

Middle-Snake-Tamarac Rivers Watershed District

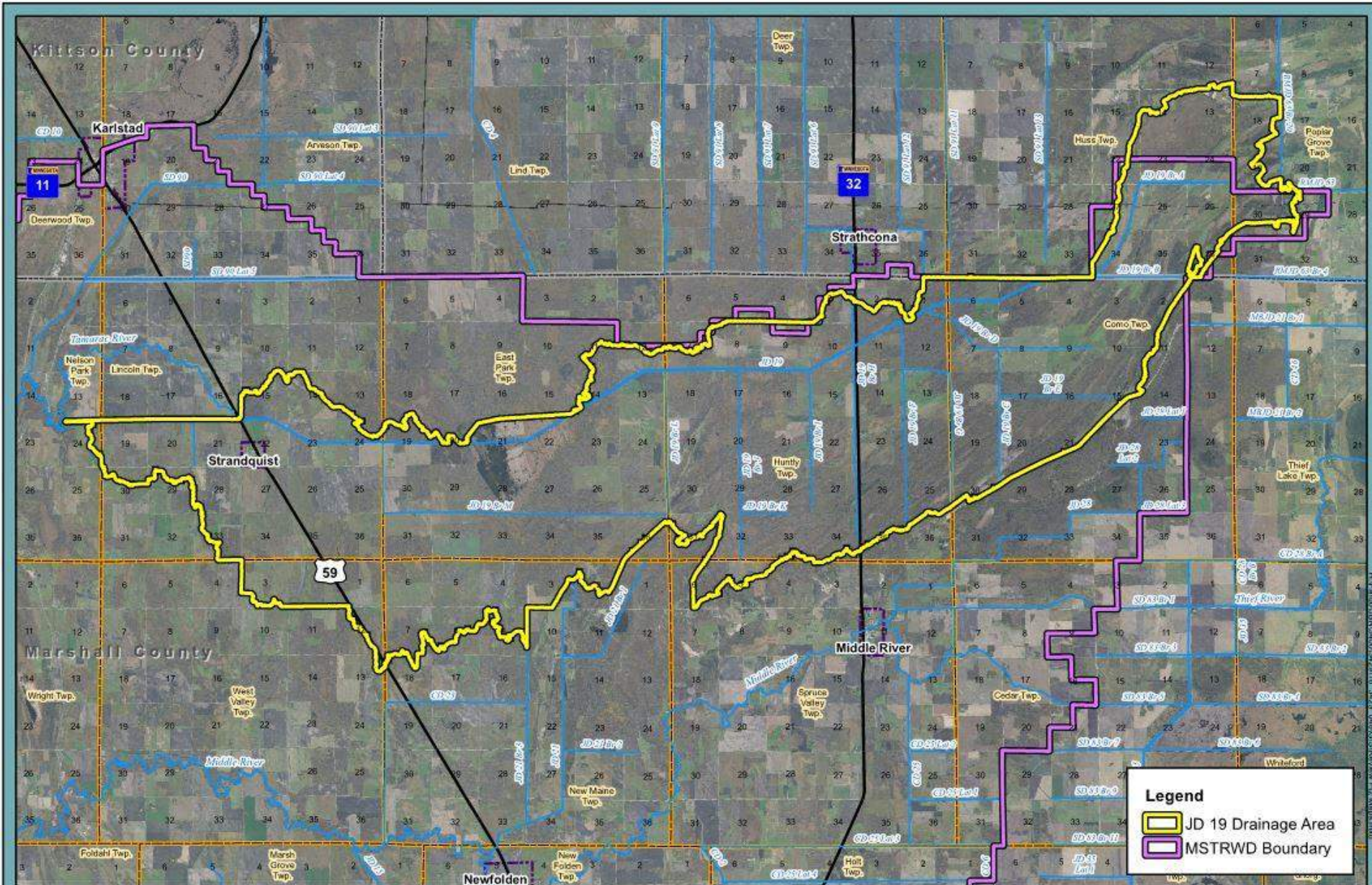
Judicial Ditch #19 Sub-Watershed
Regional Conservation Partnership Program (RCPP)
Interdisciplinary Team Meeting

February 20, 2020

Agenda

- * Overview of Last Project Team Meeting
- * Progress Since Last Meeting
- * Status of RCPP Planning Process – Review Point 1-6
- * Status of Review Point #4 - Alternatives
- * Overview of JD 19 Sub-Watershed Alternatives Analyzed
- * Alternative 7 – Nelson Slough Improvement
 - * MSTRWD/DNR East Park WMA (Nelson Slough) FDR Strategy
- * Recommend Preferred Alternative
- * Questions/Discussion
- * Path Forward

Study Area



Overview of Last Project Team Meeting

- * July 18, 2019
- * Status of Review Point No. 2 - 4
- * Overview of East Park WMA (Nelson Slough) DNR Meeting October 2018
- * MSTRWD Nelson Slough Flood Damage Reduction (FDR) Strategy
- * DNR Response Letter April 2019
- * Outcomes:
 - * Continue RCPP Process and Assemble Alternative Screening Document for the JD 19 sub-watershed
 - * Continue communication with DNR about potential FDR strategy for Nelson Slough

Progress Since Last Meeting

- * 3 meetings between the MSTRWD and DNR discussing FDR strategies for Nelson Slough – September 2019, December 2019, & January 2020
- * Hydraulic and Hydrologic (H&H) Modeling of Potential FDR Strategies Nelson Slough
- * H&H Modeling of Potential Alternatives for entire JD 19 Sub-Watershed
- * Development of the Alternative Screening Document
 - * Analyze Alternatives

RCPP Planning Process

INITIATE PLANNING

- * Discuss purpose and need for project with sponsors/Initiate study. REVIEW POINT NO. 1

Step 1 - IDENTIFY PROBLEMS, OPPORTUNITIES & CONCERNS

- * Identify the need for the proposed action (quantify, extent, magnitude, timing, frequency etc.)

Step 2 - DETERMINE OBJECTIVES

- * Write purpose and need statement and Write scope of plan-EA/EIS REVIEW POINT NO. 2

Step 3 - INVENTORY RESOURCES

- * Conduct detailed resource inventories and watershed assessment
- * Economics, social effects, Archeological and historic resources
- * Engineering/Geology/Support maps
- * Document problems

Step 4 - ANALYZE RESOURCE DATA

- * Geology, Hydrology & Hydraulics, Cultural, Economics and Social - REVIEW POINT NO. 3

Step 5 - FORMULATE ALTERNATIVES - REVIEW POINT NO. 4

- * Develop reasonable alternatives, mitigation strategies and costs (Preliminary plans)

Step 6 - EVALUATE ALTERNATIVES - REVIEW POINT NO. 5

- * Env. Resources, Geotechnical, Hydrology & Hydraulics, Economics, Significance of effects,...

Step 7 - MAKE DECISIONS (EA/EIS, Public Involvement,...) - REVIEW POINT NO. 6

Purpose and Need

3 PURPOSE AND NEED FOR ACTION (REVIEW POINT NO. 2A)

3.1 PURPOSE:

The 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 Judicial Ditch #19 sub-watershed. A secondary purpose of this action is to help contribute to the overall basin-wide goal of reducing peak flows to the Red River of the North by 20%.

3.2 NEED:

There is a need for 10-year 24-hour flood damage reduction for agricultural land and reduction in public transportation infrastructure flood damages in the Judicial Ditch #19 sub-watershed. Additional information supporting this need is included in the following list:

- The JD 19 system was originally designed for a 2-5-year rainfall event. Hydraulic modeling efforts have shown that the ditch system has less capacity in the upstream reaches, performing more consistent with the 2-year event, while the downstream reaches were originally designed with greater slope, so they perform more consistent with the 5-year event. Minimal maintenance has been performed on the system causing channel restrictions. Improved agricultural drainage since the system was built has caused runoff to enter the system more efficiently.
- Reduce flood damages within the JD 19 sub-watershed associated with spring snow melt and rains.
- Flooding also results in damages to some rural transportation systems and other public drainage systems. Based on information from the Minnesota Disaster Declaration, Counties, Townships, and watershed district data, road and culvert damages occurred in multiple locations within the JD 19 sub-watershed during floods in 1996, 1997, 1999, 2000, 2001, 2006, 2009, and 2011. In the year 2009, Marshall County was eligible for approximately \$3.5 million, while Roseau County was eligible for approximately \$4.4 million in damages due to severe storms and flooding. In the year 2011, Marshall County was eligible for approximately \$1.2 million, while Roseau County was eligible for approximately \$1.5 million in damages due to flooding. These dollar amounts are given on a county wide basis and the JD 19 sub-watershed is only a small portion of these two counties, but this shows that flood damage is a costly occurrence throughout the MSTRWD and the Red River Basin.

Table 1 – Inundated Lands Summary

Return Period	4-Day* Rainfall (in.)	Total Inundated Acres	Agriculture** Inundated Acres
2 – year	3.1	15,843	2,288
5 – year	3.9	21,982	3,442
10 – year	4.6	26,663	4,416
25 – year	5.6	32,405	5,721
50 – year	6.5	36,244	6,706
100 – year	7.5	39,585	7,608

Review Point No. 4

Technical Paper No. 11

Red River Basin Flood Damage Reduction Framework

Red River Basin Flood Damage Reduction Work Group
Technical and Scientific Advisory Committee
Technical Paper No. 11

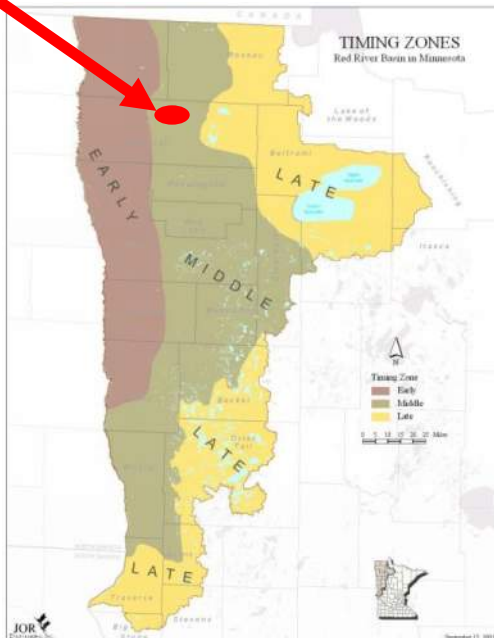
- * **Reduce Flood Volume**
 - * Construction or Restoration of Depressional Wetlands, Cropland BMPs, Conversion of Cropland to Perennial Grassland, Conversion of Land Use to Forest, Other Beneficial Uses of Stored Water
- * **Increase Conveyance Capacity**
 - * Channelization, Agricultural Drainage, Diversions, Setting Back Existing Levees, Increasing Road Crossing Capacity
- * **Increase Temporary Flood Storage**
 - * On Channel Impoundments, Off Channel Impoundments, Restored or Created Wetlands, Drainage, Culvert Sizing, Setting Back Existing Levees, Overtopping Levees
- * **Protection / Avoidance**
 - * Urban Levees, Farmstead Levees, Agricultural Levees, Evacuation of the Floodplain, Floodproofing, Flood Warning and Emergency Response Planning

Technical Paper No. 11

Red River Basin Flood Damage Reduction Framework

Red River Basin Flood Damage Reduction Work Group
Technical and Scientific Advisory Committee
Technical Paper No. 11

JD #19
Sub-Watershed



Red River Impacts of Strategies

* Reduce Flood Volume

- * Construction or Restoration of Depressional Wetlands, Cropland BMPs, Conversion of Cropland to Perennial Grassland, Conversion of Land Use to Forest, Other Beneficial Uses of Stored Water

* Increase Conveyance Capacity

- * Channelization, Agricultural Drainage, Diversions, Setting Back Existing Levees, Increasing Road Crossing Capacity

* Increase Temporary Flood Storage

- * On Channel Impoundments, Off Channel Impoundments, Restored or Created Wetlands, Drainage, Culvert Sizing, Setting Back Existing Levees, Overtopping Levees

* Protection / Avoidance

- * Urban Levees, Farmstead Levees, Agricultural Levees, Evacuation of the Floodplain, Floodproofing, Flood Warning and Emergency Response Planning

Technical Paper No. 11

Flood Damage Reduction (FDR) Measures	Red River “Middle” Area Contribution Ranking	JD 19 RCPP Technical Review
Reduce Runoff Volume		
Construction or Restoration of Depressional Wetlands	+	✓
Cropland BMPs	++	✓
Conversion of Cropland to Perennial Vegetation	++	✓
Conversion of Land Use to Forest	++	✓
Other Beneficial Uses of Stored Water	++	✓
Increase Conveyance Capacity		
Channelization	-	X
Agricultural Drainage	-	✓
Diversions	Variable	X
Setting Back Existing Levees	-	X
Increasing Road Crossing Capacity	-	✓

Technical Paper No. 11

FDR Strategy	Red River “Middle” Area Contribution Ranking	JD 19 RCPP Technical Review
Increase Temporary Storage		
Impoundments	++	✓
Restored or Created Wetlands	+	✓
Drainage	+	✗
Culvert Sizing	+	✗
Setting Back Existing Levees	++	✗
Overtopping Levees	+	✗
Protection/ Avoidance		
Urban Levees	-	✗
Farmstead Levees	-	✗
Agricultural Levees	-	✗
Evacuation of the Floodplain	0	✗
Floodproofing	0	✗
Flood Warning and Emergency Response Planning	0	✗

Technical Review of Strategies

- * Reduce Runoff Volume – Cropland Conversion
 - * Upstream of Nelson Slough
 - * Entire Watershed
- * Increased Conveyance Capacity – Doubled Culvert Sizes
- * Drainage Improvement
- * Increase Temporary Flood Storage
 - * Upstream of MN 32
 - * Upstream of Nelson Slough

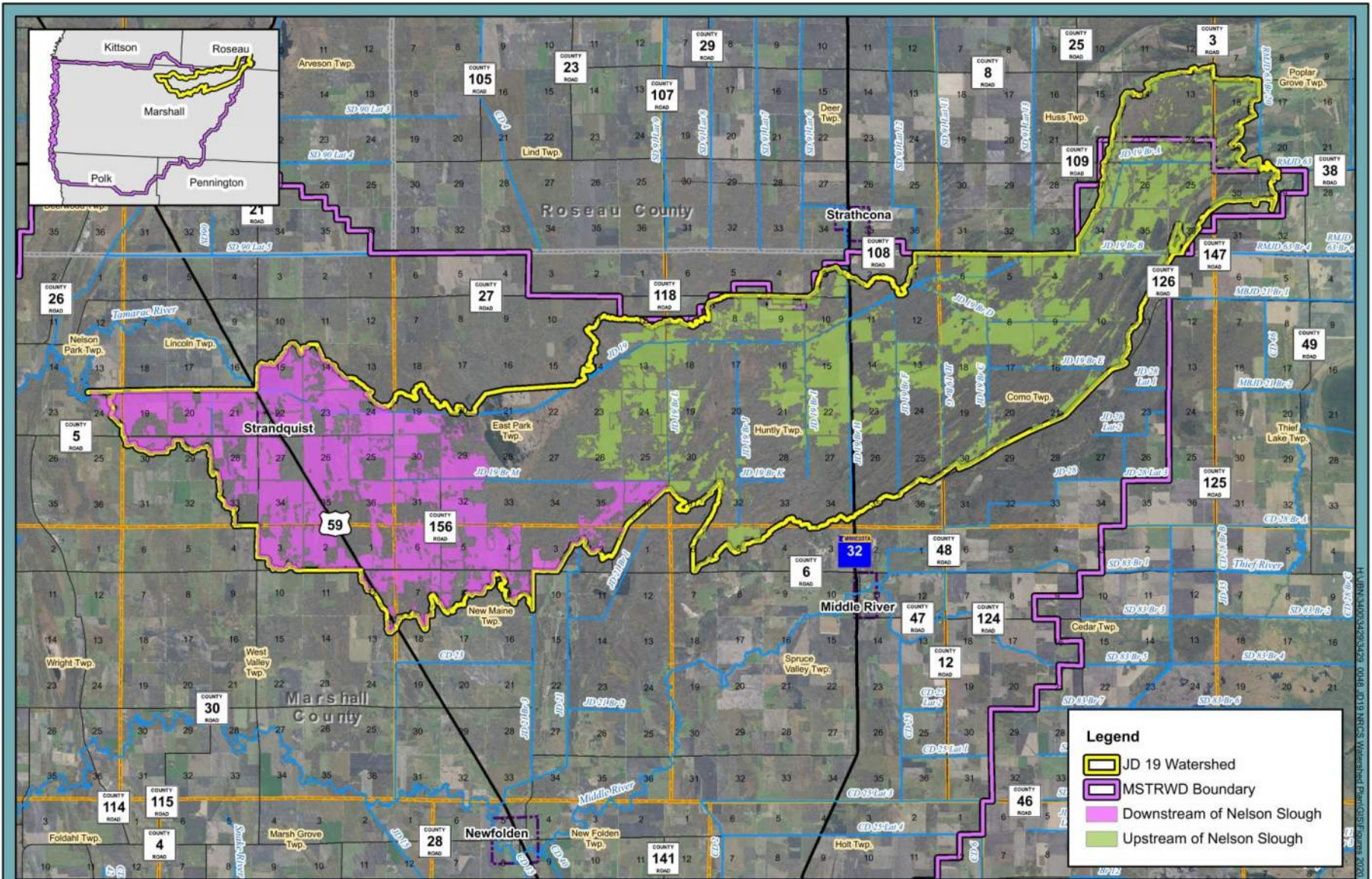
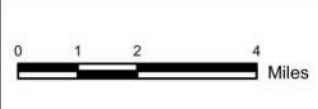


Fig. 2.1.1

Figure 2.1.1: Reduce Runoff Volume
 Judicial Ditch #19 Watershed Plan
 Screening of Alternatives for Detailed Review
 Middle-Snake-Tamarac Rivers Watershed District

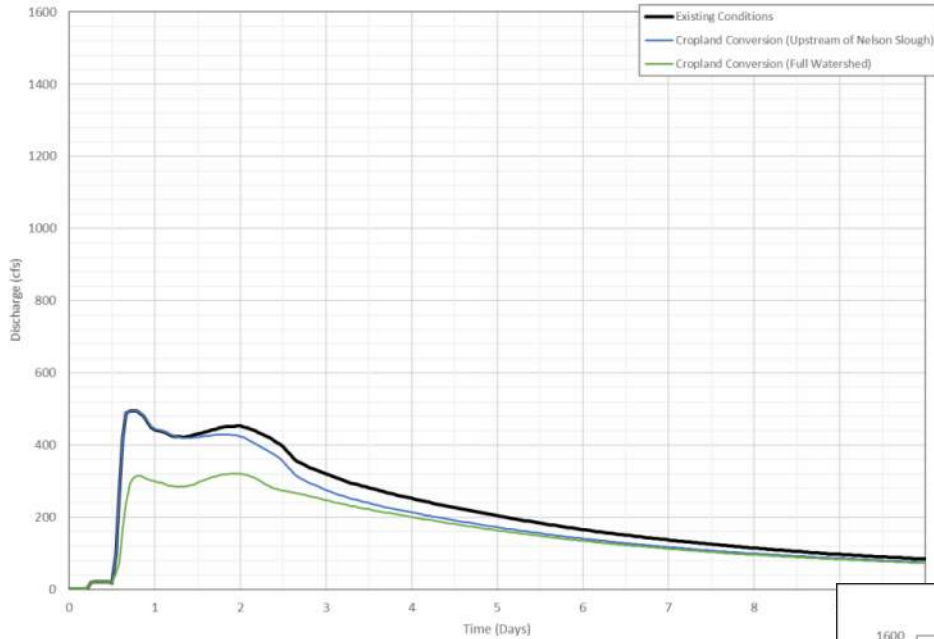


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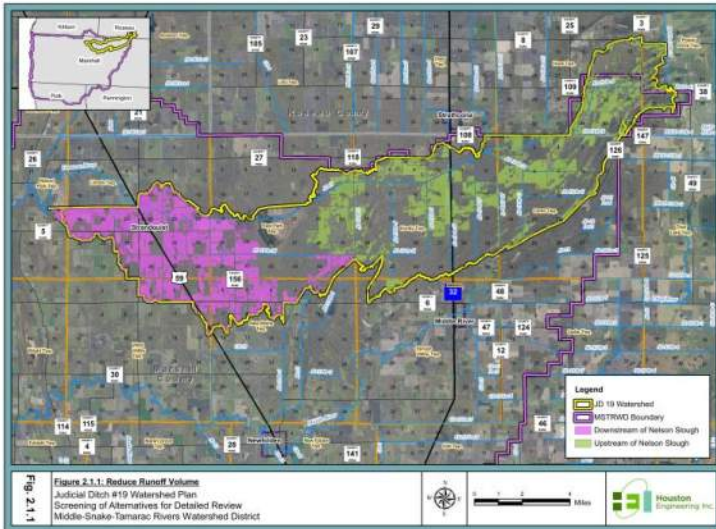
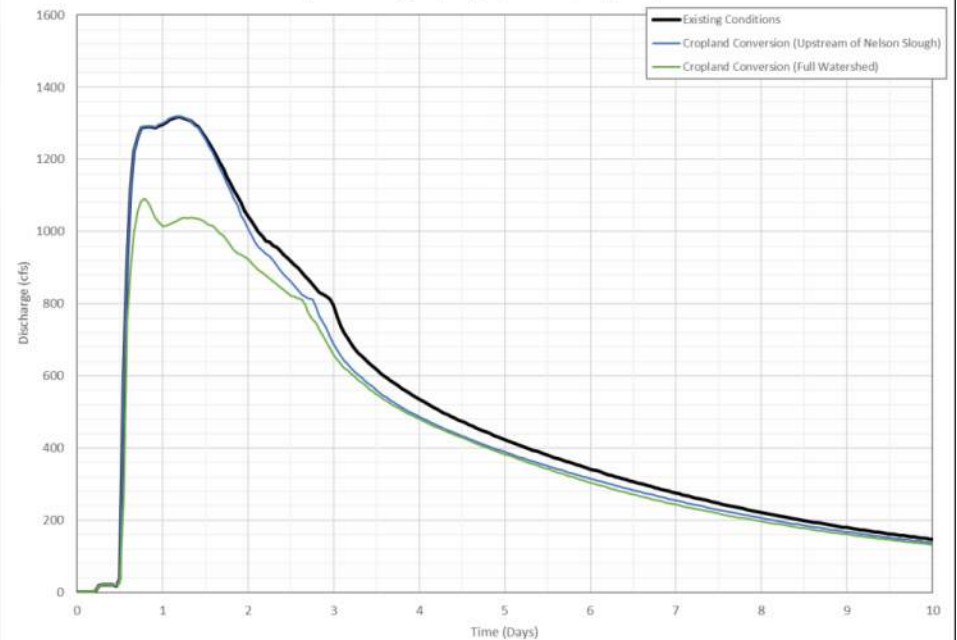
Reduce Runoff Volume: Cropland Conversion

US Highway 59

10-year Discharge Hydrograph at JD 19 Highway 59



100-year Discharge Hydrograph at JD 19 Highway 59



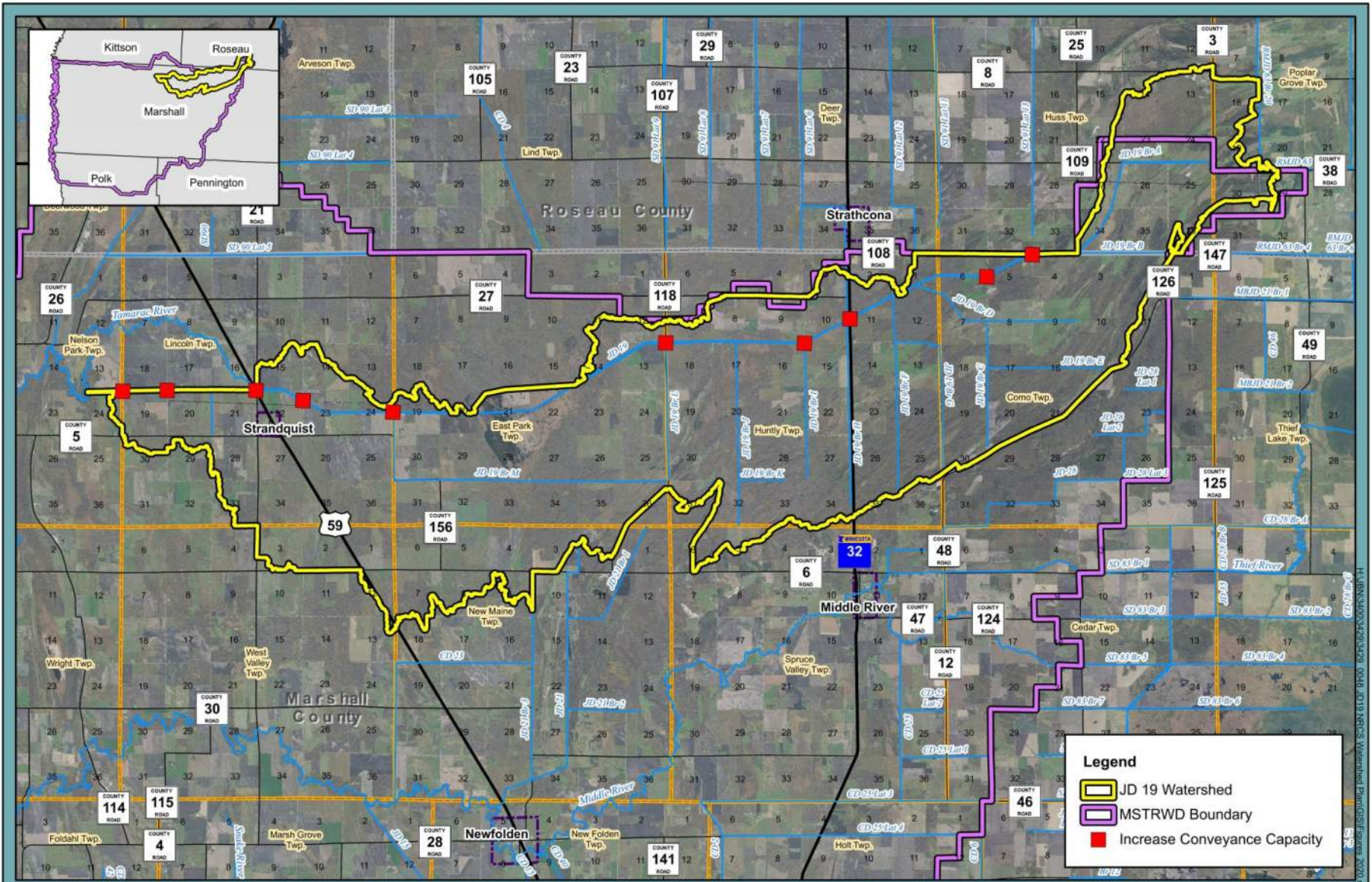
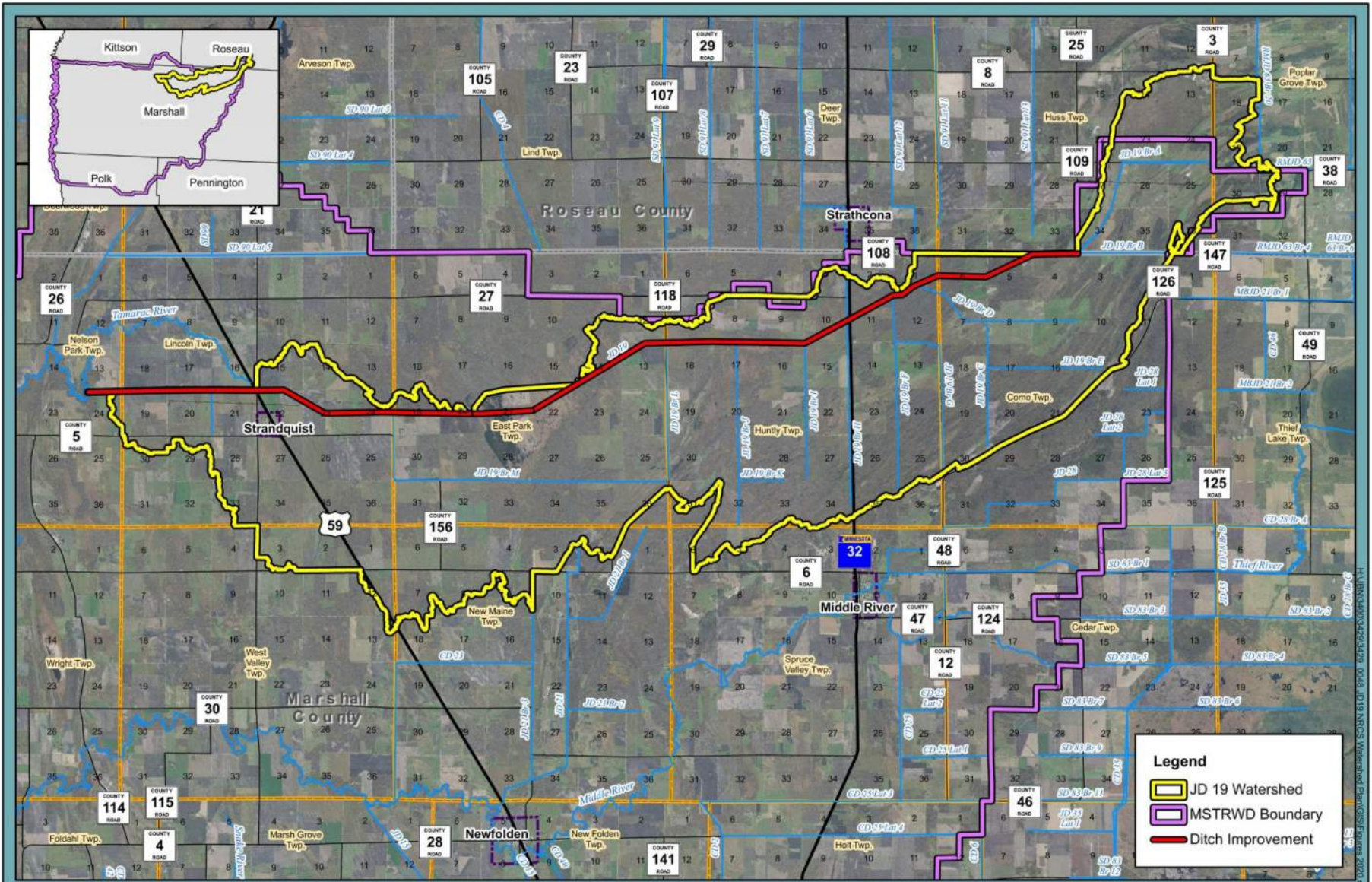


Fig. 2.1.12

Figure 2.1.2: Increase Conveyance Capacity
 Judicial Ditch #19 Watershed Plan
 Screening of Alternatives for Detailed Review
 Middle-Snake-Tamarac Rivers Watershed District



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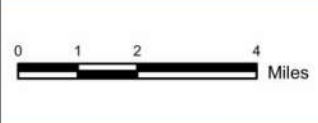
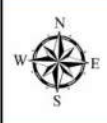


Legend

- JD 19 Watershed
- MSTRWD Boundary
- Ditch Improvement

Fig. 3.1.1

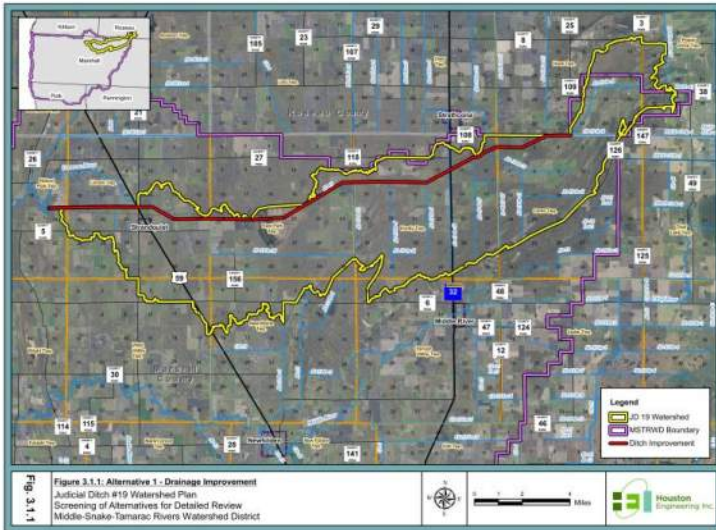
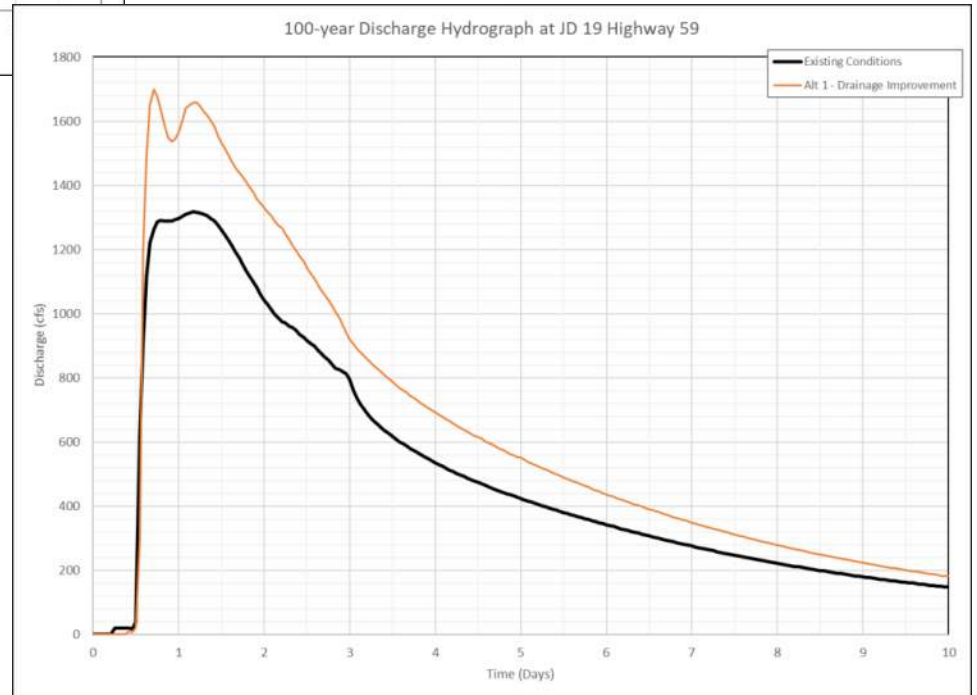
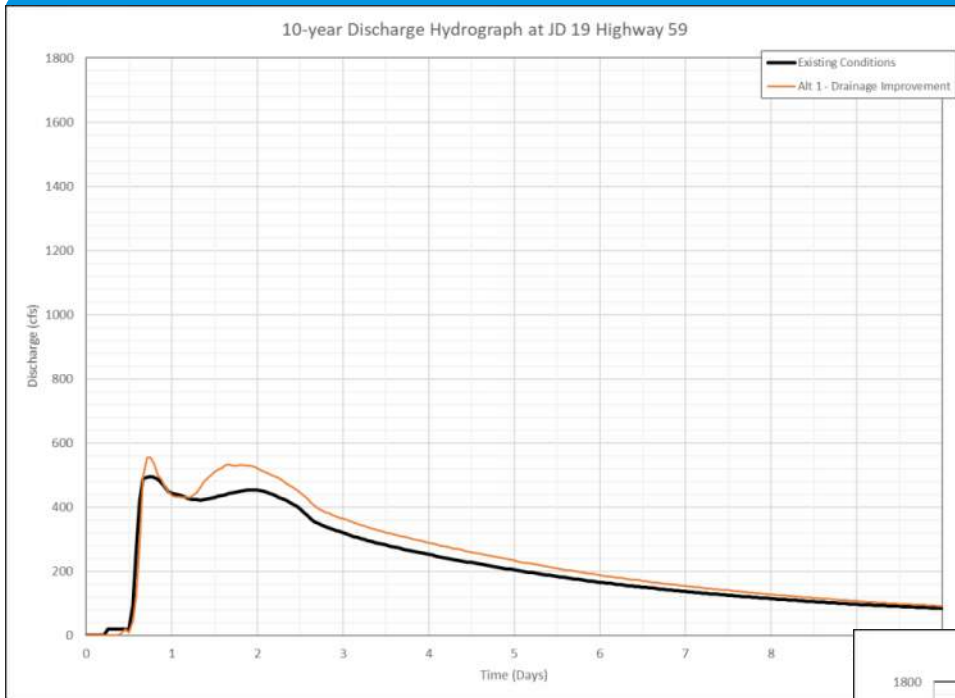
Figure 3.1.1: Alternative 1 - Drainage Improvement
 Judicial Ditch #19 Watershed Plan
 Screening of Alternatives for Detailed Review
 Middle-Snake-Tamarac Rivers Watershed District

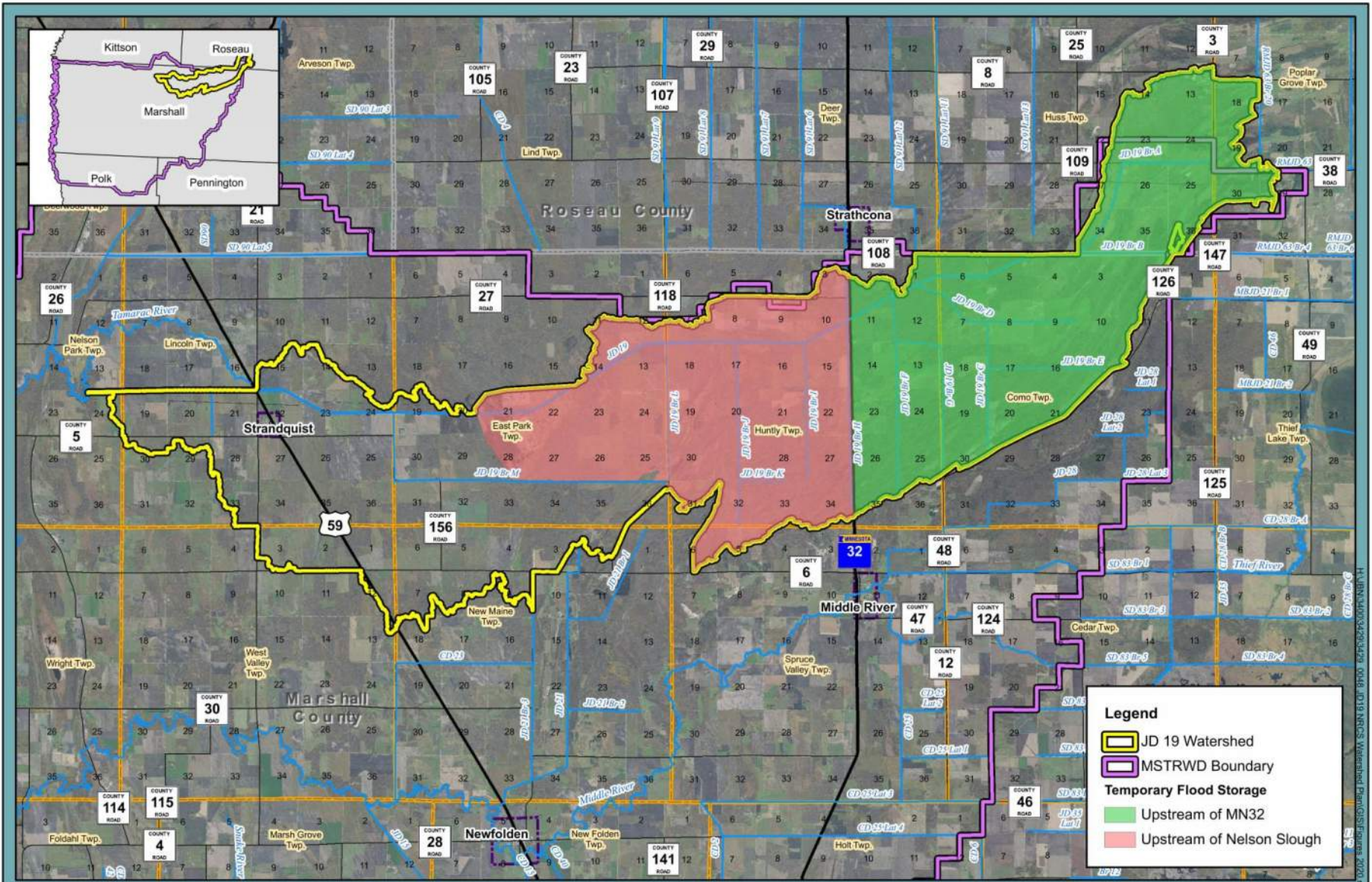


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 H:\A\19\3025\2525\Fig 3.1.1 - Alternative 1 - Drainage Improvement.dwg
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 H:\A\19\3025\2525\Fig 3.1.1 - Alternative 1 - Drainage Improvement.dwg
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Drainage Improvement

US Highway 59





Legend

- JD 19 Watershed
- MSTRWD Boundary
- Temporary Flood Storage**
- Upstream of MN32
- Upstream of Nelson Slough

Fig. 2.1.3

Figure 2.1.3: Increase Temporary Flood Storage
 Judicial Ditch #19 Watershed Plan
 Screening of Alternatives for Detailed Review
 Middle-Snake-Tamarac Rivers Watershed District

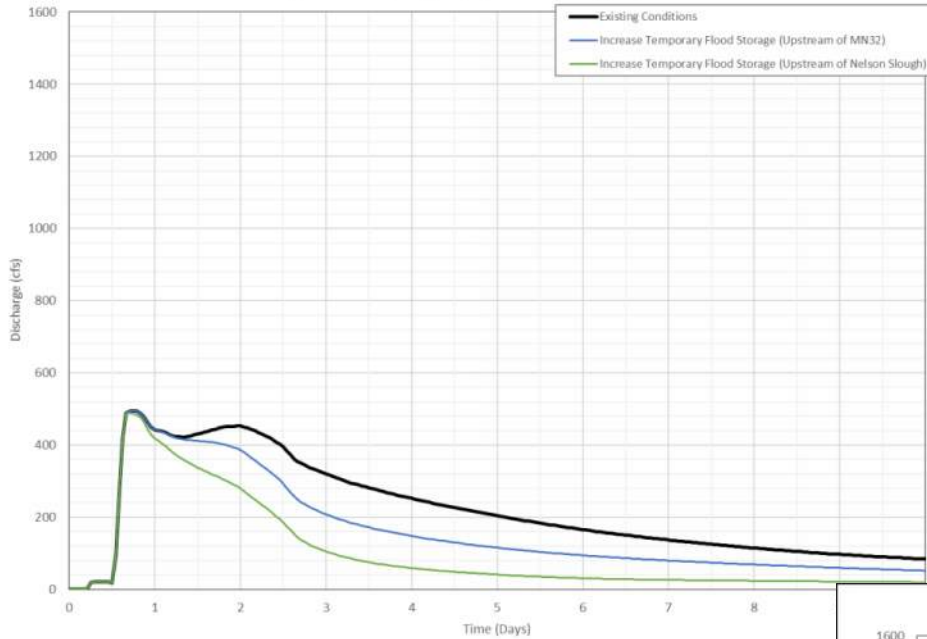


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Increase Temporary Flood Storage

US Highway 59

10-year Discharge Hydrograph at JD 19 Highway 59



100-year Discharge Hydrograph at JD 19 Highway 59

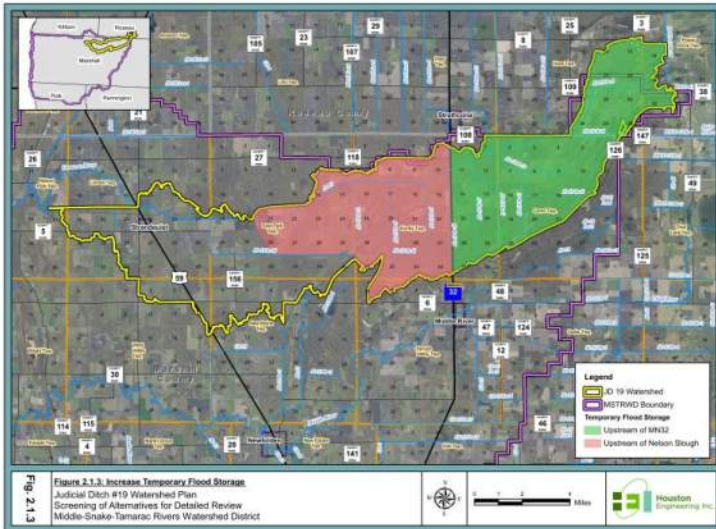
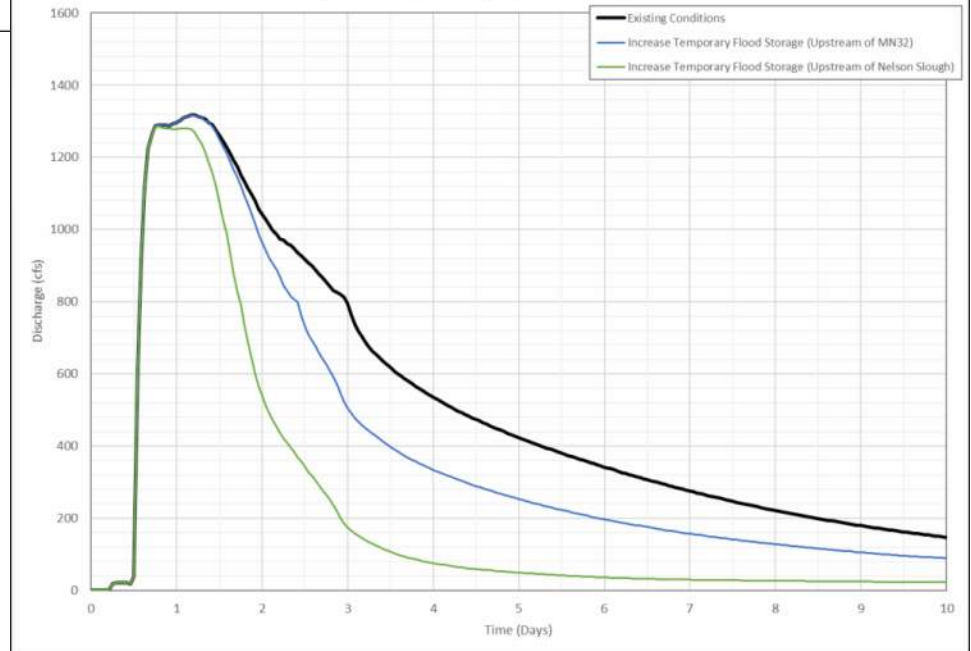


Figure 3.3.3. Increase Temporary Flood Storage
Judicial Ditch #19 Watershed Plan
Screening of Alternatives for Detailed Review
Middle-Snake-Tamarac Rivers Watershed District



Technical Review of Strategies

- * **Reduce Runoff Volume – Cropland Conversion**
 - * **Upstream of Nelson Slough**
 - * **Entire Watershed**
- * **Increased Conveyance Capacity**
- * **Drainage Improvement**
- * Increase Temporary Flood Storage
 - * Upstream of MN 32
 - * Upstream of Nelson Slough

Not Practical
Do not meet P&N

Alternative Analysis

- * Branch M Impoundment Site
- * Branch J Impoundment Site Option 1
- * Branch J Impoundment Site Option 2
- * East Park Township Impoundment Site
- * Lincoln Township Impoundment Site
- * Nelson Slough Improvements

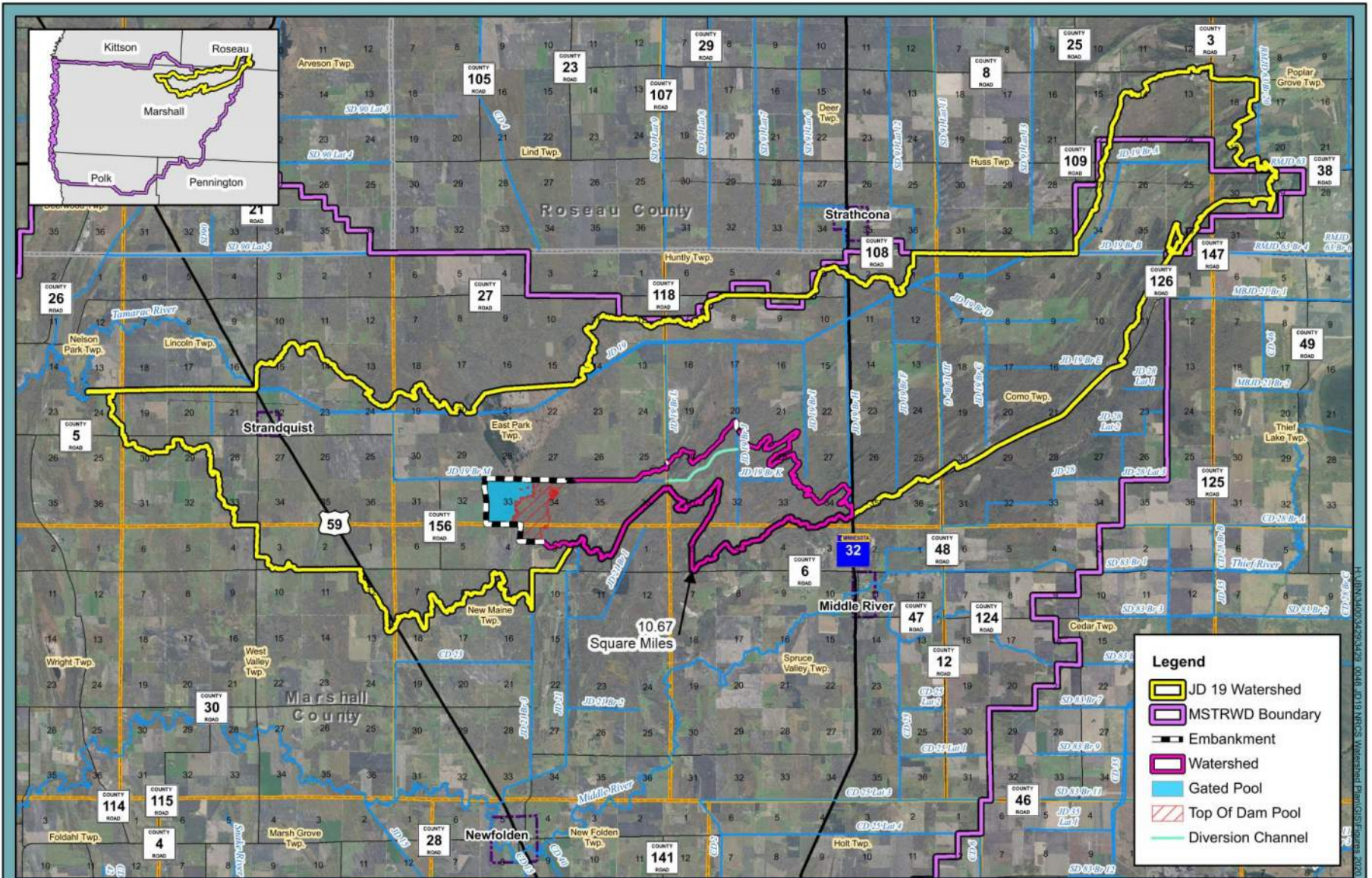


Fig. 3.1.2

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



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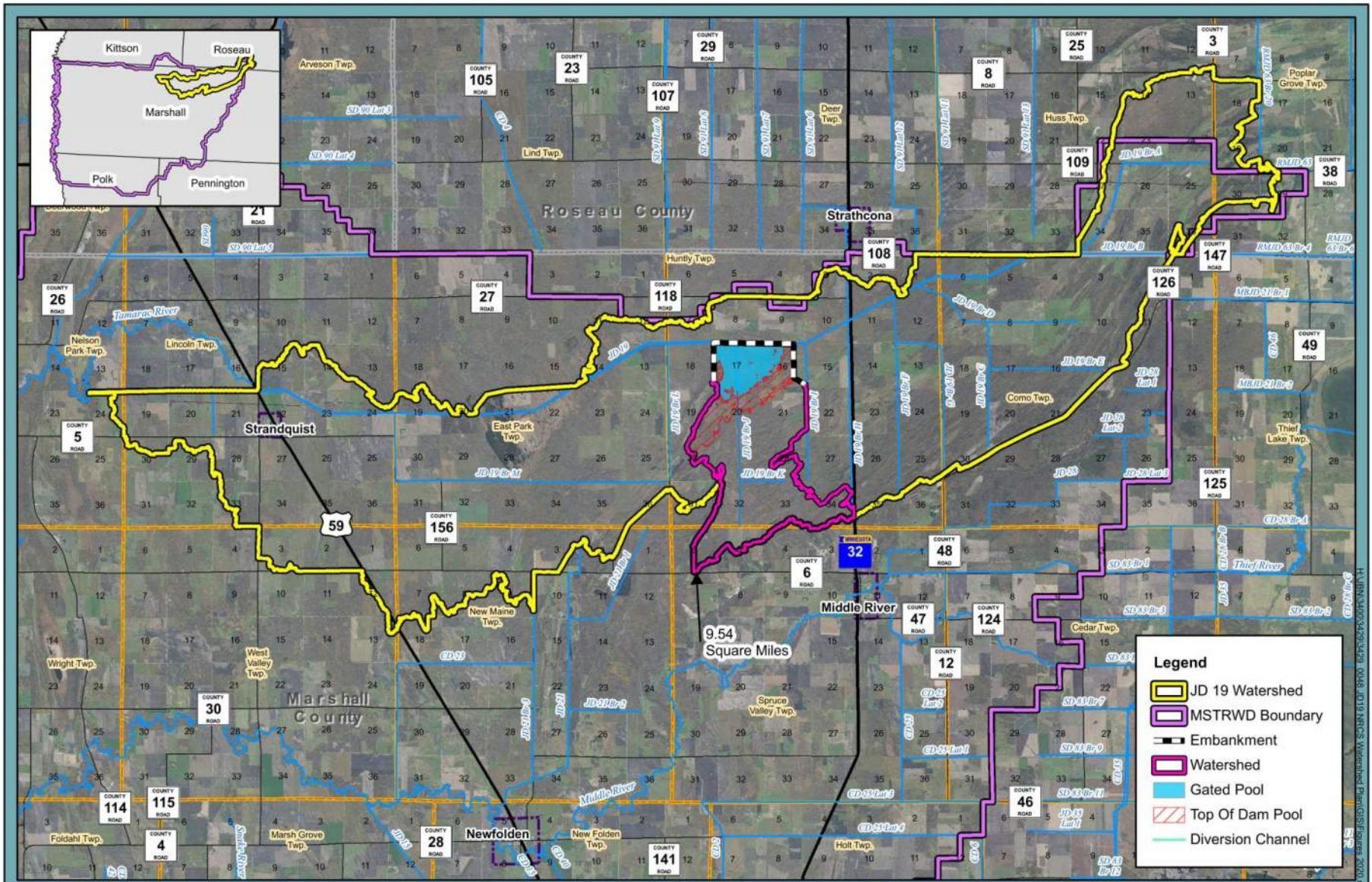
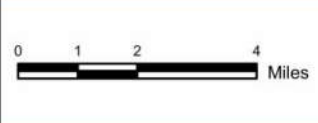
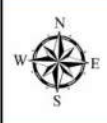


Fig. 3.1.2

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



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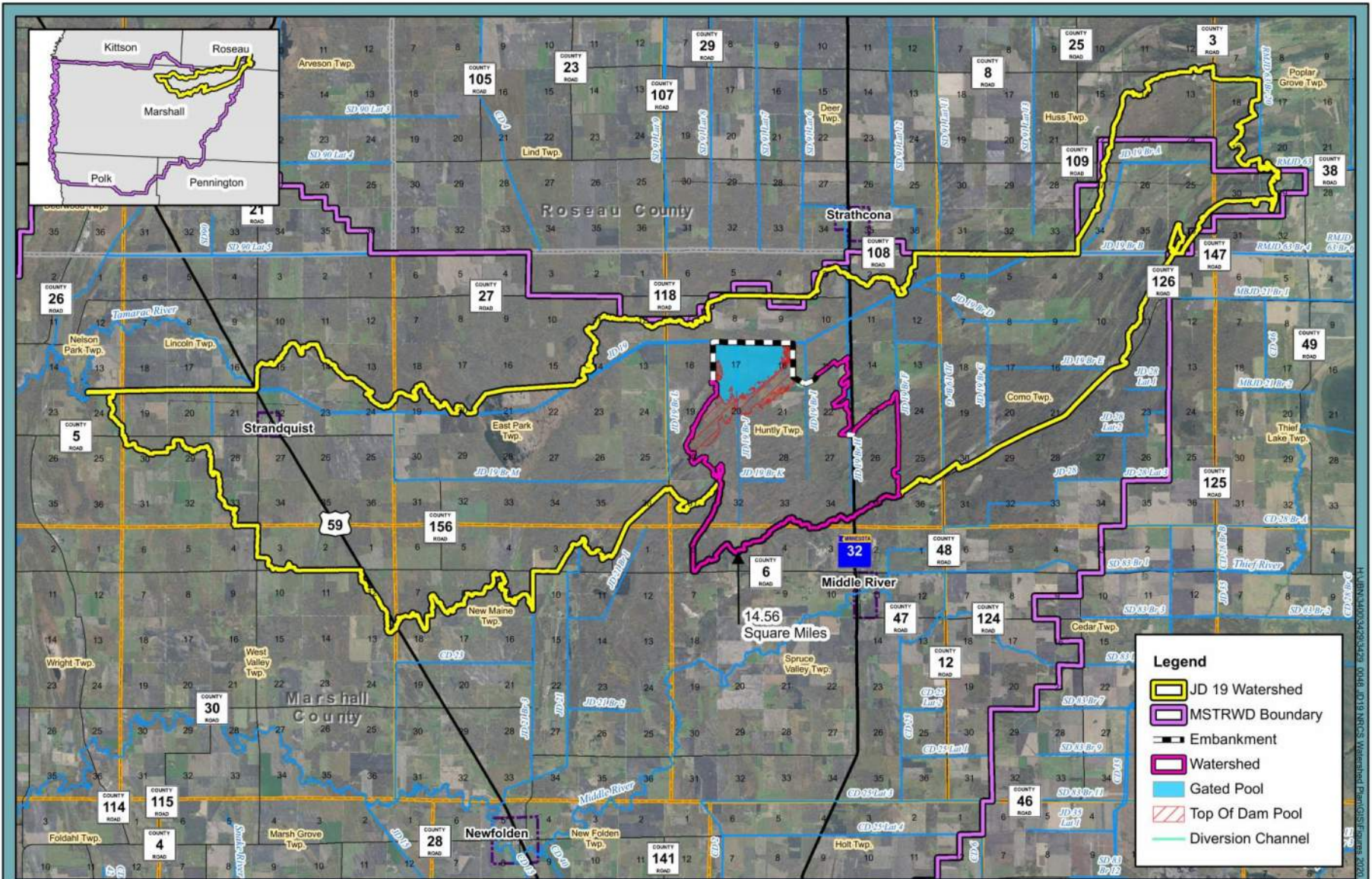
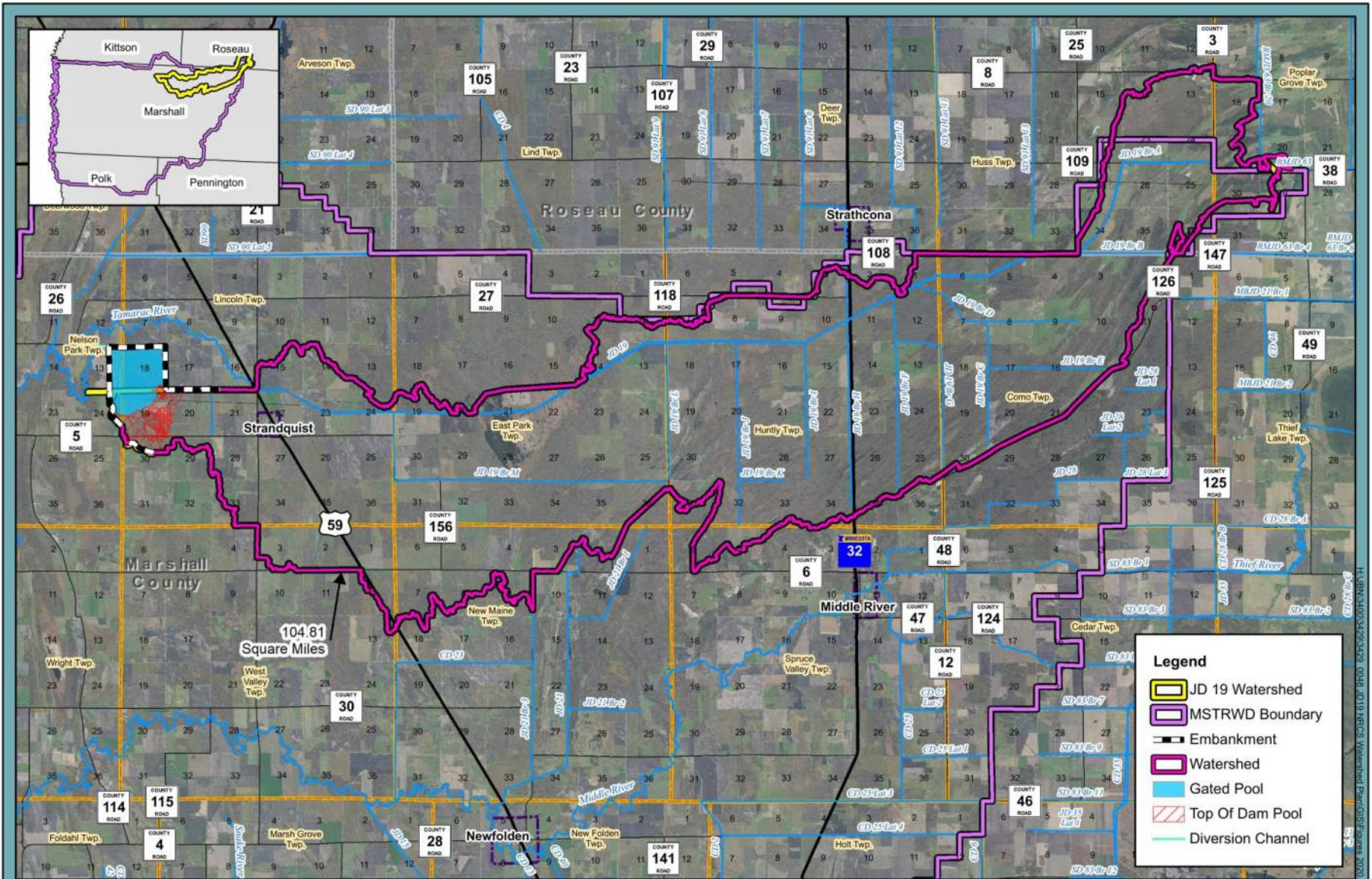


Fig. 3.1.3

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



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Legend

- JD 19 Watershed
- MSTRWD Boundary
- Embankment
- Watershed
- Gated Pool
- Top Of Dam Pool
- Diversion Channel

Fig. 3.1.5

Figure 3.1.6: Alternative 6 - Lincoln Township Impoundment Site
 Judicial Ditch #19 Watershed Plan
 Screening of Alternatives for Detailed Review
 Middle-Snake-Tamarac Rivers Watershed District



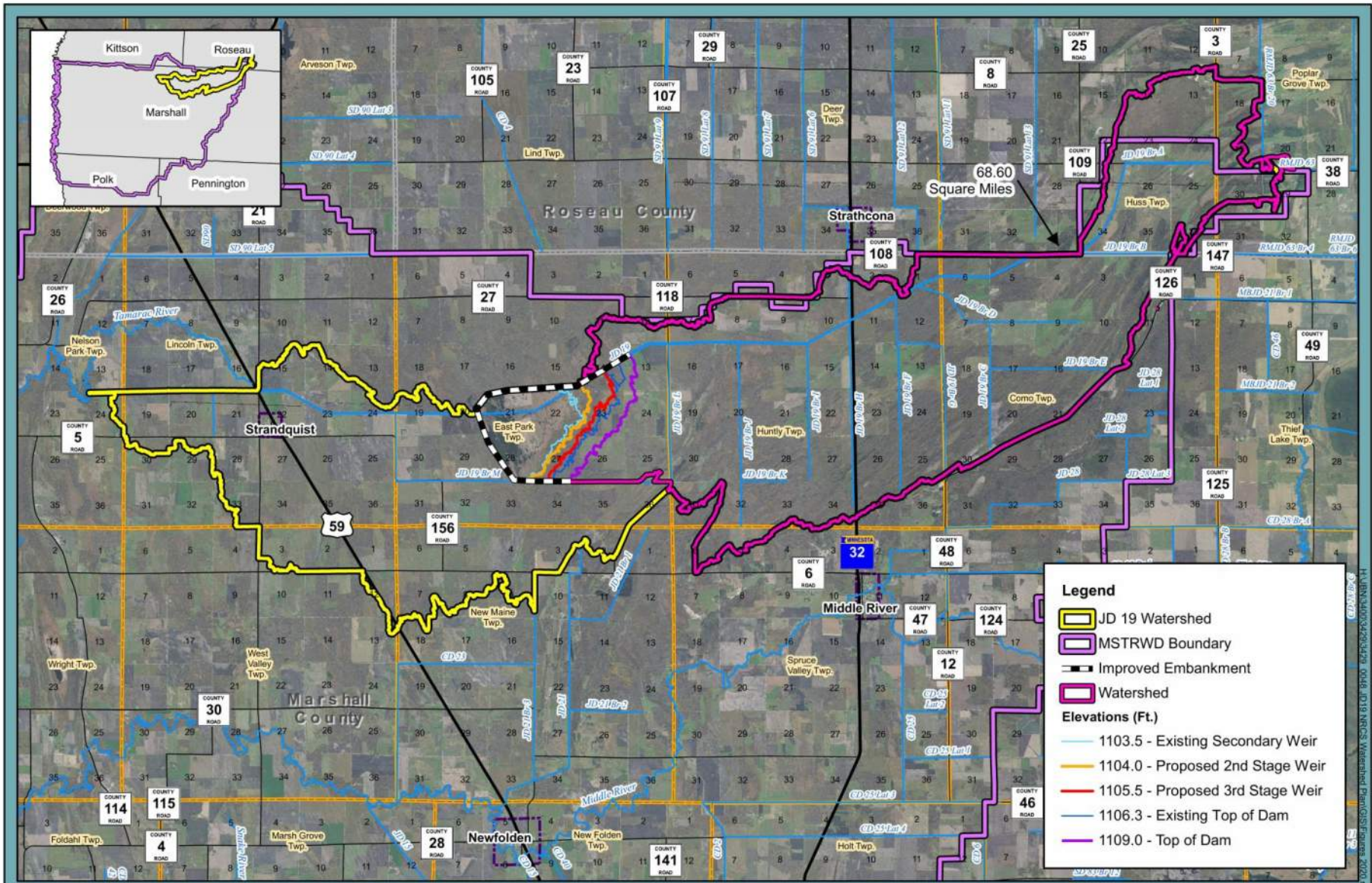
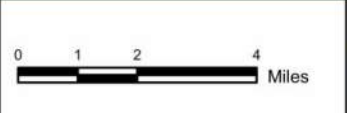


Fig. 3.1.5

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



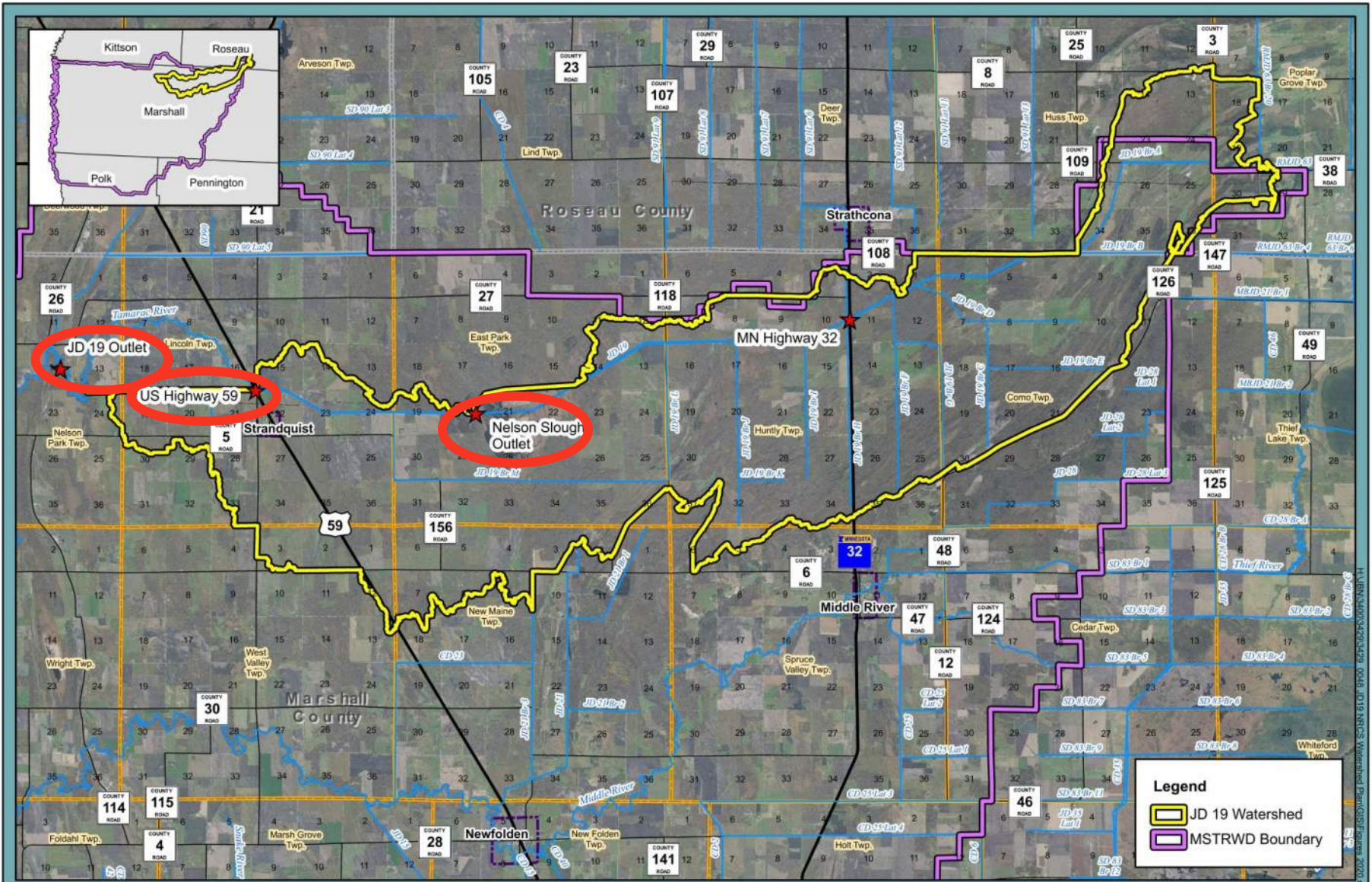


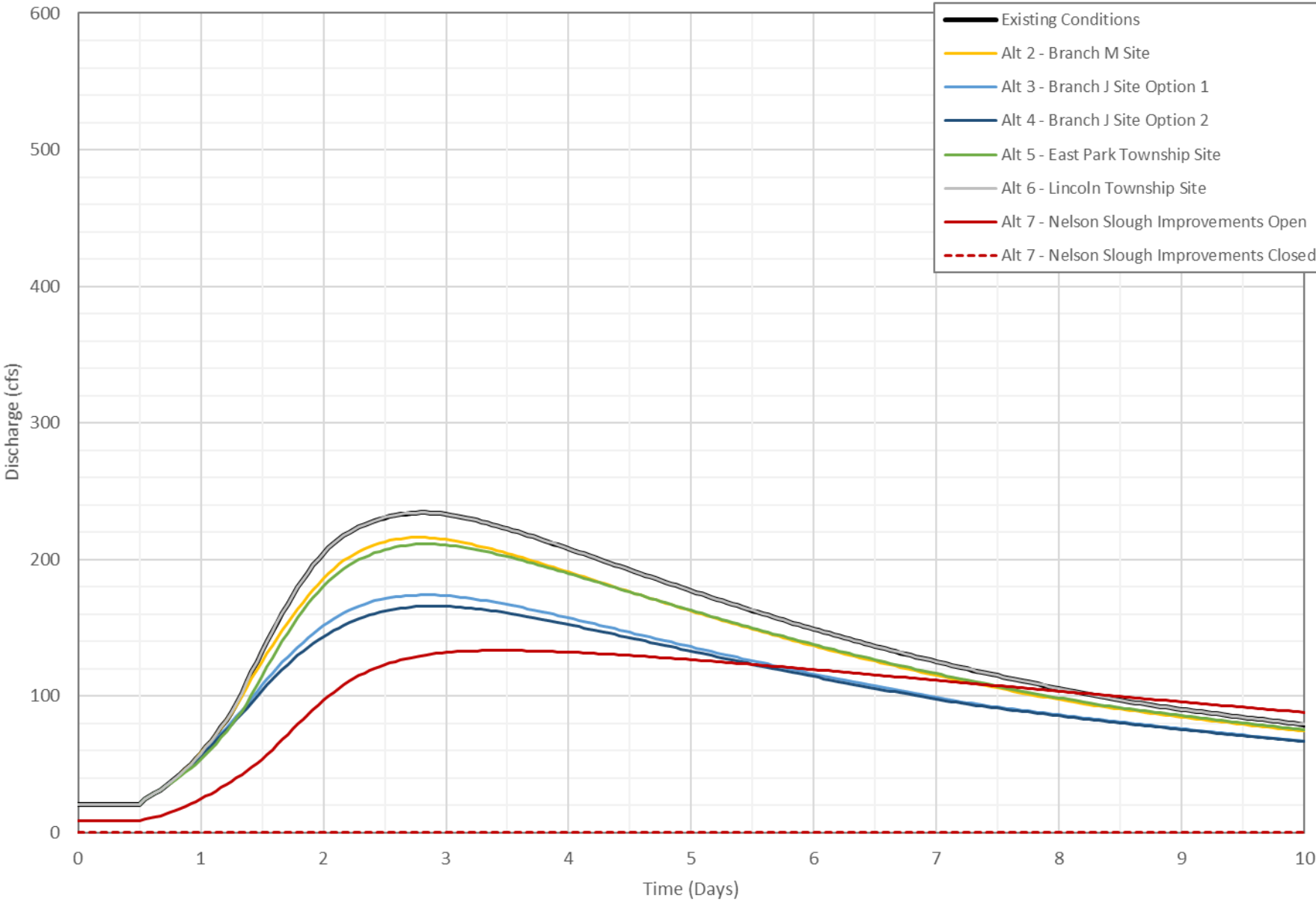
Fig. B.1

Figure B.1: Identified Alternatives - Reporting Locations
 Judicial Ditch #19 Watershed Plan
 Screening of Alternatives for Detailed Review
 Middle-Snake-Tamarac Rivers Watershed District

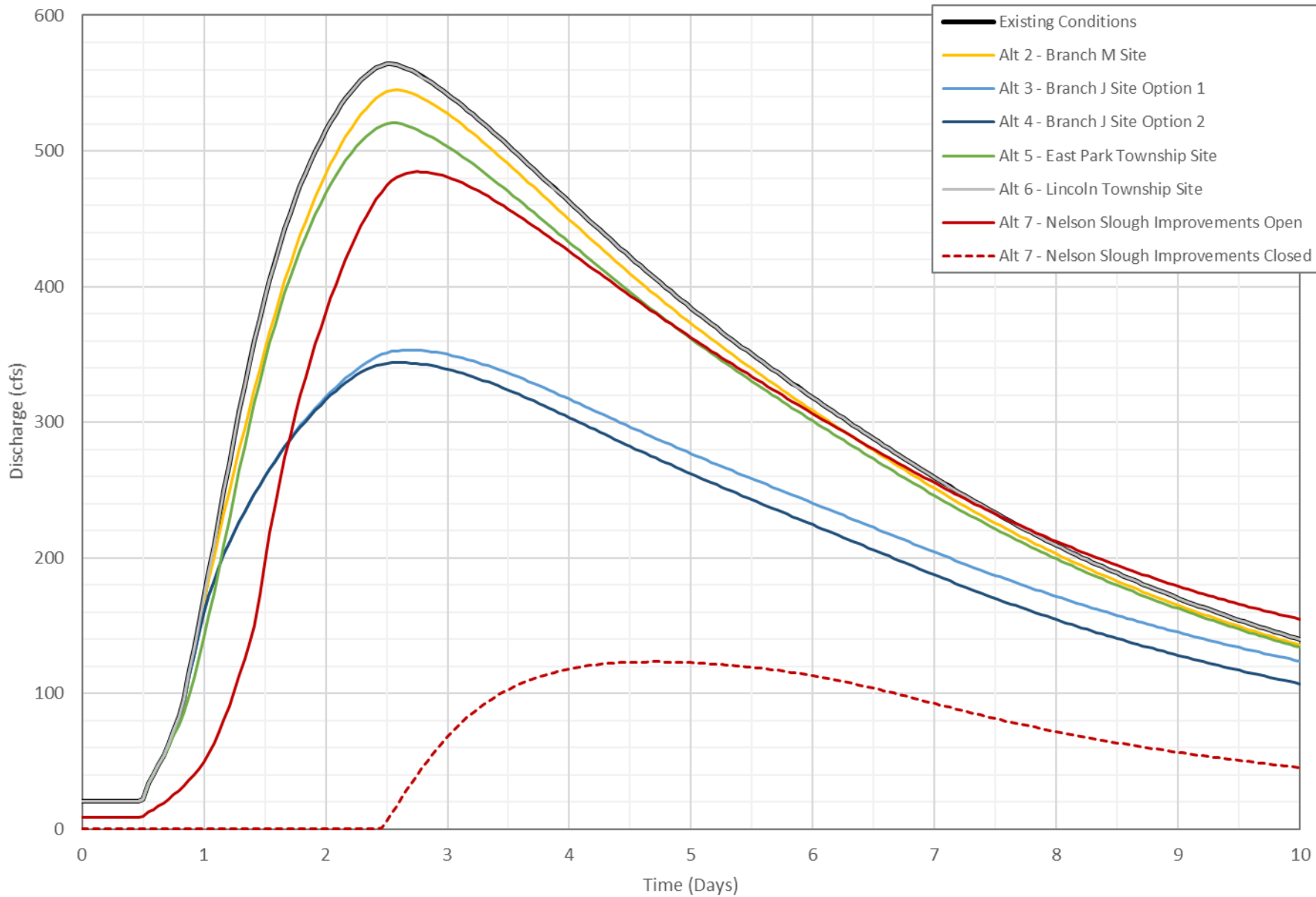


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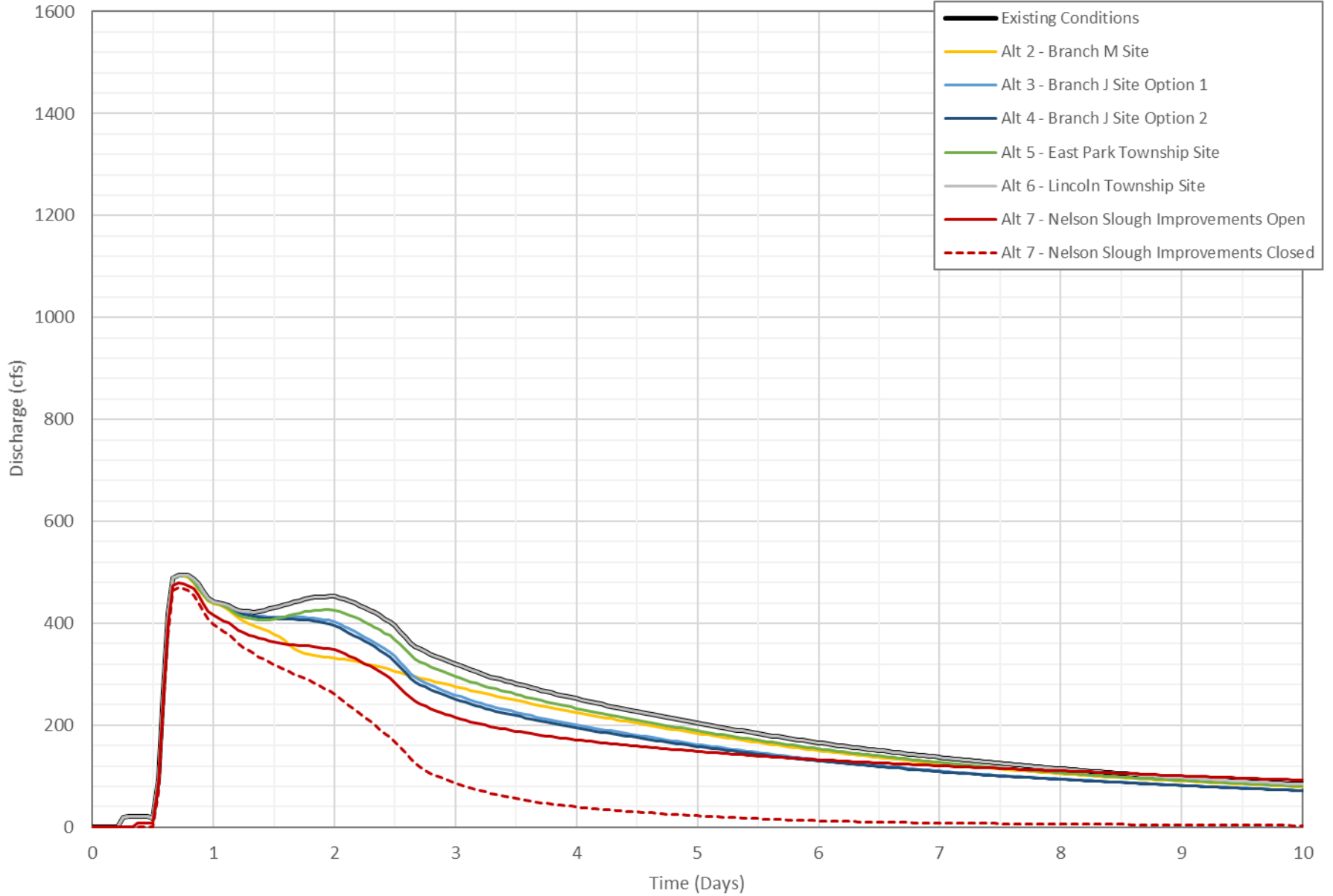
10-year Discharge Hydrograph at Nelson Slough Outlet



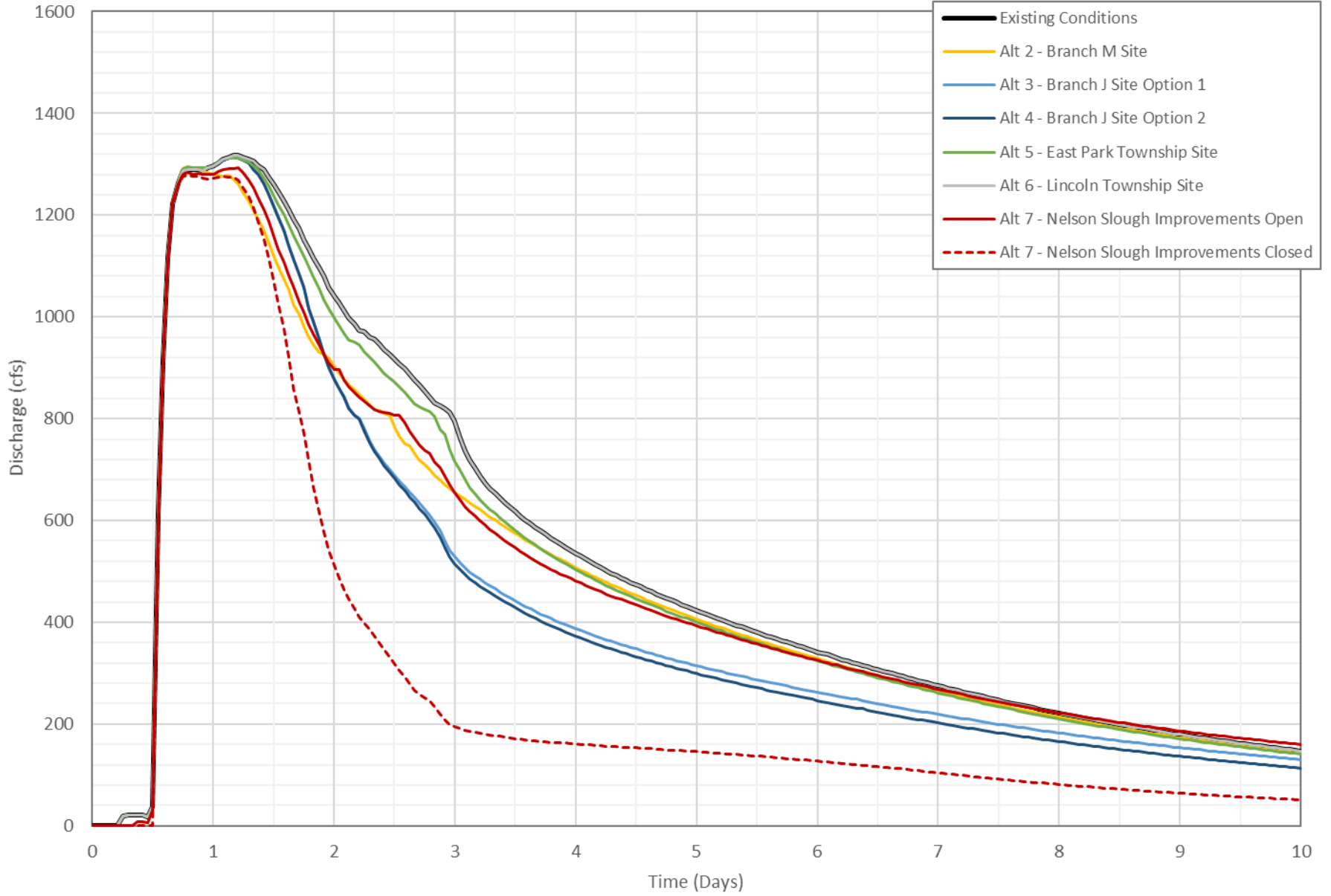
100-year Discharge Hydrograph at Nelson Slough Outlet



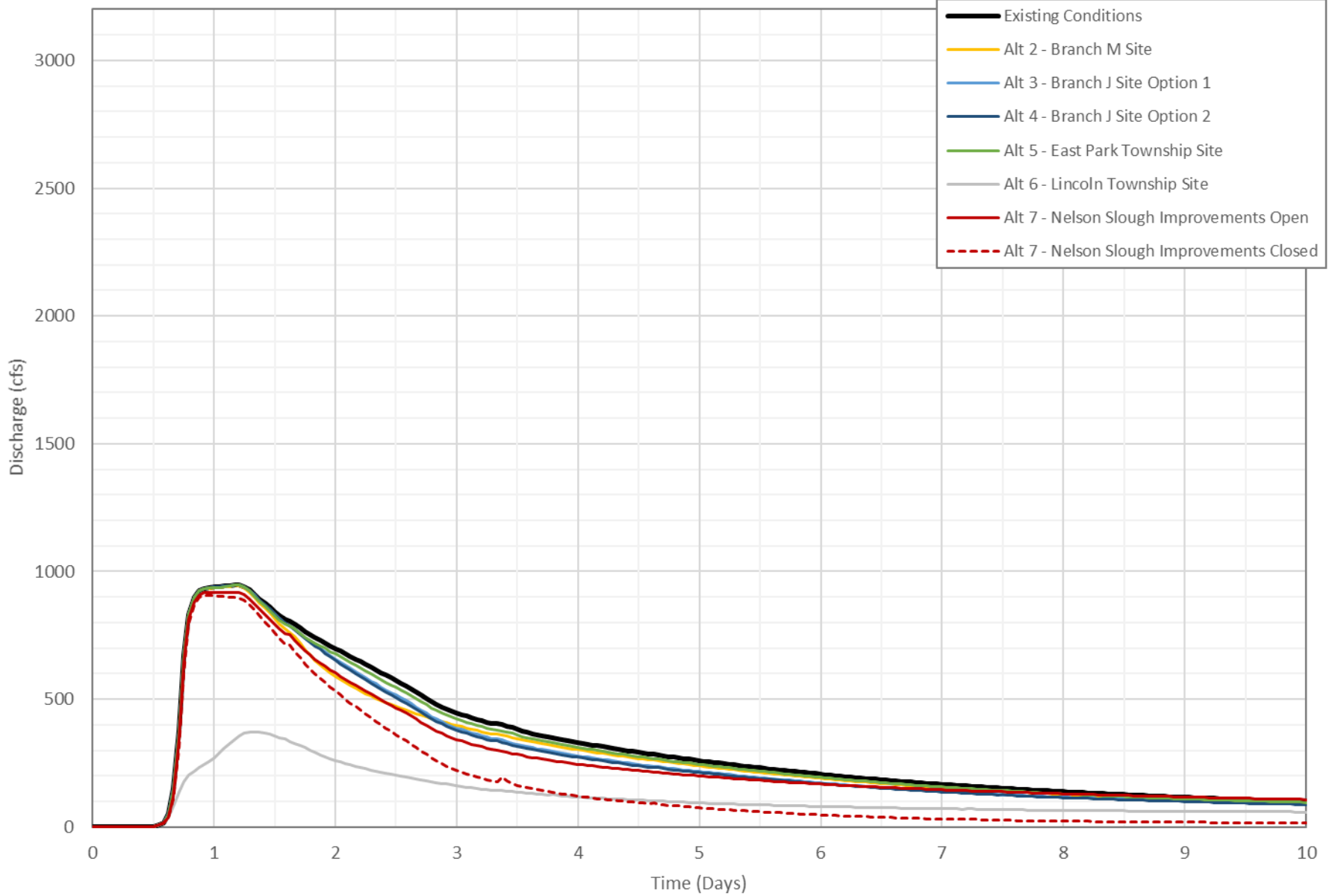
10-year Discharge Hydrograph at JD 19 Highway 59



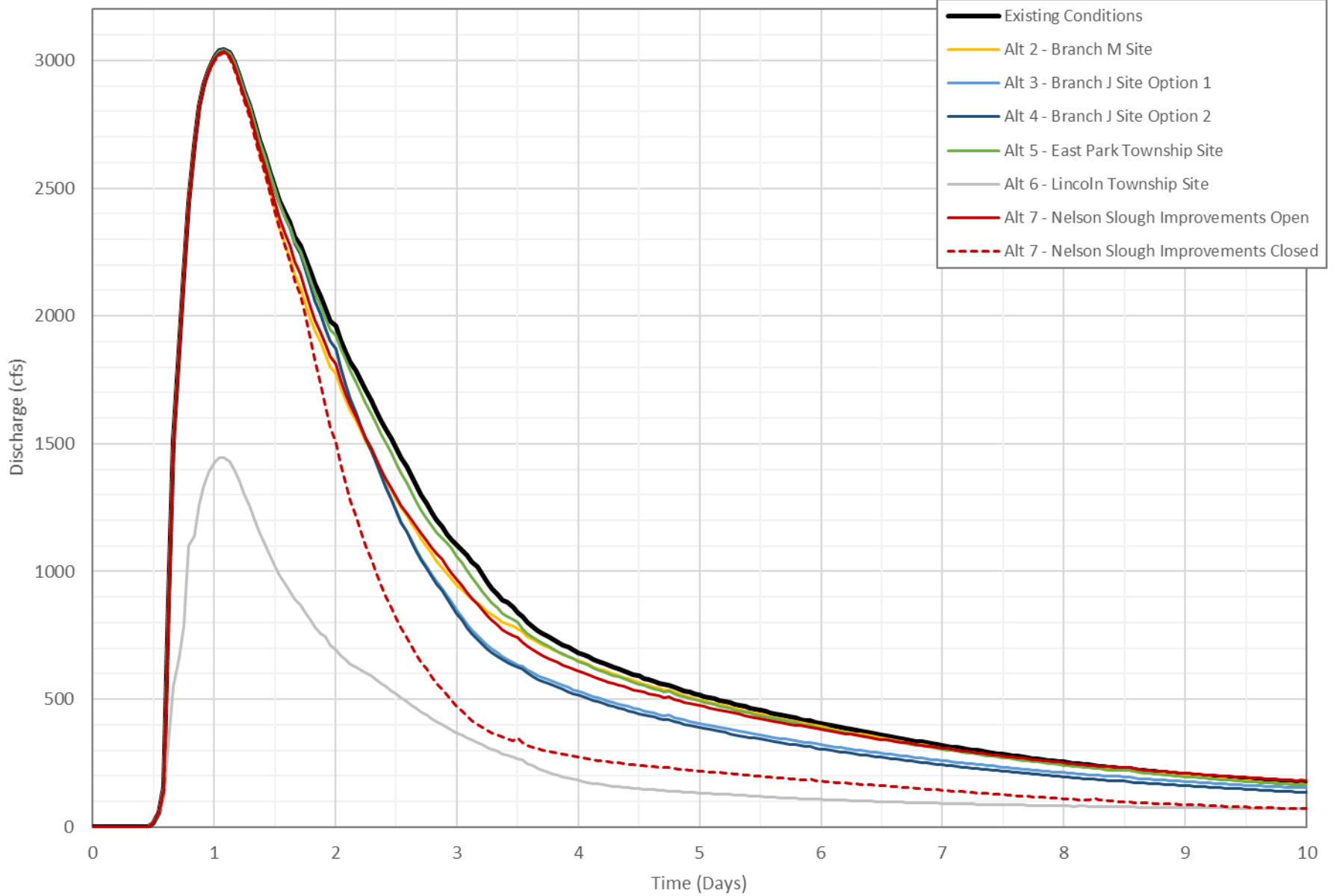
100-year Discharge Hydrograph at JD 19 Highway 59



10-year Discharge Hydrograph at JD19 Outlet



100-year Discharge Hydrograph at JD19 Outlet

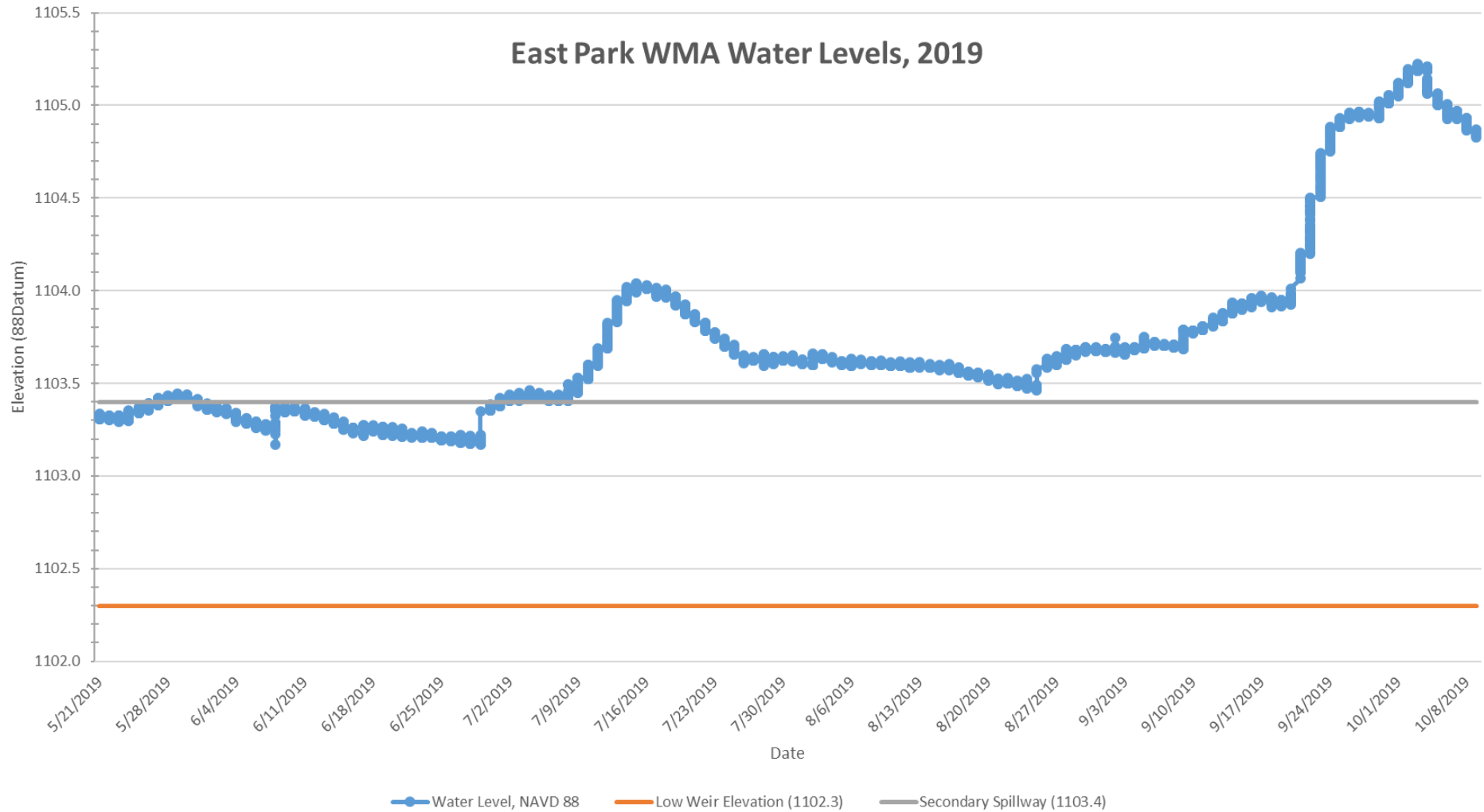


ALT. 7 – NELSON SLOUGH IMPROVEMENTS

July 18, 2019



East Park WMA (Nelson Slough)

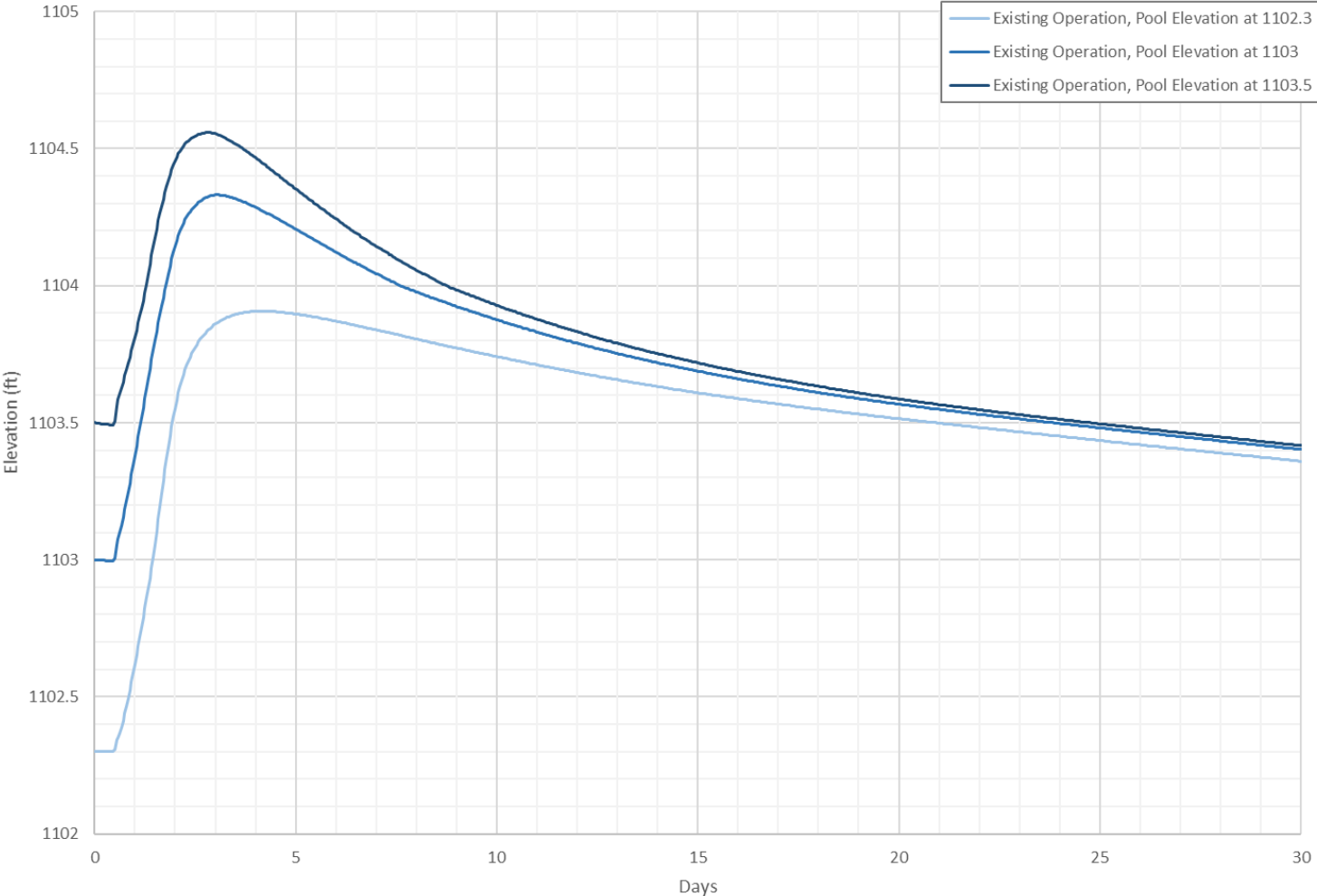


Average Elevation 5/21/19 through 10/8/19 = 1103.7

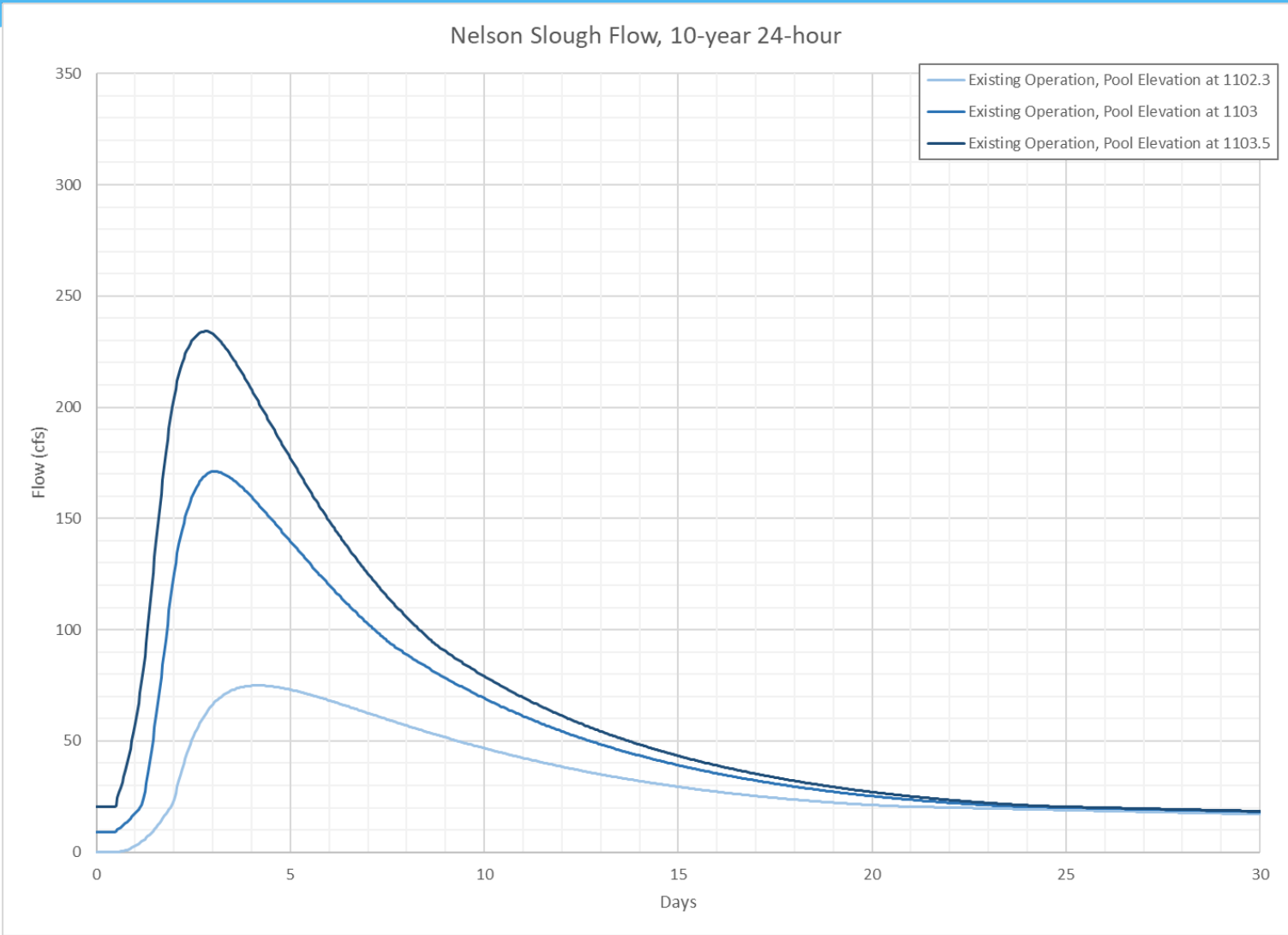
Average Elevation 5/21/19 through 9/4/19 = 1103.5

East Park WMA (Nelson Slough)

Nelson Slough Pool Elevation, 10-year 24-hour

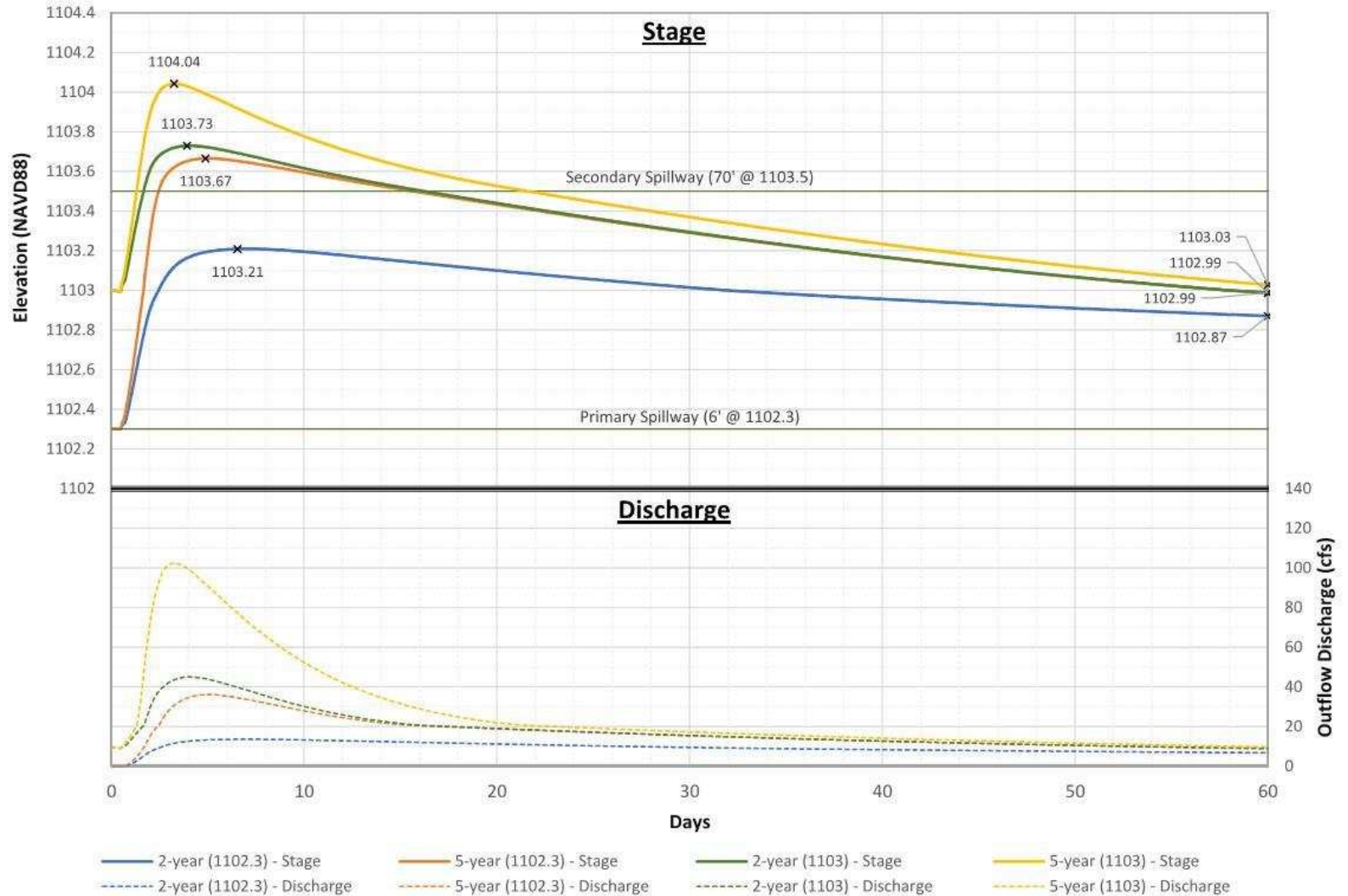


East Park WMA (Nelson Slough)



East Park WMA (Nelson Slough)

Nelson Slough 24-hour Rainfall Events 60-day Drawdown



ALT. 7 – NELSON SLOUGH IMPROVEMENTS

- * Construct New Outlet Structure – Build in Cattail Debre Deterrent
- * Address Existing Levee Height – Current Dam Design Criteria (TR-60)
 - * Increase from approx. 1106.3 to 1109.0
- * Borrow Source Likely within the Impoundment Site – Create NRE/Habitat
- * Agreement on New O&M Plan – Joint Operation MSTRWD/DNR
- * Operation
 - * No Fall Drawdown Below 1102.3 (Current Identified Normal Pool Elevation)
 - * Summer/Fall Drawdown at 1102.3
 - * Summer Gated Storage 1104.0
 - * Spring Gated Storage 1105.5
 - * Summer/Spring Release Based on Trigger Points Downstream

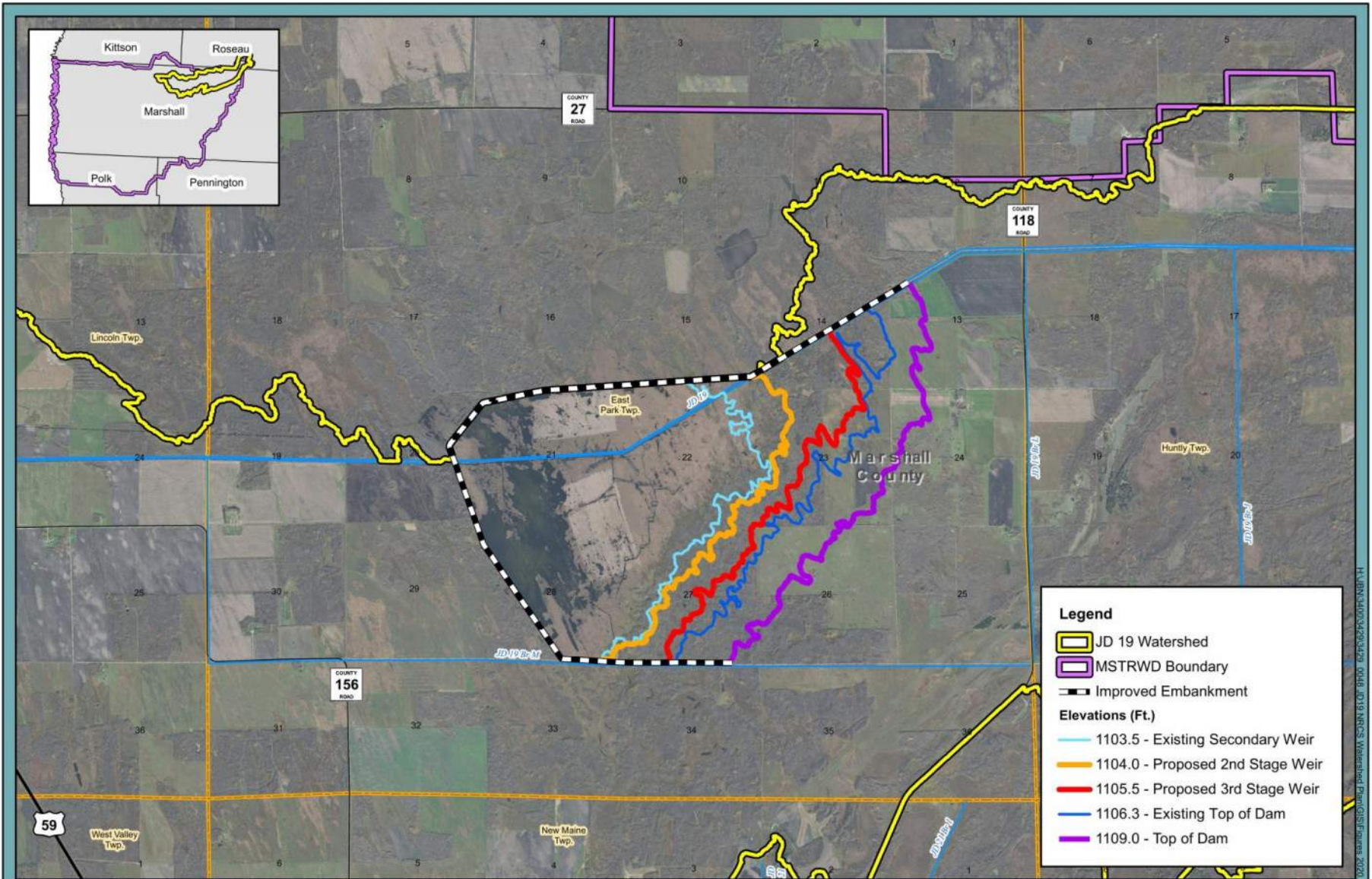


Fig. 3.1.5

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



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Gated Storage Characteristics

- * Spring Gated Storage

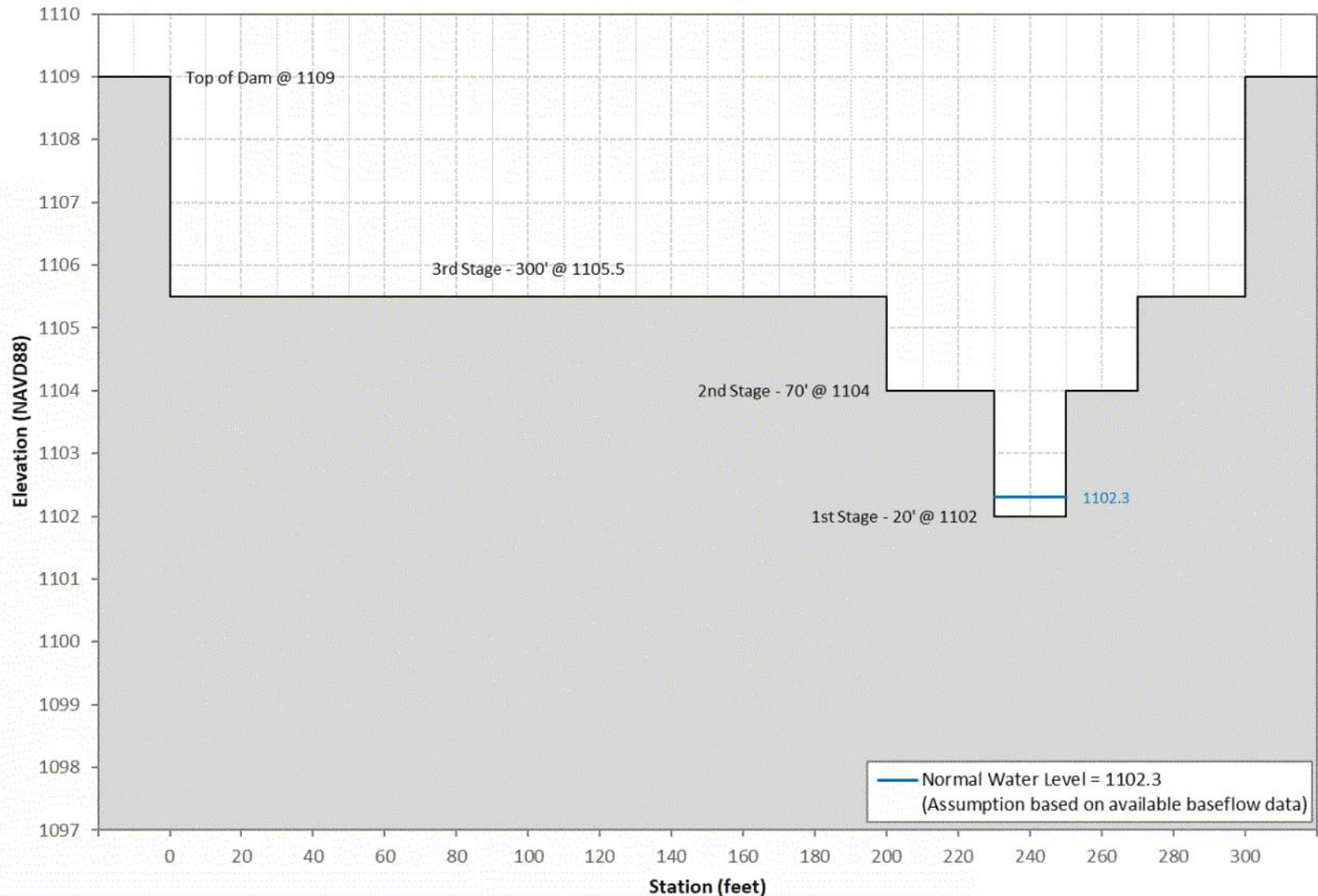
- * Spring Gated Storage 1102.3 to 1105.5 (6,878 acre-feet gated storage, 1.8” runoff)

- * Summer Gated Storage

- * Summer Gated Storage 1102.3 to 1104.0 (3,227 acre-feet gated storage, 0.9” runoff)

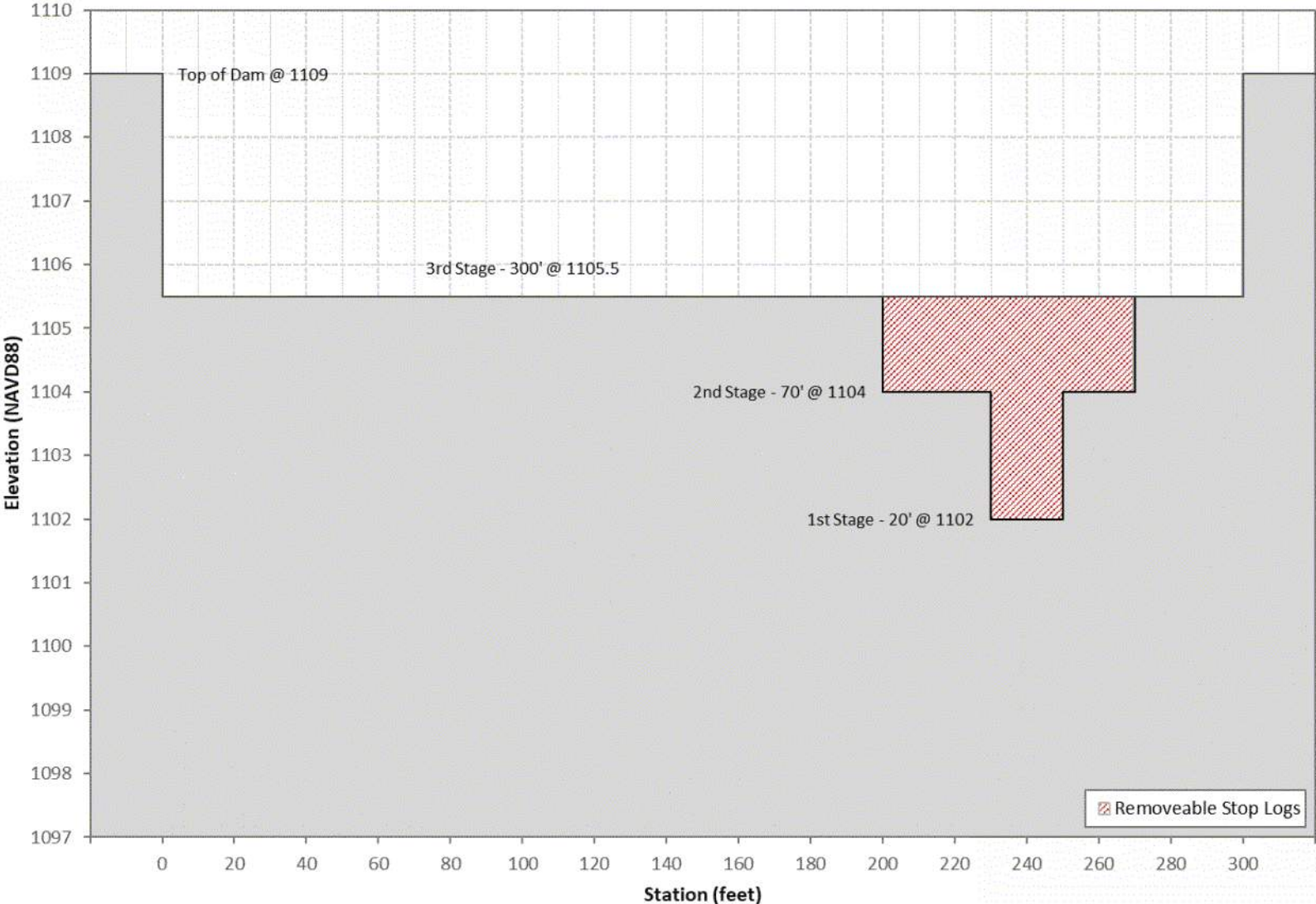
Nelson Slough Outlet Structure (Open)

Nelson Slough Outlet Structure Profile



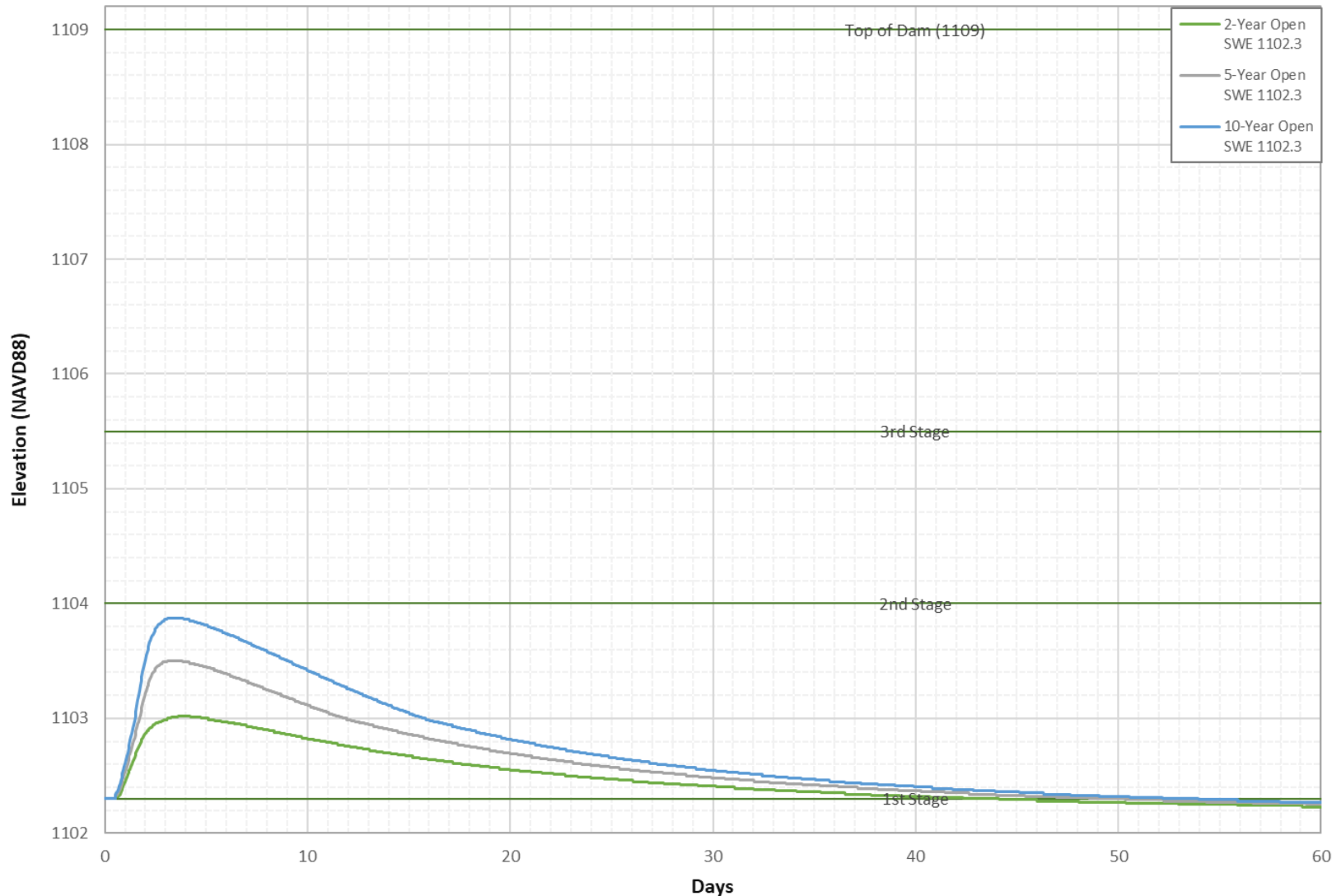
Nelson Slough Outlet Structure (Closed)

Nelson Slough Outlet Structure Profile



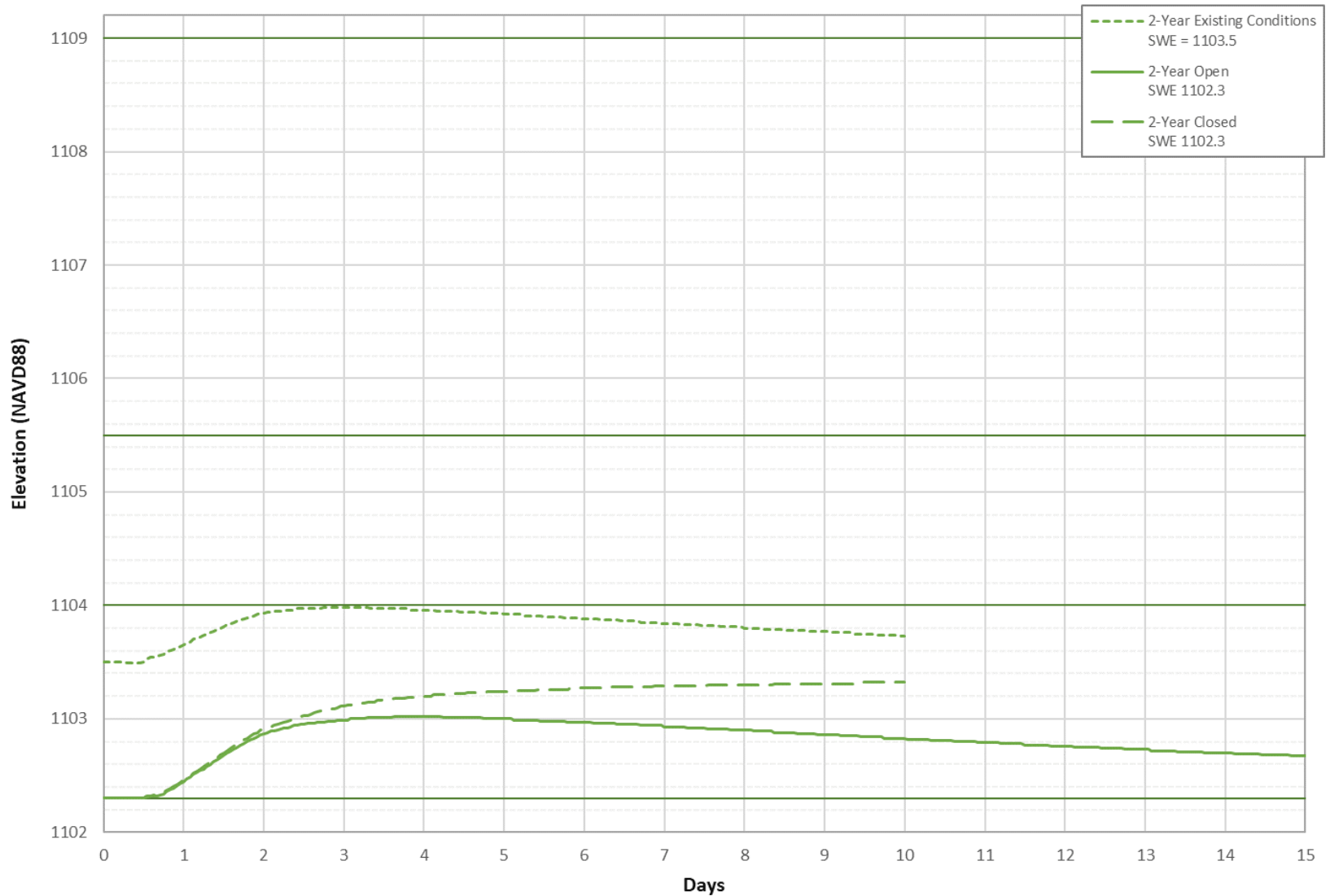
Nelson Slough Outlet Structure (Low Weir 1102.0)

Nelson Slough Stage Hydrograph



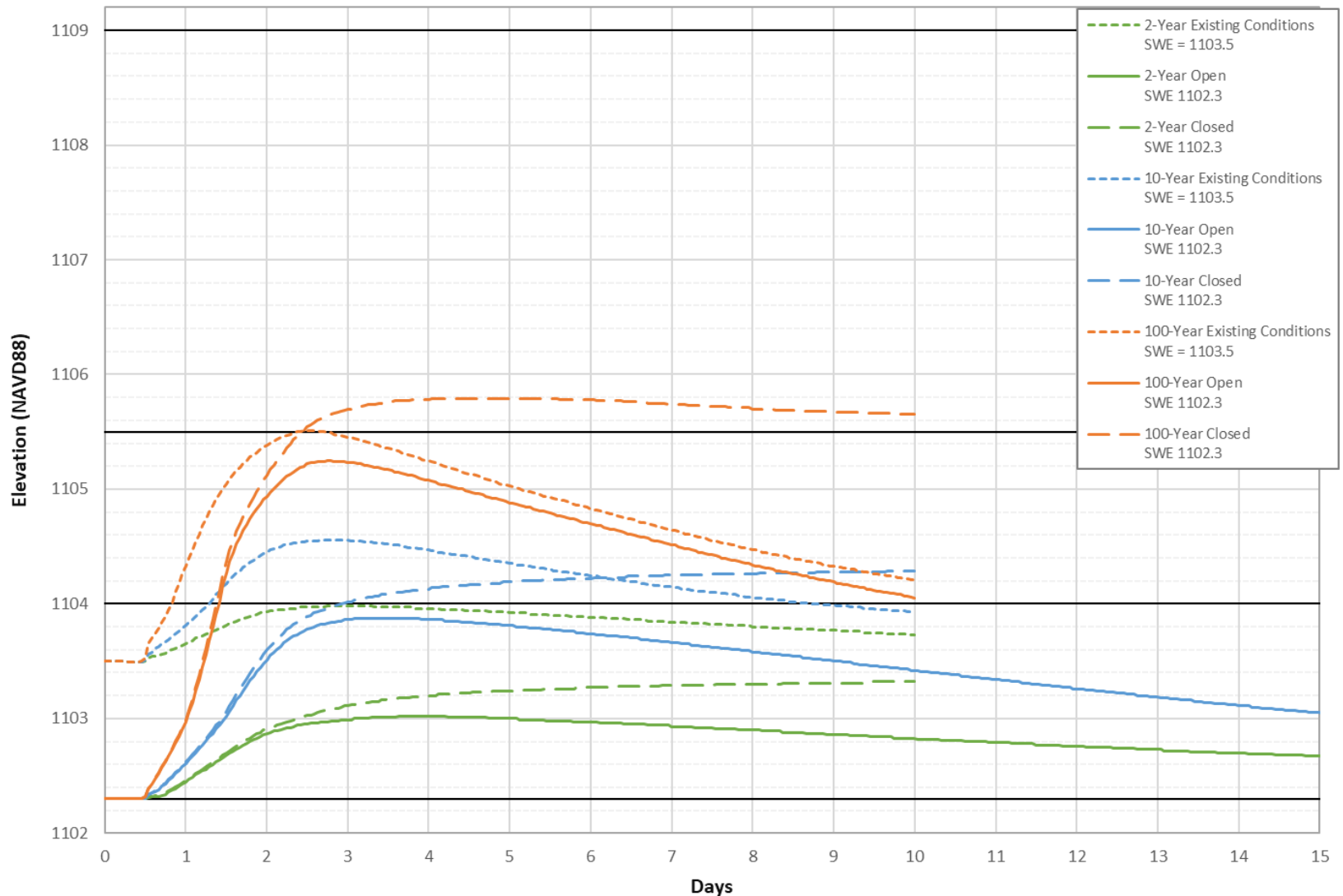
Nelson Slough Outlet Structure

Nelson Slough Stage Hydrograph



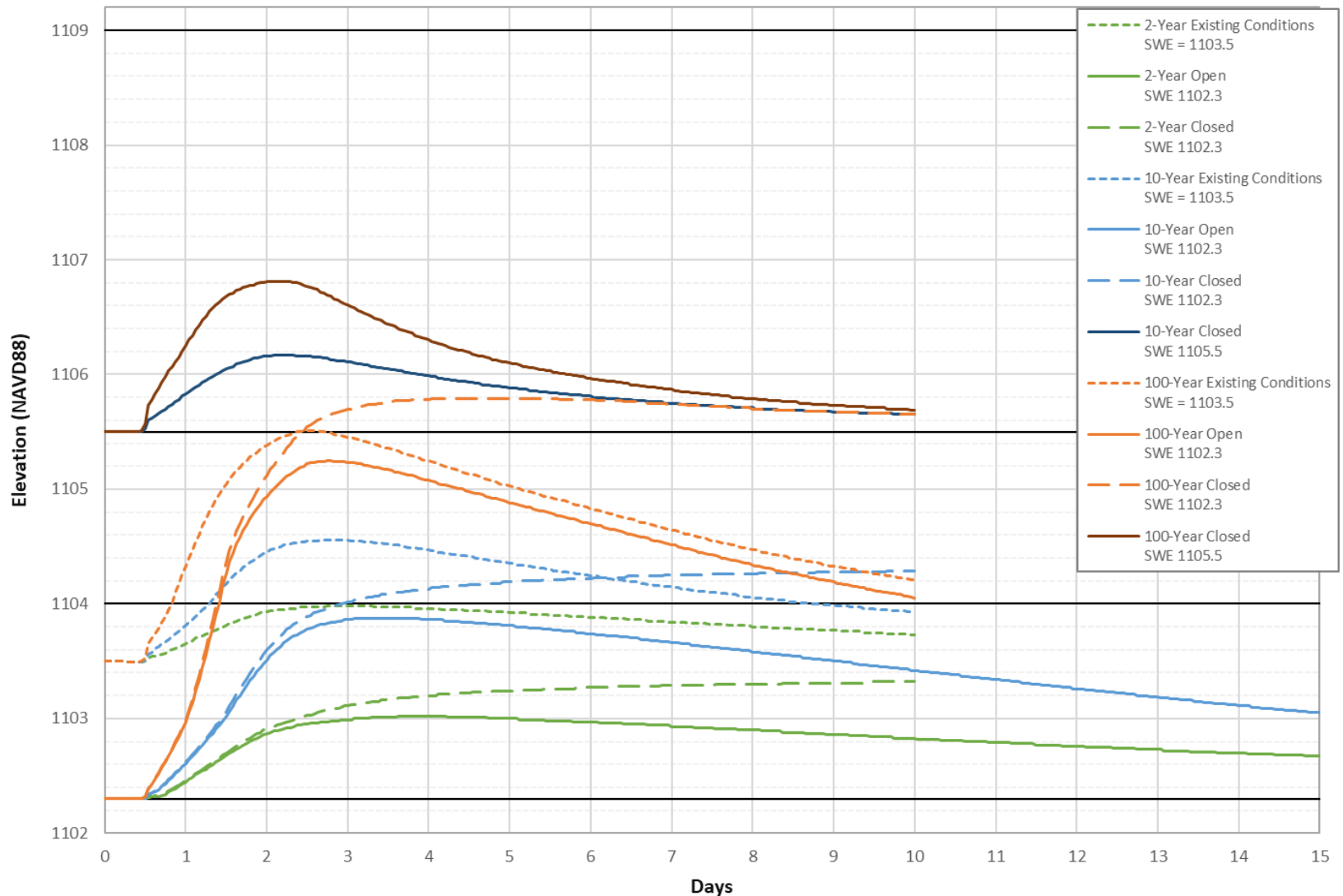
Nelson Slough Outlet Structure

Nelson Slough Stage Hydrograph



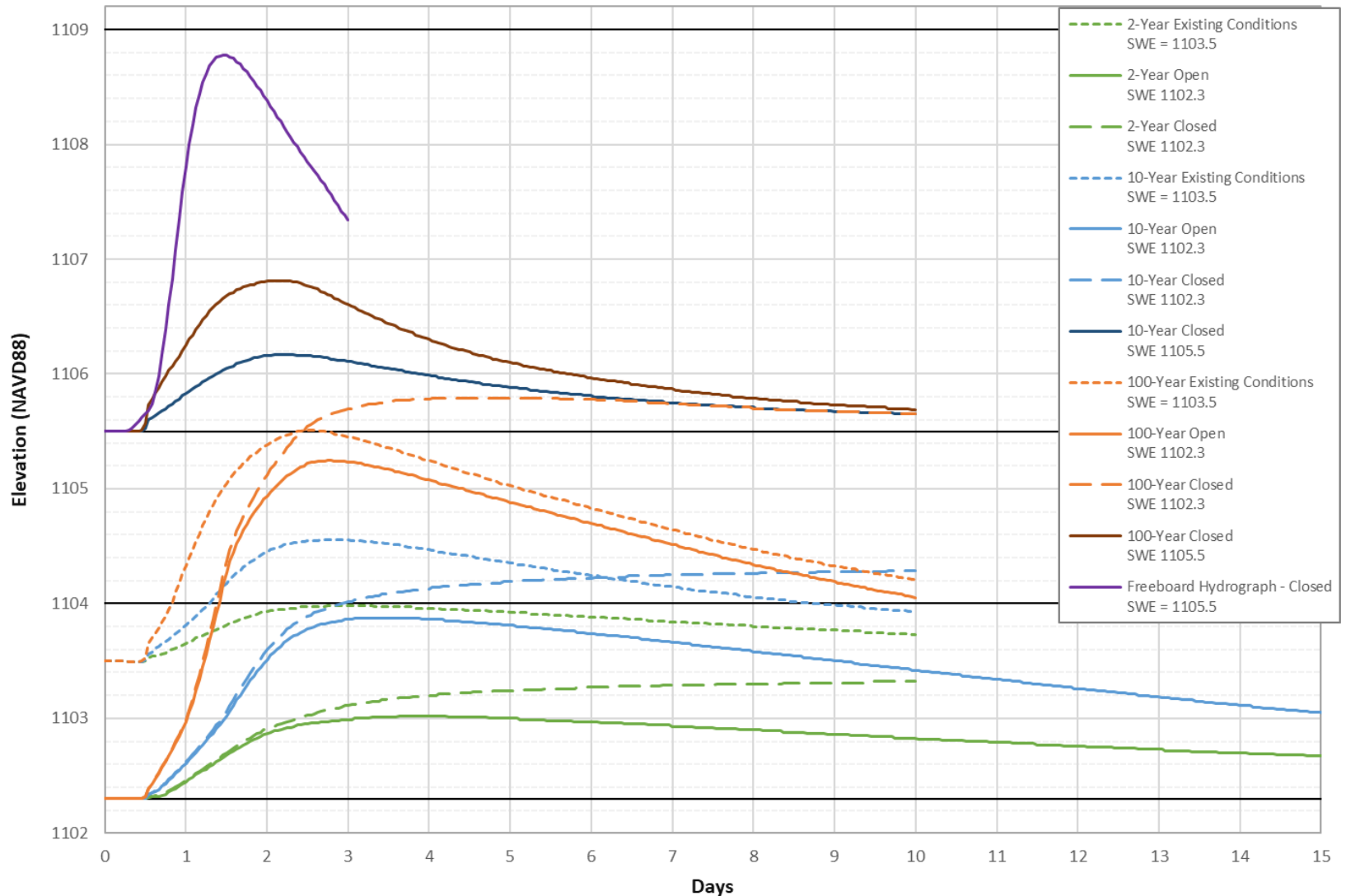
Nelson Slough Outlet Structure

Nelson Slough Stage Hydrograph



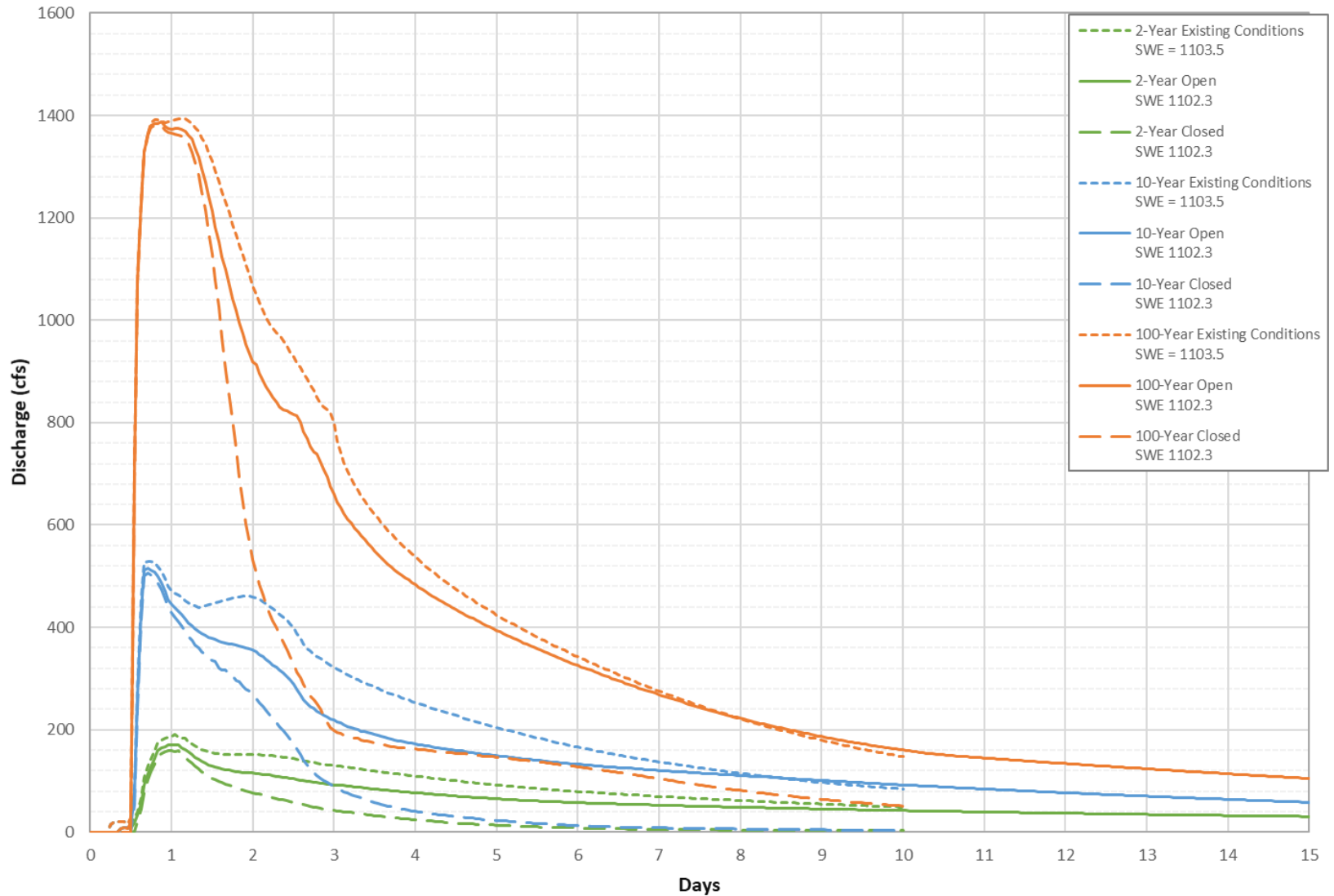
Nelson Slough Outlet Structure

Nelson Slough Stage Hydrograph



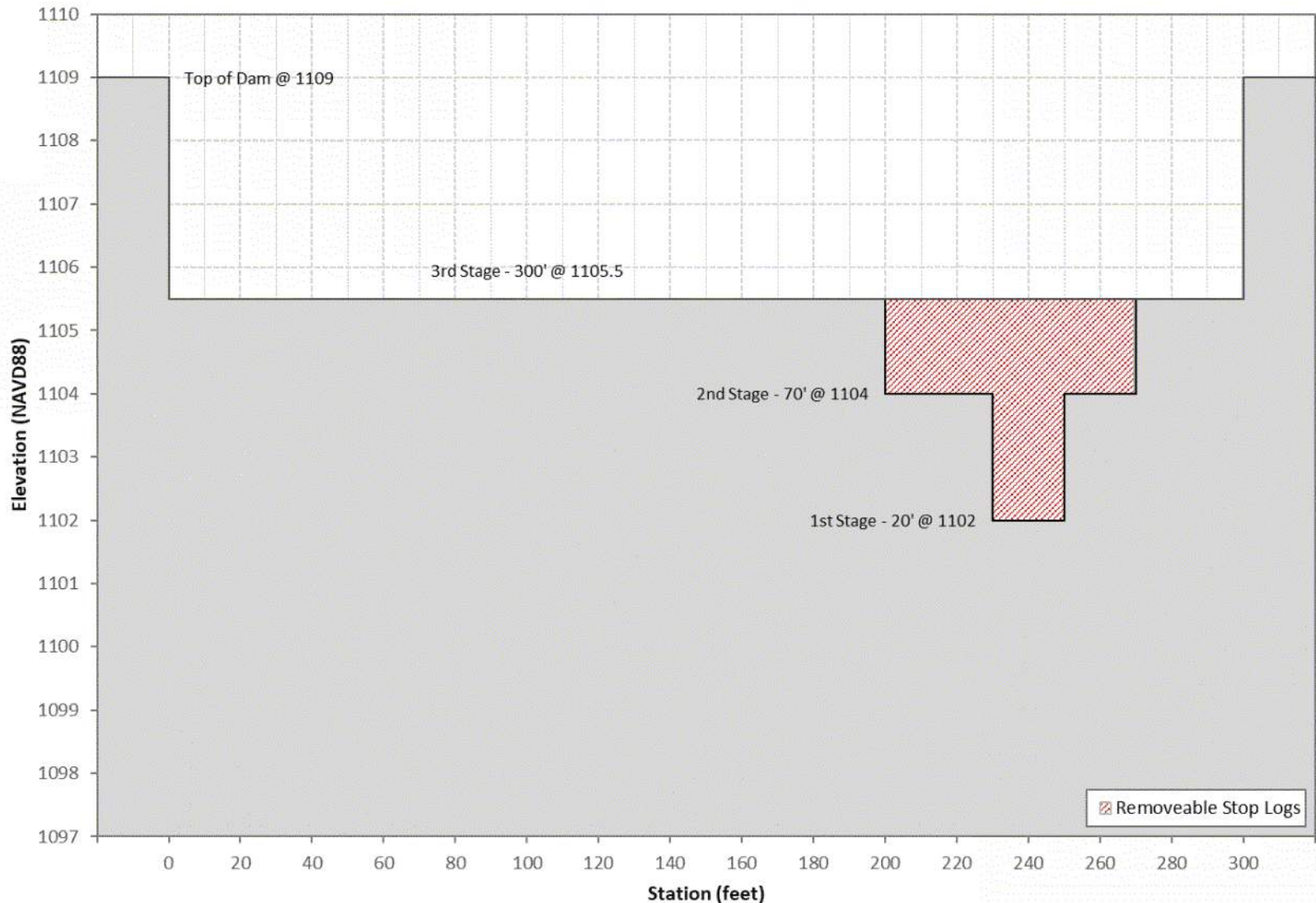
Nelson Slough Outlet Structure

Highway 59 Discharge Hydrograph



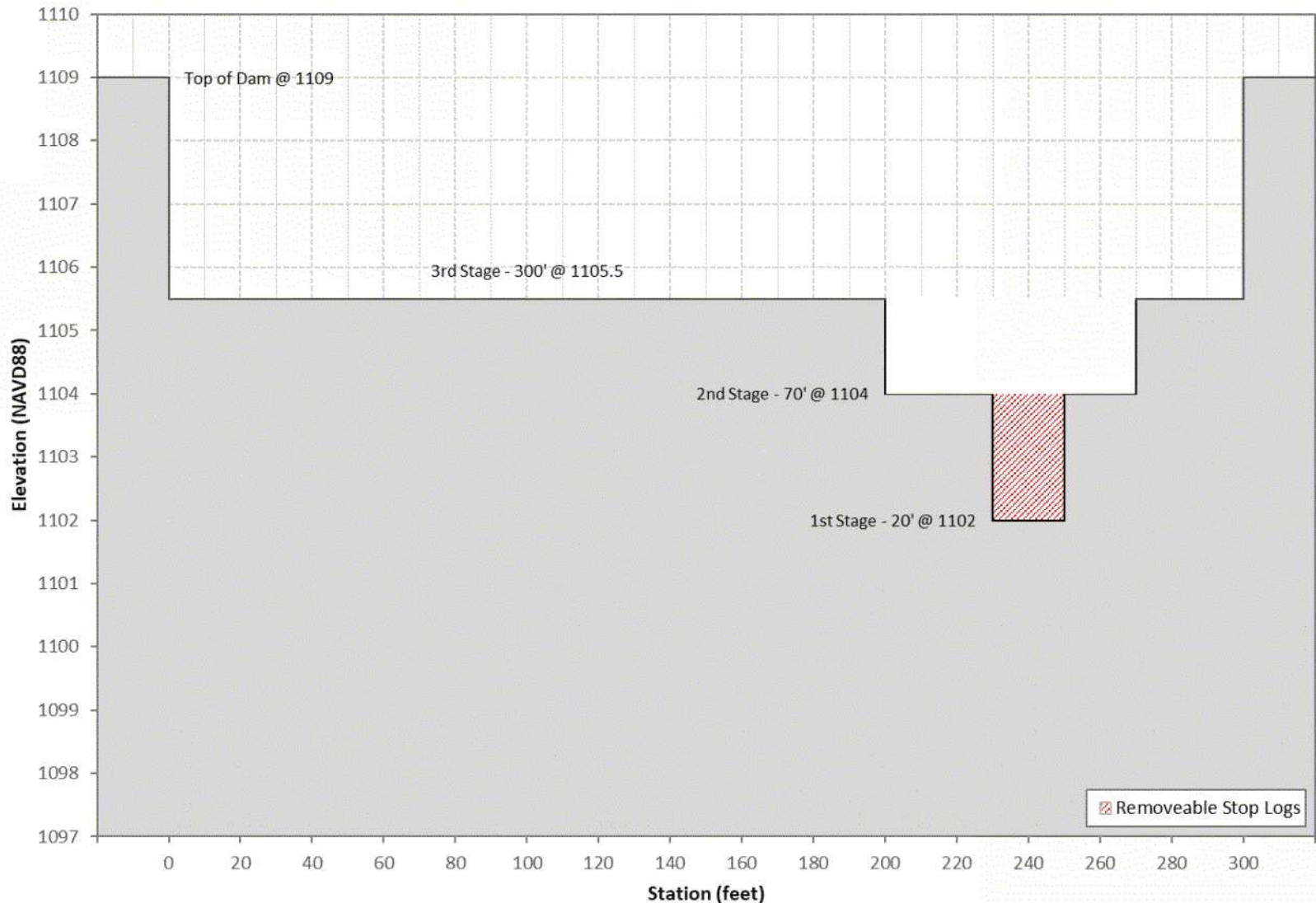
Nelson Slough Outlet Structure (Drawdown)

Nelson Slough Outlet Structure Profile



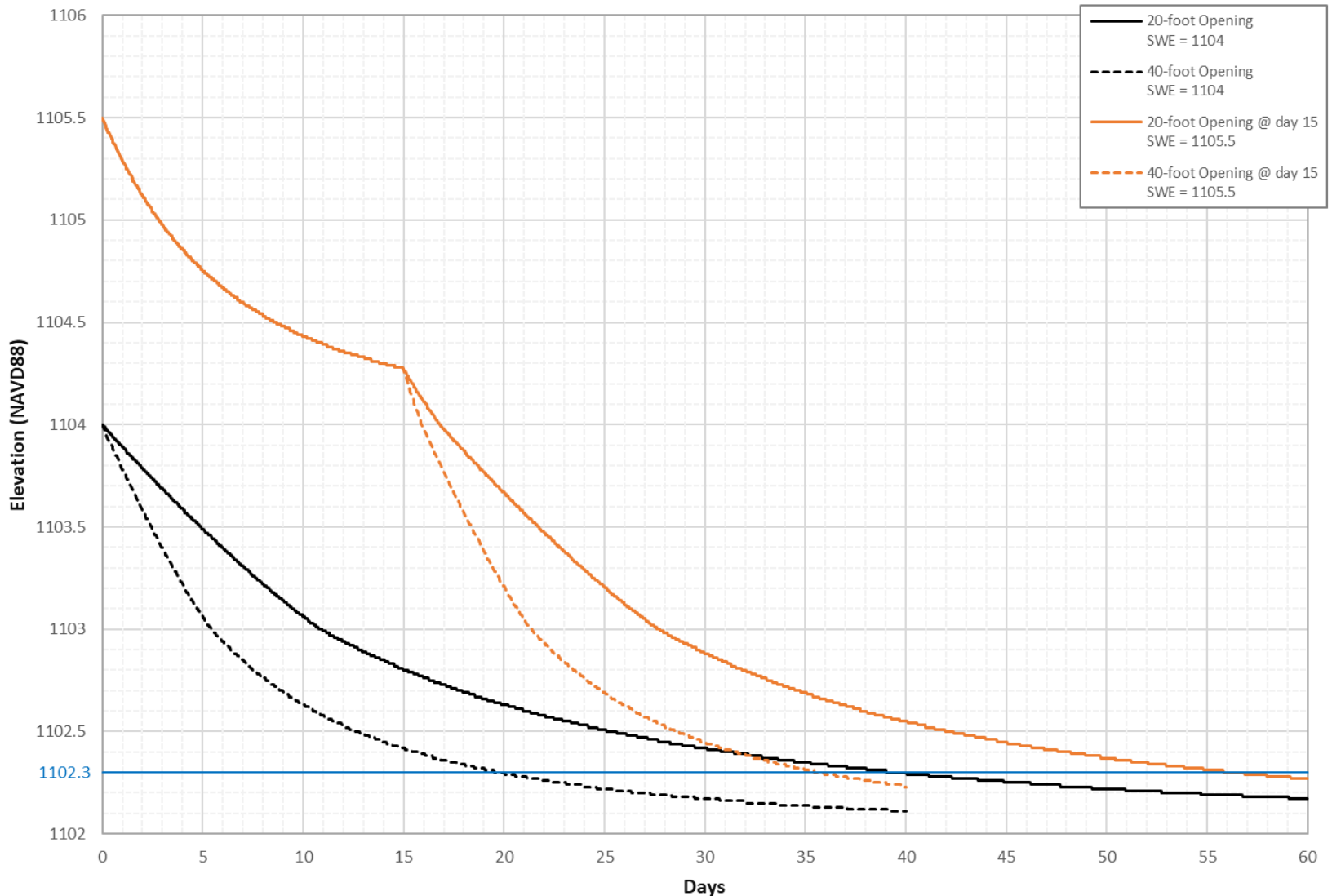
Nelson Slough Outlet Structure (Drawdown)

Nelson Slough Outlet Structure Profile



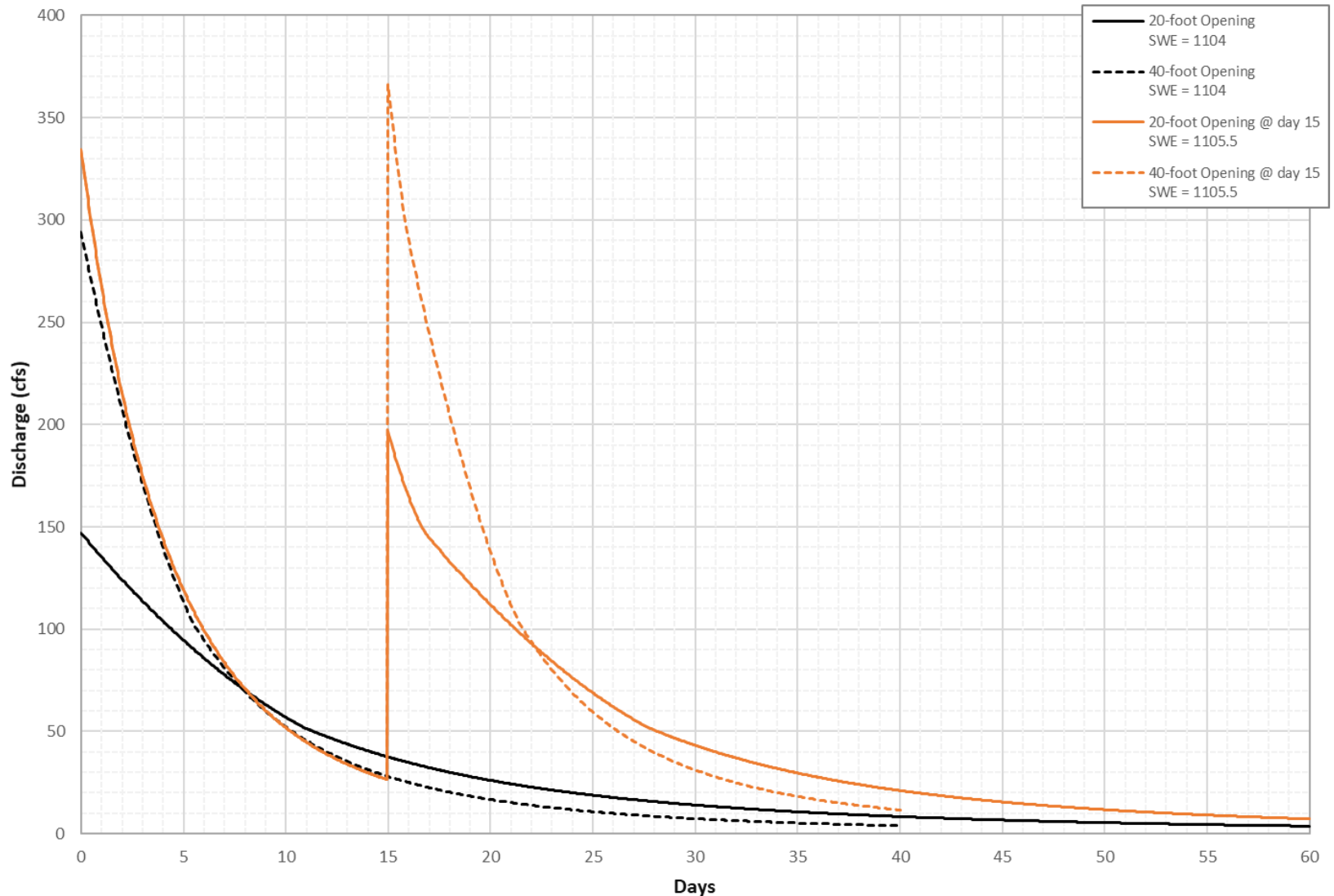
Nelson Slough Outlet Structure

Nelson Slough Drawdown Hydrograph



Nelson Slough Outlet Structure

Nelson Slough Drawdown Outflow Hydrograph



Recommended Preferred Alternative

- * Alternative 7 – MSTRWD/DNR Nelson Slough FDR Strategy including downstream grade stabilization of JD 19 and potential upstream repairs to more efficiently allow flow into Nelson Slough
 - * Meets the Purpose and Need for the majority of Sub-Watershed
 - * Provides the largest upstream gated storage capacity
 - * Increase Flood Storage within Nelson Slough Site
 - * Address Existing Freeboard Concerns with Nelson Slough (Levee Height)
 - * Minimize Bounce During Nesting Season
 - * Enhance NRE's
 - * Improve Downstream Flow Conditions
 - * Landowner Willingness
 - * Most Practical Solution

Alternative Screening Document

- * Still putting finishing touches on Alternative Screening Document
- * Alternative Screening Document will be Posted on the Middle-Snake-Tamarac Rivers Watershed District Website **2-26-2020**
 - * <https://mstrwd.org/>
 - * MSTRWD will remind Project Team of Posting Date
 - * Comment Period Ends March 11, 2020

Questions

Path Forward

- * Project Team Review Alternative Screening Document
- * Project Team recommends Alternative to MSTRWD Board
- * MSTRWD Board Approve Project
- * MOU between MSTRWD & MnDNR
- * Begin Preliminary Engineering

Operating Plan

East Park Flood Control and Wildlife Management Area
(R-2) Nelson Slough Structure (PL566)

*Redlines
changed to
88 datum*

23 September 2003

The East Park Flood Control Project (R-2 Nelson Slough) (project no. W71-59, permit no. 70-605) was built under the Watershed Protection and Flood Prevention Act by the Marshall County Board of Commissions cooperating with the Marshall County Soil and Water Conservation District (SWCD). Assistance provided by the Minnesota Department of Natural Resources (MN DNR) Division of Game and Fish [Division of Wildlife] and the US Department of Agriculture Soil Conservation Service [Natural Resource Conservation Service (NRCS)]. This project was part of the Tamarac River Watershed Work Plan (1965).

The work plan for the Tamarac River Watershed was prepared by the Marshall County Soil Conservation District [SWCD] and the Village Council of Stephen, Minnesota, as the sponsoring local organizations. Technical assistance was provided by the Soil Conservation Service [NRCS], the US Forest Service, US Fish and Wildlife Service, and the Minnesota Department of Conservation [MN DNR].

On 18 March 1971, the State of Minnesota, DNR, Division of Game and Fish [Division of Wildlife], entered into an agreement with the Marshall County SWCD to be responsible for the operation and maintenance of the (R-2) Nelson Slough Flood Control and Wildlife Project. The MN DNR Division of Wildlife assumed responsibility of the operation and maintenance of the project in accordance with the Tamarac River Watershed Work Plan upon completion of the project.

Operation

The MN DNR Division of Wildlife will manage and manipulate water levels up to 1101.0 feet above sea level in accordance with the Tamarac River Watershed Work Plan.

1102.3 (88 datum)

The pool will be primarily managed at elevation ^{1102.3} ~~1101.0~~ (normal pool) for wildlife and wildlife habitat purposes. Periodic partial or complete draw down may be necessary to facilitate wildlife management objectives or to perform repairs and maintenance to the earthen dike or control structure. The Watershed District will be notified prior to draw downs.

During major runoff events or severe flooding, the primary spillway gate will remain closed in order to prevent additional water flow below that of the low stage crest from being discharged down stream. Water may be released when conditions permit in order to bring the pool down to normal pool levels. Water will not be released if it causes or contributes to down stream flood problems.

Maintenance

Inspection

The control structure will be inspected at least once annually and after major rainfall events by DNR Wildlife personnel. The annual inspection will occur at the end of May each year.

Routine maintenance

Typical maintenance items will include work such as cleaning cattail debris, logs or other material that may be impeding the function of the control structure. Repair minor erosion adjacent to the control will also be performed if necessary.

Emergency maintenance

If the DNR wildlife personnel in conjunction with DNR or contracted engineers determine that immediate repairs and protective measures are necessary to preserve the integrity of the structure, they shall, without delay, notify the watershed, and Regional Wildlife Supervisor and take action necessary to minimize damage to human health and property.

Structure Data

General

Construction material: concrete
Type: sluiceway
Completed: 1971

Spillways

Primary

crest: 1101.0- **1102.3**
sill: 1097.2- **1098.4**
width: 6 ft.
height: 4' 6"

mechanical type: original construction--stoplog bay.
: New structure, sliding gate 10/2003

fixed type: concrete weir--1101.0 (low stage weir)
width: 6 ft **1102.3**
height: 1.2 ft

Secondary

fixed crest: 1102.2 **1103.4**
Length: 70 ft.

09/23/2003 10:48 2187553181

R1 WILDLIFE

PAGE 04

height: 5' 6"

Dike

earthen: ~~1105.0~~ 1106.2 According to lidar, areas closer to 1105.9 + 1106.0.
length: 5.1 miles
top width: 12 ft.
height: varies

Storage

normal pool: ~~1101.0~~ 1102.3 3329 ac. ft. 1720 surface acres
flood pool: ~~1103.3~~ 1104.5 4520 ac. ft. 2310 surface acres

Drainage area: 70 sq. mi.

Approval:


Regional Wildlife Supervisor


Date

Overview of East Park WMA (Nelson Slough) Meeting with DNR October 2018

* History

- * Tamarac River Watershed Work Plan 1965
- * Built under the Watershed Protection & Flood Prevention Act by Marshall County Board, SWCD, MnDNR, & SCS (NRCS).
- * 1971 MnDNR Division of Game and Fish (Wildlife) agreed on responsibility of O&M of Nelson Slough Flood Control & Wildlife Project.

* Operation

- * Manage and manipulate water levels up to 1102.3.
- * Managed at elevation 1102.3 (normal pool) for wildlife.
- * Complete or partial drawdown for maintenance or facilitate wildlife management objectives.
- * During severe flooding, low spillway gate will remain closed to prevent water flow below 1102.3.

* Maintenance

- * Control Structure inspected annually (May) or after major rainfall events.
- * Routine maintenance includes cleaning cattail debris, logs, or other material at the outlet structure.
- * Emergency maintenance may be performed to preserve the integrity of the structure to minimize damage to human health and property.

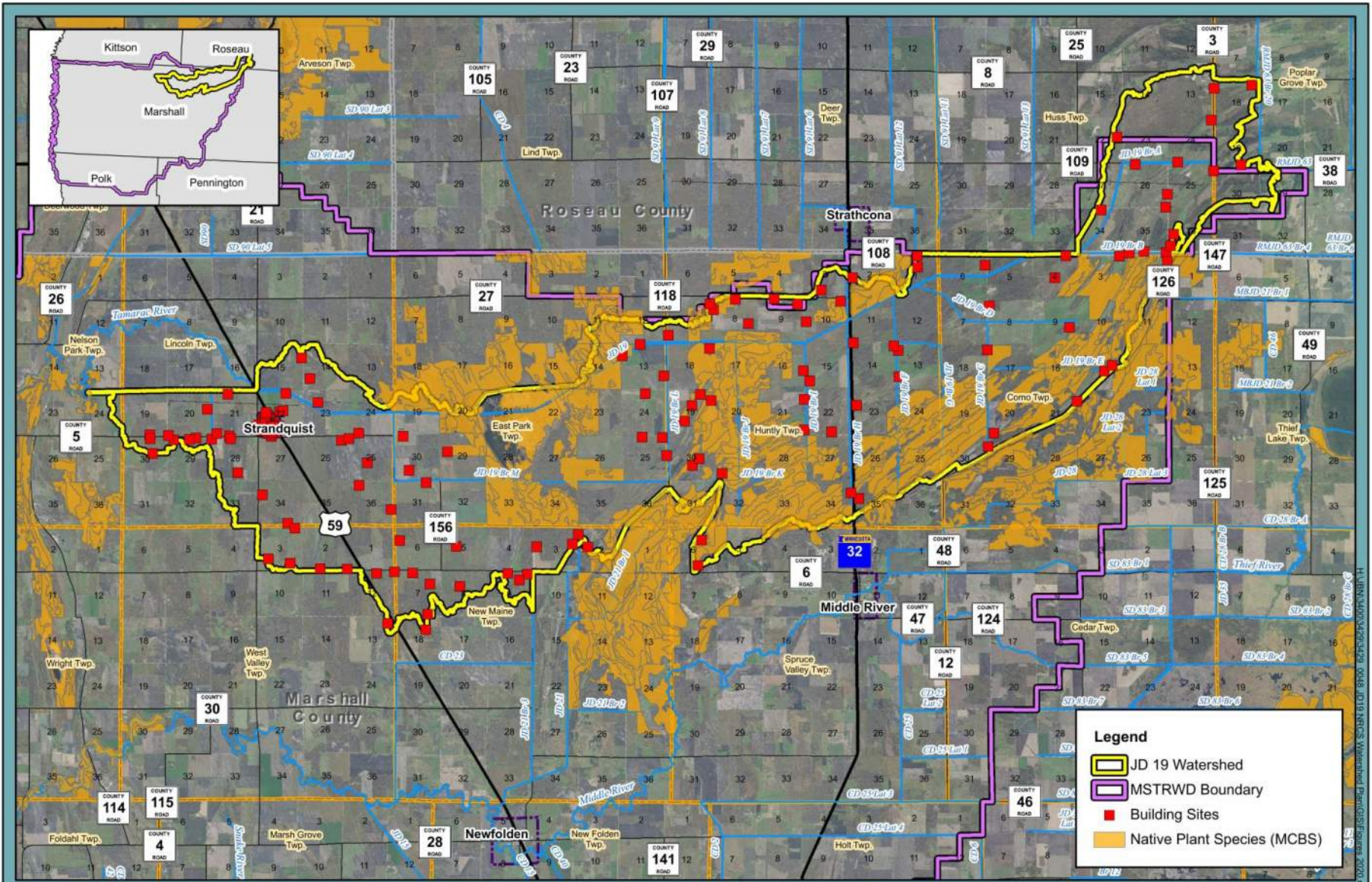


Existing Operating Plan East Park Flood Control & Wildlife Management Area (Nelson Slough)



Site Statistics

Site	Drainage Area	Gated Elevation	Top of Dam Elevation	Max Dam Height	Gated Storage			Top of Dam		
	<i>sq. mi.</i>	<i>NAVD88</i>	<i>NAVD88</i>	<i>feet</i>	<i>acres</i>	<i>acre-feet</i>	<i>inches</i>	<i>acres</i>	<i>acre-feet</i>	<i>inches</i>
Branch M	10.7	1,105.0	1,110.0	13.0	536	1,723	3.0	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	1,714	8,080	15.9
Branch J - Option 2	14.6	1,128.5	1,133.5	11.5	1,009	2,433	3.1	1,854	9,749	12.6
East Park Township	7.9	1,113.6	1,118.6	12.6	353	1,253	3.0	685	3,884	9.2
Lincoln Township	104.8	1,045.0	1,050.0	16.0	1,071	6,630	1.2	1,610	12,986	2.3



Legend

- JD 19 Watershed
- MSTRWD Boundary
- Building Sites
- Native Plant Species (MCBS)

Fig. 3.1b

Figure 3.1b: Environmental and Public Concerns
 Judicial Ditch #19 Watershed Plan
 Screening of Alternatives for Detailed Review
 Middle-Snake-Tamarac Rivers Watershed District



H:\AIN\MapDocs\253425\253425_0006_JD19_WRS_Cons_AltScreening_Plan\GIS\Figures_2020.mxd

Table X: Peak Flow and Inundation Changes for Technical Consideration Alternatives

Scenario	Existing Conditions	Reduce Runoff Volume		Increased Roadway Conveyance Capacity	Increase Temporary Flood Storage	
		Cropland Conversion - Upstream of Nelson Slough	Cropland Conversion - Full Watershed		Upstream of MN32	Upstream of Nelson Slough
Recurrence Interval and Location	<i>Peak Flow - 10 Year, cfs (% Change)</i>					
Highway 32	467	351 (-24.8%)	351 (-24.8%)	483 (3.4%)	0 (-100.0%)	0 (-100.0%)
Nelson Slough Outlet	234	192 (-17.9%)	192 (-17.9%)	234 (0.0%)	130 (-44.4%)	22 (-90.6%)
US Highway 59	495	495 (0.0%)	321 (-35.2%)	490 (-1.0%)	495 (0.0%)	489 (-1.2%)
JD 19 Outlet	949	951 (0.2%)	550 (-42.0%)	948 (-0.1%)	949 (0.0%)	928 (-2.2%)
Recurrence Interval and Location	<i>Peak Flow - 100 Year, cfs (% Change)</i>					
Highway 32	905	829 (-8.4%)	829 (-8.4%)	1,125 (24.3%)	0 (-100.0%)	0 (-100.0%)
Nelson Slough Outlet	564	509 (-9.8%)	509 (-9.8%)	575 (2.0%)	393 (-30.3%)	29 (-94.9%)
US Highway 59	1,317	1,320 (0.2%)	1,091 (-17.2%)	1,480 (12.4%)	1,317 (0.0%)	1,286 (-2.4%)
JD 19 Outlet	3,042	3,042 (0.0%)	2,248 (-26.1%)	3,157 (3.8%)	3,042 (0.0%)	3,038 (-0.1%)

Table X: Peak Flow and Inundation Changes for Identified Alternatives

Scenario	Existing Conditions	Alternative 1 Drainage Improvement	Alternative 2 Branch M Impoundment Site	Alternative 3 Branch J Impoundment Site Option 1	Alternative 4 Branch J Impoundment Site Option 2	Alternative 5 East Park Township Impoundment Site	Alternative 6 Lincoln Township Impoundment Site	Alternative 7 Nelson Slough Improvements
Recurrence Interval and Location	<i>Peak Flow - 10 Year, cfs (% Change)</i>							
Highway 32	467	739 (58.2%)	467 (0.0%)	467 (0.0%)	467 (0.0%)	467 (0.0%)	467 (0.0%)	467 (0.0%)
Nelson Slough Outlet	234	284 (21.4%)	216 (-7.7%)	174 (-25.6%)	166 (-29.1%)	211 (-9.8%)	234 (0.0%)	133 (-43.2%)
US Highway 59	495	554 (11.9%)	493 (-0.4%)	494 (-0.2%)	494 (-0.2%)	494 (-0.2%)	495 (0.0%)	479 (-3.2%)
JD 19 Outlet	949	960 (1.2%)	946 (-0.3%)	948 (-0.1%)	948 (-0.1%)	947 (-0.2%)	373 (-60.7%)	919 (-3.2%)
Recurrence Interval and Location	<i>Peak Flow - 100 Year, cfs (% Change)</i>							
Highway 32	905	1,166 (28.8%)	905 (0.0%)	905 (0.0%)	905 (0.0%)	905 (0.0%)	905 (0.0%)	905 (0.0%)
Nelson Slough Outlet	564	839 (48.8%)	545 (-3.4%)	353 (-37.4%)	344 (-39.0%)	521 (-7.6%)	564 (0.0%)	485 (-14.0%)
US Highway 59	1,317	1,700 (29.1%)	1,295 (-1.7%)	1,314 (-0.2%)	1,314 (-0.2%)	1,314 (-0.2%)	1,317 (0.0%)	1,293 (-1.8%)
JD 19 Outlet	3,042	3,290 (8.2%)	3,039 (-0.1%)	3,042 (0.0%)	3,042 (0.0%)	3,041 (0.0%)	1,446 (-52.5%)	3,036 (-0.2%)

Nelson Slough Stage vs. Storage Curve

East Park Site Outlet Information

