JUDICIAL DITCH #19 WATERSHED PLAN

Middle-Snake-Tamarac Rivers Watershed District

Concurrence Point #3:
Identification of the Selected Alternative

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1 APPROACH

The Middle Snake Tamarac Rivers Watershed District (MSTRWD) entered into a cooperative agreement with the National Resource Conservation Service (NRCS) in 2016 to complete a Watershed Plan through the Regional Cooperation Partnership Program (RCPP) for the Judicial Ditch #19 Watershed (JD 19). The JD 19 Watershed is a 104 square mile sub-watershed of the Tamarac River Watershed and is shown on **Figure 1**. Review Point #4 of the NRCS Watershed Planning process consists of reviewing potential alternatives within the watershed. This document summaries the screening of alternatives for the Judicial Ditch #19 Watershed Plan.

1.1 PURPOSE AND NEED

Preliminary development of alternatives focused on narrowing the range of alternatives by reviewing and analyzing technical and practical considerations to evaluate potential to meet project objectives from the Purpose and Need. Strategies were first evaluated based on known causes of flooding. In some cases, a preliminary hydrologic analysis was completed to reasonably evaluate a strategies' potential to meet flood damage reduction objectives. Alternative concepts that were based on strategies that would meet the project objectives were then developed and preliminarily analyzed to further narrow the range of alternatives based on the ability to address the Purpose and Need. The Purpose and Need specifies objectives listed below for the Project.

1. Provide flood damage reduction to agricultural lands due to a 10-year 24-hour rainfall event.
2. Reduce flood damage to public transportation infrastructure within the Judicial Ditch #19 sub-watershed.
3. A secondary purpose to contribute to the overall basin-wide goal of reducing peak flows to the Red River of the North by 20%.

To assist with a comparative analysis of the alternatives, the following indicators were established as pass-fail criteria for the preliminary development of alternatives. The objectives and associated indicators are summarized below:

- **INDICATOR NO. 1:** Reduce total inundated acres for flood durations between 24 and 120 hours (1-5 days) for the 10-year, 24-hour rainfall event by 5%. While crop damage depends on both duration and depth of inundation, for this analysis it was assumed crop damages would not occur for durations less than 24 hours. Inundation greater than 5 days would result in total crop loss. Due to the existing flood damages that occur within the watershed, many landowners have taken cropland out of production. If the total inundation is reduced for durations between 24 and 120 hours during a 10-year event, then land currently out of agricultural production may be reintroduced as cropland.
- **INDICATOR NO. 2**: Reduce the peak flow rate at the US Highway 59 and Judicial Ditch #19 crossing by 20% for the 10-year and 100-year, 24-hour rainfall event.
- **INDICATOR NO. 3**: Reduce the volume of flow at the US Highway 59 and Judicial Ditch #19 crossing by 20% for the 10-year and 100-year, 24-hour rainfall event.
- **INDICATOR NO. 4**: No increase in peak flow rate at the outlet of the Judicial Ditch #19 Watershed for the 10-year and 100-year, 24-hour rainfall event. This indicator will be measured based on the flow rate of the Tamarac River downstream of the JD 19 confluence.

The alternatives that successfully achieve the objectives defined in the Purpose and Need statement based on the presented indicators are proposed to be carried forward for a detailed review. All reasonable

alternatives that were identified were considered, regardless of eligibility under Public Law 83-566, or other NRCS administered funding sources.

1.2 EXISTING CONDITIONS

The upstream 69 square miles of the JD 19 watershed flows through the existing East Park Flood Control Wildlife Management Area (Nelson Slough) impoundment. Nelson Slough's footprint covers1,700 acres and qualifies as a low hazard dam within the 10,427 acre East Park Wildlife Management Area. Construction of Nelson Slough was completed in 1971, and the outlet structure was repaired in 2003. The outlet structure consists of a sliding gate and a two stage concrete spillway. The sliding gate consists of a 6-foot wide mechanical gate that opens from the sill of the outlet structure with a maximum opening height of 4.5'. This gate is not used for day to day operation and remains closed unless drawdown is necessary for internal maintenance. The primary outlet and weir crest is a 6-foot wide fixed concrete weir, and the secondary spillway is a 70-foot wide fixed concrete weir acting as the auxiliary spillway. The critical elevations for Nelson Slough are shown in **Table 1**. The map overview is shown on **Figure 1.2**.

The plans and operations and maintenance manual for Nelson Slough reference elevations in the National Geodetic Vertical Datum of 1929 (NGVD29). Elevations within this report are in reference to the North American Vertical Datum of 1988 (NAVD88). The conversion between the two datums varies throughout North America. A conversion factor for Nelson Slough was produced using the National Geodetic Survey, VERTCON conversion tool. The conversion factor for Nelson Slough is 1.30 feet.

$$NGVD29 + 1.3' = NAVD88$$

$$1101.0'(NGVD29) + 1.3' = 1102.3'(NAVD88)$$

Table 1: East Park WMA - Nelson Slough Impoundment

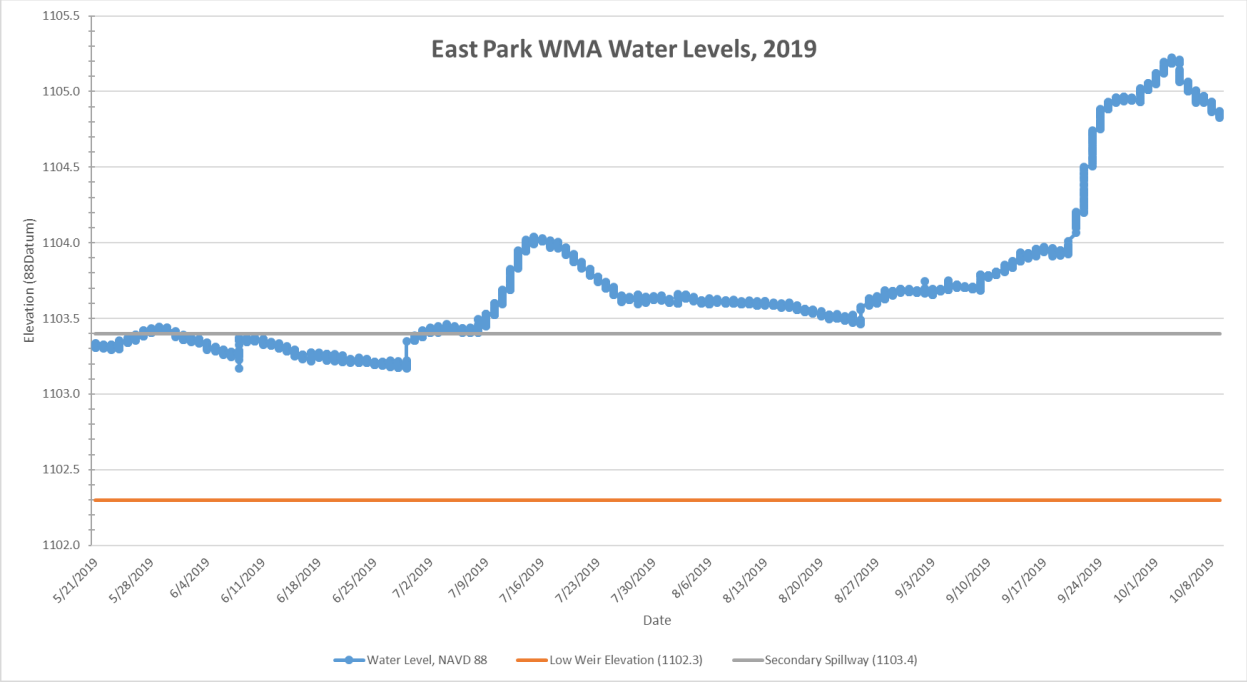
Critical Elevation[1]	Length	NGVD29	NAVD88
Sill of Primary Sliding Gate[2]	6 feet	1097.2	1098.5
Primary Weir Crest	6 feet	1101.0	1102.3
Secondary Weir Crest	70 feet	1102.2	1103.5
Top of Dam	5.1 miles	1105.0	1106.3

[1] Lengths and Elevations are published values in the Operations and Maintenance Manual

[2] Sliding gate installed in 2003. Gate is only used for drawdown.

With the current operation plan and outlet structure geometrics, Nelson Slough often maintains an elevation higher than the normal pool elevation identified in the operating plan of 1102.3'. The primary weir crest consists of a 6-foot wide weir at 1102.3'. The secondary weir crest consists of a 70-foot wide weir at 1103.5'. The DNR installed a temporary gage in 2019 to record the water level within the Nelson Slough. During this time period, the lowest water level recorded was approximately 1103.2' and the highest water level recorded was approximately 1104.1'. There was flow over the secondary spillway for approximately 75% of this time period, and the water level was 0.9' to 1.8' above the normal pool elevation for the duration of monitoring. The temporary gage readings are shown in **Table 2**.

Table 2: Nelson Slough 2019 Water Level Gage Data



Hydraulic and hydrologic modeling indicates that it would take multiple months, without any additional rainfall, for the site to draw down from 1103.5 to 1102.3. These results are validated by the water level recordings from the summer of 2019. Based on this information, it is evident that with the existing outlet operations the site will rarely operate at the normal pool elevation of 1102.3.

The starting water surface elevation for Nelson Slough for all simulations in this analysis, unless otherwise noted, was set to 1103.5'. This elevation was selected based on the 2019 DNR gage readings and the hydrologic and hydraulic modeling analysis and the drawdown duration.

2 CONCURRENCE POINT #2

2.1 ALTERNATIVE DEVELOPMENT AND INITIAL SCREENING

In the second concurrence point a wide array of potential flood damage reduction (FDR) and natural resource enhancement (NRE) measures were screened and evaluated in order to measure each one's ability to accomplish the project goals as defined in the Purpose and Need. The initial phase of the development of alternatives was a review of a comprehensive list of strategies that represent categorized types of alternatives. The goal of the strategy evaluation was to narrow the scope of preliminary alternative review through the acceptance or elimination of strategies based on limited technical evaluation, environmental affects, and practical considerations. To aid in this review, strategies from the Technical and Scientific Advisory Committee of the Red River Basin Flood Damage Reduction Work Group Technical Paper No. 11 (TSAC, 2004) were analyzed. As a result of the second concurrence point, seven alternatives were analyzed and screened. Four alternatives were determined to be carried forward for further analysis. These alternatives include:

1. ~~Drainage Improvement~~

2. Branch M Impoundment Site
3. Alternative 3 – Branch J Impoundment Site Option 1
4. Alternative 4 – Branch J Impoundment Site Option 2
5. ~~East Park Township Impoundment Site~~
6. ~~Lincoln Township Impoundment Site~~
7. Nelson Slough Improvements

3 CONCURRENCE POINT #3

The strategies identified in the Initial Strategy Evaluation were used to preliminarily identify a range of alternatives. These alternatives were then analyzed to determine their potential to attain the objectives from the Purpose and Need statement. The following sections provide a brief description of each alternative considered.

For the JD 19 Watershed, the no-action alternative, is identical to existing conditions within the watershed. No land use changes, potential hydrologic changes, or potential hydraulic changes are anticipated if an alternative is not selected as part of the Watershed Plan.

3.1 IDENTIFICATION OF THE SELECTED ALTERNATIVE

Alternatives identified for this phase of alternative investigation consisted of review of the existing conditions hydrologic and hydraulic model, available topographic field survey data, LiDAR topographic data, and other readily available geospatial information. A watershed map illustrating the location(s) of the identified alternative components is shown on **Figure 3.1a**. Throughout the alternative development process, an effort was made to minimize impacts to wetlands, biodiverse areas, and building sites. Therefore, alternative components were located to minimize the impact to native plant species identified by the Minnesota County Biological Survey (MCBS) and the National Wetland Inventory (NWI). Native plant species and wetlands identified by the NWI within the JD 19 Watershed are shown on **Figure 3.1b**. The 10-year and 100-year, 24-hour rainfall events were used to compare hydrologic and hydraulic model results. In order to evaluate the hydrologic and hydraulic model results, the same reporting locations for each alternative were used as shown on **Figure A.1** in **Appendix A**.

3.1.1 ALTERNATIVE 1 – DRAINAGE IMPROVEMENT

Alternative 1 has been eliminated as an alternative due to its potential downstream impacts to the lower portion of JD 19 Watershed and the Tamarac River (see Concurrence Point #2).

3.1.2 ALTERNATIVE 2 – BRANCH M IMPOUNDMENT SITE

Alternative 2 consists of a proposed impoundment site in East Park Township along Branch M of JD 19. The site would consist of an impoundment constructed of earthen embankments primarily located in Sections 33 and 34 in East Park Township and Sections 3 and 4 of New Maine Township. The impoundment would be constructed across JD 19 Branch M. In the upstream watershed, a 1.8 mile diversion ditch would divert flows from the upstream watersheds of Branch J and Branch K into the headwaters of Branch M. Branch M carries flows from the upstream watershed into the site. The impoundment site would include an outlet riser structure and earthen auxiliary spillway.

Branch M Impoundment Site would have a drainage area of 10.7 square miles and would provide 1,723 acre-feet (3.0 inches) of flood storage at the gated pool with a total of 2,890 acre-feet (5.1 inches) of flood storage below the auxiliary spillway. A portion of the drainage area that currently contributes to Nelson Slough will be diverted to the impoundment site via the diversion ditch. The flood pool would require a total estimated area of 1,060 acres at the top of dam elevation. Impoundment site statistics are shown in **Table 3**. The inundated area within the impoundment site would vary depending on the flood event. A site map for the Branch M Impoundment Site is shown on **Figure 3.1.2**.

The hydraulic model was modified to include the Branch M Impoundment Site and was used to analyze the 10-year and 100-year, 24-hour events. **Table 5** and **Table 6** show the resulting peak flow and volume changes at the identified reporting locations, and inundated acreage changes in the JD 19 Watershed. Inundated acres within the impoundment flood pool are not included in the reported values. Hydrographs at the identified reporting locations are available in **Appendix A.2**.

The Branch M Impoundment Site has multiple native species and wetlands within the impoundment site footprint. Wetlands located within the impoundment footprint, interior ditches, and flood pool will be impacted by fill, excavation, and varying inundation depending on operational management. The Branch M Impoundment Site is anticipated to impact approximately 462 acres of NWI identified wetlands. Anticipated wetland impacts are quantified in **Table 4**.

3.1.3 ALTERNATIVE 3 – BRANCH J IMPOUNDMENT SITE OPTION 1

Alternative 3 consists of a proposed impoundment site in Huntly Township along Branch J of JD 19. The site would consist of an impoundment constructed of earthen embankments primarily located in Sections 16, 17, 18, 19, and 20 in Huntly Township. The impoundment would be constructed across JD 19 Branch J near the confluence of Branch J and JD 19 Main. Branch K and Branch J carry flows from the upstream watershed into the site. The impoundment site would include an outlet riser structure and earthen auxiliary spillway.

Branch J Impoundment Site Option 1 would have a drainage area of 9.5 square miles and would provide 887 acre-feet (3.1 inches) of flood storage at the gated pool with a total of 1,154 acre-feet (6.9 inches) of flood storage below the auxiliary spillway. The site and drainage area are located entirely upstream of Nelson Slough. The flood pool would require a total estimated area of 1,714 acres at the top of dam elevation. Impoundment site statistics are shown in **Table 3**. The inundated area within the impoundment site would vary depending on the flood event. A site map for the Branch J Impoundment Site Option 1 is shown on **Figure 3.1.3**.

The hydraulic model was modified to include the Branch J Impoundment Site Option 1 and was used to analyze the 10-year and 100-year, 24-hour events. The total inundated acres during the 10-year event would be reduced by 8%. **Table 5** and **Table 6** show the resulting peak flow and volume changes at the identified reporting locations, and inundated acreage changes in the JD 19 Watershed. Inundated acres within the impoundment flood pool are not included in the reported values. Hydrographs at the identified reporting locations are available in **Appendix B.3**.

The Branch J Impoundment Site Option 1 has multiple native species and wetlands within the impoundment site footprint. Wetlands located within the impoundment footprint, interior ditches, and flood pool will be impacted by fill, excavation, and varying inundation depending on operational management. The Branch J

Impoundment Site Option 1 is anticipated to impact approximately 1,202 acres of NWI identified wetlands. Anticipated wetland impacts are quantified in **Table 4**.

3.1.4 ALTERNATIVE 4 – BRANCH J IMPOUNDMENT SITE OPTION 2

Alternative 4 consists of a proposed impoundment site in Huntly Township along Branch J of JD 19. The site would consist of an impoundment constructed of earthen embankments primarily located in Sections 16, 17, 18, 19, 20, and 21 in Huntly Township. The impoundment would be constructed across JD 19 Branch J near the confluence of Branch J and JD 19 Main. Two diversion ditches would be constructed in the upper watershed to divert water from Branch H and Branch I. In total, the two diversions would be less than 0.4 miles. Branches J, K, H, I, and the diversion channels carry flows from the upstream watershed into the site. The impoundment site would include an outlet riser structure and earthen auxiliary spillway.

Branch J Impoundment Site Option 2 would have a drainage area of 14.6 square miles and would provide 1,009 acre-feet (3.1 inches) of flood storage at the gated pool with a total of 1,427 acre-feet (6.0 inches) of flood storage below the auxiliary spillway. The site and drainage area are located entirely upstream of Nelson Slough. The flood pool would require a total estimated area of 1,854 acres at the top of dam elevation. Impoundment site statistics are shown in **Table 3**. The inundated area within the impoundment site would vary depending on the flood event. A site map for the Branch J Impoundment Site Option 2 is shown on **Figure 3.1.4**.

The hydraulic model was modified to include the Branch J Impoundment Site Option 2 and was used to analyze the 10-year and 100-year, 24-hour events. The total inundated acres during the 10-year event would be reduced by 3%. **Table 5** and **Table 6** show the resulting peak flow and volume changes at the identified reporting locations, and inundated acreage changes in the JD 19 Watershed. Inundated acres within the impoundment flood pool are not included in the reported values. Hydrographs at the identified reporting locations are available in **Appendix B.3**.

The Branch J Impoundment Site Option 2 has multiple native species and wetlands within the impoundment site footprint. Wetlands located within the impoundment footprint, interior ditches, and flood pool will be impacted by fill, excavation, and varying inundation depending on operational management. The Branch J Impoundment Site Option 2 is anticipated to impact approximately 1,224 acres of NWI identified wetlands. Anticipated wetland impacts are quantified in **Table 4** below.

3.1.5 ALTERNATIVE 5 – EAST PARK TOWNSHIP IMPOUNDMENT SITE

Alternative 5 has been eliminated as an alternative due to its inability to meet the project purpose and need (see Concurrence Point #2).

3.1.6 ALTERNATIVE 6 – LINCOLN TOWNSHIP IMPOUNDMENT SITE

Alternative 6 has been eliminated as an alternative due to its inability to meet the project purpose and need (see Concurrence Point #2).

3.1.7 ALTERNATIVE 7 – NELSON SLOUGH IMPROVEMENTS

Alternative 7 consists of improvements to the existing Nelson Slough impoundment site. The improvements include raising the top of dam from 1106.3 to 1109.0. Raising the top of dam will bring the impoundment site into compliance with current dam safety design standards. The outlet structure would also be

reconfigured. The new outlet structure would be a concrete weir structure with 3 stages. The first stage has two 20-foot openings at 1102.0. The wider and lower first stage outlet will allow for the normal water level to be near 1102.3 which is the current normal pool operating level. During normal operations one 20-foot opening would be closed and only operated during drawdown conditions. Results presented in this report only have a 20-foot wide first stage opening. The second stage is a 70-foot opening at 1104. The third stage is a 300-foot opening at 1105.5. This outlet configuration would act as both the primary and secondary spillway. The extents of the drainage area and flood pools at the different stages are shown on **Figure 3.1.7a** and **Figure 3.1.7b**.

The site would be designed to incorporate removable stop logs for the first and second stage outlets. The stop logs would be used to control spring runoff volume from the upstream watershed. Results presented in this report show both open condition (no stop logs in place) and closed conditions (both the first and second stage outlets with stop logs in place).

The hydraulic model was modified to include the Nelson Slough Improvements and was used to analyze the 10-year and 100-year, 24-hour events. At US Highway 59, peak flow rates for the open (no stop logs) scenario are reduced by 3% for the 10-year and 2% for the 100-year event. At US Highway 59, peak flow rates for the closed (stop logs in place) scenario are reduced by 5% for the 10-year and 3% for the 100-year event. The volume of flow at US Highway 59 for the open scenario is reduced by 19% and 7% for the 10-year and 100-year event, respectively. The volume of flow at US Highway 59 for the closed scenario is reduced by 63% and 48% for the 10-year and 100-year event, respectively. The total inundated acres during the 10-year event would be reduced by 13% for both open and closed scenarios. **Table 5** and **Table 6** show the resulting peak flow and volume changes at the identified reporting locations, and inundated acreage changes in the JD 19 Watershed. Inundated acres within the impoundment flood pool are not included in the reported values. Hydrographs at the identified reporting locations are available in **Appendix B.3**.

The Nelson Slough Improvement alternative has multiple native species and wetlands adjacent to the existing impoundment footprint. Wetlands located within the proposed expanded impoundment footprint, and potential borrow areas will be impacted by fill and excavation. Nelson Slough has approximately 2,826 acres of wetlands within the pool delineated at the current top of dam elevation. The Nelson Slough Improvement will increase the top of dam elevation by approximately 2.7 feet. This increases the pool footprint by approximately 760 acres and would impact an additional 262 acres of wetland. The increase in top of dam elevation is required to meet current freeboard design standards. The pool footprint above the current top of dam will not be inundated through the 100-year event. Therefore, the additional 262 acres of wetland impacts will not be affected through the 100-year event. Since the site already exists and similar inundation within the impoundment is expected with the proposed outlet structure and operation, no new impacts are anticipated due to inundation. The approximate 10.5 acres of wetland impact from the embankment footprint will potentially need to be mitigated. Anticipated wetland impacts are quantified in **Table 4** below.

Table 3: Impoundment Site Statistics

Site	Drainage Area	Gated Elevation	Top of Dam Elevation	Max Dam Height	Gated Storage			Auxiliary Spillway			Top of Dam		
	sq. mi.	*NAVD88*	*NAVD88*	*feet*	*acres*	*ac-ft*	*inches*	*acres*	*ac-ft*	*inches*	*acres*	*ac-ft*	*inches*
Branch M	10.7	1,105.0	1,110.0	13.0	536	1,723	3.0	839	2,890	5.1	1,060	5,955	10.5
Branch J – Option 1	9.5	1,127.6	1,132.6	10.6	887	1,562	3.1	1,154	3,515	6.9	1,714	8,080	15.9
Branch J – Option 2	14.6	1,128.5	1,133.5	11.5	1,009	2,433	3.1	1,427	4,682	6.0	1,854	9,749	12.6
Nelson Slough Improvements Closed - Summer	68.6	1104.0	1109.0	12.0	2,141	3,227*	0.9*	-	-	-	3,677	19,176*	5.2*
Nelson Slough Improvements Closed - Spring	68.6	1105.5	1109.0	12.0	2,672	6,879*	1.9*	-	-	-	3,677	19,176*	5.2*

*Nelson Slough Storage above the Normal Water Level of 1102.3'

Table 4: Anticipated NWI Wetland Impacted Acres

Site	Wetland Fill (Embankment)	Wetland Excavation (Ditching)	Inundated Wetlands within the Flood Pool[1]	Total Impacted Wetland Acres
Existing Nelson Slough	1.8	0.0	2,825	2,827
Branch M	17.2	3.0	442	462
Branch J - Option 1	10.0	3.3	1,189	1,202
Branch J - Option 2	10.7	3.3	1,210	1,224
Nelson Slough Improvements *(Increase from Existing)*	12.3 *(10.5)*	0.0 *(0.0)*	3,087 *(262)*	3,099 *(273)*

[1] Delineated based on Top of Dam pool footprint

Table 5: Peak Flow Changes for Identified Alternatives

Scenario	Existing Conditions	Alternative 2 Branch M Impoundment Site	Alternative 3 Branch J Impoundment Site Option 1	Alternative 4 Branch J Impoundment Site Option 2	Alternative 7 Nelson Slough Improvements Open	Alternative 7 Nelson Slough Improvements Closed
Recurrence Interval and Location	*Peak Flow – 10-year, cfs (% Change)*					
Highway 32	467	467 *(0.0%)*	467 *(0.0%)*	467 *(0.0%)*	467 *(0.0%)*	467 *(0.0%)*
Nelson Slough Outlet	234	216 *(-7.7%)*	174 *(-25.6%)*	166 *(-29.1%)*	133 *(-43.2%)*	0 (-100.0%)
US Highway 59	495	493 *(-0.4%)*	494 *(-0.2%)*	494 *(-0.2%)*	479 *(-3.2%)*	470 (-5.1%)
JD 19 Outlet	949	946 *(-0.3%)*	948 *(-0.1%)*	948 *(-0.1%)*	919 *(-3.2%)*	906 (-4.5%)
Recurrence Interval and Location	*Peak Flow – 100-year, cfs (% Change)*					
Highway 32	905	905 *(0.0%)*	905 *(0.0%)*	905 *(0.0%)*	905 *(0.0%)*	905 *(0.0%)*
Nelson Slough Outlet	564	545 *(-3.4%)*	353 *(-37.4%)*	344 *(-39.0%)*	485 *(-14.0%)*	123 *(-78.2%)*
US Highway 59	1,317	1,295 *(-1.7%)*	1,314 *(-0.2%)*	1,314 *(-0.2%)*	1,293 *(-1.8%)*	1,279 *(-2.9%)*
JD 19 Outlet	3,042	3,039 *(-0.1%)*	3,042 *(0.0%)*	3,042 *(0.0%)*	3,036 *(-0.2%)*	3,031 *(-0.4%)*

Duration (hours)	*Inundated Acres – 10-year (% Change)*											
	Crop.	*Total*	*Crop.*	*Total*	*Crop.*	*Total*	*Crop.*	*Total*	*Crop.*	*Total*	*Crop.*	*Total*
0-24	4,394	16,494	4,444 (1%)	16,269 (-1%)	4,408 (0%)	16,177 (-2%)	4,401 (0%)	16,214 (-2%)	4,374 (-1%)	16,458 (0%)	4,373 (-1%)	16,463 (0%)
24-48	1,067	5,968	1,003 (-6%)	5,772 (-3%)	1,016 (-5%)	5,539 (-7%)	1,021 (-4%)	5,540 (-7%)	1,082 (1%)	6,004 (1%)	1,082 (1%)	6,012 (1%)
48-72	384	2,880	366 (-5%)	2,834 (-2%)	374 (-3%)	2,723 (-6%)	373 (-3%)	2,695 (-6%)	376 (-2%)	2,718 (-6%)	377 (-2%)	2,728 (-5%)
72-96	213	1,701	206 (-3%)	1,643 (-3%)	212 (-1%)	1,609 (-5%)	210 (-1%)	1,574 (-8%)	201 (-6%)	1,477 (-13%)	203 (-5%)	1,487 (-13%)
96-120	143	1,087	145 (1%)	1,070 (-2%)	142 (-1%)	1,053 (-3%)	142 (-1%)	1,035 (-5%)	137 (-4%)	895 (-18%)	138 (-4%)	900 (-17%)
>120	1,069	8,069	1,057 (-1%)	7,925 (-2%)	1,084 (1%)	7,934 (-2%)	1,088 (2%)	7,880 (-2%)	1,012 (-5%)	5,586 (-31%)	1,009 (-6%)	5,546 (-31%)
TOTAL	7,269	36,199	7,222 (-1%)	35,513 (-2%)	7,235 (-1%)	35,035 (-3%)	7,235 (-1%)	34,937 (-4%)	7,182 (-1%)	33,138 (-9%)	7,182 (-1%)	33,136 (-9%)

Duration (hours)[1]	*Total*	*Total*	*Total*	*Total*	*Total*	*Total*
24-120	11,636	11,320 (-3%)	10,923 (-6%)	10,844 (-7%)	11,094 (-5%)	11,127 (-4%)

[1] Summary of total inundation for durations between 24 and 120 hours

Table 6: Volume Change at Reporting Locations for Identified Alternatives

Scenario	Existing Conditions	Alternative 2 Branch M Impoundment Site	Alternative 3 Branch J Impoundment Site Option 1	Alternative 4 Branch J Impoundment Site Option 2	Alternative 7 Nelson Slough Improvements Open	Alternative 7 Nelson Slough Improvements Closed
Recurrence Interval and Location	*Volume – 10-year, ac-ft (% Change)*					
Highway 32	1,538	1,538 *(0%)*	1,537 *(0%)*	1,538 *(0%)*	1,538 *(0%)*	1,538 *(0%)*
Nelson Slough Outlet	2,774	2,564 *(-8%)*	2,171 *(-22%)*	2,114 *(-24%)*	1,962 *(-29%)*	0 *(-100%)*
US Highway 59	4,363	3,853 *(-12%)*	3,762 *(-14%)*	3,701 *(-15%)*	3,527 *(-19%)*	1,602 *(-63%)*
JD 19 Outlet	6,262	5,760 *(-8%)*	5,668 *(-10%)*	5,605 *(-11%)*	5,412 *(-14%)*	3,547 *(-43%)*
Recurrence Interval and Location	*Volume – 100-year, ac-ft (% Change)*					
Highway 32	3,010	3,010 *(0%)*	3,010 *(0%)*	3,010 *(0%)*	3,010 *(0%)*	3,010 *(0%)*
Nelson Slough Outlet	6,181	5,954 *(-4%)*	4,445 *(-28%)*	4,213 *(-32%)*	5,429 *(-12%)*	1,309 *(-79%)*
US Highway 59	10,145	9,401 *(-7%)*	8,468 *(-17%)*	8,233 *(-19%)*	9,423 *(-7%)*	5,323 *(-48%)*
JD 19 Outlet	15,697	14,839 *(-6%)*	14,012 *(-11%)*	13,783 *(-12%)*	14,803 *(-6%)*	10,752 *(-32%)*

3.2 SELECTED ALTERNATIVE

The selected alternative should meet the purpose and need of the project, be practicable, and avoid impacts to the aquatic ecosystem to the greatest extent possible. The identified preliminary alternatives were evaluated using the hydrologic and hydraulic model in order to assess their potential to meet objectives from the Purpose and Need. The indicators described in Section 1 were used to determine if the alternatives meet the objectives from the Purpose and Need.

Since all alternatives failed to meet indicator 2, 20% peak flow reduction at US Highway 59, all alternatives producing no net increase in peak flow were considered to partially meet the criteria. Results indicate that the peak flow at US Highway 59 is driven by localized runoff. The alternatives do show significant changes to the volume of flow passing US Highway 59. In general, the volume of flow is reduced on the trailing limb when the upstream watershed contributes to US Highway 59.

Available GIS data was also reviewed to estimate potential site characteristics and resource impacts as shown in **Table 3** and **Table 4**. **Table 7** provides information on the ability of each alternative to meet objectives defined in the Purpose and Need statement based on performance for the indicators discussed in Section 1 and provides the rationale to either carry forward or eliminate alternatives from further consideration. Due to the preliminary nature of this review, if the alternative peak flow was within 1% of the required peak flow reduction for an indicator, it was considered passing for that indicator. Alternatives were categorized as either meeting the indicator, partially meeting the indicator or failing to meet the indicator. After evaluating each of the alternatives for their ability to meet the purpose and need, practicability, and review of potential impacts to the aquatic ecosystem, the following alternative has been selected as the Least Environmentally Damaging Practicable Alternative (LEDPA):

- Alternative 7 – Nelson Slough Improvements

Once concurrence is found with the USACE for the selected alternative as outlined in this report, the selected alternative will be further evaluated in Concurrence Point No. 4. Through this concurrence point, the USACE will be engaged during project design to aid in minimizing impacts to aquatic resources.

Table 7: Preliminary Alternative Evaluation Summary

Alternative	INDICATOR 1	INDICATOR 2		INDICATOR 3		INDICATOR 4		Wetland Impacts	Determination	Additional Comments
	Reduce total inundation for flood durations between 24 and 120 hours (1-5 days) for the 10-year event by 5% *(Percent Change)*	Reduce the peak flow rate at US Highway 59 by 20%		Reduce the volume of flow at US Highway 59 by 20%		No increase in peak flow rate at the JD 19 outlet		Total acres of impacted wetlands within the embankment footprint, interior ditches, and the flood pool (NWI Wetlands)		
		(Percent Change)		*(Percent Change)*		*(Percent Change)*				
		10-year	100-year	10-year	100-year	10-year	100-year			
2. Branch M Impoundment Site	**Partially Met** -3%	**Partially Met** 0%	**Partially Met** -2%	**Partially Met** -12%	**Partially Met** -7%	**YES** 0%	**YES** 0%	462 acres	Eliminate	•The impoundment site will impact 462 acres of wetlands and therefore is not the LEDPA
3. Branch J Impoundment Site Option 1	**YES** -6%	**NO** 0%	**NO** 0%	**Partially Met** -14%	**Partially Met** -17%	**YES** 0%	**YES** 0%	1,202 acres	Eliminate	•The impoundment site is located upstream of Nelson Slough, which minimizes the downstream benefit of the site without altered operation of Nelson Slough •The impoundment site will impact 1,202 acres of wetlands and therefore is not the LEDPA
4. Branch J Impoundment Site Option 2	**YES** -7%	**NO** 0%	**NO** 0%	**Partially Met** -15%	**YES** -19%	**YES** 0%	**YES** 0%	1,224 acres	Eliminate	•The impoundment site is located upstream of Nelson Slough, which minimizes the downstream benefit of the site without altered operation of Nelson Slough •The impoundment site will impact 1,224 acres of wetlands and therefore is not the LEDPA
7. Nelson Slough Improvements Open	**YES** -4%	**Partially Met** -3%	**Partially Met** -2%	**YES** -19%	**Partially Met** -7%	**YES** -3%	**YES** 0%	3,099 acres (273 acre increase from the existing Nelson Slough impacts)	**Carry Forward**	•Alternative meets or partially meets all indicators •The 273 acres of wetland impacts are in the upper portion of the pool above the third stage spillway. Inundation within this extent will remain unchanged through the 100-year event from existing conditions
7. Nelson Slough Improvements Closed	**YES** -4%	**Partially Met** -5%	**Partially Met** -3%	**YES** -63%	**YES** -48%	**YES** -5%	**YES** 0%	3,099 acres (273 acre increase from the existing Nelson Slough impacts)	**Carry Forward**	•Alternative meets or partially meets all indicators •Operating the structure with the stop logs in place provides greater reductions to meet the indicators •The 273 acres of wetland impacts are in the upper portion of the pool above the third stage spillway. Inundation within this extent will remain unchanged through the 100-year event from existing conditions

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Homer, C., Dewitz, J., Yang, L., Jin, S., Danielson, P., Xian, G., . . . and Megown, K. (2015). Completion of the 2011 National Land Cover Database for the Conterminous United States-Representing a Decade of Land Cover Change Information. *Photogrammetric Engineering and Remote Sensing*, 345-354.

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FIGURES

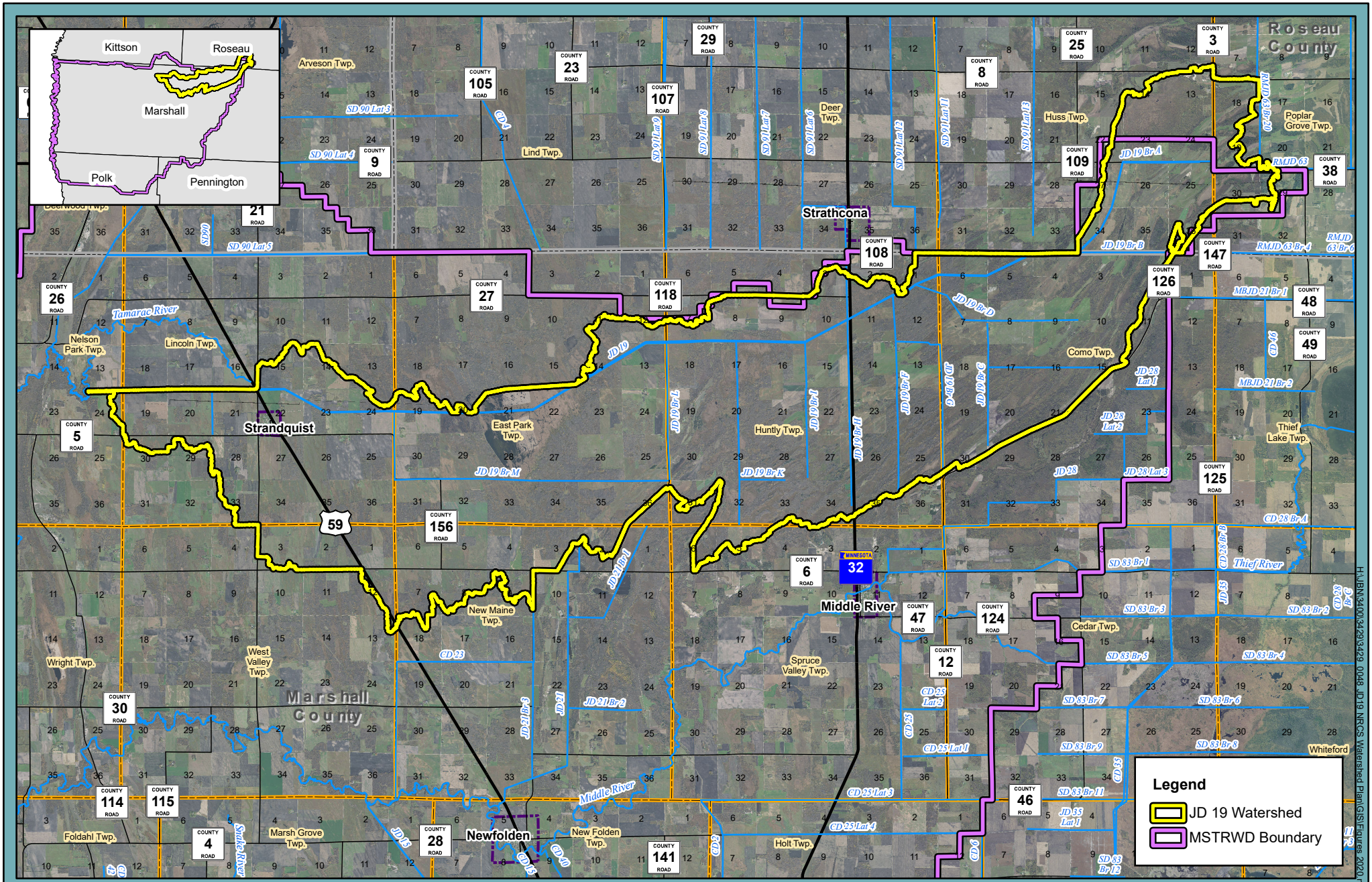

Fig. 1

Figure 1: JD 19 Watershed

Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District

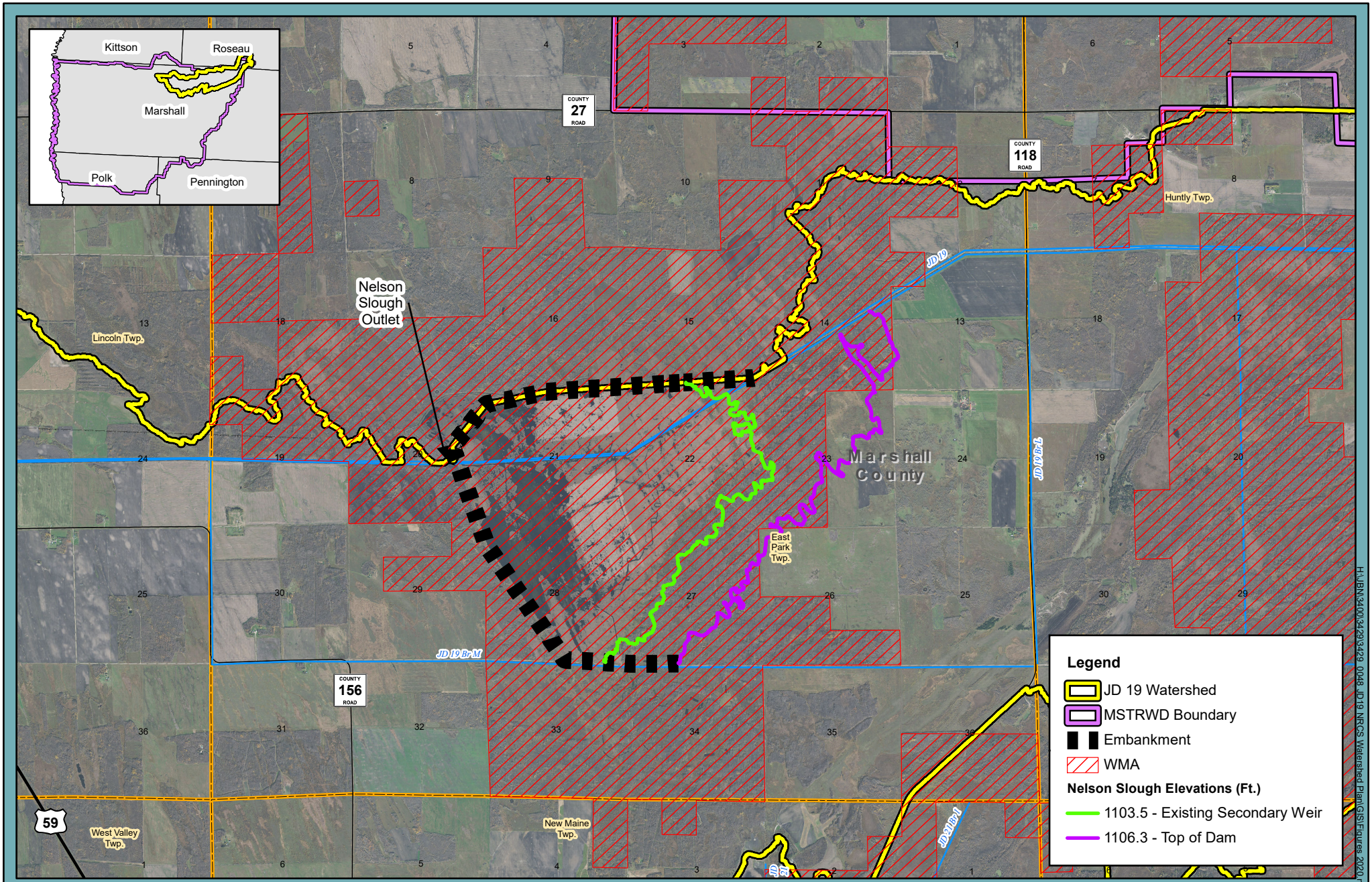

Fig. 1.2

Figure 1.2: East Park WMA (Nelson Slough)

Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District

N W E S

0 0.375 0.75 1.5 Miles

Houston Engineering Inc.

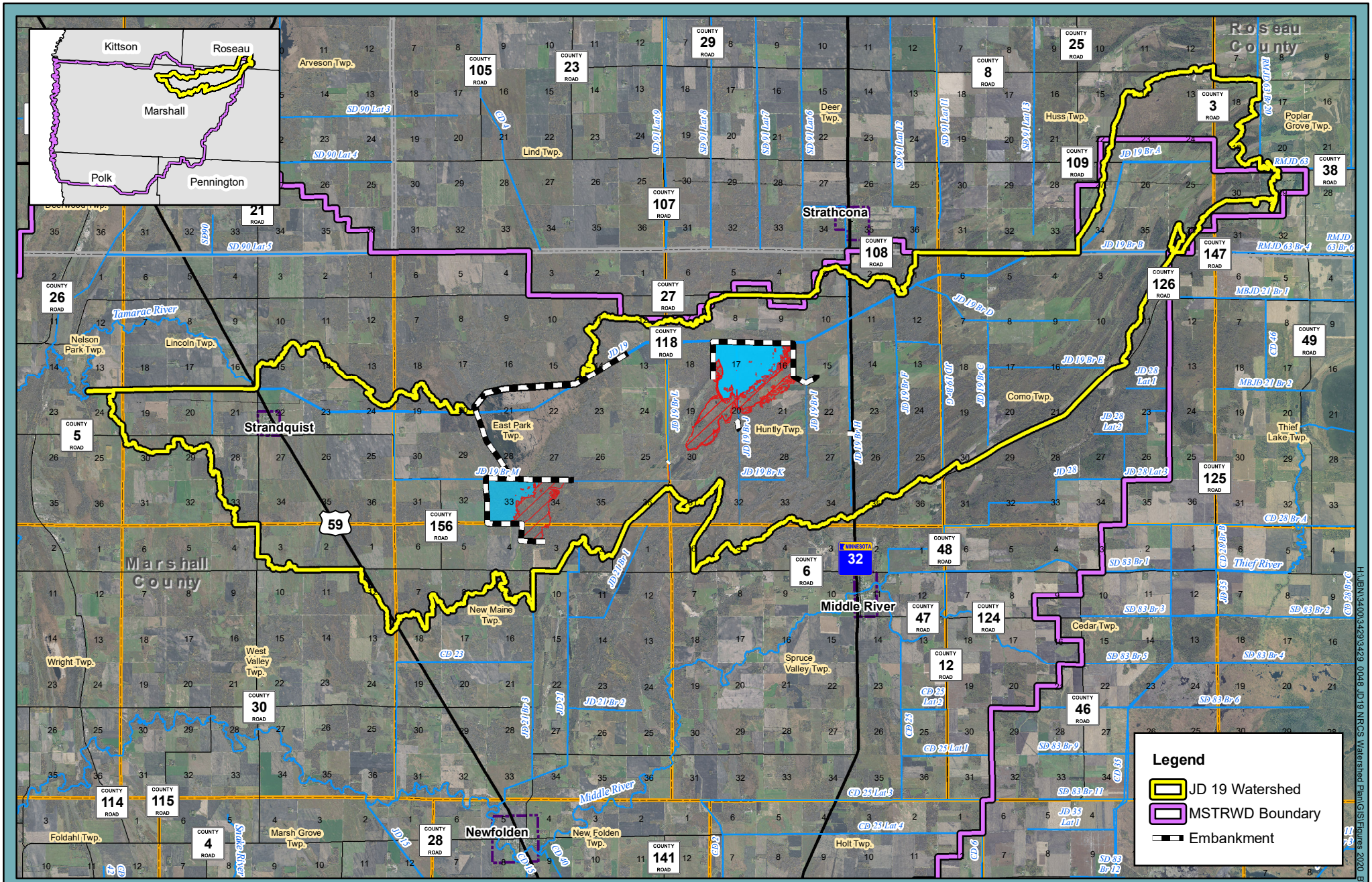

Fig. 3.1a

Figure 3.1a: Identified Alternatives

Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District

N
W E
S

0 1 2 4 Miles

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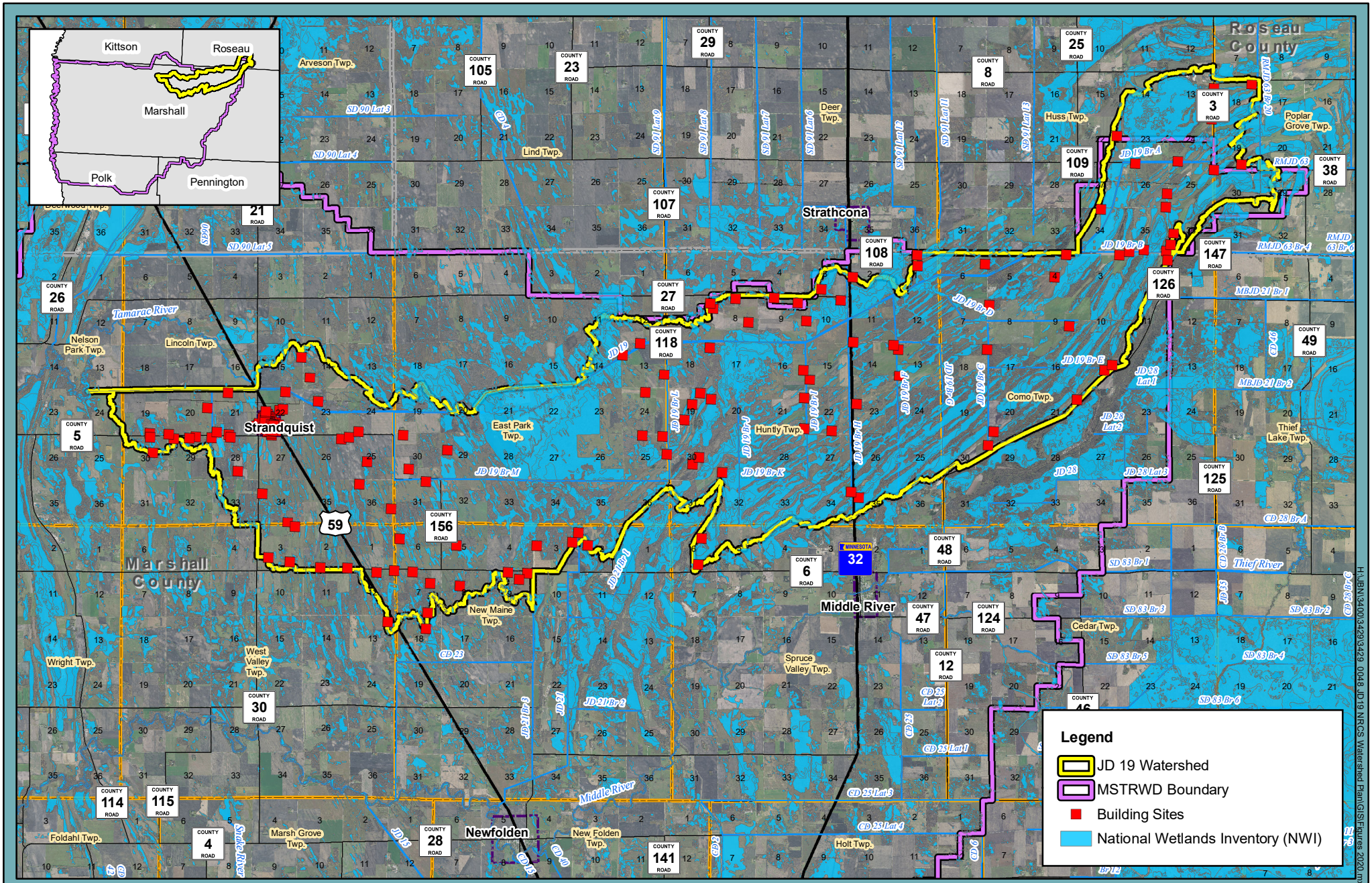

Fig. 3.1b

Figure 3.1b: NWI Wetlands

Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District

Houston Engineering Inc.

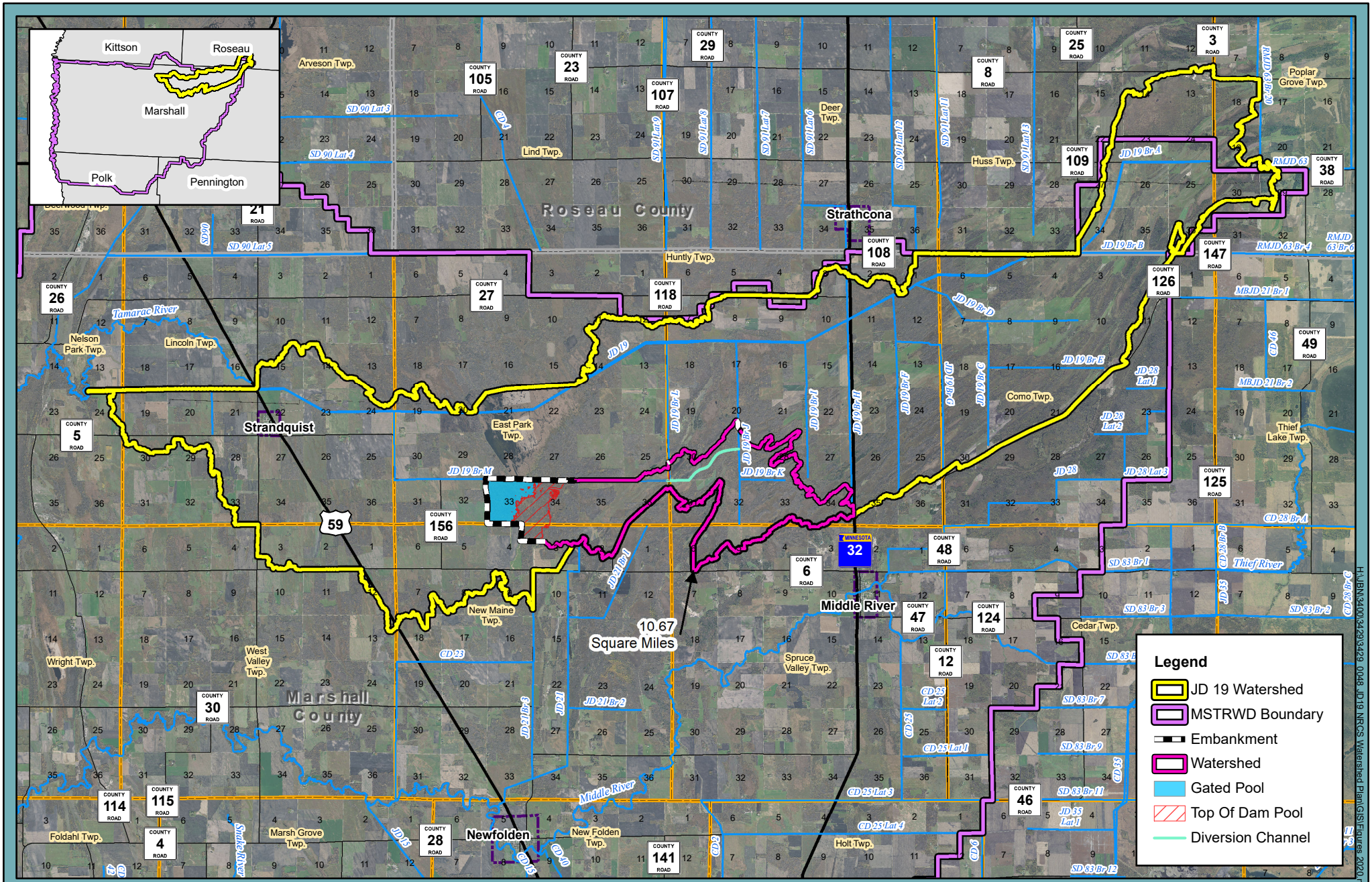

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Fig. 3.1.2

Figure 3.1.2: Alternative 2 - Branch M Impoundment Site

Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District

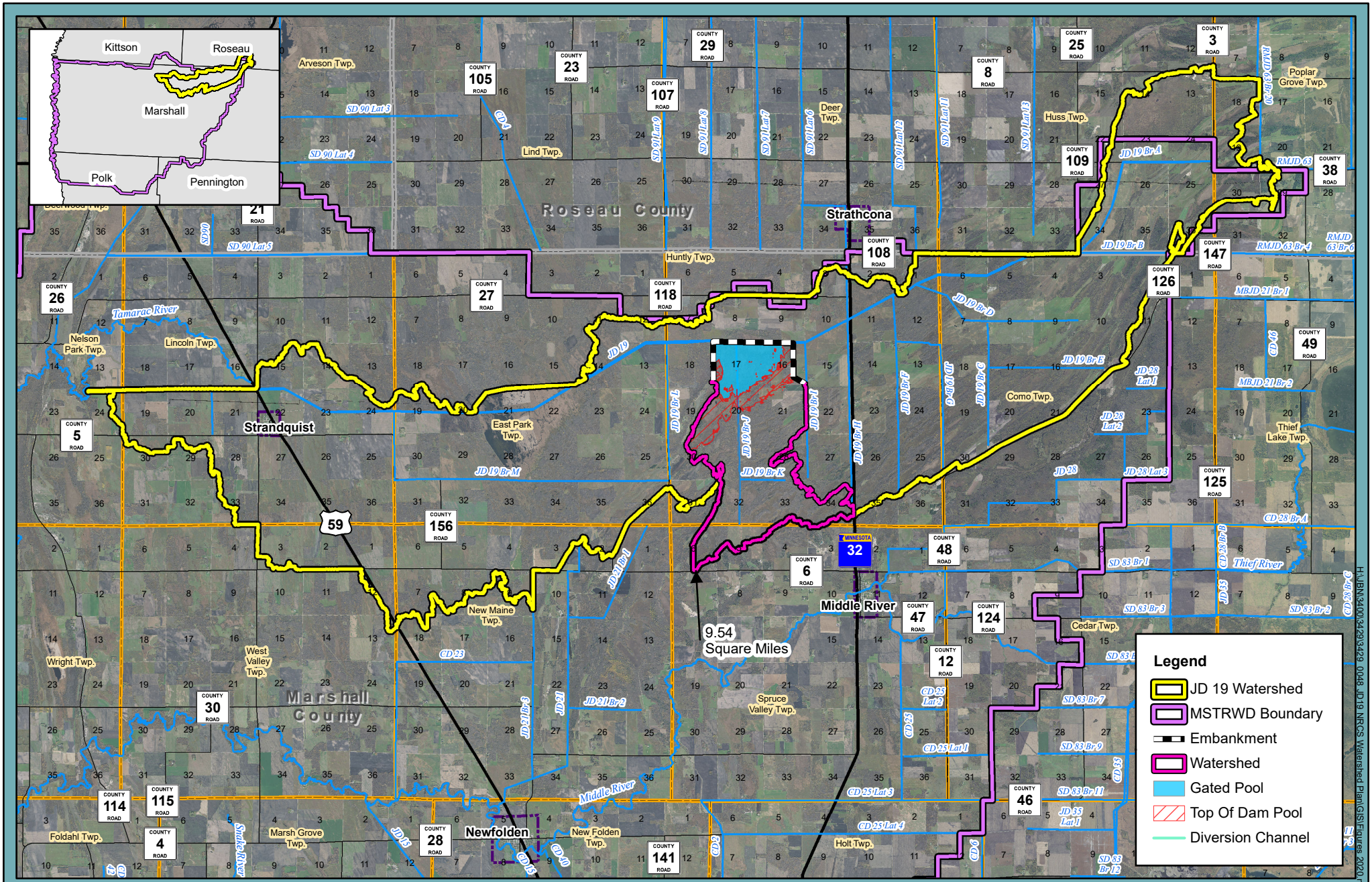

Fig. 3.1.3

Figure 3.1.3: Alternative 3 - Branch J Impoundment Site Option 1

Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District

Houston Engineering Inc.

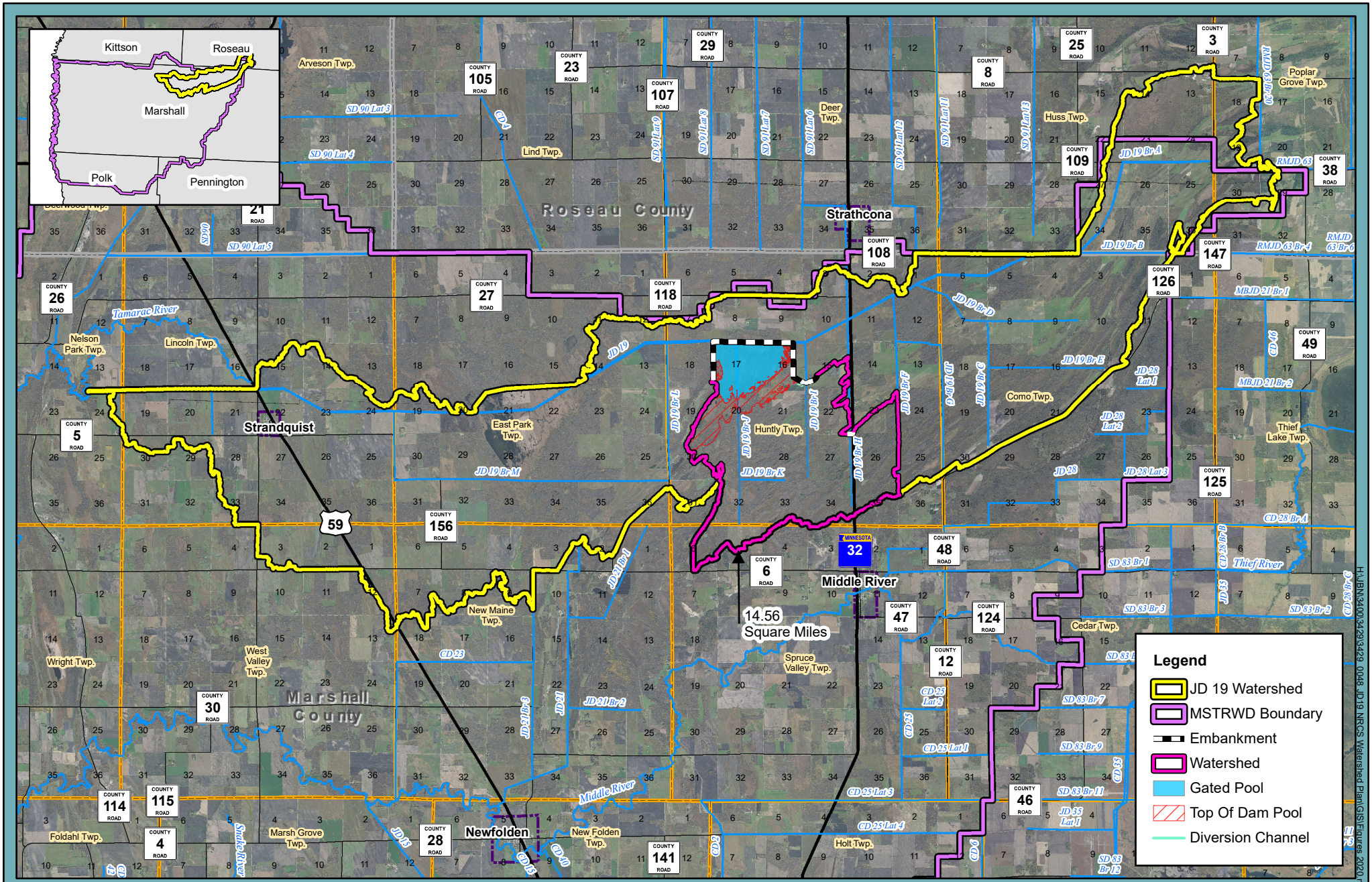

Fig. 3.1.4

Figure 3.1.4: Alternative 4 - Branch J Impoundment Site Option 2

Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District

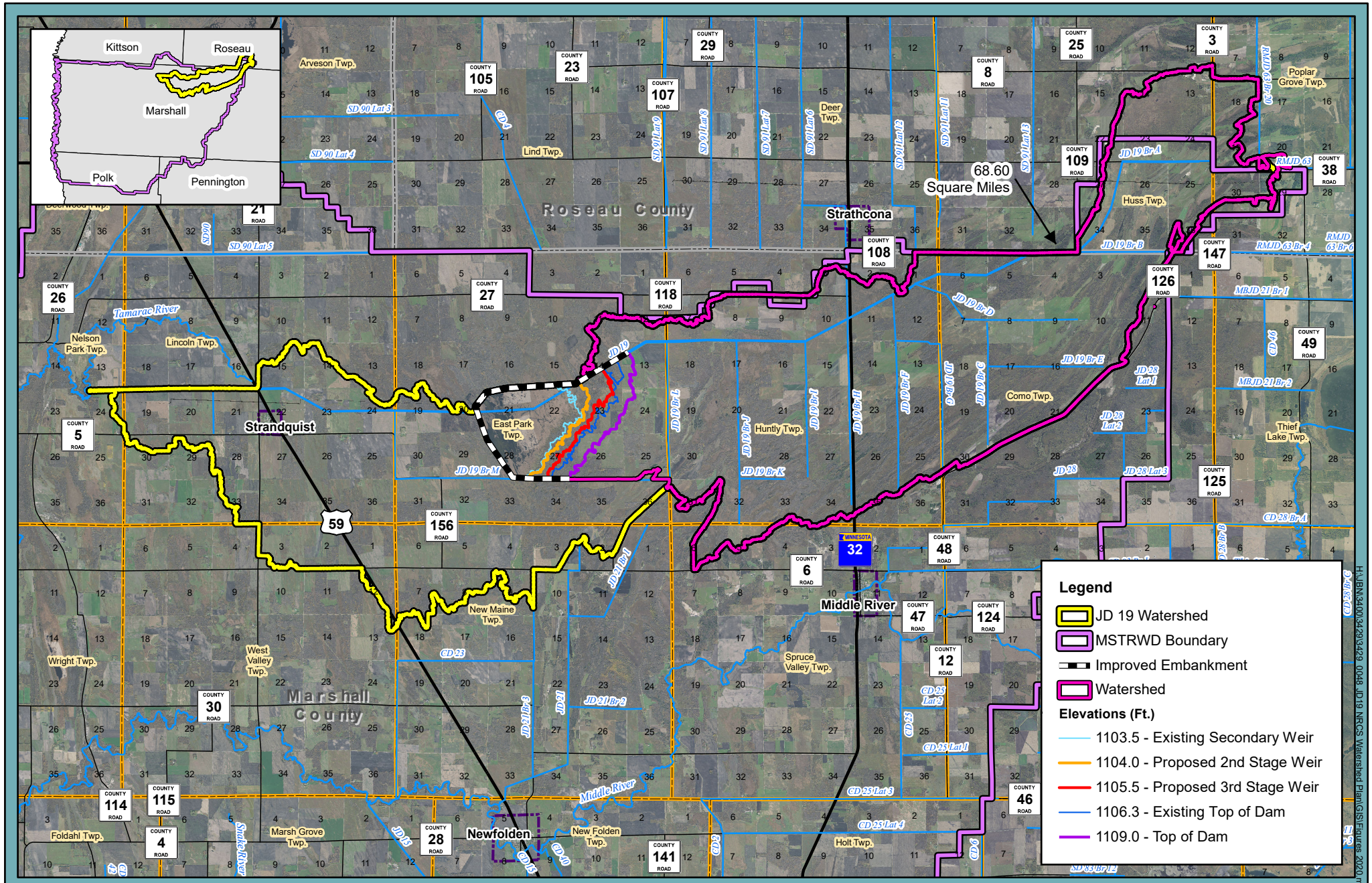

Fig. 3.1.7a

Figure 3.1.7a: Alternative 7 - Nelson Slough Improvements

Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District

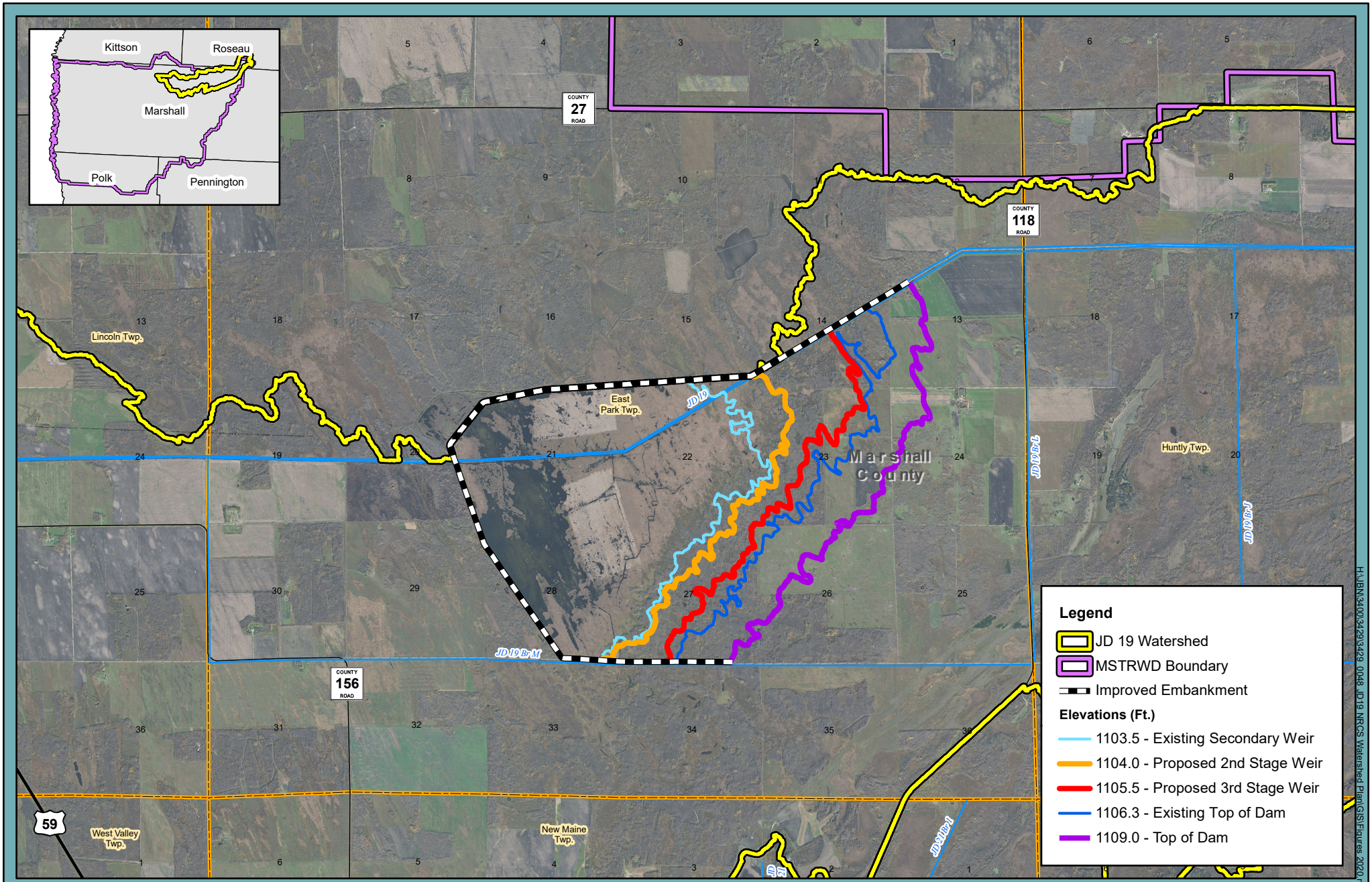

Fig. 3.1.7b

Figure 3.1.7b: Alternative 7 - Nelson Slough Elevations

Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District

N W E S

0 0.375 0.75 1.5 Miles

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APPENDIX A

Figure A.1: Identified Alternatives – Reporting Locations
A.2 Impoundment Site Alternatives – Hydrographs

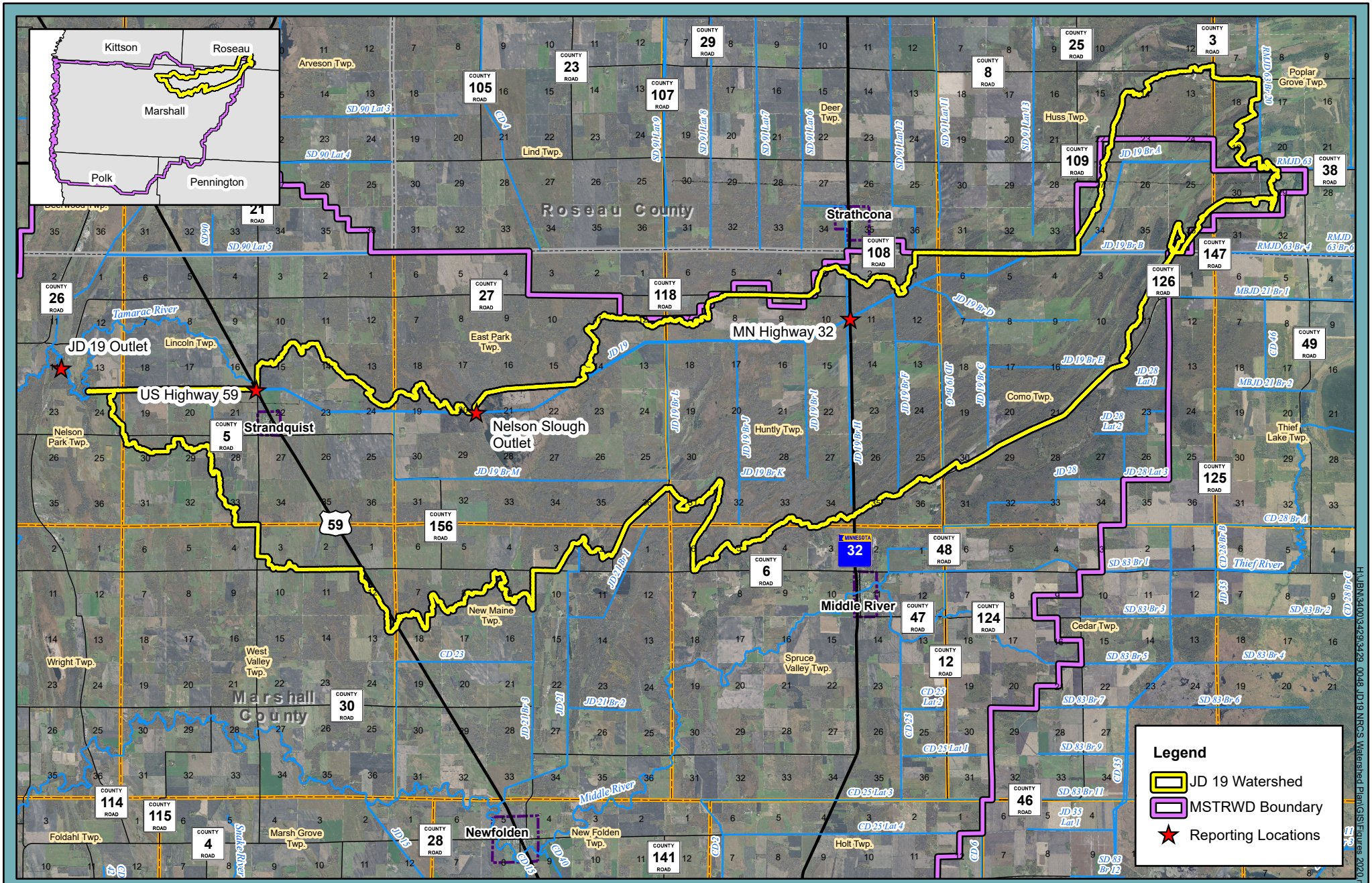

Fig. A.1

Figure A.1: Identified Alternatives - Reporting Locations

Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District

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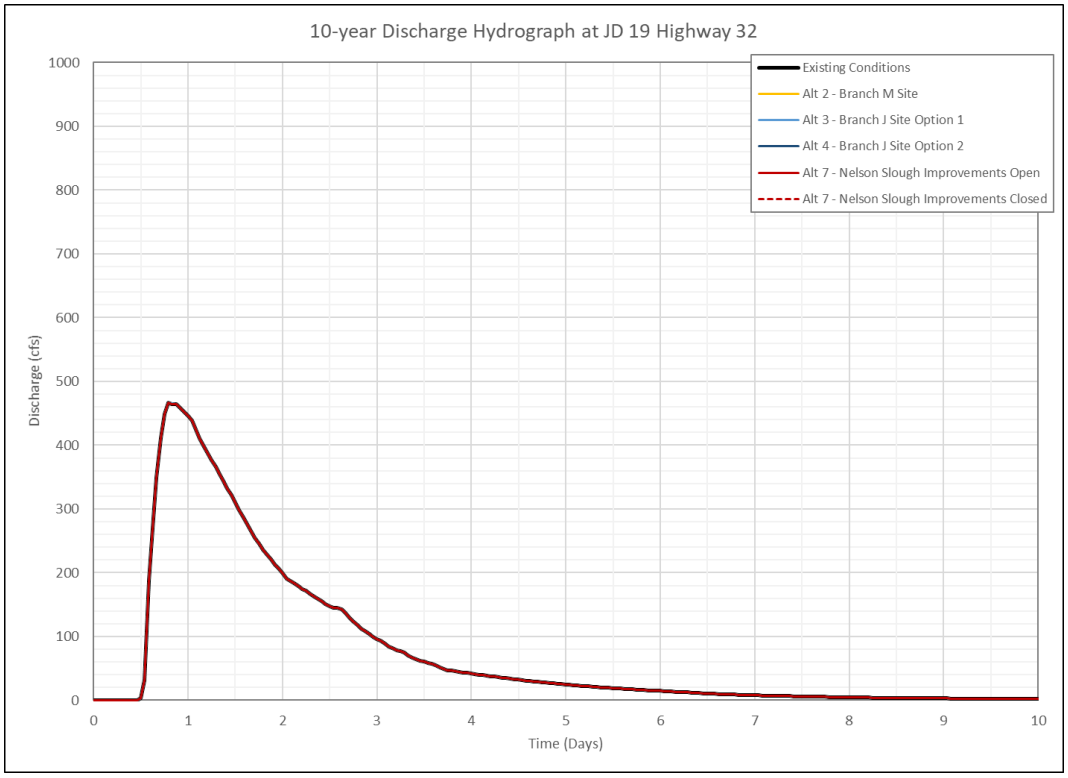
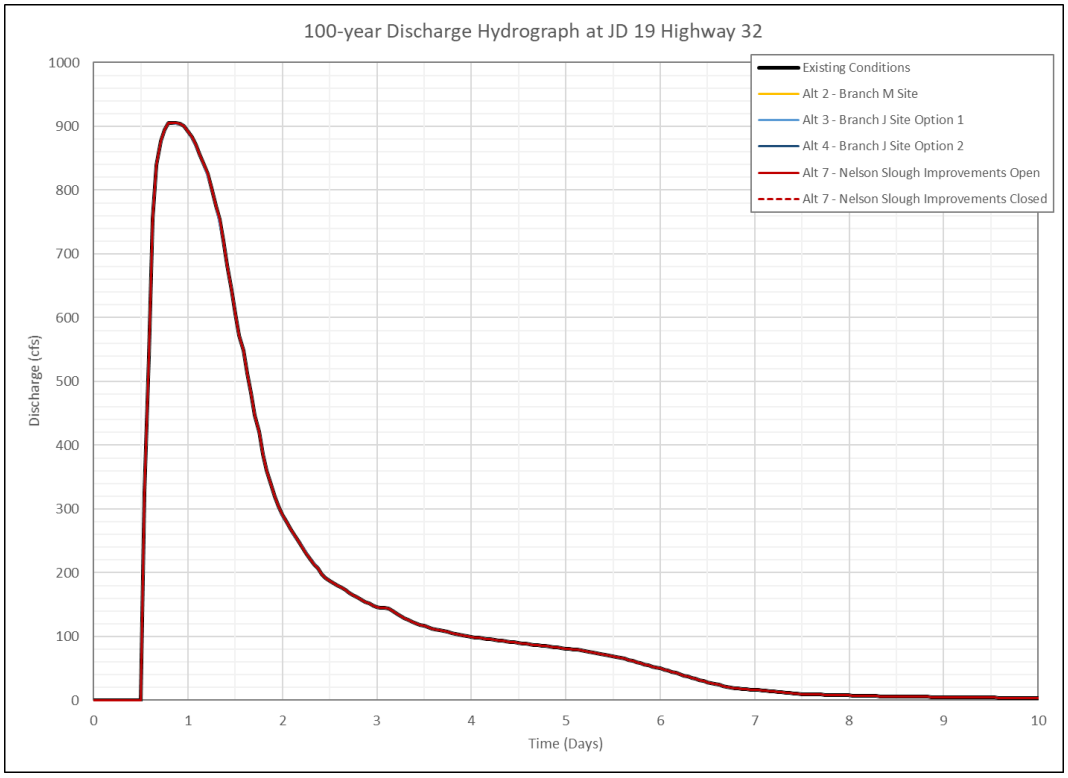
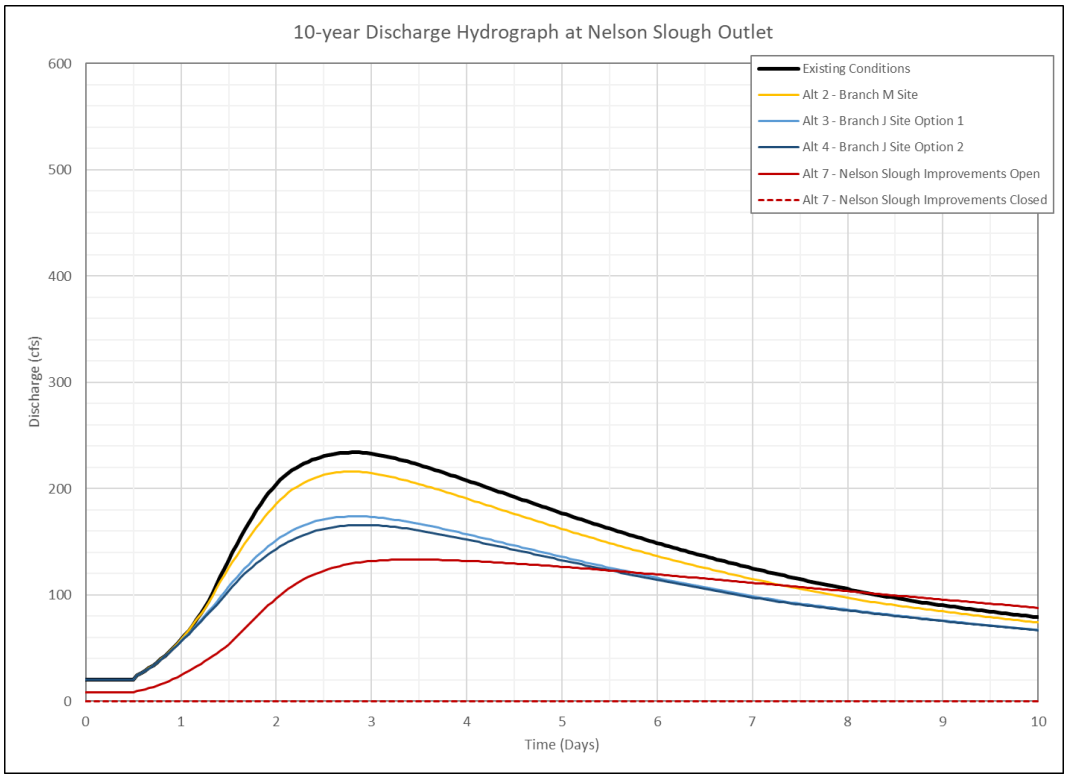
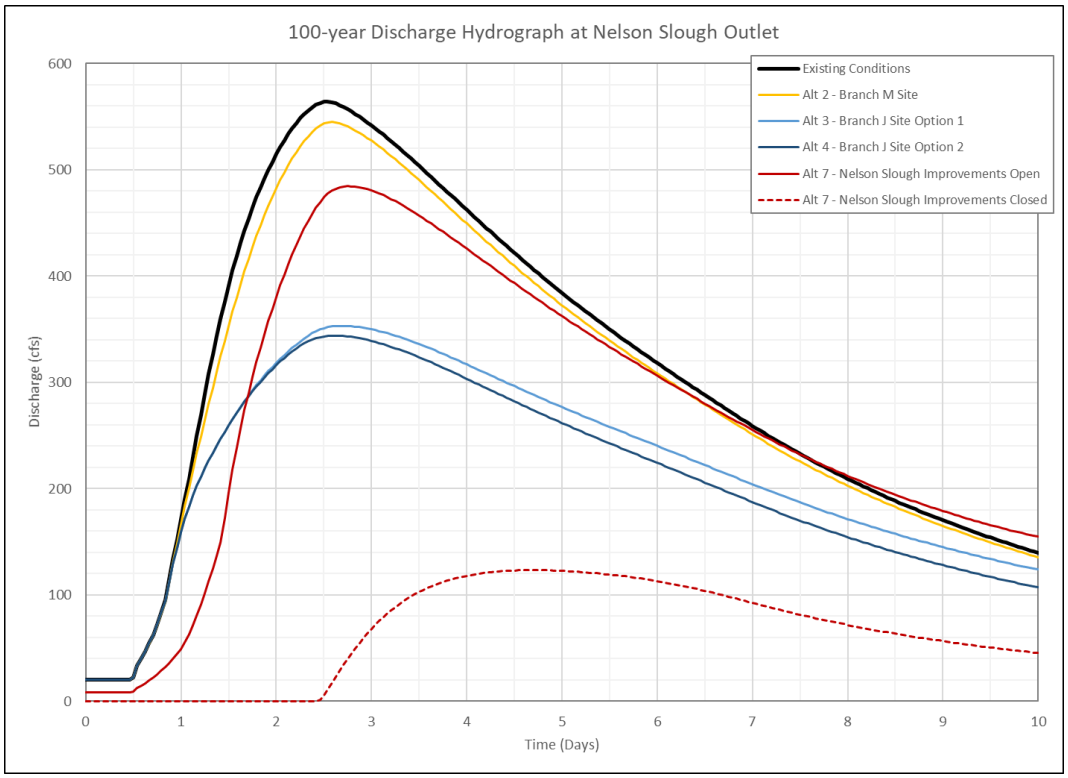
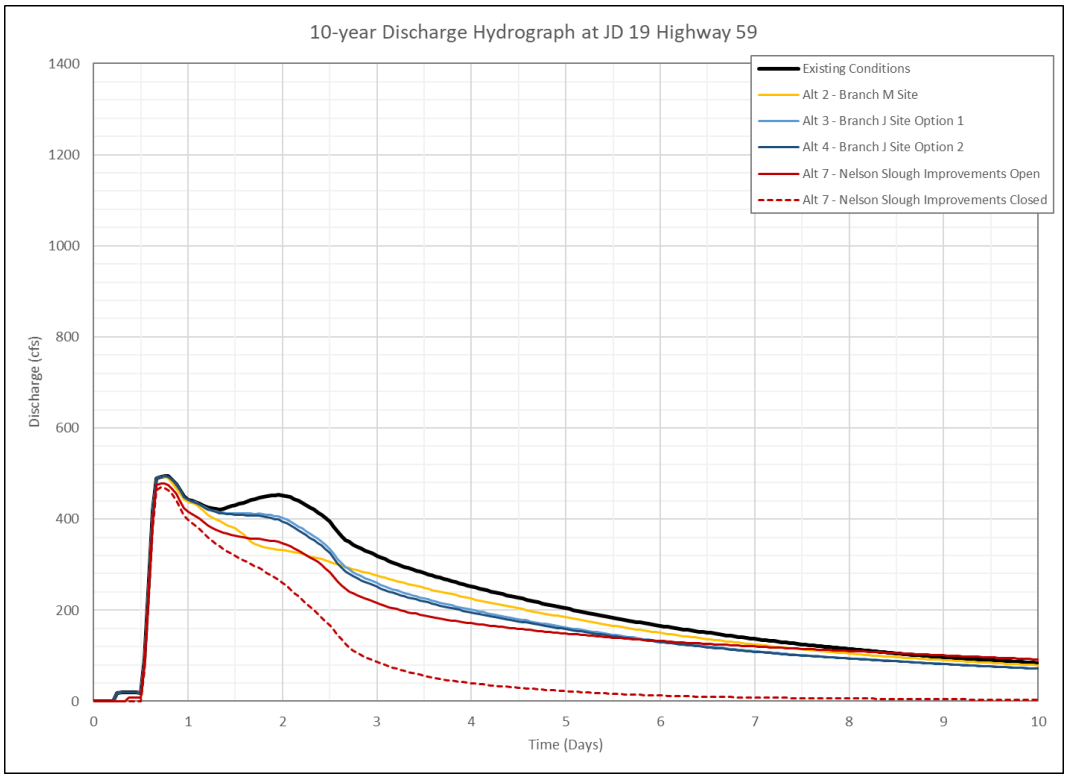
A.2 IMPOUNDMENT SITE ALTERANTIVE HYDROGRAPHS

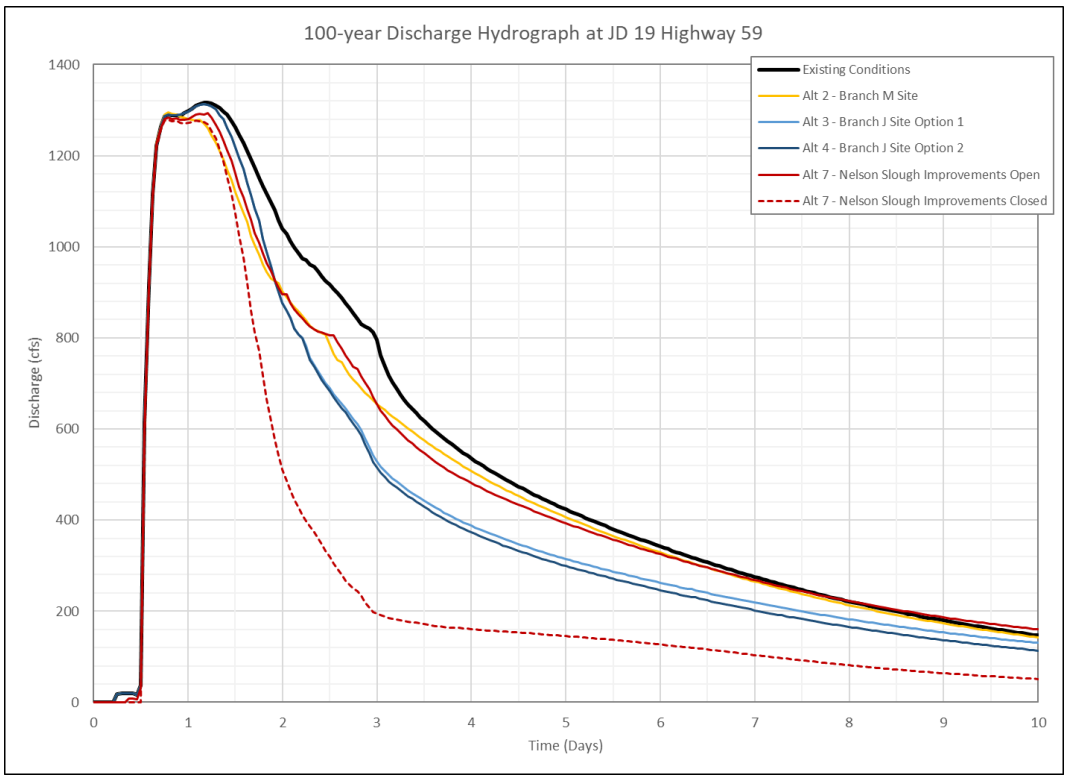


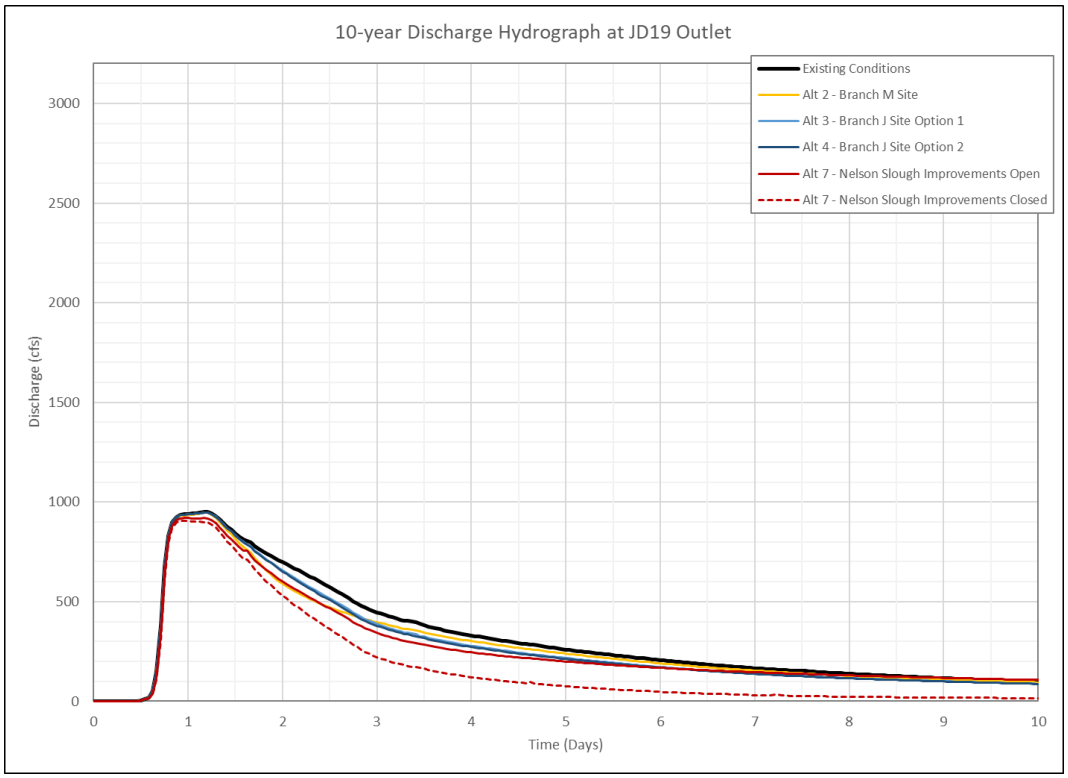


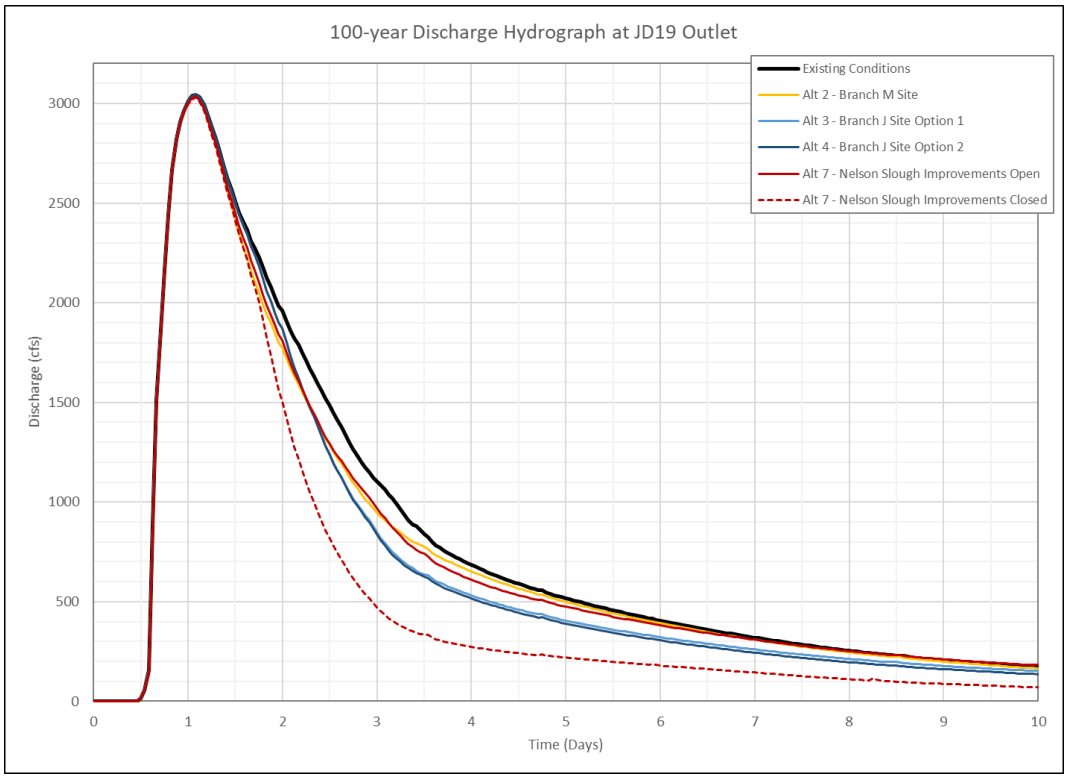

10-year Discharge Hydrograph at Nelson Slough Outlet
Discharge (cfs)
Time (Days)
Existing Conditions
Alt 2 - Branch M Site
Alt 3 - Branch J Site Option 1
Alt 4 - Branch J Site Option 2
Alt 7 - Nelson Slough Improvements Open
Alt 7 - Nelson Slough Improvements Closed


100-year Discharge Hydrograph at Nelson Slough Outlet
Discharge (cfs)
Time (Days)
Existing Conditions
Alt 2 - Branch M Site
Alt 3 - Branch J Site Option 1
Alt 4 - Branch J Site Option 2
Alt 7 - Nelson Slough Improvements Open
Alt 7 - Nelson Slough Improvements Closed


10-year Discharge Hydrograph at JD 19 Highway 59
Existing Conditions
Alt 2 - Branch M Site
Alt 3 - Branch J Site Option 1
Alt 4 - Branch J Site Option 2
Alt 7 - Nelson Slough Improvements Open
Alt 7 - Nelson Slough Improvements Closed
Discharge (cfs)
Time (Days)
0
200
400
600
800
1000
1200
1400
0
1
2
3
4
5
6
7
8
9
10


100-year Discharge Hydrograph at JD 19 Highway 59
Existing Conditions
Alt 2 - Branch M Site
Alt 3 - Branch J Site Option 1
Alt 4 - Branch J Site Option 2
Alt 7 - Nelson Slough Improvements Open
Alt 7 - Nelson Slough Improvements Closed
Discharge (cfs)
Time (Days)
0
200
400
600
800
1000
1200
1400
0
1
2
3
4
5
6
7
8
9
10


10-year Discharge Hydrograph at JD19 Outlet
Existing Conditions
Alt 2 - Branch M Site
Alt 3 - Branch J Site Option 1
Alt 4 - Branch J Site Option 2
Alt 7 - Nelson Slough Improvements Open
Alt 7 - Nelson Slough Improvements Closed
Discharge (cfs)
0
500
1000
1500
2000
2500
3000
Time (Days)
0
1
2
3
4
5
6
7
8
9
10


100-year Discharge Hydrograph at JD19 Outlet
Existing Conditions
Alt 2 - Branch M Site
Alt 3 - Branch J Site Option 1
Alt 4 - Branch J Site Option 2
Alt 7 - Nelson Slough Improvements Open
Alt 7 - Nelson Slough Improvements Closed
Discharge (cfs)
0
500
1000
1500
2000
2500
3000
Time (Days)
0
1
2
3
4
5
6
7
8
9
10