



HYDROLOGY & HYDRAULICS REPORT

**STRUCTURE No.: WAR-350-0873
S.R. 350 OVER TODD'S FORK**

APRIL 8, 2024

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1.0 Project Description

An existing bridge is being replaced carrying State Route 350 over Todds Fork Creek in Warren County (Bridge No. WAR-350-0873) The purpose of this hydraulic report is to determine the impacts of the proposed improvements on the water surface elevations of West Fork, determine the hydraulic adequacy of the proposed structure, evaluate the flood hazard potential of the proposed conditions, and to address scour potential of the proposed conditions.

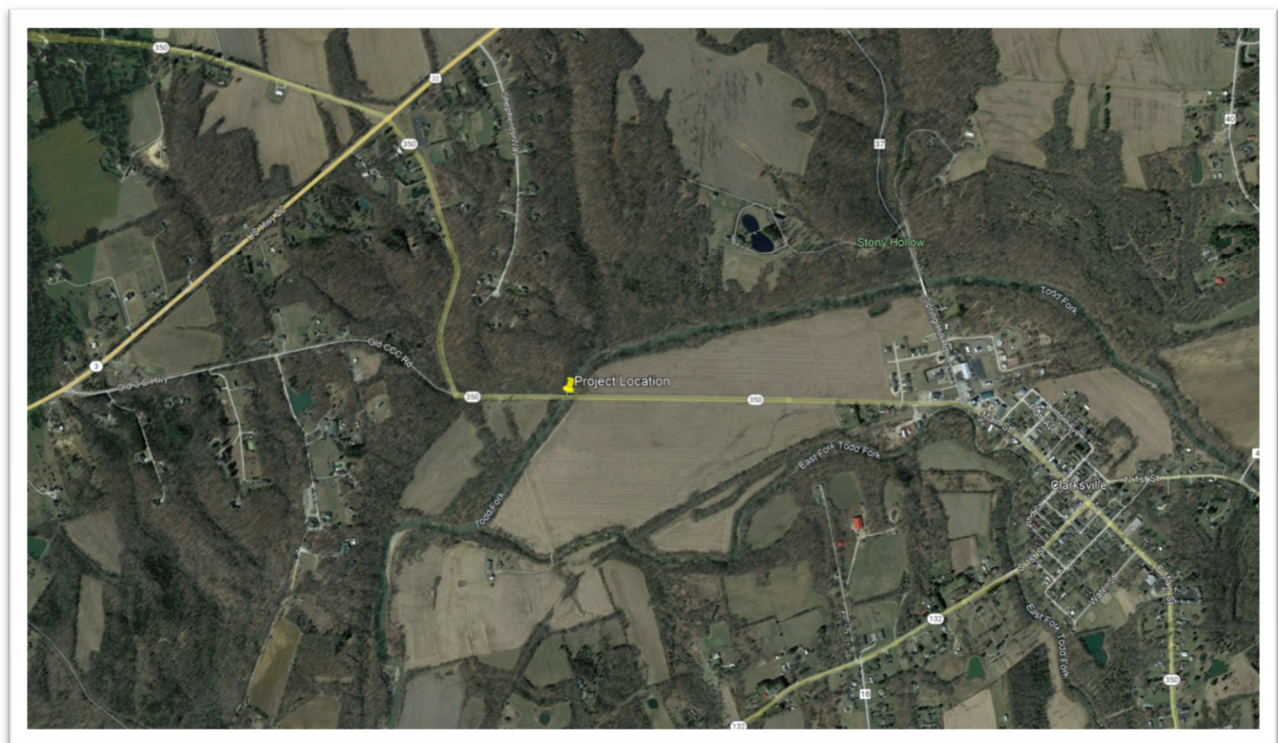


FIGURE 1 - PROJECT LOCATION

2.0 Existing Conditions and Proposed Structure

Existing Conditions - The concrete abutments of the existing bridge were constructed 1931 with the original structure. In 1976 the superstructure was replaced with an adjacent non-composite prestressed box beam. The existing bridge has 3 spans measuring approximately 50.20', 63.27' and 50.20'. The width of the existing bridge is approximately 28'-0" face to face of bridge railing. The existing bottom chord elevation is approximately 796.70. Pier 1 is historically prone to collecting significant amounts of debris on an annual basis due to gradual bend in the stream alignment upstream of the structure, requiring frequent maintenance to remove the debris from the pier.

The crossing of State Route 350 over Todd's Fork is within a Federal Emergency Management Agency (FEMA) regulated floodplain with a designated floodway, Zone AE, with established base flood elevations. The Flood Insurance Rate Map (FIRM) and portions of the FIS can be seen in Figure 2 and in Appendix B of this report.



FIGURE 2 - FEMA Floodplain

Bridge No. WAR-350-0873 carries the existing two-lane State Route 350 over Todd's Fork. WAR-350-0873 is a three-span prestressed concrete non-composite box beam superstructure, supported on reinforced concrete wall type piers and abutments with spread footings founded on bedrock. WAR-350-0873 is located approximately 1,150-ft east of the intersection of SR 350 and Old CCC Highway. Photos of the existing structure can be seen in Appendix E of this report.

Proposed Conditions - The project will replace the existing bridge carrying SR 350 over Todd's Fork with a single span steel girder superstructure supported on semi-integral wall type reinforced concrete abutments founded on drilled shafts. The existing horizontal alignment is a tangent alignment and the proposed horizontal alignment of SR 350 will match existing. The proposed vertical alignment of the approach pavement and at the bridge is adjusted and raised a maximum of 1.5' to account for the increased superstructure depth and to meet current design standards and to tie back into the alignment of the existing pavement. The

proposed bottom chord elevation will decrease from an elevation of approximately 796.98 to an elevation of 793.83. The proposed span of 167-1½” will retain the existing distance between the faces of the existing wall type abutments to optimize hydraulics and while minimizing girder depth. The proposed structure lowers the 10% AEP and 1% AEP water surface elevations.

WAR-350-8.73 has a functional classification of Rural Major Collector with a design year ADT of 2,300. The structure will carry two 11-ft travel lanes and 8-ft shoulders with a total width of 38'-0” face to face of the bridge railing, in accordance with the Scope of Services. The legal speed limit at the site is 55mph and the design speed is 60 mph. The proposed bridge uses wall type abutments piers founded on drilled shafts with rock sockets to support the reinforced concrete deck on steel girder superstructure. The bridge deck will have overside drainage utilizing the TST-2-21 bridge railing.

3.0 Hydraulic Analysis

The proposed crossing is in a Federal Emergency Management Agency (FEMA) regulated floodplain (Zone AE) and the requirements of the National Flood Insurance Program (NFIP) will apply. The existing conditions model is used for determining if proposed conditions result in an increase in water surface elevations. Per ODOT L&D Manual Volume 2 Section 1004.2 the design year frequency is the 10% AEP. The proposed design increases the waterway opening available under the structure for the conveyance of the peak flood discharge and will have no adverse impact on the 100-year water surface elevations. A temporary access fill (TAF) or pipe conveyance will likely be required, and the amount of conveyance to be provided (two times the maximum monthly mean flow) will be noted on the plans and in waterway permit determination documents.

Hydraulics for the structure have been calculated using HEC-RAS version 6.5. The crossing is within a FEMA floodplain that has a detailed study with base flood elevations. The limits of the study end at the downstream opening of the existing structure. The upstream portion of the stream is within a FEMA floodplain that does not have a detailed study with base flood elevations determined. The model was adjusted near the bridge to reflect the surveyed conditions.

A HEC-RAS analysis was performed on Todds Fork from 1765’ upstream of the S.R. 350 bridge to 405’ downstream of the bridge. To perform the analysis, a topographic survey was performed in the area, and for areas outside of the topographic survey, Ohio Geographically Referenced Information Program (OGRIP) contours were used. The topographic survey obtained elevation data at the bottom of the existing beams, the top of the existing bridge deck and roadway characteristics in the vicinity of Todds Fork. The topographic survey also obtained elevation data of the stream bottom, banks and overbanks upstream and downstream of the structure along the entire study limits. The flow discharges for the 1% AEP, 2% AEP, & 10% AEP events, as listed in the FIS, were used in the analysis. The design discharge for the 4% AEP event are not included in the FIS. Logarithmic regression utilizing the flows provided in the FIS was used to calculate the design flow required for the 4% AEP event. The drainage area to the bridge location is approximately 148 square miles. The peak discharges used in the model are summarized below in Table 1.

Table 1: Model Flows

Storm	Flow (cfs)	
10% AEP	16,050	Design Flood
1% AEP	23,930	Check Flood
4 % AEP	19,228	Scour Design Flood
2 % AEP	21,700	Scour Check Flood

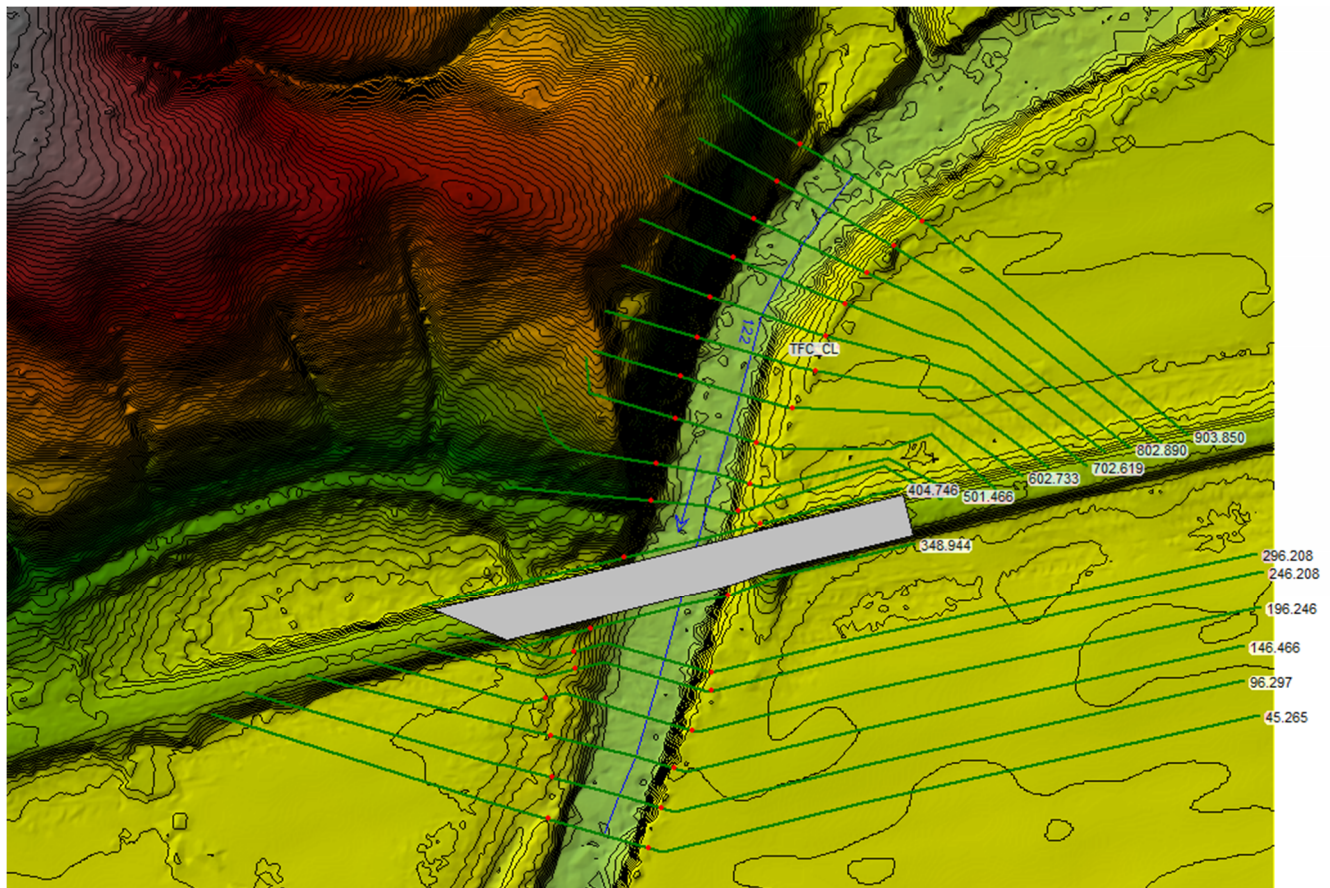


FIGURE 3 - Hydraulic Cross Sections Layout

The modeled n-coefficients for the channel and overbanks are based on the range of roughness coefficients provided in Table 14 of the FIS. Field analysis from visiting the site and the use of the n-coefficients taken from Table 3-1 of the HEC-RAS User’s Manual was used to refine the ranges provided in the FIS. The main channel was given a 0.040 as the channel bottom within the study limits contained stones, vegetation and pools. The main channel banks are lined with a single tree line with some low laying branches. The overbanks upstream and downstream along the east bank of the creek are lined with a single line of trees with some low laying branches before opening up to farm fields on the overbanks. A value of 0.040 was used for the east overbank upstream and downstream of the structure. The west overbank upstream and downstream of the structure is primarily lined with a heavy stand of trees and therefore was given a 0.07 n value.

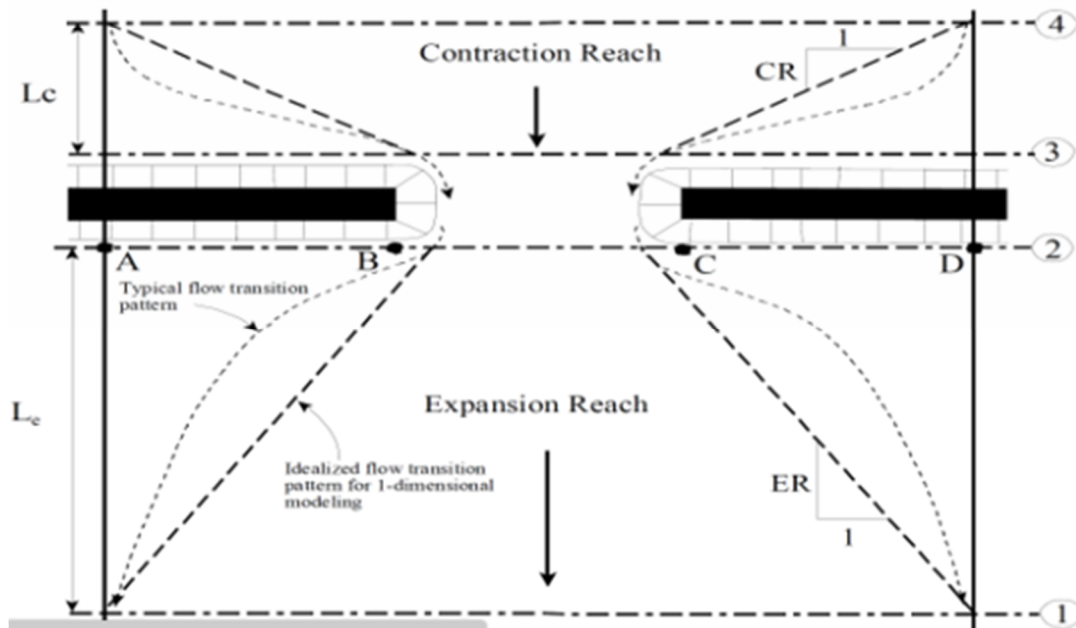
The internal bridge cross sections were modeled using an n-coefficient value of 0.011 for the portion of the wetted perimeter in contact with the face of the concrete abutment during peak flow conditions. The main channel directly under the bridge was given a 0.035 based on close observation.

Losses due to contraction and expansion of flow at the bridge were determined using the recommendations provided in the study completed by the Hydrologic Engineering Center entitled "Flow Transitions in Bridge Backwater Analysis" (HEC, 1995).

$$C_e = -0.09 + (0.57 * (D_{ob}/D_c)) + (0.075 * (F_{c2}/F_{c1})) = 0.182245$$

D_{ob} (ft) = 4.704947 Flow Area = 4388.68 Top Width = 932.78
 D_c (ft) = 15.41 Min Ch Elev 778.5 W.S. Elev. 793.91
 F_{c1} (ft) = 0.42
 F_{c2} (ft) = 0.55

Notation	Description
D_{ob}	hydraulic depth (flow area divided by top width) for the overbank at the fully-expanded flow section (Section 1)
D_c	hydraulic depth for the main channel at the fully-expanded flow section
F_{c1}	main channel Froude number at Section 1
F_{c2}	main channel Froude number at Section 2



The regression equation yielded a result of 0.18 for the expansion coefficient. 0.20 was used in the analysis. A contraction coefficient of 0.30 was used as provided in *Table 5-2 Subcritical Flow Contraction and Expansion Coefficients* of the HEC-RAS Hydraulic Reference Manual.

4.0 Flood Hazard Evaluation

The Flood Insurance Rate Map (FIRM) indicates that most inhabitable structures are outside of the floodplain limits with most of the mapped area in cultivated fields. The hydraulic modeling of the proposed conditions indicates that the modifications associated with the structure replacement will not have an adverse effect on the regulatory water surface elevations within the study area.

5.0 Scour Evaluation

Scour analysis has been completed based upon soil classifications provided by the subsurface exploration. The scour analysis was completed for the 50-year check storm as required per ODOT L&D 1008.10. The minimum total scour will extend to the top of rock at both the abutment locations. The lateral analysis of the drilled shafts does not include any soil in the models. The proposed abutments will be supported on drilled shafts socketed into bedrock and will be protected with Type B Rock Channel Protection (RCP) which is a sufficient scour countermeasure. Per Location and Design manual Volume 2, 1107.3, 2.5' thick, Type B (RCP) is to be used for a bridge channel mean velocity of 8 to 10 ft/second. Per the HECRAS program output, maximum channel velocity for the 25 year design flood at the project location is approximately 9.6 ft/s.

6.0 Summary of Results

Table 2: 10-Year Water Surface Elevations

Cross Section	Existing Conditions Water Surface Elevation	Proposed Conditions Water Surface Elevation	Difference Between Existing and Proposed
9+04	795.04	794.93	-0.11
8+53	794.87	794.75	-0.12
8+03	794.71	794.57	-0.14
7+53	794.58	794.43	-0.15
7+03	794.40	794.23	-0.17
6+53	794.19	793.98	-0.21
6+03	794.00	793.74	-0.26
5+52	793.56	793.09	-0.47
5+01	793.49	793.22	-0.27
4+52	792.31	792.34	0.03
4+05	792.86	792.69	-0.17
3+74 [BRIDGE]			
3+49	792.66	792.66	0
2+96	792.97	792.96	-0.01
2+46	792.87	792.86	-0.01
1+96	792.70	792.69	-0.01
1+46	791.79	792.01	0.22
0+96	791.65	791.55	-0.1
0+45	791.69	791.69	0

Table 3: 100-Year Water Surface Elevations

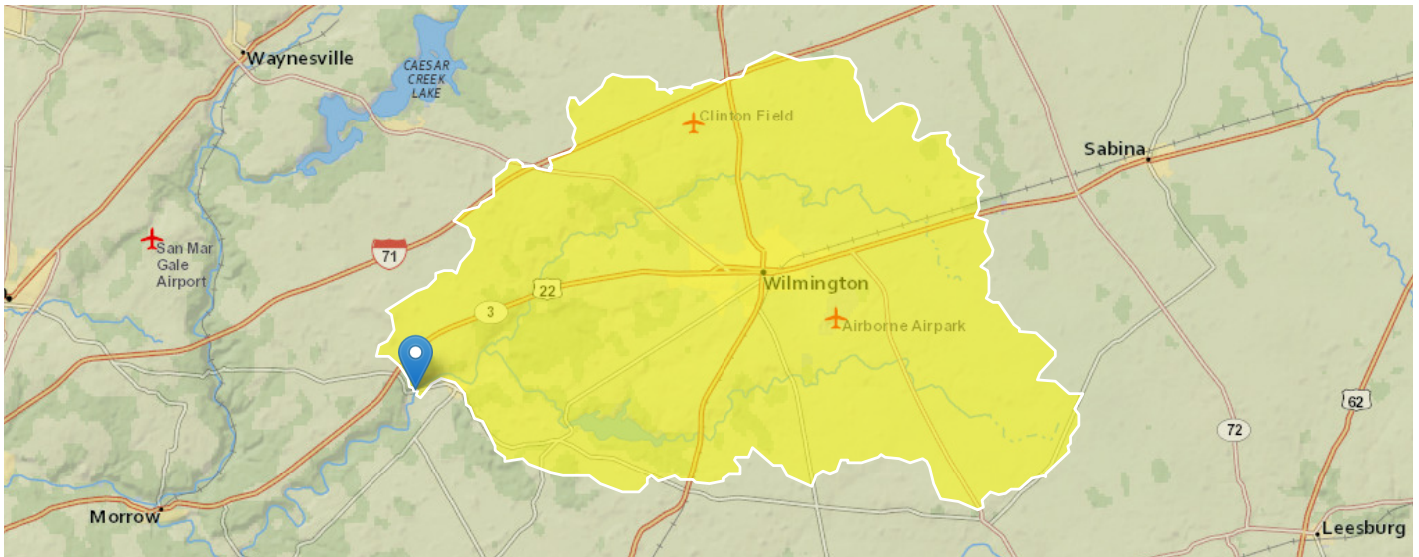
Cross Section	Existing Conditions Water Surface Elevation	Proposed Conditions Water Surface Elevation	Elevation
9+04	796.87	796.74	-0.13
8+53	796.71	796.57	-0.14
8+03	796.55	796.39	-0.16
7+53	796.42	796.25	-0.17
7+03	796.24	796.05	-0.19
6+53	796.01	795.8	-0.21
6+03	795.77	795.52	-0.25
5+52	795.33	794.97	-0.36
5+01	795.14	794.95	-0.19
4+52	793.97	793.27	-0.7
4+05	794.41	793.73	-0.68
3+74 [BRIDGE]			
3+49	792.95	792.95	0
2+96	793.91	793.91	0
2+46	793.84	793.84	0
1+96	793.68	793.68	0
1+46	792.78	792.78	0
0+96	792.63	792.63	0
0+45	792.73	792.73	0

7.0 Conclusion

This project will have minimal impact to the floodplain as determined by modeling in HEC-RAS does not cause inundation of the roadway. The roadway is of moderate risk as a minor local road with ADT < 2,000, however if fully inundated during large storm events the proposed structures will be structurally sound due to deep shaft foundations. Scour has been assessed and channel armoring with RCP is included in the design.

StreamStats Report

Region ID: OH
Workspace ID: OH20230822132721519000
Clicked Point (Latitude, Longitude): 39.40002, -84.00123
Time: 2023-08-22 09:27:46 -0400



[+ Collapse All](#)

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CSL1085LFP	Change in elevation divided by length between points 10 and 85 percent of distance along the longest flow path to the basin divide, LFP from 2D grid	12.2	feet per mi
DRNAREA	Area that drains to a point on a stream	146	square miles
FOREST	Percentage of area covered by forest	13.6	percent
LAT_CENT	Latitude of Basin Centroid	39.4364	decimal degrees
LC92STOR	Percentage of water bodies and wetlands determined from the NLCD	1.12	percent
OHREGA	Ohio Region A Indicator	0	dimensionless
OHREGC	Ohio Region C Indicator	1	dimensionless
PRECIPCENT	Mean Annual Precip at Basin Centroid	43.3	inches
STREAM_VARG	Streamflow variability index as defined in WRIR 02-4068, computed from regional grid	0.58	dimensionless

Peak-Flow Statistics

Peak-Flow Statistics Parameters [100.0 Percent (146 square miles) Peak Flow Full Model Reg C SIR2019 5018]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	146	square miles	0.26	2514
OHREGC	Ohio Region C Indicator 1 if in C else 0	1	dimensionless	0	1
OHREGA	Ohio Region A Indicator 1 if in A else 0	0	dimensionless	0	1
CSL1085LFP	Stream Slope 10 and 85 Longest Flow Path	12.2	feet per mi	3.24	131

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
LC92STOR	Percent Storage from NLCD1992	1.12	percent	0	1.23

Peak-Flow Statistics Flow Report [100.0 Percent (146 square miles) Peak Flow Full Model Reg C SIR2019 5018]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	ASEp
50-percent AEP flood	6580	ft ³ /s	3410	12700	40.1
20-percent AEP flood	9740	ft ³ /s	5290	17900	37.2
10-percent AEP flood	12000	ft ³ /s	6470	22200	37.6
4-percent AEP flood	15100	ft ³ /s	8090	28200	38.1
2-percent AEP flood	17500	ft ³ /s	9280	33000	37.8
1-percent AEP flood	20000	ft ³ /s	10500	38100	39.6
0.2-percent AEP flood	26300	ft ³ /s	13700	50600	40.3

Peak-Flow Statistics Citations

Koltun, G.F., 2019, Flood-frequency estimates for Ohio streamgages based on data through water year 2015 and techniques for estimating flood-frequency characteristics of rural, unregulated Ohio streams: U.S. Geological Survey Scientific Investigations Report 2019-5018, 25 p. (<https://dx.doi.org/10.3133/sir20195018>)

› Monthly Flow Statistics

Monthly Flow Statistics Parameters [Low Flow LatLE 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	146	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	1.12	percent	0	19
PRECIPCENT	Mean Annual Precip at Basin Centroid	43.3	inches	34	43.2
FOREST	Percent Forest	13.6	percent	0	99.1
LAT_CENT	Latitude of Basin Centroid	39.4364	decimal degrees	38.68	41.2
STREAM_VARG	Streamflow Variability Index from Grid	0.58	dimensionless	0.25	1.13

Monthly Flow Statistics Disclaimers [Low Flow LatLE 41.2 wri02 4068]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Monthly Flow Statistics Flow Report [Low Flow LatLE 41.2 wri02 4068]

Statistic	Value	Unit
January Mean Flow	276	ft ³ /s
February Mean Flow	291	ft ³ /s
March Mean Flow	337	ft ³ /s
April Mean Flow	294	ft ³ /s
May Mean Flow	198	ft ³ /s
June Mean Flow	121	ft ³ /s
July Mean Flow	68	ft ³ /s
August Mean Flow	68	ft ³ /s
September Mean Flow	43.9	ft ³ /s
October Mean Flow	33.6	ft ³ /s

Statistic	Value	Unit
November Mean Flow	95.1	ft ³ /s
December Mean Flow	177	ft ³ /s

Monthly Flow Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p
(<https://pubs.er.usgs.gov/publication/wri024068>)

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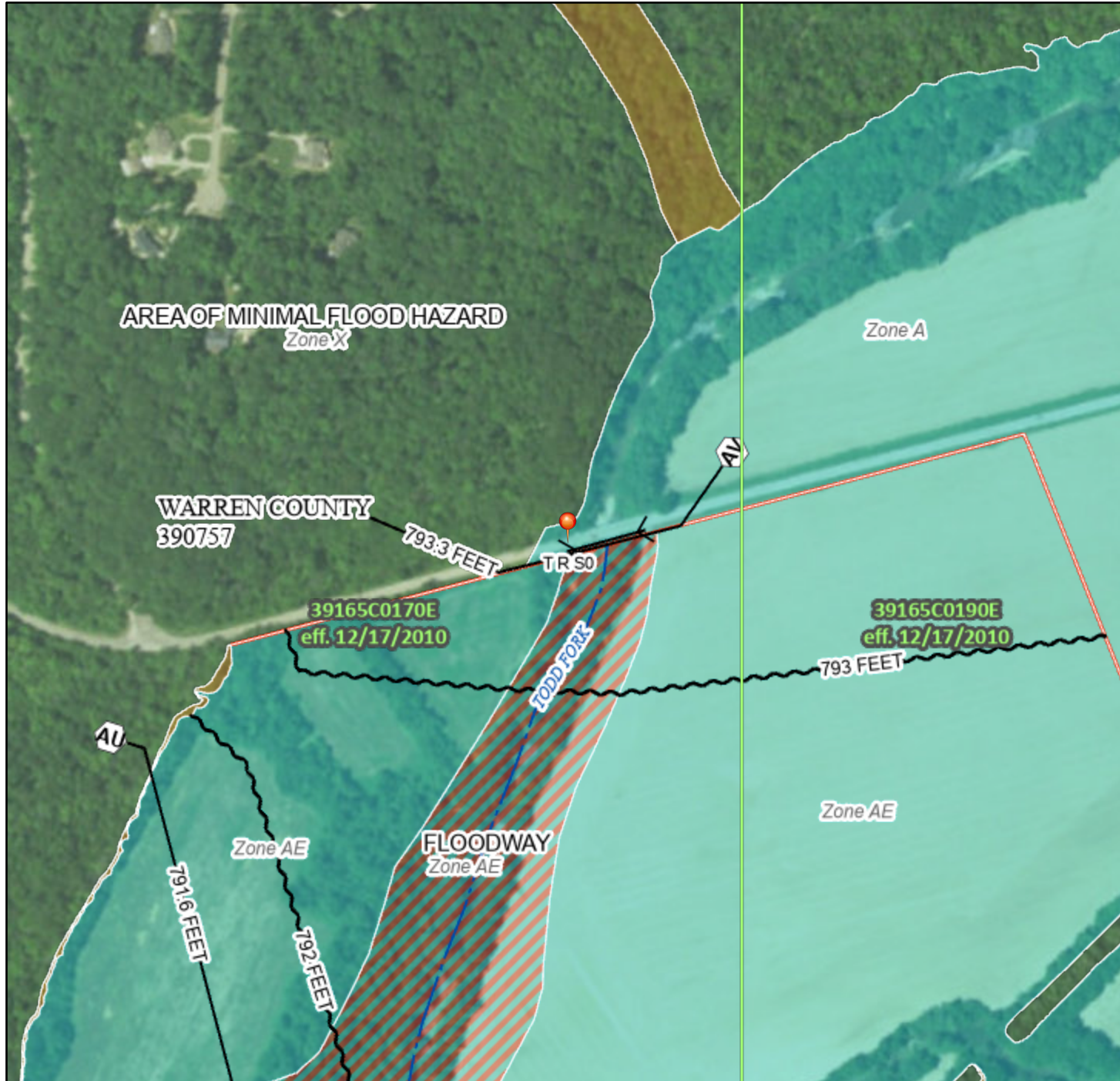
USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.16.1
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

National Flood Hazard Layer FIRMMette



84°0'25"W 39°24'14"N



Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X

OTHER AREAS OF FLOOD HAZARD		Area with Flood Risk due to Levee Zone D
		NO SCREEN Area of Minimal Flood Hazard Zone X

OTHER AREAS		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall

OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Base Flood Elevation Line (BFE)
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary

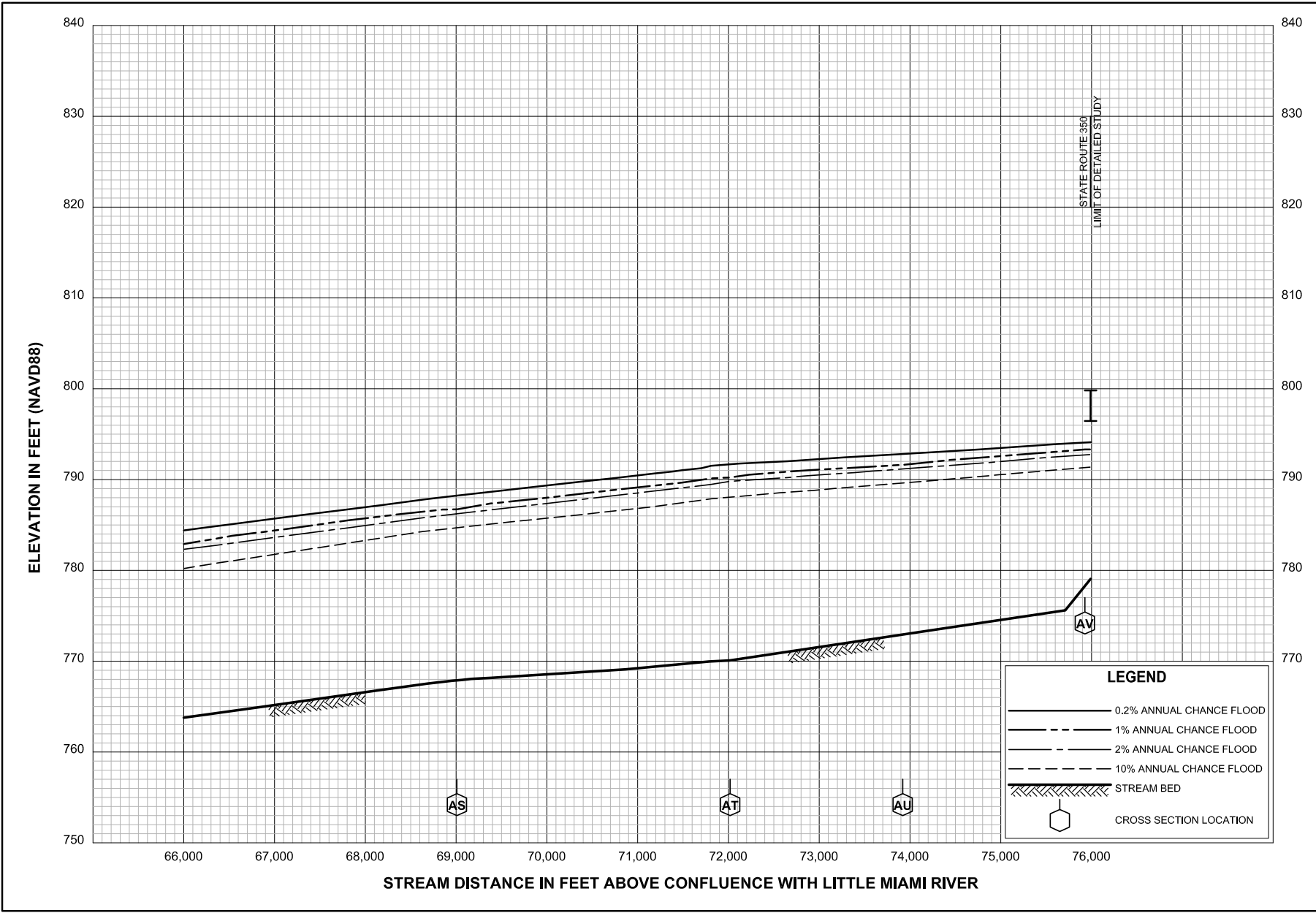
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/11/2022 at 12:19 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



FLOOD PROFILES

TODD FORK

FEDERAL EMERGENCY MANAGEMENT AGENCY

WARREN COUNTY, OH
AND INCORPORATED AREAS

HEC-RAS Plan: Existing Conditions River: 122 Reach: TFC_CL

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
TFC_CL	903.850	100yr	20000.00	780.56	796.05		796.60	0.001360	6.80	3786.47	595.37	0.36
TFC_CL	903.850	10yr	12000.00	780.56	793.98		794.45	0.001370	6.01	2565.09	577.82	0.35
TFC_CL	853.288	100yr	20000.00	780.43	795.90		796.54	0.001627	7.36	3512.40	563.25	0.39
TFC_CL	853.288	10yr	12000.00	780.43	793.81		794.37	0.001630	6.56	2361.02	532.77	0.38
TFC_CL	802.890	100yr	20000.00	780.58	795.74		796.45	0.001789	7.75	3348.73	538.87	0.41
TFC_CL	802.890	10yr	12000.00	780.58	793.66		794.28	0.001870	6.92	2239.76	526.54	0.40
TFC_CL	752.658	100yr	20000.00	780.56	795.62		796.36	0.001915	7.96	3242.19	515.65	0.42
TFC_CL	752.658	10yr	12000.00	780.56	793.53		794.19	0.002023	7.13	2174.07	507.06	0.42
TFC_CL	702.619	100yr	20000.00	780.64	795.45		796.27	0.002166	8.30	3076.44	493.76	0.44
TFC_CL	702.619	10yr	12000.00	780.64	793.36		794.08	0.002311	7.44	2057.06	482.11	0.44
TFC_CL	653.391	100yr	20000.00	780.39	795.25		796.16	0.002500	8.71	2887.07	463.29	0.47
TFC_CL	653.391	10yr	12000.00	780.39	793.17		793.96	0.002686	7.79	1935.83	452.21	0.47
TFC_CL	602.733	100yr	20000.00	780.43	795.04		796.05	0.002602	9.08	2757.97	431.14	0.48
TFC_CL	602.733	10yr	12000.00	780.43	793.02		793.85	0.002567	7.89	1896.86	421.40	0.47
TFC_CL	552.074	100yr	20000.00	780.41	794.65		795.91	0.002860	10.45	2574.04	407.90	0.52
TFC_CL	552.074	10yr	12000.00	780.41	792.67		793.71	0.002666	8.99	1777.75	397.15	0.49
TFC_CL	501.466	100yr	20000.00	780.30	794.54		795.79	0.002904	10.11	2485.96	363.01	0.52
TFC_CL	501.466	10yr	12000.00	780.30	792.65		793.56	0.002410	8.32	1808.52	351.93	0.46
TFC_CL	451.575	100yr	20000.00	780.74	793.88		795.61	0.004098	11.88	2168.48	352.77	0.62
TFC_CL	451.575	10yr	12000.00	780.74	792.14		793.40	0.003412	9.71	1564.10	342.86	0.55
TFC_CL	404.746	100yr	20000.00	779.00	794.16	789.83	795.30	0.002175	8.95	2660.52	538.51	0.46
TFC_CL	404.746	10yr	12000.00	779.00	792.45	786.74	793.12	0.001483	6.67	1984.35	395.54	0.37
TFC_CL	374.006		Bridge									
TFC_CL	348.944	100yr	20000.00	779.00	793.20		794.55	0.002399	9.44	2322.42	420.24	0.48
TFC_CL	348.944	10yr	12000.00	779.00	792.26		792.86	0.001179	6.27	2001.99	402.98	0.33

HEC-RAS Plan: Existing Conditions River: 122 Reach: TFC_CL (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
TFC_CL	296.208	100yr	20000.00	778.50	793.48		794.08	0.001649	7.24	3988.69	919.66	0.39
TFC_CL	296.208	10yr	12000.00	778.50	792.28		792.71	0.001238	5.80	2915.79	879.44	0.33
TFC_CL	246.208	100yr	20000.00	778.00	793.40		794.01	0.001748	7.39	4072.92	1000.74	0.40
TFC_CL	246.208	10yr	12000.00	778.00	792.17		792.65	0.001414	6.12	2844.16	993.74	0.35
TFC_CL	196.246	100yr	20000.00	777.50	793.23		793.92	0.002014	7.67	3901.28	1066.05	0.42
TFC_CL	196.246	10yr	12000.00	777.50	792.00		792.57	0.001681	6.42	2590.38	1060.97	0.38
TFC_CL	146.466	100yr	20000.00	777.00	792.70		793.78	0.002946	9.44	3321.91	1114.20	0.51
TFC_CL	146.466	10yr	12000.00	777.00	791.55	787.02	792.44	0.002361	7.82	2045.81	1099.98	0.45
TFC_CL	96.297	100yr	20000.00	776.50	792.68		793.64	0.002441	9.10	3650.53	1183.31	0.47
TFC_CL	96.297	10yr	12000.00	776.50	791.50	786.38	792.32	0.001972	7.61	2263.46	1168.52	0.42
TFC_CL	45.265	100yr	20000.00	776.00	792.79	792.00	793.46	0.002002	8.16	4316.80	1281.75	0.43
TFC_CL	45.265	10yr	12000.00	776.00	791.48	787.06	792.19	0.002001	7.52	2636.31	1272.06	0.42

WAR-350-0873 Proposed Conditions

HEC-RAS Plan: Plan 27 River: 122 Reach: TFC_CL

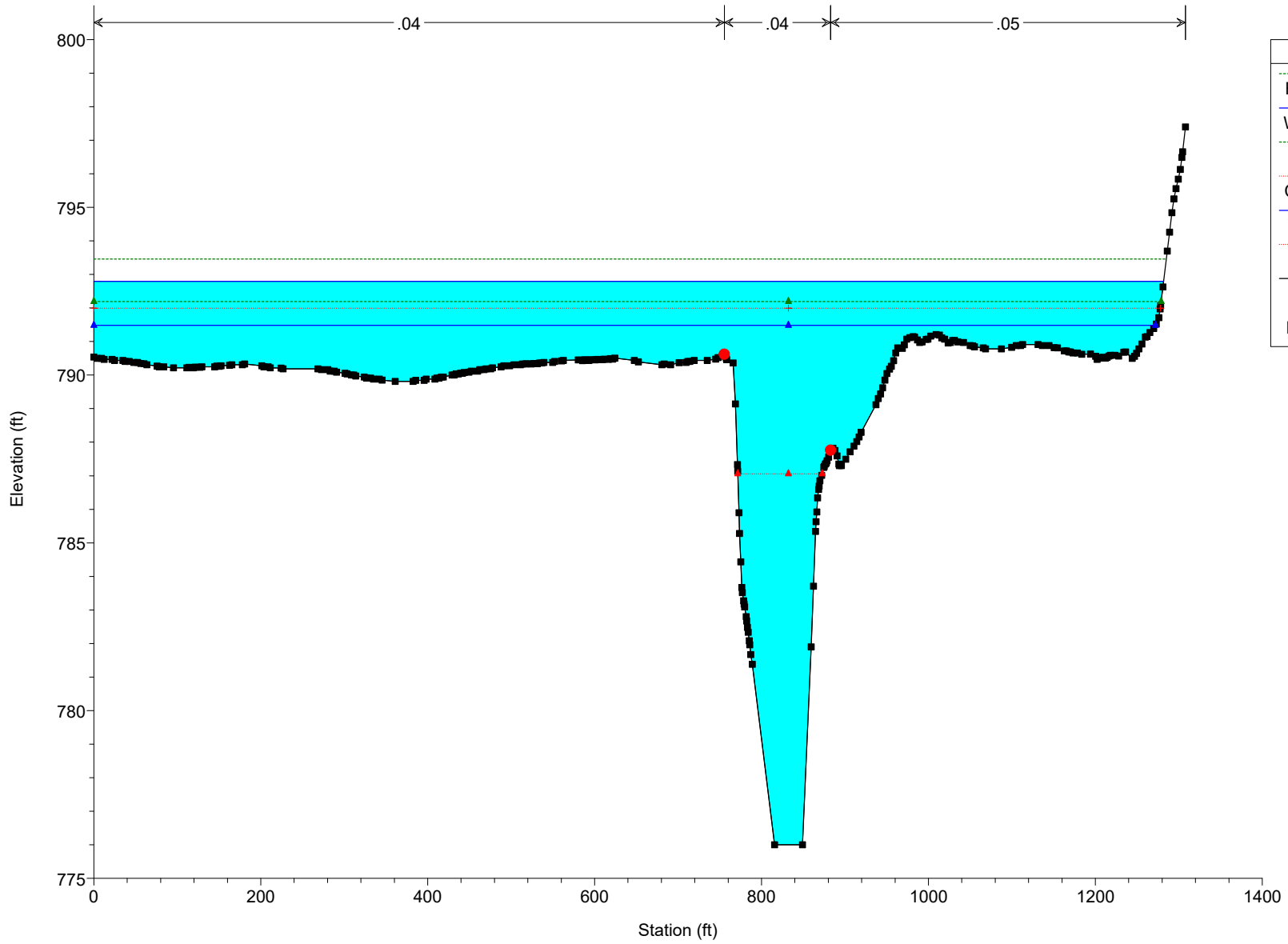
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
TFC_CL	903.850	100yr	23930.00	780.56	796.74		797.37	0.001446	7.29	4196.65	596.99	0.37
TFC_CL	903.850	10yr	16050.00	780.56	794.93		795.48	0.001489	6.63	3124.30	587.02	0.37
TFC_CL	853.288	100yr	23930.00	780.43	796.57		797.29	0.001738	7.91	3892.10	568.59	0.40
TFC_CL	853.288	10yr	16050.00	780.43	794.75		795.40	0.001825	7.26	2873.37	555.09	0.40
TFC_CL	802.890	100yr	23930.00	780.58	796.39		797.20	0.001922	8.34	3701.31	541.19	0.42
TFC_CL	802.890	10yr	16050.00	780.58	794.57		795.30	0.002026	7.67	2725.08	531.50	0.42
TFC_CL	752.658	100yr	23930.00	780.56	796.25		797.11	0.002077	8.60	3566.92	516.45	0.44
TFC_CL	752.658	10yr	16050.00	780.56	794.43		795.20	0.002205	7.92	2631.28	511.23	0.44
TFC_CL	702.619	100yr	23930.00	780.64	796.05		797.00	0.002377	9.01	3373.16	497.02	0.47
TFC_CL	702.619	10yr	16050.00	780.64	794.23		795.09	0.002552	8.32	2476.74	487.49	0.47
TFC_CL	653.391	100yr	23930.00	780.39	795.80		796.88	0.002797	9.53	3143.46	466.40	0.51
TFC_CL	653.391	10yr	16050.00	780.39	793.98		794.95	0.003030	8.80	2304.70	456.44	0.51
TFC_CL	602.733	100yr	23930.00	780.43	795.52		796.75	0.003018	10.07	2968.03	433.81	0.53
TFC_CL	602.733	10yr	16050.00	780.43	793.74		794.81	0.003128	9.15	2201.95	424.75	0.52
TFC_CL	552.074	100yr	23930.00	780.41	794.97		796.58	0.003574	11.88	2704.33	409.49	0.59
TFC_CL	552.074	10yr	16050.00	780.41	793.09		794.62	0.003843	11.07	1943.71	399.87	0.59
TFC_CL	501.466	100yr	23930.00	778.73	794.95		796.41	0.002866	10.85	2774.34	364.82	0.52
TFC_CL	501.466	10yr	16050.00	778.73	793.22		794.37	0.002530	9.38	2147.90	355.66	0.48
TFC_CL	451.575	100yr	23930.00	779.25	793.27	793.27	796.10	0.006195	14.86	2064.01	349.36	0.76
TFC_CL	451.575	10yr	16050.00	779.25	792.34		794.16	0.004229	11.63	1742.40	344.05	0.62
TFC_CL	404.746	100yr	23930.00	779.00	793.73	790.91	795.58	0.003640	11.30	2480.30	516.92	0.59
TFC_CL	404.746	10yr	16050.00	779.00	792.69	788.51	793.80	0.002421	8.65	2069.73	422.18	0.47
TFC_CL	374.006		Bridge									
TFC_CL	348.944	100yr	23930.00	779.00	792.95		795.00	0.003743	11.62	2234.53	419.24	0.60
TFC_CL	348.944	10yr	16050.00	779.00	792.66		793.65	0.001856	8.05	2136.09	418.13	0.42

HEC-RAS Plan: Plan 27 River: 122 Reach: TFC_CL (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
TFC_CL	296.208	100yr	23930.00	778.50	793.91		794.60	0.001853	7.88	4388.68	932.78	0.42
TFC_CL	296.208	10yr	16050.00	778.50	792.96		793.47	0.001443	6.56	3517.94	898.24	0.36
TFC_CL	246.208	100yr	23930.00	778.00	793.84		794.52	0.001920	7.96	4518.10	1002.23	0.42
TFC_CL	246.208	10yr	16050.00	778.00	792.86		793.40	0.001581	6.79	3536.99	998.59	0.38
TFC_CL	196.246	100yr	23930.00	777.50	793.68		794.43	0.002178	8.21	4378.47	1067.45	0.45
TFC_CL	196.246	10yr	16050.00	777.50	792.69		793.32	0.001856	7.10	3326.00	1064.18	0.40
TFC_CL	146.466	100yr	23930.00	777.00	792.78	792.78	794.25	0.004003	11.05	3406.59	1114.51	0.60
TFC_CL	146.466	10yr	16050.00	777.00	792.01	788.69	793.16	0.003086	9.23	2550.54	1110.98	0.52
TFC_CL	96.297	100yr	23930.00	776.50	792.63	792.63	794.05	0.003615	11.04	3591.24	1182.97	0.57
TFC_CL	96.297	10yr	16050.00	776.50	791.55	788.26	792.97	0.003440	10.09	2321.94	1175.49	0.55
TFC_CL	45.265	100yr	23930.00	776.00	792.73	792.39	793.73	0.003004	9.96	4233.18	1281.43	0.52
TFC_CL	45.265	10yr	16050.00	776.00	791.69	789.26	792.75	0.003005	9.35	2910.28	1275.80	0.51

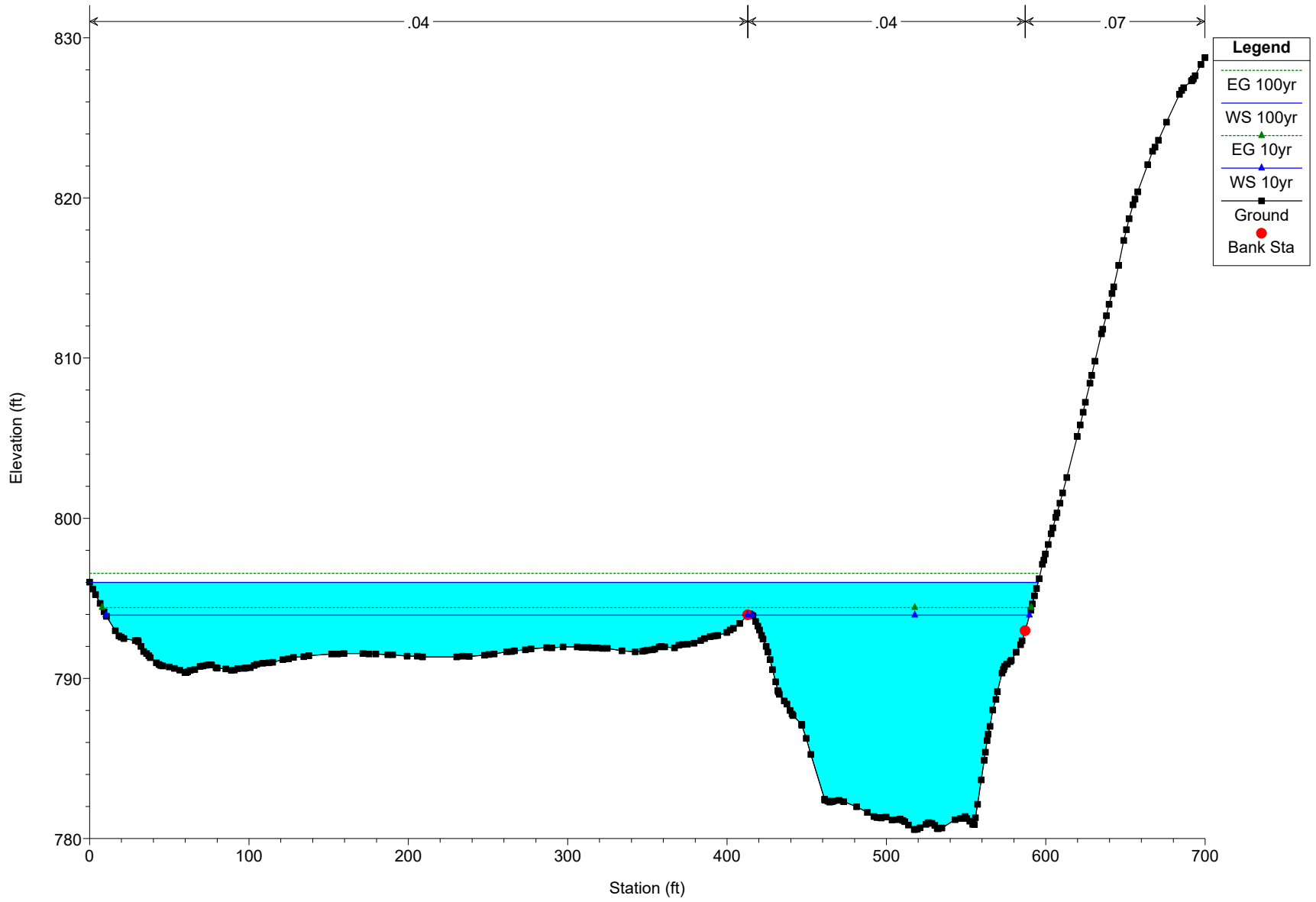
PROPOSED CONDITIONS CROSS SECTIONS

WAR350 Plan: Proposed Conditions 4/12/2024

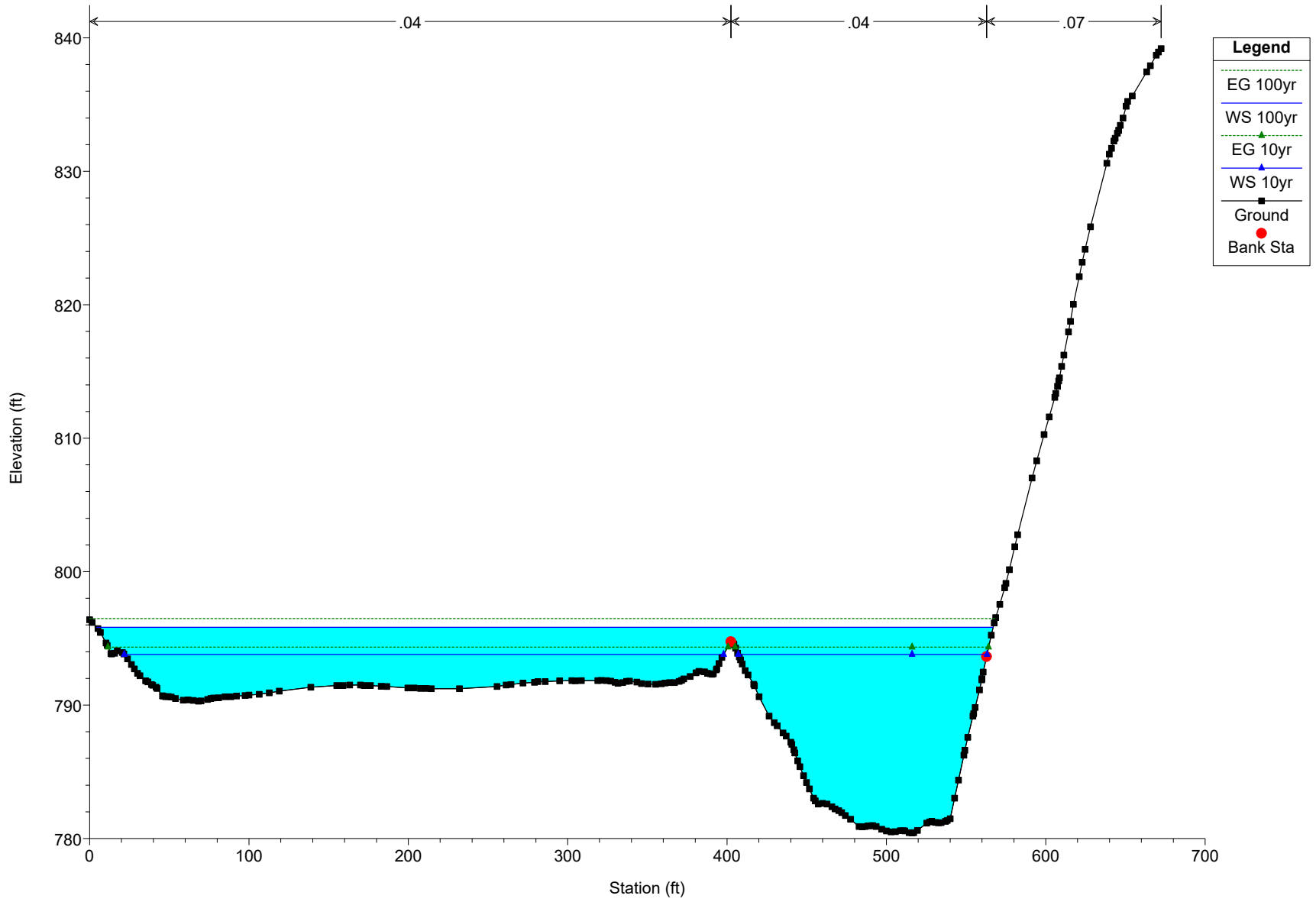


Legend

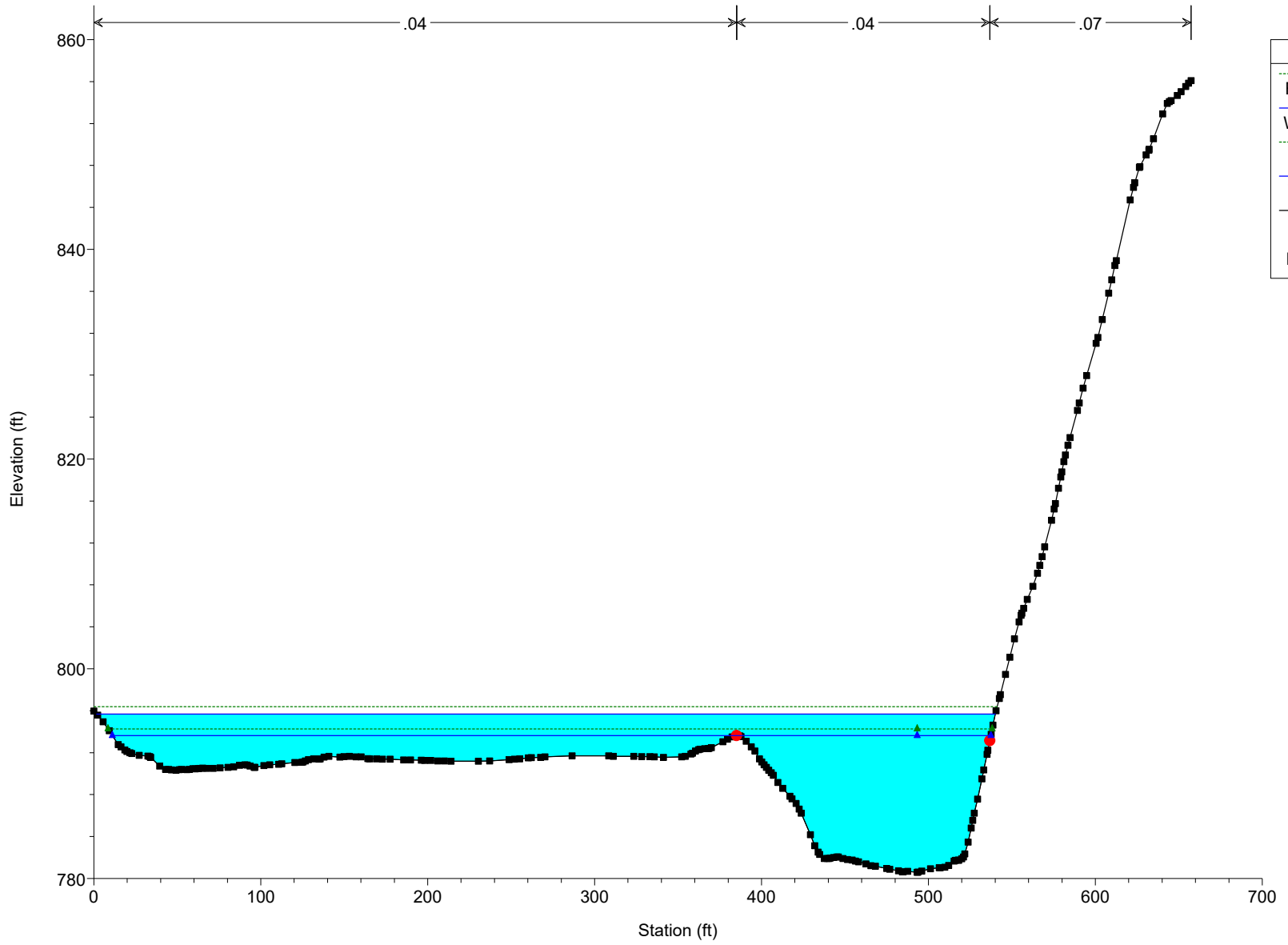
- EG 100yr
- WS 100yr
- EG 10yr
- Crit 100yr
- WS 10yr
- Crit 10yr
- Ground
- Bank Sta



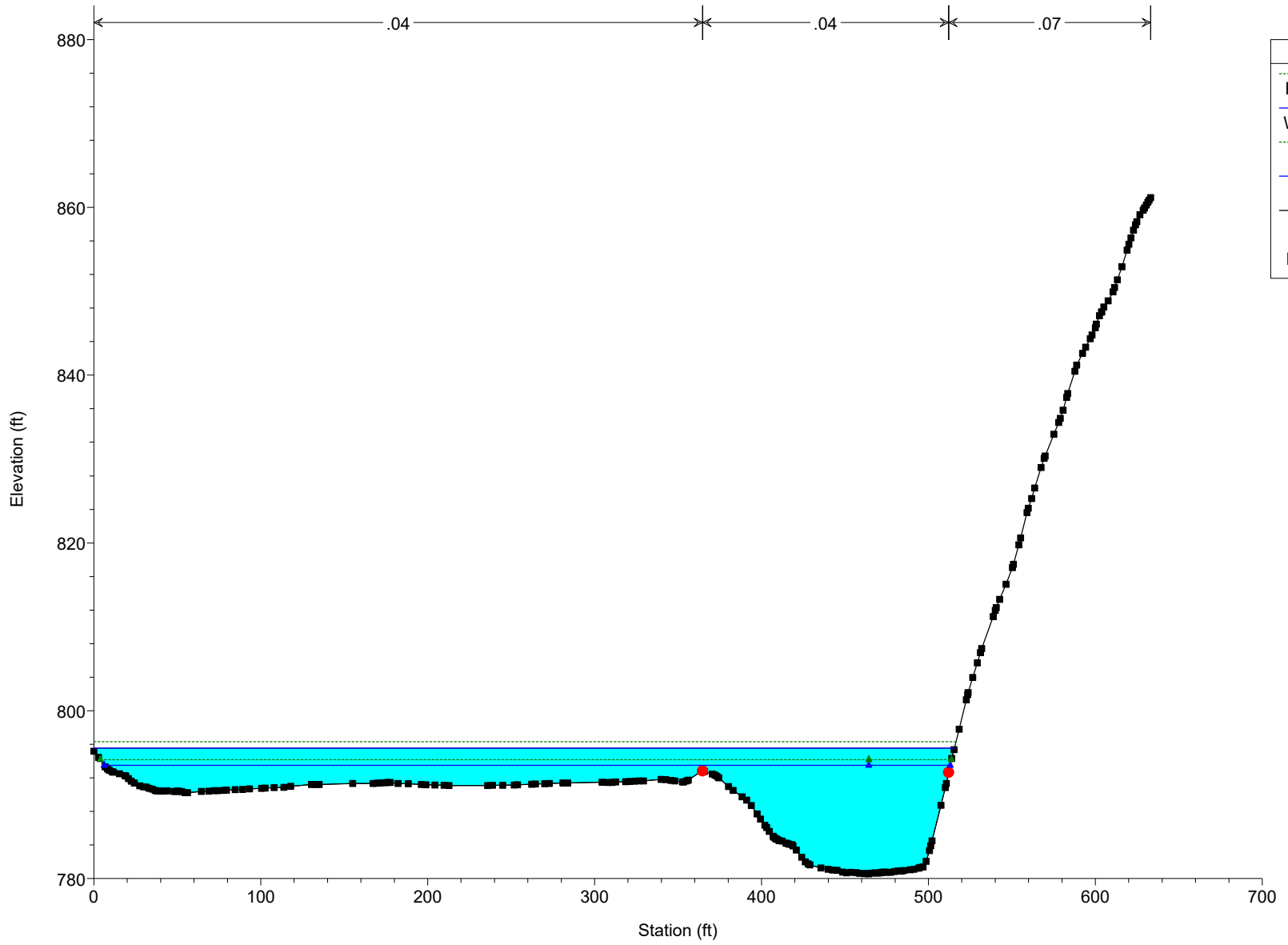
WAR350 Plan: Proposed Conditions 4/12/2024



WAR350 Plan: Proposed Conditions 4/12/2024



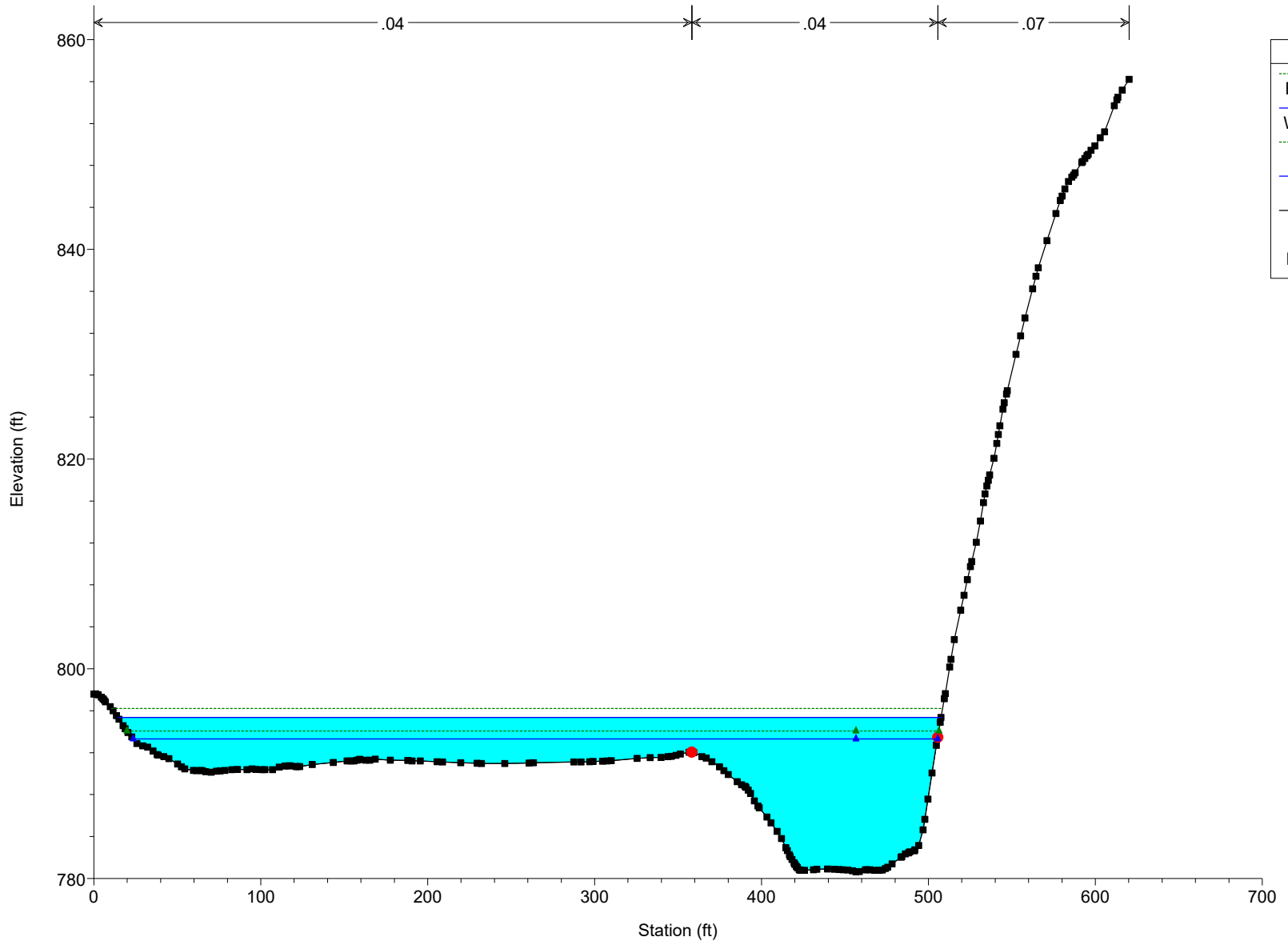
WAR350 Plan: Proposed Conditions 4/12/2024



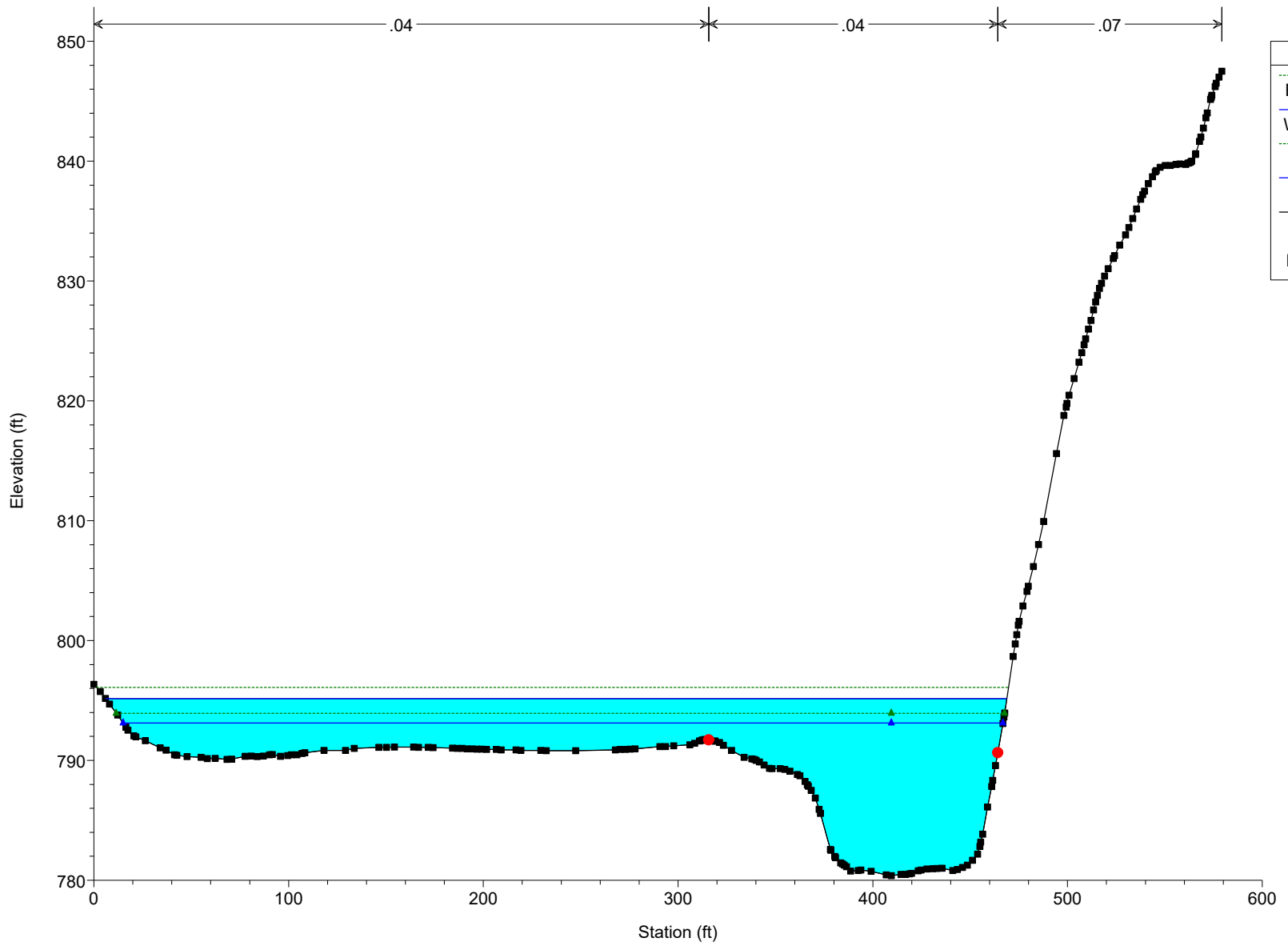
Legend

- EG 100yr
- WS 100yr
- EG 10yr
- WS 10yr
- Ground
- Bank Sta

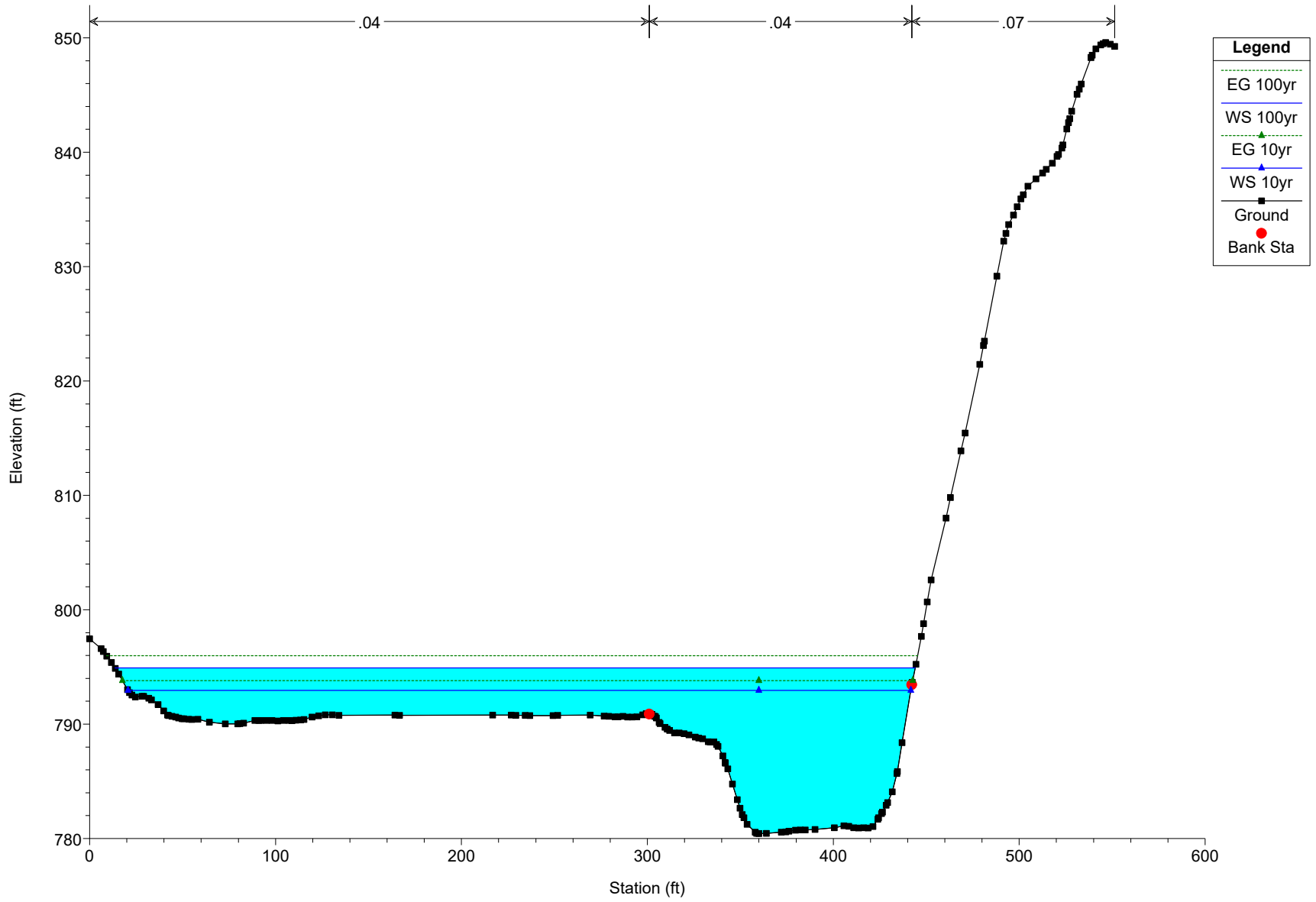
WAR350 Plan: Proposed Conditions 4/12/2024



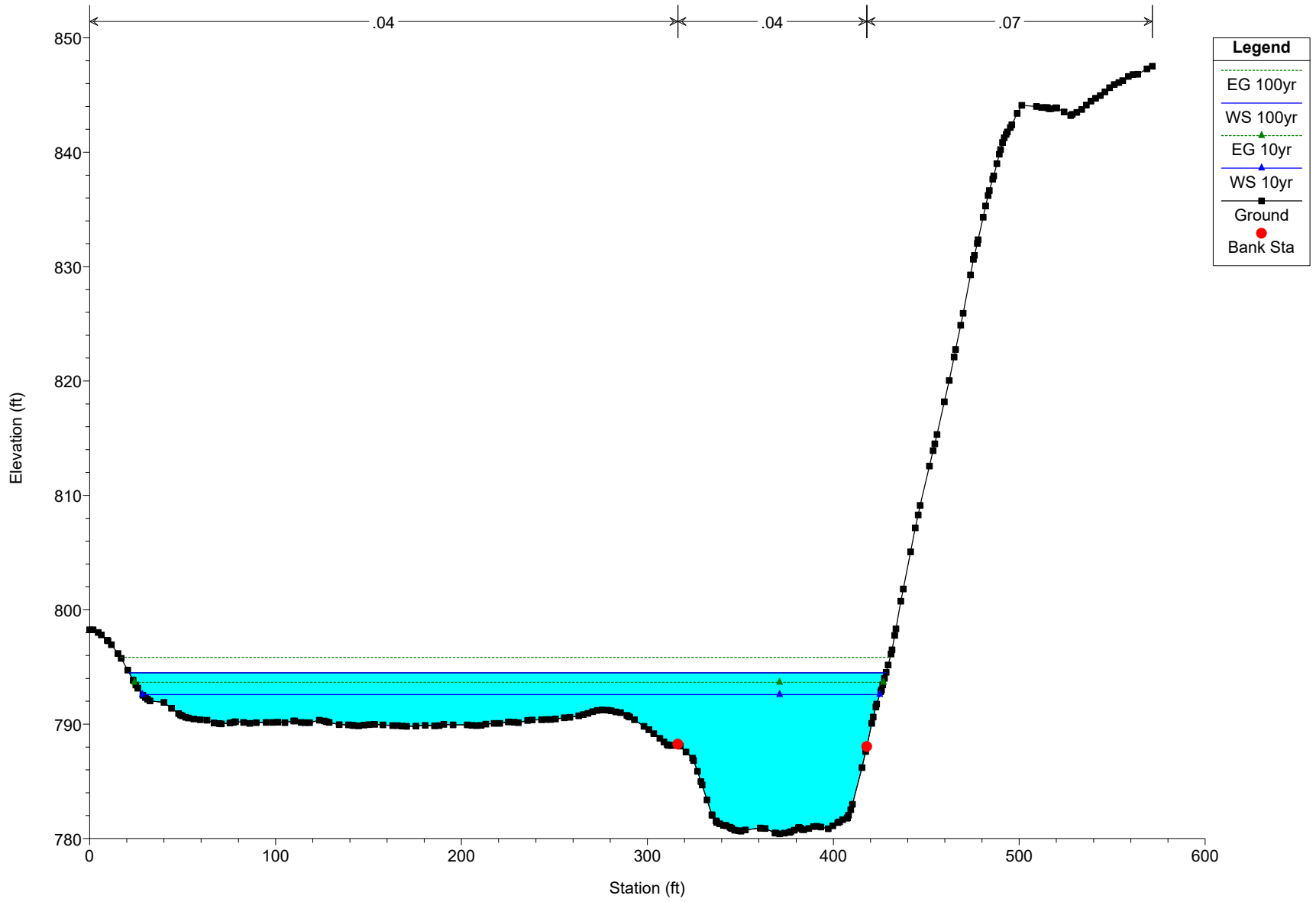
Legend	
EG 100yr	---
WS 100yr	—
EG 10yr	---▲---
WS 10yr	—▲—
Ground	—■—
Bank Sta	●



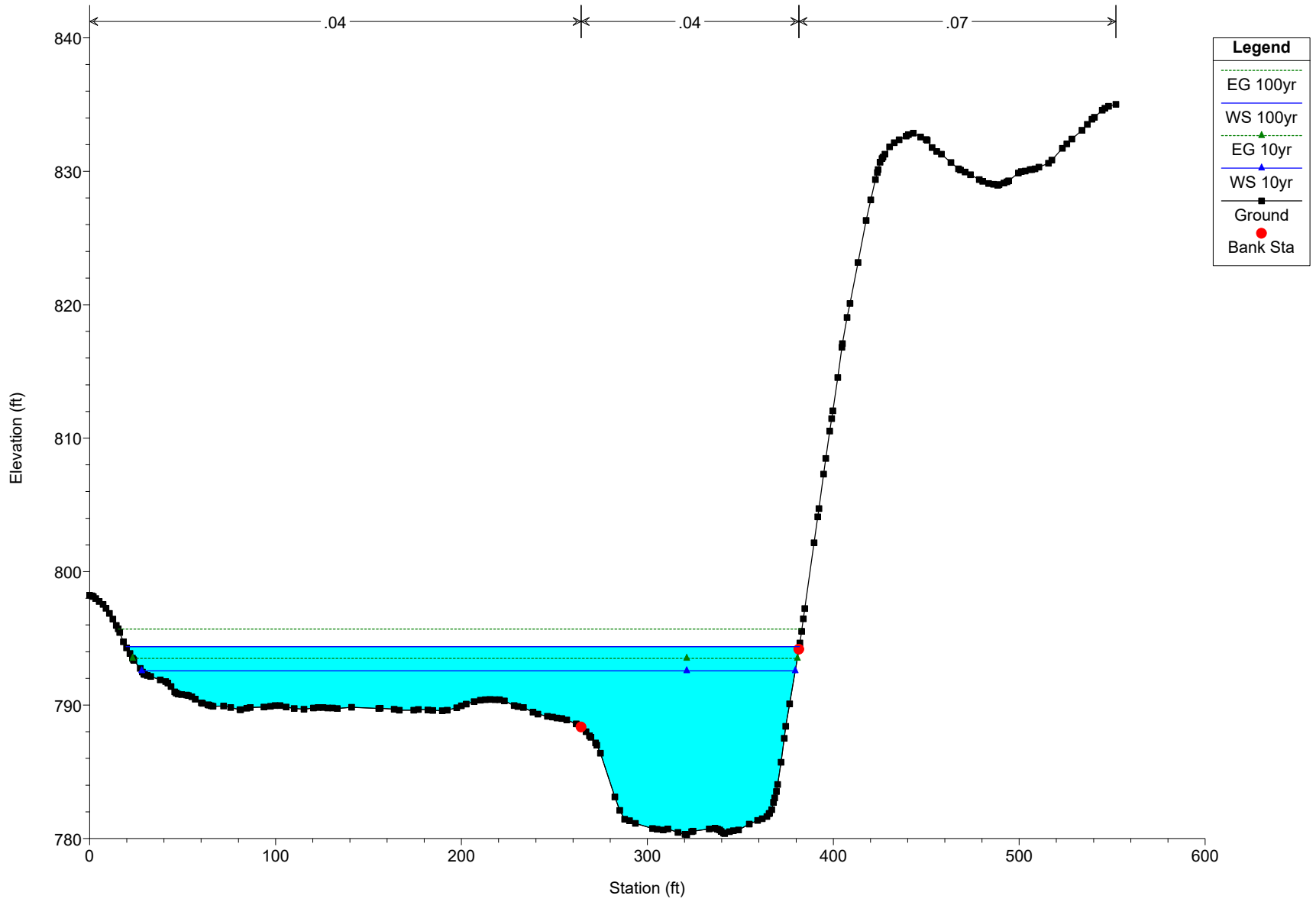
WAR350 Plan: Proposed Conditions 4/12/2024



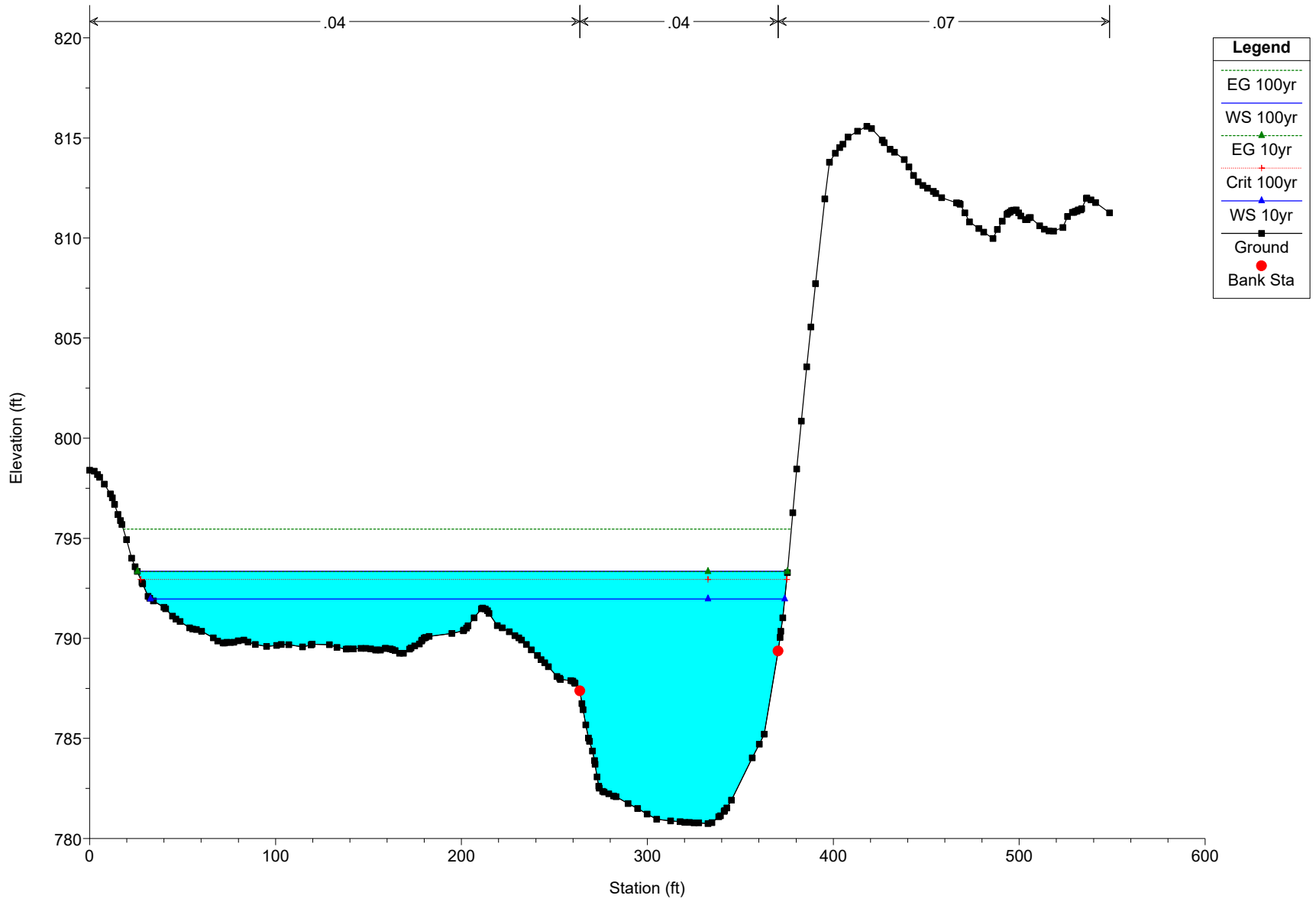
WAR350 Plan: Proposed Conditions 4/12/2024



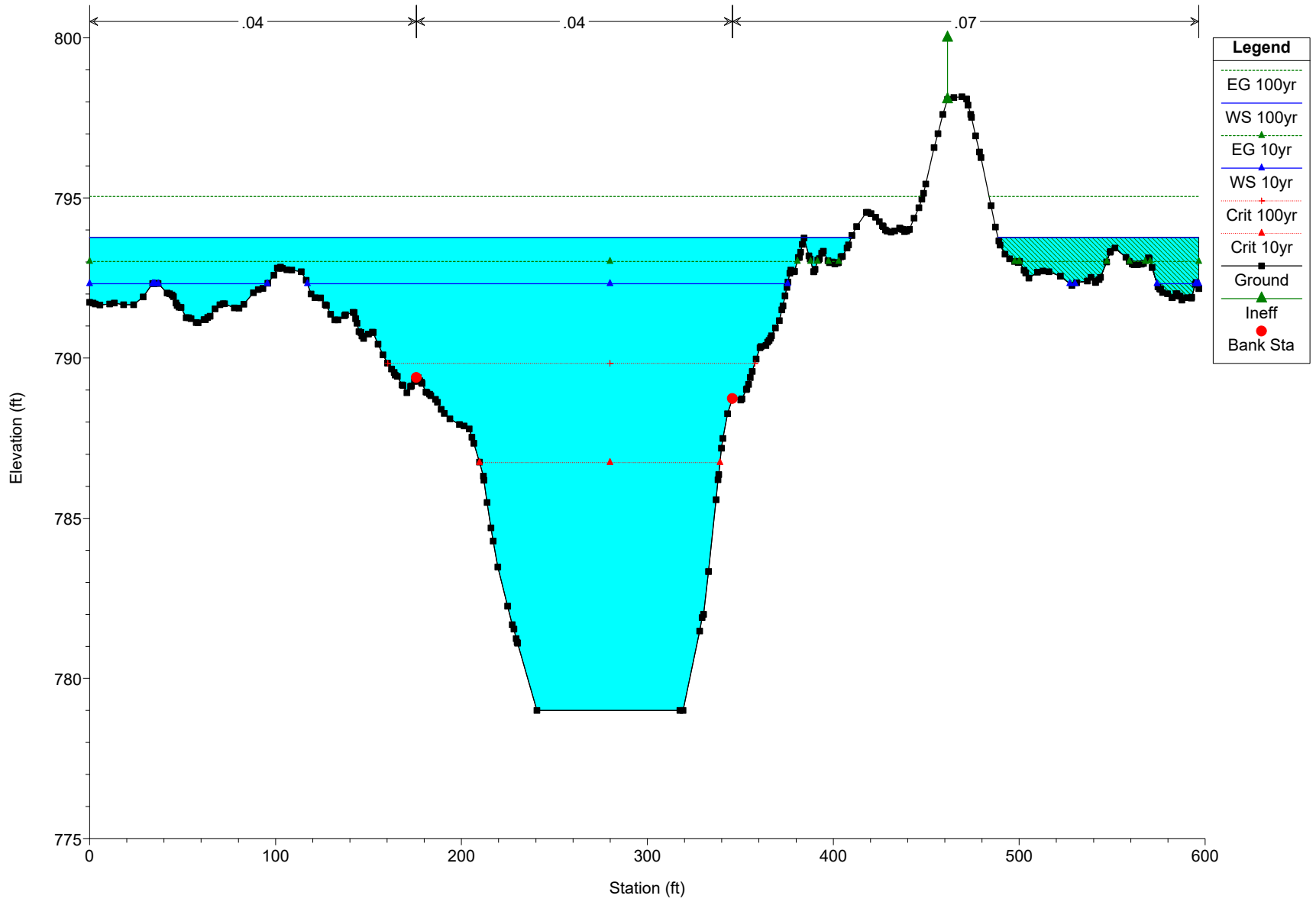
WAR350 Plan: Proposed Conditions 4/12/2024



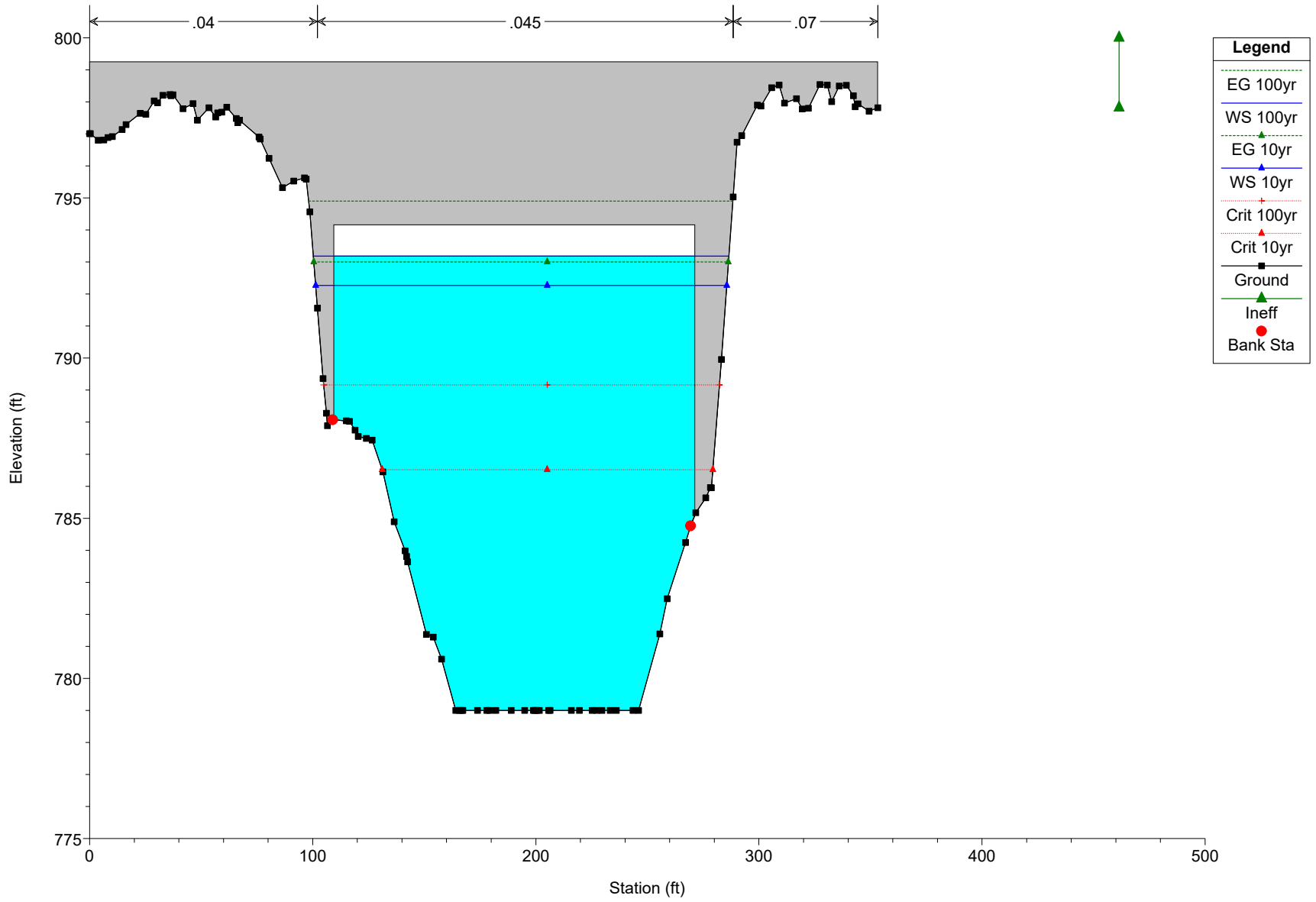
WAR350 Plan: Proposed Conditions 4/12/2024



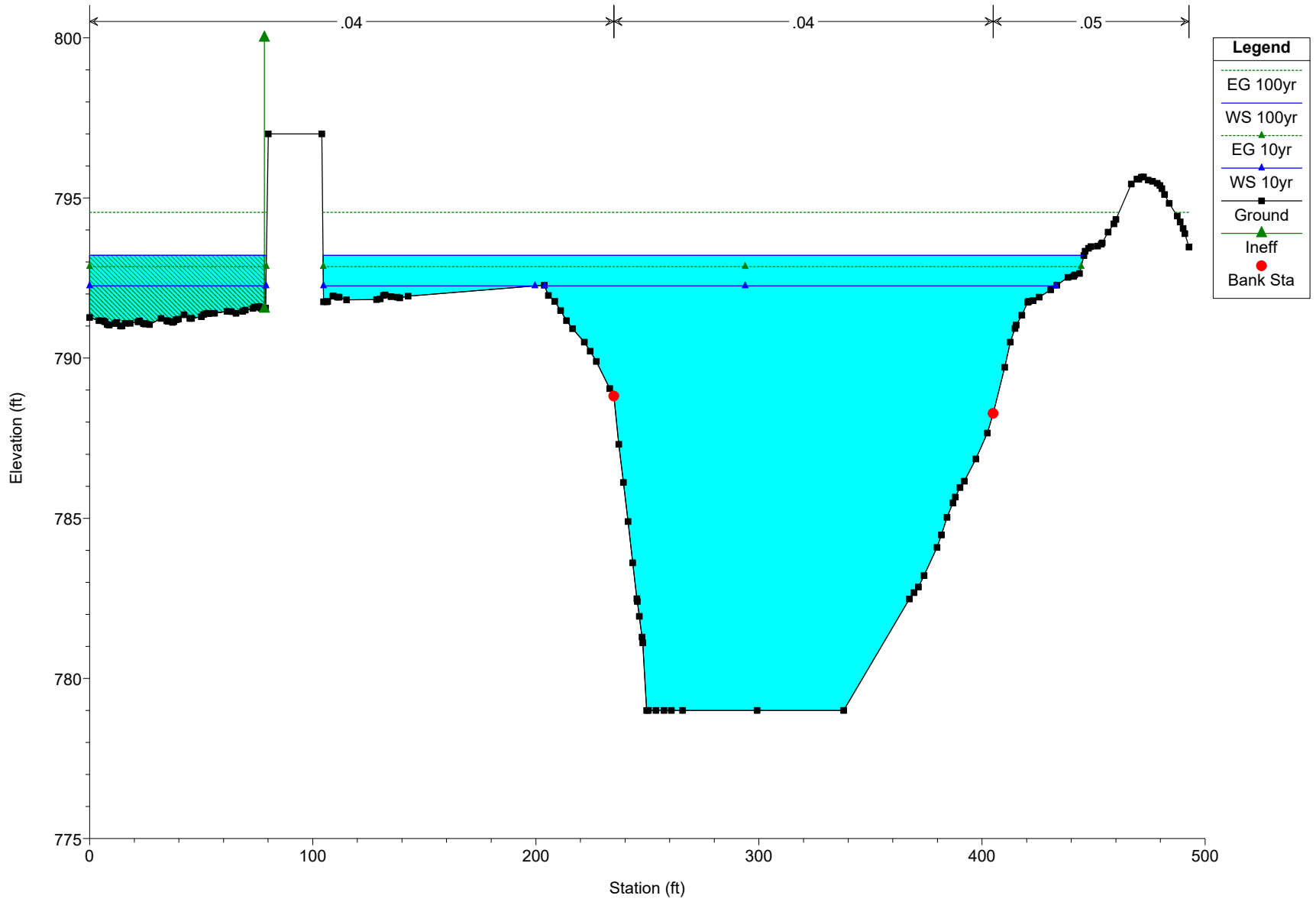
WAR350 Plan: Proposed Conditions 4/12/2024



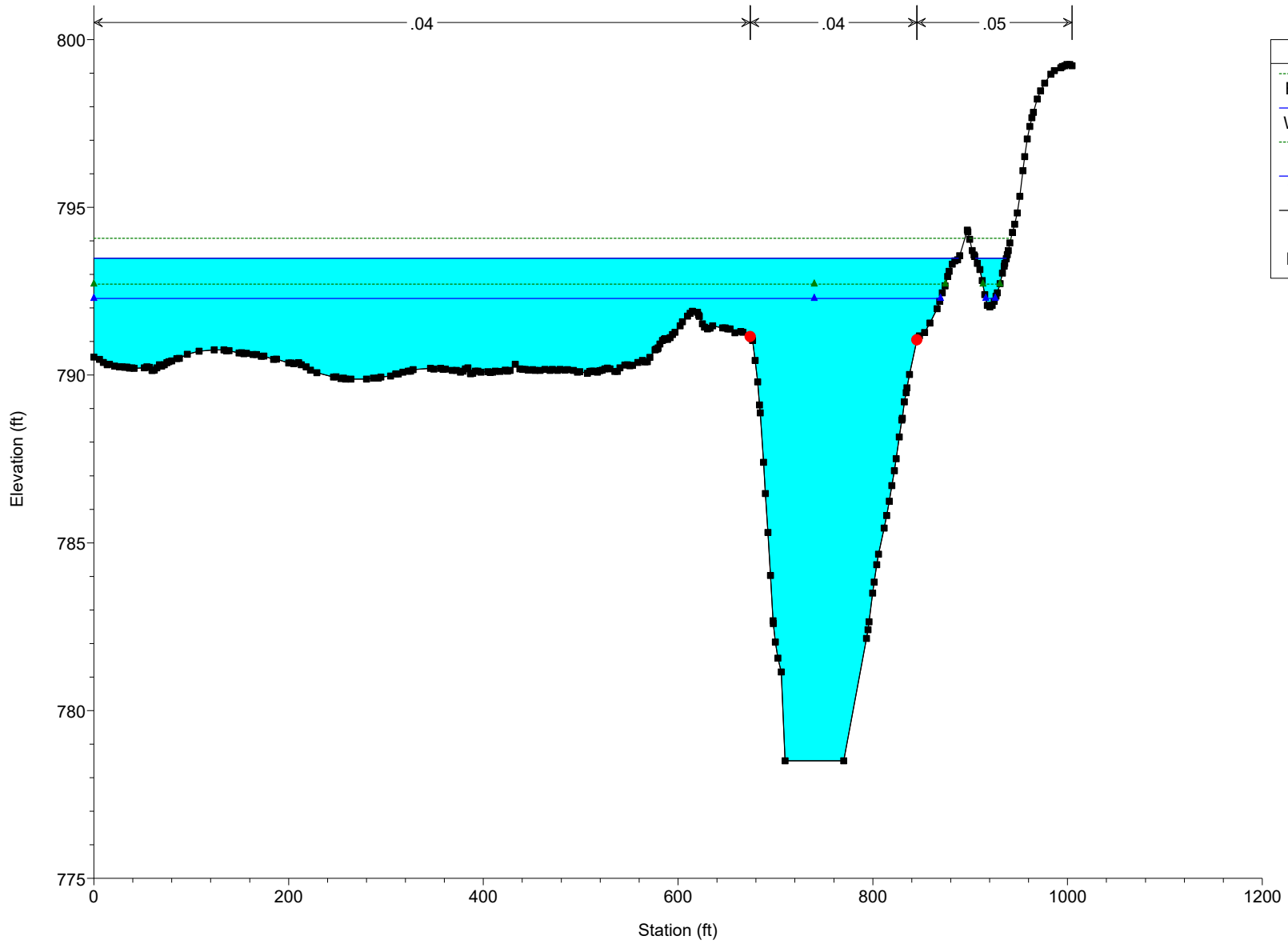
WAR350 Plan: Proposed Conditions 4/12/2024

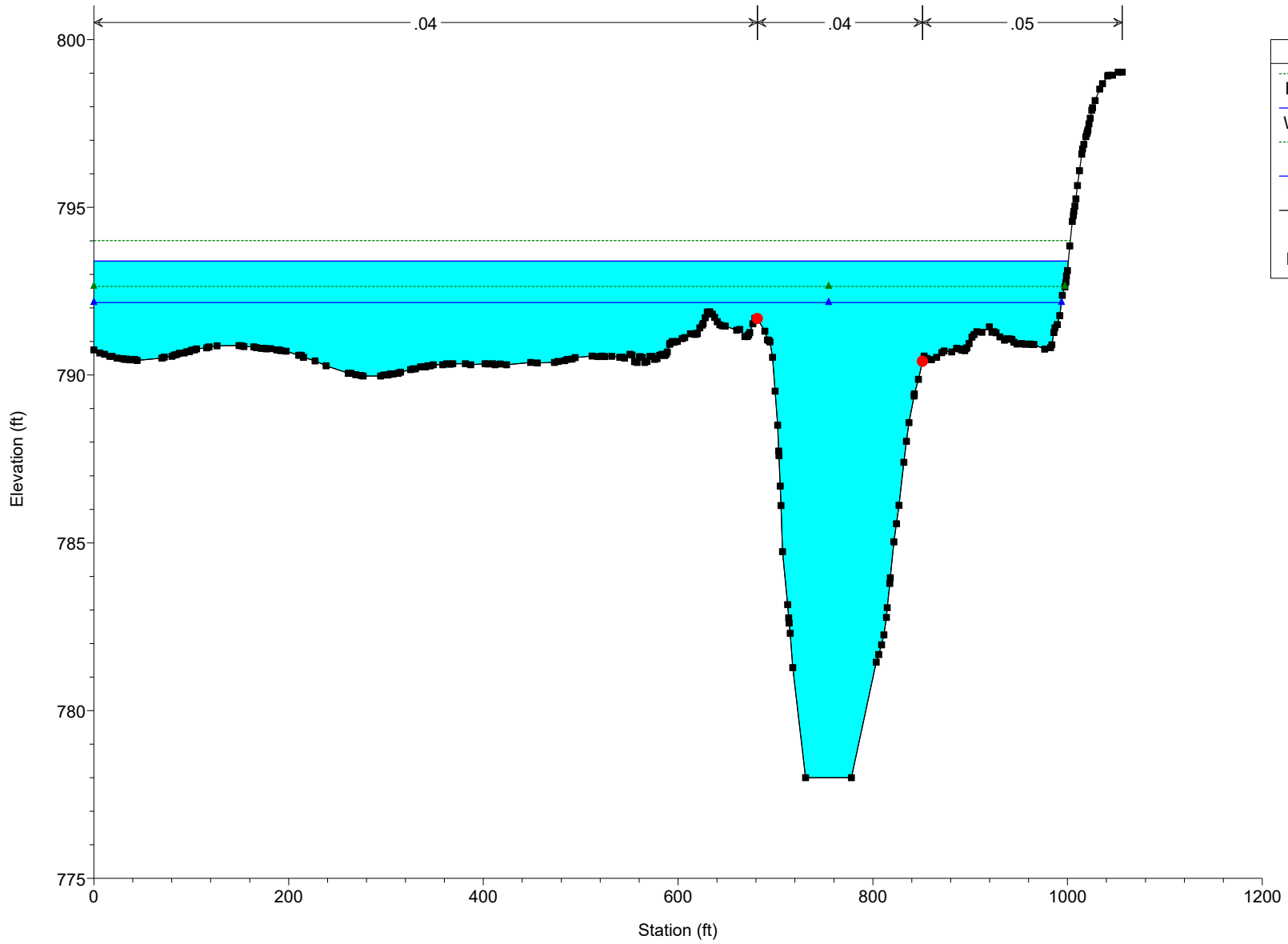


WAR350 Plan: Proposed Conditions 4/12/2024

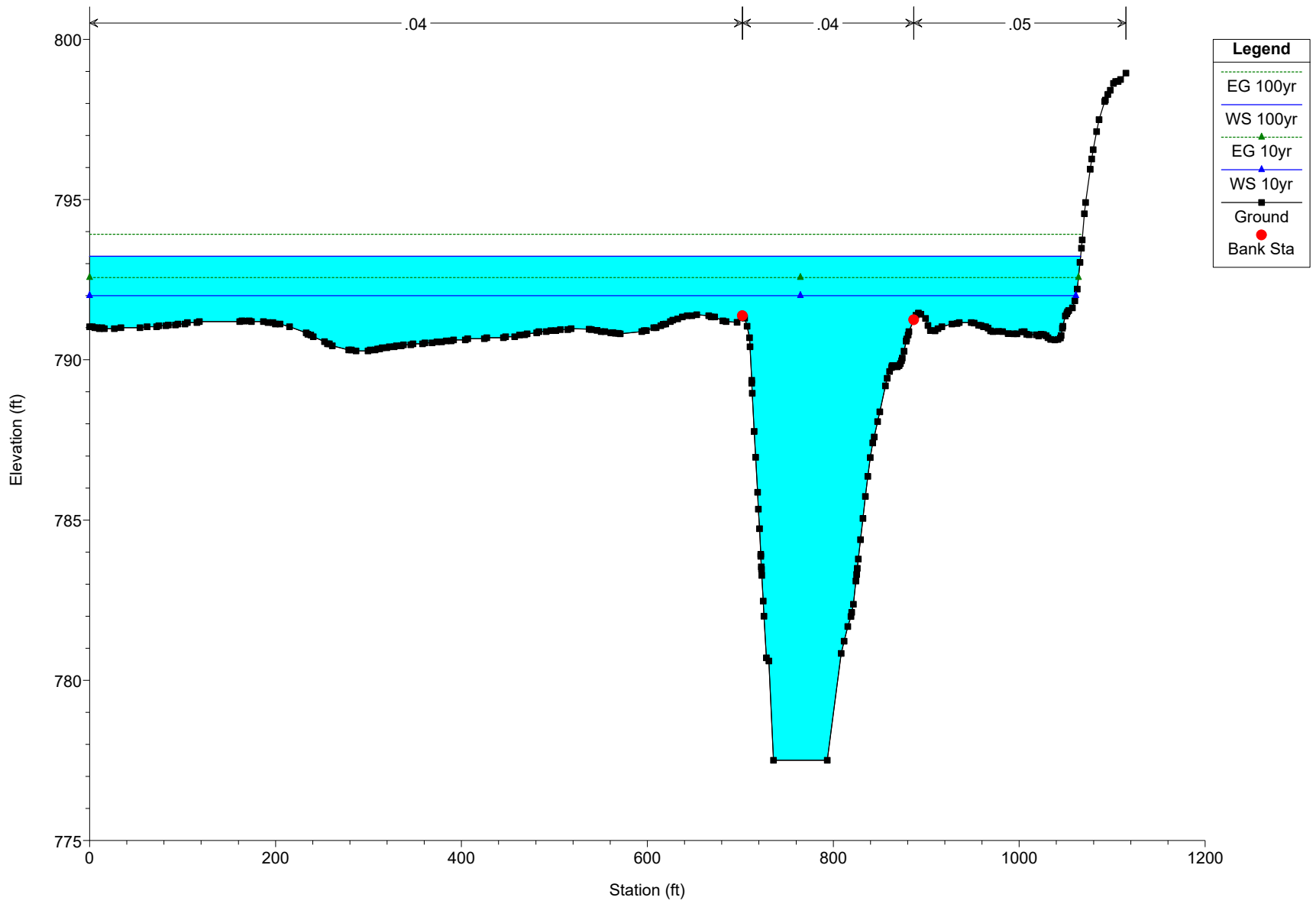


WAR350 Plan: Proposed Conditions 4/12/2024

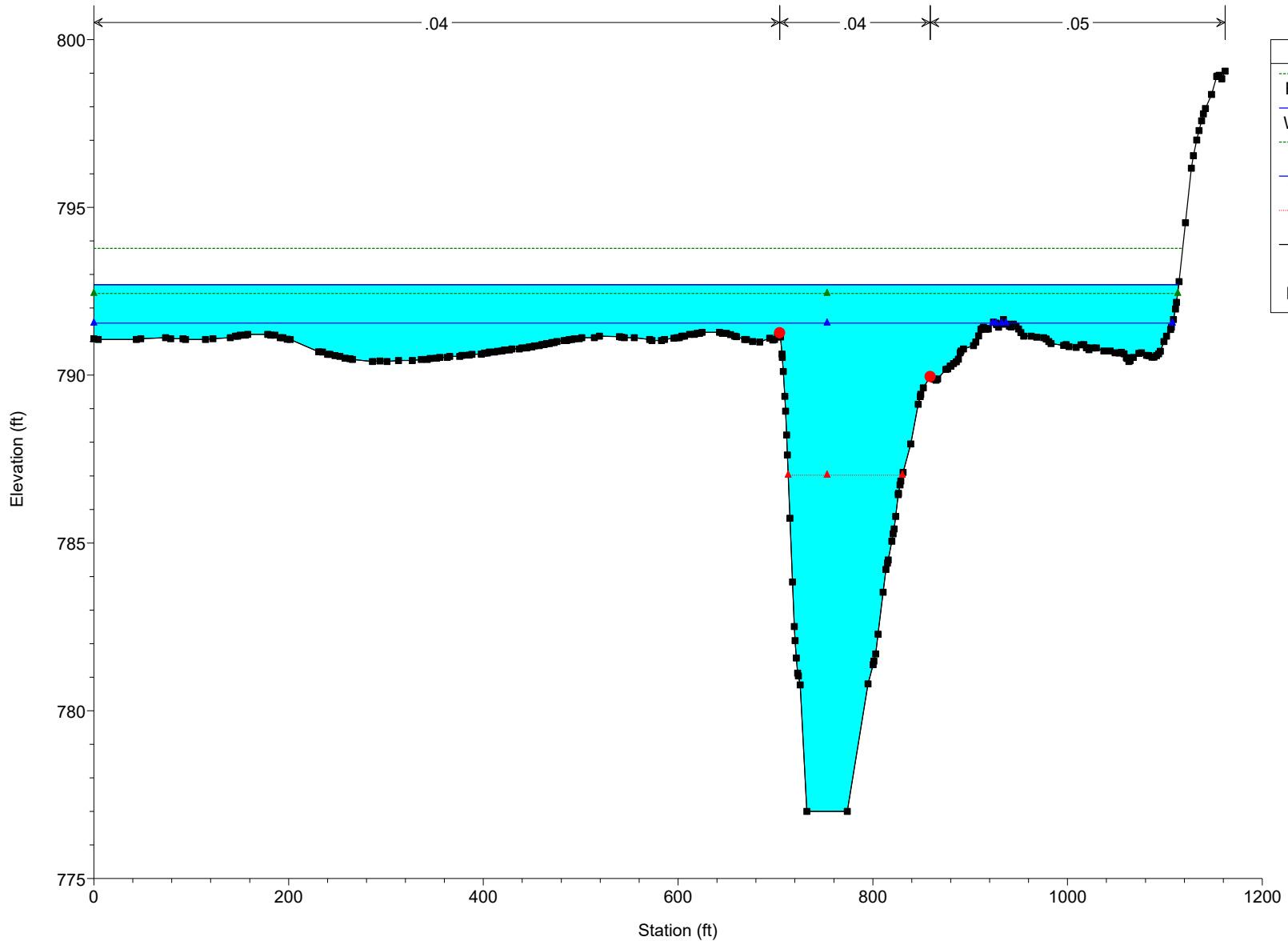




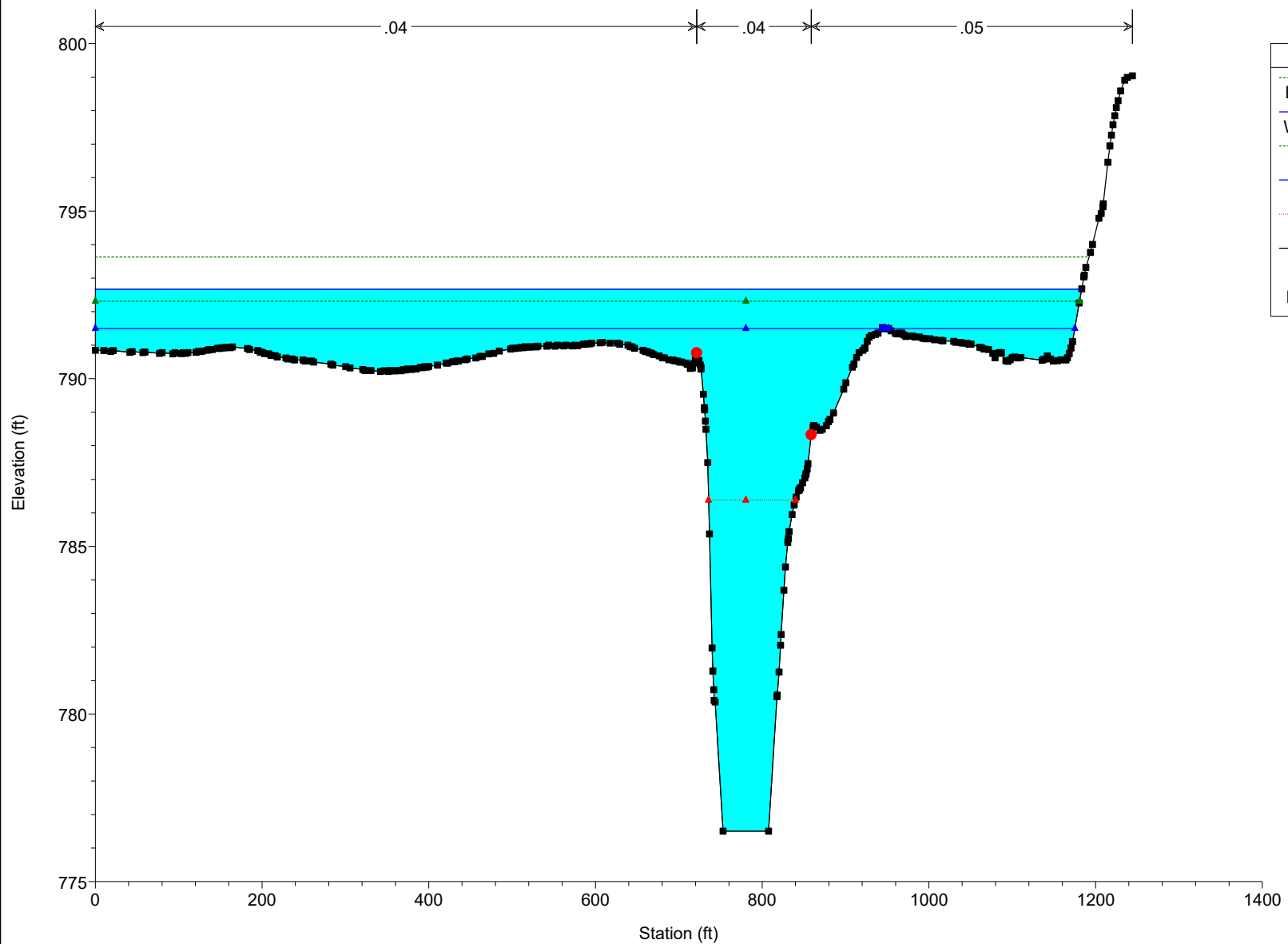
WAR350 Plan: Proposed Conditions 4/12/2024



WAR350 Plan: Proposed Conditions 4/12/2024

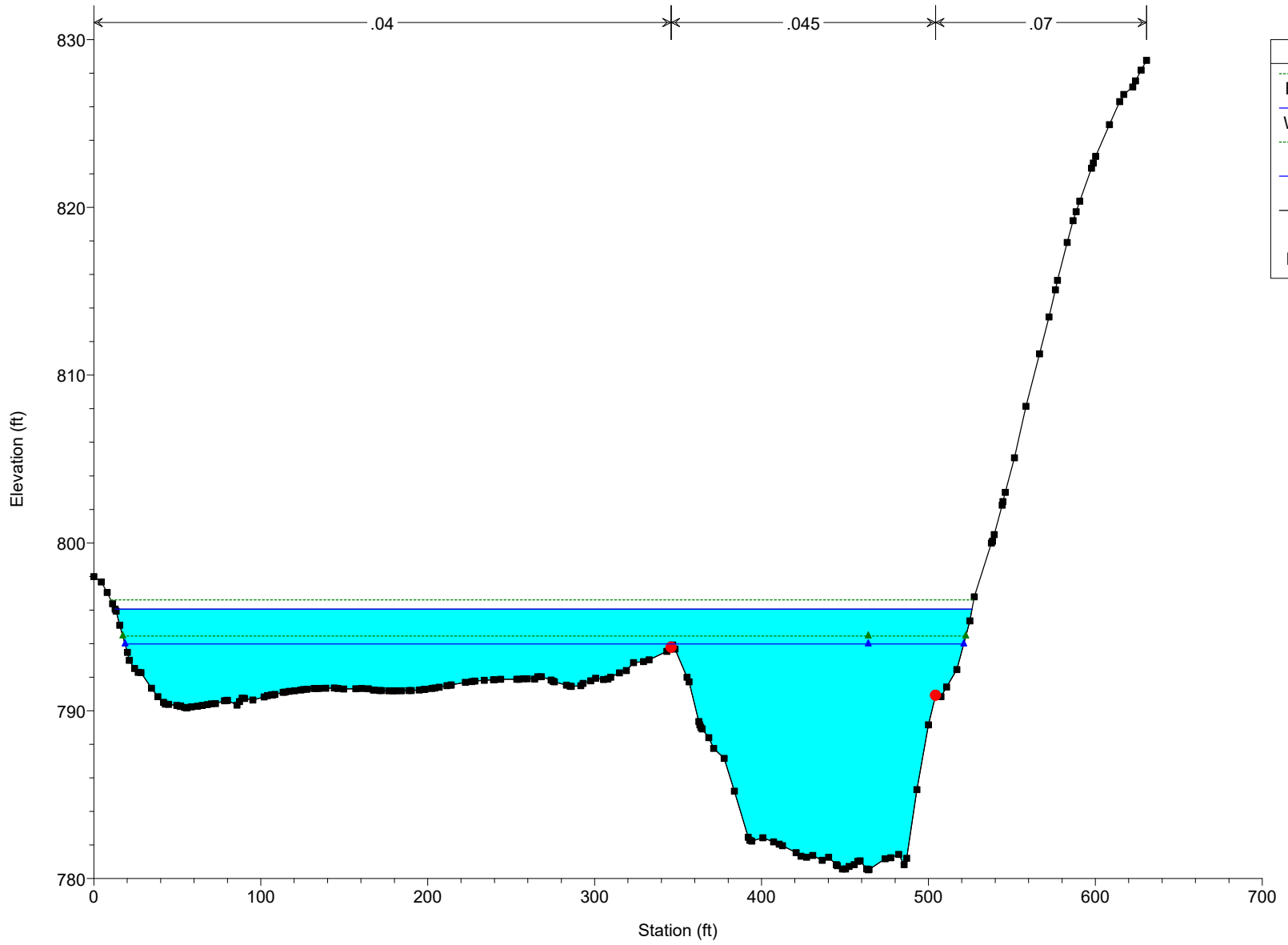


WAR350 Plan: Proposed Conditions 4/12/2024

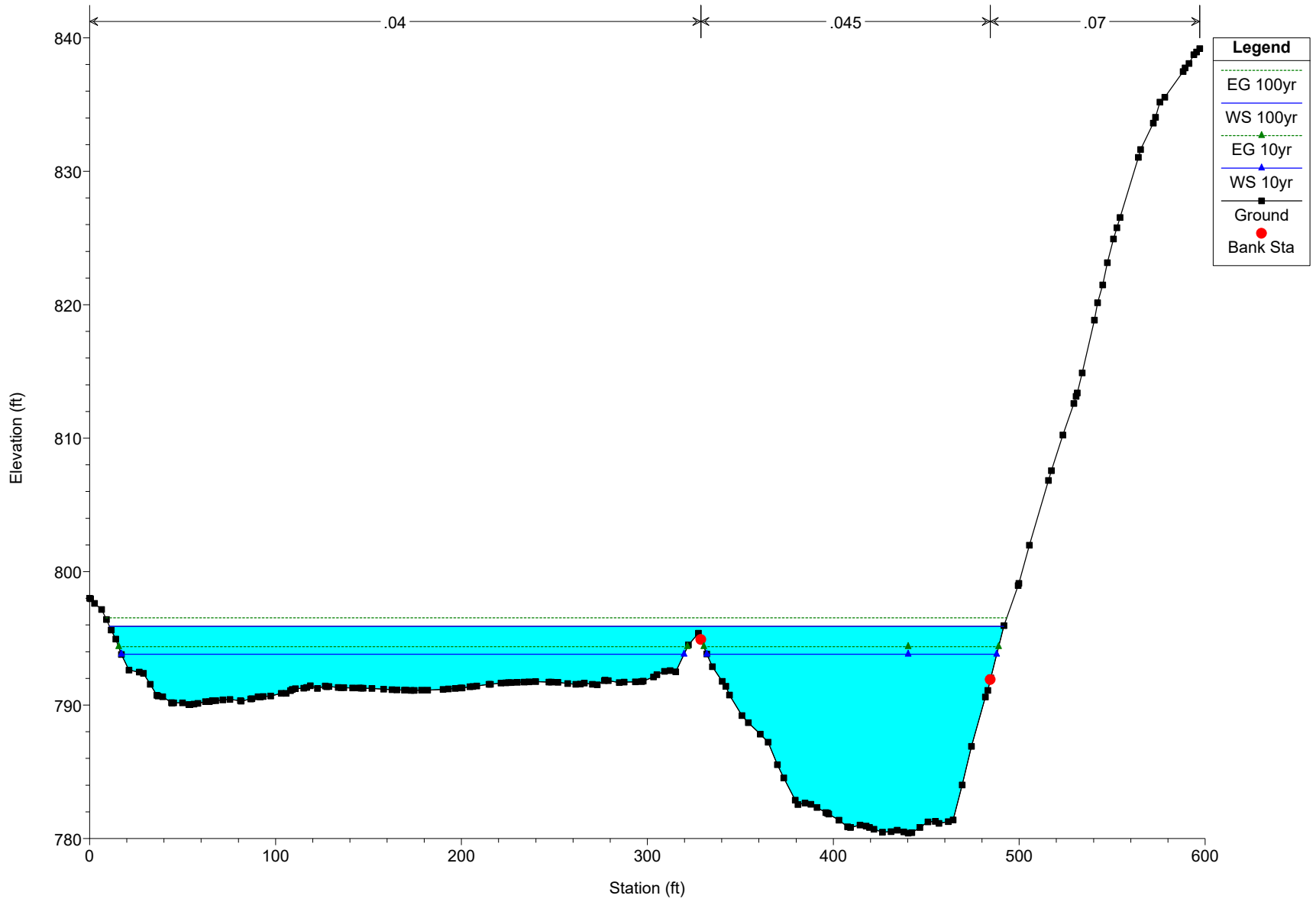


EXISTING CONDITIONS CROSS SECTIONS

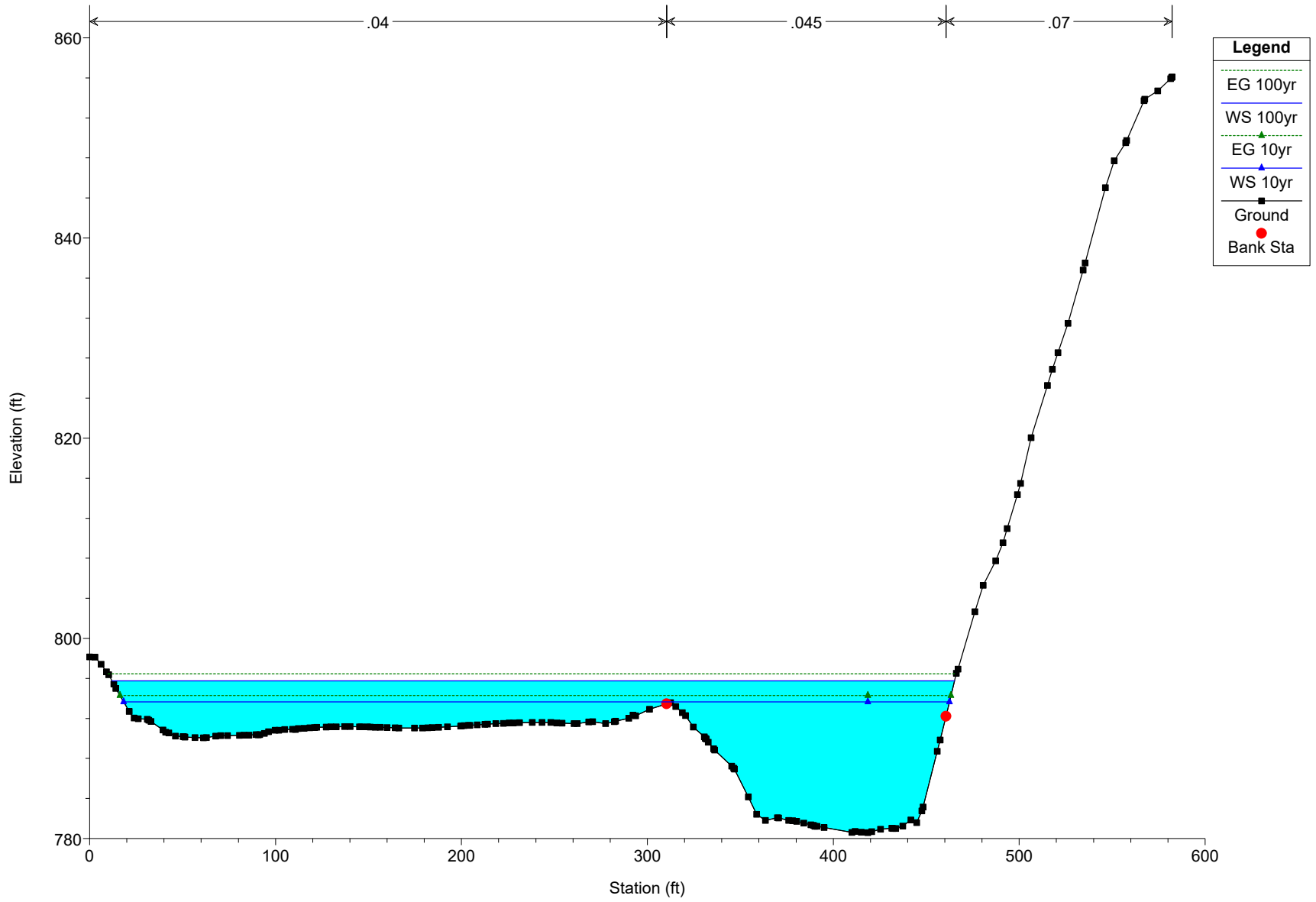
WAR350 Plan: Existing Conditions 4/12/2024



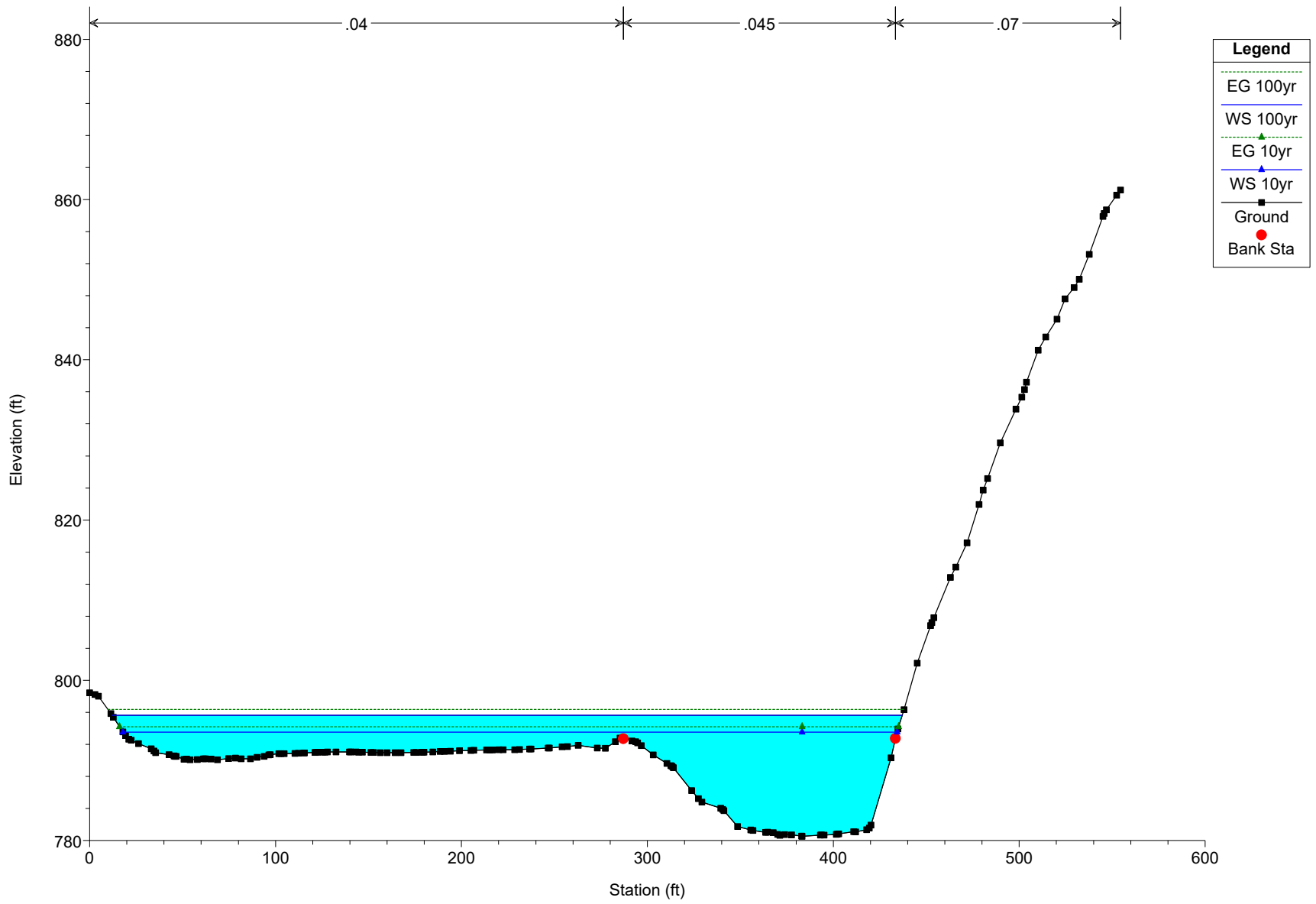
WAR350 Plan: Existing Conditions 4/12/2024



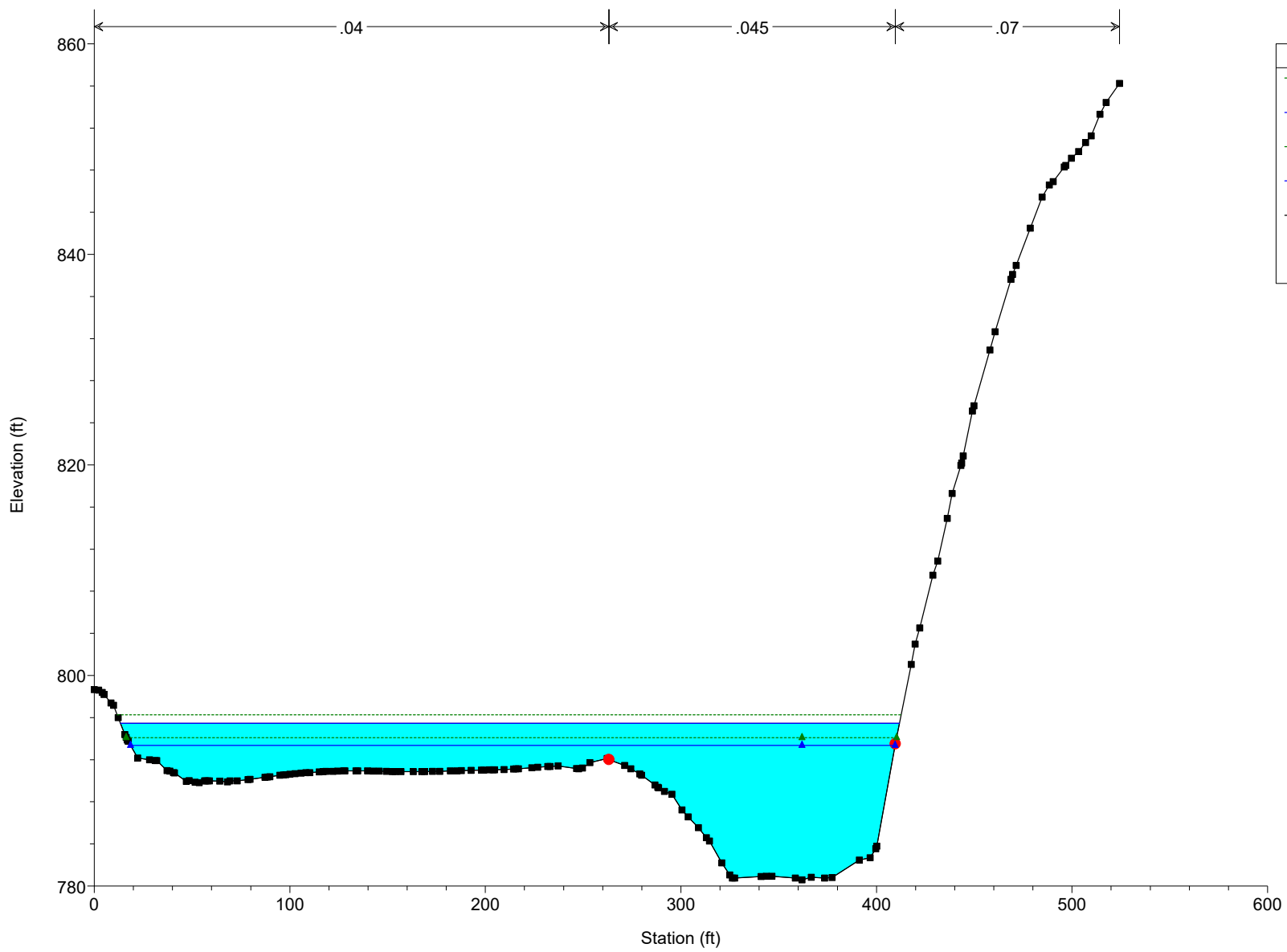
WAR350 Plan: Existing Conditions 4/12/2024



WAR350 Plan: Existing Conditions 4/12/2024



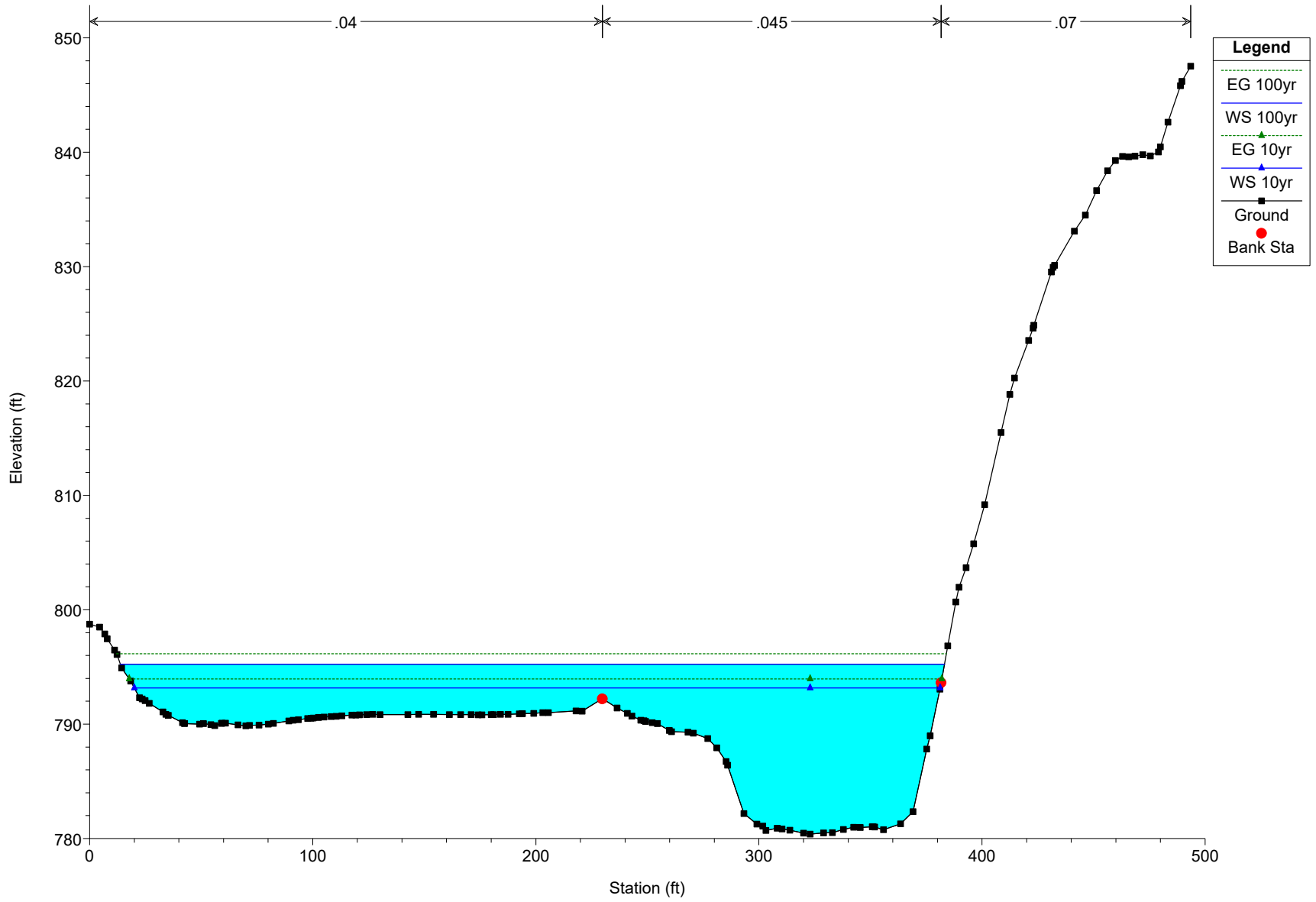
WAR350 Plan: Existing Conditions 4/12/2024



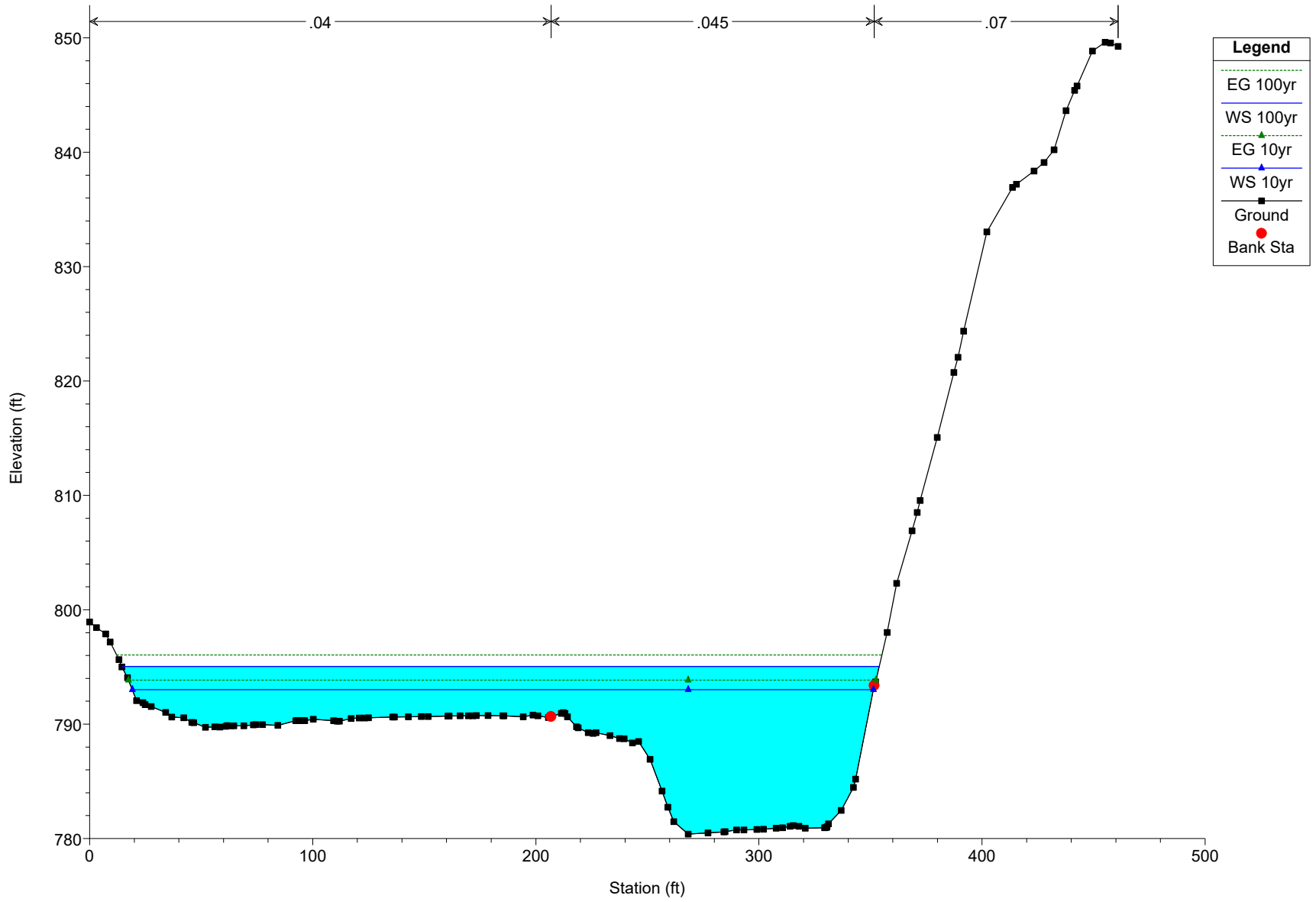
Legend

- EG 100yr
- WS 100yr
- EG 10yr
- WS 10yr
- Ground
- Bank Sta

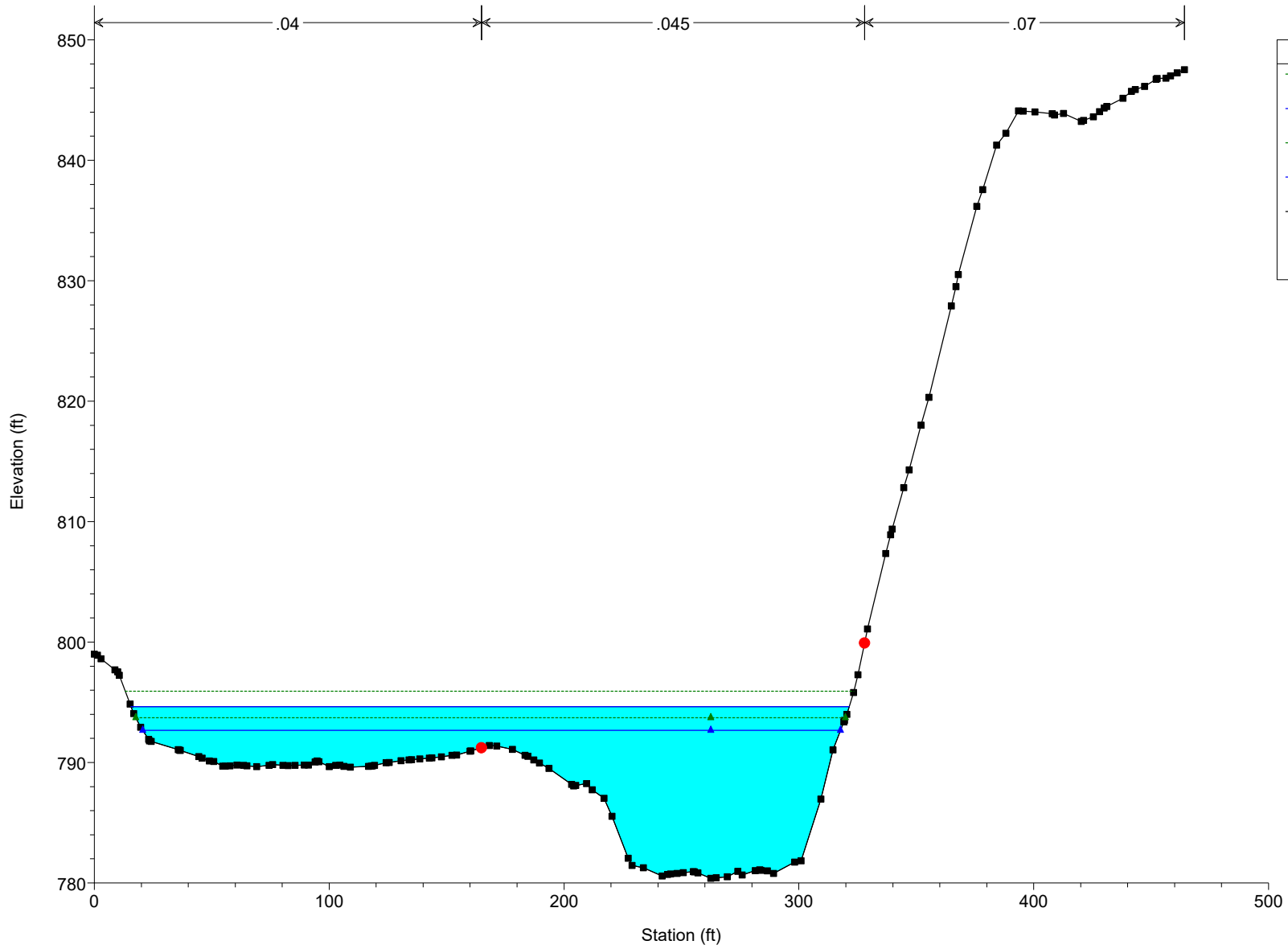
WAR350 Plan: Existing Conditions 4/12/2024



WAR350 Plan: Existing Conditions 4/12/2024

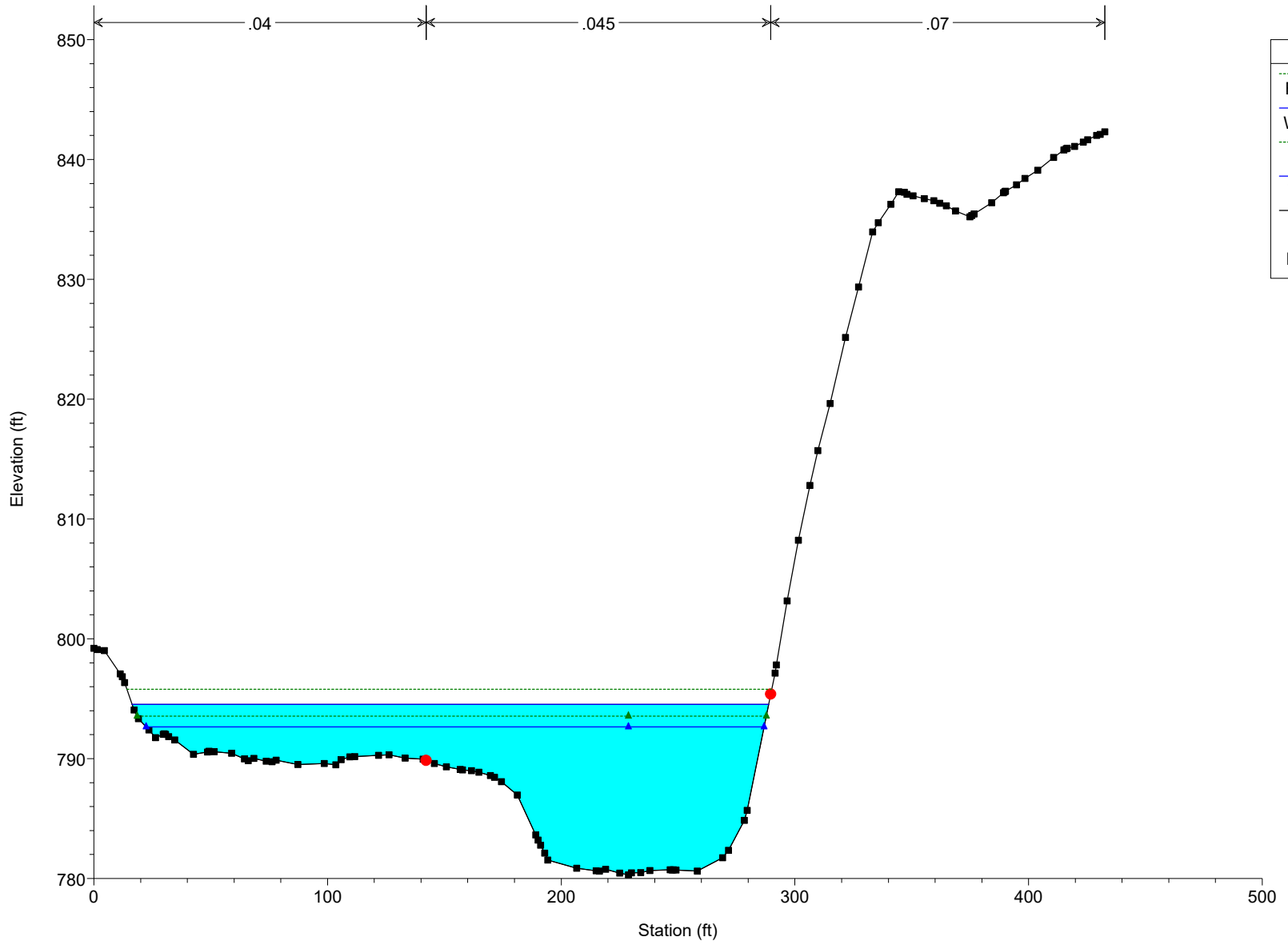


WAR350 Plan: Existing Conditions 4/12/2024

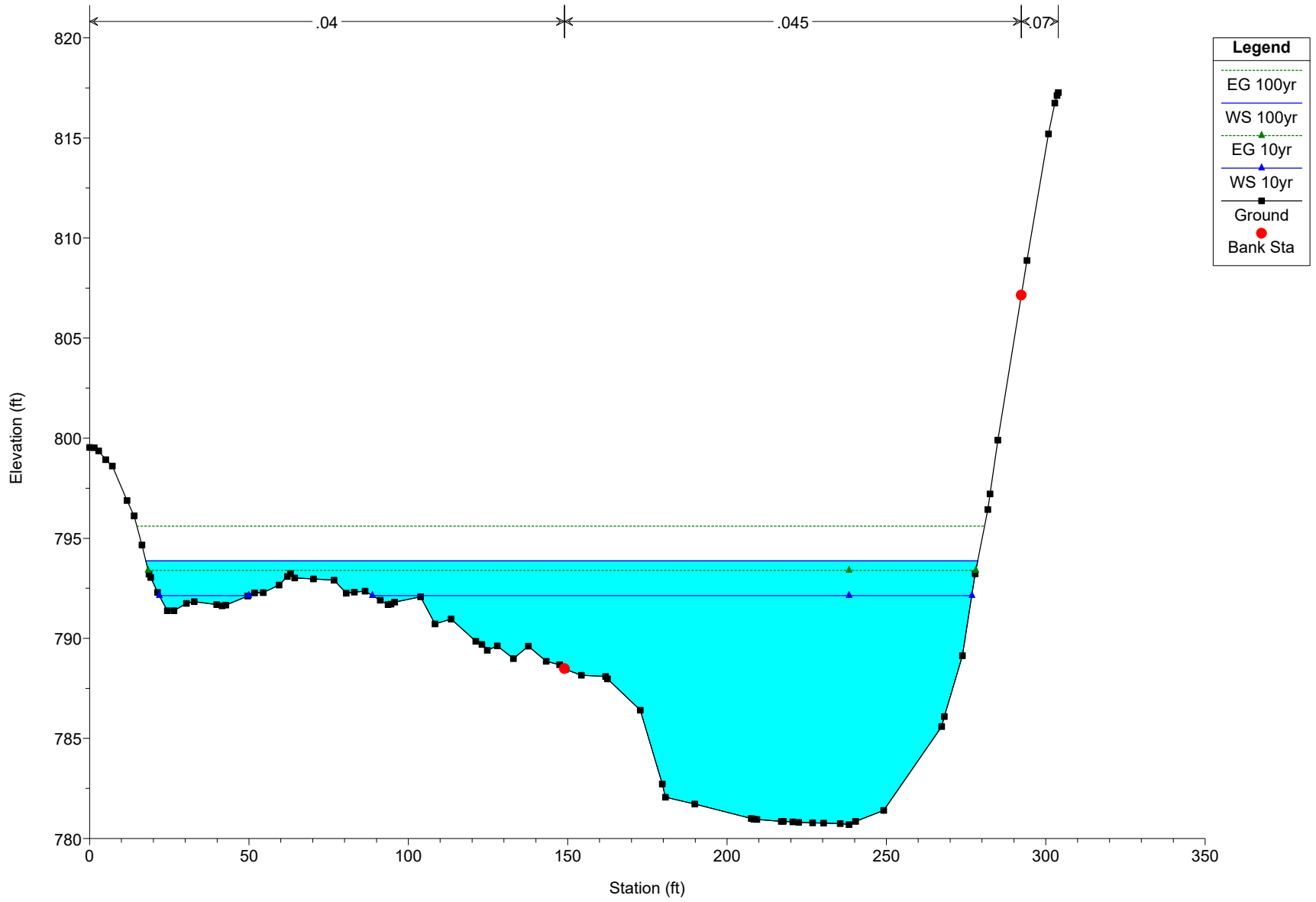


Legend	
EG 100yr	(Dotted Green Line)
WS 100yr	(Blue Line)
EG 10yr	(Dotted Green Line)
WS 10yr	(Blue Line)
Ground	(Black Line with Squares)
Bank Sta	(Red Dot)

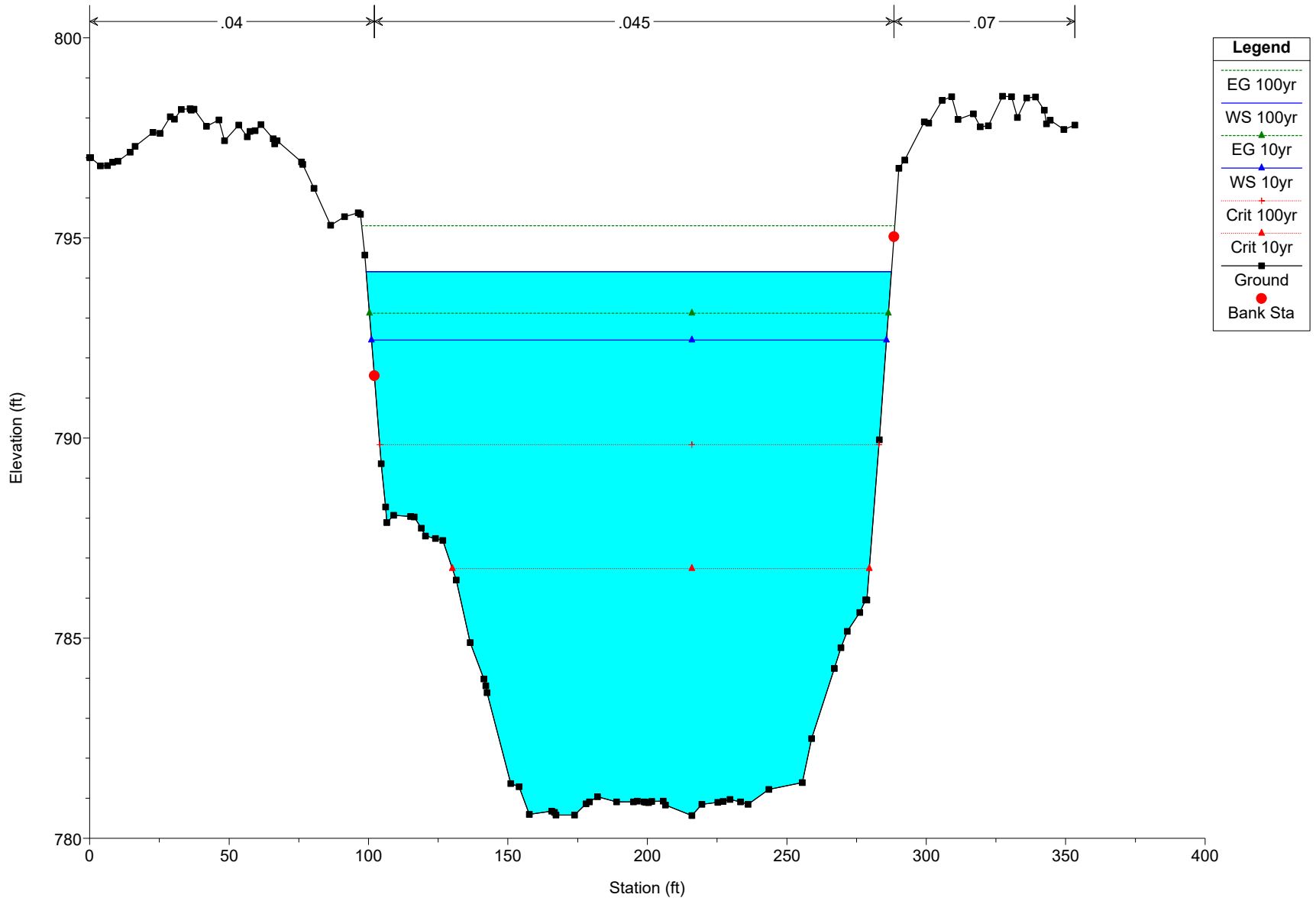
WAR350 Plan: Existing Conditions 4/12/2024



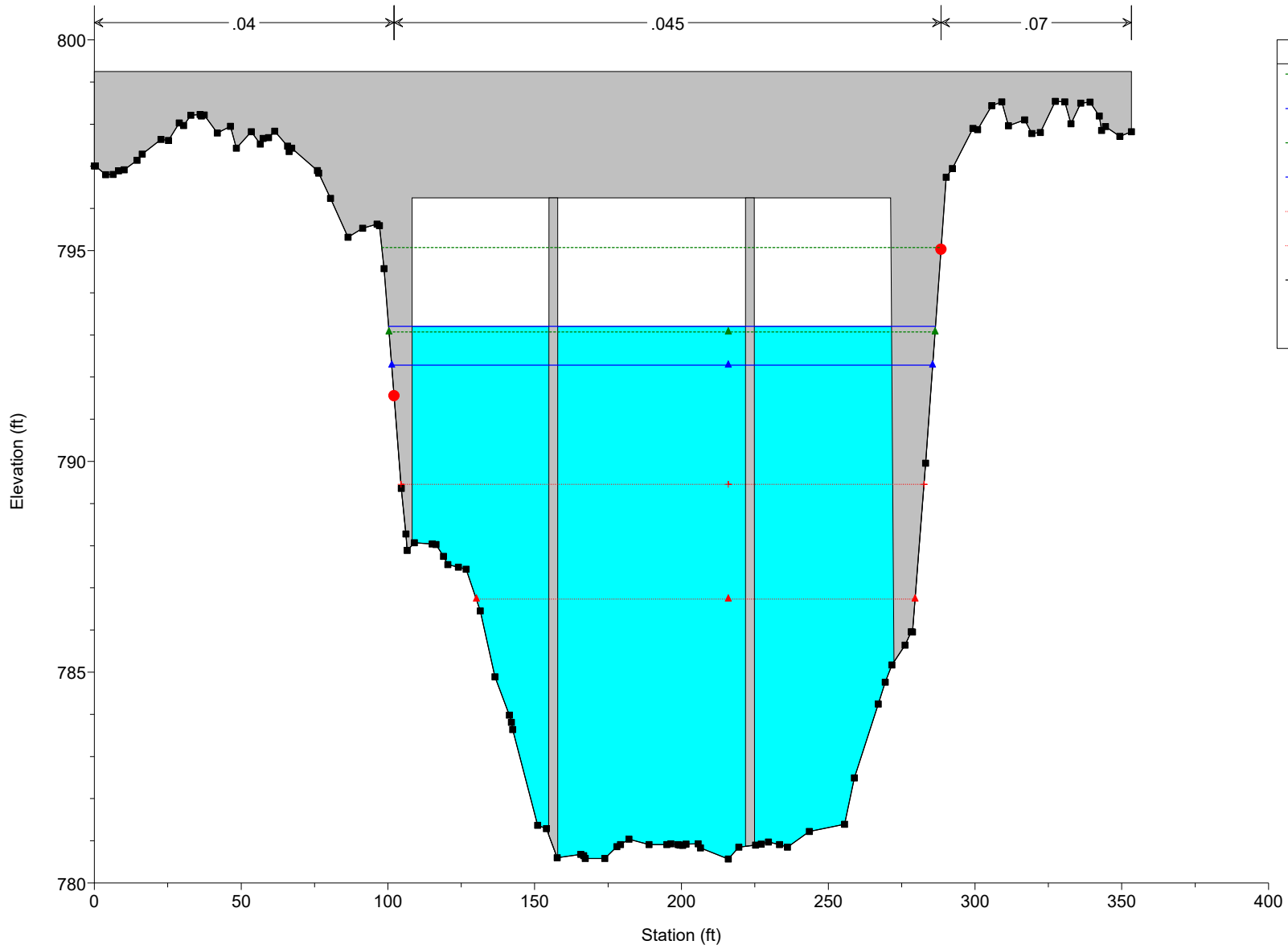
WAR350 Plan: Existing Conditions 4/12/2024



WAR350 Plan: Existing Conditions 4/12/2024



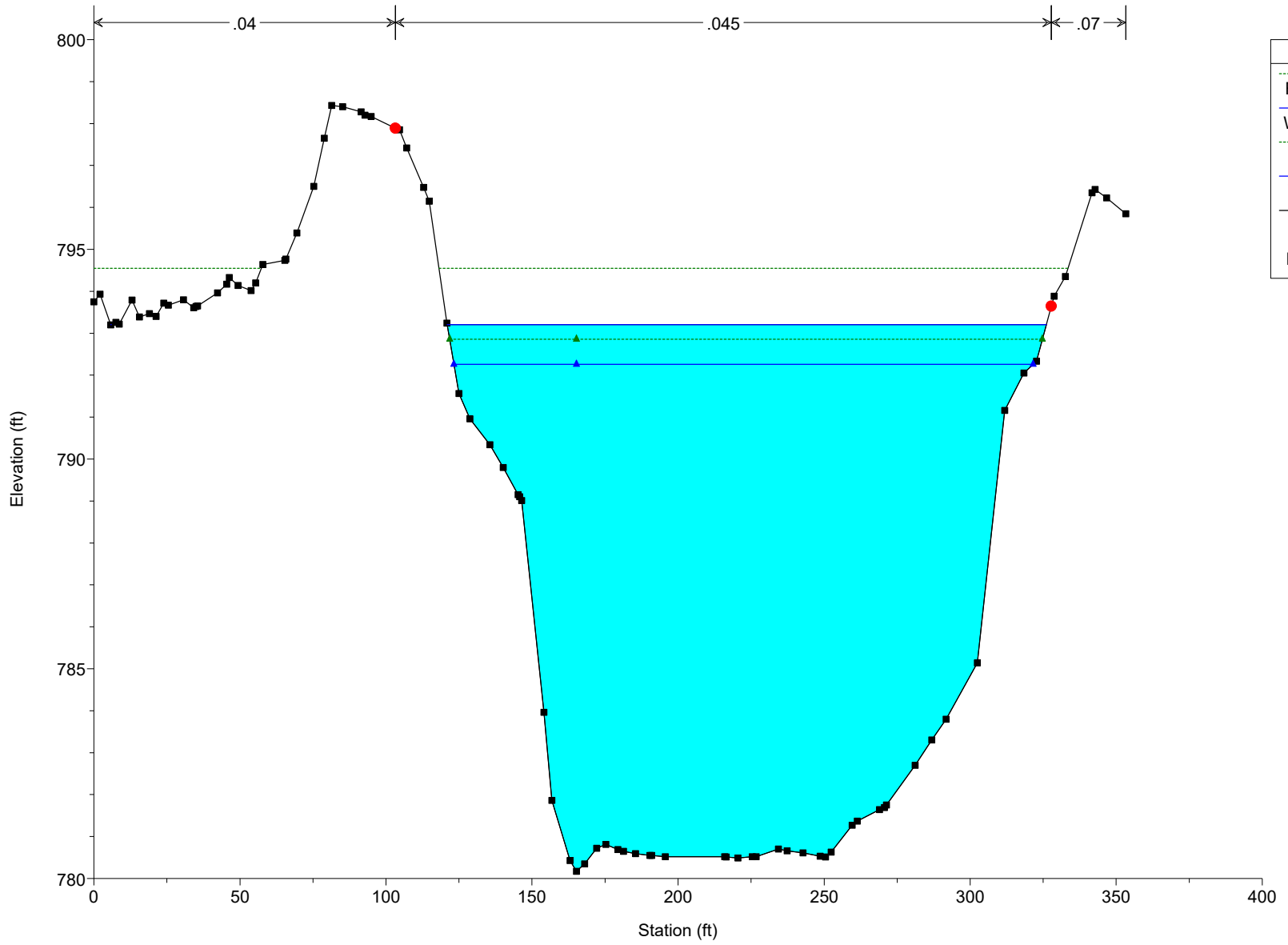
WAR350 Plan: Existing Conditions 4/12/2024



Legend

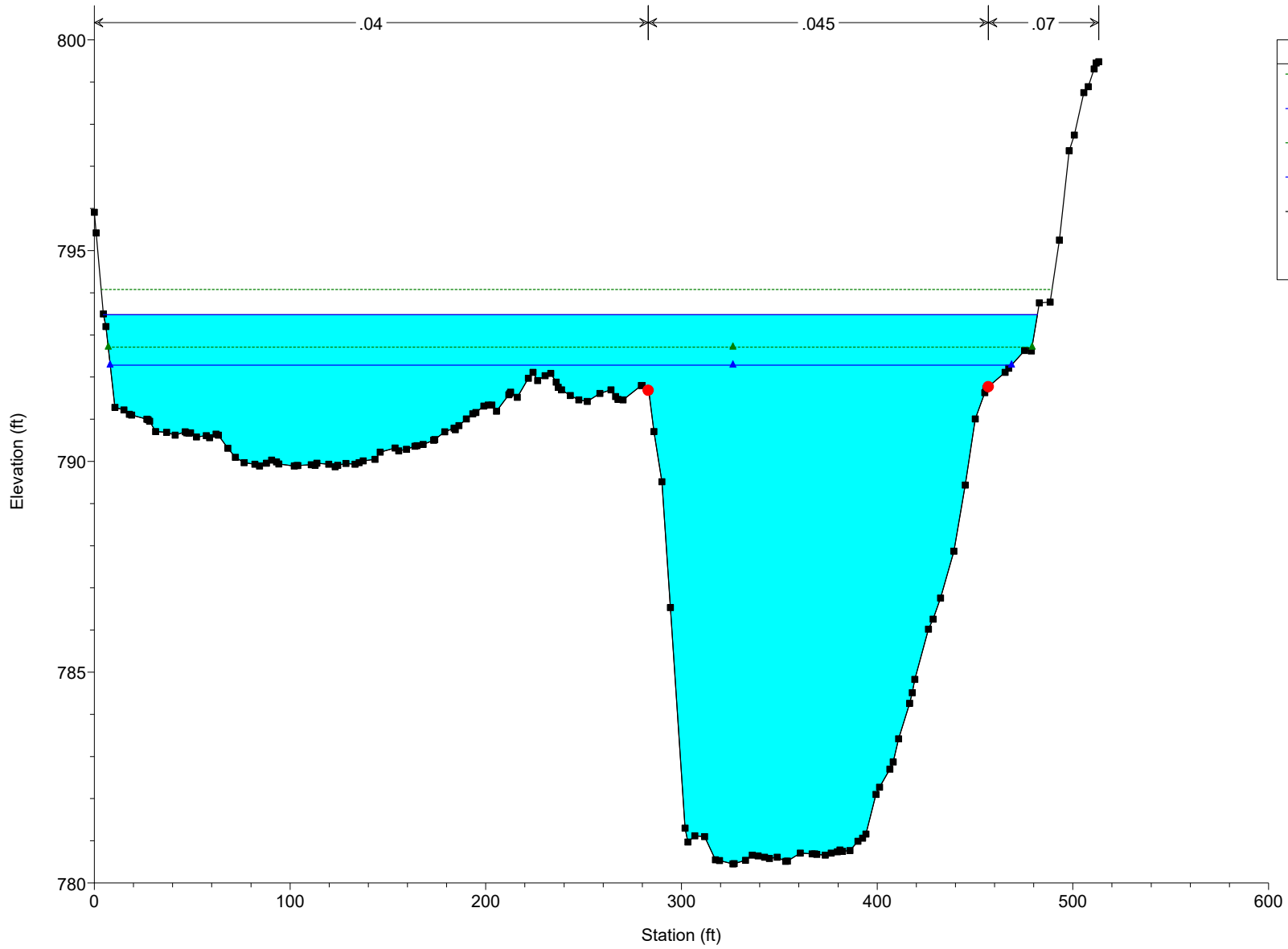
- EG 100yr
- WS 100yr
- EG 10yr
- WS 10yr
- Crit 100yr
- Crit 10yr
- Ground
- Bank Sta

WAR350 Plan: Existing Conditions 4/12/2024



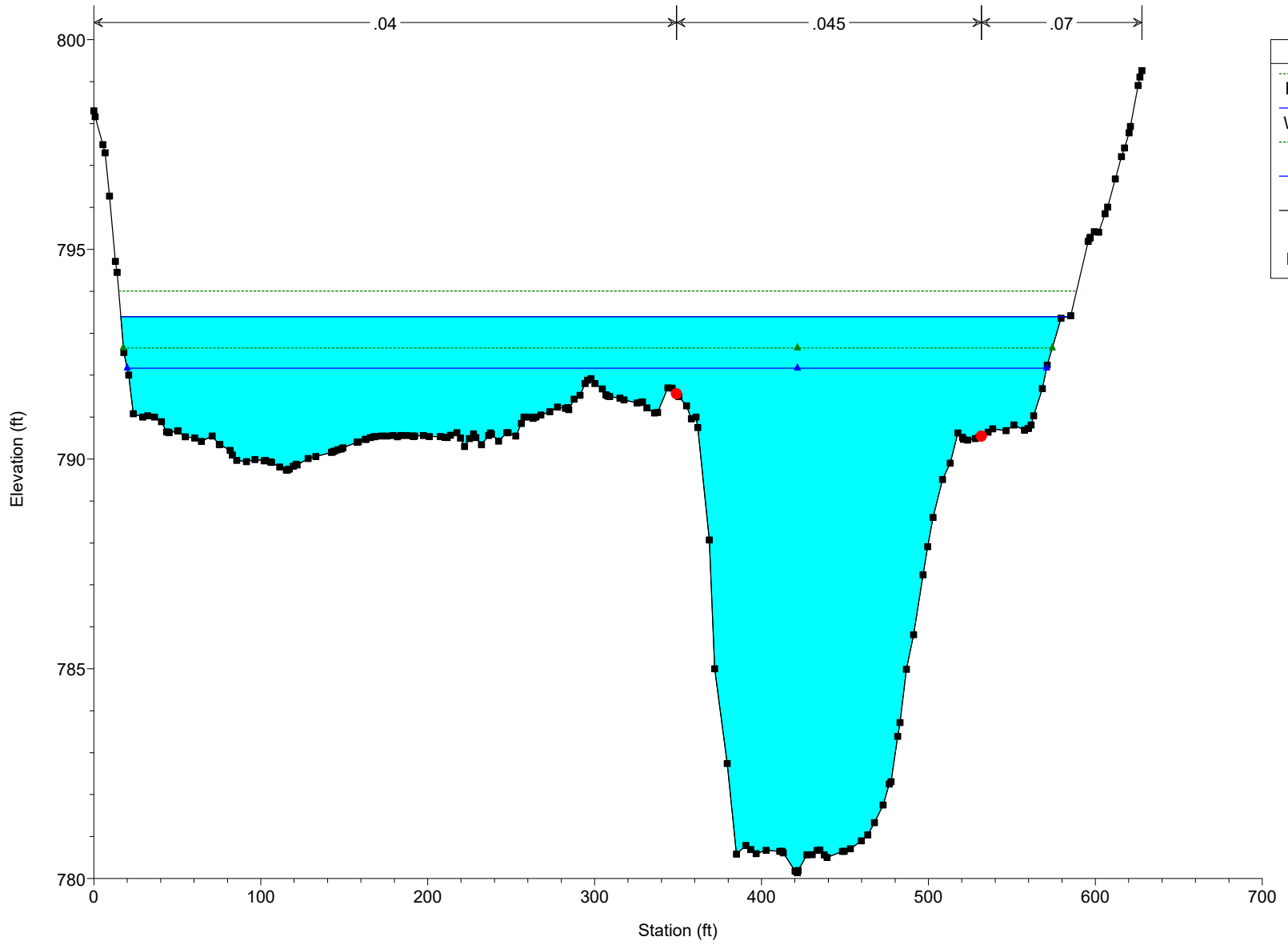
Legend	
EG 100yr	(Dotted green line with triangle)
WS 100yr	(Solid red line with triangle)
EG 10yr	(Dashed green line with triangle)
WS 10yr	(Solid blue line with triangle)
Ground	(Solid black line with square)
Bank Sta	(Red circle)

WAR350 Plan: Existing Conditions 4/12/2024

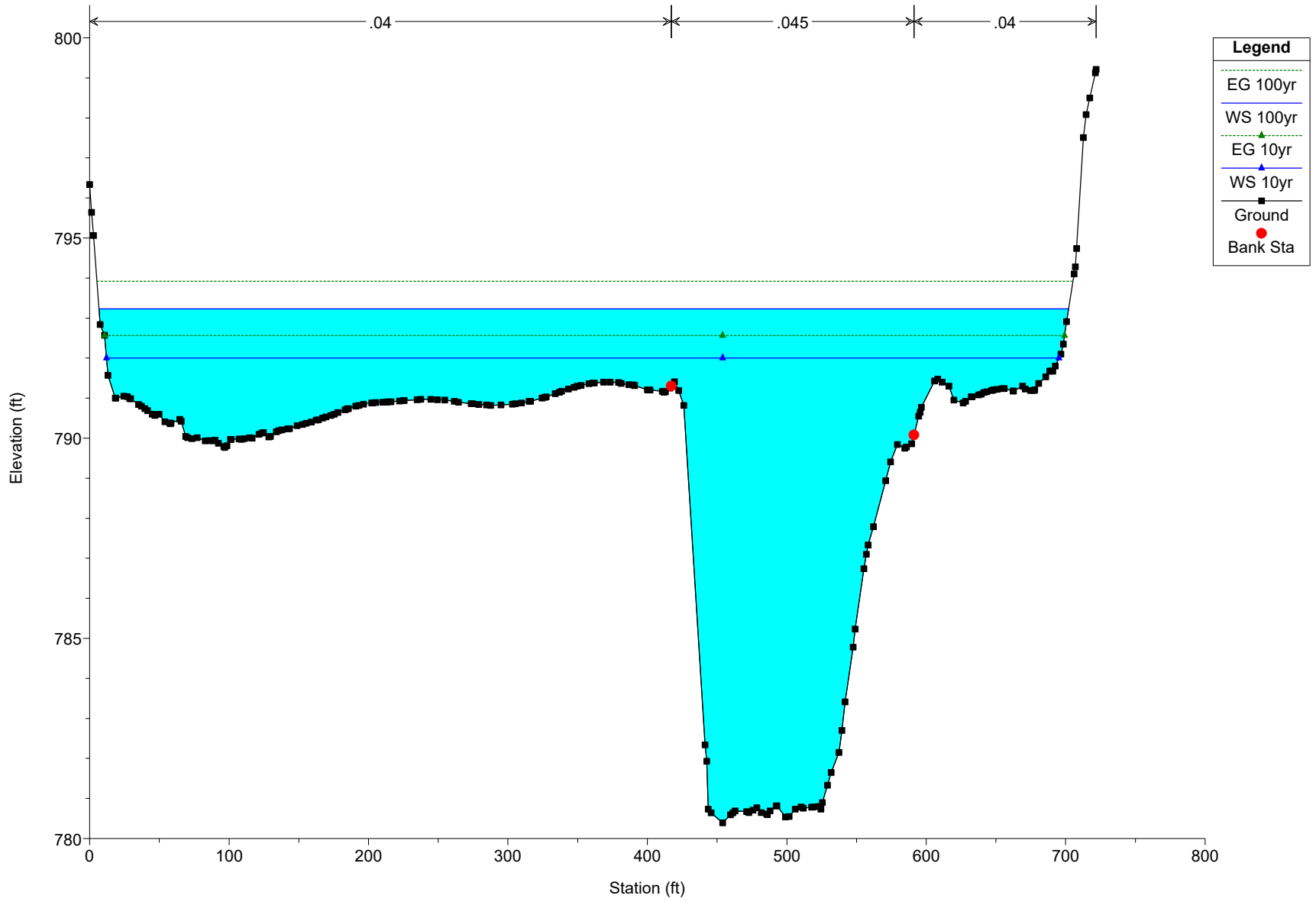


Legend	
EG 100yr	Black dotted line
WS 100yr	Red solid line
EG 10yr	Green dotted line
WS 10yr	Blue solid line
Ground	Black solid line
Bank Sta	Red solid circle

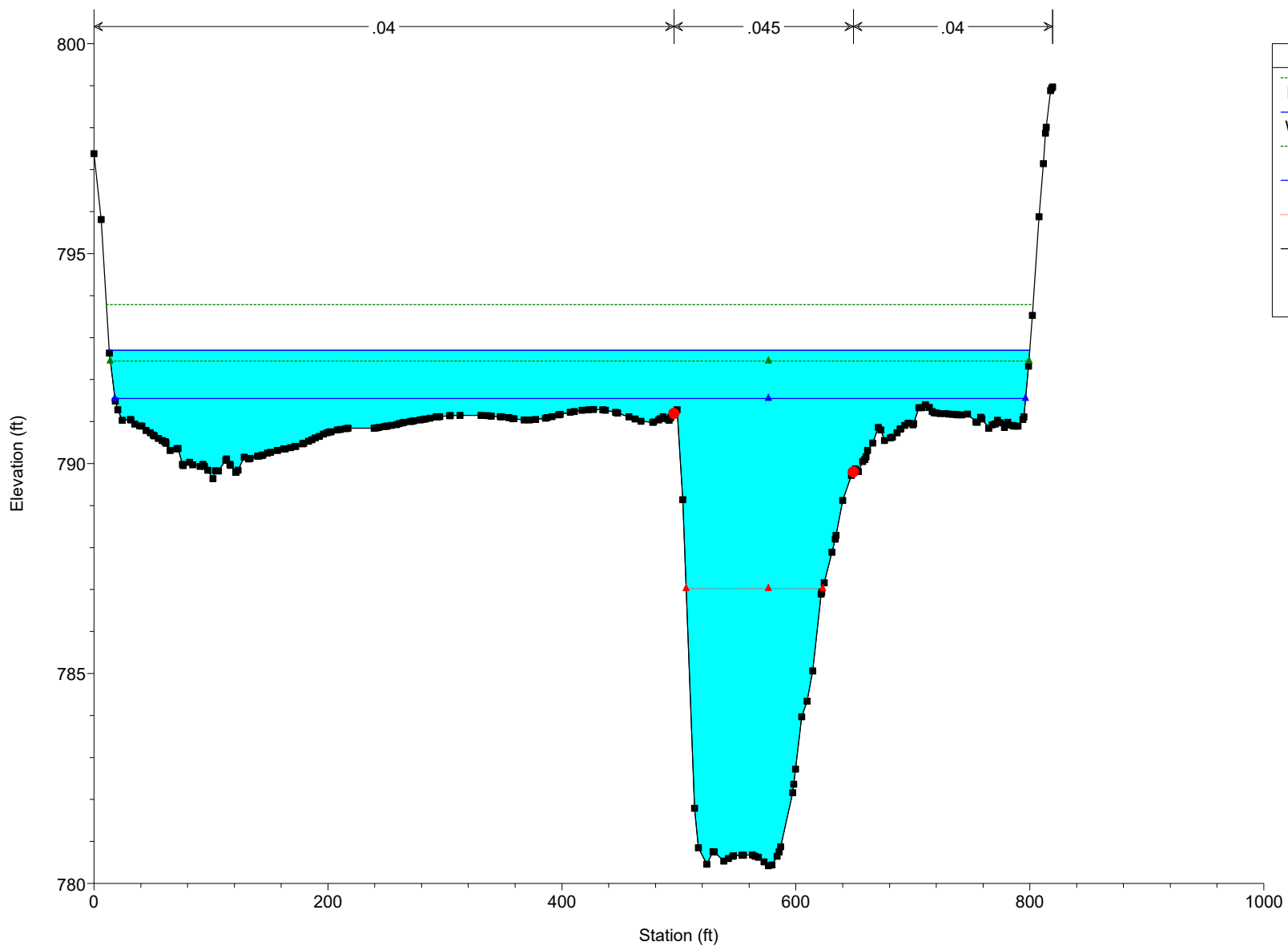
WAR350 Plan: Existing Conditions 4/12/2024



WAR350 Plan: Existing Conditions 4/12/2024

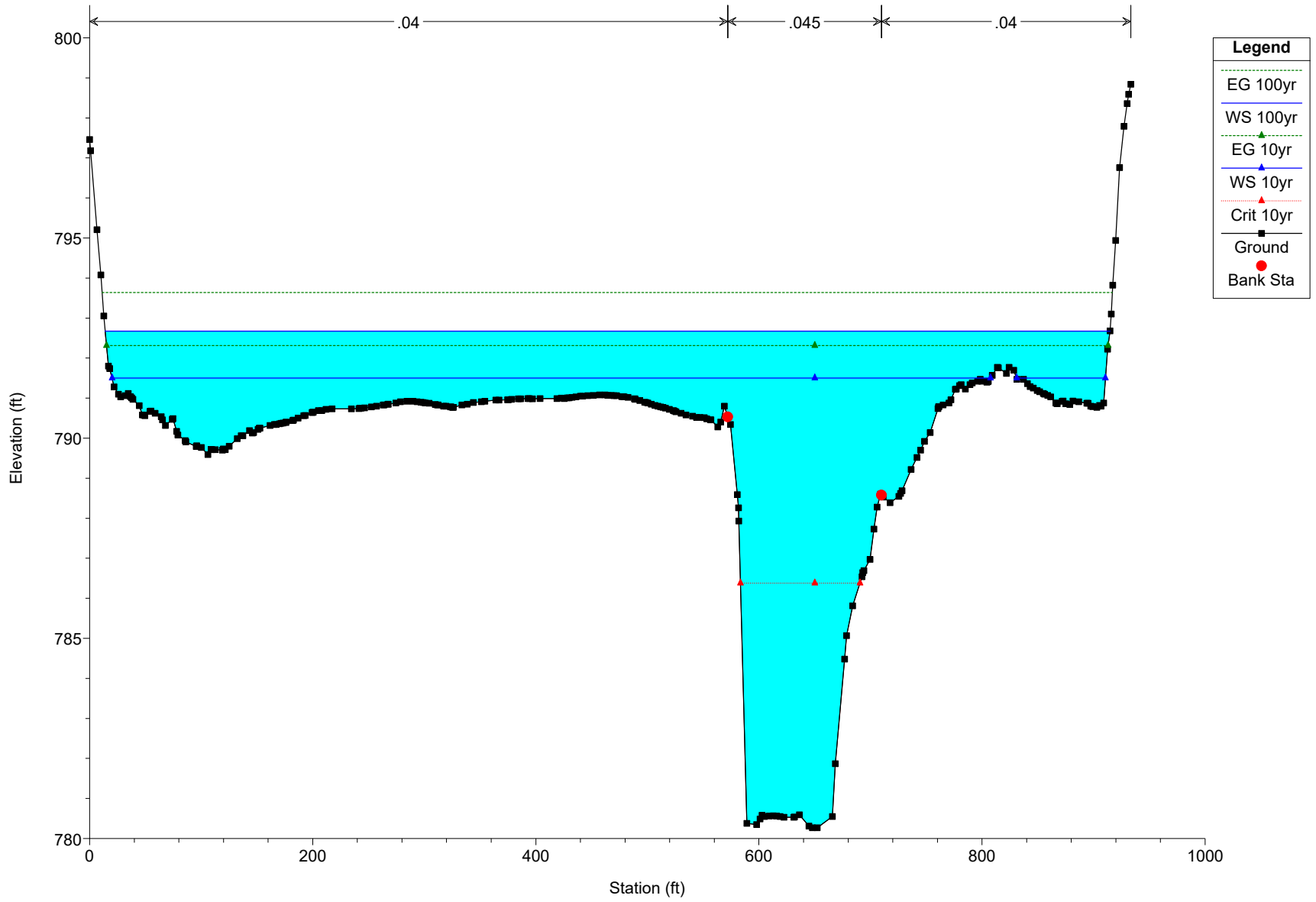


WAR350 Plan: Existing Conditions 4/12/2024

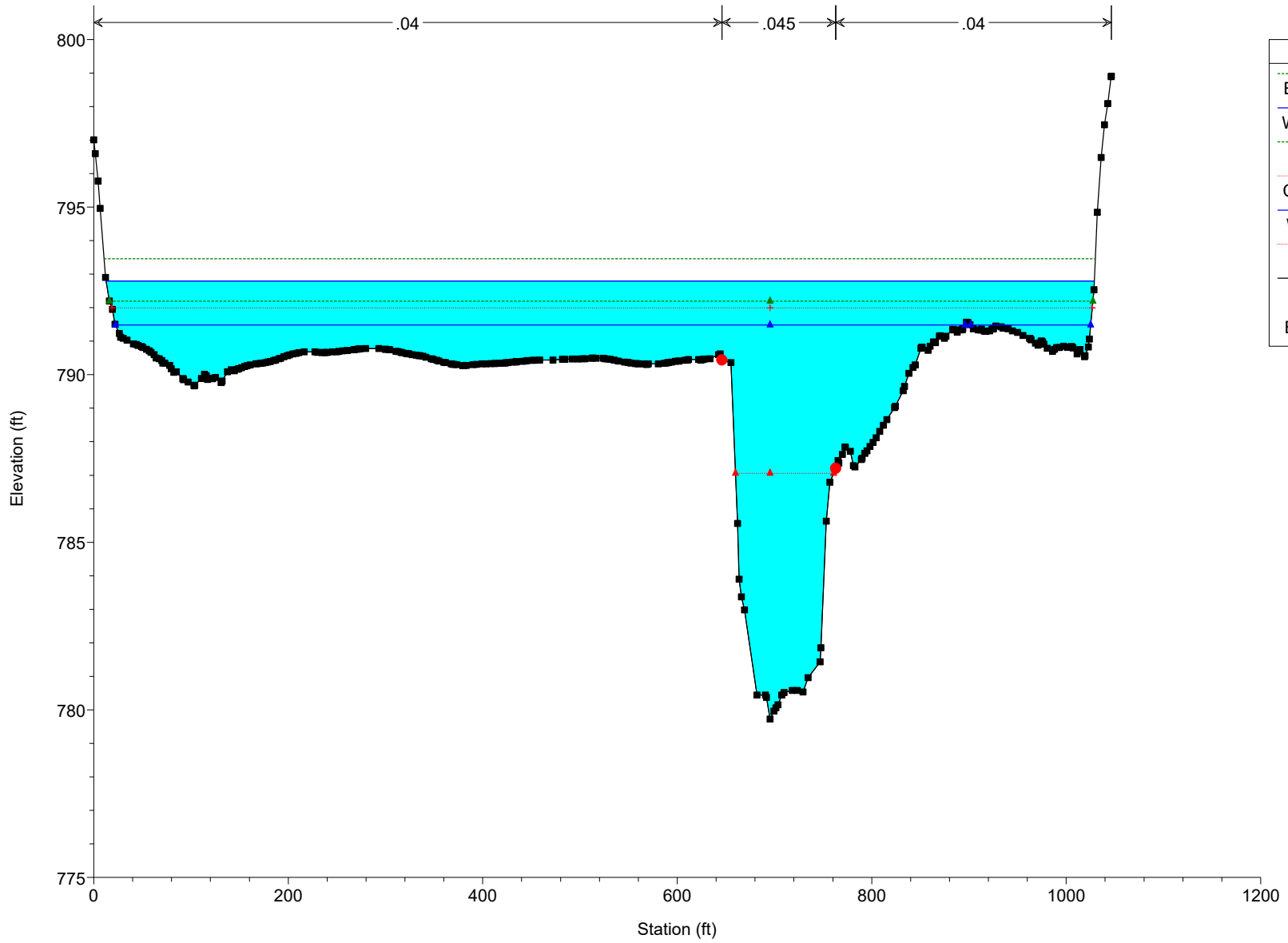


Legend	
EG 100yr	Green dashed line with triangle marker
WS 100yr	Blue solid line with triangle marker
EG 10yr	Green dashed line with triangle marker
WS 10yr	Blue solid line with triangle marker
Crit 10yr	Red dotted line with triangle marker
Ground	Black solid line with square marker
Bank Sta	Red solid circle marker

WAR350 Plan: Existing Conditions 4/12/2024



WAR350 Plan: Existing Conditions 4/12/2024



Legend	
EG 100yr	(dotted green line with triangles)
WS 100yr	(solid blue line)
EG 10yr	(dotted green line with triangles)
Crit 100yr	(dotted red line with triangles)
WS 10yr	(solid blue line)
Crit 10yr	(dotted red line with triangles)
Ground	(black line with squares)
Bank Sta	(red circles)







05/30/2023 11:09



05/30/2023 11:09



05/30/2023 11:12



05/30/2023 11:27