308,759,176 \$ 11,308,759,176	\$ 11,308,759,176	\$ 11,308,759,176	\$ 11,308,759,176	\$ 11,308,759,176 \$ 11,310,257,083		*	\$		•	(1,497,906)	•	· •	· •>	\$	69	<i>چ</i> ه	(1,117,403
2023	\$ 11,387,070,301	\$ 11,387,070,301 \$ 11,387,070,301 \$ 11,387,070,301	\$ 11,387,070,301	\$ 11,387,070,301	\$ 11,387,070,301	\$ 11,387,070,301 \$ 11,388,416,259 \$. +	*	\$		•	\$ (1,345,958)	•	· •	· •>	\$	69	<i>چ</i> ه	(977,656
2024	\$ 11,473,004,447		\$ 11,469,764,572 \$ 11,467,298,740 \$ 11,472,969,140	\$ 11,472,969,140	\$ 11,472,847,765	\$ 11,473,870,229	- \$	\$ 3,239,875	5 \$ 5,705,707	7 \$ 35,307	\$ 156,682	(865,782)	- \$	\$ 2,291,461	1 \$ 4,035,466	\$ 24	,971 \$	\$ 918,011	(612,340
2025	\$ 11,543,692,550		\$ 11,543,692,550 \$ 11,543,692,550 \$ 11,543,692,550 \$ 11,543,692,550 \$ 11,544,734,611	\$ 11,543,692,550	\$ 11,543,692,550	_	- \$	- \$. \$	\$	- \$	\$ (1,042,061)	- \$. \$	•	\$	\$	-	(717,64
2026	\$ 11,622,003,674	\$ 11,622,003,674 \$ 11,622,003,674 \$ 11,622,003,674 \$ 11,622,003,674 \$ 11,622,003,674 \$ 11,622,893,787	\$ 11,622,003,674	\$ 11,622,003,674	\$ 11,622,003,674	_	•	•	*	•	- \$	\$ (890,113)	- \$	*	•	\$	\$	·	(596,882
2027	\$ 11,700,314,799	\$ 11,700,314,799	\$ 11,700,314,799 \$ 11,700,314,799	\$ 11,700,314,799	\$ 11,700,314,799	\$ 11,701,052,963	- \$	\$	· •	\$	- \$	\$ (738,165)	- \$	•	•	\$	49	·	(481,97
2028	\$ 11,787,764,911	\$ 11,783,964,956	\$ 11,780,952,901	\$ 11,787,642,557		\$ 11,787,407,358 \$ 11,787,829,008	. 69	\$ 3,799,955	5 \$ 6,812,010	122,354	\$ 357,553	\$ (64,097)	- \$	\$ 2,415,91	1 \$ 4,330,896	\$	\$ 062'22	227,323 \$	(40,751
2029	\$ 11,856,937,048	\$ 11,856,937,048	\$ 11,856,937,048 \$ 11,856,937,048 \$ 11,856,937,048	\$ 11,856,937,048		\$ 11,856,937,048 \$ 11,857,371,315 \$	- \$	\$	\$	\$	- \$	\$ (434,268)	- \$. \$	•	\$	\$	•	(268,837
2030	\$ 11,935,248,172	\$ 11,935,248,172 \$ 11,935,248,172 \$ 11,935,248,172 \$ 11,935,248,172 \$ 11,935,248,172 \$ 11,935,530,492	\$ 11,935,248,172	\$ 11,935,248,172	\$ 11,935,248,172		- \$	\$	\$	\$	- \$	\$ (282,319)	- \$. \$	•	\$	\$	•	(170,178
2031	\$ 12,013,559,297	\$ 12,013,559,297	\$ 12,013,559,297	\$ 12,013,559,297		\$ 12,013,559,297 \$ 12,013,689,668	- \$. \$	\$	\$	- \$	(126'081)	- \$. \$		\$	\$ -	\$	(76,520
2032	\$ 12,102,525,376	\$ 12,098,165,340	\$ 12,094,607,063	\$ 12,102,315,974	\$ 12,101,966,951	\$ 12,101,787,788		\$ 4,360,036	6 \$ 7,918,313	3 \$ 209,402	\$ 558,424	\$ 737,587		\$ 2,491,786	6 \$ 4,525,362	\$ 119,674	574 \$	319,143 \$	421,536
2033	\$ 12,170,181,546	\$ 12,170,181,546	\$ 12,170,181,546 \$ 12,170,181,546 \$ 12,170,181,546	\$ 12,170,181,546	\$ 12,170,181,546	\$ 12,170,181,546 \$ 12,170,008,020	. 69	· •		· •	· •>	\$ 173,526	· &9	· •	· 69	€9	69	69 '	96,564
2034	\$ 12,248,492,670	\$ 12,248,492,670 \$ 12,248,492,670 \$ 12,248,492,670 \$ 12,248,492,670 \$ 12,248,492,670 \$ 12,248,167,196	\$ 12,248,492,670	\$ 12,248,492,670	\$ 12,248,492,670		. \$	\$	\$	\$	•	\$ 325,474	•	\$	\$	\$	\$	\$	176,358
2035	\$ 12,334,383,626	\$ 12,334,383,626 \$ 12,331,583,225 \$ 12,328,852,112 \$ 12,333,948,388	\$ 12,328,852,112	\$ 12,333,948,388	\$ 12,333,379,271	\$ 12,333,379,271 \$ 12,332,936,748		\$ 2,800,401	1 \$ 5,531,515	5 \$ 435,238	\$ 1,004,355	\$ 1,446,878	•	\$ 1,477,507	7 \$ 2,918,458	\$ 229,634	\$	529,903 \$	763,381

8/30/2011 SEH, Inc.

			Yearly VHT (Only Non-Flood Event Year	n-Flood Event Year	.)				Yearly VHT (Only Flood Event Years)	lood Event Years)				Com	bined Yearly Vehick	Combined Yearly Vehicle Hours Traveled (VHT)	нт)	
Year	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)
2015	1,038,386,392	1,038,386,392	1,038,386,392	1,038,386,392	1,038,386,392	1,037,179,241	1,039,055,746	1,038,728,817	1,038,622,037	1,038,937,381	1,038,922,097	1,037,803,189	1,038,386,392	1,038,386,392	1,038,386,392	1,038,386,392	1,038,386,392	1,037,179,241
2016	1,053,509,690	1,053,509,690	1,053,509,690	1,053,509,690	1,053,509,690	1,052,132,673	1,054,277,201	1,053,927,535	1,053,771,593	1,054,135,075	1,054,097,475	1,052,825,531	1,054,277,201	1,053,927,535	1,053,771,593	1,054,135,075	1,054,097,475	1,052,825,531
2017	1,068,632,988	1,068,632,988	1,068,632,988	1,068,632,988	1,068,632,988	1,067,086,105	1,069,498,655	1,069,126,253	1,068,921,149	1,069,332,768	1,069,272,852	1,067,847,872	1,068,632,988	1,068,632,988	1,068,632,988	1,068,632,988	1,068,632,988	1,067,086,105
2018	1,083,756,286	1,083,756,286	1,083,756,286	1,083,756,286	1,083,756,286	1,082,039,538	1,084,720,109	1,084,324,971	1,084,070,705	1,084,530,462	1,084,448,230	1,082,870,214	1,083,756,286	1,083,756,286	1,083,756,286	1,083,756,286	1,083,756,286	1,082,039,538
2019	1,098,879,584	1,098,879,584	1,098,879,584	1,098,879,584	1,098,879,584	1,096,992,970	1,099,941,564	1,099,523,688	1,099,220,260	1,099,728,155	1,099,623,607	1,097,892,555	1,098,879,584	1,098,879,584	1,098,879,584	1,098,879,584	1,098,879,584	1,096,992,970
2020	1,114,002,882	1,114,002,882	1,114,002,882	1,114,002,882	1,114,002,882	1,111,946,403	1,115,163,018	1,114,722,406	1,114,369,816	1,114,925,848	1,114,798,985	1,112,914,897	1,115,163,018	1,114,722,406	1,114,369,816	1,114,925,848	1,114,798,985	1,112,914,897
2021	1,129,126,180	1,129,126,180	1,129,126,180	1,129,126,180	1,129,126,180	1,126,899,835	1,130,384,473	1,129,921,124	1,129,519,372	1,130,123,542	1,129,974,363	1,127,937,238	1,129,126,180	1,129,126,180	1,129,126,180	1,129,126,180	1,129,126,180	1,126,899,835
2022	1,144,249,478	1,144,249,478	1,144,249,478	1,144,249,478	1,144,249,478	1,141,853,267	1,145,605,927	1,145,119,842	1,144,668,928	1,145,321,235	1,145,149,740	1,142,959,580	1,144,249,478	1,144,249,478	1,144,249,478	1,144,249,478	1,144,249,478	1,141,853,267
2023	1,159,372,776	1,159,372,776	1,159,372,776	1,159,372,776	1,159,372,776	1,156,806,700	1,160,827,381	1,160,318,560	1,159,818,483	1,160,518,929	1,160,325,118	1,157,981,921	1,159,372,776	1,159,372,776	1,159,372,776	1,159,372,776	1,159,372,776	1,156,806,700
2024	1,174,496,074	1,174,496,074	1,174,496,074	1,174,496,074	1,174,496,074	1,171,760,132	1,176,048,836	1,175,517,278	1,174,968,039	1,175,716,622	1,175,500,496	1,173,004,263	1,176,048,836	1,175,517,278	1,174,968,039	1,175,716,622	1,175,500,496	1,173,004,263
2025	1,189,619,372	1,189,619,372	1,189,619,372	1,189,619,372	1,189,619,372	1,186,713,565	1,191,270,290	1,190,715,996	1,190,117,595	1,190,914,316	1,190,675,873	1,188,026,604	1,189,619,372	1,189,619,372	1,189,619,372	1,189,619,372	1,189,619,372	1,186,713,565
2026	1,204,742,670	1,204,742,670	1,204,742,670	1,204,742,670	1,204,742,670	1,201,666,997	1,206,491,745	1,205,914,714	1,205,267,151	1,206,112,009	1,205,851,251	1,203,048,946	1,204,742,670	1,204,742,670	1,204,742,670	1,204,742,670	1,204,742,670	1,201,666,997
2027	1,219,865,968	1,219,865,968	1,219,865,968	1,219,865,968	1,219,865,968	1,216,620,429	1,221,713,199	1,221,113,432	1,220,416,706	1,221,309,703	1,221,026,629	1,218,071,287	1,219,865,968	1,219,865,968	1,219,865,968	1,219,865,968	1,219,865,968	1,216,620,429
2028	1,234,989,266	1,234,989,266	1,234,989,266	1,234,989,266	1,234,989,266	1,231,573,862	1,236,934,653	1,236,312,150	1,235,566,262	1,236,507,396	1,236,202,006	1,233,093,629	1,236,934,653	1,236,312,150	1,235,566,262	1,236,507,396	1,236,202,006	1,233,093,629
2029	1,250,112,564	1,250,112,564	1,250,112,564	1,250,112,564	1,250,112,564	1,246,527,294	1,252,156,108	1,251,510,868	1,250,715,818	1,251,705,090	1,251,377,384	1,248,115,970	1,250,112,564	1,250,112,564	1,250,112,564	1,250,112,564	1,250,112,564	1,246,527,294
2030	1,265,235,862	1,265,235,862	1,265,235,862	1,265,235,862	1,265,235,862	1,261,480,727	1,267,377,562	1,266,709,586	1,265,865,374	1,266,902,783	1,266,552,762	1,263,138,312	1,265,235,862	1,265,235,862	1,265,235,862	1,265,235,862	1,265,235,862	1,261,480,727
2031	1,280,359,160	1,280,359,160	1,280,359,160	1,280,359,160	1,280,359,160	1,276,434,159	1,282,599,017	1,281,908,303	1,281,014,929	1,282,100,477	1,281,728,139	1,278,160,653	1,280,359,160	1,280,359,160	1,280,359,160	1,280,359,160	1,280,359,160	1,276,434,159
2032	1,295,482,458	1,295,482,458	1,295,482,458	1,295,482,458	1,295,482,458	1,291,387,591	1,297,820,471	1,297,107,021	1,296,164,485	1,297,298,170	1,296,903,517	1,293,182,995	1,297,820,471	1,297,107,021	1,296,164,485	1,297,298,170	1,296,903,517	1,293,182,995
2033	1,310,605,756	1,310,605,756	1,310,605,756	1,310,605,756	1,310,605,756	1,306,341,024	1,313,041,925	1,312,305,739	1,311,314,041	1,312,495,864	1,312,078,895	1,308,205,336	1,310,605,756	1,310,605,756	1,310,605,756	1,310,605,756	1,310,605,756	1,306,341,024
2034	1,325,729,054	1,325,729,054	1,325,729,054	1,325,729,054	1,325,729,054	1,321,294,456	1,328,263,380	1,327,504,457	1,326,463,597	1,327,693,557	1,327,254,272	1,323,227,678	1,325,729,054	1,325,729,054	1,325,729,054	1,325,729,054	1,325,729,054	1,321,294,456
2035	1,340,852,352	1,340,852,352	1,340,852,352	1,340,852,352	1,340,852,352	1,336,247,889	1,342,815,480	1,342,360,750	1,341,377,507	1,342,340,261	1,341,893,945	1,337,626,071	1,342,815,480	1,342,360,750	1,341,377,507	1,342,340,261	1,341,893,945	1,337,626,071
														motorinated Name Calculation				

			Annual Time Cost	ime Cost					Travel Time Benefit	e Benefit				4	Present Value Travel Time Benefit (2011 dollars)	I Time Benefit ([2011 dollars]		
Year	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event	TH 169 Permanent Improvement (Year Round Canacity)	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement	TH 169 Temporary Improvement	TH 169 Permanent Improvement (Flood Event	TH 169 Permanent Improvement (Year Round	No Build	TH 41 Bridge Improvement	TH 101 Bridge	TH 169 Temporary		TH 169 Permanent Improvement (Flood Event Canacity Only)	TH 169 Permanent Improvement (Year Round Canacity)
2015																			
2016	\$ 14,874,797,024	\$ 14,869,863,587	\$ 14,867,663,407	\$ 14,872,791,767	\$ 14,872,261,268	\$ 14,854,315,411	. \$	\$ 4,933,437	\$ 7,133,617	\$ 2,005,257	\$ 2,535,756	\$ 20,481,612	•	\$ 4,318,147	47 \$ 6,243,923	49	1,755,165 \$	2,219,501 \$	17,927,178
2017	\$ 15,077,342,824	\$ 15,077,342,824	\$ 15,077,342,824 \$ 15,077,342,824	\$ 15,077,342,824		\$ 15,077,342,824 \$ 15,055,517,860 \$	- \$	- \$	- \$	- +	•	\$ 21,824,964	. \$	69	\$	\$	-	\$	18,600,768
2018	\$ 15,290,717,436	\$ 15,290,717,436	\$ 15,290,717,436	\$ 15,290,717,436	\$ 15,290,717,436 \$ 15,290,717,436 \$ 15,290,717,436 \$ 15,290,717,436 \$ 15,290,717,436 \$ 15,266,495,837	\$ 15,266,495,837 \$	-	- \$	- \$	- \$	- \$	\$ 24,221,598	- \$	•	\$	\$	-	\$	20,100,631
2019	\$ 15,504,092,047		\$ 15,504,092,047 \$ 15,504,092,047	\$ 15,504,092,047		\$ 15,504,092,047 \$ 15,477,473,815 \$	- \$	- \$	- \$	- \$	- \$	\$ 26,618,232	- \$	•	\$	\$	-	\$	21,508,774
2020	\$ 15,733,835,024	\$ 15,727,618,431	\$ 15,722,643,735 \$ 15,730,488,796	\$ 15,730,488,796	\$ 15,728,698,881	\$ 15,702,116,277	- \$	\$ 6,216,593	\$ 11,191,289	\$ 3,346,228	\$ 5,136,143	\$ 31,718,747	•	\$ 4,891,234	34 \$ 8,805,340	49	2,632,822 \$	4,041,133 \$	24,956,405
2021	\$ 15,930,841,270	\$ 15,930,841,270	\$ 15,930,841,270	\$ 15,930,841,270	\$ 15,930,841,270 \$ 15,899,429,771	_	- \$. \$. \$	- +	•	\$ 31,411,499	•	\$	\$	€9	•	•	24,064,910
2022	\$ 16,144,215,882	\$ 16,144,215,882	\$ 16,144,215,882	\$ 16,144,215,882	\$ 16,144,215,882 \$ 16,144,215,882 \$ 16,144,215,882 \$ 16,144,215,882 \$ 16,144,215,882 \$ 16,144,215,882	_	. \$	•	•	- +	•	\$ 33,808,133	•	+	\$	49	69 '	•	25,220,071
2023	\$ 16,357,590,493	\$ 16,357,590,493	\$ 16,357,590,493	\$ 16,357,590,493	\$ 16,357,590,493 \$ 16,357,590,493 \$ 16,357,590,493 \$ 16,357,590,493 \$ 16,321,385,726		. 8	. \$. \$	•	•	\$ 36,204,767	•	69	69	49	69		26,297,861
2024	\$ 16,592,873,024	\$ 16,585,373,275	\$ 16,577,624,063	\$ 16,588,185,826	\$ 16,585,136,494	\$ 16,549,917,142	- \$	\$ 7,499,749	\$ 15,248,961	\$ 4,687,198	\$ 7,736,529	\$ 42,955,882	- \$	\$ 5,304,335	35 \$ 10,785,108	8	3,315,107 \$	5,471,803 \$	30,381,336
2025	\$ 16,784,339,716	\$ 16,784,339,716	\$ 16,784,339,716	\$ 16,784,339,716	\$ 16,784,339,716 \$ 16,784,339,716 \$ 16,784,339,716 \$ 16,784,339,716 \$ 16,784,339,716 \$ 16,743,341,682	_	- \$	- \$	- \$	- \$	- \$	\$ 40,998,034	- \$	\$	\$	\$	-	\$	28,234,287
2026	\$ 16,997,714,328	\$ 16,997,714,328	\$ 16,997,714,328	\$ 16,997,714,328	\$ 16,997,714,328 \$ 16,997,714,328 \$ 16,997,714,328 \$ 16,997,714,328 \$ 16,997,714,328 \$ 16,954,319,659	_	- \$. \$. \$	- +	•	\$ 43,394,668	•	•	\$	€9	•	•	29,099,111
2027	\$ 17,211,088,939	\$ 17,211,088,939	\$ 17,211,088,939 \$ 17,211,088,939 \$ 17,211,088,939	\$ 17,211,088,939		\$ 17,211,088,939 \$ 17,165,297,637 \$				· 69	· •	\$ 45,791,302		· •	€9	69	<i>€</i> 9	•	29,898,947
2028	\$ 17,451,911,024	\$ 17,443,128,120	\$ 17,432,604,391 \$ 17,445,882,855	\$ 17,445,882,855	\$ 17,441,574,108	\$ 17,441,574,108 \$ 17,397,718,008	- \$	\$ 8,782,904	\$ 19,306,633	\$ 6,028,169	\$ 10,336,916	\$ 54,193,016	. \$	\$ 5,583,938	38 \$ 12,274,646	69	3,832,550 \$	\$ 6,571,938 \$	34,454,487
2029	\$ 17,637,838,162		\$ 17,637,838,162 \$ 17,637,838,162 \$ 17,637,838,162	\$ 17,637,838,162	\$ 17,637,838,162	\$ 17,637,838,162 \$ 17,587,253,592 \$	- \$	- \$	- \$	- 5	•	\$ 50,584,569	. \$	69	\$	\$	-	\$	31,314,831
2030	\$ 17,851,212,773	\$ 17,851,212,773	\$ 17,851,212,773	\$ 17,851,212,773	\$ 17,851,212,773 \$ 17,851,212,773 \$ 17,851,212,773 \$ 17,851,212,773 \$ 17,851,212,773 \$ 17,798,231,570	_	- \$	- \$	- \$	- 5	•	\$ 52,981,203	. \$	69	\$	\$	-	\$	31,936,211
2031	\$ 18,064,587,385	\$ 18,064,587,385 \$ 18,064,587,385 \$ 18,064,587,385 \$ 18,064,587,385	\$ 18,064,587,385	\$ 18,064,587,385		\$ 18,064,587,385 \$ 18,009,209,548 \$	- \$	- \$	- \$	- \$	- \$	\$ 55,377,837	- \$	•	\$	\$	-	\$	32,503,275
2032	\$ 18,310,949,024	\$ 18,300,882,964	\$ 18,287,584,719 \$ 18,303,579,885	\$ 18,303,579,885	\$ 18,298,011,721	\$ 18,245,518,873		\$ 10,066,060	\$ 23,364,305	\$ 7,369,139	\$ 12,937,303	\$ 65,430,151	. \$	\$ 5,752,812	12 \$ 13,352,837	\$	4,211,506 \$	7,393,744 \$	37,393,714
2033	\$ 18,491,336,608	\$ 18,491,336,608	\$ 18,491,336,608 \$ 18,491,336,608 \$ 18,491,336,608	\$ 18,491,336,608	\$ 18,491,336,608 \$ 18,431,165,503					· 69	· •	\$ 60,171,104		69	€9	69	<i>€</i> 9	•	33,484,069
2034	\$ 18,704,711,219	\$ 18,704,711,219	\$ 18,704,711,219	\$ 18,704,711,219	\$ 18,704,711,219 \$ 18,704,711,219 \$ 18,704,711,219 \$ 18,704,711,219 \$ 18,642,143,481		,			· •		\$ 62,567,738		· 69	€9	69	69 '	•	33,902,385
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8/30/2011 SEH, Inc.

Benefit Cost Table A8 Operating & Maintenance Benefits

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1	Year	No Build	TH 41 Bridge Improvement	TH 101 Bridge Improvement		TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)		TH 41 Bridge Improvement			TH 169 Permanent Improvement (Flood Event Capacity Only)	TH 169 Permanent Improvement (Year Round Capacity)	No Build	TH 41 Bridge Improvement			<u> </u>		169 anent rement Round icity)
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	Total							- \$		₩		- \$ (- \$	- \$		\$	↔		\$	-

NOTES: No Build Maintenance cost include any work to close, open and maintain flooded roadways

TH 41 Bridge Improvement Maintenace includes any work to close, open and maintain remaining roadways

TH 101 Bridge Improvement Maintenace includes any work to close, open and maintain remaining roadways

TH 169 Temporary Improvement Maintenace includes any work to close, open and maintain flooded roadways and to implement and remove Temporary Stripping changes

TH 169 Permanent Improvement Maintenace includes any work to close, open and maintain flooded roadways

Maintenance Costs:

(to close, open and repair flooded roadways)

a lodo (ocolo os)	(co cioco, obeni ana iopani nocaca ioaana)o,	odana)		
	2010	2011	Average	
TH 101 Closure	\$ 71,000	\$ 76,000	\$ 73,500	
TH 41 Closure	000'06 \$	\$ 53,400	\$ 71,700	
TH 169 **				
Temporary	· &	\$ 426,000	€9	426,000 ** \$270,000 for Tem
Improvements				

emporary Project, plus \$85,000 supplemental agreement, plus\$71,000 miscelaneous.

Appendix G

Summary List of Assumptions

Minnesota River Flood Mitigation Study – Assumptions for Highway 41 River Crossing

Highway 41 Flood Elevations (Existing)

Hydraulic Event	Water Surface Elevation (ft, NGVD 29)
10-Year Flood	714.2
50-Year Flood	720.3
100-Year Flood	722.5
500-Year Flood	727.7

Highway 41 Roadway/Bridge Low and Closure Elevations (Existing/Proposed)

	Existing	Proposed
Roadway/Bridge Low Elevation (ft, NGVD 29)	716.6	722.5
Closure Elevation (ft, NGVD 29)	714.6	719.6
Note: MnDOT alogos transportation routes when flood waters read	an alayation of annuarimataly type fact	halow the low road elevation of

Note: MnDOT closes transportation routes when flood waters reach an elevation of approximately two feet below the low road elevation at the crossing.

Highway 41 Preferred Concept Description

Characteristics	Description
Minimum Road Centerline Elevation	722.5 feet (NGVD 29)
Bridge Length	1,350 feet
Pile Spacing	100 feet
Pile Diameter	18 inches in model
Bridge Depth of Structure	56 inches (36-inch beam)
Proposed Bridge Width	72 feet with concrete barriers ¹ (Includes 12-foot travel lanes, 8-foot outside shoulders, and 12-foot trail with barrier separation from traffic)
Proposed Roadway Width	72 feet (Includes 12-foot travel lanes, 8-foot outside shoulders, and 10-foot trail with separation from driving lanes)
Staging and Constructability	Constructed Under Traffic, Half at a Time; 18-Month Duration
¹ Same as Bridge No. 70041 which was designed to ca	arry traffic while under construction.

Highway 41 Existing and Forecast Average Daily Traffic (ADT)

Event	Existing ADT (2009)	Forecast ADT (2030)
Non-Flood Event (Highway 101 and 41 Open to Traffic)	12,500	20,200
Flood Event (Highway 41 Open to Traffic, Highway 101 Closed to Traffic)	22,300	29,200

Minnesota River Flood Mitigation Study – Assumptions for Highway 101 River Crossing

Highway 101 Flood Elevations (Existing)

Hydraulic Event	Water Surface Elevation (ft, NGVD 29)
10-Year Flood	712.0
50-Year Flood	718.4
100-Year Flood	720.7
500-Year Flood	726.0

Highway 101 Roadway/Bridge Low and Closure Elevations (Existing/Proposed)

	Existing	Proposed
Roadway/Bridge Low Elevation (ft, NGVD 29)	711.4	724.0
Closure Elevation (ft, NGVD 29)	709.4	722.0
Note: MnDOT closes transportation routes when flood waters reach	an elevation of approximately two feet	below the low road elevation at

Note: MnDOT closes transportation routes when flood waters reach an elevation of approximately two feet below the low road elevation at the crossing.

Highway 101 Preferred Concept Description

Characteristics	Description		
Minimum Road Centerline Elevation	724.0 feet (NGVD 29)		
Bridge Length	3,080 feet		
Pile Spacing	100 feet		
Pile Diameter	18 inches in model		
Bridge Depth of Structure	54 inches (36-inch beam)		
Proposed Bridge Width	56 feet with concrete barriers (Includes 12-foot travel lanes, 8-foot outside shoulders, and 12-foot trail with barrier separation from traffic)		
Proposed Roadway Width	56 feet (Includes 12-foot travel lanes, 8-foot outside shoulders, and 10-foot trail with guardrail separation from driving lanes)		
Staging and Constructability	Full Closure; 12-Month Duration		

Highway 101 Existing and Forecast Average Daily Traffic (ADT)

Event	Existing ADT (2009)	Forecast ADT (2030)
Non-Flood Event (Highway 101 and 41 Open to Traffic)	20,400	24,700
Flood Event (Highway 101 Open to Traffic, Highway 41 Closed to Traffic)	27,900	36,200

Appendix H

Community Support Letters

BOARD OF COUNTY COMMISSIONERS CARVER COUNTY, MINNESOTA

Date: <u>September 20, 2011</u>		Resolution No: 52-11	
Motion by Commissioner:	Lynch	Seconded by Commissioner: Workman	_

Resolution in Support of Funding the Construction of a TH 101 Bridge Crossing over the Minnesota River

- WHEREAS, Flooding from snow melt and rainfall often closes the Trunk Highway ("TH") 101, TH 41 and County State Aid Highway ("CSAH") 11 Minnesota River crossings, which has a detrimental effect on traffic in the region;
- WHEREAS, Closures of these roadways affects approximately 40,000 vehicle trips every day, and detouring these vehicles puts a massive burden on the area's economy by increasing congestion on TH 169 and TH 494 and other highways and significantly extending the commute for many travelers. Having these roads impassable is also a severe strain on emergency response access between Scott and Carver Counties;
- WHEREAS, The Minnesota of Transportation (MnDOT) has prepared a Minnesota River Flood Mitigation Study ("Study") which modeled the effect of the 10-yr, 50-yr, 100-yr, and 500-yr flood events at the TH 101 and TH 41 river crossings, modeled the impact to traffic with current volumes and expected 2030 volumes, prepared alternatives to construct new bridges at TH 101 and TH 41 to keep the highways open during the 10-yr and 50-yr flood events, and calculated the Benefit to Cost ("B/C") ratio of constructing these bridges as well as capacity improvements on the TH 169 river crossing;
- WHERAS, It is understood that the Study is independent of the Tiered Environmental Impact Statement to select a new TH 41 alignment and river crossing and preserve the corridor for future construction, which is ongoing and will be completed.
- WHEREAS, The Study estimates the costs of closing TH 101 and TH 41 due to flooding is \$670,000 per day for existing traffic and \$1,675,000 for 2030 traffic;
- WHERAS, The Study shows the B/C ratio to construct the TH 101 bridge is 3.81 with a construction cost of approximately \$22,300,000 and the B/C to construct the TH 41 bridge is 3.06 with a cost of approximately \$13,800,000;
- WHERAS, The Study shows that with a B/C greater than 1.0 that the new bridges will provide great benefit to the travelling public and investing in the improvements is clearly warranted;
- WHERAS, It is understood that the bridges will not provide 100 percent flood relief but will protect travelers from the majority of flood events at a reasonable cost;
- WHERAS, It is understood that MnDOT has set aside \$50,000,000 for trunk highway flood mitigation projects in the state, of which a portion has already been allocated;
- WHERAS, It is understood that MnDOT will be soliciting for flood mitigation projects in the Fall of 2011 to utilize the remaining funding;
- WHERAS, It is understood that the MnDOT Metro District intends to submit either the TH 101 or TH 41 bridge project for funding consideration;

WHEREAS, The study, design, and programming of flood mitigation projects for TH 101 and TH 41 was a 2011 Legislative Priority for Carver County, as was bonding for highway improvement projects and in particular state trunk highway turnback projects;

WHERAS, TH 101 is planned to be turned back to Carver County;

My Commission expires

DIANE M. WABBE

V Stamp

Notary Public-Minnesota

My Comm. Expires Jan. 31, 2015

- NOW, THEREFORE, BE IT RESOLVED, that the Board of Commissioners of Carver County expresses great appreciation to MnDOT for completing the Minnesota River Flood Mitigation Study and for its consideration in funding a new TH 101 or TH 41 river crossing bridge;
- NOW, THEREFORE, BE IT FURTHER RESOLVED, that the Board of Commissioners of Carver County considers both river crossings critical to the economic welfare, safety and quality of life of its residents and the region as a whole, and requests that both bridge projects are programmed for construction;
- NOW, THEREFORE, BE IT FURTHER RESOLVED, that the Board of Commissioners of Carver County understands that there are limited resources available to construct both river bridges in the near future and therefore requests that the TH 101 project be constructed first utilizing the state flood mitigation funding and supports using county turnback funds and to assist in fully funding the project.

YES	ABSENT		NO
Degler			
Ische			
Lynch			
Maluchnik			
Workman			
STATE OF MINNESOTA COUNTY OF CARVER			
I, Dave Hemze, duly appointed a certify that I have compared the foregoing Commissioners, Carver County, Minnesota Administration office, and have found the	copy of this resolution va, at its session held on the	with the original minutes of the he <u>20th</u> day of <u>Septemb</u>	
Dated this 20th day of Septer	mber , 2011.	Dave Hemze	County Administrator
Subscribed and sworn to before me thi	s	gave nomize y	County Manimistration
20 th day of September, 2011.			
Notary Public Dean M. L	affec		

BOARD OF COUNTY COMMISSIONERS SCOTT COUNTY, MINNESOTA

Date:	September 27, 2011
Resolution No.:	2011-189
Motion by Commissioner:	Menden
Seconded by Commissioner:	Marschall

RESOLUTION NO. 2011-189 ENDORSING THE MINNESOTA RIVER FLOOD MITIGATION STUDY FINDINGS, REQUESTING THAT MINNESTOA DEPARTMENT OF TRANSPORTATION (MN/DOT) METRO DISTRICT SUBMIT THE TRUNK HIGHWAY (TH)101 BRIDGE PROJECT IN THE STATEWIDE CHAPTER 152 FLOOD MITIGATION FUNDING SOLICITATION AND URGING MN/DOT TO PROGRAM THE TH 41 AND TH 169 PROJECT RECOMMENDATIONS IN THE NEXT 20 YEAR PLAN UPDATE

WHEREAS, the businesses and the commuters in this region rely on three major river crossings to provide access to jobs, services and shopping; and

WHEREAS, the southwest metro area continues to be a growing area of the region and by 2030 all major river crossings serving this part of the region are expected to be at capacity; and

WHEREAS, during the last two decades, three of the five bridges serving Carver, Scott and southwestern Hennepin County have been closed six times due to flooding; and

WHEREAS, the frequency and duration of these closures appear to be on the rise causing great concern for the disruption and risks they create; and

WHEREAS, the only river crossing that is not vulnerable to closures caused by flooding of the Minnesota River is the TH 169, Bloomington Ferry Bridge; and

WHEREAS, I-35W, TH 101, TH 41, CH 9, and TH 25 all are at risk for 100 year flood events; and

WHEREAS, these bridges currently together carry nearly 250,000 trips daily; and

WHEREAS, the study estimated that when closures occur on just TH101, TH41 and CH 9 the daily costs of such closures were \$670,000 in 2009 and by 2030 with no actions taken to mitigate the problem, costs to the traveling public would exceed \$1.67 million daily; and

WHEREAS, the river crossing capacity in this part of the metro area has a larger statewide impact as the TH 169 interregional corridor serves the Mankato metropolitan area and Southern Minnesota, provides access to, and markets for, its products and service; and

WHEREAS, because of the critical nature of these river crossing and their vulnerability to flood closures, Mn/DOT Metro District and Bridge Office conducted a flood mitigation feasibility study during 2011; and

WHEREAS, this study was intended to identify shorter term lower cost projects that could be implemented prior to the long term development of a new river crossing between TH 212 and TH 169 in which a tiered EIS process is nearing completion; and

WHEREAS, this study involved the cities of Bloomington, Chanhassen, Chaska and Shakopee; Townships of Jackson and Louisville Township, Counties of Carver, Scott and Hennepin; and the Metropolitan Council; and

WHEREAS, the study included early coordination with environmental and permitting agencies including the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service and the Minnesota Department of Natural resources; and

WHEREAS, the study developed options for land bridges on TH 41 and TH 101 and both temporary and permanent options for TH 169; and

BOARD OF COUNTY COMMISSIONERS SCOTT COUNTY, MINNESOTA

Date:	September 27, 2011
Resolution No.:	2011-189
Motion by Commissioner:	Menden
Seconded by Commissioner:	Marschall

WHEREAS the study recommended that TH 41 Bridge No. 70041 be replaced with a 1,350 foot land bridge, increasing closure elevation form 714.6 feet to 719.6 feet, increasing flood protection near a 50-year flood event. The benefit cost of this alternative is 3.06 based on an estimated cost of \$19 million; and

WHEREAS, the study recommended that TH 101 Bridge No. 10007 and the land embankment in the causeway be replaced with a 3,080 foot land bridge raising the closure elevation from 709.4 to 722, increasing the flood protection level to the 100-year flood event. The benefit cost is 3.81 based on a estimated cost of \$31 million; and

WHEREAS, the study also identified two options for TH 169, one that would allow for temporary restriping of an additional lane of capacity during flood events at a cost of under \$1 million and benefit cost ratio of 19:1; and a second option that would add a lane of capacity year round at a cost of \$44 million and a benefit cost ratio of 15.1; and

WHEREAS, all options recommended are considered cost effective and beneficial; and

WHEREAS, it was the consensus of the study partners that TH 101 should be the first project completed, because it carries the most traffic today, and will provide the best long term paybacks to the region; and

WHEREAS, pursuing the TH 101 project first will capitalize on investments and complete the trail system utilizing the recently restored historic bridge in Shakopee; and

WHEREAS, the investments being made to the CH 69 Scott County and the 101 corridor in both Carver County and Scott County will support the 101 corridor's regional connectivity well into the future; and

WHEREAS, Scott County strongly endorses that Mn/DOT Metro district proceed with a request for Chapter 152 Flood mitigation funds for the TH 101 corridor; and,

WHEREAS, Scott county acknowledges that it will take a partnership effort to put together a complete funding package for the TH 101 bridge and commits to working with Mn/DOT and Carver County to secure the necessary resources and funding to deliver the project. Scott County has already initiated that partnership by submitting an application to the Transportation Advisory Board's 2011 Federal Funding solicitation; and

WHEREAS, Scott County has jurisdiction of the Highway 101 bridge to the County line and commits to future joint ownership of this bridge with Carver County agreeing to its long term operation and maintenance once constructed; and

WHEREAS, Scott County requests that Mn/DOT work collaboratively with its local partners and permitting agencies during the project development process to identify possible construction innovations or right of way expansions that may reduce or possibly eliminate the construction closure duration; and

WHEREAS, Scott County believes it is prudent to maximize the carrying capacity of these existing river crossings from an environmental, public investment and community development perspective. Scott County commits to work with Mn/DOT, Carver County and the resource agencies in the design process to consider possible widening of the bridge either with this project or in the future to meet minimum county standards for existing and projected 20 year traffic volumes on this corridor; and

BOARD OF COUNTY COMMISSIONERS SCOTT COUNTY, MINNESOTA

Date:	September 27, 2011
Resolution No.:	2011-189
Motion by Commissioner:	Menden
Seconded by Commissioner:	Marschall

WHEREAS, Scott County has also deemed that improvements to support temporary restriping on TH 169 are a wise investment that should receive priority consideration for congestion mitigation funding by Mn/DOT and the region. This provides flexibility and options for traffic management during flood closures and for managing traffic impacts caused by construction on adjacent river crossings. With the expected reconstruction of the I35W Minnesota river bridge in the next decade, and a potential mitigation project, setting up the 169 corridor for temporary restriping is a very low cost high benefit project to undertake; and

WHEREAS, the other recommended options should be carried forth and given strong consideration for inclusion in the next update of the district's 20 year plan and Metropolitan Council's Transportation Policy Plan.

NOW THEREFORE BE IT RESOLVED that the Scott County Board of Commissioners endorses the Minnesota River Flood Mitigation Study findings for short and mid-term transportation solutions; and

BE IT FURTHER RESOLVED, Scott County requests that Mn/DOT Metro District submit the TH 101 Bridge project in the second round of the 2011 statewide Chapter 152 Flood Mitigation funding solicitation; and

BE IT FURTHER RESOLVED, Scott County requests that Mn/DOT consider programming in the 2013-2016 Transportation Improvement Program funds from the congestion mitigation set aside for improvements needed to support temporary restriping of the TH 169 river bridge during flood related or construction closures; and

BE IT FURTHER RESOLVED, Scott County supports inclusion of the TH 101, TH 41 and TH 169 project recommendations from the Minnesota River Flood Mitigation Study in the next Metro District 20 year plan update and Metropolitan Council Transportation Plan; and

BE IT FURTHER RESOLVED, Scott County supports Mn/DOT completing the TH 41 Tier I FEIS as a long term transportation solution to the Minnesota River Flooding issues; continuing to move the corridor's preservation forward; and

BE IT FINALLY RESOLVED, Scott County Board of Commissioners thanks the Minnesota Department

of Transportation Metro District and Bridge offices for funding and leading this study.

COMMISSIONERS			VOTE	
Wagner	▼ Yes	Г No	☐ Absent	┌ Abstain
Wolf	▼ Yes	┌ No	☐ Absent	☐ Abstain
Menden	▼ Yes	ΓNο	厂 Absent	☐ Abstain
Marschall	▼ Yes	Г По	☐ Absent	☐ Abstain
Ulrich	▼ Yes	ΓNo	☐ Absent	☐ Abstain

State of Minnesota)
County of Scott)

I, Gary L. Shelton, duly appointed qualified County Administrator for the County of Scott, State of Minnesota, do hereby certify that I have compared the foregoing copy of a resolution with the original minutes of the proceedings of the Board of County Commissioners, Scott County, Minnesota, at their session held on the 27th day of September, 2011 now on file in my office, and have found the same to be a true and correct copy thereof.

Witness my hand and official seal at Shakopee, Minnesota, this 27th day of September, 2011.

County Administrator

Administrator's Designee



September 12, 2011

Ms. Nicole Peterson, P.E. South Area Engineer, Carver and Scott Counties Minnesota Department of Transportation 1500 West County Road B-2 Roseville, MN 55113

RE: Minnesota River Flood Mitigation Study

Final Report - Alternatives

Dear Ms. Peterson:

The City of Bloomington would like to thank MnDOT for the work in completing the Minnesota River Flood Mitigation Study. We also appreciate the opportunity to submit comments regarding the alternatives presented in the report.

Increasing congestion is the most significant challenge that the Bloomington roadway network will face in the coming years. Part of Bloomington's current congestion is due to development within the City. Another significant component, however, is the spillover of traffic from outside Bloomington onto local streets in an effort to avoid highly congested portions of the regional highway system such as I-494 and Highway 169. To address congestion, the City is supportive of measures that eliminate bottlenecks, diversify transportation options, facilitate high quality transit systems, and increase roadway capacities while avoiding relocating or exasperating congestion or bottlenecks elsewhere.

The limited number of north/south bridge crossings on the Minnesota River has long been recognized as a bottleneck to traffic in the region. With four of the established crossings directly adjacent to the City of Bloomington, we are uniquely affected by changes in traffic caused by bridge closures resulting from seasonal flooding and capacity variations. This is especially true of closures on Highway 101 and Highway 41, which again this year had to be closed due to high water, resulting in increased traffic on Highway 169 and use of detour routing onto the local street network. The City has long dealt with the effects of cut-through traffic on local roadways resulting from congestion at the 169/494 interchange and along the I-494 and TH 169 corridors. When congestion occurs on Highway 169 and 1-494, regional trips spillover onto Bloomington's local roadway system as drivers search for travel alternatives between the two regional roadways. This cut-thru traffic is a major community concern.

The report studied three alternatives, including:

- Rebuilding the Highway 101 bridge crossing over the Minnesota River
- Constructing a land bridge crossing at Highway 41 at the Minnesota River
- Expanding capacity on Highway 169, either permanently, or during flood events

The alternatives studied for raising the crossings at Highway 101 and 41 would bring both roadways above the 100 year flood elevation. The City of Bloomington recognizes that the alternatives to raise the crossings provides benefit not only to other local agencies along the southern portions of the corridor, but also to Bloomington as they avoid increasing traffic volumes along TH 169 caused by bridge closures. Therefore, the City supports both of these alternatives and hopes additional efforts will be made to fund and bring these concepts to fruition.

The study work done on the alternative to expand the capacity of TH 169, temporarily or permanently, did not include analysis on the effects of adding traffic to the 169/494 interchange, including how the additional traffic would affect the local road network. While the City recognizes that the study work on the capacity alternatives indicates positive benefit/cost analysis for Highway 169 mainline, we would not support any permanent or semi-permanent modifications to Highway 169 unless a detailed operational analysis were performed showing that proposed improvements increase corridor capacity without overloading the I-494/169 interchange including the local roadway roundabout network, and do not increase cut thru traffic in our community. Additionally, a key component of any temporary capacity modification needs to include improvements that maintain the use of all existing entrance and exit ramps, eliminating the need for established detour routes on the local roadway network.

The comments above are based on the partial draft report materials shared with the City on September 2, 2011. The City may have additional comments once a complete report is prepared.

The bridges over the Minnesota River play a key role in the transportation system for the region. Managing demand north of the river will continue to be a prime focus for the City. The City of Bloomington appreciates the work done by MNDOT in responsibly managing these assets and looks forward to our continued partnership and participation with MNDOT on improvements along the Highway 169 corridor.

Sincerel

Gene Winstead

Mayor



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Administration

Phone: 952.227.1100 Fax: 952.227.1110

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Recreation Center

2310 Coulter Boulevard Phone: 952.227.1400 Fax: 952.227.1404

Planning & Natural Resources

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Public Works

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Senior Center

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Web Site

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September 14, 2011

Ms. Nicole Peterson MnDOT Metro District South Area Engineer MnDOT Metro District 1500 W. County Road B-2 Roseville, MN 55113

RE: Minnesota River Flood Mitigation Study – PW067E2

Dear Ms. Peterson:

I would like to thank MnDOT for taking the initiative to study the Minnesota River crossings in the southwest portion of the metropolitan area. As you know, TH 41 and TH 101 have flooded several times in recent years, which created significant traffic problems for the region. It appears the Minnesota River is trending for more frequent flooding and work on improving the river crossings in this region is necessary. We are very supportive of every effort to mitigate flooding on both TH 41 and TH 101 and feel both crossings should be improved; however, based on the mitigation report, TH 101 shows the greatest short and long term benefits if only one river crossing can be improved at this time.

Based on the findings of the Mitigation Study, the benefits for making improvements to TH 101are as follows:

- The TH 101 river crossing improvements have a better cost/benefit than the proposed improvements to the TH 41 River crossing.
- TH 101 currently carries and is anticipated to carry more traffic than TH 41.
- TH 101 would be raised to a 100 year flood event. The proposed improvements to TH 41 only raise the river crossing to a 50 year flood elevation.
- The Trunk Highway 41 Minnesota River Crossing Tier I Draft Environmental Impact Statement (June 2007) identifies a long-term replacement solution at the Highway 41 crossing that elevates the bridge out of the 100-year flood level.
- TH 101 currently floods more frequently and stays closed longer than the TH 41 river crossing.
- The regional economic benefits will be greater since the corridor directly connects two communities.
- The project is compatible with the future turnback of TH 101 and turnback funds could potentially be leveraged as another funding source.
- MnDOT will be able to remove this corridor from its maintenance requirements once the turnback is complete.
- The investment that MnDOT has recently made to the historic bridge in Shakopee should be better utilized by constructing a pedestrian bridge with an improved TH 101 Minnesota River crossing to connect to the LRT Regional Trail and the local trail system on the Carver County side of the river.

Ms. Nicole Peterson September 14, 2011 Page 2

- Hennepin County is planning to make improvements on Flying Cloud Drive to make it more flood proof in 2015. These improvements will benefit the TH 101 Minnesota River crossing.
- The length of time to construct TH 101 is shorter than the TH 41 improvements.

Improvements to the TH 101 corridor are a high priority for the City of Chanhassen, as it would provide long-term benefit to the region and improve the state's trunk highway system. For these same reasons, the City also supports designing the TH 101 improvements to accommodate a 4-lane design in order to plan for future growth. The City will be a supportive partner in this project if TH 101 is selected for funding. The City commits to assist, in any way it can, by helping to identify and seek out additional funding for the project.

On behalf of the City of Chanhassen and its City Council, thank you for your continued assistance and consideration of this letter expressing our support for the selection and funding of the proposed improvements to the TH 101 Minnesota River crossing.

Sincerely,

CITYOF CHANHASSEN

Tom Furlong Mayor

TF:PO:k



September 20, 2011

Ms. Nicole Peterson MnDOT South Area Engineer 1500 West Co Rd B-2 Roseville, Mn. 55113

Dear Ms. Peterson,

Chaska views the Minnesota River Flood Mitigation Report as a significant step toward providing a viable river crossing option for traffic during flood events. The need for such a project has been well documented, especially in the last few years. Chaska appreciates the opportunity to be a participant in the preparation of the report and provide the City's position on its findings.

There is no question from Chaska's perspective that both the TH101 and TH41 improvements as described are beneficial to the area as stand alone projects. This position is verified by each project's cost/benefit ratio. In terms of which project serves the area better in providing a reliable river crossing option, Chaska supports the TH101 option for the following reasons:

- 1. Structural limitations on the existing TH41 river bridge restrict the height of the flood proofing improvements.
- 2. TH101 can be elevated to a closer elevation equal to the 1965 flood, which is equated to a 100-year event.
- 3. TH101 currently carries a higher traffic volume and is projected to retain that edge over TH41 in the future.
- 4. Work along the TH101 corridor, both north and south of the Minnesota River, already in progress or being discussed, will potentially create a direct connection from Shakopee to TH212.

It is also important to note that Chaska has been working with MnDOT for some time on developing the ultimate section of TH41/Chestnut Street through downtown. Chaska has been slow to embrace MnDOT's proposal that a five (5) lane section is needed due to its impact on Chestnut Street also being the City's main street. Based on the current and projected traffic projections on TH41 presented in the Report, Chaska proposes to revisit this issue with MnDOT in hopes of justifying a three-lane section. We propose to have this discussion sooner than later, as this is a high priority to our community. Again, Chaska appreciates being involved and able to comment on this potential project.

Sincerely,

Mark Windschitl Mayor, City of Chaska

Mark Windshill

September 15, 2011

Ms. Nicole Peterson MnDOT Metro District South Engineer MnDOT Metro District 1500 W. County Road B-2 Roseville, MN 55113

RE: Minnesota River Flood Mitigation Study PW 067E2

Dear Ms. Peterson:

I am pleased that MnDOT has undertaken a study of the Minnesota River crossings in the southwest metropolitan region. Flooding in this area causes significant traffic problems for this area. I am supportive of all efforts to alleviate flooding at both the TH 101 and the TH 41 crossings but feel that the TH 101 has the greatest merit and should be the priority project.

TH 101 currently carries more traffic than TH 41 and projected improvements to that crossing would address 100-year flood levels rather than 50-year flood levels. In addition the construction time for a TH 101 project would be shorter than the TH 41 improvements and thus the region could reap the benefits of that investment sooner. The TH 101 crossing also floods more frequently and stays closed longer than the TH 41 crossing.

With limited options for crossing the Minnesota River, our residents and businesses are greatly affected when these crossings are closed. While recognizing that there are limited dollars to make improvements and thus priority needs to be assigned to certain projects, we would hope that the TH 101 improvements take precedence.

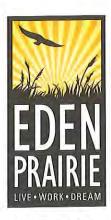
Thank you for your continued support of efforts to address road issues in our area.

Sincerely,

Nancy Tyra-Lukens

Janey Tyra Zukem

Mayor



OFC 952 949 8300 FAX 952 949 8390 TDD 952 949 8399

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Lynn P. Clarkowski MnDOT Metro District South Manager 1500 West County Road B2 Roseville, MN 55133

Subject:

Minnesota River Flood Mitigation Study/Highway 101 Crossing

Dear Ms. Clarkowski:

I am writing on behalf of City of Shakopee in support of improvements to the Scott County Highway 101 River Crossing.

As you are very aware, travelers and commuters in the Carver, Southwest Hennepin, and Scott County areas have long been inconvenienced by increasingly frequent closures, due to flooding of the Minnesota River. The Highway 101 Bridge is one of the first to be closed, and last to re-open due to high water.

The preliminary findings of the Minnesota River Flood Mitigation Study have indicated that an improved Highway 101 River Crossing makes the most sense in terms of cost/benefit, and will have a significant regional transportation benefit. The proposed reconstruction of this river crossing will provide a reliable high water crossing, serving the 20,400 vehicles per day which currently use it. Using Metropolitan Council's forecasts, the crossing could serve up to 24,700 ADT by the year 2030 - that assumes two lanes of traffic. We would greatly prefer the crossing to be four lanes, which would enhance that number.

The County of Scott and City of Shakopee are in the process of completing improvements to CR101/First Avenue to the east of the crossing. Those jurisdictions are planning similar improvements heading west on CR69 to its intersection with TH169 and also an interchange at CR69 and TH169. These enhanced approaches will allow improved traffic flow to Highway 101 River Crossing.

The recently completed renovation of the historic Holmes Street bridge in downtown Shakopee, could also be better utilized by having the 101 River Crossing include a pedestrian path. This would provide for a connection to the Southwest Regional Trail, Minnesota DNR Regional Trail and local trail systems on both sides of the river.

In summary, the TH41 River Crossing is decades away, and is estimated to cost in the hundreds of millions of dollars. Conversely, the Highway 101 River Crossing as studied could be constructed for a fraction of that cost, and in a much shorter time frame. It is critical for the movement of regional traffic to facilitate, as quickly as possible, the improvements to the Highway 101 River Bridge. It is a high priority for the City of Shakopee.

On behalf of the City of Shakopee and Shakopee City Council, I ask for your help on this, and appreciate your consideration of our request for this much needed improvement.

John J. Schmatt

Mayor, City of Shakopee