

SWIFT COULEE / MARSHALL COUNTY DITCH #3 WATERSHED PLANNING

Swift Coulee Sub-Watershed
Middle-Snake-Tamarac Rivers Watershed
District

Concurrence Point #2:
Alternatives Development and Initial Screening

April 12, 2019



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1 BACKGROUND

1.1 INTRODUCTION

The Middle-Snake-Tamarac Rivers Watershed District (MSTRWD) is composed of approximately 1,476 square miles and is in the northern (downstream) end of the Red River Valley in northwestern Minnesota. The MSTRWD encompasses drainage basins of the Middle River, Snake River and Tamarac Rivers. The MSTRWD includes parts of Marshall, Polk, Pennington, Kittson, and Roseau Counties. For this watershed planning effort, the Swift Coulee / Marshall County Ditch #3 (MCD #3) Watershed is a sub-watershed within the Snake River basin. [Exhibit 1](#) shows the approximate 47.6-square mile sub-watershed drainage area with respect to the Snake River watershed boundary. [Exhibit 2](#) through [Exhibit 3](#) provide additional detail of problems within the Swift Coulee / MCD #3 sub-watershed study area.

The activities of the district are guided by its Watershed Management Plan (WMP), which has been developed in accordance with both Minnesota Watershed and Drainage Law, as well as the Red River Basin Flood Damage Reduction Workgroup Agreement (December 9, 1998) and other jurisdictional requirements. As part of the framework of the Red River Basin Flood Damage Reduction Workgroup Agreement, the MSTRWD has implemented the Mediation Project Team (PT) process as the methodology to investigate documented water related problems within the district and begin planning for potential water resource management projects. The PT is a multi-disciplinary collaboration of members of local, state and federal governments, as well as private organizations and local stakeholders.

The PT and watershed district have identified several water related problems within the Swift Coulee / MCD #3 sub-watershed. This report is prepared at the direction of the Board of Managers of the MSTRWD in order to document the purpose and need for a water resource management project within the Swift Coulee / MCD #3 sub-watershed.

1.2 LOCATION

Swift Coulee begins in the Lake Agassiz Aspen Parklands portion of the Red River Basin in Foldahl and Comstock Townships of Marshall County, Minnesota. From there, the Swift Coulee generally flows westward through portions of Alma, McCrea, and Warrenton Townships, all in Marshall County. In Section 4 of Warrenton Township, the Swift Coulee junctions with a channelized legal ditch known as MCD #3 and flows west along the north boundary of Sections 4, 5, 6 of Warrenton Township, Sections 1 through 6 of Vega Township, and Sections 1 and 2 of Oak Park Township before flowing to its confluence with the Snake River in Section 34 of Big Woods Township. The total drainage area of the Swift Coulee / MCD #3 sub-watershed to the confluence with the Snake River is approximately 47.6 square miles.

The Swift Coulee is designated by the Minnesota Department of Natural Resources as “Public Waters” starting in the northwest corner of Section 9, McCrea Township moving west including MCD #3 in its entirety to the confluence with the Snake River.

2 ALTERNATIVE DEVELOPMENT AND INITIAL SCREENING

2.1 CONCURRENCE POINT BACKGROUND

The first concurrence point for the Swift Coulee / MCD #3 Water Resource Management Project was submitted for concurrence on October 8, 2018 and concurred upon by the United States Army Corps of Engineers on December 21, 2018. **The concurred upon purpose of this project is to provide flood damage reduction to agricultural lands due to a 10-year 24-hour rainfall event and to reduce flood damage to public transportation infrastructure in the Swift Coulee / MCD #3 sub-watershed.**

The purpose of the second concurrence point is to develop a wide array of potential flood damage reduction (FDR) and natural resource enhancement (NRE) measures and perform an initial evaluation of each measure's ability to accomplish the project goals as defined in the first concurrence point document. After screening each measure and determining whether the solution will meet (or partially meet) the purpose and need of the project, the measures are then additionally evaluated based on both their anticipated environmental effects and their practicality. The purpose of this multi-level screening process is to eliminate some measures from further investigation to concentrate efforts on further detailed analysis of alternatives that will ultimately contribute toward meeting the watershed goals as identified in the first concurrence point document. Justification for the elimination of each measure is also documented in this report.

2.2 EVALUATION OF MEASURES

2.2.1 INITIAL LIST OF CONSIDERED MEASURES

The initial set of measures considered were established from the FDR measures identified in the MN Flood Damage Reduction Work Group Technical Paper 11 (TP 11). Though not an exhaustive list, TP 11 provides a variety of flood damage reduction measures that have proven track records of success within the Red River Valley. These measures are divided within TP 11 into four distinct categories, representing four unique methodologies to alleviate flooding. The full list of measures by category is presented in **Table 1**.

Table 1: TP 11 FDR Measures

Category 1 – Reduce Flood Volume	Category 2 – Increased Conveyance Capacity	Category 3 – Increase Temporary Flood Storage	Category 4 – Protection/Avoidance
1A - Restore or create wetlands	2A - Channelization	3A - On-Channel Impoundments	4A - Urban levees
1B - Use cropland BMPs	2B - Agricultural Drainage	3B - Off-Channel Impoundments	4B - Farmstead levees
1C - Convert cropland to prairie or other types of perennial grassland	2C - Diversions	3C - Restore or create wetlands	4C - Agricultural levees
1D - Convert land use to forest	2D - Setting back existing levees (to restore floodway capacity)	3D - Drainage	4D - Evacuation of the floodplain
1E - Other beneficial uses of stored runoff	2E - Increasing road crossing capacity	3E - Culvert sizing	4E - Floodproofing
		3F - Setting back existing levees (to restore floodplain storage areas)	4F - Flood warning and emergency response planning
		3G - Overtopping levees	

An additional category of measures not included in TP 11 was developed. The additional measures have proven track records of accomplishing FDR or NRE goals within the Red River Basin. These measures are listed in the Best Management Practices chapter (Chapter 5) of the Minnesota Public Drainage Manual and include:

- Channel restoration to natural channel/two-stage channel design
- Side inlet pipes for grade stabilization
- Water and sediment control basins (WASCOBs)
- Saturated buffers
- Denitrifying bioreactors
- Rock riffles for in-channel rock grade control structures
- Reinforced concrete spillway for grade control
- Grassed waterways for channel tributaries
- Setting back existing levees/spoil banks to provide an appropriate floodplain width

2.2.2 EVALUATION OF CRITERIA

Each of the flood damage reduction measures listed in **Table 1** as well as the additional BMP measures identified from the MN Public Drainage Manual have undergone several evaluations to eliminate some from further consideration and analysis. The evaluations considered:

1. How well the measure addresses the purpose and need of the project.
2. The weight the environmental effects have on the measure.
3. The practicality of each measure.

For each evaluation, a measure was either designated to be carried forward for further evaluation or eliminated. A justification for each 'do not carry forward' designation is documented as part of the evaluation.

2.2.3 EVALUATION OF MEASURE BASED ON PURPOSE AND NEED

Each measure was first evaluated based on whether the alternative could substantially or partially accomplish the established project goals (purpose and need). It is unlikely that any one measure could accomplish both the flood damage reduction and natural resource enhancement goals of the project. However, some measures would have a negative impact on the established goals, and should be eliminated from consideration. TP 11 provides guidance on whether FDR measures will have a positive impact on flood damage reduction goals for the main stem of the Red River based on the project location. The Swift Coulee / MCD #3 project area is located entirely within the “early” portion of the “early-middle-late” designation described in TP-11, as shown in [Exhibit 4](#). However; the MSTRWD 2011 Watershed Management Plan contains guidance on runoff reduction volume goals for the Swift Coulee / MCD #3 sub-watershed. Measures from TP 11 that were not anticipated to meet the purpose and need are identified in red in **Table 2** below.

Table 2: Measure Evaluation based on Purpose and Need

Category 1 – Reduce Flood Volume	Category 2 – Increased Conveyance Capacity	Category 3 – Increase Temporary Flood Storage	Category 4 – Protection/Avoidance
1A - Restore or create wetlands	2A - Channelization	3A - On-Channel Impoundments	4A - Urban levees
1B - Use cropland BMPs	2B - Agricultural Drainage	3B - Off-Channel Impoundments	4B - Farmstead levees
1C - Convert cropland to prairie or other types of perennial grassland	2C - Diversions	3C - Restore or create wetlands	4C - Agricultural levees
1D - Convert land use to forest	2D - Setting back existing levees (to restore floodway capacity)	3D - Drainage	4D - Evacuation of the floodplain
1E - Other beneficial uses of stored runoff	2E - Increasing road crossing capacity	3E - Culvert sizing	4E - Floodproofing
		3F - Setting back existing levees (to restore floodplain storage areas)	4F - Flood warning and emergency response planning
		3G - Overtopping levees	

Category 5 - Additional BMPs from MN Public Drainage Manual
5A - Channel restoration to natural channel/two-stage channel design
5B - Side inlet pipes for grade stabilization
5C - Water and sediment control basins (WASCOBs)
5D - Saturated buffers
5E - Denitrifying bioreactors
5F - Rock riffles for in-channel rock grade control structures
5G - Reinforced concrete spillway for grade control
5H - Grassed waterways for channel tributaries
5I - Setting back existing levees/spoil banks to provide an appropriate floodplain width

2.2.3.1 JUSTIFICATION FOR NOT CARRIED FORWARD DESIGNATIONS

- Measure 1E: Other Beneficial Uses of Stored Water – Based on guidance from TP 11 this measure involves changing the operation plan of an existing storage reservoir to better utilize the NRE and FDR benefits of an existing project. Since there is no pre-existing project for the Swift Coulee / MCD #3 sub-watershed this measure will not meet the projects purpose and need and can therefore be eliminated from further analysis.
- Measure 3E: Culvert Sizing – Due to land slope and breakout elevations, systematically down-sizing culverts throughout the project area to retain water behind roadways will not meet the overall project goal of 10-year protection of agricultural lands. Therefore, this measure will not meet the purpose and need and can be eliminated.
- Measure 3G: Overtopping Levees – This flood damage reduction method is best used to preserve floodplain storage during large events by constructing levees that are to be overtopped during large events. Due to the land slope and existing roadway levels in this area, overtopping levees *would not* provide a significant amount of flood storage. Therefore, this measure can be eliminated since it does not meet the purpose and need.
- Measure 4A: Urban Levees – This measure can be eliminated since it does not apply to the project area and would not meet the purpose and need of the project.
- Measure 4B: Farmstead Levees – This measure can be eliminated since it does not apply to the project area and would not meet the purpose and need of the project.
- Measure 4F: Flood warning and emergency response planning – This measure was designated to not be carried forward since it does not address the project goals stated in Concurrence Point No. 1.
- Measure 5F: Rock Riffles for in-channel rock grade control structures – This measure can be eliminated since it is typically used as a measure to combat widespread stream erosion rather than aggradation. Isolated locations exist where channel erosion has taken place, but the majority of the channel has aggradation and rock riffles for in-channel rock grade control structures *would not* provide a significant amount of contribution towards the project need alone and therefore can be eliminated.
- Measure 5G: Reinforced concrete spillway for grade control – This measure can be eliminated since it is meant for unstable streams that are experiencing degradation, which does not apply to this project. Therefore, it can be eliminated since it does not meet the purpose and need.

2.2.4 MEASURE EVALUATION BASED ON ENVIRONMENTAL EFFECTS

After determining that specific measures could partially or substantially meet projects goals, each remaining measure was evaluated based on its anticipated effect on the aquatic ecosystem. Part of this evaluation was to identify fatal flaws that any of the measures might contain, as defined by the USACE. Each measure was then determined to be carried forward or eliminated from further analysis based on the anticipated environmental effects. Some measures have the potential to be environmentally damaging to areas downstream without being combined with another measure, which requires further study to

evaluate the combined effects. The measures within the second category from TP 11, (Increased Conveyance Capacity) 2B – 2E fall into this category. They have been given a ‘use caution’ designation and are highlighted in orange as shown in Table 3. Table 3 lists the remaining alternatives and highlights in red measures that are not to be carried forward.

Table 3: Measure Evaluation based on Environmental Effects

Category 1 – Reduce Flood Volume	Category 2 – Increased Conveyance Capacity	Category 3 – Increase Temporary Flood Storage	Category 4 – Protection/Avoidance
1A - Restore or create wetlands	2A - Channelization	3A – On-Channel Impoundments	4C - Agricultural levees
1B - Use cropland BMPs	2B - Agricultural Drainage	3B – Off-Channel Impoundments	4D - Evacuation of the floodplain
1C - Convert cropland to prairie or other types of perennial grassland	2C - Diversions	3C - Restore or create wetlands	4E - Floodproofing
1D - Convert land use to forest	2D - Setting back existing levees (to restore floodway capacity)	3D - Drainage	
	2E - Increasing road crossing capacity	3F - Setting back existing levees (to restore floodplain storage areas)	

Category 5 - Additional BMPs from MN Public Drainage Manual
5A - Channel restoration to natural channel/two-stage channel design
5B - Side inlet pipes for grade stabilization
5C - Water and sediment control basins (WASCOBs)
5D - Saturated buffers
5E - Denitrifying bioreactors
5H - Grassed waterways for channel tributaries
5I - Setting back existing levees/spoil banks to provide an appropriate floodplain width

2.2.4.1 JUSTIFICATION FOR NOT CARRIED FORWARD DESIGNATIONS

- Measure 2A: Channelization – Though channelization of the natural waterways would have a flood reduction benefit to the direct project area, it would increase flood damages downstream and significantly decrease the natural resources within the region. Therefore, this measure would not meet the project goals.
- Measure 3A: On-Channel Impoundments – An on-channel impoundment would reduce flood damages in the area but would also have profound adverse impacts on the natural environment. These impacts include the loss of stream connectivity, the loss of habitat within the dam footprint, and long term sedimentation within the pool area, leading to degraded water quality and aquatic habitat. Ultimately, this measure would contribute to the flood damage reduction goals of the project but have negative implications for the natural resource enhancement goals. For this reason, this measure should not be carried forward for further analysis.

- Measure 3D: Drainage – The flood reduction benefits from increasing subsurface drainage (through the installation of tile lines) to increase storage within the soil profile is in most cases offset by the drainage of depressional areas that had previously held surface runoff on the landscape. Draining depressional areas like these also has adverse effects on natural resources within the region.
- Measure 4C: Agricultural Levees – Agricultural levees within the context of this report are defined as levees built within the natural floodplain meant to protect cropped lands to a certain stage or water surface elevation. While agricultural levees would have flood damage reduction benefits to agricultural areas within the project, constricting the floodplain would have adverse ecological effects within the project reach, as well as potentially adverse flood damage effects downstream (by removing a portion of the natural floodplain storage). For these reasons, this measure would adversely affect the natural resource enhancement goals of the project and should be eliminated from further analysis.

2.2.5 MEASURE EVALUATION BASED ON PRACTICALITY

Each of the remaining measures were also evaluated from a practicality standpoint as another method for comparing potential solutions and narrowing the number of measures to be carried forward for further analysis. The practicality evaluation was based on each measure’s estimated cost, logistics, and existing technology restraints. The logistical evaluation of each measure considered several important project attributes, including estimated assurance of voluntary participation, financial resources necessary for project component construction/implementation, probability of attaining environmental permits and other necessary approvals, and technical/topographic feasibility. Since the proposed measures rely on existing methods and means of construction (none require a new technology to be developed for implementation), the existing technology category is considered evenly split between the identified solutions. Based on the practicality evaluation, each measure was categorized with either a ‘carry forward’ or ‘do not carry forward’ designation. Table 4 below summarizes each remaining measure’s designation based on practicality (do not carry forward designations highlighted in red).

Table 4: Measure Evaluation based on Practicality

Category 1 – Reduce Flood Volume	Category 2 – Increased Conveyance Capacity	Category 3 – Increase Temporary Flood Storage	Category 4 – Protection/Avoidance
1A - Restore or create wetlands	2B - Agricultural Drainage	3B - Off-Channel Impoundments	4D - Evacuation of the floodplain
1B - Use cropland BMPs	2C - Diversions	3C - Restore or create wetlands	4E - Floodproofing
1C - Convert cropland to prairie or other types of perennial grassland	2D - Setting back existing levees (to restore floodway capacity)	3F - Setting back existing levees (to restore floodplain storage areas)	
1D - Convert land use to forest	2E - Increasing road crossing capacity		

Category 5 - Additional BMPs from MN Public Drainage Manual
5A - Channel restoration to natural channel/two-stage channel design
5B - Side inlet pipes for grade stabilization
5C - Water and sediment control basins (WASCOBs)
5D - Saturated buffers
5E - Denitrifying bioreactors
5H - Grassed waterways for channel tributaries
5I - Setting back existing levees/spoil banks to provide an appropriate floodplain width

2.2.5.1 JUSTIFICATION FOR NOT CARRIED FORWARD DESIGNATIONS

- Measure 1B: Use cropland BMPs – The use of cropland BMPs, such as conservation tillage, to increase infiltration and thereby reduce runoff amounts would have both positive effects on flood damage reduction and natural resource enhancement in the region. However, a large amount of land within the watershed would need to adopt such practices to meet the projects established goals for flood damage reduction. It is not practicable to assume so many different landowners within the watershed would be willing to embrace these conservation measures and therefore this alternative can be eliminated from further analysis.
- Measure 1C: Convert cropland to prairie or other types of perennial grassland – Like measure 1B, this measure would be an effective means of reducing flood damages and enhancing the natural resources of the region if an impracticable number of landowners participated. Since the practicable amount of land that can be assumed to be converted to grassland will not make a significant difference in reducing the flood peak or volume, this measure can be eliminated from further analysis.
- Measure 1D: Convert land use to forest – This measure would require the acquiring of both permanent easement (or purchase) of large amounts of land and the planting to establish a forested ecosystem. This measure is not practicable due to both the estimated financial investment and the willingness of many landowners to sell or enroll their land for such a practice. The amount of land that could be practicably converted to forest would not meet the flood damage reduction goals of the project, and can thereby be eliminated from further analysis.
- Measure 2E: Increasing road crossing capacity – Increasing each road crossing capacity would lead to larger peak flows downstream of each crossing, potentially resulting in adverse flood conditions and landowner disputes. It is neither practicable nor prudent to implement this measure as a solution to the problems identified within the watershed. Therefore, it can be eliminated from further consideration.
- Measure 4D: Evacuation of the Floodplain – The evacuation of the floodplain would have positive effects utilizing existing flood storage and partially remove the need for a flood damage reduction type project within the sub-watershed. However, a large amount of land within the watershed would need to adopt evacuation to meet the projects established goals for flood damage reduction. It is not practicable to assume so many different landowners within the watershed would be willing to embrace these conservation measures and therefore this alternative can be eliminated from further analysis.

- Measure 4E: Floodproofing – Floodproofing includes raising buildings and critical access roads to higher elevations to avoid inundation during flooding times. Though this might reduce flood risk for some properties, it is impracticable to floodproof every property at risk within the watershed. Further, floodproofing will have no effect on agricultural land damages, will not satisfy the purpose and need for the project, and little effect on enhancing natural resources. Therefore, this measure can be eliminated from further analysis.
- Measure 5C: Water and sediment control basins (WASCOBs) – WASCOBs require both landowner participation and the right amount of topographic relief to be technically feasible. WASCOBs are generally small structures that have the most benefit to regions directly downstream of them with diminishing benefit further downstream in the watershed. Therefore, its use as a measure to address the problems within the watershed can be eliminated based on its technical inability to reach the project goals.
- Measure 5D: Saturated buffers – Saturated buffers utilize a tiled field and control structures to disperse subsurface runoff over a wide vegetated area before it enters the waterway. Most of the fields adjacent to the Swift Coulee / MCD #3 corridor are not tiled, and therefore could not utilize this measure. It is impracticable and financially infeasible to implement the amount of tile, land, and control structures that would be required to meet the project goals using saturated buffers. Therefore, this measure can be eliminated from further analysis.
- Measure 5E: Denitrifying bioreactors – Denitrifying bioreactors are used to reduce nitrogen levels from subsurface agricultural flows. Though there are some tiled fields within the watershed, most of the land does not drain through subsurface drainage. Therefore, the use of this measure to reduce nutrient loads is not feasible. In addition, many of the already tiled fields lack adequate room for the installation of a bioreactor. Therefore, this measure can be eliminated based on its technical infeasibility to meet the project goals.
- Measure 5H: Grassed waterways for channel tributaries – Several small localized agricultural drainageways flow into the Swift Coulee that are not already grassed and buffered. The additional enrollment of these small tributaries into some form of conservation easement would provide some NRE benefit but little to no flood damage reduction. Therefore, this measure can be eliminated from further consideration.

2.3 ALTERNATIVES DEVELOPMENT

After eliminating multiple measures from further evaluation, ten potential measures remain. Three of the measures include setting back existing levees for various reasons and are essentially the same measure (setting back existing levees). Two of the measures involve restoring or creating wetlands to reduce flood volume or increase temporary flood storage and are essentially the same measure (restore or create wetlands). Therefore, seven total measures remain and are listed below:

- Restore or create wetlands
- Agricultural Drainage
- Diversions
- Setting back existing levees
- Off-channel impoundment sites
- Channel restoration
- Side inlet pipe installations

The remaining measures can be combined to form project alternatives for development and screening. [Exhibit 5](#) illustrates some conceptual layout of the remaining measures that potentially can contribute to the project goals set forth in Concurrence Point #1. Many of the measures could be combined with multiple other measures to formulate alternatives, creating hundreds of potential alternative combinations to evaluate. A comprehensive, but not exhaustive, list of alternatives has been formulated based primarily on whether the alternative is anticipated to meet the project's established goals of flood damage reduction and potential enhancement of natural resources. A list of the project alternatives for further development and screening are provided below:

1. Restore or create wetlands
2. Agricultural drainage and side inlet pipe installations
3. Diversion
4. Off-channel impoundment site
5. Channel restoration, set back levees, and side inlet pipe installations
6. Combination of alternatives 1, 2, and 3
7. Combination of alternatives 1, 2, and 4
8. Combination of alternatives 1, 3, and 4
9. Combination of alternatives 1, 2, 3, and 4
10. Combination of alternatives 1, 2, and 5
11. Combination of alternatives 1, 4, and 5
12. Combination of alternatives 1, 2, 4, and 5

2.3.1 ELIMINATION OF ALTERNATIVES THROUGH PRELIMINARY HYDROLOGIC AND HYDRAULIC MODELING

It has been determined that six of the alternatives would not substantially meet the purpose and need of the project and have been eliminated from further analysis.

2.3.1.1 JUSTIFICATION FOR ELIMINATION OF ALTERNATIVE

- 1. Restore or create wetlands – The restoration or creation of wetlands was eliminated based on the watershed’s lack of drained wetland basins. However, this measure would have some FDR/NRE benefit and could be part of a multi-measure approach to accomplish the purpose and need of the project. Therefore, the alternative should remain as part of combination alternatives that move forward for further analysis.
- 2. Agricultural drainage and side inlet pipe installation – The agricultural drainage and side inlet pipe installation alternative was eliminated because as a standalone alternative, drainage improvements to MCD #3 alone would not satisfy the purpose and need of the project. This alternative alone would not provide flood damage reduction to agricultural lands from 10-year 24-hour rainfall event upstream of MCD #3 adjacent to the Swift Coulee. Drainage improvements to MCD #3 would benefit agricultural lands adjacent to MCD #3 and could be part of a multi-alternative approach to accomplish the purpose and need of the project. Therefore, the alternative should remain as part of combination alternatives that move forward for further analysis.
- 3. Diversion – The diversion of portions of the Swift Coulee alternative was eliminated because as a standalone alternative, diversion alone would not satisfy the purpose and need of the project. This alternative alone would not provide flood damage reduction to agricultural lands from 10-year 24-hour rainfall event downstream on MCD #3 and areas of the downstream portions of the Swift Coulee. Diversion would benefit agricultural lands adjacent to the Swift Coulee in the upstream end of the sub-watershed and could be part of a multi-alternative approach to accomplish the purpose and need of the project. Therefore, the alternative should remain as part of combination alternatives that move forward for further analysis.
- 4. Off-channel impoundment site – Off-channel impoundment site alternative was eliminated because as a standalone alternative, an off-channel impoundment site located either upstream or downstream within the sub-watershed alone would not satisfy the purpose and need of the project. This alternative alone would not provide flood damage reduction to agricultural lands from the 10-year 24-hour rainfall event for the entire the sub-watershed. An off-channel impoundment would benefit agricultural lands downstream from the impoundment site location and could offset potential impacts created from other alternatives that increase capacity and could be part of a multi-alternative approach to accomplish the purpose and need of the project. Therefore, the alternative should remain as part of combination alternatives that move forward for further analysis.
- 5. Channel restoration, set back levees, and side inlet pipe installations – The channel restoration, set back levees, and side inlet pipe installation alternative was eliminated because as a standalone alternative, channel restoration and set back levees of the Swift Coulee alone would not satisfy the purpose and need of the project. This alternative alone would not provide flood damage reduction to agricultural lands from a 10-year 24-hour rainfall event for the majority of the sub-watershed. Channel restoration and set back levees of the Swift Coulee would benefit agricultural lands adjacent to the Swift

Coulee and could be part of a multi-alternative approach to accomplish the purpose and need of the project. Therefore, the alternative should remain as part of combination alternatives that move forward for further analysis.

Alternatives 1 through 5 will be eliminated when considered as sole measure solutions.

2.3.2 ALTERNATIVES MOVING FORWARD FOR DETAILED ANALYSIS

The remaining alternatives 6, 7, 8, 9, 10, 11, and 12 will be carried forward for further analysis in Concurrence Point #3. The remaining list of alternatives have provided enough benefit through preliminary Hydrologic and Hydraulic modeling to at least partially satisfy the purpose and need of the project and warrant further detailed analysis.

Table 5: Alternatives Evaluation Matrix

Swift Coulee - MCD #3 Alternative Evaluation Matrix							
	Potential to Reduce Breakouts on MCD #3	Potential to Improve Adjacent Ag Drainage	Potential to Reduce Impacts to Infrastructure	Benefit Upstream of HWY 75	Benefit Downstream of HWY 75	Effect on Snake River	Potential to Meet Purpose and Need
1	Restore or Create Wetlands	0	0	0	0	0	N
2	CD3 Ditch Improvement	++	++	+	0	++	N
3	Diversion	-	0	0	+	-	N
4a	Upstream Impoundment Site	0	+	+	+	0	N
4b	Downstream Impoundment Site	++	++	+	0	+	N
5	Channel Restoration, Set Back Levees	0	++	+	++	-	N
6	Diversion + CD3 Ditch Improvement	+	+	+	+	-	Y
7	Upstream Impoundment + CD3 Ditch Improvement	++	+	+	+	++	Y
8	Downstream Impoundment + Diversion	+	+	+	+	0	Y
9	Downstream Impoundment + Diversion + CD3 Ditch Improvement	++	++	++	+	++	Y
10	CD3 Ditch Improvement + Channel Restoration, Set Back Levees	++	++	++	++	-	Y
11	Downstream Impoundment + Channel Restoration	++	++	++	++	0	Y
12	CD 3 Ditch Improvement + Downstream Impoundment + Channel Restoration	++	++	++	++	0	Y

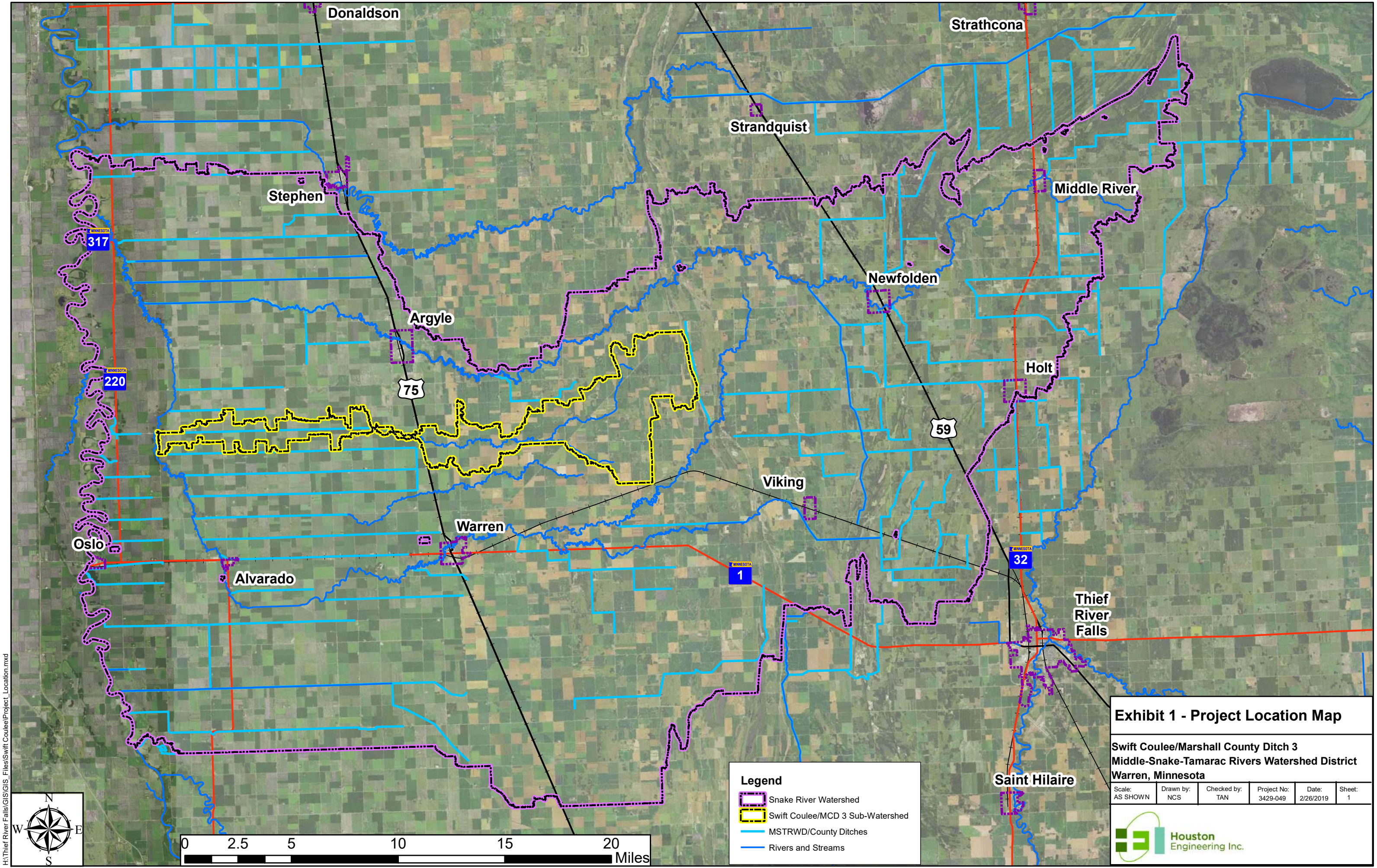






Exhibit 1 - Project Location Map

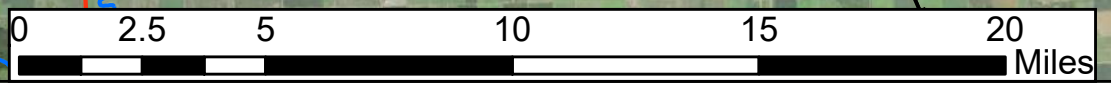
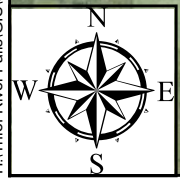
Swift Coulee/Marshall County Ditch 3
 Middle-Snake-Tamarac Rivers Watershed District
 Warren, Minnesota

Scale: AS SHOWN	Drawn by: NCS	Checked by: TAN	Project No: 3429-049	Date: 2/26/2019	Sheet: 1
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Legend

-  Snake River Watershed
-  Swift Coulee/MCD 3 Sub-Watershed
-  MSTRWD/County Ditches
-  Rivers and Streams

H:\Thief River Falls\GIS\GIS_Files\Swift Coulee\Project_Location.mxd



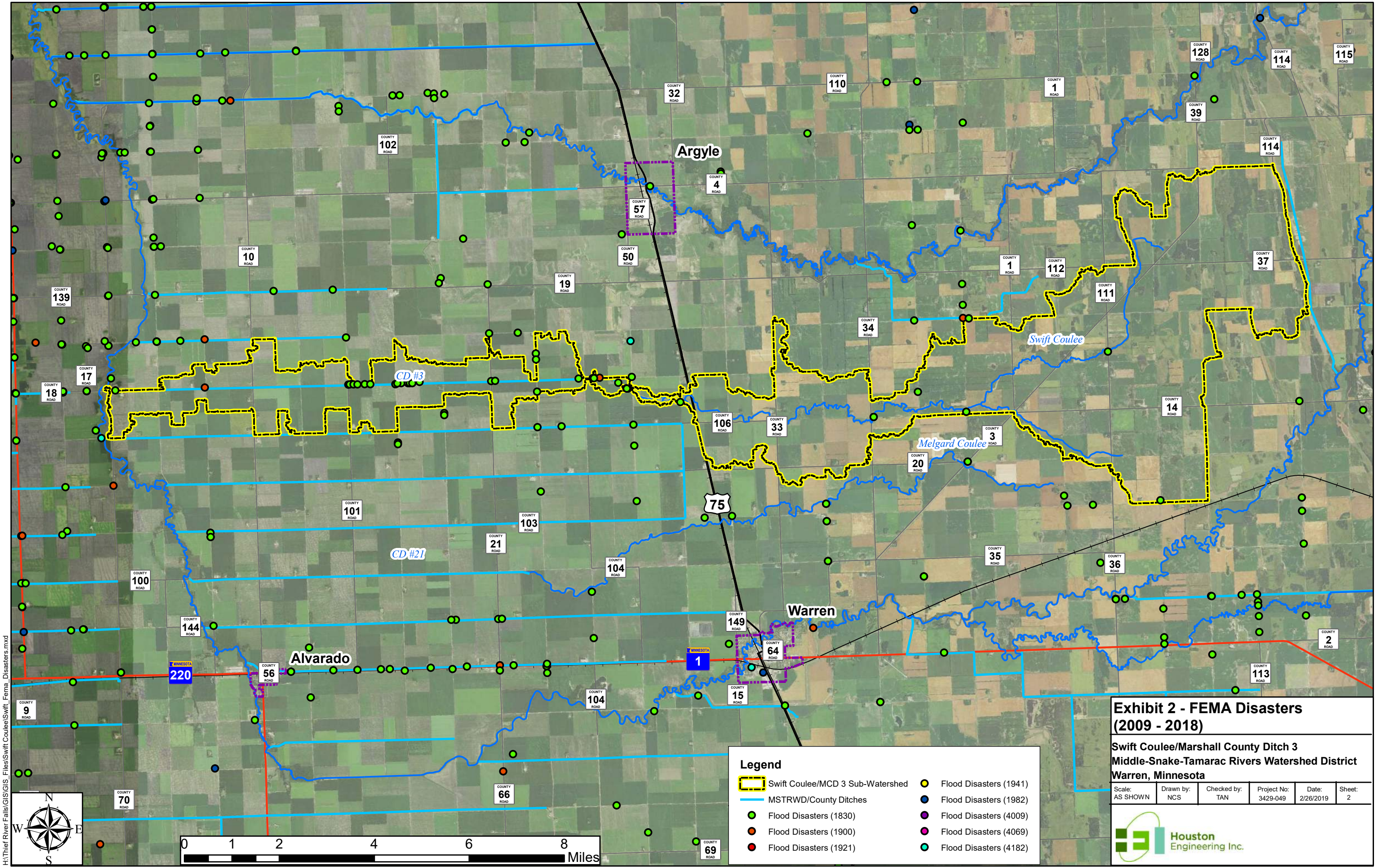


Exhibit 2 - FEMA Disasters (2009 - 2018)

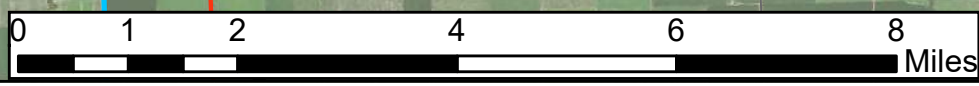
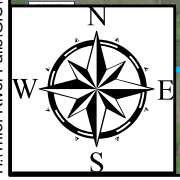
**Swift Coulee/Marshall County Ditch 3
Middle-Snake-Tamarac Rivers Watershed District
Warren, Minnesota**

Scale: AS SHOWN	Drawn by: NCS	Checked by: TAN	Project No: 3429-049	Date: 2/26/2019	Sheet: 2
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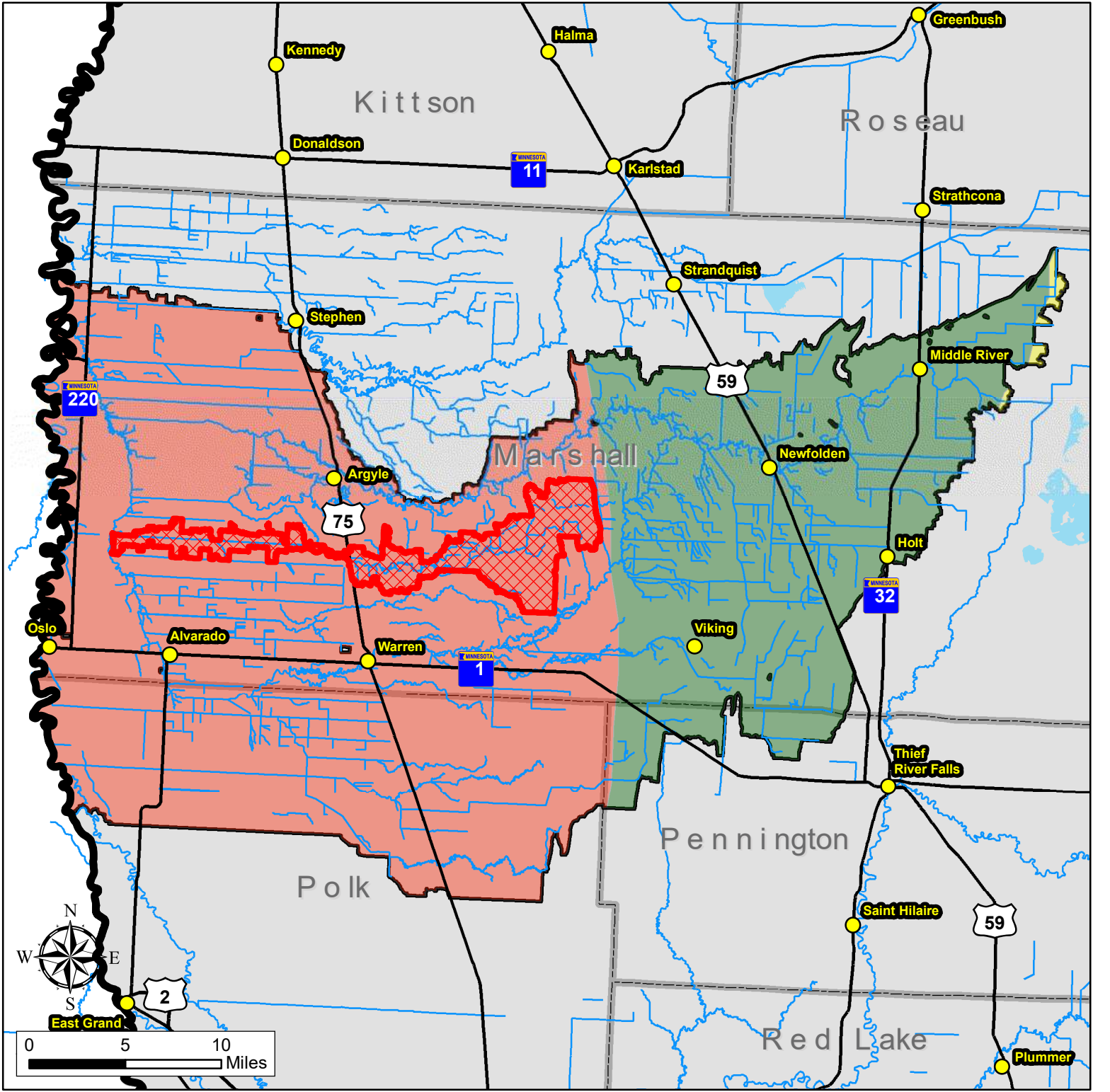
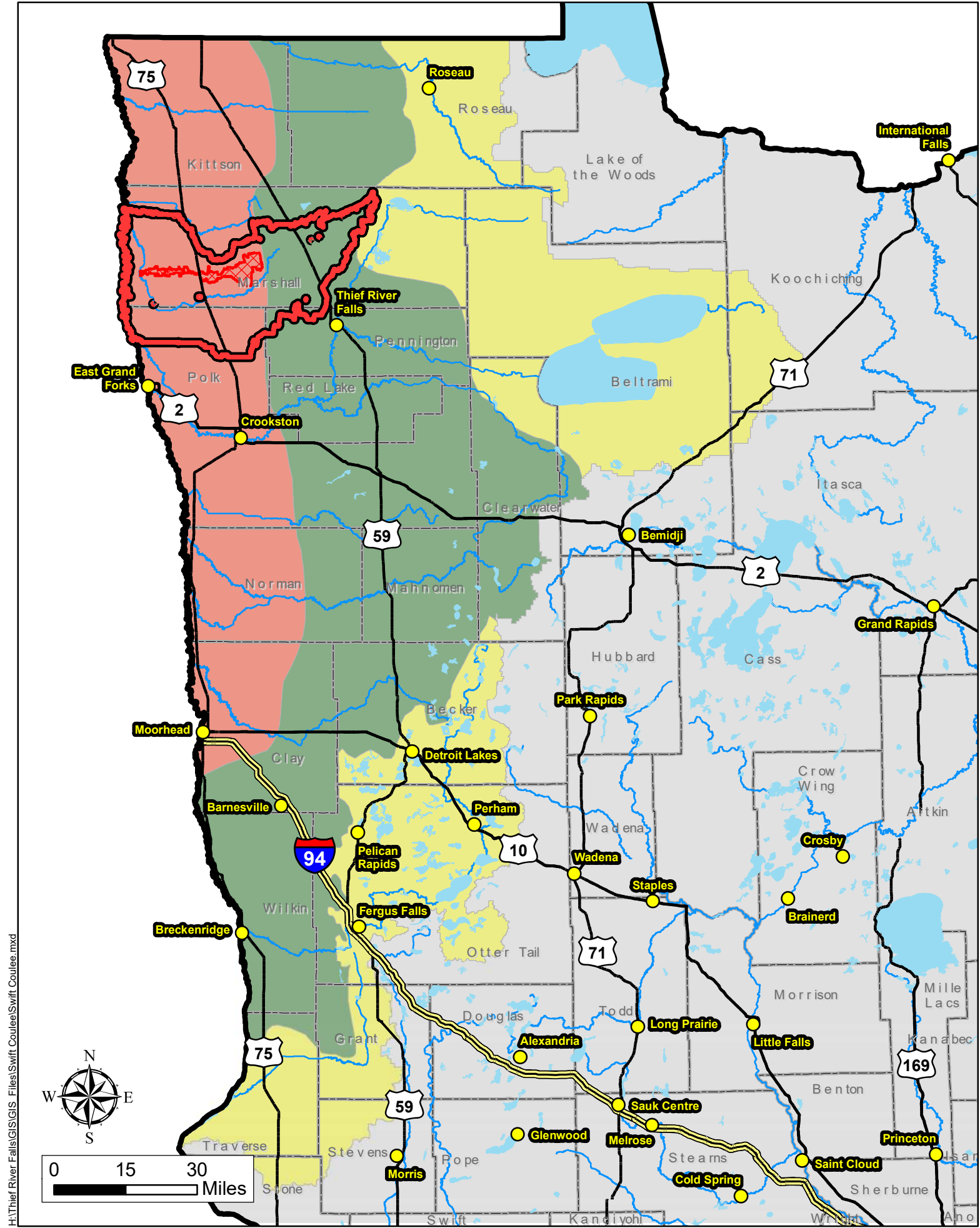
Legend

- Swift Coulee/MCD 3 Sub-Watershed
- MSTRWD/County Ditches
- Flood Disasters (1830)
- Flood Disasters (1900)
- Flood Disasters (1921)
- Flood Disasters (1941)
- Flood Disasters (1982)
- Flood Disasters (2009)
- Flood Disasters (2069)
- Flood Disasters (2018)

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Houston Engineering Inc.



General Timing Zones

- Early
- Middle
- Late

Snake River Watershed

Swift Coulee/MCD #3 Drainage Area

Cities

Counties

Exhibit 4: Early-Middle-Late Flood Timing Concept

Swift Coulee/Marshall County Ditch 3
Middle-Snake-Tamarac Rivers Watershed District
Warren, Minnesota

Scale: AS SHOWN	Drawn by: NCS	Checked by: TAN	Project No.: 3429-049	Date: 2/25/2019	Sheet: 4
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HoustonEngineering Inc.

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Swift Coulee/MCD#3

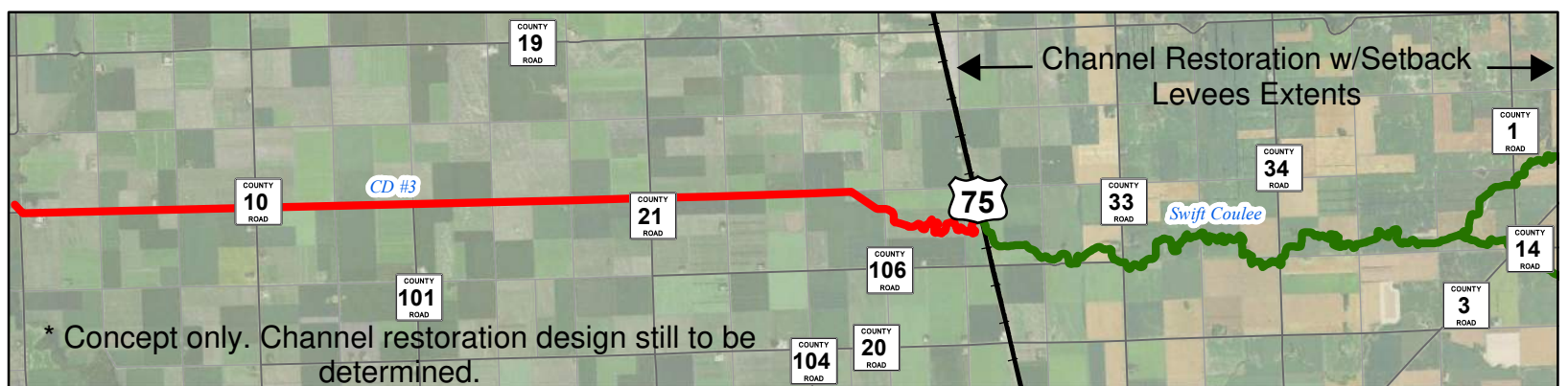
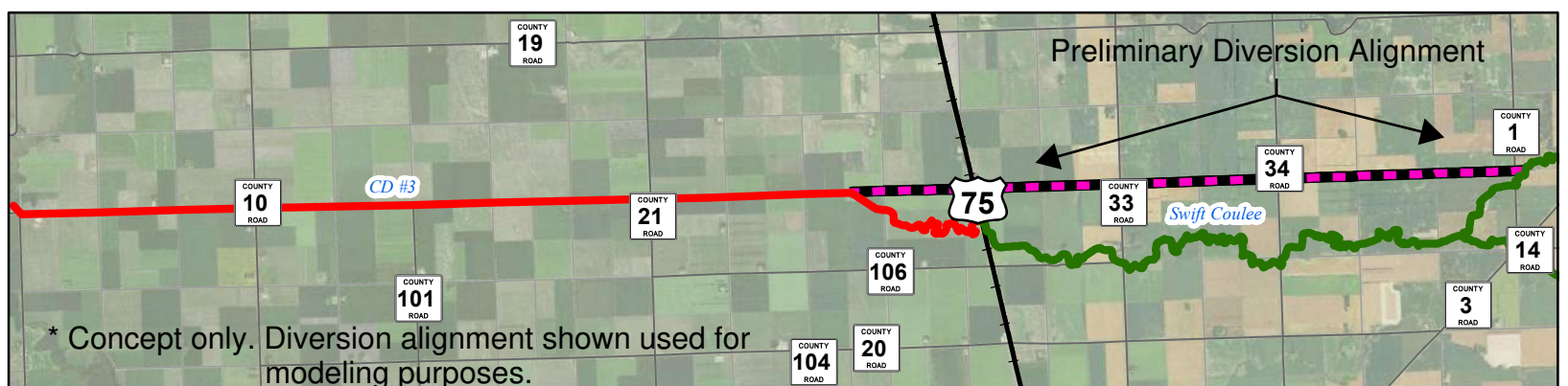
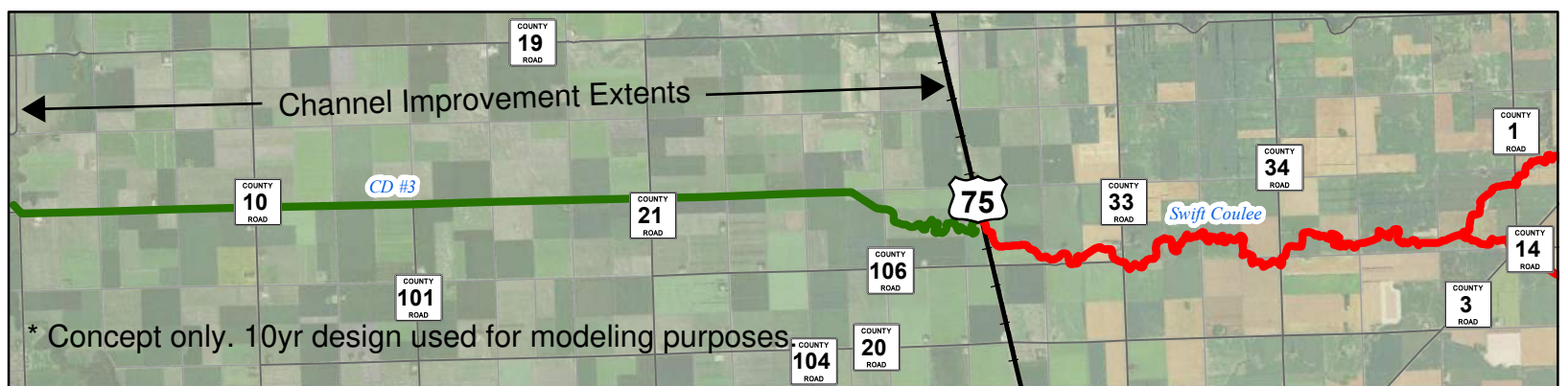
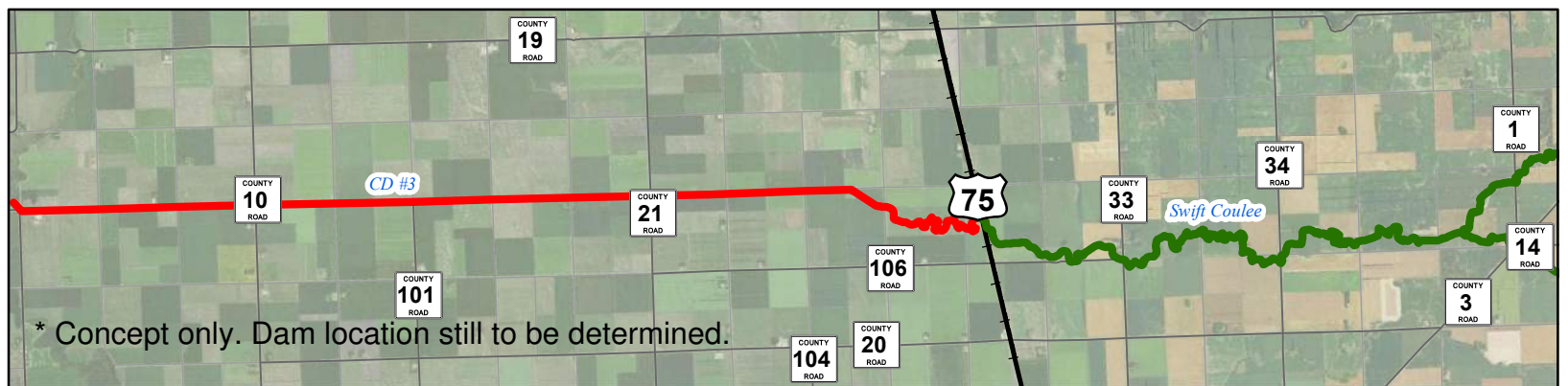
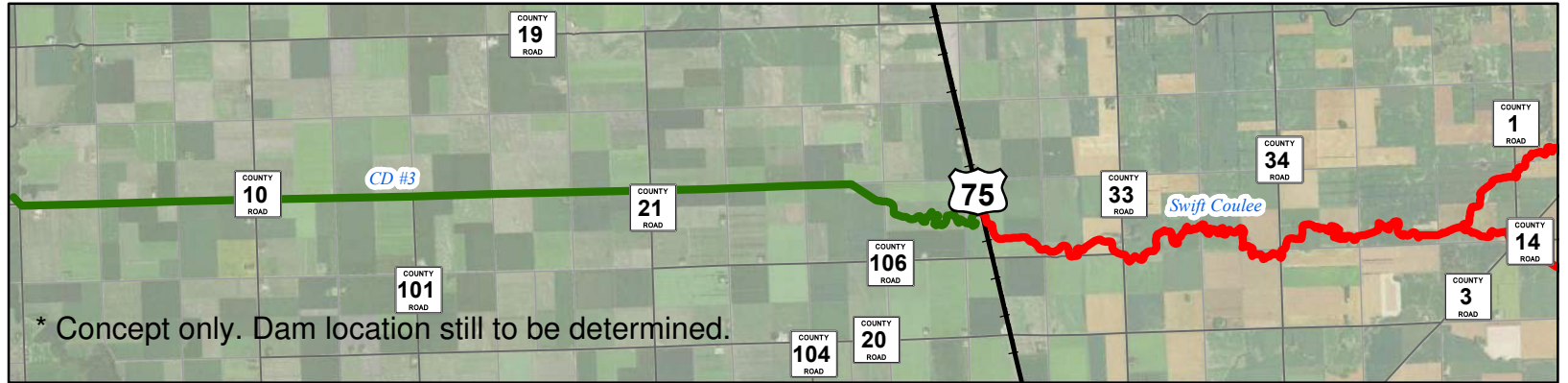
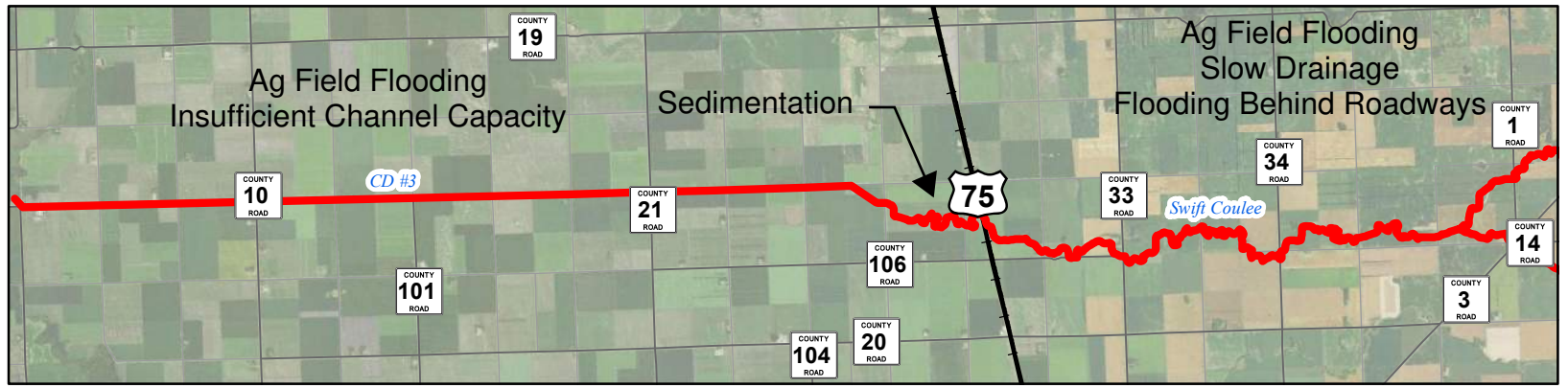


Exhibit 5: Alternative Development & Initial Screening

Swift Coulee/Marshall County Ditch #3
Middle-Snake-Tamarac Rivers Watershed District
Warren, Minnesota

