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South Diversion Master Transportation Plan

Final Report

KLJ

HMG
Houston-Moore Group

Flood Diversion Authority

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1 EXECUTIVE SUMMARY

Through various meetings with key transportation stakeholders directly affected by the proposed diversion channel and associated embankments, it was clear the diversion project offers several transportation obstacles corresponding to connectivity, accessibility and mobility. In response to these obstacles, the study team developed solutions to remedy or minimize project impacts. Not only are engineering solutions identified in this study, relationships and consensus was built with those directly affected. The relationships offer benefits throughout the entire FM Fargo-Moorhead diversion project from development into construction. ***FIGURE 1-1 – Proposed Improvement Plan*** on page 5 illustrates each study recommendation on one map.

1.1 CONNECTIVITY

In regards to this study, connectivity refers to the frequency of diversion crossings connecting the exterior and interior sides of the diversion channel or overflow and tieback embankments. Increased connectivity can help distribute traffic, reduce travel distances and times and improve routing options for roadway users. Based upon an assessment of existing roadway barriers, structural deficiencies and motorist convenience, the following locations are recommended for a diversion or embankment crossing:

- Cass County Road 10
- 38th Street West (North Dakota)
- Cass County Road 8
- Cass County Road 6
- Cass County Road 14
- Combined Cass County Road 16 and 17
- Cass County Road 81
- US Highway 75
- Clay County State Aid Highway 7
- Clay County Road 61
- 50th and 51th Street SE: these roads are currently at elevations that cross the overflow embankment so improvements are not necessary at these locations.

This diversion also disconnects Interstates 29 and 94 and multiple railway lines; however, analysis of the interstate and railway lines is planned to be completed as part of later independent studies and not included in this report.

To maintain regional connectivity and mobility as well as meet Minnesota Department of Transportation (MnDOT) recommended roadway access spacing standards, it is recommended US Highway 75 be raised throughout the storage area including grade raises for each intersecting roadway.

For the most part, crossings intersected the diversion or embankment perpendicularly, requiring no roadway alignment revisions. The crossings at 38th Street West, Cass CR 14 and Cass CR 16/17 do not intersect the diversion perpendicularly. Proposed roadway realignments balanced the safety implications of lower speeds at roadway curves, right-of-way impacts associated with large curves and costs required to build longer bridges that do not intersect the diversion alignment perpendicularly.

The proposed alignment of the combined crossing at Cass CR 16 and 17 required additional considerations due to the high volume of conflicting traffic forecasted at the intersection of these two high volume roadways. The proposed alignment (refer to ***FIGURE 1-1 – Proposed Improvement Plan*** on page 5) was developed based upon an evaluation of existing traffic volumes and forecasted traffic growth or depreciation. The proposed alignment

included a roundabout on the dry side of the diversion where the bridge will intersect Cass CR 16 and 17 in an attempt to distribute prioritization evenly between these two corridors and the diversion crossing and provide traffic control for this highly traveled future intersection

1.2 ACCESSABILITY

In regards to this study, accessability refers to the ability to access property from an adjacent roadway. According to the results of a cost comparison analysis, three parcels are severed from the existing roadway network that are large enough to warrant a roadway connection (refer to ***FIGURE 1-1 – Proposed Improvement Plan*** on page 5 for illustration of these improvements). According to the cost comparison analysis, it would be economically advantageous to purchase the remaining 10 properties that will be severed from the roadway network rather than develop roadway connections. Regardless of economic feasibility, access agreements between neighboring landowners should be discussed during the right-of-way acquistion process to prevent unnecessary right-of-way acquistion and roadway construction.

To maintain accessability to property abutting the diversion, it is recommended roadways terminate as dead-ends similar to how township roadways currently terminate at the interstate. The only exception is at 26th Street West between the diversion and 21st Avenue West. It is recommended this section of roadway be considered for removal as it does not provide accessabilitiy benefits and will provide maintenance complications.

1.3 MOBILITY

Mobility refers to the efficient movement of people and goods. Roadway discontinuities caused by the diversion channel and embankments may funnel vehicle trips onto roadways that are not designed for increased traffic loads, resulting in poor mobility. The following improvements are recommended to improve mobility by collecting traffic redistributed by roadway discontinuites caused by the diversion project (refer to ***FIGURE 1-1 – Proposed Improvement Plan*** on page 5 for illustration of these improvements).

- Improve the section of 38th Street West from Cass CR 8 to 43rd Street SE/64th Avenue South from an earth roadway to gravel.
- Improve the section of 38th Street West from Cass CR 14 to Cass CR 16 from an earth roadway to gravel.
- Develop a collector roadway between crossings at 38th Street SW and Cass CR 8 40th Avenue W/41st Street SE using existing infrasturue. The corridor would require the following improvements:
    - Improve 15th Street SW from Cass CR 8 (40th Avenue South/41st Street SE) to 21st Avenue West/39th Street SE including realigning the intersection of 15th Street SW with 21st Avenue W/39th Street SE.
    - Improving the curve that transitions 15th Street SW to 13th Avenue West to meet design standards for a 55 mph curve.

Due to the length of construction, temporary construction bypass routes are recommended to accommodate traffic. Construction traffic will be routed onto existing infrastructure, if available, within a reasonable distance. At multiple locations, roadway improvements are required (i.e. earth to gravel roadway improvements) to accommodate rerouted traffic. At Cass CR 10, Cass CR 14 and Cass CR 81, where existing infrastructure is not readily available, new temporary bypass routes directly adjacent to the existing roadways are recommended to maintain traffic during bridge construction.

Once all other mobility improvements are completed, construction access to the diversion can be provided every two miles with minimal improvements. During construction, it is critical the contractor, or contractors in combination, maintain all county and township roads at the same levels of service they currently operate at. The contractor is also responsible for returning all roadways to their original surfacing unless requested otherwise by the township, once construction is complete. For motorist convenience, it is recommended the contractor (or contractors in coordination) shall not be permitted to have consecutive county roads under construction at a single time. Finally, construction sequencing and timing should be properly communicated to stakeholders.

1.4 DISCARDED ALTERNATIVES, AREAS OF FURTHER DISCUSSION AND FUTURE STUDIES

During development of this report, multiple alternatives were developed and discussed with stakeholders that were inevitably not recommended in this report. The items were characterized into one of the following categories:

Discarded Improvement Alternatives: This category included any improvement alternative requested by a stakeholder group that was either discarded in favor of an alternate improvement or discarded because technical analysis revealed the improvement was not triggered solely by construction of the diversion. The following requested improvement alternatives were discarded during the study's development:

- New bridges on 26th Street NW over both the Maple River and Drain 14 – discarded during technical analysis
- Roadway surface improvements on 26th Street SW/168th Avenue SE from 76th Avenue South/44th Street SE and 100th Avenue South/46th Street SE – discarded in favor of complimentary alternative
- Roadway grade raised over the tieback embankment at Clay CR 59 – discarded during technical analysis
- Diversion crossing at Cass CR 21 – discarded during technical analysis

Area of Further Discussion: This category included items discussed with a stakeholder group that would require a change in current standards or diversion alignment. This category also included potential improvement alternatives that would be an acceptable substitute for the proposed improvement plan but offered fewer benefits. This included the following discussion items:

- Bridge Width: the majority of local farmers indicated that bridge widths in excess of 40 feet are preferred to transport large farm equipment.
- Tieback Embankment Location: the majority of Clay County stakeholders indicated that tieback embankment created inconvenient transportation routes for abutting landowners because it was not located on the section or half-section line.
- Bridge Crossing Locations: there was discussion regarding whether diversion crossings should be located at 32nd Avenue South/40th Street SE and 52nd Avenue South/42nd Street SE rather than Cass CR 8 (40th Avenue South/41st Street SE) to align with existing I-29 interchanges. Based upon discussions with stakeholders, CR 8 (40th Avenue South/41st Street SE) was the most desirable crossing location of the three due to current travel patterns. Additionally, future traffic demand is not anticipated to warrant an additional crossing within the bridge's lifecycle.

Future Studies: This category includes items discussed with stakeholders that were transportation-related but beyond the scope of this report. The following issues, along with potential solutions, are documented in the body of the report to assist in development of future transportation studies.

- Railway Through Comstock: a study is recommended to evaluate the improvement plan for the railroad line through Comstock. The study should incorporate meetings with both Burlington North Santa Fe

(BNSF) representatives and the citizens of Comstock. If the railway line is raised through Comstock, adjacent buildings (including the Comstock elevators) will be impacted. Maintaining current elevation of the line will result in railway closures during flood events.

- Red River Valley & Western Short-Line Spur Needs Assessment: Multiple stakeholder groups indicated removal of the spur through Horace has been discussed multiple times in the past 10 years. Meetings should be held with railroad officials and the citizens of Horace to determine whether maintenance of the line is warranted.
- Low-Flow Crossings in Staging Area: Increased flows in the storage area may result in low-flow crossing wash-outs and corresponding transportation deficiencies. A study should be conducted to determine benefits and costs of replacing the existing low-flow crossings located in the storage area with more protected crossings.

Key	Cost	Total
A	Cass County Road 10 Diversion Crossing	$6,378,400
B	38th Street West Diversion Crossing	$7,621,400
C	Cass County Road 8 Diversion Crossing	$5,840,800
D	Cass County Road 6 Diversion Crossing	$5,805,000
E	Cass County Road 14 Diversion Crossing	$7,944,200
F	Combined Cass County Road 16/17 Diversion Crossing[1]	$10,739,700
G	Cass County Road 81 Diversion Crossing	$3,504,400
H	US Highway 75 Grade Raise[2]	$36,176,500
I	Clay County State Aid Highway 7 Grade-Raise	$212,800
J	Clay County Highway 61 Grade-Raise	$58,000
K, L, M	Accessability Improvements[3]	$710,500
N, O, P, Q	Mobility Improvements	$2,610,100
	Total	$87,601,800

Note 1: Cost Includes 25% Contingency and 20% Engineering Fee.
Note 2: Bridge Cost Estimates Include Necessary Grade Raises Leading Up to the Bridge.
[1]Sub-total includes the cost of the proposed roundabout (≈$195,000 without engineering and contingencies).
[2]Maintenance of traffic plan contingent upon project phasing. Not Included in Cost Estimate.
[3]Only accounts for roadway connections betweeen roadway system and inaccessable parcels.

STUDIED IN NORTH DIVERSION MASTER TRANSPORTATION PLAN

Optional: Improve Roadway Surface From Earth to Gravel If Used As A Construction Route

Reconstruct Horizontal Alignment to Meet Design Standards

Optional: Remove Roadway Section Upon Completion of the Diversion

Realign South Approach of Intersection

Improve From Earth Roadway to Gravel Roadway

Improve From Earth Roadway to Gravel Roadway

Bypass Required: Final Alignment of Bypass Contingent Upon Whether Railroad Spur is Maintained

Improve From Earth Roadway to Gravel Roadway

Raise US Highway 75 Throughout Storage Area

Figure 1-1
Proposed Improvement Plan

Legend

- Tributaries/Other Rivers
- Major Rivers
- Drains
- Railroad
- Proposed Diversion Footprint
- Tieback Embankment
- Overflow Embankment
- Roadway Connection to Parcel Not Warranted
- Roadway Connection to Parcel Warranted
- Roadway Connection to Severed Parcel
- Diversion Crossing
- Embankment Crossing
- Mobility Improvements
- 67 Clay County Road
- Construction Detours
- Construct Bypass
- Use Existing Roadway - Upgrade to Gravel
- Use Existing Roadway (Currently Gravel)
- 36 Cass County Road/ Clay County State Aid Highway

South Red River Diversion Master Transportation Plan

2 INTRODUCTION

To reduce flood risk and flood damages in the Fargo-Moorhead metropolitan area, a feasibility study was completed by the US Army Corps of Engineers (USACE) in 2011 to identify flood risk management measures that could be implemented and developed into a federal project. The feasibility study results identified a 36-mile diversion alignment that would start approximately four miles south of the confluence of the Red and Wild Rice Rivers, extend west and north around the cities of Horace, Fargo, West Fargo and Harwood and ultimately re-enter the Red River north of the confluence of the Red River and Sheyenne Rivers near the City of Georgetown, MN.

During the feasibility study, the depth of the proposed diversion channel would range from 15 to 30 feet. The channel bottom generally being 250 feet wide. The total footprint of the diversion channel was estimated to have a maximum width of 2,200 feet including areas for soil disposal piles, leaving an affected acreage of 11,302 acres.

Although the diversion channel alignment has been refined since the USACE study, the overall impact to the existing transportation network has remained constant. The diversion channel cuts through the existing grid of township, county and state roads resulting in gaps in connectivity to roadways aligned both north and south and east and west.

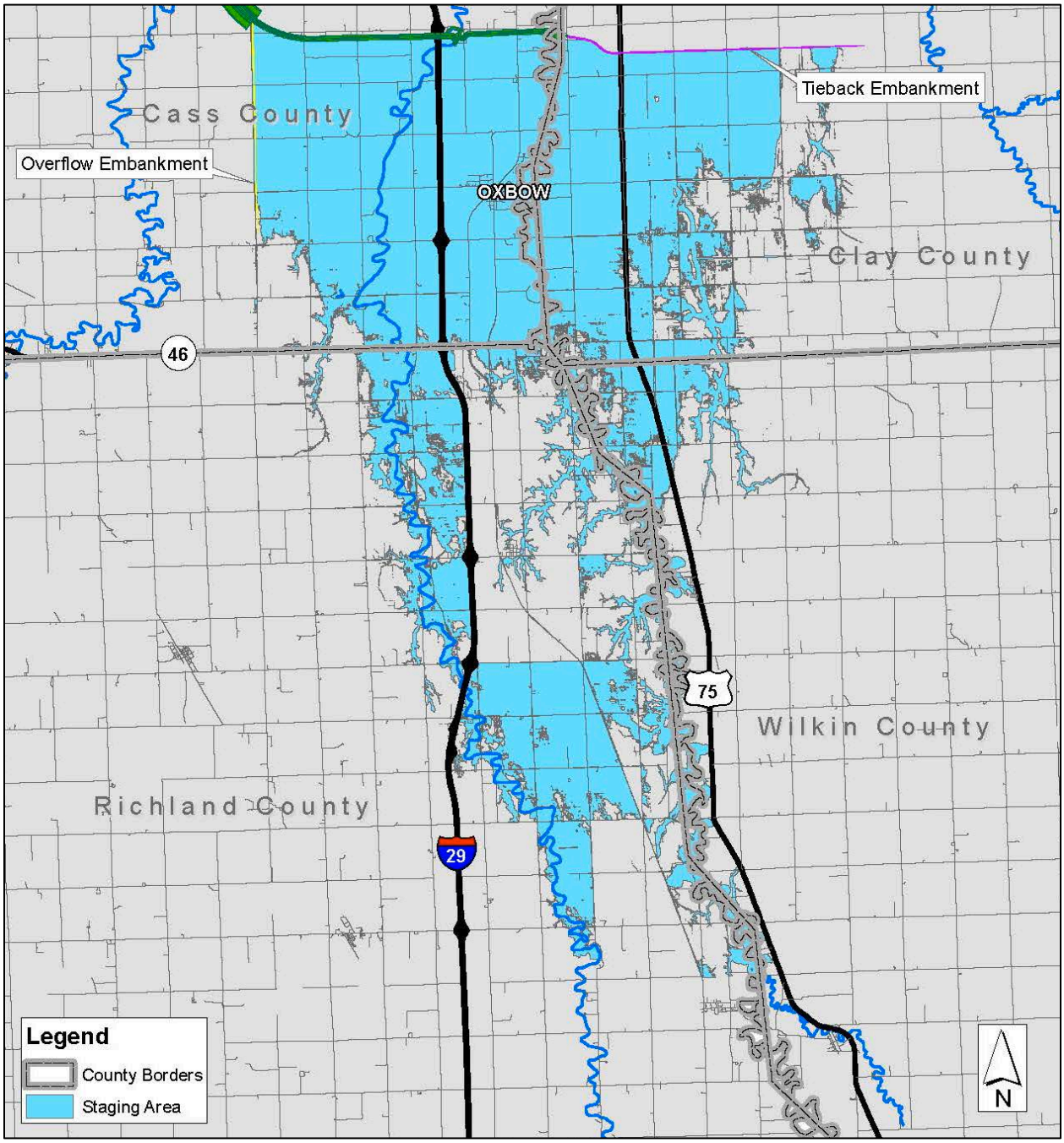
To offset downstream project impacts, a staging area is planned south of the diversion channel where water is stored during flooding events (refer to ***FIGURE 2-1 – Staging Area***). To mitigate the extent of the staging area, the following embankments are proposed as part of the diversion project. The embankments act as a transportation barrier similar to the diversion channel.

- Approximately 4-mile north-south overflow embankment south of the diversion channel just east of County Road 17
- Nearly 6-mile east-west tieback embankment east of the diversion channel in Minnesota between Clay County Roads 4 and 60

This study's purpose is to analyze disruptions to roadway system connectivity, accessibility and mobility for the diversion channel and associated embankments, to analyze resulting impacts these disruptions have on roadway users and formulate recommendations intended to mitigate the impacts. Definitions of connectivity, accessibility and mobility in terms of how they related to this study are as follows:

- Connectivity: connectivity refers to the frequency of diversion crossings connecting the wet and dry sides of the diversion channel or associated embankments. Increased connectivity can help distribute traffic, reduce travel distances and times and improve routing options for roadway users.
- Accessability: accessability refers to the ability to access property from an adjacent roadway. The diversion channel and embankments sever several roadway ties to properties that would normally be accessable.
- Mobility: mobility refers to the efficient movement of people and goods. Roadway discontinuities caused by the diversion channel and embankments may funnel vehicle trips onto roadways not designed for increased traffic loads.

FIGURE 2-1 – Staging Area



Source: US Army Corps of Engineers

The limits of this study include all roadways within four miles of the proposed diversion channel alignment and embankments between the diversion origin south of the FM metro area north to the Maple River (refer to ***FIGURE 2-2 – Study Area***). A similar transportation study was completed for the section of diversion channel from the Maple River north to the outlet back into the Red River in early 2012.

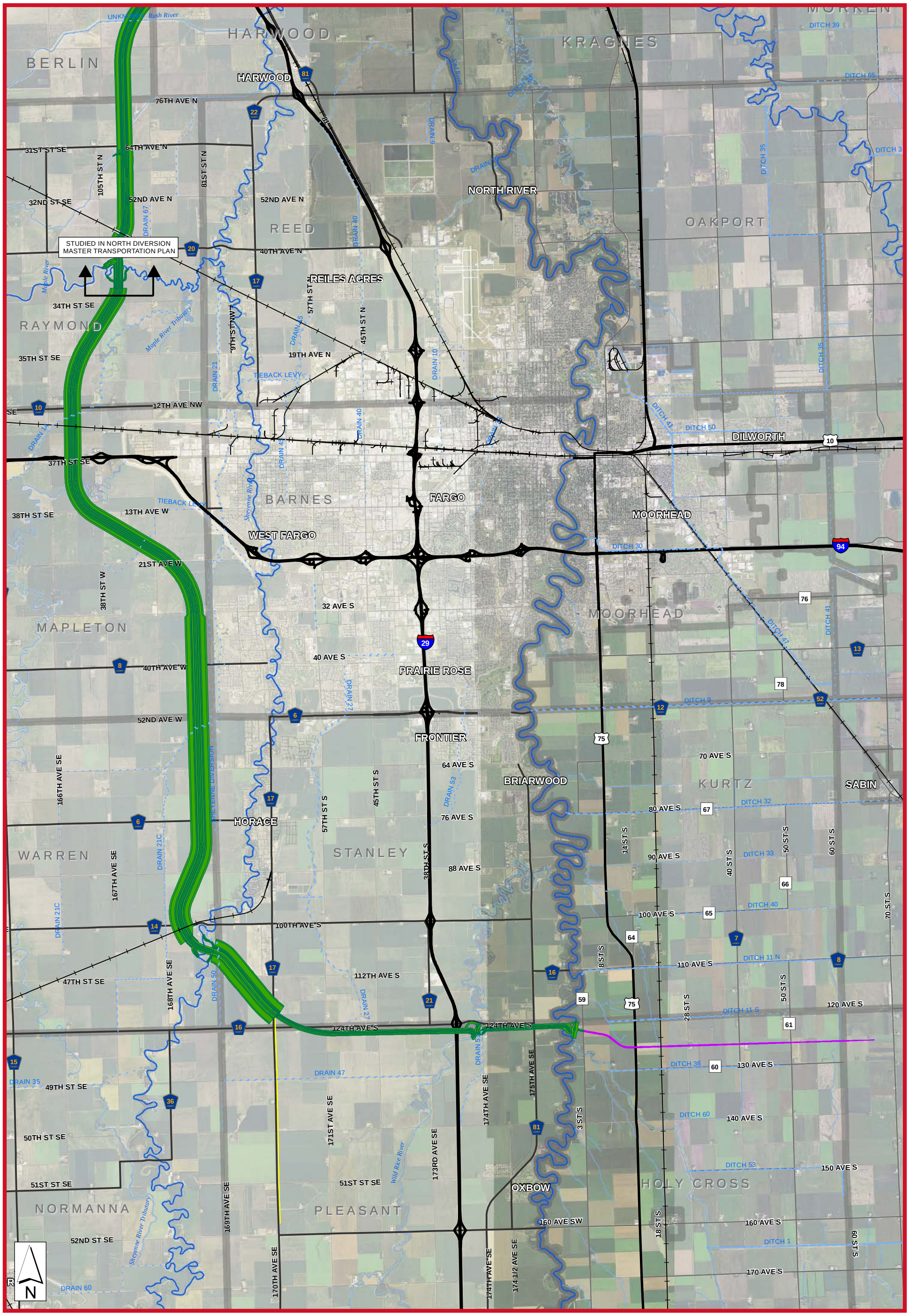


Figure 2-2
Study Area

Legend

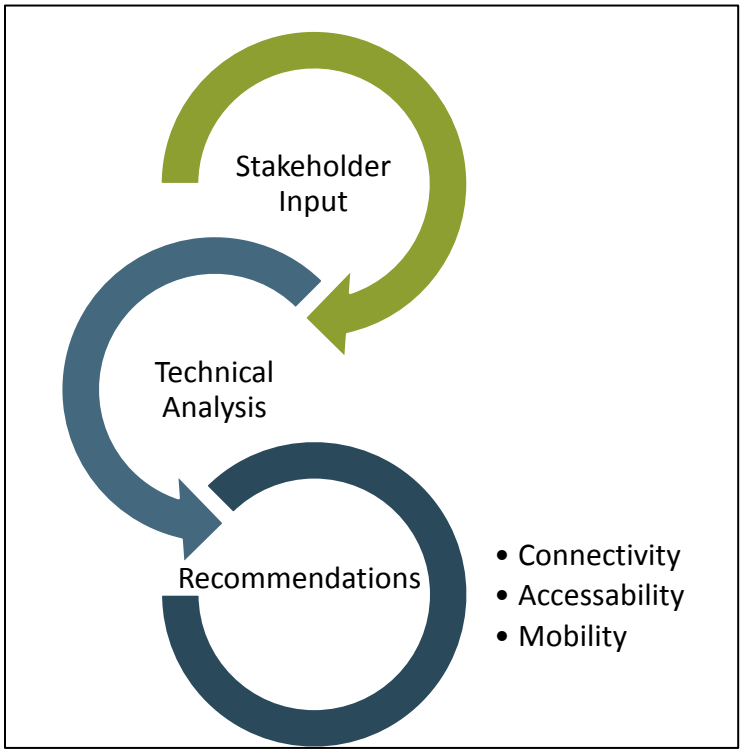
- Tributaries/Other Rivers
- Major Rivers
- Drains
- Railroad
- Proposed Diversion Footprint
- Tieback Embankment
- Overflow Embankment
- Cass County Road/Clay County State Aid Highway
- Clay County Road

South Red River Diversion Master Transportation Plan

3 PLANNING PROCESS

Roadway networks can be highly complex and serve a variety of user groups, trip purposes and levels of facilities. This study looks at the network as the sum of its parts to understand the relationship between those parts and the capabilities, impacts and effectiveness of the system as a whole. To study this collaboration of parts, a three-phase planning approach was employed. The process included the following steps: stakeholder input, technical analysis and recommendation formulation. The primary outlet for reliable data was from the people who lived and worked in the communities closest to the proposed diversion alignment. As a result, stakeholder involvement guided the technical analysis of the project which in turn led to project goals, deliverables and recommendations (refer to ***FIGURE 3-1 – Planning Process***).

FIGURE 3-1 – Planning Process



Objectives of the project's stakeholder input phase were as follows:

- Establish desired plan deliverables and outcomes
- Work with roadway users directly affected by the diversion project to identify critical transportation-specific deficiencies directly caused by the diversion project
- Work in collaboration with stakeholders to develop solutions to anticipated deficiencies

This consensus-building stakeholder input approach was developed to minimize potential controversy and negative public opinion of the project. The approach also aimed to develop relationships that will offer benefits throughout the entire FM diversion project from planning to construction.

The following key transportation stakeholders were solicited for input. The stakeholders were met individually or invited to one of the four public input meetings held specifically for the project. It is important to note that several of the groups solicited for input chose not to attend any of the meetings.

- Engineering and Public Works Staff
  - Cass County Highway Department
  - Clay County Highway Department
  - West Fargo Engineering
  - West Fargo Public Works
- Cass County Property Owner Representatives
  - Barnes Township Board
  - Mapleton Township Board
  - Normanna Township Board
  - Pleasant Township Board
  - Raymond Township Board
  - Reed Township Board
  - Stanley Township Board
  - Warren Township Board
  - Wiser Township Board
- Clay County Property Owner Representatives
  - Alliance Township
  - Elmwood Township

    - Holy Cross Township Board
    - Kurtz Township
- School District Transportation Representatives
    - Central Cass
    - Fargo
    - Fargo Catholic Schools
    - Fargo Lutheran Schools
    - Kindred
    - Mapleton
    - Moorhead School District
    - Northern Cass
    - West Fargo
- Post Offices
    - Casselton
    - Comstock
    - Davenport
    - Fargo
    - Harwood
    - Horace
    - Kindred
    - Mapleton
    - Moorhead
    - Sabin
    - West Fargo
- Emergency Responders
    - Cass County Sheriff's Department
    - Clay County Sheriff's Department
    - Horace Fire Department
    - Kindred Ambulance service
    - Mapleton Fire Department
    - Red River Dispatch Center
    - Sabin Fire Department
    - West Fargo Dispatch
    - West Fargo Fire Department
    - West Fargo Police Department

The meetings not only helped to identify network deficiencies and improvement opportunities, but also led to insight regarding the community values in the study area. This insight allowed the study team to develop goals and objectives that met the functional transportation needs of the area without significantly disrupting the existing culture. The community-centric process resulted in recommendations that are formulated based upon the needs of the community as identified by the community.

4 CONNECTIVITY

The study area consists of the approximately 23-mile section of diversion channel, 4-mile overflow embankment and 6-mile tieback embankment stretching from the upstream diversion origin at the Red River to the Maple River. This section of diversion channel and embankments effectively disconnects 17 east-west and 15 north-south county and township roadways. This section of the diversion also disconnects Interstates 29 and 94 and two railway lines; however, analysis of the interstate and railway lines is planned to be completed as part of later independent studies and not included in this report.

Bridge and grade raises are required at specific locations across the diversion channel and embankments to maintain an acceptable level of connectivity between the two sides. Financial constraints require that crossing locations be judiciously selected. To identify specific crossing sites, regional travel demand was evaluated on a macroscopic level. The macroscopic analysis evaluated the following factors:

- Current and future roadway utilization
    - Continuity of existing roadway infrastructure
    - Structural capacity of existing roadway infrastructure
- Motorist convenience
    - Crossing redundancy
    - Connectivity gaps

4.1 CURRENT AND FUTURE ROADWAY UTILIZATION

Due to the lack of recent daily traffic volume data along county and township roads throughout the study area, current and future roadway utilization was estimated using the following roadway characteristics:

Continuity of Existing Roadway Infrastructure: Limitations of existing infrastructure were analyzed through an inventory of existing barriers on the county and township roadway network that restricted regional traffic flow. Intuitively, roadways that serve the needs of the region carry more vehicles per day as they are not restricted by existing barriers. Existing barriers within the study limits included rivers, drains and the interstate. Roadways with barriers that restricted regional traffic flow were eliminated from bridge crossing consideration. A buffer zone of three miles was used to evaluate whether each roadway provided adequate continuity within the vicinity of the diversion channel or embankments. Refer to ***FIGURE 4-1 – Existing Roadway Conditions*** for barrier locations.

Structural Capacity of Existing Roadway Infrastructure: Bridges will be located intermittently throughout the diversion channel. As a result, ancillary roadways will be funneled onto the bridged roadways to cross the diversion, causing increased traffic volumes on these bridged roadways. The roadways in the study area are predominantly gravel or minimum maintenance earth roads with occasional sections of paved roadway at higher volume locations. Many of the roadways are not designed to carry high traffic loadings. As a result, capacity of the existing roadway infrastructure was analyzed through an inventory of existing roadway surfaces. Earth roadways are incapable of efficiently carrying high traffic loadings and as a result were eliminated from diversion or embankment crossing consideration. A buffer zone of three miles was used to evaluate whether each roadway provided adequate structural capacity within the vicinity of the diversion channel or embankments. Refer to ***FIGURE 4-1 – Existing Roadway Conditions*** for an illustration of the existing roadway surface conditions.

Based upon the assessment of roadway continuity and structural capacity within a 3-mile buffer of the diversion channel and associated embankments, the following roadways would justify a crossing:

- Cass County Road 10
- 40th Street SE/32nd Avenue West
- Cass County Road 8
- Cass County Road 6
- Cass County Road 14
- Cass County Road 16
- Cass County Road 17
- Cass County Road 21
- US Highway 81
- US Highway 75
- Clay County State Aid Highway 7

It is important to note that although none of the roadways that intersect the overflow embankment meet either roadway utilization criterion, the current elevations of 50th and 51st Street SE are greater than the embankment elevation. This results in only one roadway severed by the overflow embankment (49th Street SE). This crossing arrangement will provide adequate connectivity between the wet and dry side of the overflow embankment.

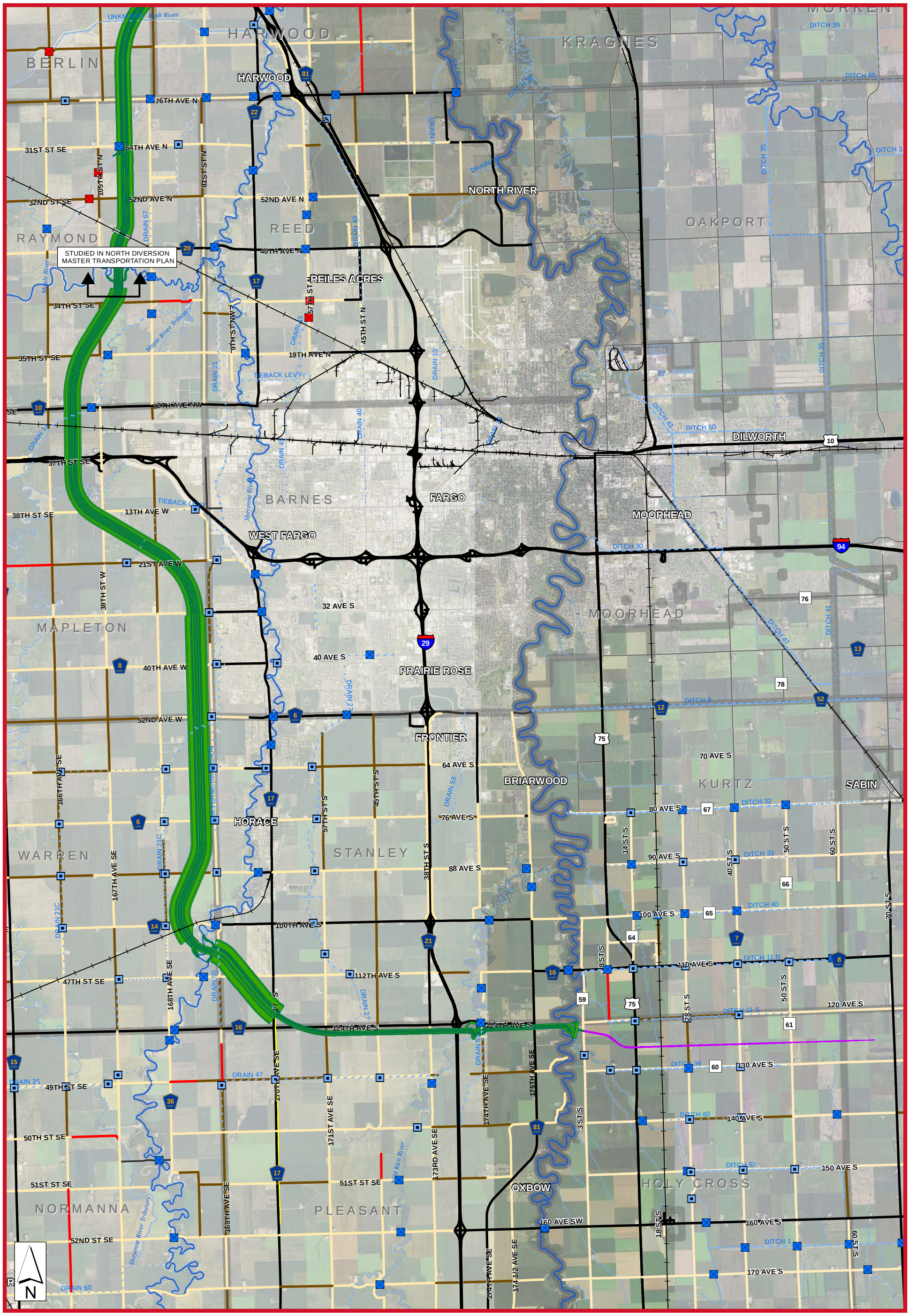


Figure 4-1
Existing Roadway Conditions

Legend

- Tributaries/Other Rivers
- Major Rivers
- Drains
- Railroad
- Cass County Road/ Clay County State Aid Highway
- Clay County Road
- Proposed Diversion Footprint
- Tieback Embankment
- Overflow Embankment
- Bridge
- Culvert
- Low Flow Crossings

Roadway Surfaces

- Unimproved
- Earth
- Gravel
- Paved

South Red River Diversion Master Transportation Plan

4.2 MOTORIST CONVENIENCE

Motorist convenience is a major consideration when selecting crossing locations. If crossings are not conveniently located, motorists can waste time commuting to the closest crossing and money spent on fuel and vehicle depreciation over time. Conversely, an excess of crossings provide minimal benefits and waste valuable resources.

4.2.1 32ND AVENUE WEST, CASS COUNTY ROADS 16 AND CASS COUNTY ROAD 17

First, redundant crossing points were identified to be removed. Redundant crossings are classified as crossings with an adjacent crossing one mile away that serves similar vehicular movements. Crossings serving diverse vehicular movements were not considered redundant. For example, Cass County Road (CR) 10 and Interstate 94 serve substantially different purposes and such were not considered redundant.

For financial purposes, the roadway maintained and operated by the smaller agency was recommended for removal. For example, if a township and county roadway were classified as redundant, the township road was recommended for removal because the County has greater funding resources to maintain the bridge and connecting roadway.

Based upon the logic of redundancy, the crossing at 32nd Avenue West /40th Street SE was classified as redundant and removed from further crossing consideration. Additionally, it is recommended Cass CR 16 and 17 be combined due to their proximity.

4.2.2 38TH STREET SW

With the 32nd Avenue W /40th Street SE crossing removed for redundancy purposes, a 5-mile gap in connectivity develops between I-94 and Cass CR 6. This gap increases to 6 miles for farm equipment that are restricted from driving on the interstate. Including the 40th Street SE/32nd Avenue West crossing does little in terms of shortening the gap as this roadway is only one mile north of Cass CR 8.

To eliminate this major gap in connectivity, a crossing at 38th Street SW is recommended. A crossing at this location also improves traffic circulation south of I-94, and maintains the functionality of the Raymond interchange. This interchange without any connectivity improvements will serve a very limited number of properties resulting in motorists who have historically used the interchange to reroute to adjacent interchanges and take circuitous routes to arrive at their destination.

4.2.3 CASS COUNTY ROAD 21

The Cass CR 21 crossing would provide connectivity to the diversion upstream staging area to the west of I-29. Due to increased frequency of flooding in the staging area, all structures are to be removed from the staging area with the exception of a ring dike around the city of Oxbow and rural developments of Hickson, and Bakke in North Dakota and a ring dike around the city of Comstock, Minnesota. Oxbow, Hickson, Bakke and Comstock are all east of I-29 and would not benefit from a Cass CR 21 crossing. In summary, the Cass CR 21 crossing would only carry agriculture traffic to the sections of land that are closer to Cass CR 21 than to Cass CR 17. Motorists also have the opportunity to access this land from the south from Cass CR 18 which has direct access to I-29 and US Highway 81.

To evaluate whether a crossing at this location is warranted, a cost comparison analysis was conducted using the following parameters:

- The no-build alternative increased the total distance traveled for each diverted trip by 2 to 6 miles. An even distribution between each section of land was assumed.
- Planning level cost estimate for the bridge alternative is approximately $2.7 million with 20% engineering and 25% contingencies factored in.
- Based upon median perceived vehicle type distribution, corresponding mean miles per gallon from the US Department of Energy's publication Fuel Economy Guide 2012 and a $3.50 per gallon price of fuel, the average price of fuel for every mile a vehicle is detoured equates to approximately $0.21 per mile per vehicle.
- Based upon the median income for Cass County residents and the time required to drive one mile at 55 mph, the equivalent cost of loss productivity for every mile a vehicle is detoured equates to approximately $0.24 per mile per vehicle.
- A study horizon of 50 years was selected to correlate with a typical concrete bridge service life (maintenance requirements not considered).
- A 1.4% inflation rate was applied to each applicable cost value through the study horizon.
- 0% traffic growth was assumed due to the agriculture only restriction in the area.

Based upon the cost comparison analysis, more than 20,000 vehicles per year would be required for the next 50 years to justify a crossing at this location. Assuming a typical agricultural season of 3 to 5 months where traffic may be expected, between 17 to 28 trips per day to each 1-mile section of land benefitted by this crossing would be needed for the benefits to outweigh the costs. For a 1-mile section of agriculture land, 17-28 trips per day would far exceed anticipated trip generation rates. As such, it is recommended the Cass CR 21 crossing be discarded.

4.2.4 CLAY COUNTY ROAD 61

Clay CR 61 has limited connectivity as it terminates slightly more than 1.5 miles north of the tieback levee. However, the corridor is a well-maintained gravel roadway that only needs to be raised 5 feet to cross the tieback levee. The cost to raise this road is nearly 100 times less expensive than the cost of a diversion crossing. Using the same cost comparison analysis approach used for Cass CR 21, a very minimal number of daily vehicles would need to use the crossing to justify the grade raise. As such, it is recommended this roadway be raised across the tieback levee.

4.2.5 US HIGHWAY 75

According to the Environmental Impact Statement produced by the USACE and all ensuing documents, US Highway 75, the BNSF railway and Interstate 29 will be raised throughout the staging area to maintain transportation during flood events. All other roadways within the staging area would be allowed to flood when project operations require staging of flood water.

US Highway 75 is a major corridor carrying regional travel between the FM metropolitan area and surrounding areas. Once US Highway 75 is raised, this corridor will act as a barrier for east-west connectivity unless intersecting roadways are raised to cross US Highway 75. In contrast to diversion and embankment alignments that disconnect township roads that only provide local traffic, disconnecting access onto US Highway 75 is not only an issue for connectivity but is also a major hindrance to regional mobility. Specifically, US Highway 75 carries twice as many vehicles as any north-south Minnesota corridor that is south of Moorhead and west of I-94. According to MnDOT

guidance, rural principal arterials are recommended to have access every 1 mile. Thus, it is recommended every section line have access to and across US Highway 75.

Although traffic volumes on these intersecting roadways range from 10 to 45 vehicles per day for all roadways except Clay County State Aid Highway (CSAH) 2, which carriers nearly 900 vehicles per day, 7 of the 10 intersecting roadways only need to be raised 5 feet or less. In other words, although overall traffic is minimal, the investment required to raise the grades of these intersecting roadways is far less than the cost required to construct a diversion crossing. All intersecting roadways should consist of the same surface material of the original road to alleviate potential for additional maintenance requirements.

4.3 CROSSING ALIGNMENTS

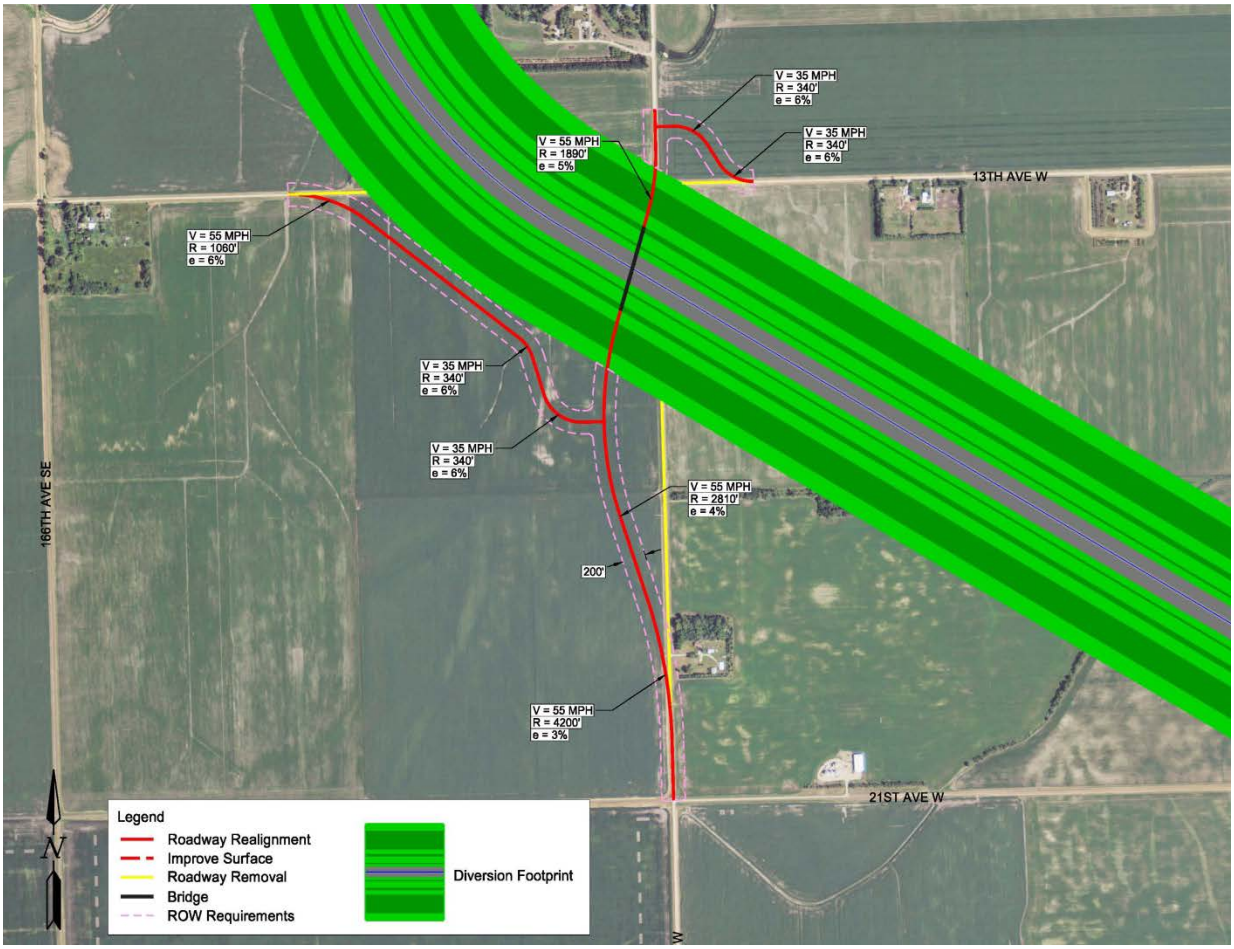
Due to the proposed diversion channel alignment, many of the proposed bridge crossings would not intersect the channel perpendicularly. Each degree of skew at the bridge location requires additional bridge deck to compensate for the longer crossing. For example, a bridge crossing location that would be 600 feet if perpendicular to the diversion channel would be extended by nearly 250 feet if the bridge was skewed by 45 degrees. It is important to note that this is not a constant rate. For example, a 10 degree skew requires 10 feet of additional bridge length.

Using cost estimates derived from Cass County standards, nearly 100 feet of gravel roadway can be built for every foot of bridge deck. As such, bridge skews were minimized as much as possible. However, to intersect the diversion perpendicularly requires either large right-of-way (ROW) commitments to realign the roadway or the roadway speeds to be reduced on horizontal curves.

A similar scenario was experienced when planning for the CR 32 diversion crossing as part of the *North Diversion Master Transportation Plan*. Due to the skewed crossing angle at CR 32, five crossing alternatives were developed for stakeholder review. The options ranged from 55 mph design speed alignment with significant ROW requirements to a 40 mph design speed alignment with minimal ROW requirements. The input received was varied. The majority of the general public preferred the option with the smallest ROW impacts whereas the Emergency Responders and Sherriff's Office representatives preferred the 55 mph design speed configuration for run off the road type crash considerations. In order to provide an increased degree of safety without requiring substantial ROW acquisition, a bridge alternative with a minor skew of 15 degrees was developed that utilized the higher design speed but limited ROW impacts.

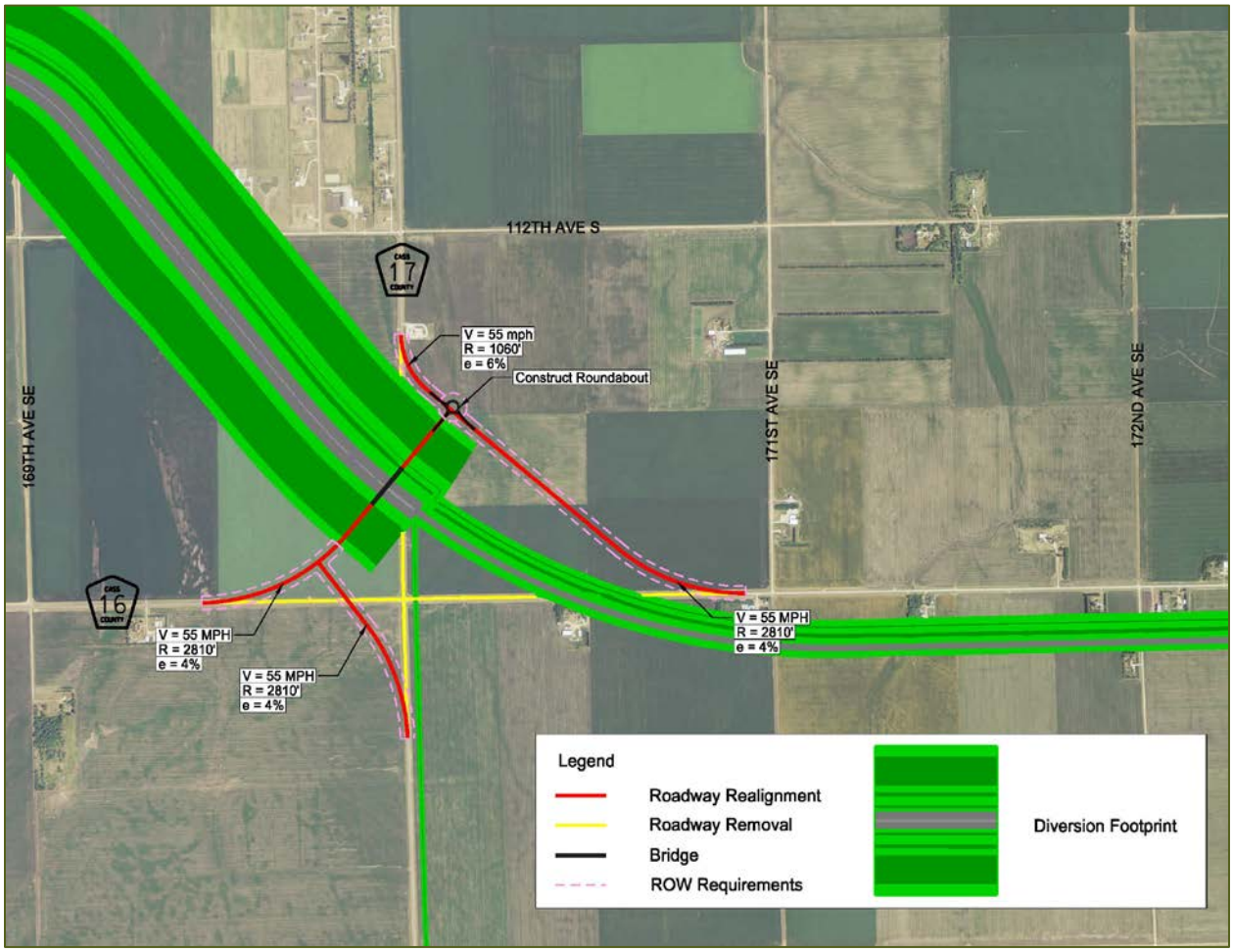
To once again balance safety and ROW impacts, bridge alignments of up to 15 degrees were studied where crossings did not cross perpendicularly with the diversion channel. Fifteen degree skews were used at the 38th Street West, Cass CR 14 and Cass CR 16/17 combination crossings. Refer to ***FIGURE 4-2 – 38th Street West Bridge Crossing*** for an illustration of the recommended 38th Street West alignment.

FIGURE 4-2 – 38th Street West Bridge Crossing



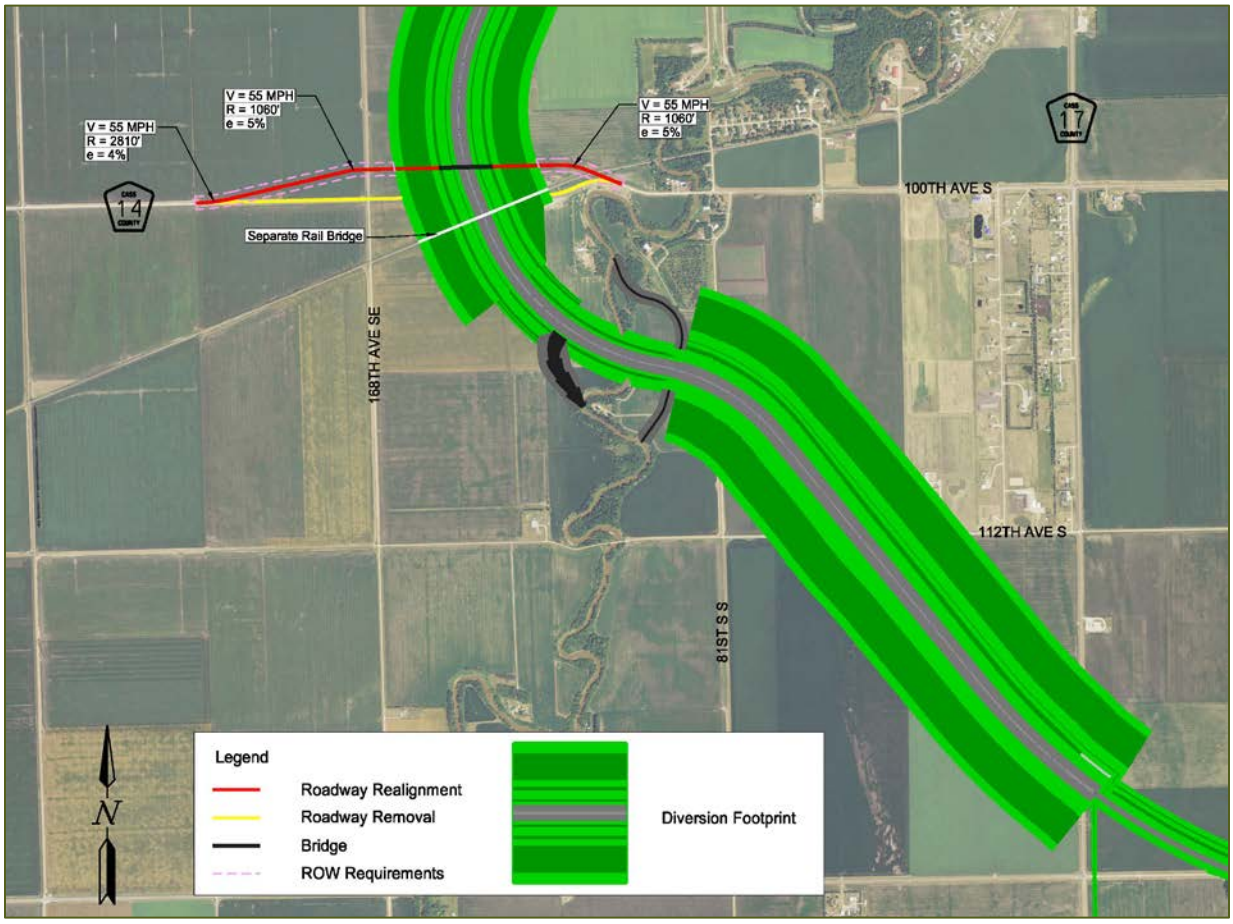
Cass CR 16 and 17 are both major routes in the study area. The recommended alignment for this crossing (refer to ***FIGURE 4-3 – Cass County Road 16/17 Crossing***) was developed based upon an evaluation of existing traffic volumes and forecasted traffic growth or reduction. Using this approach, the west approach of CR 16 should be prioritized over the south approach of CR 17 due to current traffic volumes from the North Dakota Department of Transportation (NDDOT) and the fact that traffic volumes will decrease on the south approach as structures are removed from the staging area. Based upon current traffic patterns from NDDOT, future potential growth areas and overall connectivity, the priority between the north approach of CR 17 and the east approach of CR 17 are approximately equal. To control traffic and distribute the volumes as evenly as possible, a T-intersection with a roundabout is recommended.

FIGURE 4-3 – Cass County Road 16/17 Crossing



A railroad spur intersects Cass CR 14 within the diversion footprint; this spur is the Red River Valley & Western Short Line. The line serves the grain elevator in Horace with approximately one train every two weeks. Further discussion regarding future prospects of the railroad track are discussed in the section titled ***Red River Valley & Western Short-Line Spur Needs Assessment*** on page 35. At the time this report was developed there had not been any discussions with BNSF or the Horace elevator regarding removal of the railroad spur. As a result, it was assumed the line would be maintained. ***FIGURE 4-4 – Cass County Road 14 Crossing*** illustrates the proposed alignment.

FIGURE 4-4 – Cass County Road 14 Crossing



During stakeholder interviews, an alternative combining these two bridges was discussed. However, this alternative was ultimately discarded as it provided minimal cost savings and required the roadway to cross the railroad tracks at an angle, creating potential visibility and subsequent safety concerns.

4.4 SUMMARY

In regards to this study, connectivity refers to the frequency of diversion crossings connecting the wet and dry sides of the diversion channel or overflow and tieback embankments. Increased connectivity can help distribute traffic, reduce travel distances and at times improve routing options for roadway users. Based upon an assessment of existing roadway barriers, structural deficiencies and motorist convenience, the following locations are recommended for a diversion or embankment crossing:

- Cass County Road 10
- 38th Street West (North Dakota)
- Cass County Road 8
- Cass County Road 6
- Cass County Road 14
- Combined Cass County Road 16 and 17
- Cass County Road 81

- US Highway 75
- Clay County State Aid Highway 7
- Clay County Road 61
- 50th and 51th Street SE: these roads are currently at elevations that cross the overflow embankment so improvements are not necessary.

It is important to note that to maintain regional connectivity and mobility and meet MnDOT recommended roadway access spacing standards, it is recommended US Highway 75 be raised throughout the storage area including grade raises for each intersecting roadway.

For the most part, crossings intersected the diversion or embankment perpendicularly, requiring no roadway alignment revisions. The crossings at 38th Street West, Cass CR 14 and Cass CR 16/17 do not intersect the diversion perpendicularly. Proposed roadway realignments balanced the safety implications of lower speeds at roadway curves, right-of-way impacts associated with large curves and costs required to build longer bridges that do not intersect the diversion alignment perpendicularly.

The alignment of the combined crossing at Cass CR 16 and 17 required additional considerations due to the high volume of conflicting traffic forecasted at the intersection of these two high volume roadways. The proposed alignment was developed based upon an evaluation of existing traffic volumes and forecasted traffic growth or reduction. The alignment included a roundabout on the dry side of the diversion where the bridge will intersect Cass CR 16 and 17 in an attempt to distribute prioritization to the three approaches and provide traffic control for the highly traveled corridors.

Refer to ***FIGURE 4-5 – Connectivity Improvement Plan*** for an illustration of each proposed diversion and embankment crossings along with the proposed alignments.

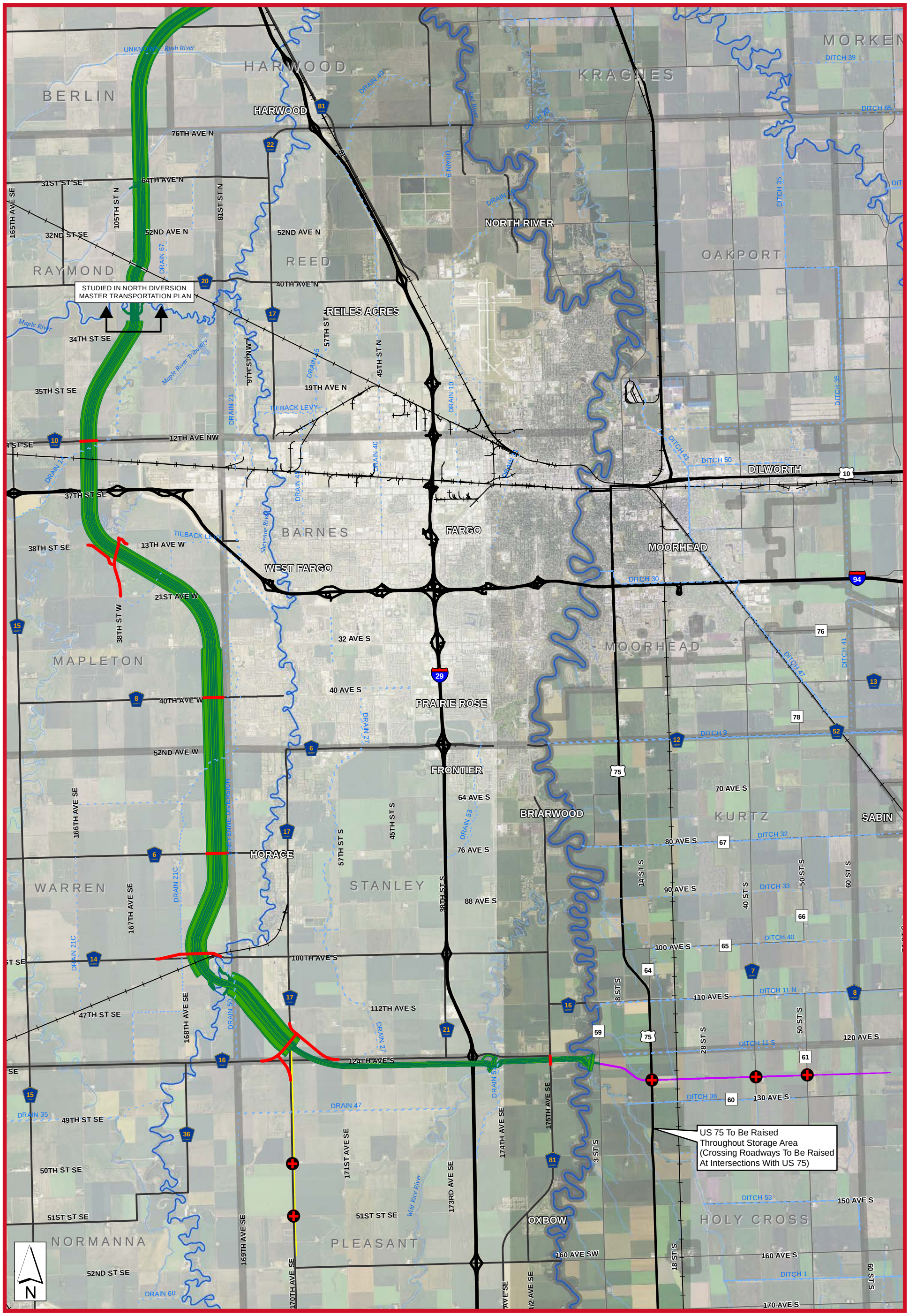


Figure 4-5
Connectivity Improvement Plan

South Red River Diversion Master Transportation Plan

5 ACCESSIBILITY

5.1 SEVERED PROPERTIES

Where access is already limited, the diversion channel may completely restrict access to a particular section of land. Specifically, 14 parcels of land remain inaccessible once the diversion project is completed. All other parcels of land are either directly accessible from existing roadways or from adjoining property maintained by the same property owner.

A cost comparison analysis was conducted to evaluate whether it is more cost effective to develop a new gravel roadway connection between the existing roadway network and the severed parcel of land or if the entire parcel should be acquired during the diversion ROW acquisition process. It is important to note that leasing and access agreements were not studied as part of this study. Leasing agreements offer the potential for one party to maintain adjoining parcels of land eliminating accessibility restrictions. Access agreements consist of agreements between adjacent property owners to allow cross access between properties. If it is determined an existing leasing or access agreement is in place or can be developed or a land exchange can be completed, the cost benefit recommendations can be discarded.

Below is a summary of the property accessibility cost comparison analysis process:

- ***Cost of New Roadway Connection > Cost of Severed Parcel of Land:*** landowner is allowed to either have their land acquired or allowed to independently pursue an access agreement or sell their land to an adjacent landowner.
- ***Cost of New Roadway Connection ≤ Cost of Severed Parcel of Land:*** landowner is allowed to either have a gravel roadway built directly to their property or independently pursue an access agreement or sell their land to an adjacent landowner.

Of the 13 parcels severed by the diversion, 3 parcels warrant transportation amenities according to the cost comparison analysis. ***FIGURE 5-1 – Accessibility Improvement Plan*** illustrates the results of the accessibility cost comparison analysis and also illustrates potential roadway connections where warranted. It is important to note that the owner of one of the severed parcels that warranted transportation amenities is neighbored by owners with the same last name. If related, this may increase the potential for an access agreement for the severed parcel.

5.2 ROADWAY TERMINATION

The diversion channel will split the township roads at varying points. Based upon input received from county and township officials, maintaining roadways is recommended to maintain farming accessibility on split properties. The roadways would terminate as dead-ends similar to how township roadways currently terminate at the interstate.

There were, however, two links at the intersection of 26th Street West and 21st Avenue West that could be considered for removal: the north and east approaches. These two roadways are 1/10 of a mile or less and the abutting property is accessed by an adjacent roadway. Removing these minor links would allow the adjacent larger properties to absorb the small piece of land adjacent to the diversion and alleviate township maintenance responsibilities.

Removing both links would convert the intersection into a curve. To meet design standards, this would require that the 90 degree curve be redesigned to allow a vehicle traveling at or near the design speed to safely navigate the curve. This would require additional ROW acquisition from the property on the southwest quadrant and several thousand feet of new roadway be constructed. To avoid these additional property impacts and costs, it is recommended only the smaller link (north approach) be considered for removal. It is important to note that these improvements are optional as removing the sections is not critical for overall roadway network efficiency, which is the goal of this report. Final decisions whether to remove the links should be discussed during ROW acquisition negotiations and project development. The cost of this improvement will be incidental to the overall cost of the diversion due to the proximity of this roadway to the diversion footprint and minimal scope of this project.

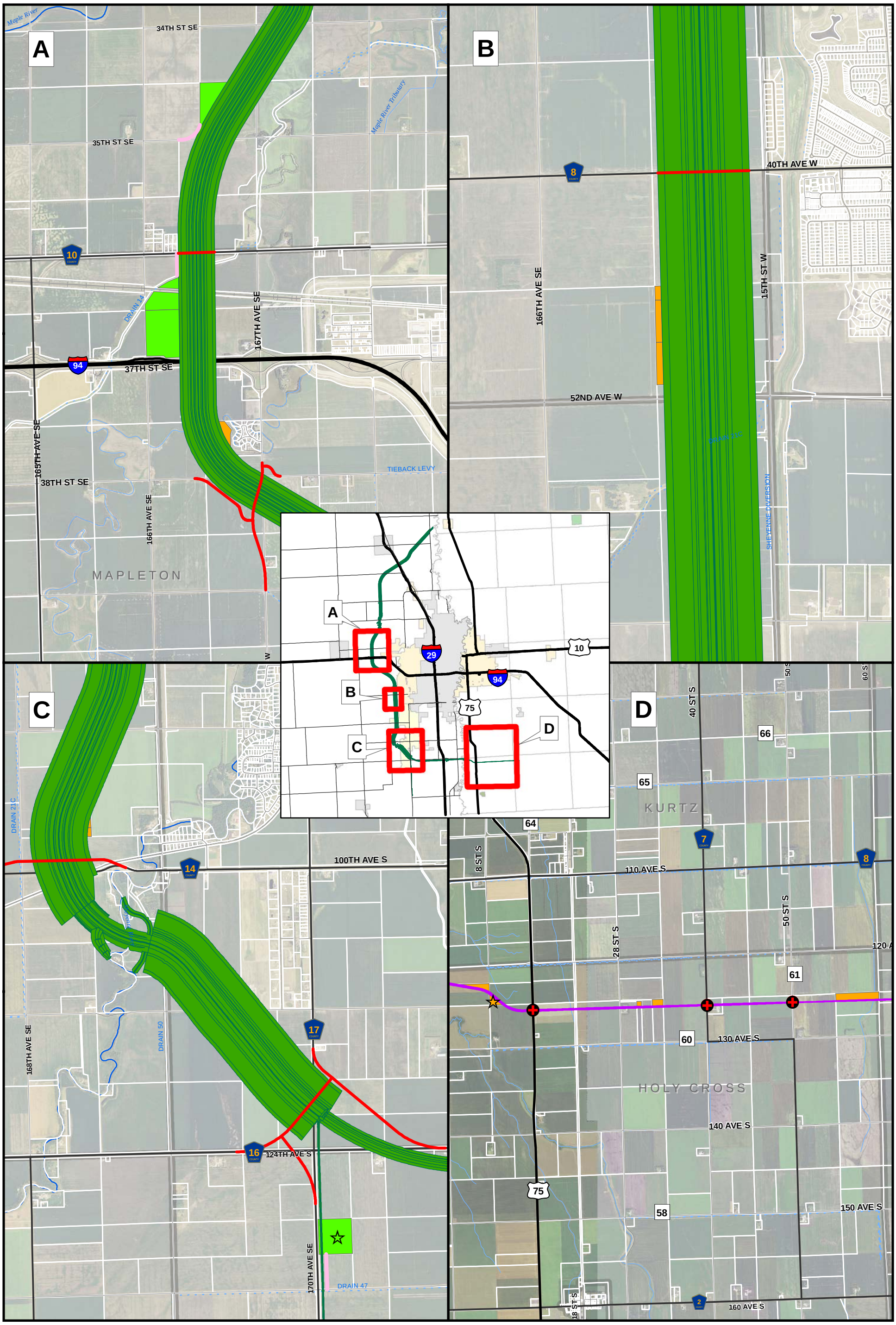
5.3 SUMMARY

In regards to this study, accessability refers to the ability to access property from an adjacent roadway. The diversion channel and embankments sever several roadway ties to properties that would normally be accessable. According to the results of a cost comparison analysis, three parcels are severed from the existing roadway network and it would be cheaper to develop a roadway connection than to buy the parcel. There are 10 other properties where it would be economically advantageous to purchase rather than develop roadway connections. Regardless of economic feasibility, accessabilitiy agreement between neighboring landowners should be discussed during the ROW acquistion process.

To maintain accessability to property abutting the diversion, it is recommended roadways terminate as dead-ends similar to how township roadways currently terminate at the interstate. It is recommended the roadway section of 26th Street West between the diversion and 21st Avenue West be considered for removal as this roadway does not provide accessabilitiy benefits and will provide maintenance complications.

Figure 5-1
Accessibility Improvement Plan

South Red River Diversion Master Transportation Plan



Legend

- Tributaries/Other Rivers
- Major Rivers
- Drains
- Railroad
- Proposed Diversion Footprint
- Tieback Embankment
- Diversion Crossing
- Embankment Crossing
- Potential Access From Adjacent Parcel**
- Roadway Connection Not Warranted*
- Roadway Connection Warranted*
- Roadway Connection
- 36 Cass County Road/Clay County State Aid Highway
- 67 Clay County Road

*Based upon benefit to cost analysis of property value versus the cost of a roadway connection
**Owner of adjacet parcel has the same last name

6 MOBILITY

6.1 RECURRING TRAFFIC

The county and township roads in the study area are predominantly gravel or minimum maintenance earth roads with intermittent sections of paved roadway at higher volume locations. The diversion channel and associated embankments will sever township road connections which will result in a funnel effect of all motorists onto roadways where crossings are built. To access the corridors with connectivity across the diversion or associated embankments, motorists may travel on earth roadways and low-flow crossings to make the connection. These roadways are not designed for increased traffic volumes and may require roadway resurfacing or bridge/box culvert improvements to withstand the new loadings.

Collector roadways that run parallel to the diversion are an effective way to manage the funneling effect onto the major roadways. The parallel corridors will collect traffic not traveling on roadways with diversion or embankment crossings and circulate them to corridors that do traverse the diversion or embankments. The majority of the study area already has such corridors. For example, 15th Street West parallels both the FM Diversion and Sheyenne Diversion between Cass CR 8 and the Sheyenne River (3/4 mile south of 45th Street SE/88th Avenue South).

It is recommended this structure of development collector roadways parallel to the diversion be maintained throughout the entirety of the project limits with the exception of in the staging area. With the exception of potentially Oxbow, Hickson and Bakke (still being evaluated), all buildings are to be removed in the staging area as part of the diversion project. This will minimize the amount of traffic in the area. To provide a network of collector roadways running parallel to the diversion, the following improvements are recommended (refer to ***FIGURE 6-1 – Recurring Traffic Mobility Improvements*** for an illustration of the recommended improvements):

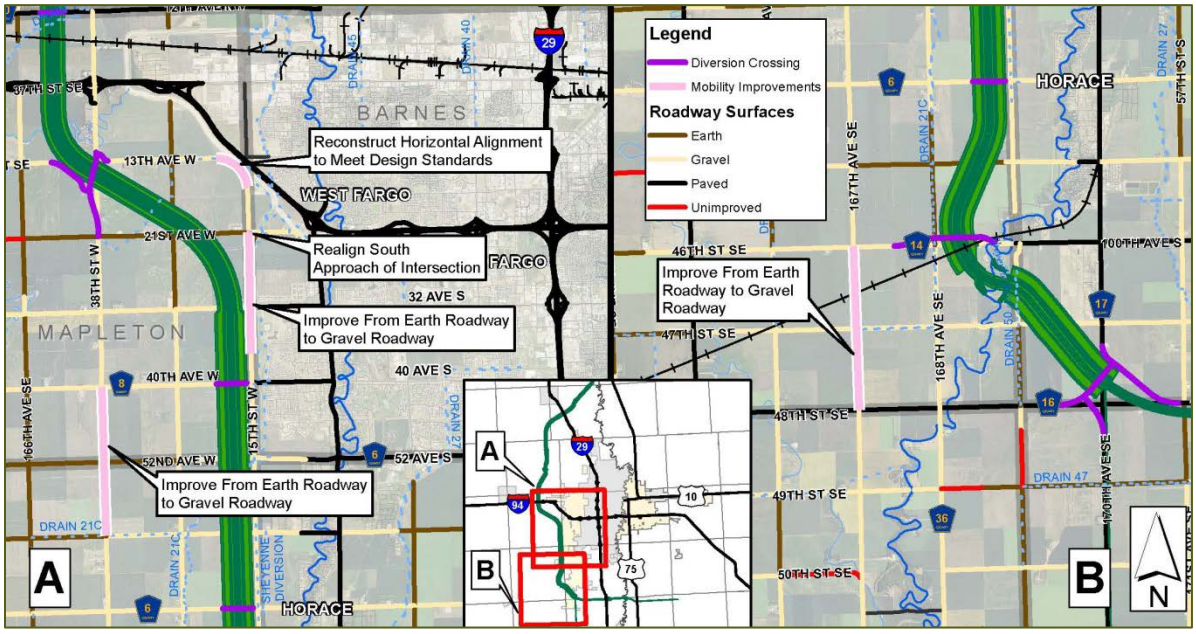
- Improve the section of 38th Street West from Cass CR 8 to 43rd Street SE/64th Avenue South from an earth roadway to gravel.
- Improve the section of 38th Street West from Cass CR 14 to Cass CR 16 from an earth roadway to gravel.
- Develop a collector roadway between crossings at 38th Street SW and Cass CR 8 (40th Avenue South/41st Street SE) using existing infrastructure. This corridor would require the following improvements:
    - Improve 15th Street SW from Cass CR 8 (40th Avenue South/41st Street SE) to 21st Avenue West/39th Street SE including realigning the intersection of 15th Street SW with 21st Avenue West/39th Street SE.
    - Improving the curve that transitions 15th Street SW to 13th Avenue West to meet design standards for a 55 mph curve.

Although the collector roadway between 38th Street SW and 40th Avenue South/41st Street SE may not serve a high volume of trips today, the undeveloped area between the diversion and I-94 is a major potential growth area. The corridor would provide access not only to a diversion crossing but to I-94 and other major arterials leading into the metro area. Other alignment alternatives that involved developing a new corridor paralleling the diversion roadway were presented to the public. Based upon feedback from stakeholders, the preferred alternative was to use existing infrastructure to limit impacts.

Based upon input received during stakeholder meetings, mobility would be adequately serviced under the proposed configuration of diversion and embankment crossings in addition to the mobility improvements proposed above. The overarching input received from the public was that regional mobility is primarily serviced via interstate, US highways and county roads. As such, maintaining connectivity across these corridors and

mobility to and from these corridors from township roads will not significantly impact mobility for emergency responders, postal workers, school transportation services and travel patterns for the average driver.

FIGURE 6-1 – Recurring Traffic Mobility Improvements



6.2 CONSTRUCTION-SPECIFIC TRAFFIC

It is critical to route construction-specific traffic to principal arterials designed to handle truck loads such as interstate and major county roads. However, to promote efficient construction of the diversion, it is also critical that access be provided from these major arterials to the diversion itself at incremental locations. Providing access every mile would require that nearly every roadway within the study area be improved to gravel, which is unrealistic. Alternatively, 2-mile access can be provided with minimal roadway improvements once the recurring mobility improvements are completed. Refer to ***FIGURE 6-2 – Construction Routes Map*** for an illustration of the construction routes map. Each route is designed to connect the diversion with the interstate system, the primary outlet for trucks throughout the region. As illustrated in the figure, 35th Street from 166th Avenue SE to the west boundary of the diversion footprint is the only roadway that may benefit from being improved to provide access every 2 miles from the interstate to the diversion channel. A final decision to improve this nearly half-mile section of roadway should be decided during construction if deemed necessary.

Bridge construction is anticipated to impact traffic at crossing locations for multiple years. Due to the length of construction, temporary construction bypass routes are recommended. Wherever possible, existing infrastructure within one mile of the bridge under construction was used for the bypass route. If the adjacent section line was an earth roadway and not designed for increased traffic loading, roadway improvements were recommended.

Although the 38th Street West, Cass CR 14 and Cass CR 16/17 crossings will not be located within the current roadway alignment, roadway closures will be necessary to connect the existing roadway to the new alignments. As such, bypass routes were identified for these crossing locations. It is important to note, however, that these bypass routes will be utilized for much shorter durations than at crossings located on the existing roadway alignment.

Where adjacent infrastructure is not readily available for bypass routes, new temporary gravel bypass roads are recommended approximately 200 feet from the existing roadway. Although this approach is more expensive, an adjacent bypass provides a reduction in overall vehicle miles traveled during construction. This is particularly beneficial for emergency responders. The following locations were selected for new temporary bypass routes:

- Cass CR 10 due to the lack of adjacent roadways. Although I-94 is one mile south of Cass CR 10, it is undesirable to use the interstate as a bypass route due to its functionality and restrictions. For example, farm equipment is prohibited from using the interstate. It is important to note that the majority of this proposed bypass can be constructed within the ROW required for the diversion channel.
- Cass CR 14 due to the lack of adjacent roadways. Although a bridge across the Sheyenne River is currently in place one mile south of Cass CR 14, this crossing is closed due to a deficient structural rating of 36. The Cass County Highway Department indicated plans to remove and not replace the bridge in the near future. It is important to note that the final bypass configuration is contingent upon whether the railroad spur adjacent to Cass CR 14 is maintained.
- Cass CR 81 due to the lack of adjacent roadways. Although I-29 is one mile west of Cass CR 81, it is undesirable to use the interstate as a bypass route due to its functionality and restrictions.

Refer to ***FIGURE 6-2 – Construction Routes Map*** for an illustration of the proposed construction bypass routes.

As previously discussed, due to the regional significance and traffic volumes on US Highway 75, it is recommended the roadway be raised throughout the entirety of the staging area to avoid losing access and restricting mobility throughout the entire flood inundation period. Approximately 8.3 miles of the corridor will be raised as much as 13 feet, although primarily in the 4 feet to 6 feet range. Due to the overall magnitude of this grade-raise project, it is recommended the project be constructed in segments with bypass alternatives evaluated for each phase. The actual construction phasing is unknown at this time so specific maintenance of traffic recommendations are not included in this report.

Construction phasing was a topic of discussion at the majority of the meetings. The concept of constructing the bridges before the diversion was fully supported; however, it was requested that traffic not be impacted on consecutive county roads as these are the primary outlets for regional travel in the study area. Based upon this input, it is recommended the contractor (or contractors in coordination) would not be permitted to have consecutive county roads under construction at a single time.

Another topic of discussion at the majority of meetings was maintenance of any roadway used as a construction route. The study team assured all stakeholders that maintenance agreements would be established with all contractors prior to beginning any work. It is recommended, however, that the breadth of this agreement be extensive to ensure each roadway is maintained in a timely manner, specifically after periods of inclement weather.

Although construction routes are provided, construction sequencing and timing should be properly communicated to stakeholders. It will not only help to avoid negative project opinions, but this information is vital to emergency responders to provide the most efficient response times possible.

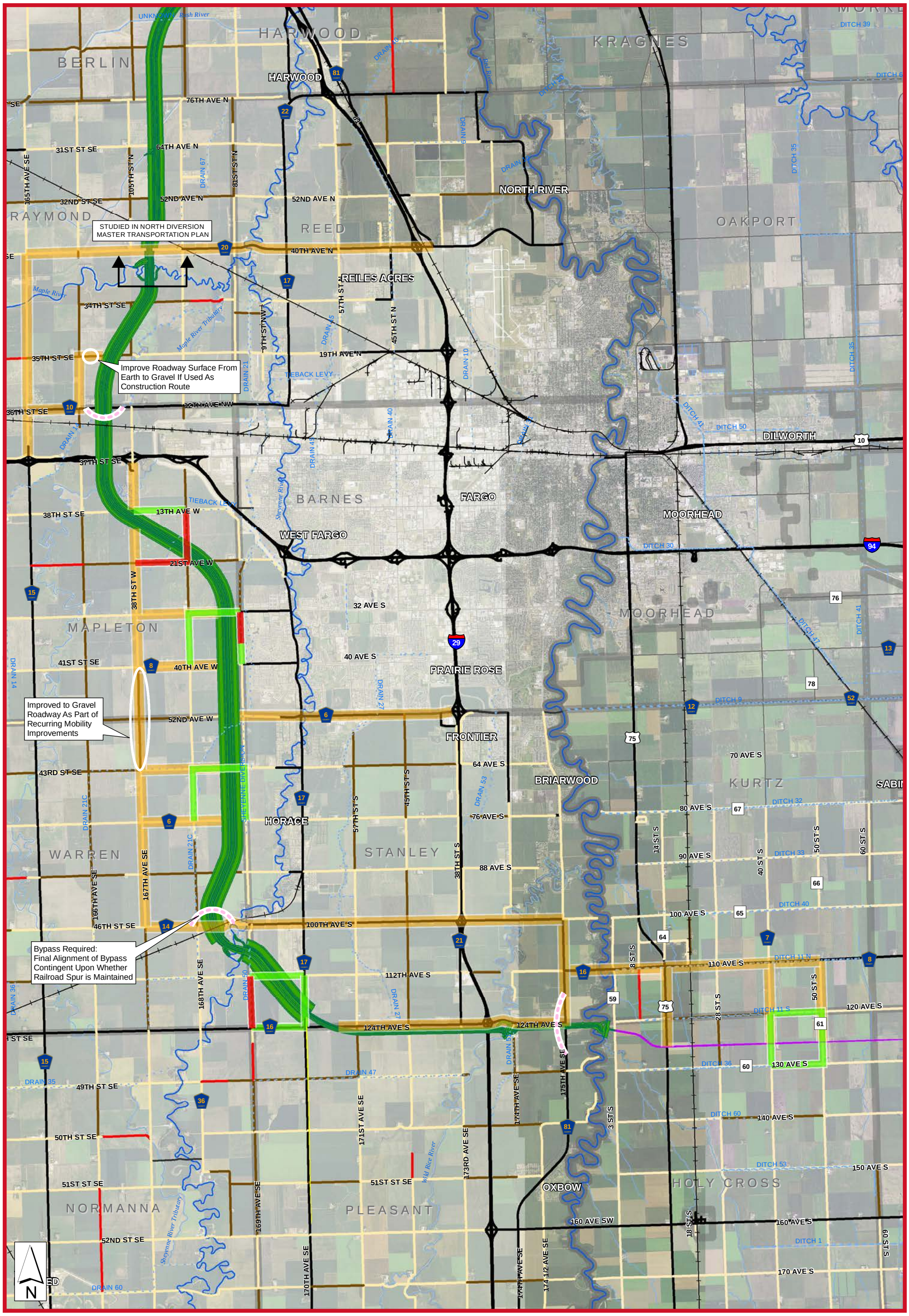


Figure 6-2
Construction Routes Map

Legend

- Tributaries/Other Rivers
- Major Rivers
- Drains
- Railroad
- Proposed Diversion Footprint
- Tieback Embankment
- Overflow Embankment

Construction Detours
- Use Existing Roadway - Upgrade to Gravel
- Use Existing Roadway (Currently Gravel or Paved)
- Construct Bypass

Roadway Surfaces
- Earth
- Gravel
- Paved
- Unimproved

- Construction Route
- 36 Cass County Road/ Clay County State Aid Highway
- 67 Clay County Road

South Red River Diversion
Master Transportation Plan

6.3 SUMMARY

Mobility refers to the efficient movement of people and goods. Roadway discontinuities caused by the diversion channel and embankments may funnel vehicle trips onto roadways that are not designed for increased traffic loads, resulting in poor mobility. The following improvements are recommended to improve mobility by collecting traffic redistributed by roadway discontinuites caused by the diversion project (refer to ***FIGURE 6-3 – Mobility Improvement Plan*** for illustration of these improvements).

- Improve the section of 38th Street West from Cass CR 8 to 43rd Street SE/64th Avenue South from an earth roadway to gravel.
- Improve the section of 38th Street West from Cass CR 14 to Cass CR 16 from an earth roadway to gravel.
- Develop a collector roadway between crossings at 38th Street SW and Cass CR 8 40th Avenue West/41st Street SE using existing infrastructure. This corridor would require the following improvements:
    - Improve 15th Street SW from Cass CR 8 (40th Avenue South/41st Street SE) to 21st Avenue West/39th Street SE including realigning the intersection of 15th Street SW with 21st Avenue West/39th Street SE.
    - Improving the curve that transitions 15th Street SW to 13th Avenue West to meet design standards for a 55 mph curve.

Due to the length of construction, temporary construction bypass routes are recommended to accommodate traffic. Construction traffic will be routed onto existing infrastructure if available within a reasonable distance. At multiple locations, roadway improvements are required (i.e. earth to gravel roadway improvements) to accommodate rerouted traffic. At Cass CR 10, Cass CR 14 and Cass CR 81, where existing infrastructure is not readily available, new temporary bypass routes directly adjacent to the existing roadways are recommended to maintain traffic during bridge construction.

Once all other mobility improvements are completed, construction access to the diversion can be provided every 2 miles with minimal improvements. During construction, it is critical the contractor, or contractors in combination, maintain all county and township roads at the same levels of service they currently operate at. The contractor is also responsible for returning all roadways to their original surfacing, unless requested otherwise by the township, once construction is complete. For motorist convenience, it is recommended the contractor (or contractors in coordination) would not be permitted to have consecutive county roads under construction at a single time. Finally, construction sequencing and timing should be properly communicated to stakeholders.

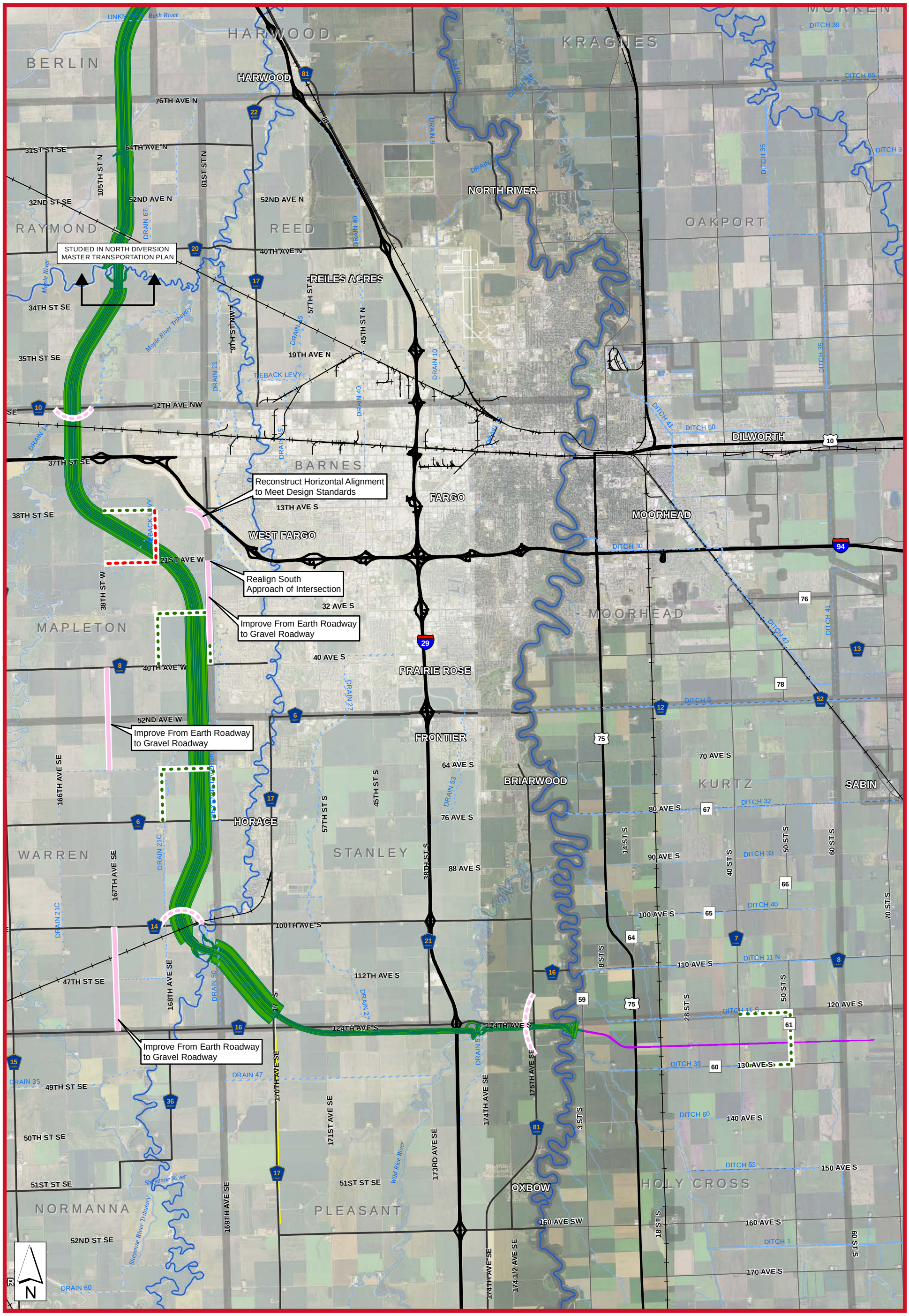


Figure 6-3
Mobility Improvement Plan

South Red River Diversion Master Transportation Plan

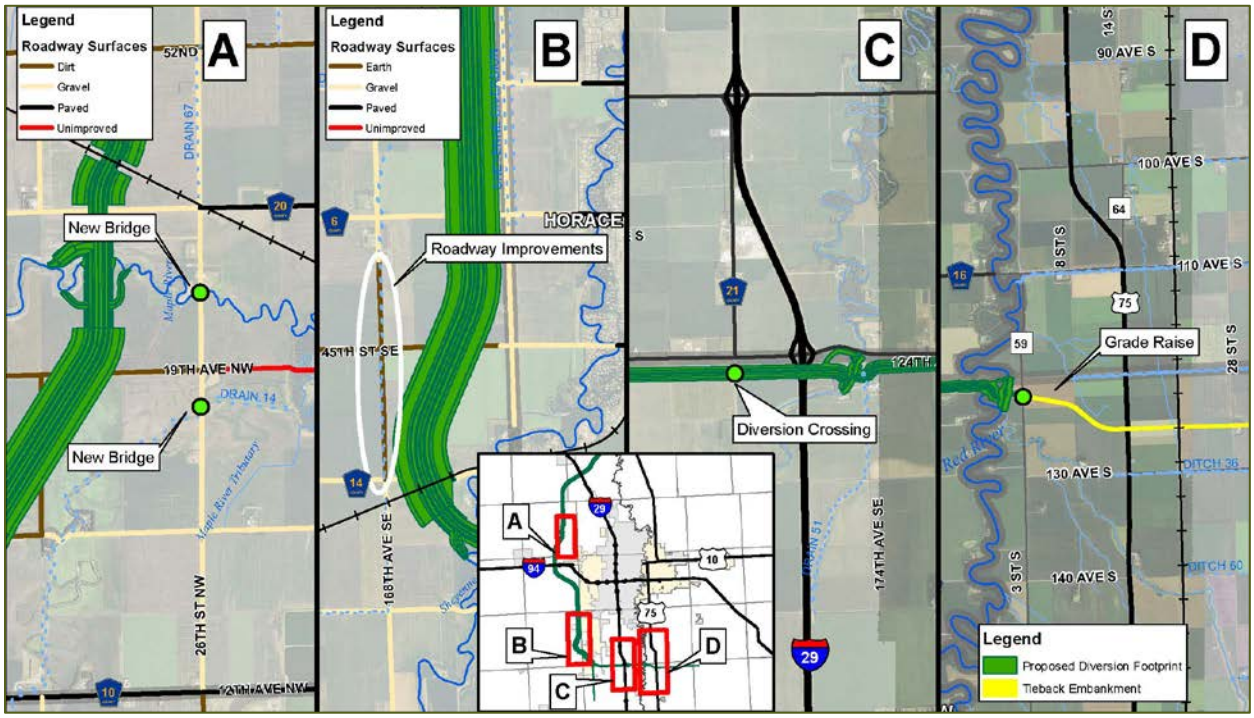
7 DISCARDED ALTERNATIVES, AREAS OF FURTHER DISCUSSION AND FUTURE STUDIES

7.1 DISCARDED IMPROVEMENT ALTERNATIVES

Multiple alternatives were discarded during the technical analysis portion of this study. Alternatives were discarded in favor of an alternate improvement or discarded because technical analysis revealed the improvement was not triggered solely by construction of the diversion. Specifically, the following improvement locations were discussed with stakeholders but inevitably discarded (refer to ***FIGURE 7-1 – Discarded Alternatives***):

- It was requested that new bridges be constructed on 26th Street NW over the Maple River and Drain 14, two crossings separated by less than a mile. Based upon current traffic circulation patterns, this stretch of 26th Street NW is not anticipated to experience a substantial increase in traffic volumes once the diversion is constructed. As such, these improvement alternatives were discarded.
- Roadway improvements were requested on 26th Street SW/168th Avenue SE from 76th Avenue South/44th Street SE and 100th Avenue South/46th Street SE. This alternative was discarded in favor of roadway improvements one mile west on 38th Street SW/167th Avenue SE. This corridor is currently more widely traveled and improving the corridor provides a collector roadway with direct access to Interstate 94.
- A roadway grade raise was requested at Clay CR 59 adjacent to the Red River. The corridor provides limited connectivity as it terminates 2 miles north of the tieback embankment. This alternative was discarded because unlike Clay CR 61, the roadway would require a substantial grade raise of nearly 14 feet and would provide minimal benefits as this corridor is primarily within the storage area where the nearly all structures are planned to be removed.
- A crossing was requested at Cass CR 21. A cost-benefit analysis is included in the ***Connectivity*** section of this report detailing the specifics behind why this improvement was discarded.

FIGURE 7-1 – Discarded Alternatives



7.2 AREAS OF FURTHER DISCUSSION

The following improvement alternatives were discussed with one or more stakeholder groups. The alternatives would require a change in current standards or diversion alignment. This category also includes potential improvement alternatives that would be an acceptable substitute for the proposed improvement plan but offered fewer benefits.

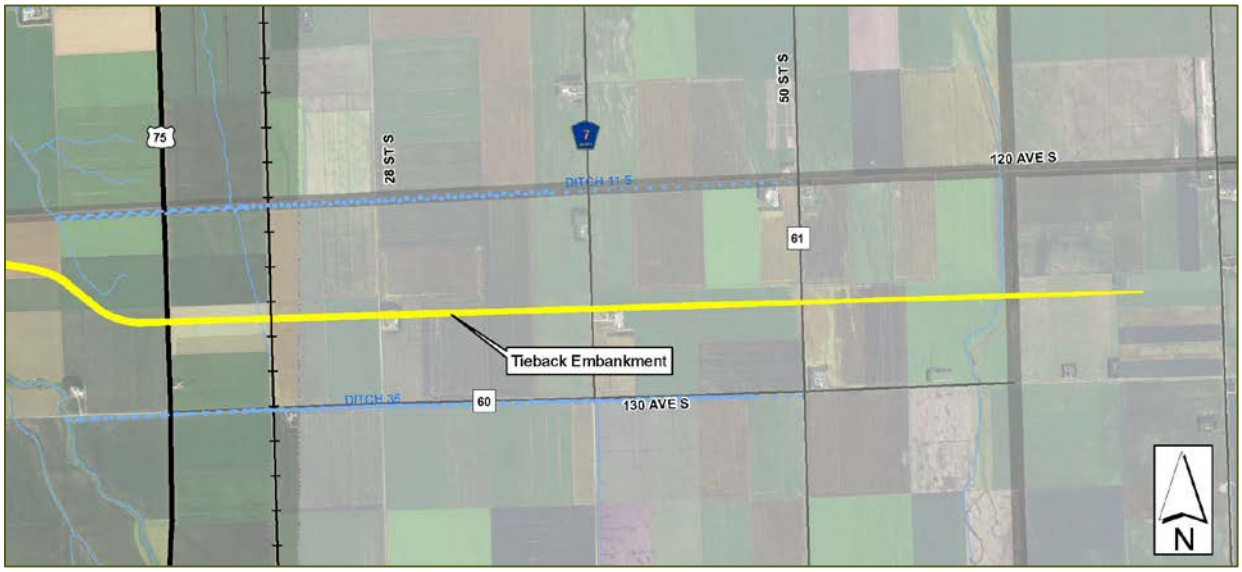
7.2.1 BRIDGE WIDTH

Bridge width was a major topic of discussion at the township meetings. The majority of township farmers preferred bridge deck widths exceeding 40 feet, which is beyond the Cass County standard for bridge decks for graveled or paved roadways. The general feeling was that a combine with an attached header would not be able to traverse a bridge with a smaller deck. Although the combine header should be able to clear the outside bridge barriers, the signs and hazard markers mounted on these barriers would create complications if they were fixed. A combine with attached header will also conflict with opposing traffic. A small group of farmers mentioned pulling the header behind the combine whenever crossing a bridge as an acceptable alternative; however, this group was in the minority.

7.2.2 TIEBACK EMBANKMENT LOCATION

Multiple stakeholder groups noted that the proposed tieback embankment location is inconvenient for abutting landowners. Specifically, most properties are divided at section or half-section lines; however, the current alignment is not located at either location (refer to ***FIGURE 7-2 – Tieback Embankment Location***). Stakeholders indicated this would result in unnecessary circuitous routes for farmers. Analyzing the alignment of diversion features is beyond the scope of this report and was not studied.

FIGURE 7-2 – Tieback Embankment Location



7.2.3 BRIDGE CROSSING LOCATIONS

During the development of this study it was discussed whether diversion crossing locations should be located at 32nd Avenue South/40th Street SE and 52nd Avenue South/42nd Street SE rather than Cass CR 8 (40th Avenue South/41st Street SE). Locating crossings on these roads would align diversion crossings with I-29 interchanges and in the case of 52nd Avenue South/42nd Street SE, a river crossing as well. This configuration was inevitably discarded in favor of the current configuration for the following reasons:

- Current traffic demand does not currently warrant an additional bridge at this time. Although studying future growth patterns and future development sites was beyond the scope of this report, it is not anticipated that traffic demand will increase to levels that will warrant an additional crossing within the useful life of a bridge. For example, two-lane 55 mph rural highways can generally handle up to 8,000 vehicles per day before exceeding NDDOT acceptable level of service thresholds (data based upon information provided in the Highway Capacity Manual).
- Based upon input from stakeholders, providing a bridge at Cass CR 8 (40th Avenue South/41st Street SE) adequately addresses connectivity requirements at this time.

7.3 FUTURE STUDIES

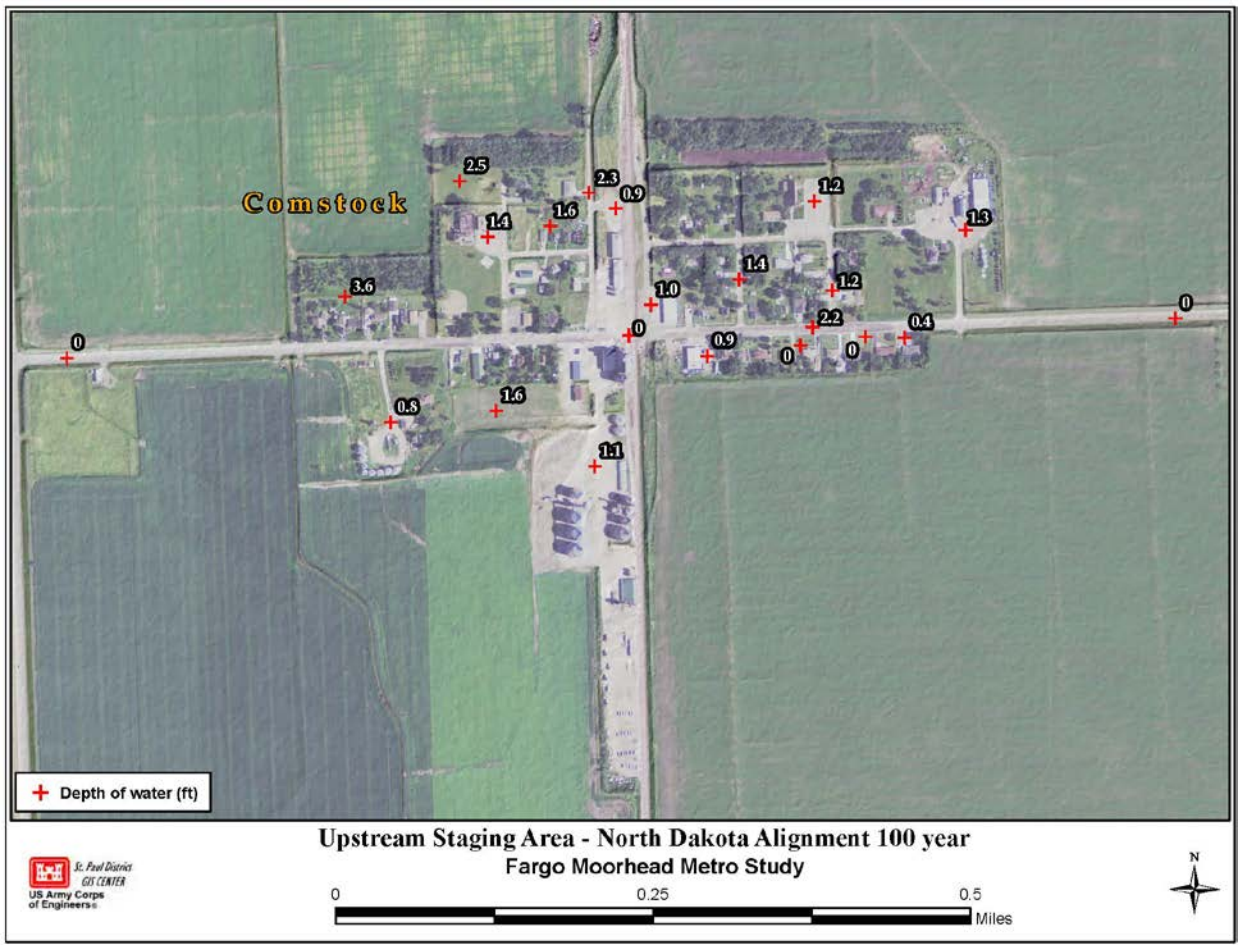
The following items were discussed with stakeholders; however, the scope of analysis required to fully evaluate the items was beyond the scope of the report. The issues and potential solutions are documented in this report to assist in development of future transportation studies.

7.3.1 RAILWAY THROUGH COMSTOCK

One area of concern raised by multiple stakeholders was a potential railway grade raise through Comstock. The railway line running through Comstock is the Moorhead Subdivision, sometimes called the Breckenridge Line. This line carries 8 to 10 trains per day, hauling all types of cargo. As previously discussed, a ring dike is planned around the City of Comstock. A railroad grade raise, depending upon the height of the raise, may potentially impact buildings adjacent to the railway line, including the elevators. If elevators are impacted, the railway line through Comstock is no longer needed.

Refer to ***FIGURE 7-3 – Comstock 100 Year Flood Water Depths*** for an illustration of the depth of water forecasted for a 100 year flood event. As illustrated in this figure, impacts of a 100 year flood event to the railway line are minimal as this line is at higher elevation than surrounding areas. However, to achieve the same amount of freeboard as the tieback levee, the tracks may still need to be raised unless a structural closure is installed. Furthermore, there is a railroad spur to the west of the tracks that is used for the Comstock elevators. This spur directly abuts the elevators and would subsequently need to be raised if the mainline is raised; raising the spur will almost certainly result in impacts to the elevators.

FIGURE 7-3 – Comstock 100 Year Flood Water Depths



Any improvements to the railway will need to be coordinated with BNSF. Coordination with BNSF and development of improvements to rail lines was beyond the scope of this report. However, based upon very preliminary analysis, the following alternatives have been developed to address the scenario where impacts to the Comstock elevators occur as the result of raising the rail line:

- Option 1: Raise the grade of the railway and relocate elevators north or south of Comstock and extend the ring dike in these directions for protection. It is important to note that if the ring dike is extended to the north, the existing wastewater lagoons could then be a part of the protected area.
- Option 2: Raise the grade of the railroad and extend the ring dike north and south at a distance that allows the railway to be lowered by the time it reaches Comstock. Based upon the desired grades for a railway line, this will substantially increase the overall footprint of the ring dike area.
- Option 3: Do not raise the grade of the elevator through Comstock and leave the ring dike open at the entrances of the railroad. When a flood event is anticipated, the railroad would then need to be closed so the dike openings could be sealed shut.

Relocating the railway line was preliminarily discarded because of ROW impacts and the fact that the Comstock elevators would need to be relocated to an area that is not protected.

7.3.2 RED RIVER VALLEY & WESTERN SHORT-LINE SPUR NEEDS ASSESSMENT

As documented multiple times in this report, the Red River Valley & Western Short Line spur intersects Cass CR 14 at the diversion, creating alignment complications. The line terminates two miles to the northeast in Horace. The line currently only services the Horace elevator with approximately one train every two weeks. The majority of the elevator's transportation needs are currently handled via truck.

Multiple stakeholder groups indicated that removal of the spur through Horace has been discussed multiple times in the past 10 years. The line was recently reduced by nearly one mile when Cass CR 17 was improved through Horace. Discussions with the railway and Horace Elevator should be conducted to determine future plans for this railway spur prior to investing in a multi-million dollar bridge. If it is determined the railroad crossing will not warrant a diversion crossing, alignment of the Cass CR 14 crossing can match the existing roadway alignment and eliminate any roadway skews. Refer to ***FIGURE 7-4 – Cass County Road 14 Crossing with Railroad Spur Removed*** for the proposed diversion crossing if the railroad spur is removed. The skew illustrated in FIGURE 7-4 is 20 degrees which is slightly greater than the 15 degree skew utilized at other crossings. However, this increased skew is incremental enough that the cost required to lengthen the bridge is mitigated by avoiding roadway realignment improvements that would be necessary with a 15 degree skew angle.

FIGURE 7-4 – Cass County Road 14 Crossing with Railroad Spur Removed

7.3.3 LOW-FLOW CROSSINGS IN STAGING AREA

Cass County engineering staff expressed interest in determining impacts the increased susceptibility to flooding in the staging area would have on existing low-flow crossings. Their request included a cost comparison evaluation

relating the costs of improving existing low-flow crossings within the staging area to an improved form of crossing versus the impacts to transportation during the period when low-flow crossings are washed out after a flood event. To complete this analysis, it would need to be determined at what levels of flow would a low-flow crossing be damaged beyond reasonable repair and how frequently this level of flow is anticipated. While the low-flow crossings in the staging area are part of the transportation system, the analysis required to evaluate flood impacts are specific to water modeling and flow analysis which is beyond the scope of this report.

7.4 SUMMARY

During development of this report, multiple alternatives were developed and discussed with stakeholders that were ultimately not recommended in this report. These items were characterized into one of the following categories:

Discarded Improvement Alternatives: This category included any improvement alternative requested by a stakeholder group that was either discarded in favor of an alternate improvement or discarded because technical analysis revealed the improvement was not triggered solely by construction of the diversion. The following requested improvement alternatives were discarded during development of this study:

- New bridges on 26th Street NW over both the Maple River and Drain 14 – discarded during technical analysis
- Roadway surface improvements on 26th Street SW/168th Avenue SE from 76th Avenue South/44th Street SE and 100th Avenue South/46th Street SE – discarded in favor of complimentary alternative
- Roadway grade raised over the tieback embankment at Clay CR 59 – discarded during technical analysis
- Diversion crossing at Cass CR 21 – discarded during technical analysis

Area of Further Discussion: This category included items discussed with a stakeholder group that would require a change in current standards or diversion alignment. This category also included potential improvement alternatives that would be an acceptable substitute for the proposed improvement plan but offered fewer benefits. This included the following discussion items:

- Bridge Width: The majority of local farmers indicated that bridge widths in excess of 40 feet are preferred to transport large farm equipment.
- Tieback Embankment Location: The majority of Clay County stakeholders indicated that tieback embankment created inconvenient transportation routes for abutting landowners because it was not located on the section or half-section line.
- Bridge Crossing Locations: There was discussion regarding whether diversion crossings should be located at 32nd Avenue South/40th Street SE and 52nd Avenue South/42nd Street SE rather than Cass CR 8 (40th Avenue South/41st Street SE) to align with existing I-29 interchanges. Based upon discussions with stakeholders, CR 8 (40th Avenue South/41st Street SE) was the most desirable crossing location of the three due to current travel patterns. Additionally, future traffic demand is not anticipated to warrant an additional crossing within the lifecycle of the bridge.

Future Studies: This category includes items discussed with stakeholders that were transportation-related but beyond the scope of this report. The following issues, along with potential solutions, are documented in the body of the report to assist in development of future transportation studies.

- Railway Through Comstock: A study is recommended to evaluate the improvement plan for the railroad line through Comstock; the study should incorporate meetings with both BNSF representatives and the citizens of Comstock. If the railway line is raised through Comstock, adjacent buildings (including the

Comstock elevators) will be impacted. Maintaining current elevation of the line will result in railway closures during flood events.

- Red River Valley & Western Short-Line Spur Needs Assessment: Multiple stakeholder groups indicated that removal of the spur through Horace has been discussed multiple times in the past 10 years. Meetings should be held with BNSF and citizens of Horace to determine whether line maintenance is warranted.
- Low-Flow Crossings in Staging Area: Increased flows in the storage area may result in low-flow crossing wash-outs and corresponding transportation deficiencies. A study should be conducted to determine the benefits and costs of replacing the existing low-flow crossings located in the storage area with more protected crossings.

8 COST ESTIMATES

TABLE 8-1 – Improvement Plan Cost Estimates illustrates anticipated costs associated with each recommendation developed for this project. Cost estimates are based upon average costs compiled from similar past KLJ, county and DOT projects. Much of this data was compiled from design-level cost estimates completed on the north section of the diversion. Input from the county indicated bridge widths are 36 feet minimum and 40 feet preferred for the project. County standards utilize a 28-foot roadway surface width for two-lane rural gravel sections and 32 feet for two-lane rural paved sections. Based upon this information and input from the county, the 36-foot bridge widths were utilized for bridges on gravel roadways and 40-foot bridges on paved roadways. Where one bridge approach was paved less than one mile away from the crossing, 40 feet was used.

TABLE 8-1 – Improvement Plan Cost Estimates

Cost	Bridge	Roadway	Bypass	Total
Cass County Road 10 Diversion Crossing	$5,235,100	$0	$1,143,300	$6,378,400
38th Street West Diversion Crossing	$4,877,000	$2,086,100	$658,300	$7,621,400
Cass County Road 8 Diversion Crossing	$5,840,800	$0	$0	$5,840,800
Cass County Road 6 Diversion Crossing	$5,805,000	$0	$0	$5,805,000
Cass County Road 14 Diversion Crossing	$5,965,700	$839,700	$1,138,800	$7,944,200
Combined Cass County Road 16/17 Diversion Crossing[1]	$5,276,700	$5,133,800	$329,200	$10,739,700
Cass County Road 81 Diversion Crossing	$2,365,600	$0	$1,138,800	$3,504,400
US Highway 75 Grade Raise[2]	$0	$36,176,500	$0	$36,176,500
Clay County State Aid Highway 7 Grade-Raise	$0	$212,800	$0	$212,800
Clay County Highway 61 Grade-Raise	$0	$58,000	$0	$58,000
Accessability Improvements[3]	$0	$710,500	$0	$710,500
Mobility Improvements	$0	$2,610,100	$0	$2,610,100
Total	$35,365,900	$47,827,500	$4,408,400	$87,601,800

Note 1: Cost Includes 25% Contingency and 20% Engineering Fee.
Note 2: Bridge Cost Estimates Include Necessary Grade Raises Leading Up to the Bridge.
[1]Sub-total includes the cost of the proposed roundabout (≈$195,000 without engineering and contingencies).
[2]Maintenance of traffic plan contingent upon project phasing. Not Included in Cost Estimate.
[3]Only accounts for roadway connections betweeen roadway system and inaccessable parcels.

9 CONCLUSION

Through various meetings with key transportation stakeholders directly affected by the proposed diversion channel and associated embankments, it was clear the diversion offers several transportation obstacles corresponding to connectivity, accessibility and mobility. In response to these obstacles, the study team developed solutions to remedy or minimize project impacts. Not only are engineering solutions identified in this study, relationships and consensus was built with those directly affected. The relationships offer benefits throughout the entire FM diversion project from development into construction.

It is recommended the outlets of communication be maintained as the project transitions from planning into design and construction. All parties are affected by the roadway closures to varying degrees, whether during a daily commute to work or during emergency response calls. Timely notification allows roadway users to adapt to the changing roadway network landscape; this will not only prevent motorist delay resulting from unnecessary detouring, but will also help improve relationships with those opposing the project. ***FIGURE 9-1 – Proposed Improvement Plan*** illustrates each study recommendation on one map.

Key	Cost	Total
A	Cass County Road 10 Diversion Crossing	$6,378,400
B	38th Street West Diversion Crossing	$7,621,400
C	Cass County Road 8 Diversion Crossing	$5,840,800
D	Cass County Road 6 Diversion Crossing	$5,805,000
E	Cass County Road 14 Diversion Crossing	$7,944,200
F	Combined Cass County Road 16/17 Diversion Crossing[1]	$10,739,700
G	Cass County Road 81 Diversion Crossing	$3,504,400
H	US Highway 75 Grade Raise[2]	$36,176,500
I	Clay County State Aid Highway 7 Grade-Raise	$212,800
J	Clay County Highway 61 Grade-Raise	$58,000
K, L, M	Accessability Improvements[3]	$710,500
N, O, P, Q	Mobility Improvements	$2,610,100
	Total	$87,601,800

Note 1: Cost Includes 25% Contingency and 20% Engineering Fee.
Note 2: Bridge Cost Estimates Include Necessary Grade Raises Leading Up to the Bridge.
[1]Sub-total includes the cost of the proposed roundabout (≈$195,000 without engineering and contingencies).
[2]Maintenance of traffic plan contingent upon project phasing. Not Included in Cost Estimate.
[3]Only accounts for roadway connections betweeen roadway system and inaccessable parcels.

STUDIED IN NORTH DIVERSION MASTER TRANSPORTATION PLAN

K — Optional: Improve Roadway Surface From Earth to Gravel If Used As A Construction Route

A — Reconstruct Horizontal Alignment to Meet Design Standards

B — Optional: Remove Roadway Section Upon Completion of the Diversion

N — Realign South Approach of Intersection

O — Improve From Earth Roadway to Gravel Roadway

C — Improve From Earth Roadway to Gravel Roadway

P — Improve From Earth Roadway to Gravel Roadway

D — Bypass Required: Final Alignment of Bypass Contingent Upon Whether Railroad Spur is Maintained

E — Improve From Earth Roadway to Gravel Roadway

Q — Raise US Highway 75 Throughout Storage Area

F — Construct Bypass

M — Use Existing Roadway - Upgrade to Gravel

G — Use Existing Roadway (Currently Gravel)

I — Cass County Road/ Clay County State Aid Highway

J

H

Figure 9-1
Proposed Improvement Plan

Legend

- Tributaries/Other Rivers
- Major Rivers
- Drains
- Railroad
- Proposed Diversion Footprint
- Tieback Embankment
- Overflow Embankment
- Roadway Connection to Parcel Not Warranted
- Roadway Connection to Parcel Warranted
- Roadway Connection to Severed Parcel
- Diversion Crossing
- Embankment Crossing
- Mobility Improvements
- 67 Clay County Road
- Construction Detours
- Construct Bypass
- Use Existing Roadway - Upgrade to Gravel
- Use Existing Roadway (Currently Gravel)
- 36 Cass County Road/ Clay County State Aid Highway

South Red River Diversion Master Transportation Plan