APPENDIX C. GRINDSTONE RIVER DAM REMOVAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

Hydraulic Analysis for the Grindstone River Dam Removal

technical memo

HYDRAULIC ANALYSIS FOR THE GRINDSTONE RIVER DAM REMOVAL

Date |	10/12/2021
To / Contact info |	Minnesota Department of Natural Resources
From / Contact info |	Madison Rogers, EOR, Nick Hayden, PE, EOR, Ryan Fleming, PE, EOR
Regarding |	Hydraulic Analysis for the Grindstone River Dam Removal

Executive Summary

As part of the Grindstone EIS, a hydraulic evaluation has been completed to review the existing and proposed project for the removal of the Grindstone Dam. The hydraulic modeling of the existing and proposed project and partially engineered alternative shows that the removal of the dam and placement of rock riffles would not increase flood stages or velocities downstream of the existing dam. Based on the results from the steady state HEC-RAS Model, there is no increased flood risk to structures or property resulting from the dam removal.

Background

The Grindstone River Dam is located approximately 800 ft downstream of the junction of the North Branch and South Branch of the Grindstone River. The existing dam has created a reservoir (Grindstone Reservoir), also known as Lower Grindstone Lake. The Minnesota Department of Natural Resources (DNR) proposes to remove the Grindstone River Dam, resulting in the permanent removal of the Grindstone Reservoir. The purpose of the dam removal is to address public safety concerns related to dam failure and threat of drowning, restore a naturally functioning floodplain, restore fish and aquatic life habitat and connectivity, and improve hydrologic function by restoring more natural sediment and nutrient transport.

The DNR is currently drafting an Environmental Impact Statement for the proposed removal of the Grindstone Dam (proposed project). EOR completed analysis of the hydraulics impacts related to the proposed project and findings are summarized in this memo. See **Figure 1** for the project location and the area that was evaluated as a part of the Hydraulics Analysis.

The Grindstone River is a Zone A FEMA Floodplain with no detailed Base Flood Elevations, however there are existing HEC-RAS models for the reach. See **Figure 2** for the existing FEMA FIRMette Panel.

Existing Conditions

HEC-RAS Plan Name*: EXISTING COMBINED REACHES_Aug2021.p06*

The DNR completed the preliminary updates to the existing Grindstone River models. The existing models included a Steady State HEC-RAS model for the South Branch of the Grindstone River, and a separate Steady State HEC-RAS model for the North Branch and Main Reach of the Grindstone River. These are considered to be the effective FEMA models for the project area. The DNR combined the models into one Steady State HEC-RAS Model (Existing Combined Reaches Model), with results that are consistent with the effective models.

The Existing Combined Reaches Model received from the DNR was updated by EOR to include the following details:

- Bathymetry data of the Grindstone Reservoir that was collected by DNR using a Sontek Acoustic unit was incorporated into cross section data. Note that no survey data was provided for the Grindstone Dam or the downstream bridge crossings, therefore the hydraulic data for those features was not updated by EOR.

- Extended cross section lengths to capture floodplain extents through the project area where applicable.
- New cross sections were added at locations where proposed rock riffles and concept designs will be evaluated to allow an even comparison between the existing and proposed models.

Additional details regarding model updates can be found in the model "read me" document. **Appendix B** shows the comparison of water surface elevations for the 100-year event between the Existing Conditions Corrected Model and the Existing Conditions Model provided by DNR. This shows that the updates made by EOR had no significant impact on water surface elevations for the 100-year event. **Figure 3** shows the HEC-RAS Model Geometry features. The Existing Condition 100-yr Floodplain Boundary is shown in **Figure 4.**

Hydrology

HEC-RAS Steady State models utilize a peak flow rate to quantify a maximum water surface elevation and other hydraulic information at modeled cross sections. Peak flow rates for the 100-year event were used from the effective FEMA model. The existing floodplain model peak flow rate for the project location was compared with USGS Stream Stats data, and the FEMA peak flow rate for the Grindstone River was determined to be more conservative and therefore was left as the 100-year flow rate (**Table 1**).

Table 1. Comparison of Peak Flow Rates at River Station 35902.57 (Junction of North and South Branch Grindstone River)

Source	100-year Peak Flow Rate
Effective FEMA Model	1783 cfs
USGS Stream Stats	1700 cfs

EOR added other recurrence interval peak flow rate data to the model using USGS Stream Stats information. **Table 2** shows the recurrence interval peak flow rates upstream of the existing Grindstone Dam. The 100-year recurrence interval flow used is from the FEMA effective model.

Table 2. Recurrence Interval Peak Flow Rates

Recurrence Interval Storm Event	1.5-year (cfs)	2-year (cfs)	10-year (cfs)	50-year (cfs)	100-year (cfs)	500-year (cfs)
R.S. 35902.57 -Junction of North and South Reach	361	472	976	1460	1783	2240

Proposed Project and Partially Engineered Alternative

The proposed project (including short term and long term scenarios) and a partially engineered alternative (long term scenario) were evaluated. The proposed project includes the removal of the Grindstone Dam, and the placement of two rock riffles: one at the existing dam location, and an additional riffle approximately 250-ft upstream of the existing dam.

The rock riffle structures will be designed to the approximate bankfull width of 60-ft with the intention of matching characteristics of the existing channels upstream of the Grindstone Reservoir. See **Table 3** for the design characteristics used in the HEC-RAS Model to simulate the rock riffle placement in the existing Grindstone River. The lower rock riffle is intended to be built into the existing dam embankments, and the upstream rock riffle will require a wider cross-sectional area to tie into the existing topography, therefore was extended beyond 120-ft to tie into existing banks of the river.

Table 3: Rock Riffle Design Characteristics in HEC-RAS Model

Location	HEC-RAS River Station (R.S.)	Approx. Profile Length of Rock Riffle (ft)	Bankfull Width (ft)	Bankfull Maximum Depth (ft)	Cross Section Width (ft)	Riffle Crest Elevation (ft)	Downstream Profile Slope
Lower Riffle	3507.99 and 35062.90	35	60	2.8	120	1012.5	25:1
Upper Riffle	35363.32	35	60	2.8	210	1013.0	Ties into Downstream Existing Cross Section

To model the proposed project, two scenarios are reviewed:

- Short term proposed project: This scenario simulates the river thalweg as it was surveyed.
- Long term proposed project: This scenario simulates a new thalweg as shown in the "predicted low flow line" in Figure 5, provided by the DNR.

Based on the DNR field review, the North Branch of the Grindstone River contains fine mobile sediment within the existing streambed consisting of organics, silt, and sand, with a hard bottom underneath. **Figure 5** shows the North Branch Grindstone River Thalweg Profile provided by the DNR in the concept design. It is predicted that after the removal of the dam and placement of the rock riffles, the river thalweg will shift down to be the "predicted low flow line" as shown in **Figure 5.**

This report includes results for the 100-year and 500-year recurrence interval. The HEC-RAS model files include additional recurrence intervals shown in **Table 2** and their results. Results for the other recurrence interval events are consistent with the patterns discussed for the 100-year and 500-year, (i.e. no adverse water surface elevation or velocity impacts downstream or upstream).

Short Term Proposed Project

HEC-RAS Plan Name: *PR_prefer_Aug2021.p11*

The HEC-RAS model of the short term proposed project includes the removal of the dam and construction of the rock riffles. The river's thalweg profile is the same as existing conditions shown as "Surveyed Bottom" in **Figure 5**. The 100-year floodplain boundary for this scenario is shown in **Figure 6**. In **Figure 6** the proposed preferred boundary is compared to the existing floodplain boundary to show the decrease in water surface elevation as a result of the dam removal. **Appendix B** shows the comparison of the 100-year and 500-year water surface elevations between the proposed project and existing scenarios. The 100-year profile for this scenario is compared to the existing conditions profile in **Appendix C.**

Long Term Proposed Project

HEC-RAS Plan Name: *PR_prefer__LT_Aug2021.p12*

The HEC-RAS model of the long-term proposed project includes the proposed conditions of the short-term scenario, but also estimates the predicted thalweg shown as "Predicted low flow line" in **Figure 5**. This long-term analysis is a best educated prediction, and not based on any specific concept design. The thalweg elevations at the HEC-RAS cross sections were interpolated from **Figure 5** concept design, and the approximate bankfull width of 60 feet was used to delineate an assumed long-term channel into the existing cross sections. The 100-year profile for this scenario can be found in **Appendix C** and is compared to the proposed project short term profile to show the changes to the thalweg. **Figure 7** shows the 100-year floodplain boundary for the long term proposed project results as compared to the short term proposed project result. The 100-year and 500-year water surface elevations for this scenario can be found in **Appendix B.**

Partially Engineered Alternative

HEC-RAS Plan Name; *PR_prefer__alt_LT_Aug2021.p13*

The partially engineered alternative includes all the same features as the long term proposed project but adds a meander on the north branch of the river, as shown in **Figure 8**. This option would be an engineered construction alternative and is only considered for the long term scenario.

Downstream Hydraulic Analysis

In addition to water surface elevations, the bridges downstream of the dam were reviewed for hydraulic impacts as a result of the dam removal. **Table 4** shows the hydraulic characteristics for the three major bridges downstream of the dam and shows that there is no impact with the proposed project scenarios to water surface elevation or bridge opening velocity in the 100-year storm event. **Table 5** includes the hydraulic characteristics for the three major bridges downstream of the dam in the 500-year storm event, which also demonstrates there is no impact with the proposed project scenarios in the 500-year storm event.. The other modeled recurrence interval events were also reviewed and show no impact for the bridge hydraulic parameters.

Table 4. Comparison of Existing Bridge Hydraulics for the 100-year Recurrence Interval

River Station	Plan	Bridge Opening Area (sq ft)	Total Flow (cfs)	Minimum Elevation of Weir Flow (Bridge Overtopping Elevation) (ft)	Bridge Opening Velocity (ft/s)	Water Surface Elevation Upstream of Bridge (ft)	Location
34958.08	Existing	1421.33	1783	1028.24	5.83	1015.8	Willard Munger State Trail Bridge
34958.08	Proposed Short Term	1421.33	1783	1028.24	5.83	1015.8	Willard Munger State Trail Bridge
34958.08	Proposed Long Term	1421.33	1783	1028.24	5.83	1015.8	Willard Munger State Trail Bridge
34958.08	Partially Engineered Alternative	1421.33	1783	1028.24	5.83	1015.8	Willard Munger State Trail Bridge
34926.39	Existing	1784.45	1783	1035.36	4.59	1015.67	Railroad Bridge Downstream of Existing Dam
34926.39	Proposed Short Term	1784.45	1783	1035.36	4.59	1015.67	Railroad Bridge Downstream of Existing Dam
34926.39	Proposed Long Term	1784.45	1783	1035.36	4.59	1015.67	Railroad Bridge Downstream of Existing Dam
34926.39	Partially Engineered Alternative	1784.45	1783	1035.36	4.59	1015.67	Railroad Bridge Downstream of Existing Dam
34205.56	Existing	792.34	1783	1022.99	4.75	1014.41	Old Hwy 61 North
34205.56	Proposed Short Term	792.34	1783	1022.99	4.75	1014.41	Old Hwy 61 North
34205.56	Proposed Long Term	792.34	1783	1022.99	4.75	1014.41	Old Hwy 61 North
34205.56	Partially Engineered Alternative	792.34	1783	1022.99	4.75	1014.41	Old Hwy 61 North

Table 5. Comparison of Existing Bridge Hydraulics for the 500-year Recurrence Interval

River Station	Plan	Bridge Opening Area (sq ft)	Total Flow (cfs)	Minimum Elevation of Weir Flow (Bridge Overtopping Elevation) (ft)	Bridge Opening Velocity (ft/s)	Water Surface Elevation Upstream of Bridge (ft)	Location
34958.08	Existing	1421.33	2240	1028.24	6.54	1016.30	Willard Munger State Trail Bridge
34958.08	Proposed Short Term	1421.33	2240	1028.24	6.54	1016.30	Willard Munger State Trail Bridge
34958.08	Proposed Long Term	1421.33	2240	1028.24	6.54	1016.30	Willard Munger State Trail Bridge
34958.08	Partially Engineered Alternative	1421.33	2240	1028.24	6.54	1016.30	Willard Munger State Trail Bridge
34926.39	Existing	1784.45	2240	1035.36	4.90	1016.22	Railroad Bridge Downstream of Existing Dam
34926.39	Proposed Short Term	1784.45	2240	1035.36	4.90	1016.22	Railroad Bridge Downstream of Existing Dam
34926.39	Proposed Long Term	1784.45	2240	1035.36	4.90	1016.22	Railroad Bridge Downstream of Existing Dam
34926.39	Partially Engineered Alternative	1784.45	2240	1035.36	4.90	1016.22	Railroad Bridge Downstream of Existing Dam
34205.56	Existing	792.34	2240	1022.99	5.29	1015.00	Old Hwy 61 North
34205.56	Proposed Short Term	792.34	2240	1022.99	5.29	1015.00	Old Hwy 61 North
34205.56	Proposed Long Term	792.34	2240	1022.99	5.29	1015.00	Old Hwy 61 North
34205.56	Partially Engineered Alternative	792.34	2240	1022.99	5.29	1015.00	Old Hwy 61 North

Sensitivity Analysis

Additional sensitivity analysis was completed for the Manning's n roughness coefficient and the flow regime type. The effective FEMA model included a Manning's n roughness coefficient equal to 0.05 for the entire model, and no change in roughness coefficient was provided for the areas left and right of the main channel. A more detailed analysis of the roughness coefficient throughout the project area showed insignificant change in hydraulic results. Similarly, the model showed to be not sensitive to changing the flow regime type from subcritical to mixed flow (with an assumed upstream boundary condition).

In summary, the model was not sensitive to roughness values or flow regime and changing those did not affect the finding of no downstream change to water surface elevations or impacts to structures. To remain consistent with the current effective FEMA models, no changes were made for these parameters in the completed models.

Summary

In summary, the removal of the Grindstone dam and placement of the rock riffles will decrease the water surface elevations upstream of the dam for all recurrence intervals modeled in **Table 2**. The maximum decrease is at the existing dam location, where the 100-year recurrence interval water surface elevation will decrease by approximately 7.6-ft in the short term proposed project and approximately 7.7-feet in the long term proposed project. The proposed project water surface elevation for the 100-year recurrence interval will tie into the existing water surface elevation upstream of the reservoir. The proposed project scenarios hydraulic modeling shows that there is no change to the hydraulic characteristics of the bridges and other river stations of the Grindstone River that are downstream of the existing dam.

Appendix A

Figures

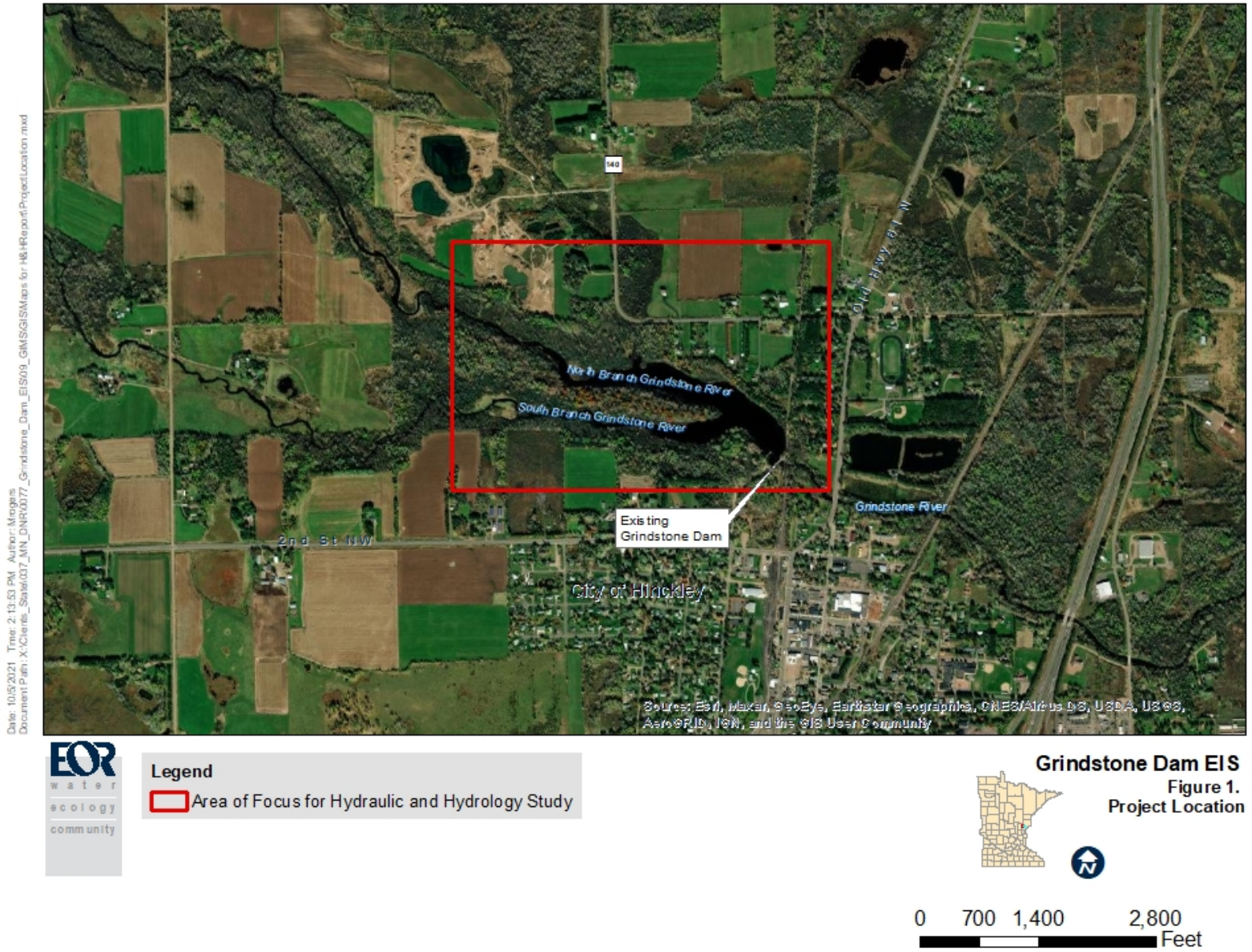

Figure 1. Project location map showing the existing aerial view of the Grindstone River and Grindstone Dam, with a box showing the area of focus for the hydrologic and hydraulic study of the Grindstone Dam removal.

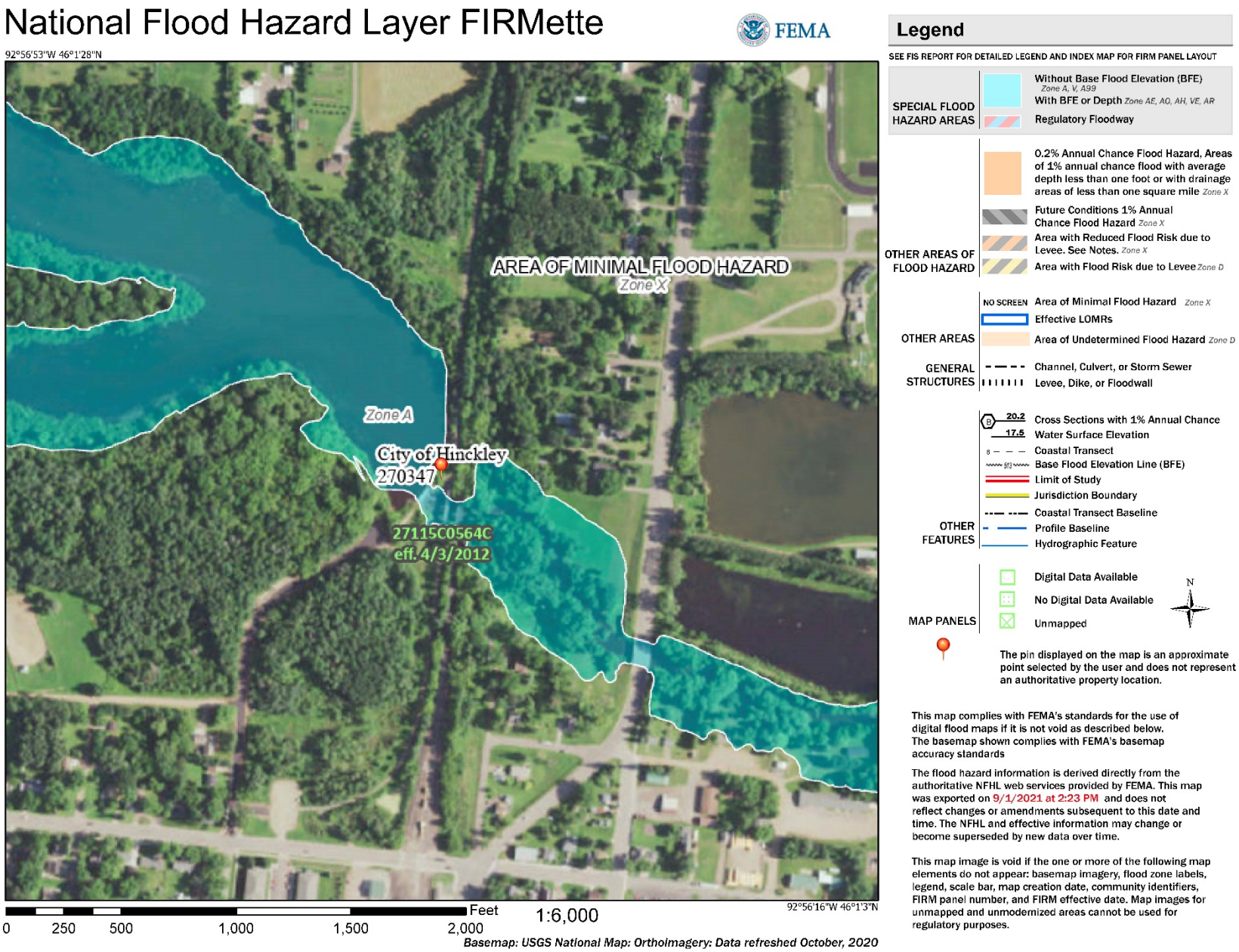

Figure 2. FEMA FIRMette, this is the official existing FEMA Zone A floodplain for the Grindstone River and Grindstone Dam project area.

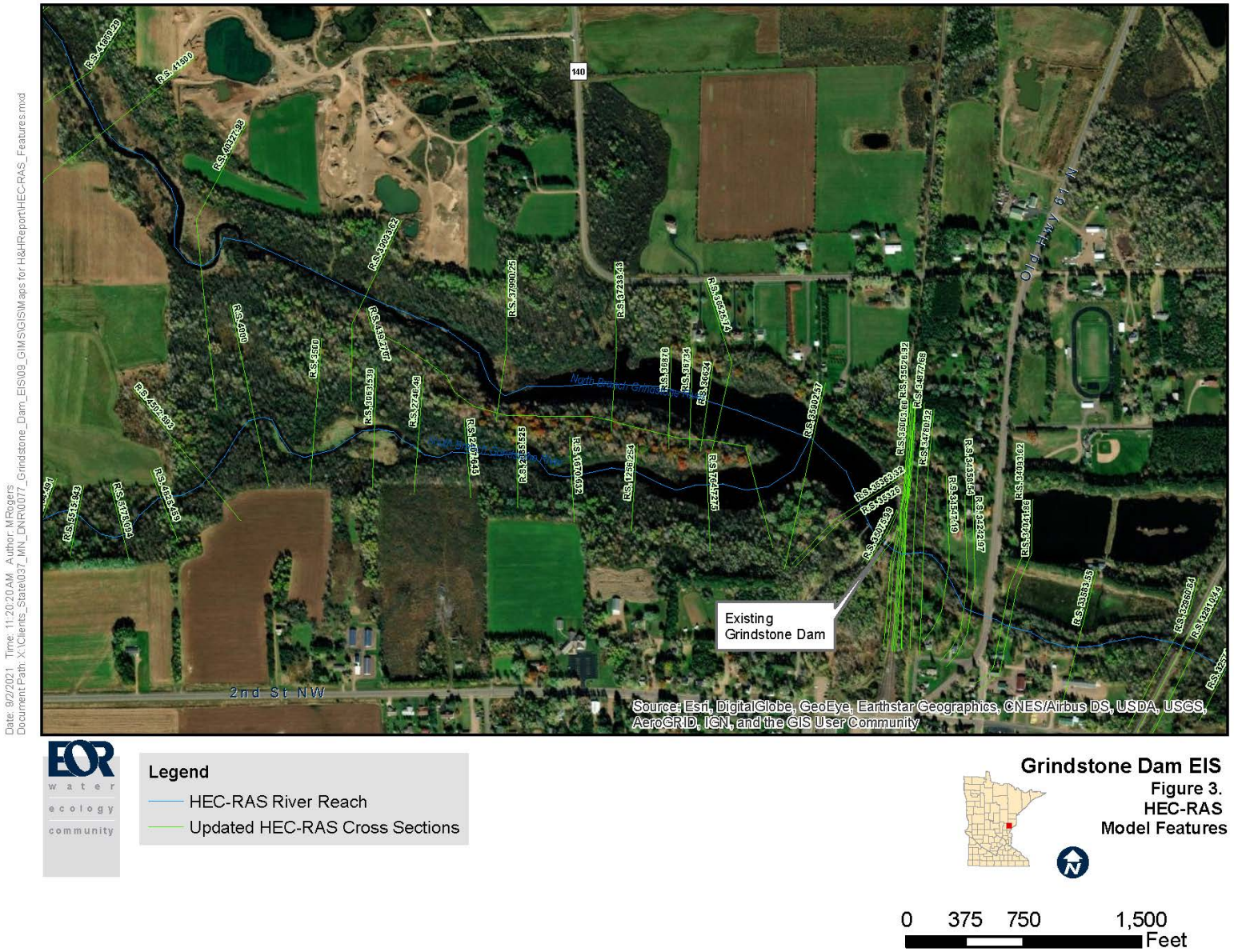

Figure 3. The HEC-RAS model features, including the river reach alignments and the cross sections updated for the hydraulic study are shown on the aerial map of the project area.

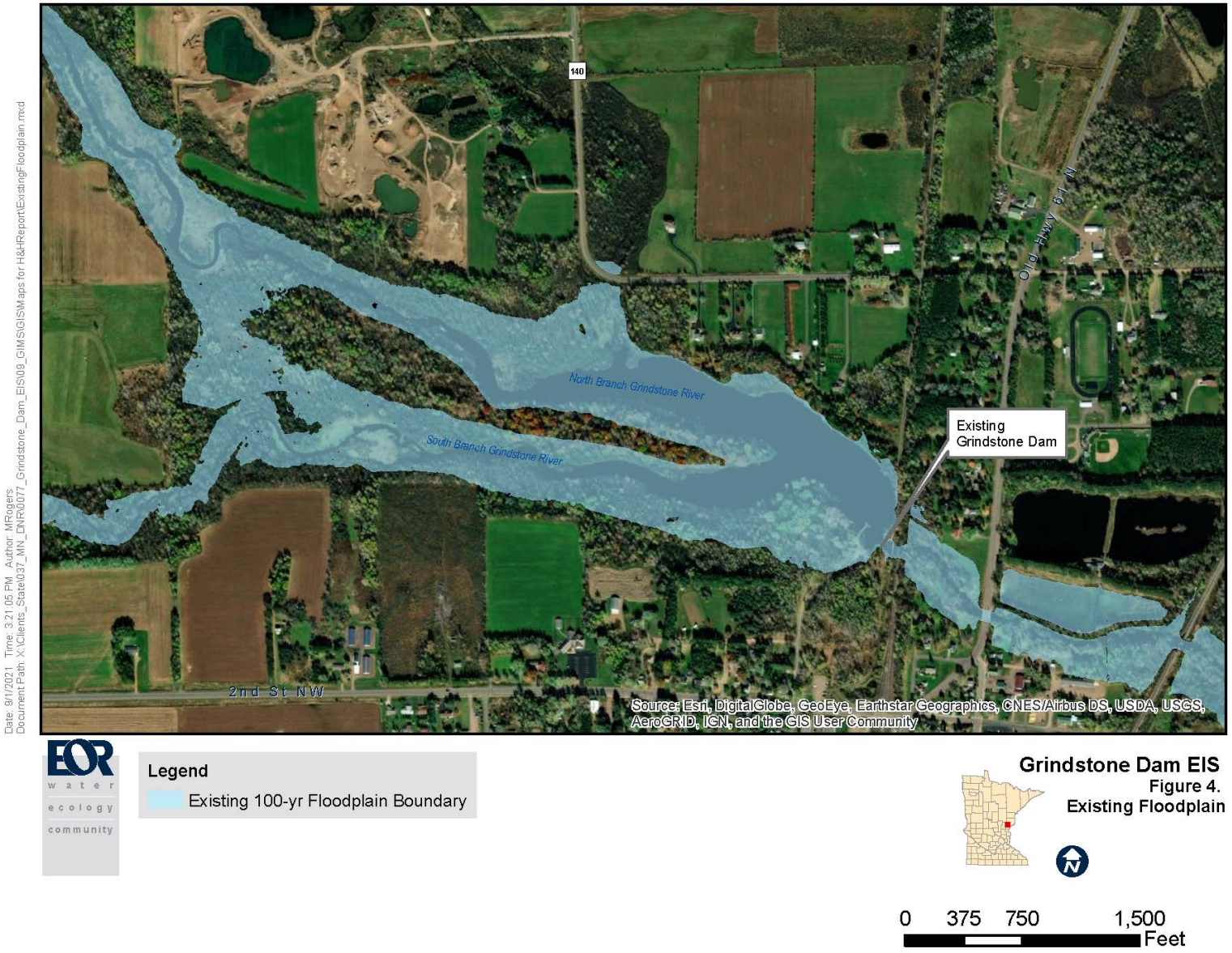

Figure 4. The existing floodplain as updated for the hydrology and hydraulic study is shown on an aerial map. The floodplain boundary clearly shows the reservoir area upstream of the existing dam that floods beyond the main river channel, and the constriction of the 100-year floodplain that occurs at the existing dam location.

Figure 5.

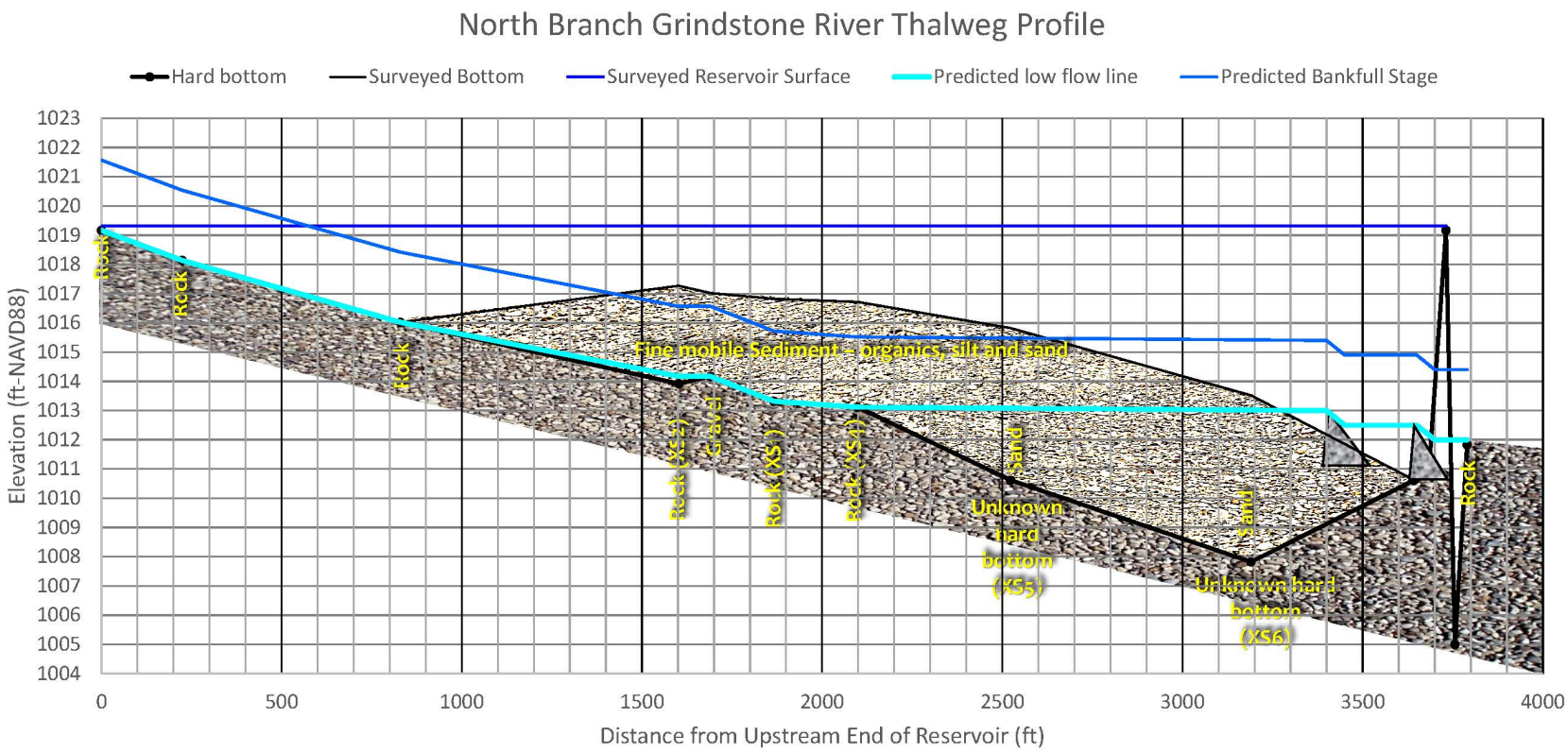

Figure 5. The North Branch Grindstone River Thalweg Profile was created by the DNR as a result of the survey and sediment analysis. The figure shows the existing hard bottom, the surveyed bottom, the surveyed reservoir surface for existing conditions. The figure uses the existing conditions and the proposed riffle locations to predict a low flow line and bankfull stage of the river once the fine mobile sediment has been transported (long term proposed scenario).

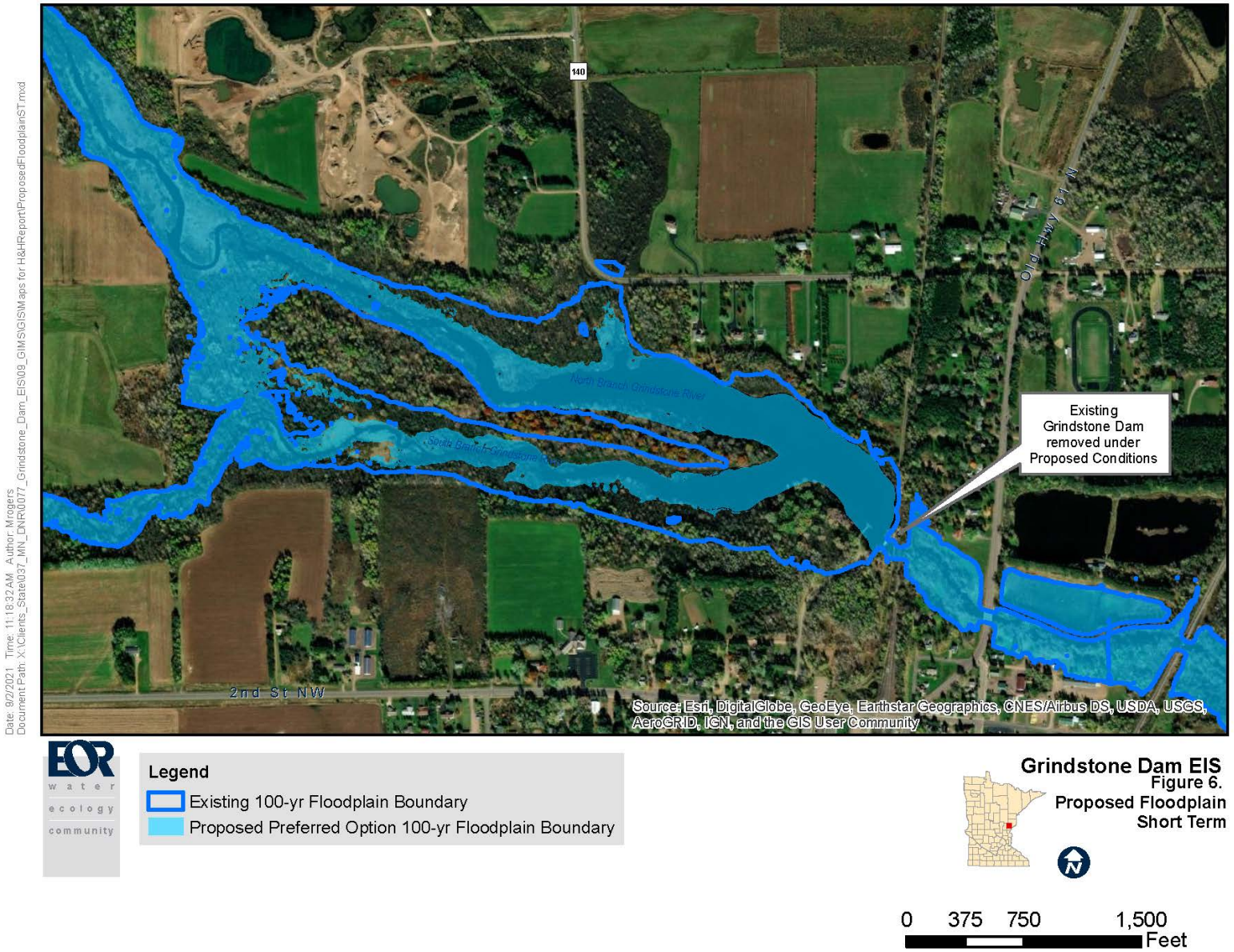

Figure 6. The proposed short term scenario 100-year floodplain is shown in this figure as compared to the existing 100-year floodplain. The proposed floodplain will decrease in elevation upstream of the existing dam as compared to the existing condition.

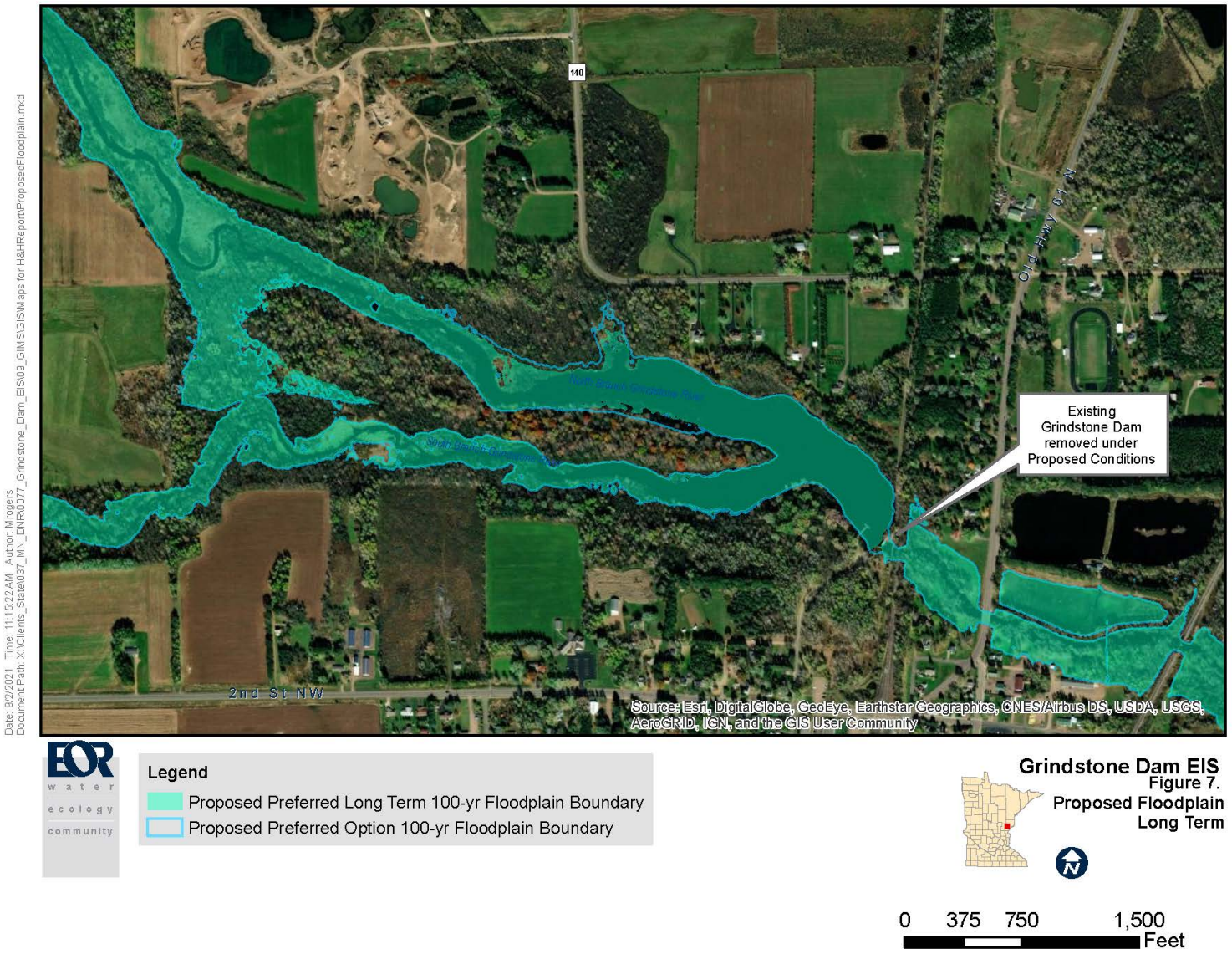

Figure 7. The proposed long term scenario 100-year floodplain boundary is shown as compared to the proposed short term scenario 100-year floodplain boundary. The comparison of the boundaries shows a slight decrease in floodplain elevation for the proposed long-term scenario on the North Branch Grindstone River as compared to the proposed short term scenario, and the South Branch and Main Branch Grindstone River boundaries do not change.

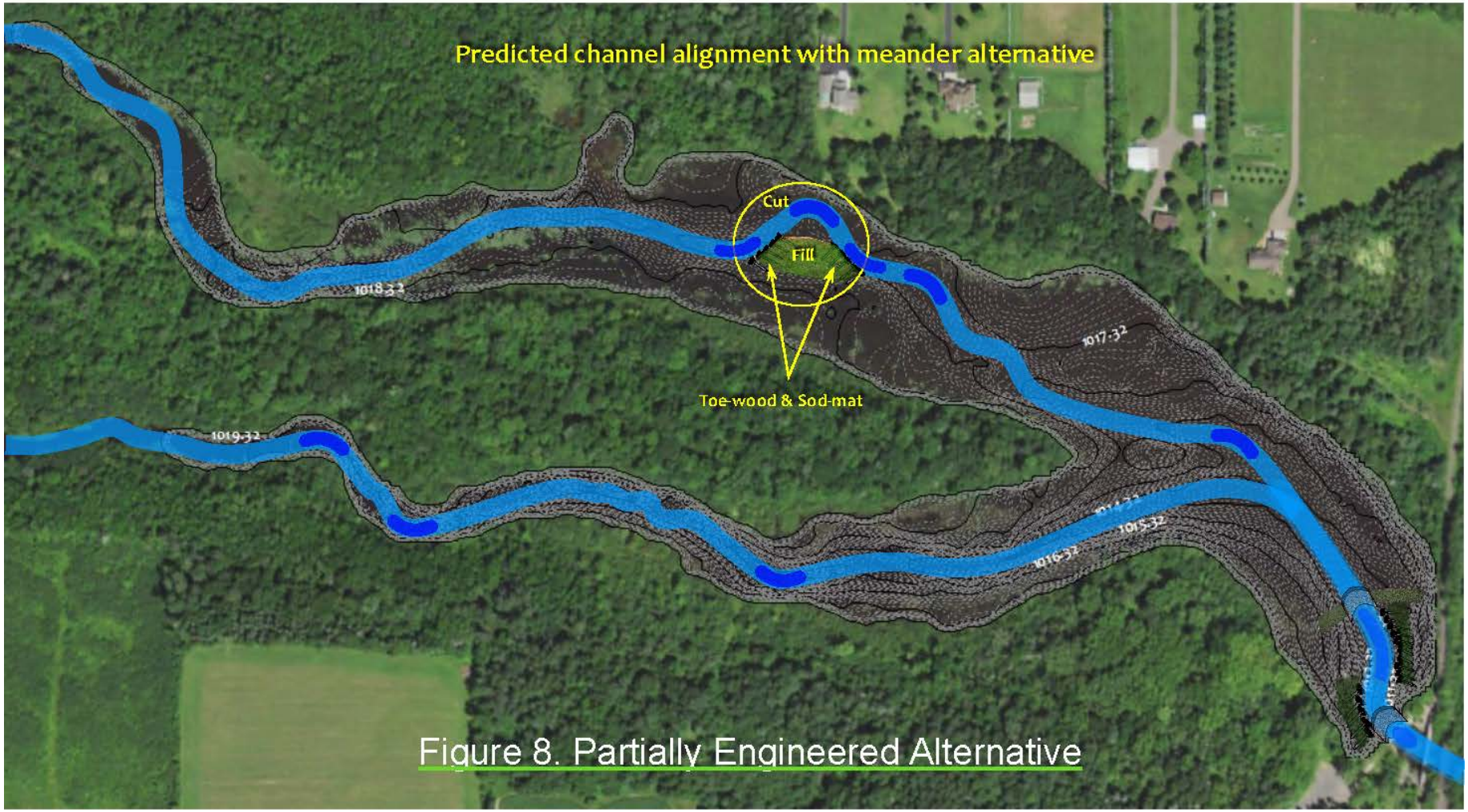

Figure 8. The partially engineered alternative is shown with the predicted channel alignment in addition to an engineered meander alternative on the North Branch Grindstone River. The dark blue areas indicate areas of pool formation. The two constructed riffles are depicted at the dam location and just upstream.

Appendix B

100-year Water Surface Elevation Comparison Table

500-year Water Surface Elevation Comparison Table

100-year Water Surface Elevation Comparison Table

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
SOUTH BRANCH	7510.254	1030.87	7510.254	1030.87	0	1030.87	0	1030.87	0	1030.87	0
SOUTH BRANCH	7275.82	1030.59	7275.82	1030.59	0	1030.59	0	1030.59	0	1030.59	0
SOUTH BRANCH	6960.151	1030.11	6960.151	1030.11	0	1030.11	0	1030.11	0	1030.11	0
SOUTH BRANCH	6686.668	1029.59	6686.668	1029.59	0	1029.59	0	1029.59	0	1029.59	0
SOUTH BRANCH	6351.747	1029.12	6351.747	1029.12	0	1029.12	0	1029.12	0	1029.12	0
SOUTH BRANCH	6063.386	1028.86	6063.386	1028.86	0	1028.86	0	1028.86	0	1028.86	0
SOUTH BRANCH	5764.491	1028.56	5764.491	1028.56	0	1028.56	0	1028.56	0	1028.56	0
SOUTH BRANCH	5515.943	1028.16	5515.943	1028.16	0	1028.16	0	1028.16	0	1028.16	0
SOUTH BRANCH	5178.094	1027.5	5178.094	1027.5	0	1027.5	0	1027.5	0	1027.5	0
SOUTH BRANCH	4825.459	1026.58	4825.459	1026.58	0	1026.58	0	1026.58	0	1026.58	0
SOUTH BRANCH	4502.893	1025.68	4502.893	1025.68	0	1025.67	-0.01	1025.67	-0.01	1025.67	-0.01
SOUTH BRANCH	4000	1025.11	4000	1025.1	-0.01	1024.88	-0.22	1024.88	-0.22	1024.88	-0.22

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
SOUTH BRANCH	3500	1024.59	3500	1024.58	-0.01	1023.79	-0.79	1023.79	-0.79	1023.79	-0.79
SOUTH BRANCH	3063.539	1024.39	3063.539	1024.38	-0.01	1022.66	-1.72	1022.66	-1.72	1022.66	-1.72
SOUTH BRANCH	2746.48	1024.35	2746.48	1024.33	-0.02	1022.2	-2.13	1022.2	-2.13	1022.2	-2.13
SOUTH BRANCH	2407.645	1024.32	2407.645	1024.31	-0.01	1021.67	-2.64	1021.67	-2.64	1021.67	-2.64
SOUTH BRANCH	2085.525	1024.3	2085.525	1024.29	-0.01	1021.08	-3.21	1021.07	-3.22	1021.07	-3.22
SOUTH BRANCH	1670.632	1024.29	1670.632	1024.28	-0.01	1020.37	-3.91	1020.36	-3.92	1020.36	-3.92
SOUTH BRANCH	1256.254	1024.27	1256.254	1024.27	0	1019.68	-4.59	1019.66	-4.61	1019.66	-4.61
SOUTH BRANCH	764.7275	1024.27	764.7275	1024.27	0	1019.13	-5.14	1019.05	-5.22	1019.05	-5.22
SOUTH BRANCH	439.2707	1024.26	439.2707	1024.27	0.01	1018.86	-5.41	1018.73	-5.54	1018.73	-5.54
NORTH BRANCH	43968.86	1035.42	43968.86	1035.42	0	1035.42	0	1035.42	0	1035.42	0
NORTH BRANCH	43570.34	1034.46	43570.34	1034.46	0	1034.46	0	1034.46	0	1034.46	0
NORTH BRANCH	43292.78	1033.33	43292.78	1033.33	0	1033.33	0	1033.33	0	1033.33	0
NORTH BRANCH	43096.4	1032.36	43096.4	1032.36	0	1032.36	0	1032.36	0	1032.36	0

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
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Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
NORTH BRANCH	42699.08	1029.39	42699.08	1029.39	0	1029.39	0	1029.39	0	1029.39	0
NORTH BRANCH	42362.91	1027.27	42362.91	1027.27	0	1027.28	0.01	1027.28	0.01	1027.28	0.01
NORTH BRANCH	41869.29	1026.88	41869.29	1026.88	0	1026.89	0.01	1026.88	0	1026.88	0
NORTH BRANCH	41500	1026.74	41500	1026.74	0	1026.76	0.02	1026.75	0.01	1026.75	0.01
NORTH BRANCH	40327.98	1026.16	40327.98	1026.17	0.01	1026.22	0.05	1026.19	0.02	1026.19	0.02
NORTH BRANCH	39093.62	1024.43	39093.62	1024.36	-0.07	1023.59	-0.77	1023.97	-0.39	1023.97	-0.39
NORTH BRANCH	37990.25	1024.3	37990.25	1024.3	0	1021	-3.3	1020.5	-3.8	1020.5	-3.8
NORTH BRANCH	37238.43	1024.28	37238.43	1024.28	0	1020.39	-3.89	1019.74	-4.54	1019.71	-4.57
			36876	1024.28		1020.03	-4.25	1019.34	-4.94	1019.29	-4.99
			36734	1024.27		1019.75	-4.52	1019.04	-5.23	1019.04	-5.23
			36624	1024.27		1019.09	-5.18	1018.67	-5.6	1018.67	-5.6
NORTH BRANCH	36525.74	1024.26	36525.74	1024.27	0.01	1018.95	-5.32	1018.73	-5.54	1018.73	-5.54
105	35902.57	1024.25	35902.57	1024.26	0.01	1018.61	-5.65	1018.52	-5.74	1018.52	-5.74
105	35363.32	1024.25	35363.32	1024.25	0	1018.07	-6.18	1018.05	-6.2	1018.05	-6.2
			35325	1024.25		1018.05	-6.2	1018.02	-6.23	1018.02	-6.23

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	35075.99	1024.22	35075.99	1024.22	0	1017.14	-7.08	1017.07	-7.15	1017.07	-7.15
105	35062.9	1024.12	35062.9	1024.11	-0.01	1016.48	-7.63	1016.39	-7.72	1016.39	-7.72
105	35054.71	**Existing Dam**	35054.71	**Existing Dam**							
			35044	1016.51		1016.42	-0.09	1016.42	-0.09	1016.42	-0.09
105	35026.92	1016.49	35026.92	1016.49	0	1016.43	-0.06	1016.43	-0.06	1016.43	-0.06
105	35003.6	1015.89	35003.6	1015.89	0	1015.89	0	1015.89	0	1015.89	0
105	34971.47	1015.9	34971.47	1015.9	0	1015.9	0	1015.9	0	1015.9	0
105	34960.08	1015.8	34960.08	1015.8	0	1015.8	0	1015.8	0	1015.8	0
105	34958.08	**State Trail BR**	34958.08	**State Trail Bridge**							
105	34947.79	1015.7	34947.79	1015.7	0	1015.7	0	1015.7	0	1015.7	0
105	34941.83	1015.65	34941.83	1015.65	0	1015.65	0	1015.65	0	1015.65	0
105	34935.87	1015.72	34935.87	1015.72	0	1015.72	0	1015.72	0	1015.72	0
105	34931.31	1015.67	34931.31	1015.67	0	1015.67	0	1015.67	0	1015.67	0
105	34926.39	**RR DS of Dam**	34926.39	**RR DS of Dam**							
105	34877.68	1015.16	34877.68	1015.16	0	1015.16	0	1015.16	0	1015.16	0
105	34780.32	1014.99	34780.32	1014.99	0	1014.99	0	1014.99	0	1014.99	0
105	34547.19	1014.85	34547.19	1014.85	0	1014.85	0	1014.85	0	1014.85	0
105	34358.54	1014.74	34358.54	1014.74	0	1014.74	0	1014.74	0	1014.74	0
105	34306.14	1014.55	34306.14	1014.55	0	1014.55	0	1014.55	0	1014.55	0

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	34242.97	1014.41	34242.97	1014.41	0	1014.41	0	1014.41	0	1014.41	0
105	34205.56	Old Hwy 61 N	34205.56	Old Hwy 61 N							
105	34093.62	1013.84	34093.62	1013.84	0	1013.84	0	1013.84	0	1013.84	0
105	34041.86	1013.83	34041.86	1013.83	0	1013.83	0	1013.83	0	1013.83	0
105	33583.55	1013.61	33583.55	1013.61	0	1013.61	0	1013.61	0	1013.61	0
105	32960.84	1013.33	32960.84	1013.33	0	1013.33	0	1013.33	0	1013.33	0
105	32888.59	1012.45	32888.59	1012.45	0	1012.45	0	1012.45	0	1012.45	0
105	32810.44	1012.72	32810.44	1012.72	0	1012.72	0	1012.72	0	1012.72	0
105	32571.96	1012.46	32571.96	1012.46	0	1012.46	0	1012.46	0	1012.46	0
105	32192.48	1012.21	32192.48	1012.21	0	1012.21	0	1012.21	0	1012.21	0
105	31819.39	1012.11	31819.39	1012.11	0	1012.11	0	1012.11	0	1012.11	0
105	31268.12	1011.95	31268.12	1011.95	0	1011.95	0	1011.95	0	1011.95	0
105	30901.21	1011.74	30901.21	1011.74	0	1011.74	0	1011.74	0	1011.74	0
105	30850.84	1011.58	30850.84	1011.58	0	1011.58	0	1011.58	0	1011.58	0
105	30785.21		30785.21								
105	30759.1	1011.04	30759.1	1011.04	0	1011.04	0	1011.04	0	1011.04	0
105	30708.23		30708.23								
105	30662.42	1010.79	30662.42	1010.79	0	1010.79	0	1010.79	0	1010.79	0
105	30612.03	1010.71	30612.03	1010.71	0	1010.71	0	1010.71	0	1010.71	0
105	29992.17	1010.05	29992.17	1010.05	0	1010.05	0	1010.05	0	1010.05	0

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	29939.68	1010	29939.68	1010	0	1010	0	1010	0	1010	0
105	29867.25		29867.25								
105	29756.78	1009.58	29756.78	1009.58	0	1009.58	0	1009.58	0	1009.58	0
105	29705.08	1009.26	29705.08	1009.26	0	1009.26	0	1009.26	0	1009.26	0
105	28595.64	1006.97	28595.64	1006.97	0	1006.97	0	1006.97	0	1006.97	0
105	28050.29	1005.87	28050.29	1005.87	0	1005.87	0	1005.87	0	1005.87	0
105	27436.09	1004.01	27436.09	1004.01	0	1004.01	0	1004.01	0	1004.01	0
105	26723.85	1002.07	26723.85	1002.07	0	1002.07	0	1002.07	0	1002.07	0
105	25959.37	1001.25	25959.37	1001.25	0	1001.25	0	1001.25	0	1001.25	0
105	25269.36	1000.56	25269.36	1000.56	0	1000.56	0	1000.56	0	1000.56	0
105	25044.77	1000.22	25044.77	1000.22	0	1000.22	0	1000.22	0	1000.22	0
105	24600.33	999.34	24600.33	999.34	0	999.34	0	999.34	0	999.34	0
105	24252.96	998.24	24252.96	998.24	0	998.24	0	998.24	0	998.24	0
105	23906.7	997.19	23906.7	997.19	0	997.19	0	997.19	0	997.19	0
105	23185.95	995.97	23185.95	995.97	0	995.97	0	995.97	0	995.97	0
105	22271.5	994.21	22271.5	994.21	0	994.21	0	994.21	0	994.21	0
105	21626.32	991.78	21626.32	991.78	0	991.78	0	991.78	0	991.78	0
105	21227.63	991.03	21227.63	991.03	0	991.03	0	991.03	0	991.03	0
105	20837.73	990.58	20837.73	990.58	0	990.58	0	990.58	0	990.58	0
105	20099.63	989.51	20099.63	989.51	0	989.51	0	989.51	0	989.51	0

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	19499.58	987.83	19499.58	987.83	0	987.83	0	987.83	0	987.83	0
105	18904.22	986.86	18904.22	986.86	0	986.86	0	986.86	0	986.86	0
105	17965.5	986.17	17965.5	986.17	0	986.17	0	986.17	0	986.17	0
105	17425.87	985.92	17425.87	985.92	0	985.92	0	985.92	0	985.92	0
105	17048.52	985.78	17048.52	985.78	0	985.78	0	985.78	0	985.78	0
105	16817.01	985.71	16817.01	985.71	0	985.71	0	985.71	0	985.71	0
105	16766.43	985.47	16766.43	985.47	0	985.47	0	985.47	0	985.47	0
105	16685.6		16685.6								
105	16573.63	981.97	16573.63	981.97	0	981.97	0	981.97	0	981.97	0
105	16501.47	981.97	16501.47	981.97	0	981.97	0	981.97	0	981.97	0
105	16166.43	981.24	16166.43	981.24	0	981.24	0	981.24	0	981.24	0
105	15855.05	980.52	15855.05	980.52	0	980.52	0	980.52	0	980.52	0
105	15698.61	980.12	15698.61	980.12	0	980.12	0	980.12	0	980.12	0
105	15635.34	980.03	15635.34	980.03	0	980.03	0	980.03	0	980.03	0
105	15480.48		15480.48								
105	15373.7	979.45	15373.7	979.45	0	979.45	0	979.45	0	979.45	0
105	15315.94	979.29	15315.94	979.29	0	979.29	0	979.29	0	979.29	0
105	15163.02	978.69	15163.02	978.69	0	978.69	0	978.69	0	978.69	0
105	14335.08	975.71	14335.08	975.71	0	975.71	0	975.71	0	975.71	0
105	13445.79	973.69	13445.79	973.69	0	973.69	0	973.69	0	973.69	0

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	12627.4	968.38	12627.4	968.38	0	968.38	0	968.38	0	968.38	0
105	10975.08	968.07	10975.08	968.07	0	968.07	0	968.07	0	968.07	0
105	9734.503	967.99	9734.503	967.99	0	967.99	0	967.99	0	967.99	0
105	9293.788	967.98	9293.788	967.98	0	967.98	0	967.98	0	967.98	0
105	9176.118		9176.118								
105	9083.416	963.09	9083.416	963.09	0	963.09	0	963.09	0	963.09	0
105	8418.57	961.84	8418.57	961.84	0	961.84	0	961.84	0	961.84	0
105	7745.789	961	7745.789	961	0	961	0	961	0	961	0
105	7345.539	960.18	7345.539	960.18	0	960.18	0	960.18	0	960.18	0
105	7023.449	958.84	7023.449	958.84	0	958.84	0	958.84	0	958.84	0
105	6584.468	956.91	6584.468	956.91	0	956.91	0	956.91	0	956.91	0
105	6190.372	954.63	6190.372	954.63	0	954.63	0	954.63	0	954.63	0
105	5924.137	952.9	5924.137	952.9	0	952.9	0	952.9	0	952.9	0
105	5714.959	951.9	5714.959	951.9	0	951.9	0	951.9	0	951.9	0
105	5492.244	950.49	5492.244	950.49	0	950.49	0	950.49	0	950.49	0
105	5144.497	947.51	5144.497	947.51	0	947.51	0	947.51	0	947.51	0
105	5035.815	946.69	5035.815	946.69	0	946.69	0	946.69	0	946.69	0
105	4848.883	945.58	4848.883	945.58	0	945.58	0	945.58	0	945.58	0
105	4489.153	943.56	4489.153	943.56	0	943.56	0	943.56	0	943.56	0
105	4222.394	941.9	4222.394	941.9	0	941.9	0	941.9	0	941.9	0

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	4037.557	941.22	4037.557	941.22	0	941.22	0	941.22	0	941.22	0
105	3818.579	940.36	3818.579	940.36	0	940.36	0	940.36	0	940.36	0
105	3604.448	939.63	3604.448	939.63	0	939.63	0	939.63	0	939.63	0
105	3376.726	938.69	3376.726	938.69	0	938.69	0	938.69	0	938.69	0
105	3022.453	936.37	3022.453	936.37	0	936.37	0	936.37	0	936.37	0
105	2699.83	934.36	2699.83	934.36	0	934.36	0	934.36	0	934.36	0
105	2419.007	933.01	2419.007	933.01	0	933.01	0	933.01	0	933.01	0
105	2258.22	932.08	2258.22	932.08	0	932.08	0	932.08	0	932.08	0
105	2092.603	930.91	2092.603	930.91	0	930.91	0	930.91	0	930.91	0
105	1919.969	929.72	1919.969	929.72	0	929.72	0	929.72	0	929.72	0
105	1761.298	928.77	1761.298	928.77	0	928.77	0	928.77	0	928.77	0
105	1517.67	927.36	1517.67	927.36	0	927.36	0	927.36	0	927.36	0
105	1265.53	925.96	1265.53	925.96	0	925.96	0	925.96	0	925.96	0

500-year Water Surface Elevation Comparison Table

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
SOUTH BRANCH	7510.254	1032.31	7510.254	1032.31	0	1032.31	0	1032.31	0	1032.31	0
SOUTH BRANCH	7275.82	1031.98	7275.82	1031.98	0	1031.98	0	1031.98	0	1031.98	0
SOUTH BRANCH	6960.151	1031.49	6960.151	1031.49	0	1031.49	0	1031.49	0	1031.49	0
SOUTH BRANCH	6686.668	1031.09	6686.668	1031.09	0	1031.09	0	1031.09	0	1031.09	0
SOUTH BRANCH	6351.747	1030.77	6351.747	1030.77	0	1030.77	0	1030.77	0	1030.77	0
SOUTH BRANCH	6063.386	1030.53	6063.386	1030.53	0	1030.53	0	1030.53	0	1030.53	0
SOUTH BRANCH	5764.491	1030.17	5764.491	1030.17	0	1030.17	0	1030.17	0	1030.17	0
SOUTH BRANCH	5515.943	1029.67	5515.943	1029.67	0	1029.67	0	1029.67	0	1029.67	0
SOUTH BRANCH	5178.094	1029.02	5178.094	1029.02	0	1029.02	0	1029.02	0	1029.02	0
SOUTH BRANCH	4825.459	1028.20	4825.459	1028.20	0	1028.20	0	1028.20	0	1028.20	0
SOUTH BRANCH	4502.893	1027.01	4502.893	1027.01	0	1027.02	0.01	1027.02	0.01	1027.02	0.01
SOUTH BRANCH	4000	1026.24	4000	1026.25	0.01	1026.12	-0.13	1026.12	-0.13	1026.12	-0.13

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
SOUTH BRANCH	3500	1025.77	3500	1025.78	0.01	1025.33	-0.45	1025.33	-0.45	1025.33	-0.45
SOUTH BRANCH	3063.539	1025.50	3063.539	1025.52	0.02	1024.39	-1.13	1024.39	-1.13	1024.39	-1.13
SOUTH BRANCH	2746.48	1025.39	2746.48	1025.41	0.02	1023.88	-1.53	1023.88	-1.53	1023.88	-1.53
SOUTH BRANCH	2407.645	1025.28	2407.645	1025.31	0.03	1023.24	-2.07	1023.24	-2.07	1023.24	-2.07
SOUTH BRANCH	2085.525	1025.21	2085.525	1025.26	0.05	1022.75	-2.51	1022.75	-2.51	1022.75	-2.51
SOUTH BRANCH	1670.632	1025.14	1670.632	1025.20	0.06	1021.96	-3.24	1021.96	-3.24	1021.96	-3.24
SOUTH BRANCH	1256.254	1025.09	1256.254	1025.16	0.07	1021.11	-4.05	1021.10	-4.06	1021.10	-4.06
SOUTH BRANCH	764.7275	1025.05	764.7275	1025.14	0.09	1020.21	-4.93	1020.17	-4.97	1020.17	-4.97
SOUTH BRANCH	439.2707	1025.02	439.2707	1025.13	0.11	1019.42	-5.71	1019.27	-5.86	1019.27	-5.86
NORTH BRANCH	43968.86	1035.63	43968.86	1035.63	0	1035.63	0	1035.63	0	1035.63	0
NORTH BRANCH	43570.34	1034.68	43570.34	1034.68	0	1034.68	0	1034.68	0	1034.68	0
NORTH BRANCH	43292.78	1033.56	43292.78	1033.56	0	1033.56	0	1033.56	0	1033.56	0
NORTH BRANCH	43096.4	1032.57	43096.4	1032.57	0	1032.57	0	1032.57	0	1032.57	0

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
NORTH BRANCH	42699.08	1029.69	42699.08	1029.69	0	1029.69	0	1029.69	0	1029.69	0
NORTH BRANCH	42362.91	1027.52	42362.91	1027.52	0	1027.51	-0.01	1027.51	-0.01	1027.51	-0.01
NORTH BRANCH	41869.29	1027.08	41869.29	1027.08	0	1027.07	-0.01	1027.07	-0.01	1027.07	-0.01
NORTH BRANCH	41500	1026.93	41500	1026.93	0	1026.92	-0.01	1026.92	-0.01	1026.92	-0.01
NORTH BRANCH	40327.98	1026.34	40327.98	1026.35	0.01	1026.33	-0.02	1026.31	-0.04	1026.31	-0.04
NORTH BRANCH	39093.62	1025.30	39093.62	1025.32	0.02	1024.14	-1.18	1024.42	-0.9	1024.42	-0.9
NORTH BRANCH	37990.25	1025.10	37990.25	1025.19	0.09	1021.87	-3.32	1021.47	-3.72	1021.47	-3.72
NORTH BRANCH	37238.43	1025.06	37238.43	1025.17	0.11	1021.16	-4.01	1020.60	-4.57	1020.60	-4.57
			36876	1025.15		1020.72	-4.43	1020.11	-5.04	1020.11	-5.04
			36734	1025.14		1020.38	-4.76	1019.81	-5.33	1019.81	-5.33
			36624	1025.14		1019.74	-5.4	1019.20	-5.94	1019.20	-5.94
NORTH BRANCH	36525.74	1025.03	36525.74	1025.13	0.1	1019.51	-5.62	1019.28	-5.85	1019.28	-5.85
105	35902.57	1024.25	35902.57	1025.12	0.87	1019.09	-6.03	1019.00	-6.12	1019.00	-6.12
105	35363.32	1024.25	35363.32	1025.11	0.86	1018.58	-6.53	1018.54	-6.57	1018.54	-6.57
			35325	1025.11		1018.55	-6.56	1018.52	-6.59	1018.52	-6.59

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12
	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	35075.99	1024.22	35075.99	1025.08	0.86	1017.62	-7.46	1017.52	-7.56	1017.52	-7.56
105	35062.9	1024.12	35062.9	1024.93	0.81	1017.23	-7.7	1017.16	-7.77	1017.16	-7.77
105	35054.71	Existing Dam	35054.71	BLANK		BLANK		BLANK		BLANK	
		BLANK	35044	1017.17		1017.07	-0.1	1017.07	-0.1	1017.07	-0.1
105	35026.92	1016.49	35026.92	1017.11	0.62	1017.08	-0.03	1017.08	-0.03	1017.08	-0.03
105	35003.6	1015.89	35003.6	1016.37	0.48	1016.37	0	1016.37	0	1016.37	0
105	34971.47	1015.90	34971.47	1016.46	0.56	1016.46	0	1016.46	0	1016.46	0
105	34960.08	1015.80	34960.08	1016.30	0.5	1016.30	0	1016.30	0	1016.30	0
105	34958.08	State Trail BR	34958.08	BLANK		BLANK		BLANK		BLANK	
105	34947.79	1015.70	34947.79	1016.18	0.48	1016.18	0	1016.18	0	1016.18	0
105	34941.83	1015.65	34941.83	1016.12	0.47	1016.12	0	1016.12	0	1016.12	0
105	34935.87	1015.72	34935.87	1016.26	0.54	1016.26	0	1016.26	0	1016.26	0
105	34931.31	1015.67	34931.31	1016.22	0.55	1016.22	0	1016.22	0	1016.22	0
105	34926.39	RR DS of Dam	34926.39	BLANK		BLANK		BLANK		BLANK	
105	34877.68	1015.16	34877.68	1015.74	0.58	1015.74	0	1015.74	0	1015.74	0
105	34780.32	1014.99	34780.32	1015.62	0.63	1015.62	0	1015.62	0	1015.62	0
105	34547.19	1014.85	34547.19	1015.49	0.64	1015.49	0	1015.49	0	1015.49	0
105	34358.54	1014.74	34358.54	1015.38	0.64	1015.38	0	1015.38	0	1015.38	0
105	34306.14	1014.55	34306.14	1015.16	0.61	1015.16	0	1015.16	0	1015.16	0
105	34242.97	1014.41	34242.97	1015.00	0.59	1015.00	0	1015.00	0	1015.00	0

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Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	34205.56	Old Hwy 61 N	34205.56	BLANK		BLANK		BLANK		BLANK	
105	34093.62	1013.84	34093.62	1014.37	0.53	1014.37	0	1014.37	0	1014.37	0
105	34041.86	1013.83	34041.86	1014.37	0.54	1014.37	0	1014.37	0	1014.37	0
105	33583.55	1013.61	33583.55	1014.19	0.58	1014.19	0	1014.19	0	1014.19	0
105	32960.84	1013.33	32960.84	1013.95	0.62	1013.95	0	1013.95	0	1013.95	0
105	32888.59	1012.45	32888.59	1012.83	0.38	1012.83	0	1012.83	0	1012.83	0
105	32810.44	1012.72	32810.44	1013.28	0.56	1013.28	0	1013.28	0	1013.28	0
105	32571.96	1012.46	32571.96	1013.06	0.6	1013.06	0	1013.06	0	1013.06	0
105	32192.48	1012.21	32192.48	1012.84	0.63	1012.84	0	1012.84	0	1012.84	0
105	31819.39	1012.11	31819.39	1012.75	0.64	1012.75	0	1012.75	0	1012.75	0
105	31268.12	1011.95	31268.12	1012.60	0.65	1012.60	0	1012.60	0	1012.60	0
105	30901.21	1011.74	30901.21	1012.39	0.65	1012.39	0	1012.39	0	1012.39	0
105	30850.84	1011.58	30850.84	1012.20	0.62	1012.20	0	1012.20	0	1012.20	0
105	30785.21	BLANK	30785.21	BLANK		BLANK		BLANK		BLANK	
105	30759.1	1011.04	30759.1	1011.64	0.6	1011.64	0	1011.64	0	1011.64	0
105	30708.23	BLANK	30708.23	BLANK		BLANK		BLANK		BLANK	
105	30662.42	1010.79	30662.42	1011.39	0.6	1011.39	0	1011.39	0	1011.39	0
105	30612.03	1010.71	30612.03	1011.30	0.59	1011.30	0	1011.30	0	1011.30	0
105	29992.17	1010.05	29992.17	1010.54	0.49	1010.54	0	1010.54	0	1010.54	0
105	29939.68	1010.00	29939.68	1010.47	0.47	1010.47	0	1010.47	0	1010.47	0

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Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	29867.25	BLANK	29867.25	BLANK		BLANK		BLANK		BLANK	
105	29756.78	1009.58	29756.78	1009.99	0.41	1009.99	0	1009.99	0	1009.99	0
105	29705.08	1009.26	29705.08	1009.66	0.4	1009.66	0	1009.66	0	1009.66	0
105	28595.64	1006.97	28595.64	1007.30	0.33	1007.30	0	1007.30	0	1007.30	0
105	28050.29	1005.87	28050.29	1006.17	0.3	1006.17	0	1006.17	0	1006.17	0
105	27436.09	1004.01	27436.09	1004.20	0.19	1004.20	0	1004.20	0	1004.20	0
105	26723.85	1002.07	26723.85	1002.44	0.37	1002.44	0	1002.44	0	1002.44	0
105	25959.37	1001.25	25959.37	1001.69	0.44	1001.69	0	1001.69	0	1001.69	0
105	25269.36	1000.56	25269.36	1000.97	0.41	1000.97	0	1000.97	0	1000.97	0
105	25044.77	1000.22	25044.77	1000.60	0.38	1000.60	0	1000.60	0	1000.60	0
105	24600.33	999.34	24600.33	999.67	0.33	999.67	0	999.67	0	999.67	0
105	24252.96	998.24	24252.96	998.53	0.29	998.53	0	998.53	0	998.53	0
105	23906.7	997.19	23906.7	997.44	0.25	997.44	0	997.44	0	997.44	0
105	23185.95	995.97	23185.95	996.16	0.19	996.16	0	996.16	0	996.16	0
105	22271.5	994.21	22271.5	994.49	0.28	994.49	0	994.49	0	994.49	0
105	21626.32	991.78	21626.32	992.09	0.31	992.09	0	992.09	0	992.09	0
105	21227.63	991.03	21227.63	991.37	0.34	991.37	0	991.37	0	991.37	0
105	20837.73	990.58	20837.73	990.91	0.33	990.91	0	990.91	0	990.91	0
105	20099.63	989.51	20099.63	989.72	0.21	989.72	0	989.72	0	989.72	0
105	19499.58	987.83	19499.58	988.15	0.32	988.15	0	988.15	0	988.15	0

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	Plan Name	**Existing Combined Reaches - From DNR** (.p03)		**Existing Combined Reaches - Corrected** (.p06)	*Change in WSEL (column 5 minus column 3)*	**Proposed Project Short Term** (.p11)	*Change in WSE (column 7 minus column 5)*	**Proposed Project Long Term** (.p12)	*Change in WSEL (column 9 minus column 5)*	**Partially Engineered Alternative Long Term** (.p13)	*Change in WSEL (column 11 minus column 5)*
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	18904.22	986.86	18904.22	987.43	0.57	987.43	0	987.43	0	987.43	0
105	17965.5	986.17	17965.5	986.96	0.79	986.96	0	986.96	0	986.96	0
105	17425.87	985.92	17425.87	986.78	0.86	986.78	0	986.78	0	986.78	0
105	17048.52	985.78	17048.52	986.68	0.9	986.68	0	986.68	0	986.68	0
105	16817.01	985.71	16817.01	986.61	0.9	986.61	0	986.61	0	986.61	0
105	16766.43	985.47	16766.43	986.33	0.86	986.33	0	986.33	0	986.33	0
105	16685.6	BRIDGE	16685.6	BRIDGE		BRIDGE		BRIDGE		BRIDGE	
105	16573.63	981.97	16573.63	982.29	0.32	982.29	0	982.29	0	982.29	0
105	16501.47	981.97	16501.47	982.32	0.35	982.32	0	982.32	0	982.32	0
105	16166.43	981.24	16166.43	981.59	0.35	981.59	0	981.59	0	981.59	0
105	15855.05	980.52	15855.05	980.92	0.4	980.92	0	980.92	0	980.92	0
105	15698.61	980.12	15698.61	980.54	0.42	980.54	0	980.54	0	980.54	0
105	15635.34	980.03	15635.34	980.44	0.41	980.44	0	980.44	0	980.44	0
105	15480.48	BRIDGE	15480.48	BRIDGE		BRIDGE		BRIDGE		BRIDGE	
105	15373.7	979.45	15373.7	979.74	0.29	979.74	0	979.74	0	979.74	0
105	15315.94	979.29	15315.94	979.57	0.28	979.57	0	979.57	0	979.57	0
105	15163.02	978.69	15163.02	978.98	0.29	978.98	0	978.98	0	978.98	0
105	14335.08	975.71	14335.08	975.92	0.21	975.92	0	975.92	0	975.92	0
105	13445.79	973.69	13445.79	974.00	0.31	974.00	0	974.00	0	974.00	0
105	12627.4	968.38	12627.4	969.29	0.91	969.29	0	969.29	0	969.29	0

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Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	10975.08	968.07	10975.08	967.42	-0.65	967.42	0	967.42	0	967.42	0
105	9734.503	967.99	9734.503	967.17	-0.82	967.17	0	967.17	0	967.17	0
105	9293.788	967.98	9293.788	967.13	-0.85	967.13	0	967.13	0	967.13	0
105	9176.118	BLANK	9176.118	BLANK		BLANK		BLANK		BLANK	
105	9083.416	963.09	9083.416	963.38	0.29	963.38	0	963.38	0	963.38	0
105	8418.57	961.84	8418.57	962.19	0.35	962.19	0	962.19	0	962.19	0
105	7745.789	961.00	7745.789	961.36	0.36	961.36	0	961.36	0	961.36	0
105	7345.539	960.18	7345.539	960.54	0.36	960.54	0	960.54	0	960.54	0
105	7023.449	958.84	7023.449	959.31	0.47	959.31	0	959.31	0	959.31	0
105	6584.468	956.91	6584.468	957.38	0.47	957.38	0	957.38	0	957.38	0
105	6190.372	954.63	6190.372	955.03	0.4	955.03	0	955.03	0	955.03	0
105	5924.137	952.90	5924.137	953.38	0.48	953.38	0	953.38	0	953.38	0
105	5714.959	951.90	5714.959	952.33	0.43	952.33	0	952.33	0	952.33	0
105	5492.244	950.49	5492.244	950.79	0.3	950.79	0	950.79	0	950.79	0
105	5144.497	947.51	5144.497	947.74	0.23	947.74	0	947.74	0	947.74	0
105	5035.815	946.69	5035.815	946.97	0.28	946.97	0	946.97	0	946.97	0
105	4848.883	945.58	4848.883	945.89	0.31	945.89	0	945.89	0	945.89	0
105	4489.153	943.56	4489.153	944.10	0.54	944.10	0	944.10	0	944.10	0
105	4222.394	941.90	4222.394	942.46	0.56	942.46	0	942.46	0	942.46	0
105	4037.557	941.22	4037.557	941.76	0.54	941.76	0	941.76	0	941.76	0

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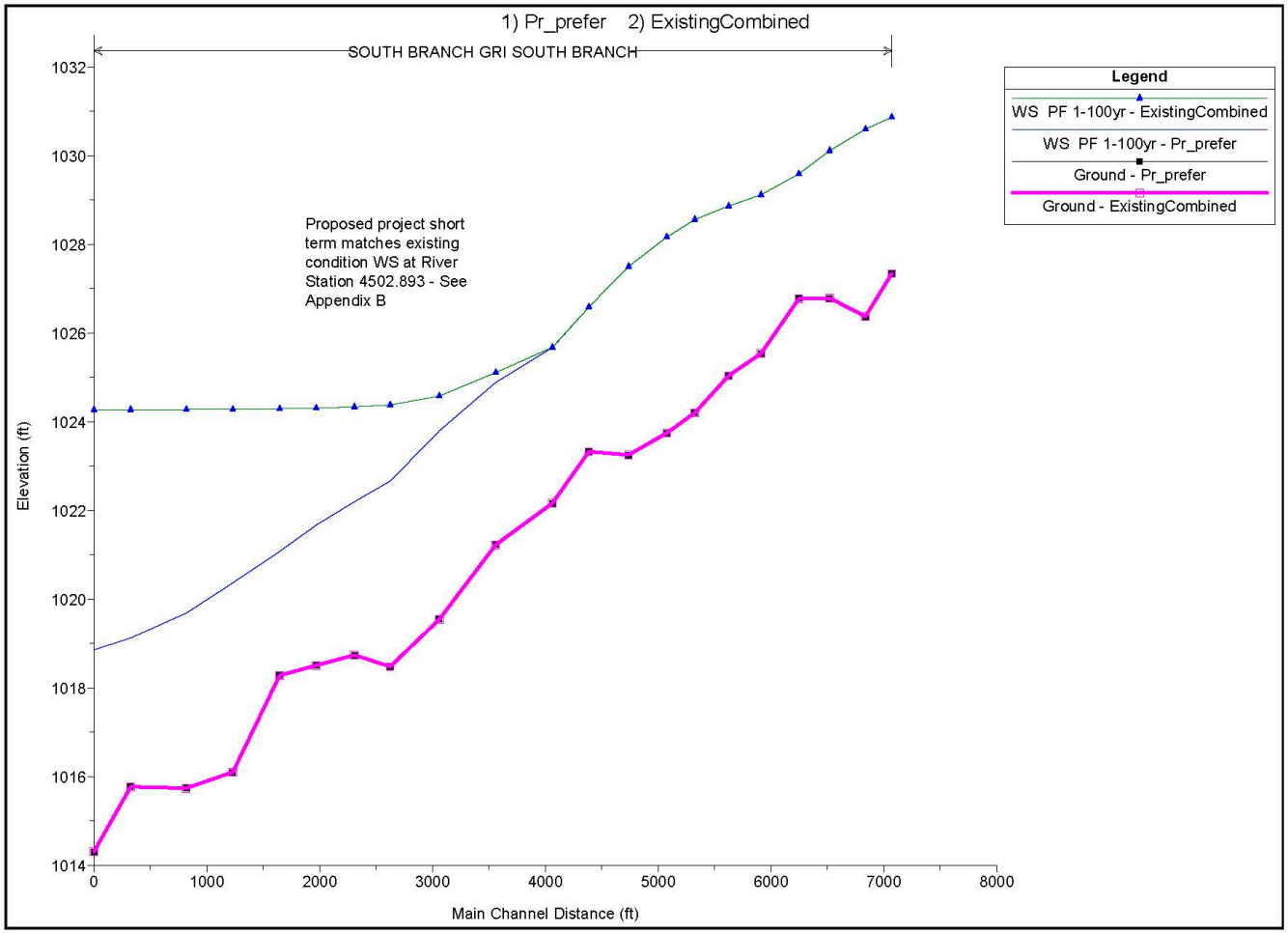
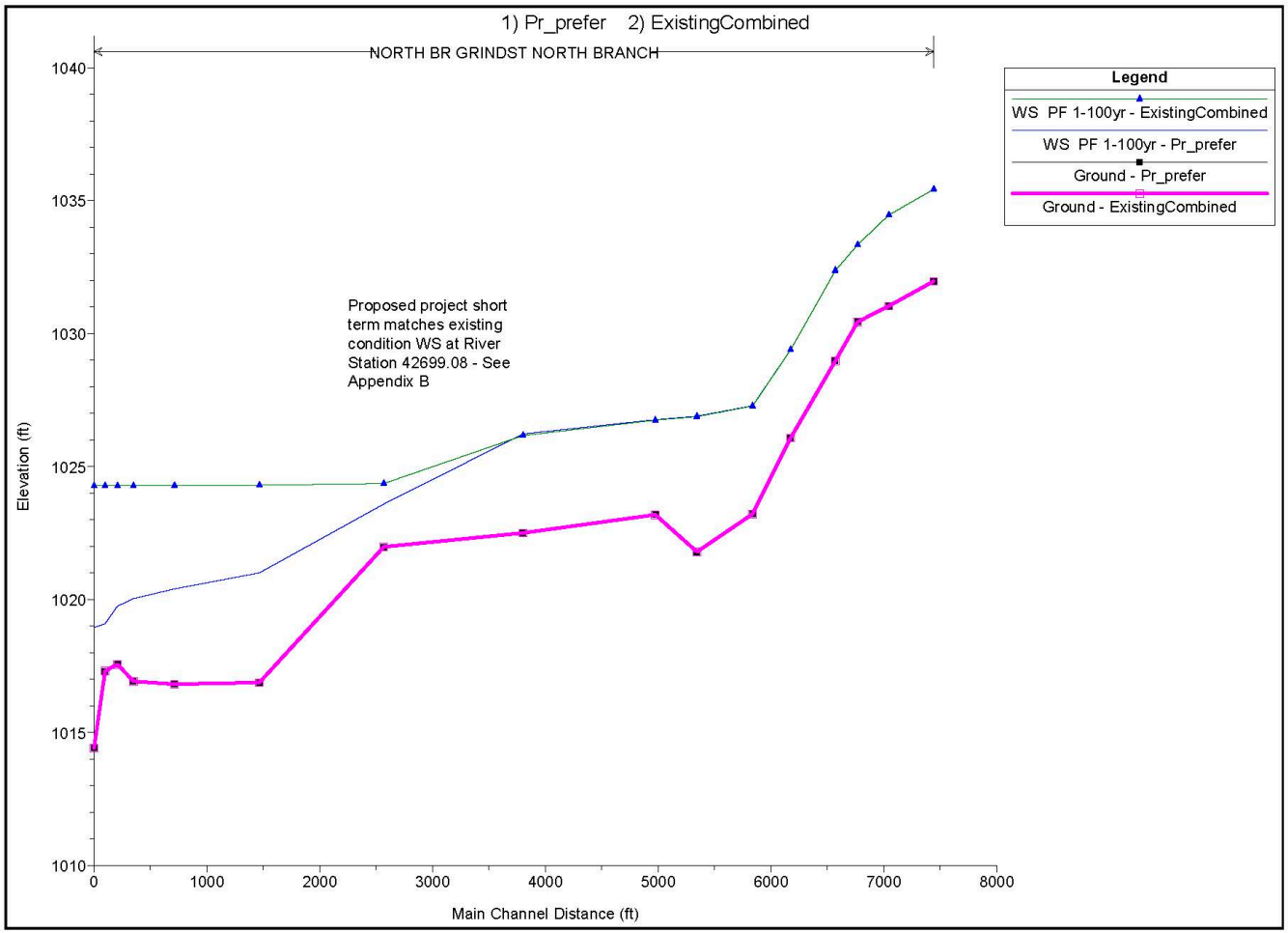
Reach	**Effective River Stations**	**(ft)**	**Updated River Stations**	**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**		**W.S. Elev (ft)**	
105	3818.579	940.36	3818.579	940.84	0.48	940.84	0	940.84	0	940.84	0
105	3604.448	939.63	3604.448	940.06	0.43	940.06	0	940.06	0	940.06	0
105	3376.726	938.69	3376.726	939.04	0.35	939.04	0	939.04	0	939.04	0
105	3022.453	936.37	3022.453	936.74	0.37	936.74	0	936.74	0	936.74	0
105	2699.83	934.36	2699.83	934.82	0.46	934.82	0	934.82	0	934.82	0
105	2419.007	933.01	2419.007	933.55	0.54	933.55	0	933.55	0	933.55	0
105	2258.22	932.08	2258.22	932.58	0.5	932.58	0	932.58	0	932.58	0
105	2092.603	930.91	2092.603	931.38	0.47	931.38	0	931.38	0	931.38	0
105	1919.969	929.72	1919.969	930.23	0.51	930.23	0	930.23	0	930.23	0
105	1761.298	928.77	1761.298	929.29	0.52	929.29	0	929.29	0	929.29	0
105	1517.67	927.36	1517.67	927.85	0.49	927.85	0	927.85	0	927.85	0
105	1265.53	925.96	1265.53	926.48	0.52	926.48	0	926.48	0	926.48	0

Appendix C

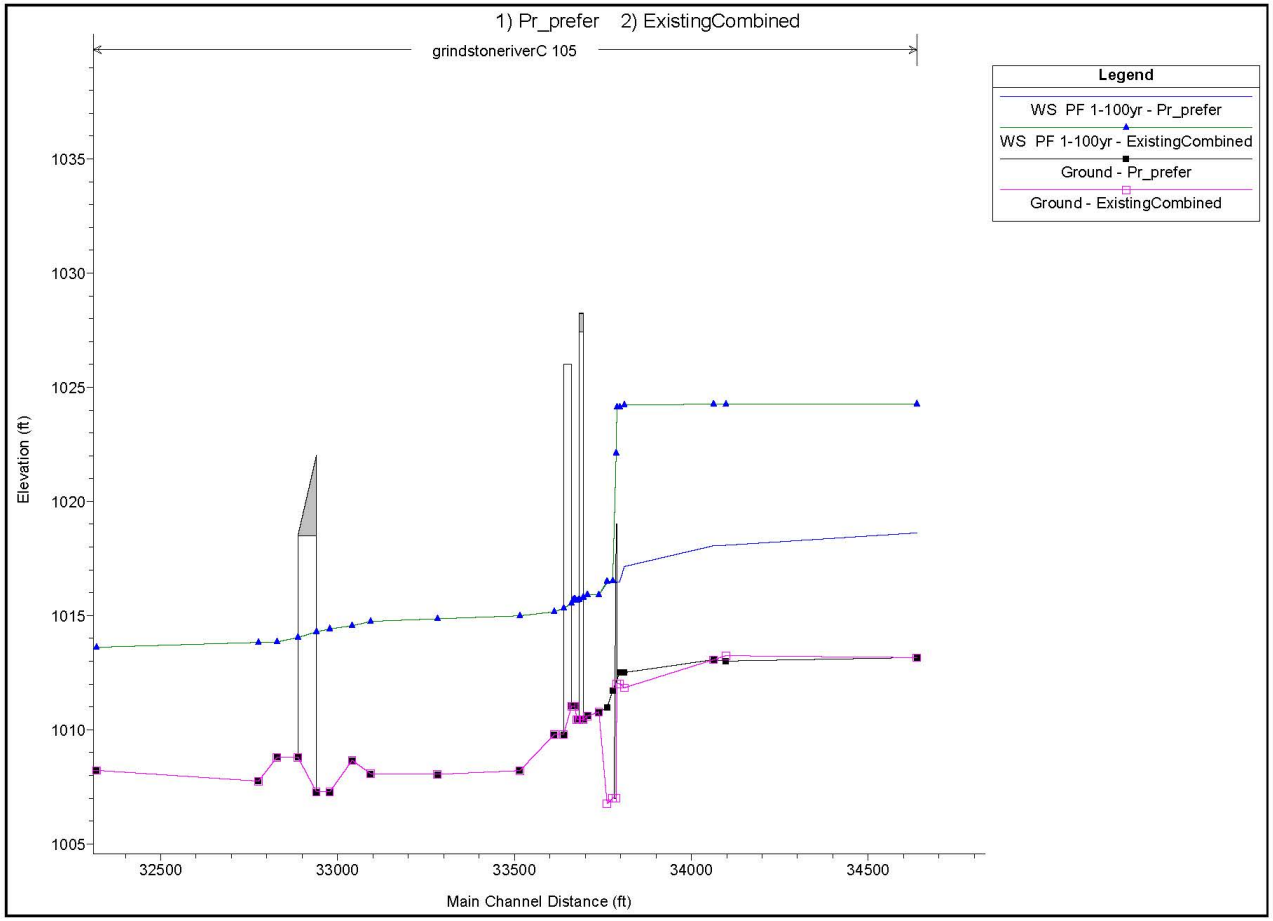
100-year Profile Comparison



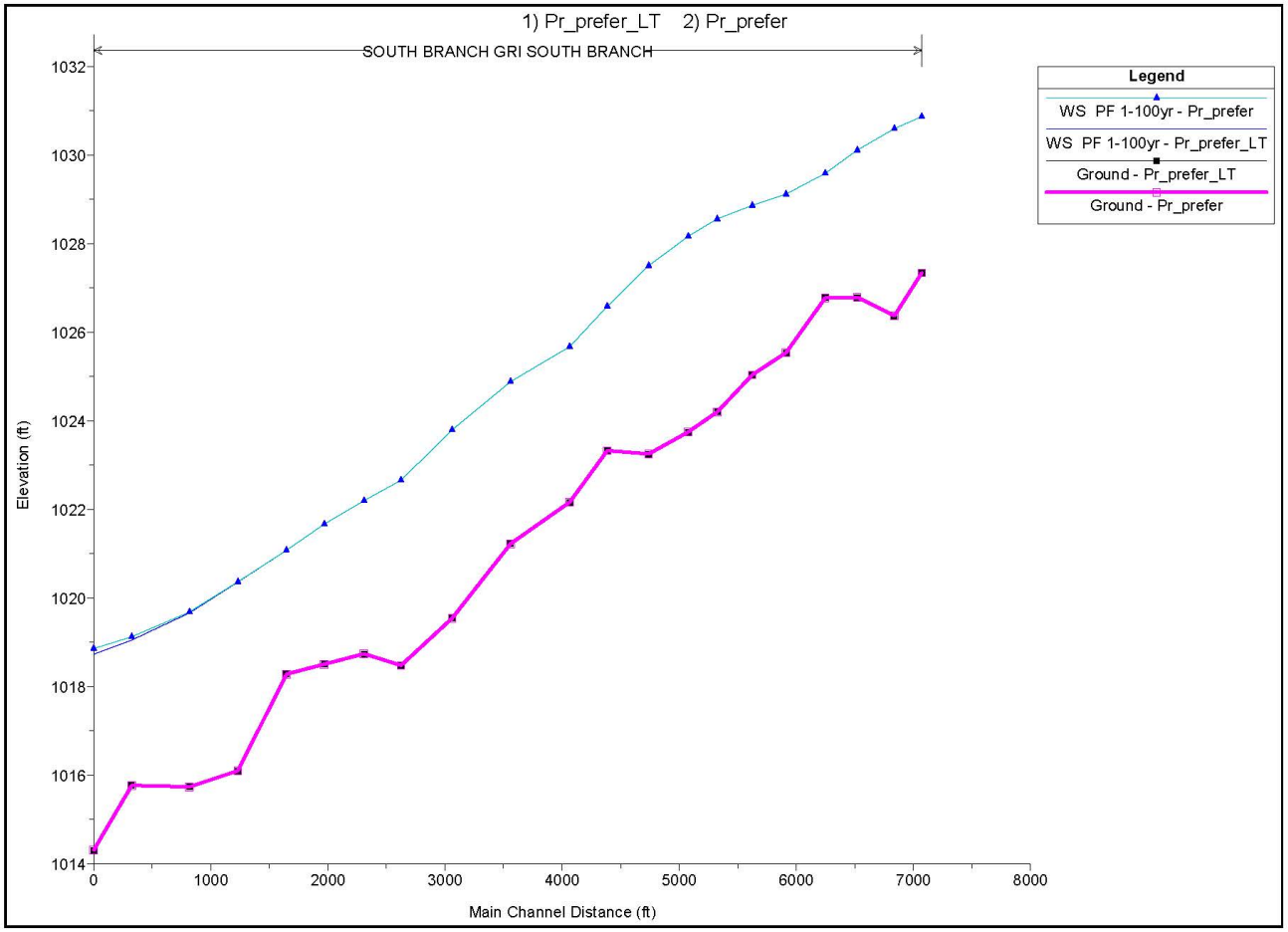
Profile 1. South Branch Grindstone River, existing scenario compared to short term proposed scenario. The thalweg is the same between existing and proposed, and the proposed short term water surface elevation decreases from existing conditions



Profile 2. North Branch Grindstone River, existing compared to short term proposed. The thalweg is the same between existing and proposed, and the proposed short term water surface elevation decreases from existing conditions



Profile 3. Main Grindstone River, existing compared to short term proposed. The thalweg is updated at the dam and upstream of the dam where the rock riffles will be placed in proposed conditions, and the proposed short term water surface elevation decreases from the existing condition



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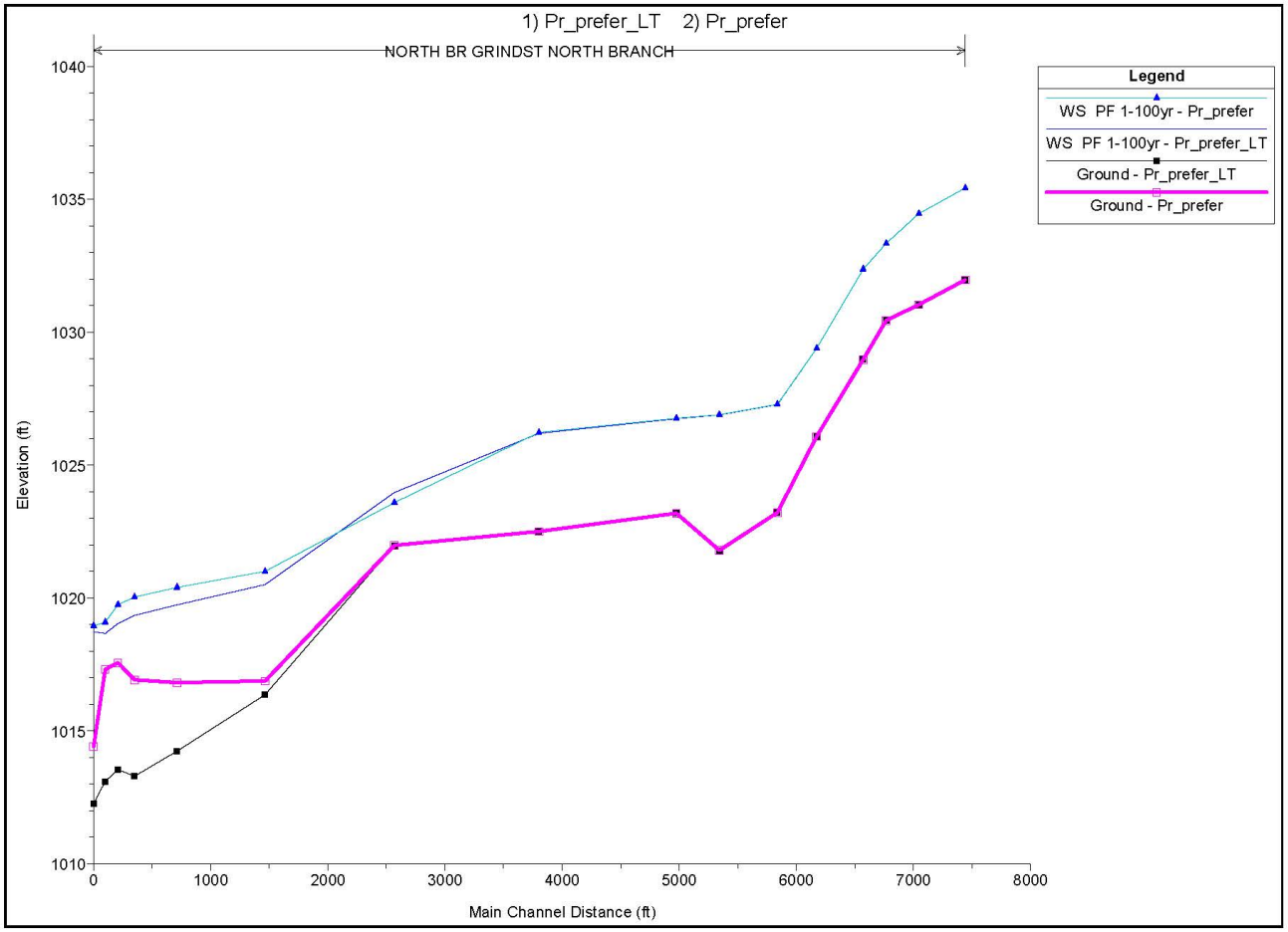
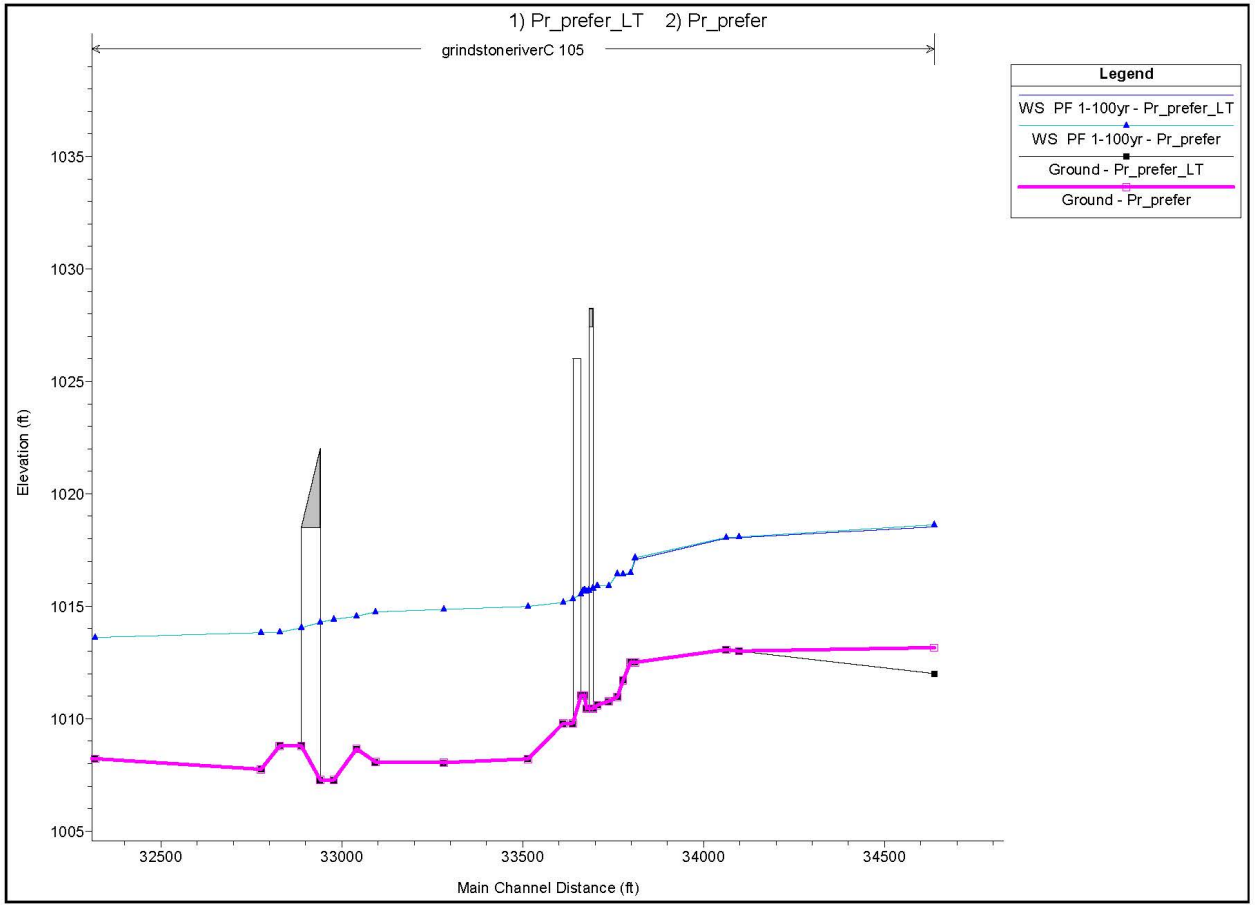
Profile 4. South Branch Grindstone River, proposed short term compared to proposed long term. The Thalweg elevation on the South Branch stays the same between short term and long term proposed scenarios because there is not predicted to be any fine sediment movement.



Profile 5. North Branch Grindstone River, proposed short term compared to proposed long term. The Thalweg elevation on the North Branch is predicted to decrease in the long term condition. The decrease in thalweg elevation shows a slight decrease in water surface elevation for the proposed long term scenario as compared to the proposed short term scenario.



Profile 6. Main Grindstone River, proposed short term compared to proposed long term. The Thalweg elevation on the main branch is predicted to stay the same, there is a slight difference at the most upstream side where the North Branch elevation is tying in. The Main Grindstone River water surface elevation stays approximately the same between the proposed short term and proposed long term scenarios