FLOODPLAIN STUDY

HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

PREPARED FOR:
HUNTINGWOOD TRAILS (COLLINGWOOD) LTD.

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CONSULTING ENGINEERS

Revision Number	Date	Comments
Rev. 0	September 2023	Floodplain Study – East Development

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1.0 INTRODUCTION

C.F. Crozier & Associates Inc. (Crozier) was retained by Huntingwood Trails (Collingwood) Ltd. to complete updated flood hazard modelling and a Floodplain Study to accompany the proposed Draft Plan of Subdivision, Zoning By-law and Official Plan Amendment applications for the proposed residential development situated on a portion of the property located at 5 Silver Creek Drive in the Town of Collingwood (Town), also known as the Huntingwood Trails Development, referred to herein as the "Subject Property". The proposed development area, referred to herein as the "Subject Lands", is predominately located on the eastern portion of the Subject Property (east of Silver Creek), with a small portion proposed to the west of Silver Creek, and includes a road connection across Silver Creek from the west of Silver Creek to the eastern portion of the Subject Lands.

The Subject Property is approximately 49 ha in size and is legally described as part of Lots 47, 48 & 49 Concession 12, Town of Collingwood. The Subject Property is bound by Highway 26 and Silver Creek Drive to the north, the Silver Glen Preserve Condominium Development to the east, the Forest Drive Subdivision to the west and the Georgian Trail to the south. The Subject Property consists of the Subject Lands, as well as a draft approved subdivision located on the west side of Silver Creek, referred to herein as the "West Development Area". The proposed Draft Plan of Subdivision for the Subject Lands includes lands within the West Development Area identified as Block 98 Future Development. Refer to **Figure 1** for the Site Location Plan which identifies both the Subject Property and the Subject Lands.

The analysis contained within this Floodplain Study was prepared using the most recent Draft Plan of Subdivision (KLM Planning, January 2023), which can be seen in **Figure 2**. The Draft Plan of Subdivision is comprised of approximately 711 m of roadway, 7 single detached units, 14 semi-detached units and 48 townhouse units.

The purpose of this Floodplain Study is to provide additional information on the parameters, set up, and function of the HEC-RAS model and to summarize the results of the updated model. This Floodplain Study evaluates the tests of Section 3.1 of the Provincial Policy Statement, NVCA, and MNR guidelines as per our Terms of Reference.

2.0 BACKGROUND

A memo is included in **Appendix A** summarizing the historic studies of Silver Creek, as well as natural hazards assessments that have previously been completed for the Subject Property. Please refer to this memo for a fulsome history of the hydraulic studies relevant to the Subject Property.

The Development Areas identified in the Official Plan, as shown on **Figure 1**, were set based on past Natural Hazards assessments by Crozier containing flood limits and erosion hazard limits.

As discussed in the memo included in **Appendix A**, through ongoing discussions with, and at the request of the Nottawasaga Valley Conservation Authority (NVCA), an updated version of the HEC-RAS model from the 2019 Flood Study was prepared for the Subject Property to assist in providing additional confidence of the previously presented regulatory floodline for the West Development Area. This model update was completed in the summer of 2022 in connection with the Ontario Land Tribunal (Case Number OLT-22-002301) in support of Draft Plan Approval of the West Development Area.

The updated model was set up and run as a georeferenced model using HEC-RAS Version 6.3. Geometry inputs were completed using a combination of RAS Mapper and the Geometry Editor. The HEC-RAS model previously circulated to reviewing agencies in 2019 was set up using HEC-RAS Version 4.0 and was not georeferenced. The purpose of the model update was to georeference the model and to associate cross section geometry directly with the surface topographic data. The

georeferenced model provides an accurate picture of how flood waters move through the Subject Property and analyze areas of flood inundation.

The model presented in this report builds upon the HEC-RAS hydraulic model updated in support of the West Development Area Floodplain modelling, developed in consultation with the NVCA, and includes the addition of a road and associated watercourse crossing over Silver Creek to provide access from the West Development Area to the Subject Lands east of Silver Creek.

Terms of Reference were prepared to outline the requirements of this Flood Study and are included in **Appendix B**. The Terms of Reference were prepared in consultation with the Town and NVCA.

3.0 STUDY AREA, RIVERS & REACHES

The study area consists of two reaches: Silver Creek and the Spill Reach, previously referred to as 'Spill B'. The Spill Reach has been referred to as Bridgewater Creek in recent studies by the Town. This nomenclature has been carried forward in this Floodplain Study and the updated model.

3.1 Silver Creek

The Silver Creek Reach consists of two notable portions within the subject model: the Subject Property, and downstream of the Subject Property to Georgian Bay. The upstream limits of the model are approximately 140 m upstream of the Georgian Trail, upstream of the Subject Property. The Silver Creek portion of the model extends through the Subject Property to Highway 26 which is located at the downstream end of the Subject Property. Downstream of Highway 26, the model continues north through the Consulate Lands. Refer to **Figure 3** for a location plan showing the Consulate Lands.

The portion of the model through the Consulate Lands uses the previously approved HEC-RAS model geometry from the Consulate Development. The Silver Creek Reach terminates at the downstream end of Consulate Lands at Georgian Bay. The cross sections have been georeferenced for conformity to the rest of the model.

3.2 Bridgewater Creek (Spill Reach)

The Bridgewater Creek Reach begins within the Subject Lands (east of Silver Creek) and accepts flow from Silver Creek proper that breaches the east bank of Silver Creek. These flows are considered spill flows as they do not return to Silver Creek but continue east in Bridgewater Creek.

Bridgewater Creek flows northeast through the Subject Property and is directed east towards the north end of the site, continuing towards the Silver Glen Preserve Subdivision. The creek is not well defined on the Subject Property with many small drainage pathways that form during spill flow events. Flows converge upstream of the Silver Glen Boulevard culvert and continue east in a grassy area towards Cranberry Trail. Two existing culverts run under Highway 26 which remove flow from the system that continues east, south of Highway 26. Remaining flows overtop Cranberry Trail West and continue east on the south side of Highway 26 through the Cranberry Golf Course lands. The model terminates upstream of Princeton Shores Boulevard.

The portion of the model east of the Subject Property (Silver Glen Boulevard, Cranberry Trail, Golf Course lands) uses the previously approved HEC-RAS model that was developed for the Silver Glen Preserve Subdivision (now constructed). The Silver Glen model extended into the northeastern portion of the Subject Property, however the portion within the Subject Property has been updated to model the flow conditions based on more detailed information of the site. The Silver Glen model cross sections have been georeferenced for conformity to the rest of the model.

3.3 Model Junction

A junction was added to the model at the upstream end of the Subject Property connecting the upstream end of the Bridgewater Creek model to the Silver Creek model. This was done as HEC-RAS Version 6.3 will not allow the user to have two separate reaches in the model. It should be noted that previous versions of HEC-RAS allowed two separate reaches, but certain geometric features are lost from the model when opened in older versions.

Flow optimization was not turned on for the Junction as this would incorrectly compute the flow split between Silver Creek and Bridgewater Creek.

Due to the addition of the junction, the Silver Creek River was split into two reaches in the model: Silver Creek, and Silver Creek Lower (downstream of the junction).

4.0 FLOW DATA

In 1989, Cumming Cockburn Limited ("CCL") conducted a study entitled "Floodline Mapping Study of Silver Creek, Spring Creek, & Village of Angus" which determined the regulatory flood flow at the Subject Property. The CCL Study concluded that Silver Creek upstream of the Subject Property has an approach flow of 109 m^3/s, some of which spills to the west upstream of the Georgian Trail, leaving a flow of 78 m^3/s entering the upstream end of the Subject Property.

A flow of 78 m^3/s was used for the Regional (Timmins) storm event through the Subject Property. This flow was confirmed through an assessment by Crozier in 2014 and re-confirmed with the updated model, finding that 78 m^3/s is a conservate design flow for the Subject Property. Refer to **Appendix A** and to **Section 7.0 Sensitivity Analysis** for additional details.

The 100-year peak flow rate of 44.5 m^3/s was used in the HEC-RAS model, as determined in the CCL Study. Refer to **Appendix A** for additional background information. The Regional and 100-year flow rates of 78 m^3/s and 44.5 m^3/s have been deemed acceptable by the NVCA, as outlined in the Terms of Reference included in **Appendix B**.

For Bridgewater Creek, an upstream flow of 1 m^3/s was used for both the Regional and the 100-year scenarios. The flow was added to improve the stability of the model and provides a conservative result. Twin 450mm diameter culverts under the Georgian Trail pass flows from a small area upstream of the Georgian Trail into the site. The capacity of the twin 450mm diameter culverts is less than 1 m^3/s and therefore the value applied to the upstream end is conservative for modelling purposes.

4.1 Boundary Conditions

4.1.1 Silver Creek

A known water surface elevation was used as the downstream boundary condition in the HEC-RAS model for Silver Creek. A water surface elevation of 178.00 was used as the 100-year peak instantaneous water level of Georgian Bay to conservatively represent a worst-case scenario. This value is from the Great Lakes System Flood Levels and Water Related Hazard document prepared by the Ontario Ministry of Natural Resources (MNR) (February 1989). As mentioned in the above Model Junction section of this Floodplain Study, a junction was added to the HEC-RAS model at the upstream end of the Bridgewater Reach, bisecting the Silver Creek Reach into two reaches: 'Silver Creek' Reach and 'Silver Creek Lower' Reach. The upstream boundary condition of Silver Creek, the upstream end of the model, is normal depth with a slope of 0.01. The model junction acts as the downstream and

upstream boundary condition for the Silver Creek Reach and the Silver Creek Lower Reach, respectively.

4.1.2 Bridgewater Creek (Spill Reach)

Normal Depth was used as the downstream boundary condition in the HEC-RAS model for the Bridgewater Creek Reach. A slope of 0.0013 was taken from the approved Silver Glen Preserve HEC-RAS model. The parameter of normal depth as the downstream boundary condition was used in this model as recommended by the NVCA in comments previously received on the Silver Glen Preserve model. As mentioned above, the upstream boundary condition for Bridgewater Creek is the model junction at the upstream end of the reach.

5.0 GEOMETRIC DATA

5.1 Topographic Surface and Georeferencing

The focus of the updated Huntingwood HEC-RAS model prepared in 2022 was to georeference the model to real world coordinates and to use the existing topographic survey data for definition of cross sections. The RAS Mapper function in HEC-RAS was used to implement these features into the model.

The topographic survey was completed in 2008 by First Base Solutions and encompasses the Subject Property with a small amount of area beyond the property line, and a portion of Forest Drive and Highway 26 to the north of the Subject Property. The surface from the survey was generated using contours and spot elevations provided by First Base Solutions. Minor modifications were completed in AutoCAD Civil 3D to incorporate the streambed through the Subject Property into the topographic surface as aerial topographic surveys are not typically accurate beyond a certain depth of water. Geometric data for the streambed was determined from a site survey completed by Crozier where various areas of Silver Creek were measured (depth, width of channel) to determine a typical cross section. Channel inverts at each cross section were maintained from the previous HEC-RAS model.

The topographic surface from 2008 was verified through a survey that was completed in 2020 using the methodology for Digital Elevation Data Vertical Accuracy Checking (Section 2.2.6) contained within the NVCA Technical Guidelines for Flood Hazard Mapping (March 2017). It was found that the 2008 First Base Solutions survey was well within the acceptable tolerance of 0.30m variance at the 95% confidence level, having an average variance of all points of 0.09m and 0.08m of all points excluding the top 5th percentile. The 2008 First Base Solutions survey was therefore deemed acceptable for the purposes of this study. Results of this assessment have been included in **Appendix A**.

To georeference the model, a 'projection' file with local coordinate data was uploaded to HEC-RAS RAS Mapper. The georeferenced AutoCAD surface was imported into RAS Mapper as a 'Terrain' file, which allows the user to automatically extrapolate geometric data from the Terrain.

The Terrain file is used to generate cross section geometry and delineate flood extents and depths within the bounds of the surface data in RAS Mapper.

5.2 Cross Sections

5.2.1 Cross Section Geometry

Geometry for the cross sections within limits of the Terrain file were generated using the Terrain. RAS Mapper allows the user to extrapolate surface elevation data and geometric data from the Terrain (station and elevations, downstream reach lengths, etc.).

Geometry for cross sections located beyond the limits of the Terrain file were maintained from the previous model.

All cross sections were georeferenced in AutoCAD in relation to the Terrain file, exported as Shape files and imported into RAS Mapper.

A few cross sections were drawn or modified directly in RAS Mapper for areas where additional cross sections were needed, or where extensions were required.

The cross sections for the Silver Creek Reach through the Subject Property terminate at the spill flow interface at the east limit of the cross section. Bridgewater Creek cross sections through the Subject Property similarly begin at the spill flow interface. Determination of the spill flow interface is discussed further in Section 5.4.2.

Cross Section locations for the model can be seen on **Figure 4**. Explanations of cross section geometry features are included on **Figure 5** which can be referred to alongside the following subsections.

Minor modifications were made to the geometry file from the 2022 HEC-RAS model to better evaluate the Subject Lands, particularly the area on the east side of Silver Creek. In the existing conditions model, one cross section was added to the Bridgewater Creek Reach at the location of the proposed development east of Silver Creek. This cross section is within the limits of the existing terrain and was generated in RAS Mapper.

5.2.2 Manning's n

Manning's n values for the study area were determined with reference to Design Chart 2.01 from the Ministry of Transportation Ontario (MTO) Drainage Management Manual. The Manning's n values used through the model have been summarized in **Appendix C** and are described below. Refer to **Figure 5** for an overlay of the cross sections on an aerial image.

Silver Creek

Generally, the Manning's n values used for the overbanks of Silver Creek through the Subject Property are for pasture with high grass (n=0.05) west of the creek, and light brush and trees to medium to dense vegetation (n=0.07 to 0.08) east of the creek as well as upstream of the Georgian Trail.

A Manning's n of 0.045 was used for the channel bottom of Silver Creek from the upstream end of the model to the downstream end of the Subject Property to reflect a natural watercourse of a fairly regular section with some weeds and light brush on the banks.

Downstream of Highway 26 (through the Consulate Lands), a roughness coefficient of 0.07 was used for the channel to represent some weeds and heavy to dense brush on banks. Overbanks on both sides of the channel consist of heavily vegetated areas north of Highway 26, becoming more sparce as the creek approaches Georgian Bay. A Manning's n of 0.10 has been used to reflect medium to dense vegetation.

Bridgewater Creek

The Bridgewater Creek spill reach through the Subject Property does not have a well-defined channel. During spill flow events, water has spread across the Subject Property in many small channels generally flowing northeast. Bank stations for the Bridgewater Creek cross sections were set to the extents of the

cross sections to reflect a consistent Manning's n through the section given the lack of a defined channel.

The Subject Lands east of Silver Creek consist of open pasture, light brush and treed areas. A roughness coefficient of 0.07 was used to represent the site conditions. Toward the downstream end of the Subject Property, the Manning's n was increased to 0.10 to reflect medium to dense vegetation.

As flow approaches Silver Glen Boulevard and continues downstream, the roughness coefficient is reduced to 0.08-0.06 to represent medium to dense vegetation and brush, then further to 0.045 downstream of Silver Glen Boulevard to reflect the grassed areas and golf course lands with a small amount of vegetation and brush. Similar to areas in the Subject Property, the Manning's n for the channel and overbanks are consistent as there is no defined channel through this reach.

5.2.3 Expansion and Contraction Coefficients

To account for the contraction and expansion losses at watercourse crossings, the corresponding coefficients were increased upstream and downstream of crossing locations.

Expansion and contraction coefficients were increased to 0.5 and 0.3, respectively, at the two cross sections upstream of each crossing and one cross section downstream of each crossing. This was applied in the existing conditions model at the Georgian Trail and Highway 26 for the Silver Creek reach, and at Silver Glen Boulevard in the Bridgewater Creek reach.

5.2.4 Overbank Length

The overbank linework was created in AutoCAD and imported into RAS Mapper as a shapefile. The overbank line along the east side of the Silver Creek was located right along the edge of the watercourse. For the west side of the Subject Property and the areas along Bridgewater Creek, upstream of the rail trail and downstream of Highway 26 the overbank line was selected as the expected path of the center of mass for the proposed overbank flow path. The overbank lengths are automatically populated in the HEC-RAS Geometry editor based on the location of the overbank line and the distance between georeferenced cross sections.

5.2.5 Ineffective Flow Areas

Ineffective flow areas were inputted into the model in specified areas up to elevations where flow is not effectively conveyed downstream due to on site features. These areas include upstream and downstream of watercourse crossings at roadways and the Georgian Trail, and around pockets of land with higher land downstream in the direction of flow. The ineffective flow areas are shown on **Figure 5**.

5.2.6 Blocked Obstructions

Blocked obstructions were used in the model to represent permanent ponds and buildings within the study area. A pond exists downstream of Highway 26 in the Consulate Lands. Blocked obstructions in sections 562, 530, and 435 represent the permanent water surface elevation of this pond.

Blocked obstructions were also used to represent the Silver Glen Preserve subdivision. Existing elevations (beyond the Terrain) from the Silver Glen model reflect the pre-development elevations in this area, and blocked obstructions were used to show proposed development that has since been filled in conjunction with the Silver Glen Development.

5.2.7 Levees

Levees were added to the model to ensure that the flows were shown contained within the watercourse prior to overtopping the banks to better represent real-world flow travel routes. The levees allow for the main channel of the watercourse to contain water prior to overtopping its banks and spilling across the Subject Property. In some instances, levee locations were selected within the overbank to ensure that the low-lying areas closest to the main channel filled with water first prior to overtopping to low-lying pockets farther away from the main channel to best represent how flows would inundate the Subject Property.

In the model the levees were added into the HEC-RAS geometry editor and the station and elevations varied for each levee. Each cross section was assessed to determine if a levee was required on one or both sides of the watercourse. **Figure 5** shows each levee location. Levees were added to the model to ensure low areas disconnected from the floodplain would not show flow conveyance. For example, in the existing condition scenario levees were added to the driveway at the north end of the Subject Property, as the driveway forces water to remain on the east side of the driveway prior to overtopping, to represent the real-world scenario more accurately.

5.3 Culverts and Bridges

5.3.1 Silver Creek at Georgian Trail

Silver Creek has three major bridge and culvert crossing locations included as part of the HEC-RAS model. The Silver Creek crossing at the Georgian Trail was modelled as a bridge and the opening size and elevations were selected based on the survey information collected by Crozier in 2014. Dimensions of the Georgian Trail crossing have not changed since 2014 as the same crossing remains. The road deck width, opening size and elevations were selected using the most up to date survey information.

5.3.2 Silver Creek at Hwy 26

The Silver Creek watercourse crossing at Highway 26 has been included in the model. The culvert under the bridge is a 1.5m x 7.5m concrete box culvert. The road deck profile and culvert were based on the survey information.

5.3.3 Silver Glen Boulevard Culvert

The Bridgewater Creek spill flows east along Highway 26 and through the Subject Property and flows under Silver Glen Boulevard. The Silver Glen Boulevard crossing culvert consists of twin 6m x 1.22m concrete box culverts. The road deck profile and culvert size and invert information are based on the design and approved HEC-RAS model completed for the Silver Glen Preserve Development and verified in the field.

5.4 Lateral Structures

5.4.1 Culverts Modelled as a Lateral Structure

In addition to the crossings modelled as bridges or culverts previously discussed in **Section 5.3,** two culverts exist that drain south to north under Highway 26 in the study area that remove water from the Bridgewater Creek spill system. These culverts have been included in the model as lateral structures with rating curves which determines outlet flow on the computed water surface elevation. The rating

curves used for these culverts are consistent with the approved HEC-RAS model for Silver Glen Preserve.

The first lateral structure is located at Station 670, between Stations 685 and 660, at the northeast corner of the Subject Property and represents a 1.66m by 5.5m concrete box culvert under Highway 26. The second lateral structure is located at Station 420, between Stations 428 and 416, downstream of Silver Glen Boulevard and represents a 1.0m by 1.55m concrete box culvert under Highway 26. Flows are removed from the system at these structures as shown in the results table in **Appendix D**. Refer to **Table 1** for a summary of the rating curves based on water surface elevation for each culvert.

Table 1: Hwy 26 Lateral Culvert Rating Curves

Culvert #1 (Station 670)		Culvert #2 (Station 420)	
Reference Water Surface Elevation	**Outlet Flow (m^3/s)**	**Reference Water Surface Elevation**	**Outlet Flow (m^3/s)**
179.79	5.55	178.62	0.62
180.04	8.33	178.67	0.78
180.23	11.10	178.80	1.09
180.64	16.65	178.97	1.55
181.05	22.20	179.22	2.33
182.96	38.85	179.62	3.10
		180.27	4.65
		181.27	6.20
		182.67	7.75

5.4.2 Spill Flow Lateral Structure

To determine spill leaving Silver Creek as water breaches the east bank, a lateral structure was delineated in AutoCAD Civil 3D through analysis of the Terrain surface to determine the location and elevation of the spill flow interface. The spill flow interface was identified along the east bank of Silver Creek at the high point where, as water passes this elevation, it would flow out of the Silver Creek watershed and into the Bridgewater Creek spill system and would not return to Silver Creek. The georeferenced location, station and elevation data were extracted from AutoCAD for the lateral structure. This information was inputted into HEC-RAS through the geometry editor as a lateral structure defined by a weir / embankment. Centerline GIS coordinates were inputted to instruct the model as to the location of the weir. As the cross sections in this area are georeferenced, the model automatically determined the headwater and tailwater connections of the lateral structure from Silver Creek and to Bridgewater Creek, respectively.

5.5 Proposed Conditions HEC-RAS Model Updates

The proposed development introduces a public road crossing over Silver Creek to access the Subject Lands east of Silver Creek, complete with a proposed watercourse crossing of Silver Creek.

Post-development conditions for the Subject Lands were modelled in HEC-RAS through updates to the Existing Conditions model to incorporate the proposed development features and to evaluate the impacts and ensure the current proposed watercourse crossing is adequately sized.

As development of the Subject Lands would only be constructed following development of the

West Development Area (since services and road access are from the West Development Area), the post-development terrain was updated in AutoCAD to reflect the full build out conditions of the West Development Area. This terrain file is used in the proposed conditions model for the purposes of this Floodplain Study.

Two hydraulic modelling scenarios were assessed in HEC-RAS for proposed conditions on the Subject Property to assess impacts on water surface elevations within the Study Area: Proposed Conditions (Option A); and Proposed Conditions (Option B). The two proposed scenarios provide options for cut areas to accommodate a cut/fill balance. Applying cut/fill balance to the site was agreed to in principle upon settlement of the West Development Area OLT file. A comparison of the results of the Proposed Conditions models to the Existing Conditions model, as well as further description of Option A and B, is included in **Section 6.0**.

The Proposed Conditions models include the proposed crossing over Silver Creek and obstructions representing units on the Subject Lands and the roadway.

The changes made to the Existing Conditions model to reflect proposed conditions are summarized below:

- The existing conditions Terrain was updated in AutoCAD Civil 3D to include fill along the limits of the West Development Area and the lots and roadway from the Subject Lands west of Silver Creek
    - Option A and Option B were graded in AutoCAD to reflect proposed 'cut' west of Silver Creek, creating two Proposed Conditions Terrains (one for each Proposed Condition modelling file)
- Cross Section geometry was updated through RAS Mapper to reflect the Proposed Conditions Terrain
- Blocked Obstructions were added to cross sections in the Bridgewater Creek Reach to reflect proposed development of the Subject Lands (roadway and lots) east of Silver Creek.
- The proposed watercourse crossing was added to represent the access road to the eastern portion of the Subject Lands:
    - Cross sections (1730 and 1705) were added to the Proposed Conditions models as bounding cross sections for the proposed road access from the West Development Area to the Subject Lands east of Silver Creek;
    - The road deck width and elevations were selected based the proposed grading design;
    - A road deck elevation of 187.5m was selected with a low chord elevation of 186.4m at the opening;
    - The opening size for the bridge was determined to be 14 m wide to ensure safe passage of the Regional Storm event and no impacts to water surface elevations upstream of the Subject Property;
    - The location of the proposed crossing has been coordinated with the environmental consultants.
- To account for the addition of the bridge, ineffective flow areas and expansion and contraction coefficients were adjusted for cross sections upstream and downstream of the proposed crossing.
- The lateral weir structure that represents the flow spill from Silver Creek to Bridgewater Creek was adjusted in the proposed condition to be downstream of the proposed crossing. Under existing conditions, the upstream end of the lateral structure is in the area of the proposed crossing. Once the bridge is constructed a small portion of the upstream lateral structure (spill area) will be removed and spill will begin downstream of the crossing.

Modelling results are discussed in the following section of this Floodplain Study including assessment of the impacts of the proposed development and watercourse crossing on existing conditions.

6.0 RESULTS

6.1 HEC-RAS Output Discussion

6.1.1 Model Computations

The RAS Mapper function in HEC-RAS generates a water inundation map for storm events on site based on the water surface elevations results calculated by the model. This function interpolates the water surface elevation from one cross section to the next through the reach to create a water surface profile. The model compares the water surface profile with the existing ground elevations to determine the limits of water inundation. In areas where the existing ground is lower than the water surface profile, the model will show water inundation.

The model results from RAS Mapper are shown in **Appendix C**, depicting the ranges of depth of inundation during the Regional storm event.

The result maps generated in RAS Mapper (**Figure 8** and **Figure 9**) have limitations and require further scrutiny and analysis. The analytical method that HEC-RAS uses does not account for areas that are fully disconnected from the floodplain. The resultant map shows pockets of inundation in low areas that flood flows would not have been high enough to reach.

On the eastern side of Silver Creek, although water is spilling east after overtopping the east bank (modelled as a lateral structure), the model output does not show inundation directly adjacent the creek. The model uses the resulting flow at each cross section, calculates the steady water surface elevation, and develops the water depth map from the results, rather than showing the flow path and lateral gradient of the spill.

The RAS Mapper results are limited to areas where the Terrain exists, and therefore the mapping does not generate results outside of the site beyond the Terrain data.

In the Subject Lands Proposed Conditions Options A and B, the RAS Mapper output shows the area of the proposed roadway connecting to the east as inundated because the Terrain in the model does not include proposed road elevations in this area. The RAS Mapper output is using the Terrain data with the water surface elevations and does not account for obstructions or added road decks. Please refer to the cross-section output of the model included in **Appendix D** for a depiction of water surface elevations adjacent the proposed crossing.

6.1.2 Spill Flow Computations

The model uses the lateral structures to calculate spill flow from Silver Creek to the east as water surface elevations exceed the elevation of the lateral structure. Between each cross section along the length of the lateral structure, the model calculates the flow leaving Silver Creek based on the water surface elevation. This flow is added to the adjacent downstream cross section of the Bridgewater Creek reach.

The existing culverts under Highway 26 in the Bridgewater Creek reach calculate the flow leaving the model based on the rating curves shown in **Table 1**. A summary of the flow through the model is shown

on the HEC-RAS output tables in **Appendix C** (existing conditions) and **Appendix D** (proposed conditions), and the cross-section locations are shown on **Figure 4.**

Table 2: Summary of Flow and Spill Flows - Existing Conditions (Regional)

Silver Creek			Bridgewater Creek		
Cross Section ID	**Flow (m^3/s)**	**Cumulative Flow Leaving[1] (m^3/s)**	**Cross Section ID**	**Flow (m^3/s)**	**Flow Leaving[3] (m^3/s)**
1744	78		1394	1[2]	
			1342	6.64	
1674	65.81	12.56	1310	13.56	
1516	40.36	38.00	1200	39.00	
1425	38.13	40.87	1135	40.87	
1313	36.71	42.60	1069	42.60	
1155	35.69	42.20	1006	43.20	
1037	39.70	40.49	936	41.49	
978	38.03	52.32	840	53.32	
911	25.47	52.53	740	53.53	
903	25.47	52.53	685	53.53	
Culvert	Culvert		Lat Struct		
858	25.47		660	29.65	23.88
808	25.47		636	29.65	
669	25.47		606	29.65	
562	25.47		588	29.65	
530	25.47		572	29.65	
435	25.47		545	29.65	
348	25.47		520	29.65	
273	25.47		Culvert		
171	25.47		475	29.65	
52	25.47		446	29.65	
			428	29.65	
			Lat Struct		
			416	23.31	6.34

[1] Flow spilling over the east bank of Silver Creek to Bridgewater Creek
[2] 1 m^3/s applied at upstream end of Bridgewater Creek for model stability
[3] Flow leaving Bridgewater Creek via culverts under Highway 26

As shown in **Table 2**, total flow of 52.53 m^3/s spills east from Silver Creek to Bridgewater Creek through the Subject Property in the Existing Condition, leaving 25.47 m^3/s within Silver Creek to continue downstream through the Consulate Lands. It should be noted that between cross-section 1155 to 1037 a small amount of flow returns to Silver Creek in the Regional Storm event. Considering the total flow leaving Silver Creek to the Bridgewater Creek spill reach, the amount returning in between these cross-sections is minor and flows throughout the Subject Property are predominantly leaving the system both upstream and downstream of this section where flows return.

6.2 Proposed Conditions Floodplain and Inundation Limits

Results of the Existing Conditions HEC-RAS model for the 100-year and Regional Storm were generated through RAS Mapper, and further assessed in AutoCAD to confirm inundation of certain areas that flood waters would not reach.

The RAS Mapper results for Existing Conditions are included on **Figure 8** and **Figure 9** for the Regional and 100-year storm events, respectively. **Figure 6** depicts the existing natural hazards on site including the 100-year and Regional floodlines west of Silver Creek, the inundation limits from the spill east of Silver Creek, and the meander belt limit, which is discussed in **Appendix A**.

As shown in **Figure 6**, the proposed development areas of the Subject Lands as well as the West Development Area are predominantly out of the floodplain limits, subject to smoothing the existing floodline as agreed upon with the NVCA. Based on the pre-development floodplain mapping, the proposed developments on the Subject Property still meet the relevant policies that permit development based on the results of this updated model.

6.3 Cut/Fill Balance

As discussed in **Section 6.1**, the results generated in RAS Mapper require further analysis and certain portions that are shown as inundated during the Regional Storm do not effectively convey floodwaters. The results associated with these areas produce an irregular floodline with pockets that would not contribute to effective flood conveyance.

Regarding the West Development Area, through discussions with the NVCA it was agreed that:

> *A reasonable delineation of the flood hazard limit should take into account the interface of areas of active flood conveyance vs. more ineffective depression areas / static pools / shallow spills that may become inundated. For the purposes of this assessments the final Flood Hazard Limit can be reasonably "smoothed" using traditional cut / fill balance techniques along the east boundary of the subject (west side of the floodplain)*

As such, we have assessed the West Development Area and Subject Lands west of Silver Creek in a condition with a smoothed floodline where areas beyond the active flood conveyance area have been filled. To maintain flood storage volumes, areas within the flood conveyance corridor west of Silver Creek have been cut to balance the filled areas.

In addition to smoothing the floodline, additional compensation has been provided to account for filling within the existing floodplain area at the proposed watercourse crossing from west to east. Similar to areas filled to smooth the floodline, cut compensation has been provided adjacent to Silver Creek within the flood conveyance corridor. This is discussed further in **Section 6.4**.

Minor cut compensation is required east of Silver Creek for the Subject Lands which has been proposed to expand an existing area between the proposed roadway and Georgian Trail.

A review of the cut/fill analysis was completed by the environmental consultant to confirm that the scope of work is not significant. Fill will be extracted from an area of the Subject Lands which is characterized as an open meadow. Therefore, minimal vegetation will need to be removed and the works will have no negative impacts.

A cut/fill analysis was completed to assess the impacts of smoothing the floodline and preventing water inundation in areas that would not effectively convey flood water.

Two proposed conditions scenarios were modelled to assess the impacts of the development with cut/fill on the Subject Property. Both scenarios include cut/fill on the Subject Lands east of Silver Creek and vary for the proposed cutting locations and depths proposed west of Silver Creek.

- **Option A – Channel:** Cut compensation areas have been provided by creating a secondary overflow channel located west of and running parallel to Silver Creek
- **Option B – Flattening:** Cut compensation areas have been provided by extending the existing floodplain locations by cutting down the surrounding higher elevation areas, generally flattening the overland flow area west of Silver Creek.

6.3.1 Cut/Fill Balance Results

A minimum 30m setback from Silver Creek was set as a buffer where cut compensation has not been proposed to respect natural onsite features. The total fill volume proposed in the floodplain was calculated in AutoCAD per the fill areas described above and with respect to the existing water surface profile elevations through the Subject Property.

The fill volume target was used to determine the corresponding requirement for cut compensation. Two scenarios were generated for cut compensation, both proposing cut between the development limits and a 30m offset west of Silver Creek and generated using grading tools in AutoCAD to determine cut volumes.

Cut and fill volumes east and west of Silver Creek were assessed independently as the systems are separate once flows overtop the eastern bank of Silver Creek and spill to Bridgewater Creek.

The results of the cut / fill balance have been summarized in **Table 3**.

Table 3: Cut / Fill Balance Summary

Location	Scenario	Fill Quantity (m^3)	Cut Quantity (m^3)
East of Silver Creek	Both A & B	334	480
West of Silver Creek	Option A	7462	7875
	Option B	7462	7693

Per **Table 3,** sufficient cut volumes have been provided to compensate for the fill volumes proposed in the Subject Property.

Refer to **Figure 12** and **Figure 13** for Cut and Fill Plans for Option A and Option B west of Silver Creek, and to **Figure 14** for the Cut and Fill Plan east of Silver Creek. Detailed grading plans will be prepared as part of future Detailed Design upon confirmation of general acceptance from NVCA and any preference for Option A or B.

6.4 Hydraulic Results

Three hydraulic modelling scenarios were assessed in HEC-RAS for the Subject Property to assess impacts on flows and water surface elevations within the Study Area.

Scenarios include:

- Existing Conditions
- Proposed Conditions (Option A)
- Proposed Conditions (Option B)

Option A (secondary channel) and Option B (flattening overland area) are the different 'cut' grading options in post-development conditions to compensate for fill as described in **Section 6.3**.

6.4.1 Flow Rates and Spill Flow

Table 4 summarizes the resulting flows in each modelling scenario throughout the Study Area.

Table 4: Comparison of Total Flows at Downstream End of the Subject Property (Regional)

Location	HEC-RAS Cross Section ID	Flow Summary (m^3/s)		
		Existing Conditions	Proposed Option A	Proposed Option B
Silver Creek				
Upstream of Subject Property	1971	78	78	78
Hwy 26 to Georgian Bay *Silver Creek East Bank*	911	25.47 (-52.53)	27.13 (-50.87)	26.08 (-51.92)
Bridgewater Creek				
Upstream end of Model [1]	1478	1	1	1
Downstream of Spill on Subject Property *Silver Creek East Bank*	740	53.53 (+52.32)	51.87 (+50.87)	52.92 (+51.92)
Northeast Corner of Huntingwood Site *Culvert Under Hwy 26*	660	29.65 (-23.67)	28.12 (-23.75)	29.31 (-23.61)
Downstream of Silver Glen Bvld. *Culvert Under Hwy 26*	416	23.31 (-6.34)	21.88 (-6.24)	23.02 (-6.29)

Note 1: 1 m^3/s applied to the upstream end of Bridgewater Creek Reach to provide model stability.
Note 2: *Italicized* text represents the lateral structure from which flows are leaving or being added to watercourses. Refer to **Section 5.4** for details on the lateral structures.
Note 3: Values in brackets represent flow leaving or being added to the watercourse.

As shown in **Table 4**, flows maintained in Silver Creek and spilling to Bridgewater Creek are similar in existing and proposed conditions scenarios, varying by a maximum of 1.66 m^3/s. In our opinion the slight reduction in spill to Bridgewater Creek in proposed Options A and B is not a material change.

Downstream of the Subject Property, areas in Bridgewater Creek have a higher flood risk than areas within Silver Creek as areas downstream of Silver Creek are currently undeveloped. Development applications for the Consulate Lands (Silver Creek downstream) include conditions to meet floodproofing requirements and provide safe conveyance of Regional flows to Georgian Bay. Removing a small volume of spill through the Subject Property from Silver Creek to Bridgewater Creek will benefit the downstream areas of the Bridgewater Creek watershed, which consists of existing developments and houses.

The results of the CCL Study yielded 47 m^3/s maintained in Silver Creek and 31 m^3/s spilling to Bridgewater Creek. The variance between the Crozier and CCL models is due to a more accurately

modelled lateral structure which simulates the spill out of Silver Creek over the eastern bank. The CCL model only included a spill area at the downstream end of the Subject Property adjacent Highway 26, thus resulting in less spill overall and more flow maintained in Silver Creek.

6.4.2 Water Surface Elevation Comparison

The Existing and Proposed Option A and Option B were assessed in HEC-RAS and the resulting water surface elevations at each cross section location have been summarized in **Table 5** and **Table 6** for Silver Creek and Bridgewater Creek Reaches, respectively.

Table 5: Silver Creek Water Surface Elevation Comparison (Regional)

Cross Section ID	Regional Water Surface Elevation (m)		
	Existing Condition	Proposed Option A	Proposed Option B
1971	188.00	188.00	188.00
1931	187.51	187.51	187.51
1848	187.43	187.43	187.43
1835	187.43	187.43	187.43
Georgian Trail			
1810	186.46	186.90	186.92
1798	186.33	186.78	186.81
1778*		186.75	186.79
1744	185.97	186.34	186.34
Proposed Access Road			
1705*		185.29	185.22
Lat Structure			
1674	185.34	185.20	185.12
1516	183.95	183.83	183.94
1425	183.45	183.44	183.49
1313	183.05	183.12	183.17
1155	182.22	182.58	182.57
1037	181.82	181.88	181.91
978	181.59	181.67	181.61
911	181.47	181.59	181.51
903	181.43	181.54	181.47
Highway 26			
858	180.91	180.93	180.92
808	180.71	180.73	180.72

* Sections added for bridge added in proposed conditions.

As shown in **Table 5** for the Silver Creek reach, the water surface elevations upstream of the Georgian Trail (1971-1835) match the existing condition and therefore proposed development will not impact lands upstream of the Subject Property.

Water surface elevations fluctuate between the existing and proposed conditions within the limits of the Subject Property; however, grading of the proposed development will be completed to ensure that the proposed lots are adequately floodproofed. Downstream of the Subject Property the proposed conditions show an insignificant increase in water surface elevation. The 1-2 cm increase in water surface elevations on Silver Creek downstream of the Highway 26 road crossing is due to the very slight flow decrease in spill flows to Bridgewater Creek, resulting in more flow being maintained in Silver Creek under Proposed Conditions (refer to **Table 4**). These areas are fully contained within the Consulate environmental land and will be reduced through future flood conveyance improvements to be implemented as part of that development. As such, the proposed development does not cause any negative impacts to upstream and downstream property owners in the Silver Creek watershed in the Study Area. Detailed HEC-RAS output information for Silver Creek existing and proposed conditions have been provided in **Appendix C** and **Appendix D** respectively.

An assessment of the water surface elevations for Bridgewater Creek is summarized in **Table 6**.

Table 6: Bridgewater Creek Water Surface Elevation Comparison

Cross Section ID	Regional Water Surface Elevation (m)		
	Existing Condition	Proposed Option A	Proposed Option B
1478	185.70	185.70	185.70
1394	185.41	185.21	185.18
1349	184.78	184.75	184.73
1310	183.84	183.66	183.59
1200	183.57	183.41	183.37
1135	183.36	183.21	183.18
1069	182.81	182.70	182.68
1006	182.35	182.25	182.26
936	182.11	182.07	182.08
840	181.18	181.17	181.17
740	180.65	180.62	180.64
685	180.59	180.55	180.58
Hwy 26 Cross Culvert #1			
660	180.58	180.54	180.57
636	180.58	180.53	180.57
606	180.57	180.53	180.56
588	180.56	180.52	180.55
572	180.55	180.51	180.54
545	180.53	180.48	180.52
520	180.41	180.36	180.40
Silver Glen Bvld			
475	180.15	180.13	180.15
446	180.08	180.06	180.08
428	179.93	179.91	179.92
Hwy 26 Cross Culvert #2			
416	179.91	179.89	179.90
381	179.89	179.87	179.89
367	179.87	179.85	179.87

The HEC-RAS model results show a decrease in water surface elevations for both proposed conditions options. As mentioned slightly more water is contained within the Silver Creek watercourse under the proposed conditions which results in reduced spill flow to Bridgewater Creek. The decrease in water surface elevations downstream of the Subject Property are minimal and within the tolerance of accuracy for the HEC-RAS model but also represent a benefit to existing flood susceptible areas within this reach.

Detailed HEC-RAS output information for Bridgewater Creek has been provided in **Appendix C** and **D,** for the existing and proposed conditions, respectively.

The HEC-RAS RAS Mapper output for the proposed condition scenarios Option A and Option B are included on **Figure 10** and **Figure 11**, respectively.

6.4.3 Proposed Watercourse Crossing

A bridge was added to the HEC-RAS model with an opening designed to convey the Regional Storm event within Silver Creek. The proposed watercourse crossing has a span of 14m, a maximum height of 2.2m at the banks, and a maximum height of 2.5m above the watercourse invert.

The opening size of the proposed watercourse crossing was determined through model iterations to ensure conveyance of all storm events without overtopping the roadway and to eliminate any upstream water surface impacts not contained on the property.

Refer to **Appendix D** for modelling results around the proposed watercourse crossing demonstrating conveyance of all storm events.

NVCA regulations require safe access and egress over proposed watercourse crossings such that the flow depth does not exceed 0.3m, velocity does not exceed 1.7 m/s, and the depth x velocity product does not exceed 0.4 m^2/s. The proposed watercourse crossing has been designed to convey flows from all storm events, including approach flow of 109 m^3/s upstream of the site prior to spill (refer to **Section 7.1** and **7.2**). Therefore, safe access and egress are provided over the proposed crossing as it conveys all storm events without overtopping.

The proposed crossing results in increased water surface elevations within the Subject Property immediately upstream of the crossing due to backwater upstream of the bridge, however these impacts do not extend upstream of the site. Proposed grading on the Subject Property at the proposed developments will be designed to have suitable floodproofing.

7.0 SENSITIVITY ANALYSIS

7.1 Approach Flow & Spill 'A' Confirmation

In 1989, CCL conducted a study entitled "Floodline Mapping Study of Silver Creek, Spring Creek, & Village of Angus" which determined the regulatory flood flow at the Subject Property. The CCL Study concluded that Silver Creek upstream of the Subject Property has an approach flow of 109 m^3/s, a significant portion of which spills to the west upstream of the Georgian Trail, leaving a flow of 78 m^3/s entering the upstream end of the Subject Property.

In March 2014, Crozier completed an analysis regarding Silver Creek flows upstream of the Subject Property to confirm the appropriateness of the Regulatory flow of 78 m^3/s determined in the CCL Study. Upstream of the Subject Property, Silver Creek conveys 109 m^3/s towards Georgian Trail. The

CCL Study established the existence of a spill condition south of the Georgian Trail on Silver Creek spilling to the west, denoted as Spill Zone 'A'. This spill flow occurs due to insufficient capacity of the Georgian Trail culverts to convey the Regional Event, combined with low elevations in the west overbank of Silver Creek upstream of the Trail. Based on their assessment of these hydraulic components, CCL established that Spill 'A', in the amount of 31 m^3/s, breaches the west bank of the Silver Creek floodplain and spills westerly to Watercourse #1. The remaining 78 m^3/s has historically been used as the Regulatory flow for the Subject Property and downstream lands. Refer to **Appendix A** for additional background information.

Spill 'A' was added to the Existing Conditions HEC-RAS model to confirm that the flows used were still applicable with the updated georeferenced model. A flow of 109 m^3/s was applied to the upstream end of Silver Creek at cross section 1971. A lateral weir was added to the model approximately 600m west of Silver Creek and shows a spill of 42 m^3/s west towards Watercourse #1. The remaining 67 m^3/s continues through the bridge at the Georgian Trail crossing into the Subject Property. Similar conclusions yielding a larger spill flow of Spill 'A' were determined through additional assessment in 2014 (refer to **Appendix A**).

Previous Natural Hazards assessments (described in **Appendix A**) completed for the Subject Property maintained the CCL flow rate of 78 m^3/s as a conservative design approach. To maintain a conservative design, this flow has been maintained as the Regulatory flow through the site for the purpose of delineating existing flood hazards downstream of the Georgian Trail. **Table 7** summarizes the CCL, Crozier 2014 Spill 'A' assessment and the Spill 'A' assessment completed with the Existing Conditions model presented in this report.

Table 7: Silver Creek Main Channel and Spill Flow Summary Upstream of Huntingwood Lands

Location	Description	CCL Flows (m^3/s)	Crozier (2014) Flows (m^3/s)	Crozier (2023) Flows (m^3/s)	Type of Flow	Direction of Flow	Downstream Channel
Silver Creek Upstream of Georgian Trail	Silver Creek	109	109	109	Main Channel	North	Silver Creek
Upstream of Georgian Trail	Overbank Spill from Silver Creek	31	34	42	Spill	West	Watercourse 1 ("Spill A")
Georgian Trail	Spill over Georgian Trail	-	18	-	Spill	West	Forest Subdivision / Watercourse 1
Georgian Trail	Spill over Georgian Trail	-	4	-	Spill	East	Spill Zone 'B'
Upstream end of Huntingwood	Silver Creek	78	53	67	Main Channel	North	Silver Creek

7.2 Flood Proofing Scenario

To ensure proposed development on the Subject Property is designed for the worst-case scenario flood proofing elevations, a sensitivity analysis was completed to determine the resulting water surface elevations in the event that the full upstream approach flow of 109 m^3/s were to enter the Subject Property at the upstream end (ie. Spill 'A' would be eliminated). This scenario also considers potential impacts of climate change through assessment of an increased flow rate through the Subject Property.

Table 1 provided in **Appendix E.1** compares the water surface elevations in Proposed Conditions Option A and Option B with flows of 78 m^3/s and 109 m^3/s. The output tables from HEC-RAS have also been included in **Appendix E.1**.

A comparison was completed to assess resulting water surface elevations at the Subject Lands and the West Development Area to confirm whether the increased flow would impact development on the Subject Property. Resulting water surface elevations near areas of proposed development with a flow of 109 m^3/s were assessed and it was determined that the development on the Subject Property would still have sufficient flood proofing in this scenario. Resulting water surface elevations at the proposed watercourse crossing were also reviewed in HEC-RAS and it was noted that the proposed crossing is sufficiently sized to convey the increased flows without overtopping, maintaining safe ingress and egress.

Conveyance of the full approach flow of 109 m^3/s will not impact development on the Subject Property. Lots will be floodproofed to the resulting water surface elevations of this scenario.

7.3 Silver Glen Boulevard Culvert

An assessment was completed to determine how the water surface elevations across the Subject Property will be affected by blockage of the Silver Glen Boulevard culverts. Existing Conditions 100-year and Regional storms were assessed with 50% blockage applied to the existing Twin 6m x 1.22m concrete box culverts under Silver Glen Boulevard. Silver Creek showed no increases in the 100-year event and negligible increases in the Regional event. Bridgewater Creek experiences increases in water surface elevations upstream of the Silver Glen Boulevard from cross-section 520 to cross-section 740 ranging from 4cm to 34cm in the 100-year and from 25cm to 42cm in the Regional storm. The impacts dissipate upstream of cross-section 740, which is located approximately 140m into the Subject Property in areas that are not proposed for development. As such, blockage of this culvert is not a sensitive parameter for the development as impacts dissipate downstream of proposed development areas. A comparison table and the HEC-RAS output table for this scenario can be found in **Appendix E.2**.

7.4 Silver Creek Downstream Boundary Condition

The downstream boundary condition of Silver Creek (known water surface elevation of Georgian Bay) was raised by 1m to 179m, to assess potential impacts to the site. The downstream end of the Subject Property is approximately 800m upstream of Georgian Bay. The impacts of raising the downstream boundary condition dissipate approximately 350m south of the outlet to Georgian Bay, which is approximately 450m north of the site boundary. Therefore, the downstream boundary condition is not a sensitive parameter to the floodplain results on the Subject Property. A comparison table and the HEC-RAS output table for this scenario can be found in **Appendix E.3**.

8.0 EROSION HAZARDS

An erosion hazard assessment of the main branch of Silver Creek was prepared as part of the overall natural hazards assessment described herein. Silver Creek is classified as an "unconfined system" according to the MNR publication Understanding Natural Hazards (MNR, 2001). This document defines an unconfined system as those systems where the watercourse is not located within a valley corridor with discernable slopes, but relatively flat to gently rolling plains and is not confined by valley walls. This is consistent with the characteristics of Silver Creek within the study area. Accordingly, the erosion hazard limit associated with unconfined systems is defined by the meander belt allowance.

The meander belt allowance is defined by the maximum extent that a channel migrates (MNR, 2001). A detailed assessment of the meander belt on a reach-specific assessment has been undertaken.

8.1 Meander Belt Allowance

In order to develop the meander belt allowance for the subject watercourse, a field assessment of the geomorphic characteristics of Silver Creek throughout the subject property was undertaken by Crozier in 2011. This assessment was completed using the Rosgen Classification System and detailed air photo topographic survey of the subject lands with reference to the methodology and data presented in the MNR (1996) publication Morphological Relationships of Rural Watercourses in Southern Ontario and Selected Methods in Fluvial Geomorphology.

Using the relationships presented in the Morphological Relationships of Rural Watercourses in Southern Ontario and Selected Methods in Fluvial Geomorphology (MNR, 1996), the meander belt width was calculated based on the bankfull stream width, measured at the largest amplitude meander. The meander belt width computed using this methodology ranged from 95 m to 119 m over the three reaches analyzed. This meander belt width is centered on the meander belt axis of each respective stream reach. Refer to **Figure 6** and **Figure 7** for the extents of the meander belt and to **Appendix F** for detailed calculations.

At the request of the NVCA through the commenting process, Parish Geomorphic completed a technical review of the meander belt limits presented in the earlier Crozier work. This review concluded that the meander belt values previously determined by Crozier resulted in a conservative result that is appropriate for the site. This assessment previously satisfied the NVCA that the meander belt limits did not impact the limits of the east and west development areas. A copy of the Parish Geomorphic Huntingwood Trails – Meander Belt Width Assessment Technical Review (July 2011) is included in **Appendix F**.

9.0 CONCLUSIONS

This Floodplain Study provides an assessment of the natural hazards associated with Silver Creek in relation to the proposed development from the perspective of potential flooding. A detailed hydraulic analysis was completed by expanding previously approved HEC-RAS models to determine the flooding and spill conditions associated with Silver Creek and to evaluate the impacts of the proposed development on these floodlines.

The results of the assessment demonstrate the following:

- Pre-development floodplain limits west of Silver Creek and inundation limits east of Silver Creek support the previously established Development Pods of the West Development Area and the Subject Lands.
- The post-development floodlines generated from Option A and Option B of the cut/fill analysis are outside of the proposed development limits shown in the Draft Plan and therefore the Subject Lands, including the proposed roadway, are outside of the flood hazard limits.
- Proposed development demonstrated in Options A and B of the cut/fill analysis do not create negative impacts upstream or downstream of the Subject Property.
- No negative impacts are experienced offsite as a result of the proposed development.
- Floodplain storage has been maintained through the cut/fill assessment.
- The proposed watercourse crossing to support the access roadway from west to east has been designed to convey the Regional flow and provides safe ingress and egress to the development east of Silver Creek on the Subject Lands.

As the proposed development respects the flooding and erosion hazards onsite as determined through this analysis, we confirm the proposed development application meets the tests of Section 3.1 of the Provincial Policy Statement, NVCA, and MNR guidelines as per our Terms of Reference.

Based on the above, we conclude that the development area and roadway in the Draft Plan is outside of the flood hazard limits.

Respectfully Submitted,

C.F. CROZIER & ASSOCIATES INC.

Jessie Elder, P.Eng.
Project Manager

C.F. CROZIER & ASSOCIATES INC.

Jon Proctor, P.Eng.
Partner

JP/je

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APPENDIX A

Historic Studies & Natural Hazard Assessments Memo

Topographic Accuracy Assessment

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MEMO

DATE	September 18, 2023	**PROJECT NO.**	281-2769
RE	Huntingwood Trails – Historic Studies & Natural Hazard Assessments		

TO	Jon Proctor, P.Eng., Partner
FROM	Jessie Elder, P.Eng., Project Manager
CC	

This memo has been prepared in support of the Huntingwood Trails Development to summarize historic hydraulic studies completed for Silver Creek and natural hazards assessments completed in connection with the proposed development on the Huntingwood Trails property (the "Subject Property").

1.0 HISTORIC STUDIES OF SILVER CREEK

In 1989, Cumming Cockburn Limited ("CCL") conducted a study entitled "Floodline Mapping Study of Silver Creek, Spring Creek, & Village of Angus" prepared under the auspices of the Federal Flood Damage Reduction Program for the NVCA. The CCL Study mapped the Regulatory Floodplain along a 5 km reach of Silver Creek extending from the outlet at Georgian Bay. The study also identified two spill zones along Silver Creek, namely; a westerly spill upstream of the Georgian Trail and the Subject Property identified as Spill Zone 'A' and an easterly spill upstream of Highway 26 through the Subject Property, identified as Spill Zone 'B'.

Since 1989, other studies have been completed which have delineated the Regulatory Floodplain along Silver Creek and addressed the hazard associated with Spill Zone B, based on the original framework provided by CCL. These studies were prepared in connection with development applications for lands to the east of the Subject Property, including Cranberry Links (C.C. Tatham, 1993) and Silver Glen Preserve (Crozier, 2006), and to the north of the Subject Property for The Consulate Development (Crozier, 2007 & 2008). These studies confirmed that spill conditions continued to be identified in the Silver Creek watershed and recommended floodproofing techniques to eliminate the spill hazard such that development could occur. Development approvals have been obtained for these properties on this basis and the Cranberry Links and Silver Glen Preserve Developments are now fully built out.

1.1 CCL Study

As outlined in the CCL Study (1989), spill zones have been identified along Silver Creek. These spill zones exist to the south of the Georgian Trail, to the south of Highway 26 on the Subject Property and to the north of Highway 26 on the Consulate Property.

A spill zone upstream of the Subject Property, denoted as Spill Zone 'A', conveys spills upstream of the Georgian Trail and flows westerly towards Watercourse #1. Watercourse #1 is located west of

the Subject Property beyond the Forest Drive Subdivision adjacent to Osler Bluff Road. Flows remaining in the Silver Creek system enter the upstream (south) end of the Subject Property.

In respect of Spill Zone 'A', the CCL Study derived an approach flow in Silver Creek of 109 m^3/s upstream of the Georgian Trail and calculated a 31 m^3/s spill flow. As such, a Regional Storm peak flow of 78 m^3/s was utilized through the Subject Property in the subsequent flood mapping assessment. The Regional Storm used in this area is the Timmins Storm of 1961.

A second spill area, denoted Spill Zone 'B', was identified in the CCL Study along Silver Creek upstream of Highway 26. Spill Zone 'B' splits a portion of the flood flows from Silver Creek within the Subject Property. Spill Zone 'B" flows in a north-easterly / easterly direction within the Subject Property away from Silver Creek toward the existing Silver Glen Preserve Residential Development and the existing Cranberry Resort Links Golf Course and Residential Development.

Within the Subject Property, the CCL Study concluded that there was a spill flow of 31 m^3/s to the east, denoted as Spill Zone 'B', leaving a remaining 47 m^3/s within Silver Creek proper at the downstream end of the Subject Property upstream of Highway 26.

It was agreed with the NVCA through an Agreed Statement of Facts (attached to this memo), prepared in support of the West Development Area Ontario Land Tribunal (OLT) appeal in summer 2022, that the CCL Study identified suitable hydrology and peak flow information to be used in the assessment of the Silver Creek watershed. Additionally, it was also agreed that Spill Zones 'A' and 'B' continue to exist within the watershed, while noting the magnitude of spills should be verified in the updated floodplain modeling assessment for the Subject Property. This updated modelling assessment was completed through the course of flood assessments and is discussed further below.

2.0 SUMMARY OF NATURAL HAZARDS ASSESSMENTS FOR THE SUBJECT PROPERTY

A number of studies have been prepared by Crozier to assess the Natural Hazards on the Subject Property, including the following:

- "Supplemental Natural Hazards Modelling" (July 2022), the "**2022 Flood Study**"
- "Natural Hazards Study" (July 2019), the "**2019 Flood Study**"
    - 2014 Spill 'A' Analysis included within Appendix D ("**2014 Spill 'A' Analysis**")
    - 2013 Flood Hazard Assessment included within Appendix D ("**2013 Flood Study**")
- Functional Servicing & Stormwater Management Report (July 2019), the "**2019 FSRSWM**", updated from the January 2011 Functional Servicing & Stormwater Management Report.
- "Natural Hazards Study." (January 2011), the "**2011 Flood Study**"

The 2013 / 2014 works referenced above were prepared as part of discussions with the NVCA and the results can be found in Appendix D of the **2019 Flood Study**.

2.1 2011 Flood Study

Crozier prepared the **2011 Flood Study** which presented a HEC-RAS model with one reach to develop the natural hazard limits and development limits on site. This updated the CCL (1989) delineation of the Regional floodline across the Subject Property. This study was submitted in connection with the original applications for Official Plan and Zoning By-Law Amendments and Draft Plan of Subdivision approvals for the Subject Property and was subsequently updated, as described below, through consultation with the NVCA.

2.2 2013 and 2014 Flood Modelling

The **2011 Flood Study** HEC-RAS model was updated through works in 2013 (**2013 Flood Study**) and 2014 (**2014 Spill 'A' Analysis**) in connection with the Official Plan Amendment (OPA) for the Subject Property using more refined topographic information obtained for the site consisting of 0.5m contours and spot elevations, field measurements, and additional modeling cross sections. Results of the updated floodplain modeling indicated that the floodplain on the west portion of the Subject Property extends approximately 30 to 80 metres from the Creek edge. The resulting floodline from the 2014 model is very similar to floodline results of the **2011 Flood Study**.

Through the Ontario Municipal Board (OMB) process in 2013 / 2014 relating to the OPA appeal, the model that was developed was accepted by the NVCA to define the development limits and hazard areas for the Subject Property. These agreed upon development limits were implemented by the OPA approved by the OMB through a settlement with the County, Town and NVCA. Development Area #1 (Huntingwood East Lands) and Development Area #2 (Huntingwood West Lands) were delineated, designating the approved areas for future development.

The 2014 OMB Settlement with the Town and NVCA included acknowledgement of the acceptance of the flood study works within site specific language contained in Section 4.3.4.4.5.8 d) of the approved OPA as referenced below.

> *The lands shown in cross hatching include a multitude of environmental and open space features including the floodplain of the Silver Creek and all appropriate buffers to those features.*

Section 4.3.4.4.5.8 a) of the Settlement also provided acknowledgement of the proposed access road location to the Subject Property within Environmental Protection area:

> *Vehicular access may occur from Forest Drive and/or Silver Creek Drive and may be established through lands designated Environmental Protection as permitted by Section 4.1.3.1.*

2.3 2019 Flood Study

In 2019, Huntingwood proceeded to process its applications for Zoning By-Law Amendment and Draft Plan of Subdivision approval. Initially, and at the time of the preparation of the **2019 Flood Study**, the Zoning By-Law and Draft Plan of Subdivision included the entirety of the Subject Property. In accordance with section 4.3.4.4.5.8 e) ii) of the OPA an updated Natural Hazards Study (the **2019 Flood Study**) was submitted in connection with the Subject Property to document the previously completed 2013 / 2014 floodplain studies, which had not previously been on public record, into a final document supporting the proposed development concept for the Subject Property. The **2019 Flood Study** also included additional analysis confirming that the proposed Draft Plan of Subdivision does not negatively impact the floodplain upstream or downstream of the Subject Property. The development limits considered in the original 2019 Draft Plan of Subdivision, upon which the **2019 Flood Study** was assessed, are consistent with the development limits established through the OPA approval in 2014.

The model and floodplain limits presented in the **2019 Flood Study** were consistent with the model approved by the NVCA in 2014 through the OMB settlement with minor updates in connection with the proposed 2019 Draft Plan of Subdivision. Model descriptions, parameters, and findings from the **2019 Flood Study** are described below.

2.3.1 2019 Flood Study Results

Modeling for the east portion of the Subject Property illustrates a series of shallow spill flow areas in which floodwaters breach the drainage divide of the Silver Creek system over the east overbank and flow away from Silver Creek in a north-easterly direction through Spill Zone 'B'. As these flows were determined through modelling to have a lower hydraulic grade line elevation than Silver Creek proper, we concluded that these flows were in fact spill flows.

The floodplain model includes the proposed development areas along the west side of Silver Creek to confirm that proposed conditions floodproofing at the entrance roadway accessing the property and Stormwater Management Facility along the west side of the Creek was sufficient and did not cause offsite impacts to flood levels.

The **2019 Flood Study** included verification of flows lost through Spill Zone 'A' and Spill Zone 'B'. These are areas in which flows breach the watercourse bank at a certain elevation and spill away from Silver Creek system, never to return. The results of these analyses indicate that flows lost to the spill zones were higher than originally calculated by CCL. The Huntingwood Trails Development's Spill 'A' Analysis (March 2014) was summarized in Appendix D of the **2019 Flood Study** and provided modelling conducted by Crozier on Spill 'A'. It confirms the existence of a spill upstream of the Georgian Trail and that a portion of the flow that overtops the Trail is also lost to the Watercourse #1 system.

The results of this Spill Zone 'A' assessment indicate that the flood flow rate which established the floodplain is conservative and overestimates the flow continuing in Silver Creek through the Subject Property, therefore underestimating the amount of land within the development limits and outside of the hazard. The updated Spill Flow 'A' estimate was closer to 52 m^3/s compared to the 31m^3/s predicted by CCL. As such, this analysis determined the Regional flow on the Subject Property is closer to 57 m^3/s (approach flow of 109 m^3/s less 52 m^3/s). This led to the conclusion that CCL underestimated the magnitude of Spill 'A' and as such the 78 m^3/s flow rate used through the Subject Property in the original CCL Study and the modelling by Crozier in 2011, 2013, 2014 and 2019 was inherently conservative. As such, the modeling of Regulatory floodplain limits along the main branch of Silver Creek overestimates the flow contained within the system and resultant limits of the floodplain on the Subject Property.

The **2019 Flood Study** also included an updated assessment of the flows conveyed through Spill Flow 'B'. Examination of more detailed site contour information, review of spring freshet flooding events, and onsite observations revealed that the predominant flow direction through the Subject Property was in a northerly direction for Silver Creek proper. However, when flood flows overtopped the east overbank of Silver Creek within the Subject Property the predominant flow direction became north-easterly, away from Silver Creek and through Spill Zone 'B'.

The 2019 model used two hydraulic reaches, representative of the Main Silver Creek Channel and Spill Zone 'B' flow route to determine flood travel paths. This modelling approach allowed us to identify the quantity of spill occurring from Silver Creek to Spill Zone 'B'. Flows from Silver Creek to Spill Zone 'B' were computed in the model based on the overbank geometry modelled as a lateral weir structure. This analysis determined that spill flow from Silver Creek to Spill Zone 'B' occurs in multiple locations along the east bank of Silver Creek throughout the Subject Property. The results of this modelling indicate that the updated Spill Flow 'B' estimate was closer to 48 m^3/s compared to the 31 m^3/s predicted by CCL.

The hazard limits and resulting development limits for the Subject Property determined from the **2019 Flood Study** remained consistent with the development limits presented in 2013/2014 model that was presented to the NVCA and used in connection with the OPA OMB settlement.

2.3.2 Access Road

Consistent with past studies, it was noted that the existing Highway 26 box culverts created a backwater effect upstream of Highway 26 and Silver Creek Drive in Regional Flood conditions. As the West Development Area frontage is restricted to Silver Creek Drive it was required that the proposed access roadway from Silver Creek Drive to the proposed lots in the West Development Area cross through the floodplain. This roadway location also allowed for the creation of a Stormwater Management Facility at the downstream site limit west of the access roadway from Silver Creek Drive within the West Development Area.

The location of the proposed access road connection to the Subject Property in the West Development Area was selected to provide appropriate setbacks from adjacent intersections and adequate sight lines for the stopping and turning movements anticipated. This access alignment also generally aligned with the historic raised driveway access into the former residential dwelling within the West Development Area. Filling along the alignment of the access road is proposed to provide safe and dry access and egress to and from the Subject Property from Silver Creek Drive. The "Functional Servicing and Stormwater Management Report" ("**2019 FSRSWM**") illustrates the proposed grading to ensure adequate dry floodproofing of the site access road. As a further benefit, creation of the access roadway in the proposed location will eliminate an area of flooding inundation in the vicinity of Silver Creek Drive on adjacent private residential properties providing a benefit to adjacent residents. The public infrastructure including roads, sewers and utilities is a permitted encroachment into the floodplain within the PPS and NVCA Planning and Regulations Guidelines. The HEC-RAS model presented in the **2019 Flood Study** demonstrated that the proposed development including the access road through a portion of the floodplain did not cause negative impacts to the floodplain elevations beyond the limits of the Subject Property. Storage lost through filling of the roadway and cutting off the floodplain can be replicated through traditional floodplain cut / fill techniques as permitted by the NVCA Natural Hazard Technical Guidelines Section 5.3 and implemented through a condition of Draft Approval (Condition #17) as proposed for the West Development Area.

The location of the proposed Stormwater Management Facility was also proposed in an acceptable location, in an area now floodproofed west of the proposed access road. As this area is outside of the pre-development 100-year floodplain it conforms to the general permissions within the NVCA Planning & Regulation Guidelines.

The results of the flood analysis and erosion analysis within the **2019 Flood Study** were combined to create a total hazard limit and set the developable limits across the West Development Area. The flood and erosion hazard limits are illustrated on an Existing Conditions Natural Hazard Limits Plan and a Post Development Conditions Natural Hazard Limits Plan included with the **2019 Flood Study** as Figure 3 and Figure 4, respectively. The analysis is discussed further below.

A post-development floodplain analysis was completed within the **2019 Flood Study** to assess the impact of the encroachment of the Site Access Roadway from Silver Creek Drive. As the main flood flow direction for the Subject Property is to the north / northeast the removal of these pre-development floodplain areas with the construction of the access road did not result in any significant changes in flood elevations or spill flows upstream or downstream of the site.

2.3.3 Meander Belt Limits

An analysis of onsite erosion hazard was also completed and incorporated with the **2019 Flood Study**. Calculations of an appropriate meander belt allowance were completed utilizing morphological relationships and onsite field reconnaissance. The results of this study produced a meander belt width ranging from 95m to 119m centered on the meander axis of Silver Creek. A peer review of the erosion assessment entitled "Huntingwood Trails – Meander Belt Width Assessment Technical Review" (Parish Geomorphic, July 2011) was conducted, confirming that the final meander belt corridor width specified was a conservative result appropriate for the Subject Property. It was agreed with the NVCA that the erosion and meander hazard setbacks as provided in the current Development Plan for the West Development Area are suitable to containing the site erosion hazards.

As discussed above, the results of the flood analysis and erosion analysis were combined to create a total hazard limit and set the developable limits across the Subject Property. Proposed residential development was directed to areas outside of the floodplain and erosion hazard limits. These limits are illustrated on an Existing Conditions Natural Hazard Limits Plan and a Post Development Conditions Natural Hazard Limits Plan included with the **2019 Flood Study** as Figure 3 and Figure 4, respectively.

The floodplain modeling works and ultimate delineation of the Regional floodplain limits presented in the **2019 Flood Study** informed the proposed Draft Plan and Zoning By-Law Applications for the proposed developments, both for the West Development Area and the lands subject to the 2023 zoning and subdivision applications (the "**Subject Lands**"). The proposed Draft Plans for the West Development Area and the Subject Lands were coordinated with the **2019 Flood Study** to incorporate the results of the natural hazard limits and confirmed components of the proposed development are situated outside of the existing natural hazards to meet the tests of Section 3.1 of the PPS. We undertook a thorough review of lots adjacent to Silver Creek to confirm they were all planned outside of the Regulatory Floodplain.

The entirety of the proposed development in the approved West Development Area Draft Plan of Subdivision and the proposed Draft Plan for the Subject Lands, save and except a portion of the access roadway and SWM Facility in the west lands, have been set outside of the natural hazard limits of the floodplain. The access road and SWM Facility locations were approved through the West Development Area Draft Plan of Subdivision. The site access will be filled to provide safe and dry ingress and egress from the Subject Property.

2.4 2022 Model Verification

Most recently in July of 2022 as part of ongoing discussions to address outstanding issues raised by the NVCA, the floodplain model was updated in response to a request by the NVCA (the **2022 Flood Study**). The July 2019 modeling has since been re-setup and run as a fully georeferenced model using an AutoCAD 3D surface file for the property and HEC-RAS Version 6.3 with the purpose of verifying the model results. Geometry inputs to the model were completed using a combination of the HEC-RAS 'RAS Mapper' and the Geometry Editor. The tools utilized to prepare this georeferenced model can extrapolate cross section geometry from the 3D surface and automatically delineate the floodplain based on resulting water surface elevations and the georeferenced topographic surface terrain. However, these new floodplain mapping tools have limitations as the model will not discern between isolated areas that are not reachable by floodwaters and will include these as part of the floodplain, where they should not be so included. As a result, engineering judgement is required to refine the results. This supplemental modelling

supports the conclusion of the original assessment prepared by our office with respect to the limits of development and hazard limits.

Due to the limitations of the georeferenced model noted above, various areas that were mapped to be floodplain in this model can be removed from the floodplain model**.** It was agreed with the NVCA that a reasonable delineation of the flood hazard limit should take into account the interface of areas of active flood conveyance versus more ineffective depression areas / static pools / shallow spills that may become inundated. These may also include areas where the water surface interpolation is incorrectly calculating backwater as floodplain, since the water surface is generated through interpolation between upstream and downstream cross sections, and the RAS Mapper tool connects these points despite a high point in elevation that water would not be able to cross. Furthermore, NVCA Natural Hazards Technical Guidelines permit the use of traditional floodplain cut / fill balance techniques to regularize the boundaries of a development to provide a better development layout. This includes an area of shallow spills over the Georgian Trail in the southeast corner of the proposed development affecting two lots and four lots proposed on an existing cattle pond and ditch connecting the pond to the creek within the West Development Area. It was agreed with the NVCA that for the purposes of this assessment the final Flood Hazard Limit can be reasonably "smoothed" using traditional cut / fill balance techniques. These areas will be filled, and other areas will be cut to maintain the flood water storage and keep the floodline continuous to the creek. A suitable condition requiring the approval of a cut / fill balance report acceptable to the NVCA has been included as a condition of Draft Plan Approval for the West Development Area. In my opinion this cut / fill approach is feasible to proceed with given the limited areas onsite impacted in conjunction with Detailed Design works and final grading approvals to be completed at the next stage of development process.

As such, the **2022 Flood Study** confirmed the results of the previous **2019 Flood Study**. The hazard limit and associated development limit produced through the **2022 Flood Study** are consistent with the development and hazard limits determined through the **2019 Flood Study**, and the work completed through 2013 and 2014 in connection with the OPA approval and including the determination of the Development Area. The results of these analyses confirm that the development limits have remained consistent with the approved Development Area per the OPA in 2014.

Sincerely,

C.F. CROZIER & ASSOCIATES INC.

Jessie Elder, P.Eng.
Project Manager
/je

Encl. Agreed Statement of Facts (August 2022)

J:\200\281 - Huntingwood - Skelton Farm\2769\Memos\2023.03.24 Flood Study Background\2023.07.31 Flood Study Background Info.docx

CROZIER CONSULTING ENGINEERS

Agreed By: Jonathan M. Proctor, P.Eng (Crozier & Associates) Jon Proctor

Agreed By: Mark Hartley, P.Eng. (NVCA) Mark Hartley

PROJ. NO:	281-2769
PROJECT:	Huntingwood - Skelton Farm
DESIGN:	JMP
DATE:	Jun 24, 2022

Issue ID	Issue	Relevant Corresponding Section and Policies	Agreed Facts	Remaining Issues
		Nottawasaga Valley Conservation Authority		
Provincial Policy Statement, 2020				
Natural Hazards				
1	Have the applications demonstrated consistency with Section **3.1.1** b) of the PPS, by demonstrating that the proposed development has been directed to areas outside of hazardous lands adjacent to river, stream and small inland lake systems which are impacted by flooding hazards and/or erosion hazards?	**3.1.1** Development shall generally be directed, in accordance with guidance developed by the Province (as amended from time to time), to areas outside of: b) hazardous lands adjacent to river, stream and small inland lake systems which are impacted by flooding hazards and/or erosion hazards; and Definition of development in PPS - means the creation of a new lot, a change in land use, or the construction of buildings and structures requiring approval under the Planning Act, but does not include: a) activities that create or maintain infrastructure authorized under an environmental assessment process;	Crozier submitted a Flooding and Natural Hazards Study for the Huntingwood Site in July of 2019 which includes their assessment of Site Hazards and Floodplain conditions building upon models previously approved by NVCA for the adjacent Silver Glen Preserve and Consulate properties.	
2	Have the applications demonstrated consistency with Section **3.1.2** c) of the PPS, by demonstrating that the proposed development is outside of an area that would be rendered inaccessible to people and vehicles during times of flooding hazards, erosion hazards and/or dynamic beach hazards, unless it has been demonstrated that the site has safe access appropriate for the nature of the development and the natural hazard?	**3.1.2** Development and site alteration shall not be permitted within: c) areas that would be rendered inaccessible to people and vehicles during times of flooding hazards, erosion hazards and/or dynamic beach hazards, unless it has been demonstrated that the site has safe access appropriate for the nature of the development and the natural hazard; and	Erosion and Meander Hazard setbacks as provided in the current West Lands Development Plan are suitable to containing the site Erosion Hazards	NVCA has yet to formally accept the Floodplain Hazard Assessment presented for Silver Creek and the associated Spill Zone
3	Have the applications demonstrated consistency with Section **3.1.2** d) of the PPS by demonstrating that the development is outside of a floodway regardless of whether the area of inundation contains high points of land not subject to flooding?	**3.1.2** Development and site alteration shall not be permitted within: d) a floodway regardless of whether the area of inundation contains high points of land not subject to flooding.	Regarding the Flood Study the Following are Agreed Facts:	
			The Silver Creek Watershed through the subject lands was studied previously through a report initiated by the NVCA under the Flood Damage Reduction Program entitled "Floodline Mapping Study for Silver Creek, Spring Creek and the Village of Angus (CCL Report, 1989)	~~This report is dated and requires updating for spill assessment and flood hazard delineation.~~ See wording added to cell D19
			The CCL report identified suitable hydrology and peak flow information to be used in the assessment of the Silver Creek Watershed.	Agreed
			The CCL report identified existing two existing Spill Zones in the Silver Creek watershed in proximity to the subject site. Spill Zone A to the west of the Site just upstream of the Georgian Trail and Spill Zone B to the East just upstream of Highway 26. These spill flows continue to exist in the watershed. The magnitude of spills should be verified in the updated flood modeling assessment for the site.	Agreed ~~that the spills still exist~~ ~~However, the magnitude of each spill requires updating~~. Added wording to the Agreed Facts speaking to this point
			The Crozier 2019 Study utilizes site specific Aerial Photography Survey obtained specifically for the subject lands from First Base Solutions supplemented with field / measurement and survey. The resulting surface is a reasonable data set in which to complete the flood hazard modeling & delineation across the subject lands	Agreed

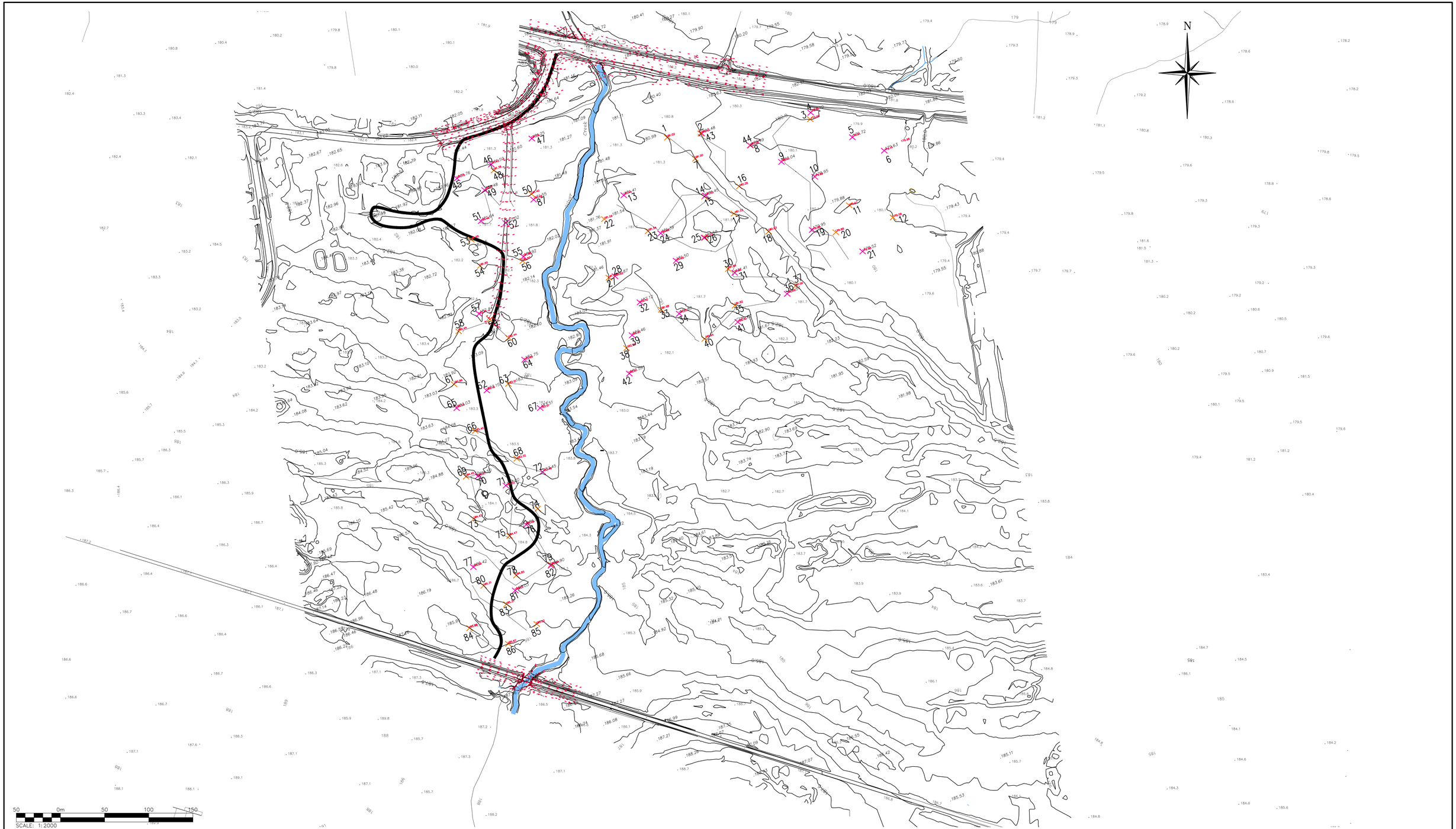
Issue ID	Issue	Relevant Corresponding Section and Policies	Agreed Facts	Remaining Issues
			The use of a 1-Dimensional HEC-RAS hydraulic flood model is an acceptable tool to assess the floodplain limits across the site.	~~1D model may be acceptable but may need to be superseded with 2D model~~. Notwithstanding previous approvals in the watershed NVCA would like to see the historic models updated to use georeferenced cross sections coupled with AutoCAD terrain data such that flood inundation limits can be automatically generated.
			It is recognized past modeling and historic spill conditions across the site indicate that the general direction of flood flow is in a north / north-easterly direction away from the proposed West Development area.	Agreed
			~~Floodplain sensitivity analysis has been completed which demonstrate that flood levels across the site are generally insensitive to modeling parameter variation.~~	~~NVCA has yet to review sensitivity analysis.~~ Remove this issue as it is not agreed.
			The impacts of the elimination of Spill A (i.e. not reducing peak flows) can be looked at through a sensitivity analysis. While this analysis will not be used to determine the regulatory flood limit adjacent the West Development areas it is prudent to ensure that future development provides flood protection (i.e. filling) for this scenario.	**Agreed**
			A reasonable delineation of the flood hazard limit should take into account the interface of areas of active flood conveyance vs. more ineffective depression areas / static pools / shallow spills that may become inundated. For the purposes of this assessments the final Flood Hazard Limit can be reasonably "smoothed" using traditional cut / fill balance techniques ~~across the subject lands.~~ **along the east boundary of the subject (west side of the flood plain)**	**Agreed**
			Downstream boundary conditions should be located sufficiently downstream such that modification of the condition does not materially affect the flood levels or spill estimate adjacent the West Development Area.	**Agreed**

CROZIER CONSULTING ENGINEERS

PROJ. NO: 281-2769
PROJECT: Huntingwood
DESIGN: J. Elder
FILE: Survey Comparison
DATE: Dec 15, 2020

Average of points excluding top 5th percentile	0.08	m
Average of all points (including top 5th percentile) =	0.09	m

Point Number	LOCATION	Old Source	OLD ELEV	NEW ELEV	DIFFERENCE	ABSOLUTE DIFFERENCE	
16	east	contour	180.50	180.26	-0.24	0.24	
67	west	point	183.51	183.31	-0.20	0.2	Top 5th percentile
80	west	contour	185.50	185.31	-0.19	0.19	
35	east	contour	182.00	181.82	-0.18	0.18	
68	west	contour	183.50	183.32	-0.18	0.18	95% Confidence Interval
85	west	contour	185.50	185.32	-0.18	0.18	
51	west	point	181.64	181.46	-0.18	0.18	
17	east	contour	181.50	181.33	-0.17	0.17	
29	east	point	181.50	181.66	0.16	0.16	
30	east	contour	181.50	181.66	0.16	0.16	
47	west	point	181.25	181.09	-0.16	0.16	
63	west	contour	183.00	183.16	0.16	0.16	
54	west	contour	182.00	181.85	-0.15	0.15	
78	west	contour	185.00	184.85	-0.15	0.15	
3	east	contour	180	179.85	-0.15	0.15	
61	west	contour	183.00	182.86	-0.14	0.14	
82	west	contour	184.90	185.04	0.14	0.14	
25	east	point	181.50	181.37	-0.13	0.13	
26	east	contour	181.50	181.37	-0.13	0.13	
56	west	contour	182.00	181.87	-0.13	0.13	
57	west	point	182.44	182.31	-0.13	0.13	
83	west	contour	185.50	185.37	-0.13	0.13	
86	west	contour	186.00	185.87	-0.13	0.13	
20	east	contour	180	179.88	-0.12	0.12	
36	east	point	181.57	181.69	0.12	0.12	
48	west	contour	181.50	181.38	-0.12	0.12	
77	west	point	185.42	185.30	-0.12	0.12	
24	east	point	181.39	181.50	0.11	0.11	
38	east	contour	182.50	182.39	-0.11	0.11	
39	east	point	182.46	182.35	-0.11	0.11	
52	west	point	182.02	181.91	-0.11	0.11	
59	west	contour	182.5	182.61	0.11	0.11	
5	east	point	179.72	179.61	-0.11	0.11	
8	east	point	179.99	180.09	0.1	0.10	
27	east	contour	182.00	181.90	-0.10	0.10	
50	west	contour	181.50	181.40	-0.10	0.10	
64	west	point	182.75	182.65	-0.10	0.10	
66	west	contour	183.50	183.40	-0.10	0.10	
44	east	contour	180.00	180.09	0.09	0.09	
6	east	point	179.63	179.71	0.08	0.08	
12	east	contour	179.50	179.58	0.08	0.08	
15	east	point	181.45	181.52	0.07	0.07	
87	west	point	181.55	181.48	-0.07	0.07	
2	east	contour	180.50	180.43	-0.07	0.07	
18	east	contour	181.00	180.93	-0.07	0.07	
34	east	point	181.88	181.95	0.07	0.07	
46	west	point	181.5	181.43	-0.07	0.07	
70	west	point	184.50	184.57	0.07	0.07	
73	west	contour	184.50	184.43	-0.07	0.07	
10	east	point	179.95	179.89	-0.06	0.06	
21	east	point	179.52	179.58	0.06	0.06	
37	east	contour	181.50	181.56	0.06	0.06	
40	east	contour	182.00	181.94	-0.06	0.06	
42	east	point	182.55	182.61	0.06	0.06	
58	west	contour	182.50	182.44	-0.06	0.06	
60	west	contour	182.50	182.44	-0.06	0.06	
55	west	point	181.92	181.86	-0.06	0.06	
31	east	point	181.41	181.46	0.05	0.05	
53	west	contour	182.00	181.95	-0.05	0.05	
69	west	contour	184.50	184.45	-0.05	0.05	
76	west	point	185.04	185.09	0.05	0.05	
28	east	point	181.87	181.92	0.05	0.05	
43	east	point	180.48	180.43	-0.05	0.05	
23	east	contour	181.50	181.54	0.04	0.04	
79	west	contour	185.00	185.04	0.04	0.04	
81	west	point	185.03	185.07	0.04	0.04	
4	east	point	180.1	179.9	0.03	0.03	
9	east	point	180.04	180.01	-0.03	0.03	
11	east	contour	180.00	179.97	-0.03	0.03	
13	east	point	181.41	181.44	0.03	0.03	
19	east	point	179.95	179.98	0.03	0.03	
41	east	point	182.67	182.70	0.03	0.03	
49	west	point	181.48	181.51	0.03	0.03	
72	west	point	183.45	183.48	0.03	0.03	
75	west	contour	184.50	184.47	-0.03	0.03	
1	east	contour	181.00	181.02	0.02	0.02	
14	east	contour	181.50	181.52	0.02	0.02	
33	east	contour	182.00	181.98	-0.02	0.02	
45	west	point	181.76	181.78	0.02	0.02	
71	west	point	184.20	184.22	0.02	0.02	
84	west	contour	186.00	185.98	-0.02	0.02	
62	west	point	183.15	183.16	0.01	0.01	
65	west	point	183.03	183.04	0.01	0.01	
7	east	contour	181	181	0	0	
32	east	point	182.12	182.12	0.00	0	
~~22~~	~~east~~	~~contour~~	~~182~~	~~181.59~~	~~-0.41~~		excluded due to horizontal inaccuracy
~~74~~	~~west~~	~~contour~~	~~N/A~~	~~N/A~~	~~N/A~~		marked point was not surveyed



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3. THIS DRAWING IS TO BE READ AND UNDERSTOOD IN CONJUNCTION WITH ALL OTHER PLANS AND DOCUMENTS APPLICABLE TO THIS PROJECT.
4. DO NOT SCALE THE DRAWINGS.
5. ALL EXISTING UNDERGROUND UTILITIES TO BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

TEMPORARY BENCHMARKS

TBM#1–
TBM#2–
TBM#3–

Town

No.	ISSUE	DATE: MM/DD/YYYY
0	SURVEY REQUEST	11/20/2020

Engineer

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

Engineer

Project

HUNTINGWOOD TRAILS
TOWN OF COLLINGWOOD

Drawing

SITE SURVEY

CROZIER CONSULTING ENGINEERS
THE HARBOUREDGE BUILDING,
40 HURON STREET, SUITE 301,
COLLINGWOOD, ON L9Y 4R3
705 446-3510 T
705 446-3520 F
WWW.CFCROZIER.CA
INFO@CFCROZIER.CA

Drawn By	Design By	Project	
J.E.	J.E.	281–2769	
Check By	Check By	Scale	Drawing
J.P.	J.P.	1: 2000	TEMP

J:\200\281 - Huntingwood - Skelton Farm\2769\Cad\Working\2769_TOPO ASSESSMENT.dwg, TEMP, 2020-12-16 4:56:48 PM, nlefebvre

APPENDIX B

Terms of Reference

UPDATED MARCH 16TH, 2023

PROJECT NO: 281-2769

SENT VIA: EMAIL

Nottawasaga Valley Conservation Authority
8195 8th Line
Utopia, ON, LOM 1TO

Attention: Mark Hartley, P.Eng., Senior Engineer

RE: HUNTINGWOOD TRAILS – EAST LANDS RESIDENTIAL DEVELOPMENT
EAST LANDS FLOODPLAIN STUDY
TERMS OF REFERENCE

Dear Mark,

Further to the Pre-consultation meeting with the Town of Collingwood for the Huntingwood East Lands Development Applications (the "East Land Development Area"), we are pleased to provide you with the following Terms of Reference for a supporting Floodplain Study.

The proposed Huntingwood East Lands Floodplain Study (the "East Floodplain Study") will build upon the Huntingwood West Lands Floodplain modelling developed through the West Lands Ontario Land Tribunal hearing and eventual settlement. The Floodplain Study will primarily focus on the flooding limits and impacts east of Silver Creek across the subject property, including the Spill Zone B route throughout the East Lands Development Area. The East Floodplain Study will be completed using HEC-RAS to determine the flood elevations in the 100-year and Regional Storm events in both pre- and post-development conditions.

To complete the Floodplain Study, we will incorporate the following elements:

Model Setup & Existing Conditions Analysis

- The Floodplain Study will be conducted in accordance with NVCA Technical Hazards Guidelines as well as the MNR Flood Hazard Guidelines.
- The Floodplain Study will utilize site specific Aerial Photography Survey obtained specifically for the subject lands from First Base Solutions supplemented with field / measurement and survey consistent with the West Lands flood modeling.
- The proposed HEC-RAS model will be a 1-Dimensional model utilizing georeferenced cross sections coupled with AutoCAD terrain data such that flood inundation limits can be automatically generated.
- The model will accurately include ineffective flow areas and obstructions on site within the model. Rationale for these additions will be provided in the accompanying report.
- The model will establish downstream boundary conditions located sufficiently downstream such that modification of the condition does not materially affect the flood levels or spill estimate adjacent the East Lands Development Area.
- The modelling will identify areas and flow rates of spill flow from Silver Creek to Spill Zone B through the east lands of the site.
- The results of the existing conditions modeling will be used identify existing conditions flood elevations, spill flow elevations, formal floodplain extents and spill flow extents including analysis of impacts (if any) on the existing East Lands Development Area # 1.

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CONSULTING ENGINEERS

Proposed Condition Modeling Analysis

- Proposed conditions modeling will build upon the existing conditions flood model created with the parameters above.
- The modelling will include roadway access from the west to the East Lands Development area and the lots to be developed across Block 98 of the Huntingwood West Lands Draft Plan.
- The modelling will include the addition of a watercourse crossing for access to the East Lands Development Area, including sizing a bridge structure to convey flows past this crossing while demonstrating safe ingress and egress from the development in accordance with NVCA guidelines.
- Model scenarios will compare pre- and post-development water surface elevations to confirm there is no negative impacts upstream or downstream of the site caused by the development and introduction of the proposed crossing.
- The modelling will identify areas and flow rates of spill flow from Silver Creek to Spill Zone B through the east lands of the site.
- The model will examine the impacts of removing Spill Zone A upstream of the rail trail through a sensitivity analysis. While this analysis will not be used to determine the regulatory flood limit adjacent to the East Lands Development Area, it is prudent to check that the future development provides flood protection (i.e. filling) for this scenario.
- The modelling will include a cut/fill analysis of the site within the flood inundation areas of Silver Creek and Spill Zone B. This will include assessment of mitigation measures to offset the construction of a roadway across Silver Creek, development of Block 98 of the West Lands Draft Plan, and any areas of inundation filled within the proposed East Lands Development Area.

Reporting

- Reporting will include an overview and discussion of the relevant Natural Hazards Policy from the Town of Collingwood, Provincial Policy Statement and NVCA Planning Guidelines, including justification on how the development proposal conforms with these policy requirements.
- Reporting will present the pre- and post-development spill inundation limits and/or spill flow interface limits in Figures to support the proposed development limits.

We trust these Terms of Reference are suitable given their consistency with the scope and history of past discussions and analyses regarding this section of Silver Creek. Should you have any questions or require any further information, please do not hesitate to contact the undersigned.

Sincerely,

C.F. CROZIER & ASSOCIATES INC.

Jonathan Proctor, P.Eng.
Associate
aw/je

J:\200\281 - Huntingwood - Skelton Farm\2769\Letters\2023.03.16 East Lands Flood Study TOR.docx

APPENDIX C

Existing Conditions HEC-RAS Modelling

Manning's n Summary Table

Silver Creek HEC-RAS Output Table

Silver Creek HEC-RAS Cross Section Output

Bridgewater Creek HEC-RAS Output Table

Bridgewater Creek HEC-RAS Cross Section Output

CROZIER CONSULTING ENGINEERS

PROJ. NO: 281-2769
PROJECT: Huntingwood
DESIGN: JE
FILE: Manning's n Summary
DATE: Oct 14, 2022

Manning's n Summary

Silver Creek			
River Station	Left Overbank	Channel	Right Overbank
1971	0.08	0.045	0.08
1931	0.08	0.045	0.08
1848	0.05	0.045	0.07
1835	0.05	0.045	0.07
1820	Bridge		
1810	0.05	0.045	0.07
1800	0.05	0.045	0.07
1745	0.05	0.045	0.07
1730	Lat Struct		
1675	0.05	0.045	0.07
1517	0.05	0.045	0.07
1426	0.05	0.045	0.07
1314	0.05	0.045	0.07
1155	0.05	0.045	0.07
1092	0.05	0.045	0.07
979	0.05	0.045	0.07
911	0.07	0.045	0.07
903	0.07	0.045	0.07
875	Culvert		
858	0.1	0.07	0.1
808	0.1	0.07	0.1
669	0.1	0.07	0.1
562	0.1	0.07	0.1
530	0.1	0.07	0.1
435	0.1	0.07	0.1
348	0.1	0.07	0.1
273	0.1	0.07	0.1
171	0.1	0.07	0.1
52	0.1	0.07	0.1

Bridgewater Creek			
River Station	Left Overbank	Channel	Right Overbank
1478	0.07	0.07	0.07
1394	0.07	0.07	0.07
1310	0.07	0.07	0.07
1200	0.07	0.07	0.07
1134	0.07	0.07	0.07
1069	0.07	0.07	0.07
1006	0.07	0.07	0.07
936	0.07	0.07	0.07
840	0.07	0.07	0.07
740	0.1	0.1	0.1
684	0.1	0.1	0.1
670	Lat Struct		
660	0.1	0.1	0.1
635	0.1	0.1	0.1
606	0.1	0.1	0.1
588	0.1	0.1	0.1
572	0.1	0.1	0.1
545	0.1	0.1	0.1
520	0.06	0.06	0.06
500	Culvert		
475	0.06	0.06	0.06
446	0.08	0.08	0.08
428	0.045	0.045	0.045
420	Lat Struct		
416	0.045	0.045	0.045
381	0.045	0.045	0.045
367	0.045	0.045	0.045
361	0.045	0.045	0.045
352	0.045	0.045	0.045
231	0.045	0.045	0.045
192	0.045	0.045	0.045
150	0.045	0.045	0.045
110	0.045	0.045	0.045
65	0.045	0.045	0.045
11	0.045	0.045	0.045

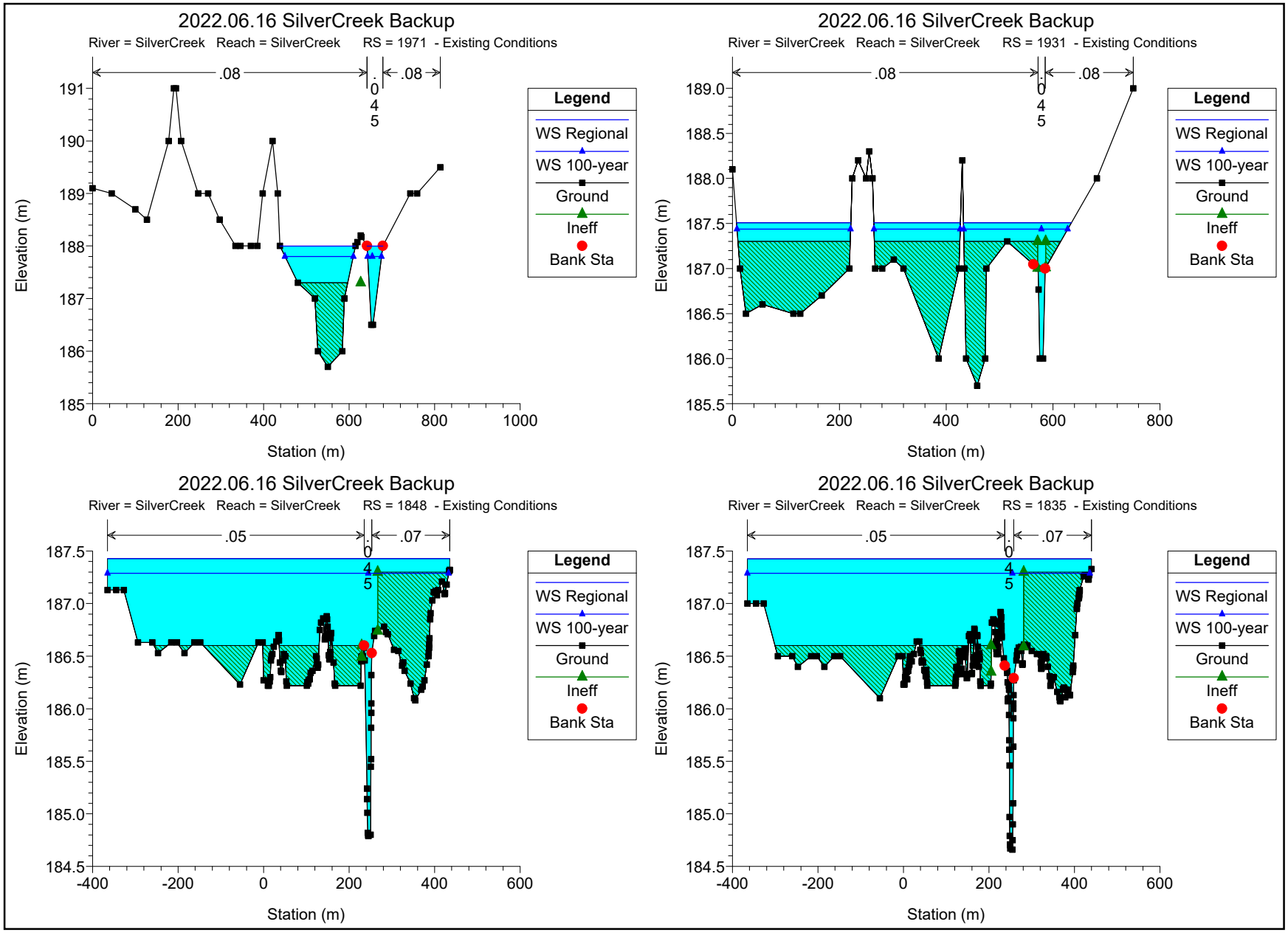
Silver Creek - Existing Conditions

HEC-RAS Plan: SC1

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek	1971	Regional	78.00	186.50	188.00	187.63	188.03	0.002734	1.02	133.26	213.83	0.36
SilverCreek	1971	100-year	44.50	186.50	187.80	187.53	187.82	0.002314	0.86	93.22	192.55	0.32
SilverCreek	1931	Regional	78.00	186.00	187.51	187.51	187.60	0.007383	1.96	131.50	578.18	0.69
SilverCreek	1931	100-year	44.50	186.00	187.44	187.44	187.52	0.005214	1.62	90.36	568.95	0.59
SilverCreek	1848	Regional	78.00	184.79	187.43		187.43	0.000075	0.30	524.93	800.30	0.07
SilverCreek	1848	100-year	44.50	184.79	187.29		187.29	0.000045	0.22	416.15	797.86	0.05
SilverCreek	1835	Regional	78.00	184.66	187.43	186.76	187.43	0.000068	0.26	552.29	804.80	0.06
SilverCreek	1835	100-year	44.50	184.66	187.29	186.25	187.29	0.000039	0.19	443.14	800.84	0.05
SilverCreek	1820		Bridge									
SilverCreek	1810	Regional	78.00	184.41	186.46		186.52	0.003063	1.60	110.00	426.43	0.40
SilverCreek	1810	100-year	44.50	184.41	186.18	186.13	186.31	0.005270	1.84	47.72	163.61	0.51
SilverCreek-Lowe	1798	Regional	78.00	184.33	186.33	186.22	186.46	0.003744	1.88	76.28	193.97	0.46
SilverCreek-Lowe	1798	100-year	44.50	184.33	186.15	185.49	186.25	0.002803	1.51	45.22	143.09	0.39
SilverCreek-Lowe	1744	Regional	78.00	184.00	185.97	185.97	186.17	0.008001	3.12	59.80	119.16	0.71
SilverCreek-Lowe	1744	100-year	44.50	184.00	185.62	185.36	185.95	0.011177	3.23	19.63	17.26	0.81
SilverCreek-Lowe	1730		Lat Struct									
SilverCreek-Lowe	1674	Regional	65.81	183.52	185.34	185.34	185.51	0.006780	2.73	57.51	128.02	0.65
SilverCreek-Lowe	1674	100-year	41.71	183.52	185.21	185.21	185.36	0.005603	2.36	41.79	111.81	0.58
SilverCreek-Lowe	1516	Regional	40.36	182.32	183.95	183.95	184.17	0.006501	2.47	30.32	83.83	0.62
SilverCreek-Lowe	1516	100-year	32.16	182.32	183.66	183.52	184.04	0.011743	2.92	13.71	26.83	0.81
SilverCreek-Lowe	1425	Regional	38.13	181.89	183.45	182.91	183.56	0.003206	1.68	36.92	106.52	0.43
SilverCreek-Lowe	1425	100-year	32.16	181.89	183.41	182.80	183.50	0.002762	1.52	32.19	100.44	0.40
SilverCreek-Lowe	1313	Regional	36.71	181.52	183.05	182.83	183.14	0.004222	1.92	42.99	112.34	0.50
SilverCreek-Lowe	1313	100-year	32.16	181.52	182.97	182.60	183.08	0.005229	2.06	34.24	96.22	0.55
SilverCreek-Lowe	1155	Regional	35.69	180.70	182.22	181.89	182.39	0.005230	2.11	25.87	56.19	0.55
SilverCreek-Lowe	1155	100-year	32.09	180.70	182.31	181.77	182.42	0.003445	1.78	30.84	62.31	0.45
SilverCreek-Lowe	1037	Regional	39.70	180.38	181.82	181.82	181.88	0.003368	1.64	58.68	169.99	0.44
SilverCreek-Lowe	1037	100-year	31.61	180.38	181.78	181.78	181.91	0.005764	2.10	31.98	94.50	0.57
SilverCreek-Lowe	978	Regional	38.03	180.17	181.59	181.15	181.62	0.001872	1.21	62.76	111.34	0.33
SilverCreek-Lowe	978	100-year	30.83	180.17	181.48	181.04	181.51	0.002291	1.27	50.83	110.31	0.36
SilverCreek-Lowe	911	Regional	25.47	179.61	181.47	180.61	181.51	0.001225	1.17	50.86	111.03	0.27
SilverCreek-Lowe	911	100-year	23.21	179.61	181.30	180.55	181.37	0.001931	1.37	33.59	92.72	0.34
SilverCreek-Lowe	903	Regional	25.47	179.55	181.43	180.52	181.50	0.001367	1.23	28.56	145.10	0.29
SilverCreek-Lowe	903	100-year	23.21	179.55	181.29	180.47	181.35	0.001620	1.26	25.18	129.84	0.31
SilverCreek-Lowe	875		Culvert									
SilverCreek-Lowe	858	Regional	25.47	179.40	180.91		181.03	0.011980	1.76	17.12	192.70	0.50
SilverCreek-Lowe	858	100-year	23.21	179.40	180.87		180.98	0.011013	1.66	16.60	192.70	0.48
SilverCreek-Lowe	808	Regional	25.47	179.40	180.71		180.73	0.002658	0.82	53.13	827.01	0.24
SilverCreek-Lowe	808	100-year	23.21	179.40	180.68		180.70	0.002489	0.78	51.07	817.15	0.23
SilverCreek-Lowe	669	Regional	25.47	179.30	180.46		180.47	0.001471	0.53	150.13	599.00	0.17
SilverCreek-Lowe	669	100-year	23.21	179.30	180.45		180.45	0.001411	0.52	141.59	581.27	0.17
SilverCreek-Lowe	562	Regional	25.47	179.20	180.13		180.16	0.008091	1.15	59.70	392.66	0.40
SilverCreek-Lowe	562	100-year	23.21	179.20	180.11	179.96	180.15	0.008868	1.18	52.47	382.18	0.42
SilverCreek-Lowe	530	Regional	25.47	179.13	179.95		179.97	0.004397	0.72	64.35	225.12	0.28
SilverCreek-Lowe	530	100-year	23.21	179.13	179.93		179.95	0.004340	0.70	59.58	215.83	0.28
SilverCreek-Lowe	435	Regional	25.47	178.10	179.13	179.13	179.23	0.021825	1.85	35.69	194.08	0.64
SilverCreek-Lowe	435	100-year	23.21	178.10	179.12	179.12	179.21	0.021714	1.82	32.39	185.02	0.64
SilverCreek-Lowe	348	Regional	25.47	177.20	178.16		178.17	0.002219	0.61	90.44	232.08	0.21
SilverCreek-Lowe	348	100-year	23.21	177.20	178.15		178.15	0.002091	0.59	86.37	228.10	0.20
SilverCreek-Lowe	273	Regional	25.47	177.10	178.06		178.06	0.001719	0.52	115.11	358.40	0.18
SilverCreek-Lowe	273	100-year	23.21	177.10	178.05		178.05	0.001543	0.49	112.03	357.11	0.17
SilverCreek-Lowe	171	Regional	25.47	176.70	178.01		178.01	0.000235	0.25	246.63	540.49	0.07

HEC-RAS Plan: SC1 (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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek-Lowe	171	100-year	23.21	176.70	178.01		178.01	0.000197	0.23	245.89	540.40	0.07
SilverCreek-Lowe	52	Regional	25.47	176.00	178.00	177.09	178.00	0.000038	0.13	466.31	625.00	0.03
SilverCreek-Lowe	52	100-year	23.21	176.00	178.00	177.07	178.00	0.000032	0.12	466.31	625.00	0.03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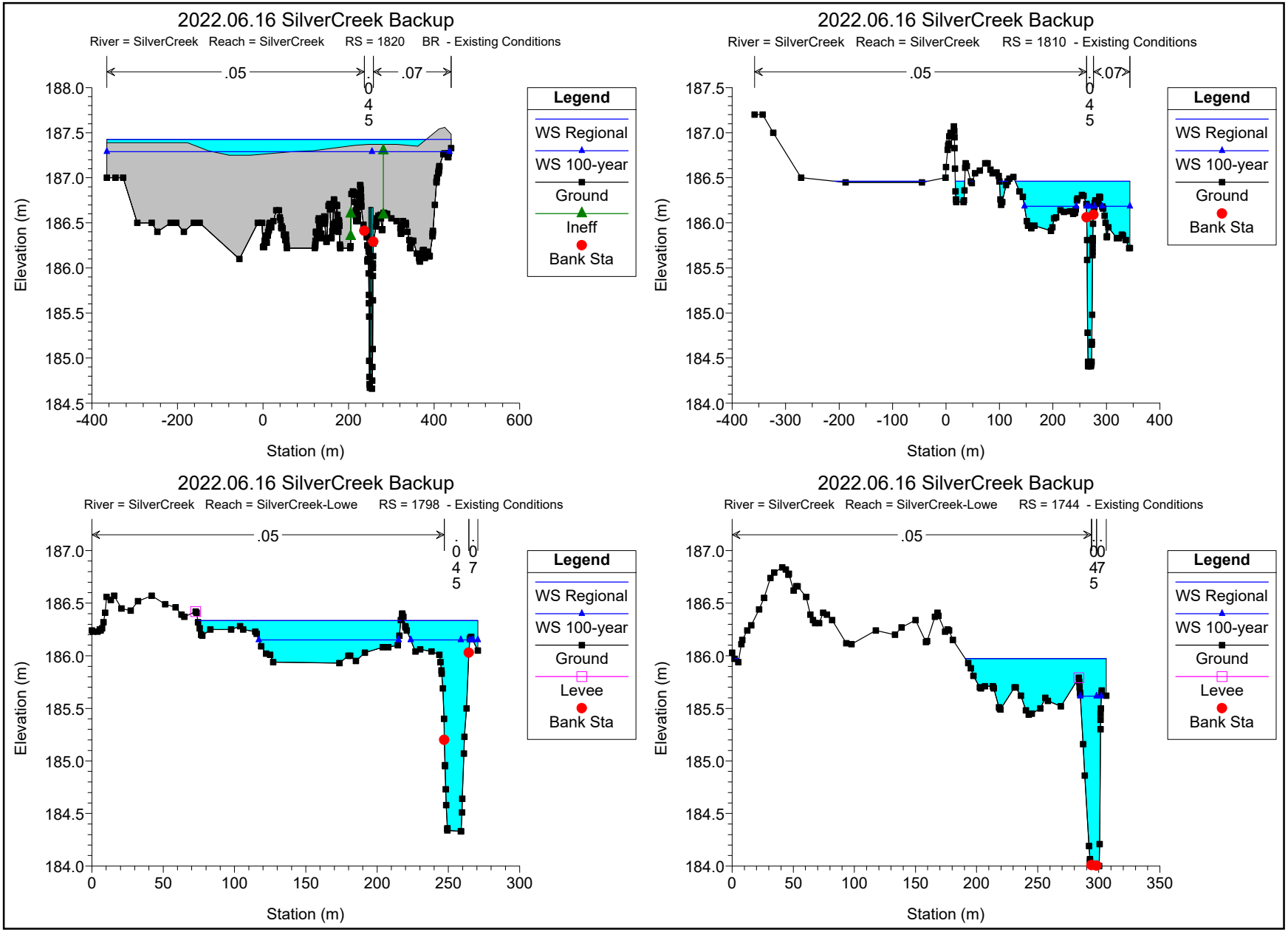
River = SilverCreek Reach = SilverCreek RS = 1971 - Existing Conditions
.08
.045
.08
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1931 - Existing Conditions
.08
.045
.08
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1848 - Existing Conditions
.05
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1835 - Existing Conditions
.05
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta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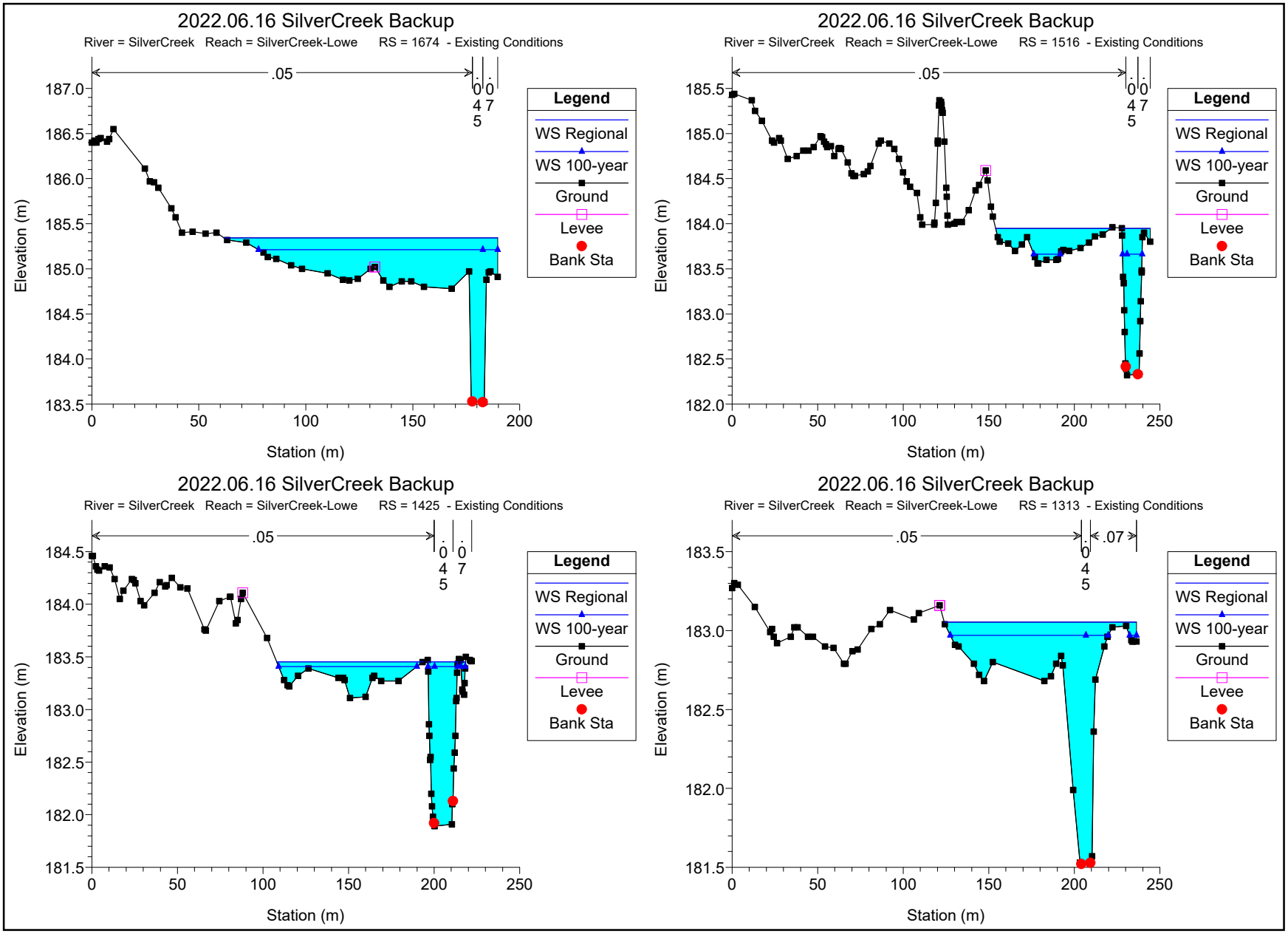
.07
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1810 - Existing Conditions
.05
.07
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1798 - Existing Conditions
.05
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1744 - Existing Conditions
.05
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta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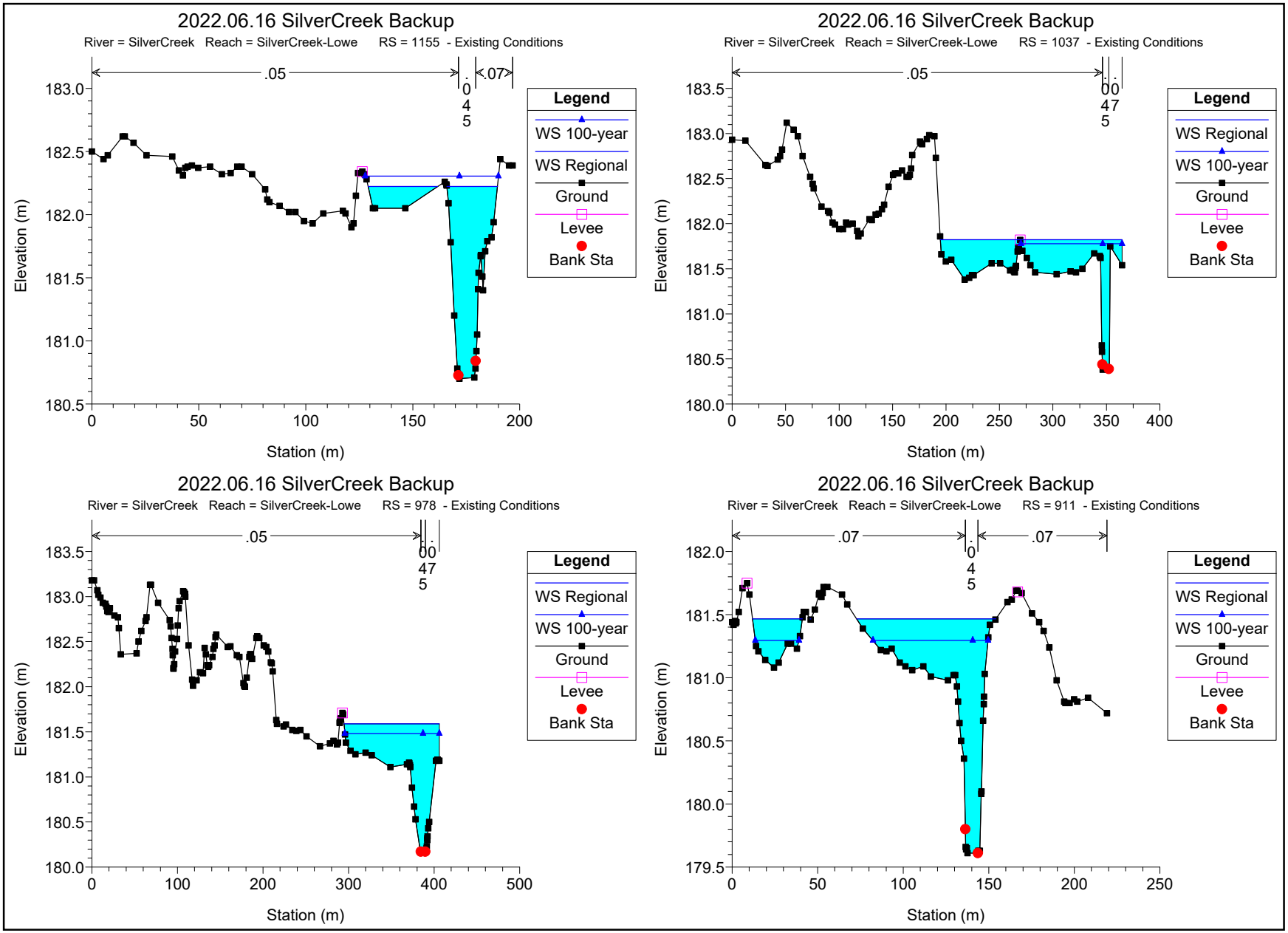
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1516 - Existing Conditions
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1425 - Existing Conditions
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1313 - Existing Conditions
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)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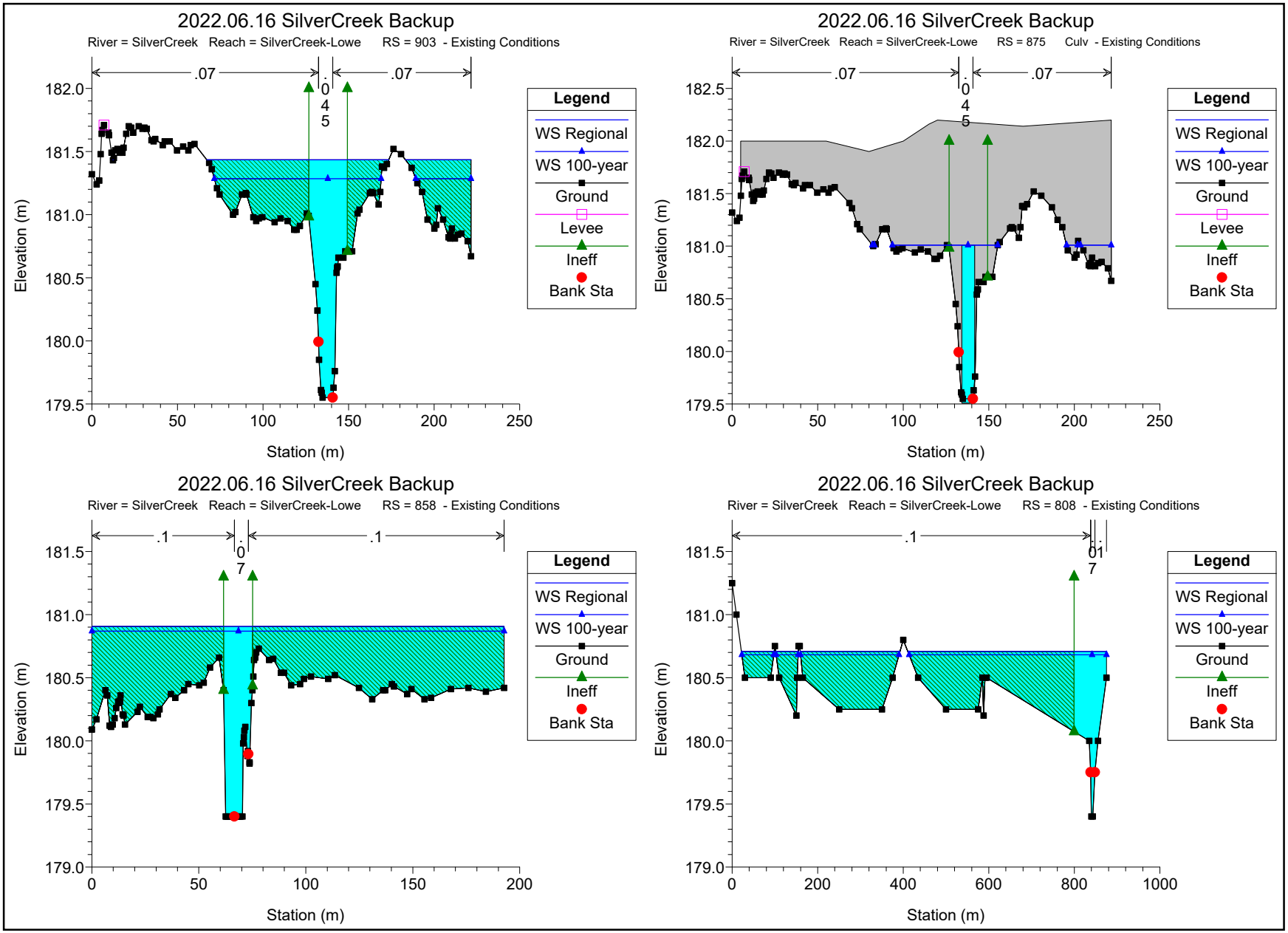
.05
.07
.045
Legend
WS 100-year
WS Regional
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1037 - Existing Conditions
.05
.0047 5
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 978 - Existing Conditions
.05
.0047 5
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 911 - Existing Conditions
.07
.07
.045
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)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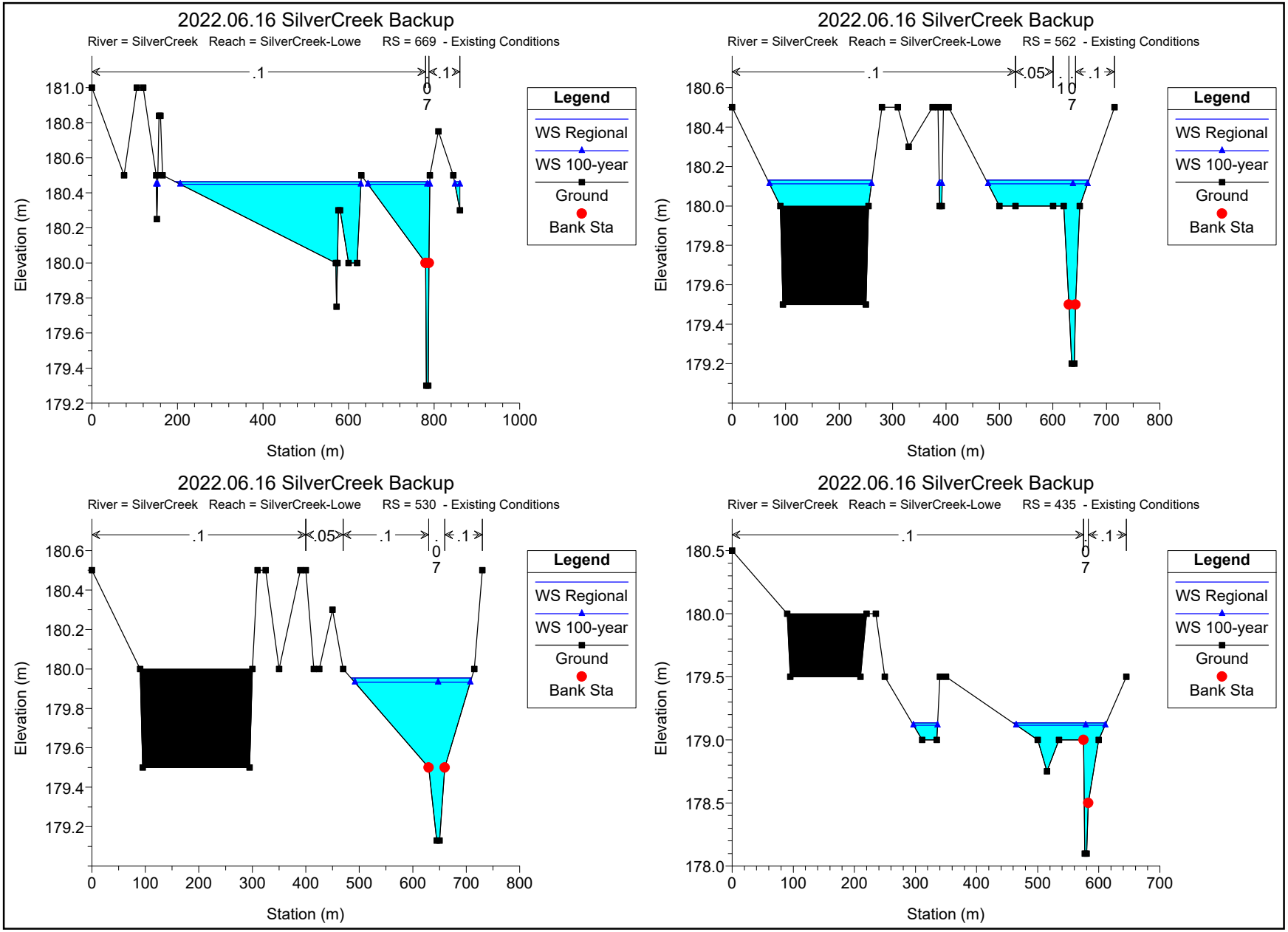
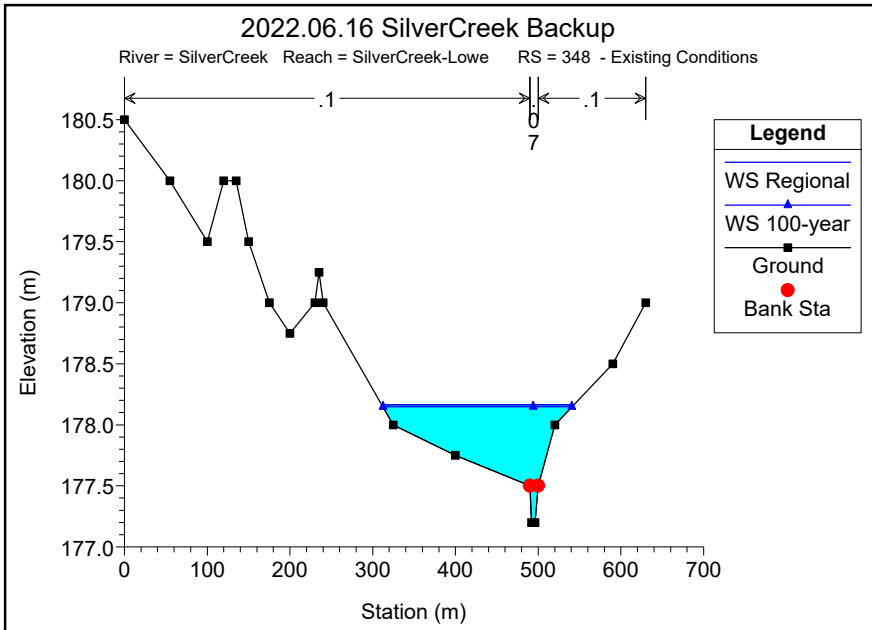
.07
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 875 Culv - Existing Conditions
.07
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 858 - Existing Conditions
.1
.07
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 808 - Existing Conditions
.1
.017
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 669 - Existing Conditions
.1
.1
0
7
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 562 - Existing Conditions
.1
.05
.1
.
1
0
7
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 530 - Existing Conditions
.1
.05
.1
.1
0
7
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 435 - Existing Conditions
.1
.1
0
7
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
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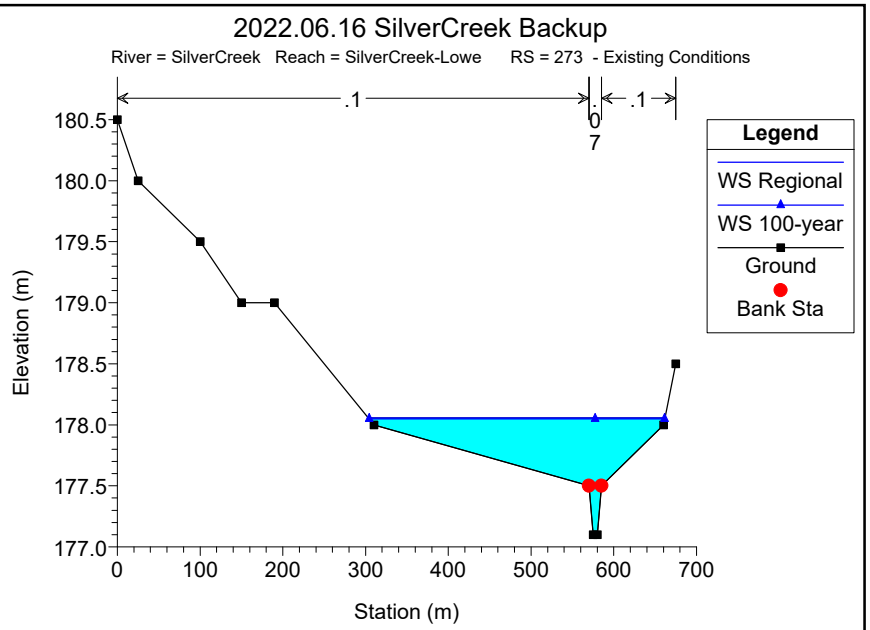
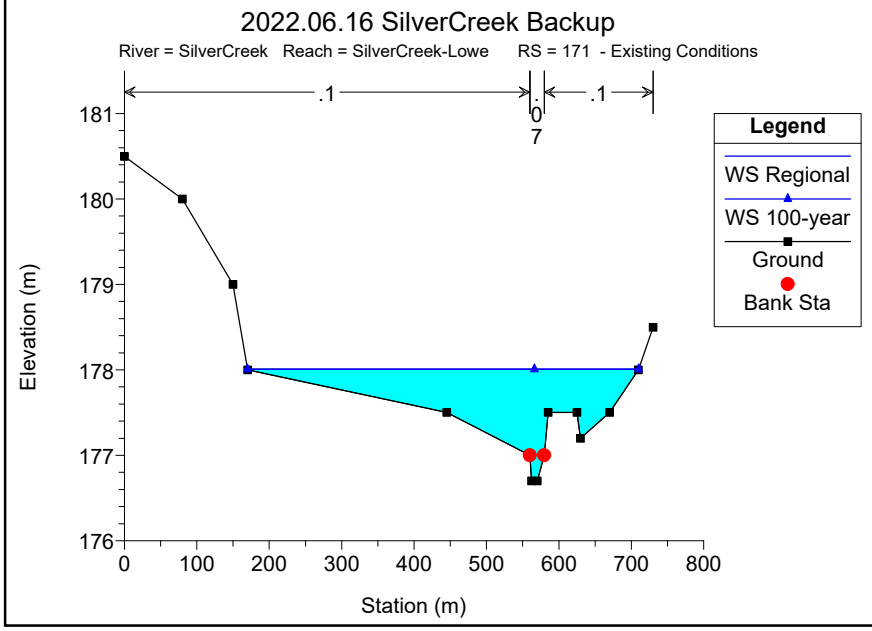
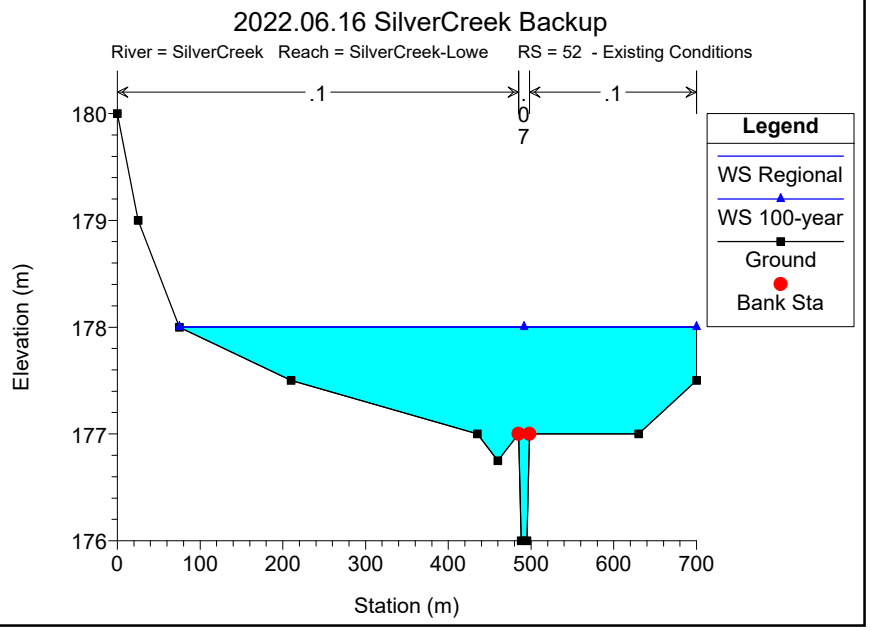
.1
.07
.1
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 273 - Existing Conditions
.1
.07
.1
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 171 - Existing Conditions
.1
.07
.1
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 52 - Existing Conditions
.1
.07
.1
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)

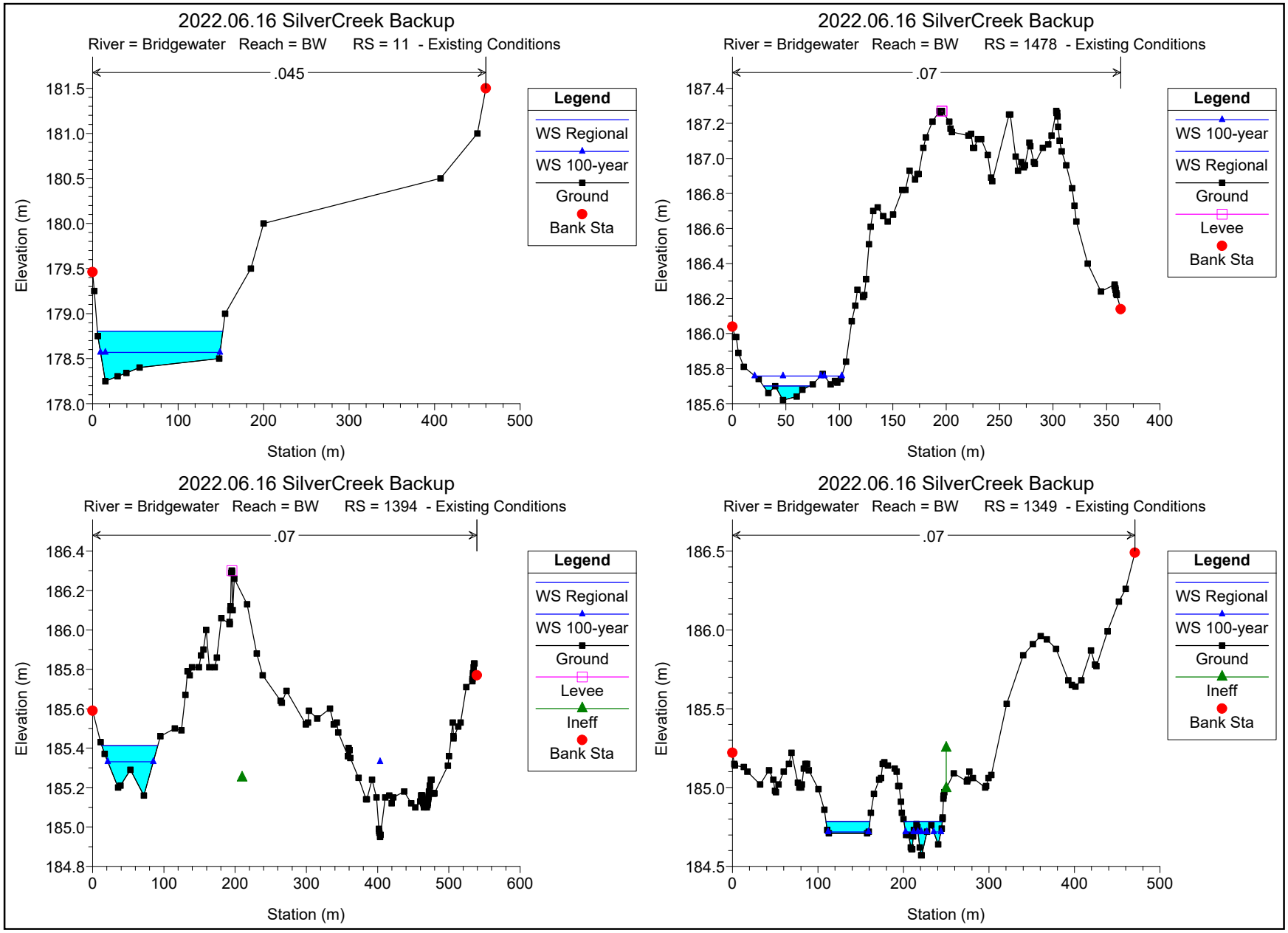
Bridgewater Creek - Existing Conditions

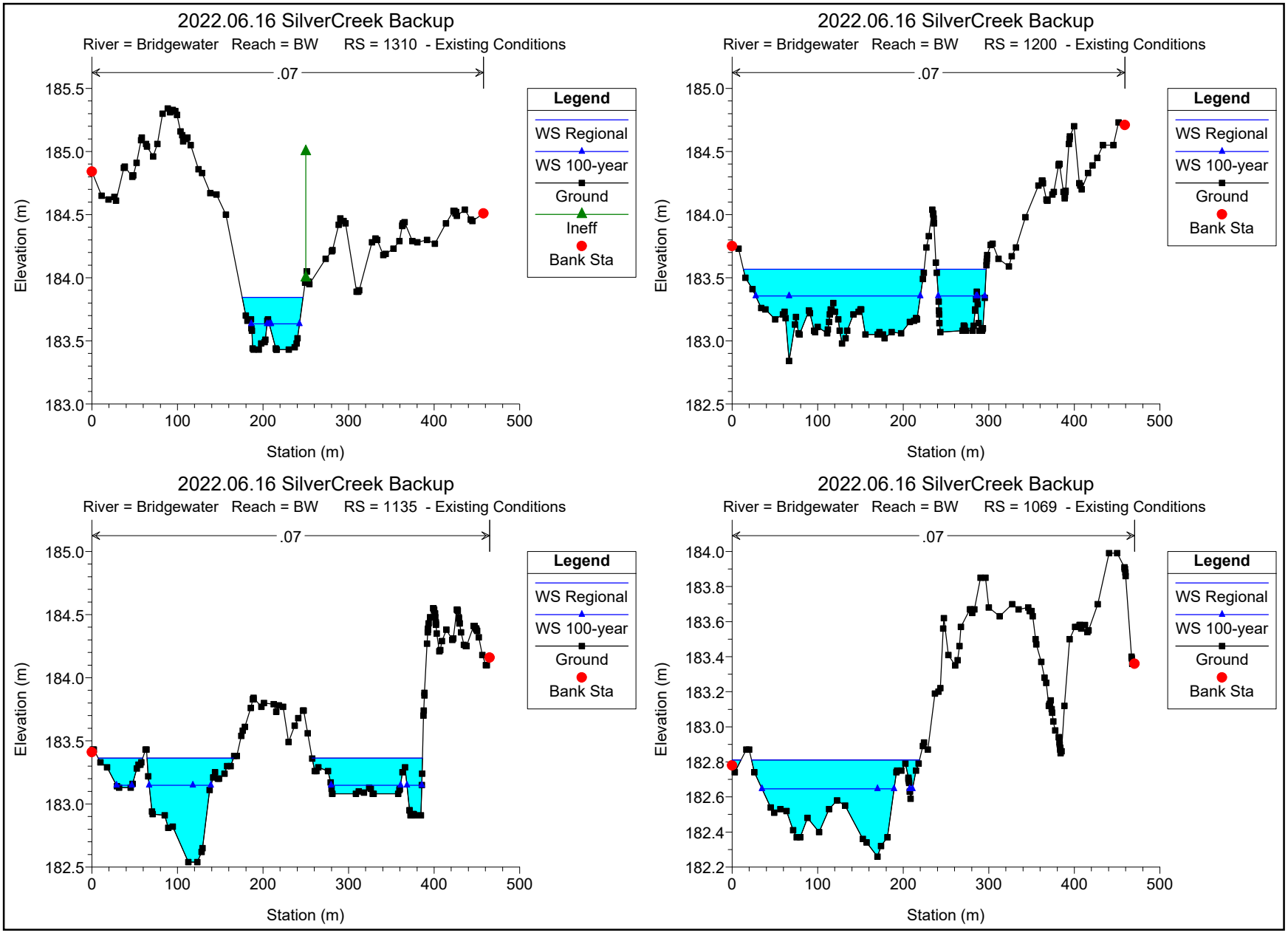
HEC-RAS Plan: SC1 River: Bridgewater Reach: BW

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	1478	Regional	1.00	185.62	185.70	185.70	185.72	0.123459	0.58	1.71	43.26	0.94
BW	1478	100-year	1.00	185.62	185.76	185.70	185.76	0.006653	0.19	5.22	78.14	0.24
BW	1394	Regional	1.00	184.95	185.41	185.25	185.41	0.000484	0.09	11.46	78.47	0.07
BW	1394	100-year	1.00	184.95	185.33	185.25	185.33	0.003925	0.18	5.64	63.90	0.19
BW	1349	Regional	6.64	184.57	184.78	184.78	184.82	0.100604	0.85	7.82	96.28	0.95
BW	1349	100-year	1.12	184.57	184.72	184.72	184.73	0.187723	0.55	2.02	75.32	1.08
BW	1310	Regional	13.56	183.43	183.84	183.66	183.86	0.008423	0.61	22.37	71.13	0.35
BW	1310	100-year	4.01	183.43	183.64	183.55	183.65	0.011294	0.46	8.82	53.66	0.36
BW	1200	Regional	39.00	182.84	183.57		183.57	0.001933	0.35	111.69	269.34	0.17
BW	1200	100-year	13.34	182.84	183.36		183.36	0.001945	0.24	56.47	245.93	0.16
BW	1135	Regional	40.87	182.54	183.36		183.37	0.005301	0.47	86.47	282.13	0.27
BW	1135	100-year	13.34	182.54	183.15		183.15	0.006149	0.37	35.96	188.66	0.27
BW	1069	Regional	42.60	182.26	182.81		182.84	0.013742	0.72	58.82	206.79	0.43
BW	1069	100-year	13.34	182.26	182.65		182.66	0.009440	0.45	29.45	157.90	0.34
BW	1006	Regional	43.20	181.70	182.35		182.36	0.004735	0.44	97.51	322.04	0.26
BW	1006	100-year	13.41	181.70	182.16		182.16	0.006512	0.34	39.79	251.66	0.27
BW	936	Regional	41.49	181.50	182.11		182.12	0.002587	0.37	111.26	302.15	0.20
BW	936	100-year	13.49	181.50	181.91		181.92	0.002082	0.24	55.72	245.83	0.16
BW	840	Regional	53.32	180.50	181.18	181.18	181.27	0.075447	1.36	39.26	191.99	0.96
BW	840	100-year	22.27	180.50	181.07		181.12	0.051293	1.00	22.36	130.36	0.77
BW	740	Regional	53.53	179.49	180.65		180.66	0.001346	0.29	184.98	263.83	0.11
BW	740	100-year	22.29	179.49	180.25		180.25	0.003440	0.28	80.27	246.31	0.16
BW	685	Regional	53.53	179.36	180.59		180.60	0.000856	0.26	204.68	242.00	0.09
BW	685	100-year	22.29	179.36	180.10		180.10	0.002147	0.25	88.87	223.05	0.13
BW	670		Lat Struct									
BW	660	Regional	29.65	179.41	180.58		180.58	0.000248	0.14	211.09	250.42	0.05
BW	660	100-year	9.58	179.41	180.08		180.08	0.000350	0.10	92.69	225.77	0.05
BW	636	Regional	29.65	179.44	180.58	179.74	180.58	0.000306	0.15	202.48	264.13	0.05
BW	636	100-year	9.58	179.44	180.07	179.61	180.07	0.000563	0.13	73.33	200.47	0.07
BW	606	Regional	29.65	179.44	180.57	179.68	180.57	0.000209	0.14	215.83	322.07	0.05
BW	606	100-year	9.58	179.44	180.05	179.59	180.05	0.000334	0.11	86.63	300.89	0.05
BW	588	Regional	29.65	179.43	180.56		180.56	0.000522	0.22	137.84	150.39	0.07
BW	588	100-year	9.58	179.43	180.04		180.04	0.000758	0.16	61.60	144.85	0.08
BW	572	Regional	29.65	179.39	180.55		180.56	0.000548	0.23	129.71	134.01	0.07
BW	572	100-year	9.58	179.39	180.03		180.03	0.000679	0.16	61.01	130.20	0.07
BW	545	Regional	29.65	179.34	180.53		180.53	0.001244	0.32	93.22	107.61	0.11
BW	545	100-year	9.58	179.34	180.00		180.00	0.002928	0.26	36.29	105.87	0.14
BW	520	Regional	29.65	179.09	180.41	179.91	180.47	0.004521	1.08	27.58	100.29	0.35
BW	520	100-year	9.58	179.09	179.84	179.47	179.88	0.007904	0.82	11.75	97.92	0.40
BW	500		Culvert									
BW	475	Regional	29.65	178.92	180.15	179.77	180.16	0.000765	0.35	84.42	126.05	0.14
BW	475	100-year	9.58	178.92	179.82	179.35	179.84	0.003492	0.63	15.10	124.43	0.28
BW	446	Regional	29.65	178.80	180.08	179.64	180.11	0.005155	0.73	40.57	187.38	0.27
BW	446	100-year	9.58	178.80	179.71	179.28	179.72	0.004939	0.46	20.72	121.69	0.24
BW	428	Regional	29.65	178.74	179.93	179.68	180.00	0.005357	1.20	24.81	210.26	0.48
BW	428	100-year	9.58	178.74	179.57	179.44	179.61	0.008319	0.88	10.85	75.77	0.52
BW	420		Lat Struct									
BW	416	Regional	23.31	178.55	179.91		179.95	0.002336	0.87	26.66	35.66	0.32
BW	416	100-year	5.09	178.55	179.56		179.57	0.000634	0.34	15.02	31.28	0.16
BW	381	Regional	23.31	178.53	179.89		179.91	0.000509	0.57	40.85	33.04	0.16
BW	381	100-year	5.09	178.53	179.56		179.56	0.000063	0.17	30.10	31.56	0.06

HEC-RAS Plan: SC1 River: Bridgewater Reach: BW (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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	367	Regional	23.31	178.77	179.87		179.90	0.001029	0.71	32.90	32.78	0.23
BW	367	100-year	5.09	178.77	179.56		179.56	0.000154	0.22	22.82	31.13	0.08
BW	361	Regional	23.31	178.90	179.79		179.88	0.006614	1.33	17.57	27.54	0.53
BW	361	100-year	5.09	178.90	179.54		179.56	0.001052	0.45	11.21	22.24	0.20
BW	352	Regional	23.31	179.30	179.76		179.80	0.006999	0.81	28.91	101.21	0.48
BW	352	100-year	5.09	179.30	179.51		179.53	0.016938	0.69	7.41	63.91	0.64
BW	231	Regional	23.31	178.15	179.33		179.36	0.002234	0.67	34.67	67.47	0.30
BW	231	100-year	5.09	178.15	178.94		178.95	0.002201	0.43	11.95	45.60	0.27
BW	192	Regional	23.31	178.14	179.28		179.29	0.001175	0.52	45.10	80.48	0.22
BW	192	100-year	5.09	178.14	178.90		178.90	0.000749	0.28	17.86	55.55	0.16
BW	150	Regional	23.31	178.48	179.19		179.22	0.002582	0.78	30.01	52.48	0.33
BW	150	100-year	5.09	178.48	178.84		178.85	0.001853	0.40	12.77	47.47	0.25
BW	110	Regional	23.31	178.37	179.00		179.05	0.008010	0.98	23.74	68.32	0.53
BW	110	100-year	5.09	178.37	178.74		178.76	0.003589	0.52	9.75	39.61	0.34
BW	65	Regional	23.31	178.27	178.88		178.89	0.001720	0.48	48.38	127.88	0.25
BW	65	100-year	5.09	178.27	178.64		178.65	0.001654	0.27	18.61	111.70	0.21
BW	11	Regional	23.31	178.25	178.80	178.55	178.81	0.001301	0.42	55.57	146.70	0.22
BW	11	100-year	5.09	178.25	178.57	178.44	178.57	0.001302	0.23	21.87	139.73	0.19


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 11 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1478 - Existing Conditions
.07
Elevation (m)
Station (m)
Legend
WS 100-year
WS Regional
Ground
Levee
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1394 - Existing Conditions
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1349 - Existing Conditions
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta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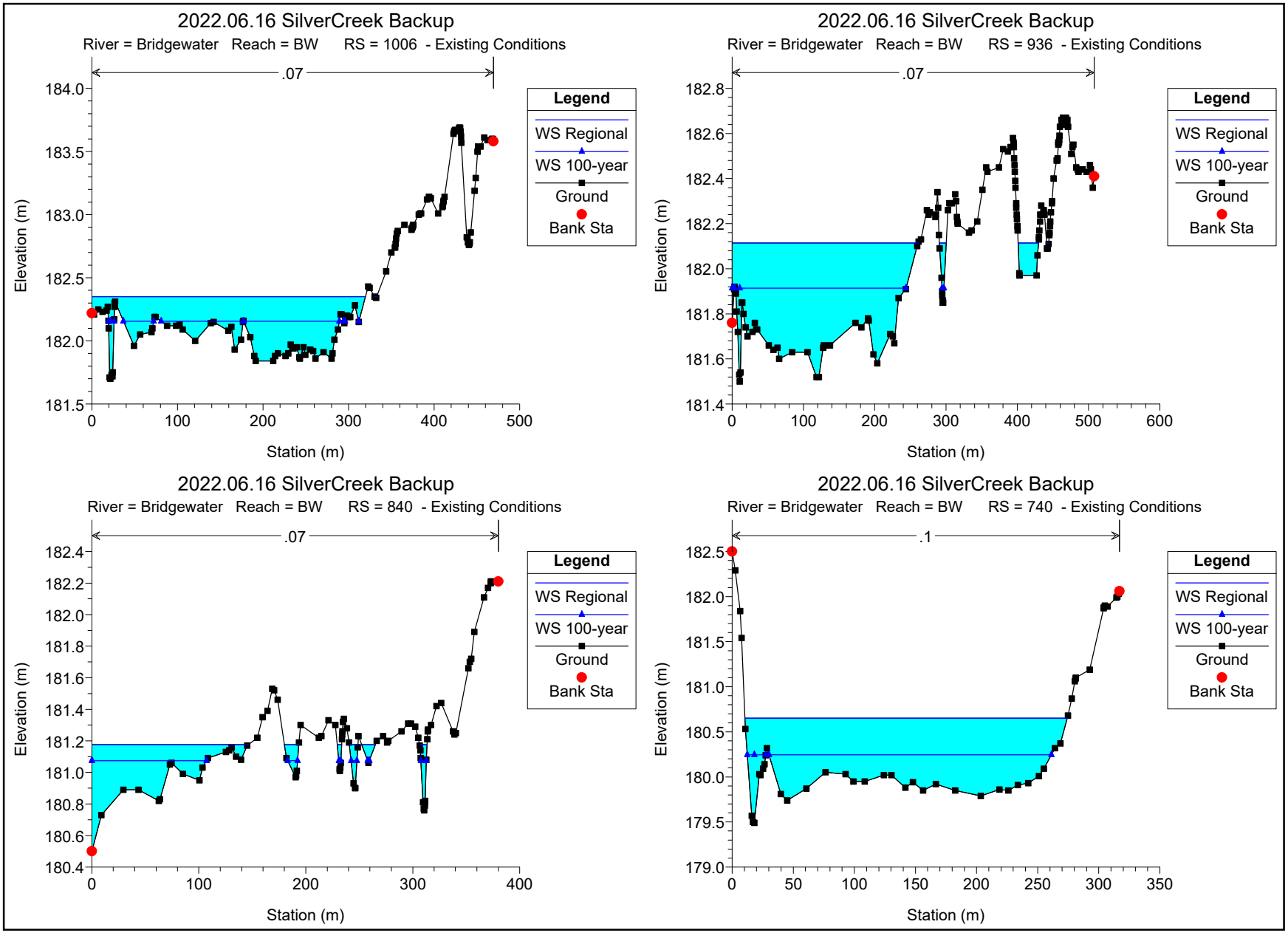
River = Bridgewater Reach = BW RS = 1310 - Existing Conditions
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1200 - Existing Conditions
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1135 - Existing Conditions
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1069 - Existing Conditions
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta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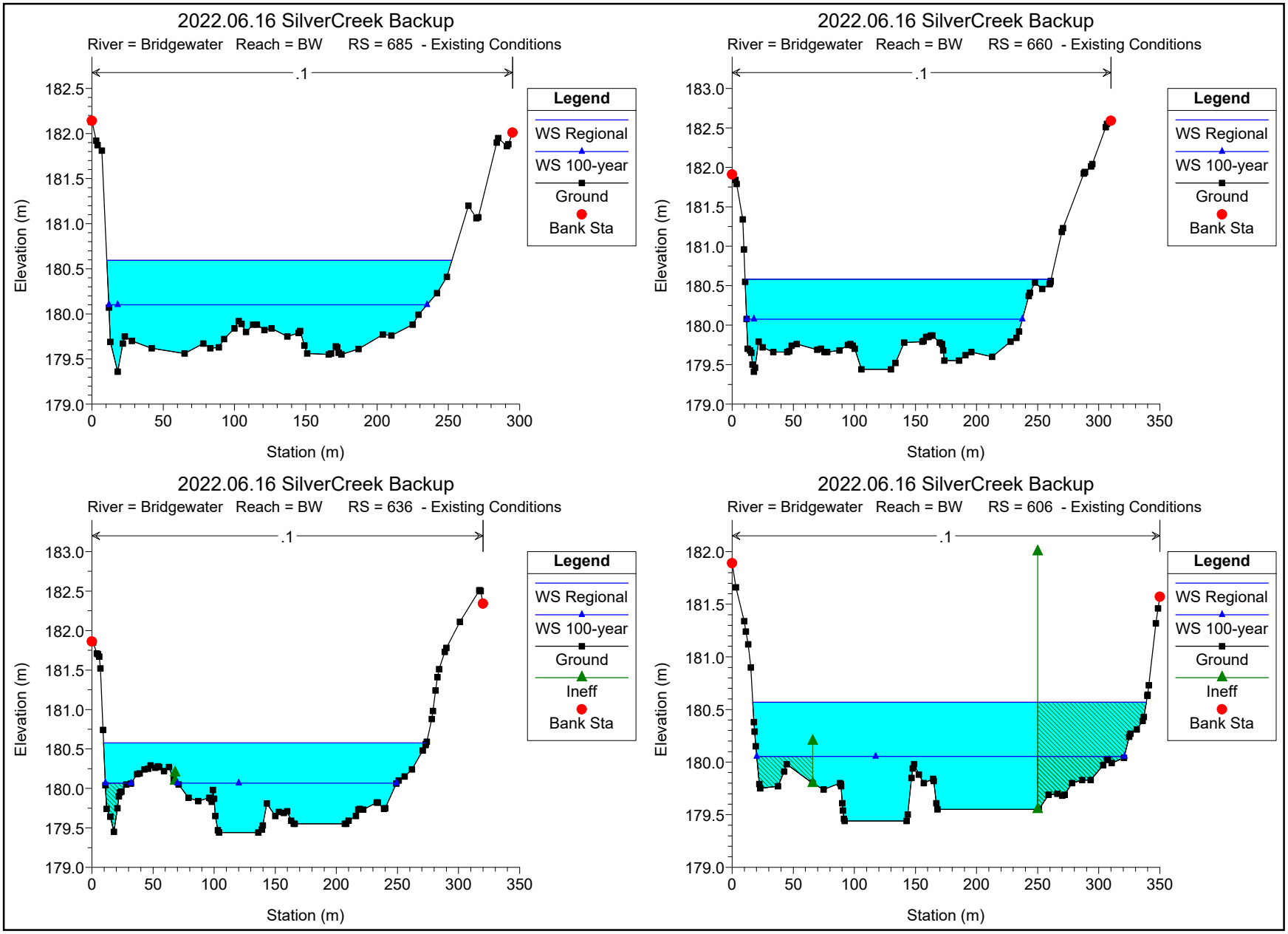
River = Bridgewater Reach = BW RS = 1006 - Existing Conditions
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 936 - Existing Conditions
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 840 - Existing Conditions
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 740 - Existing Conditions
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta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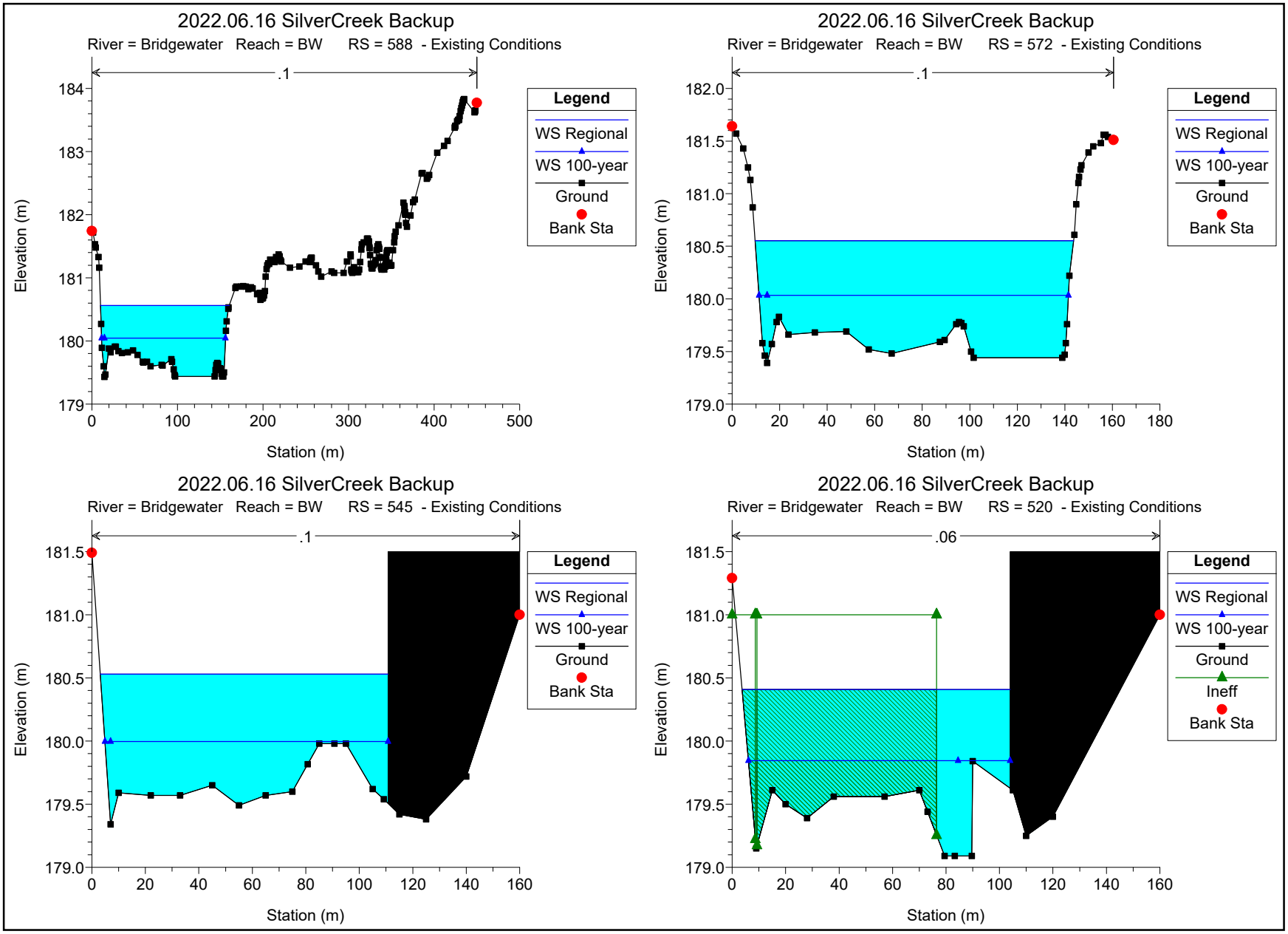
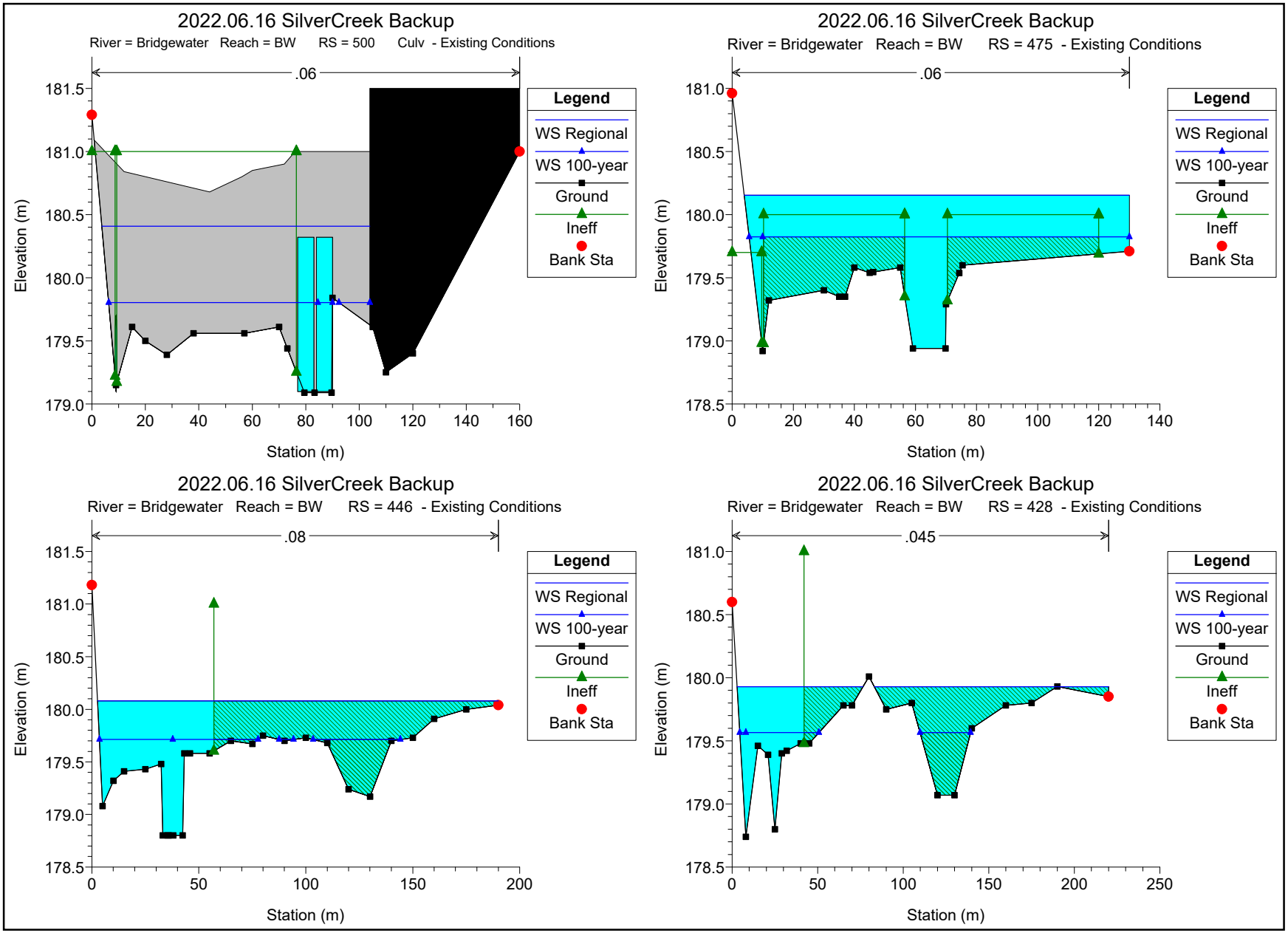
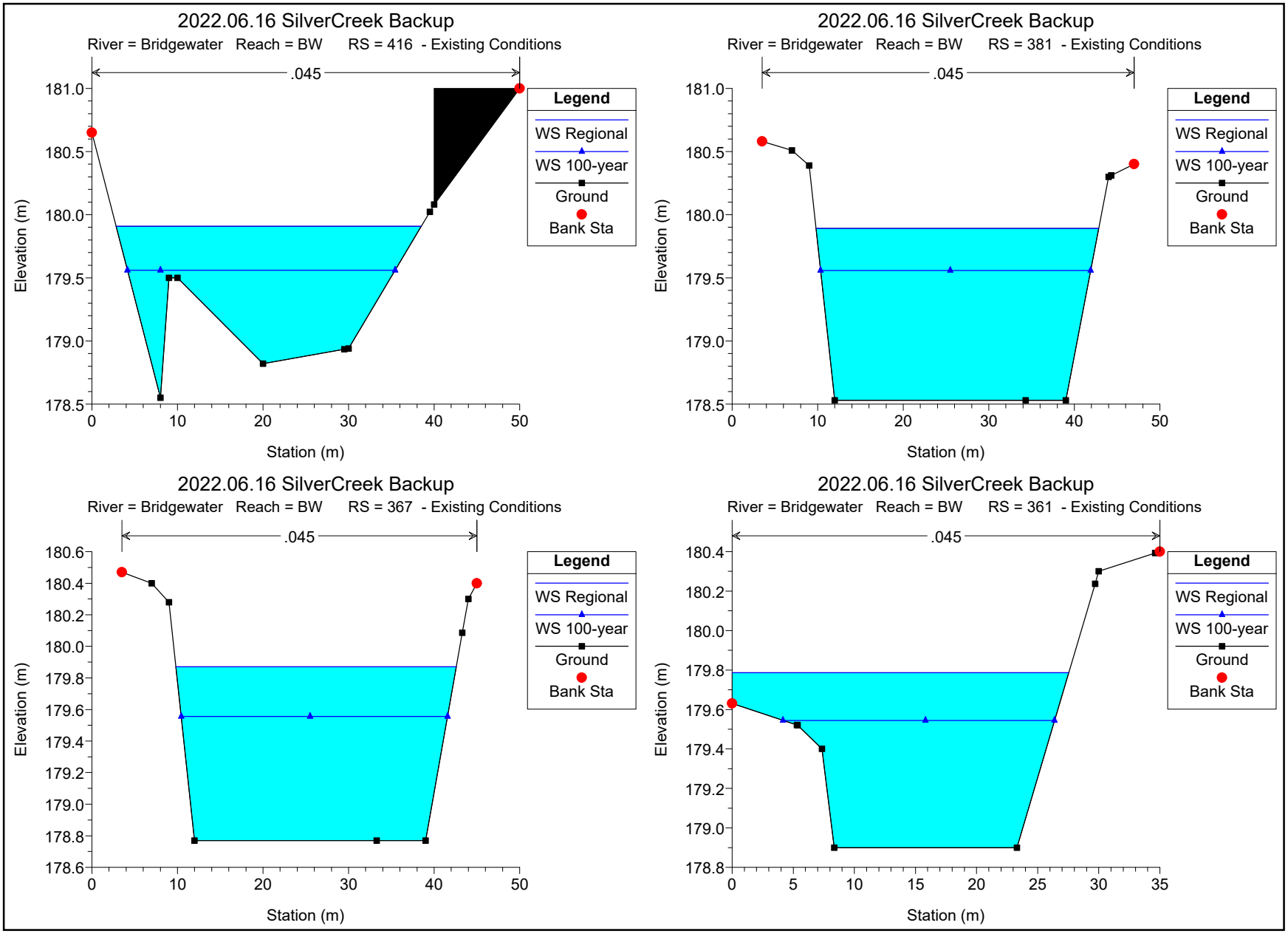
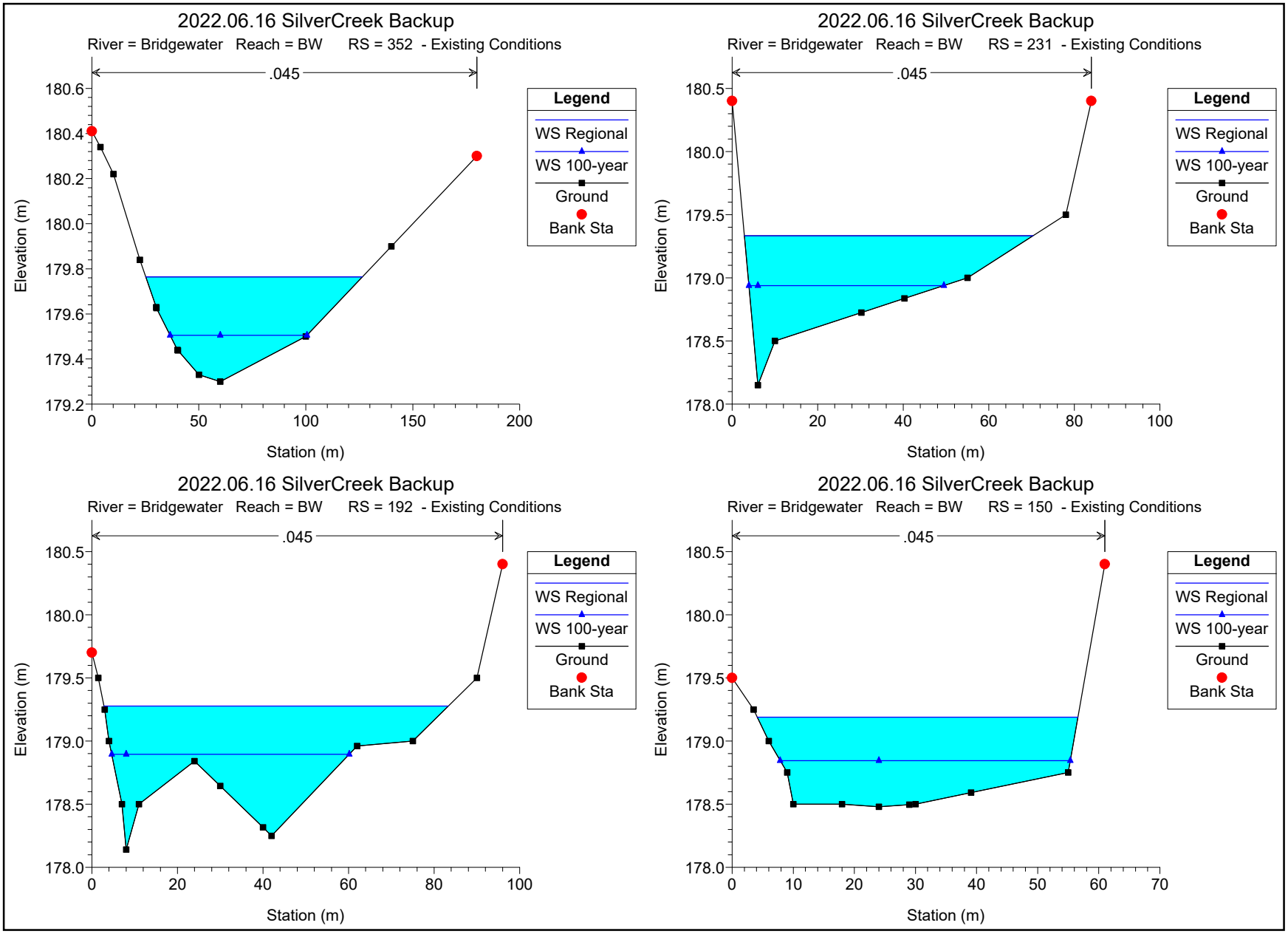
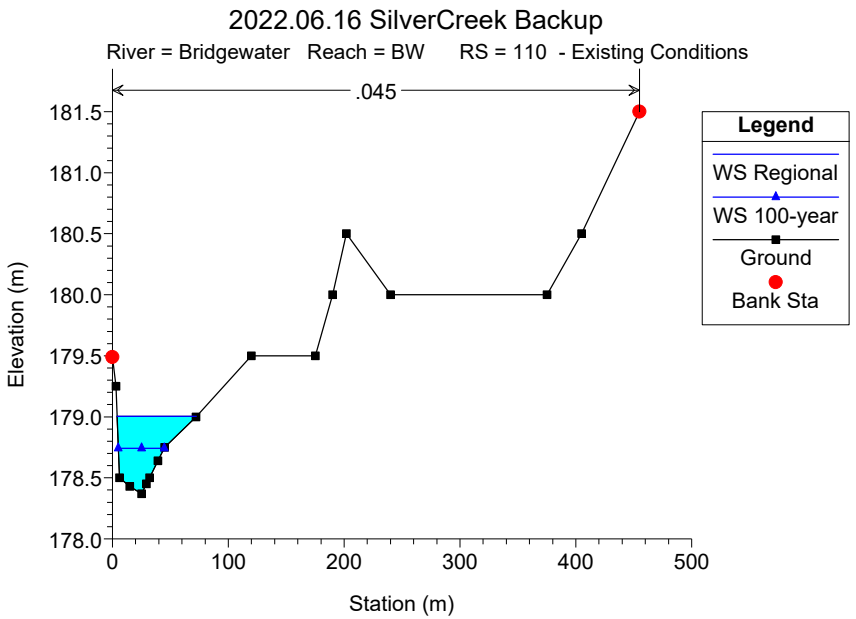
River = Bridgewater Reach = BW RS = 685 - Existing Conditions
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 660 - Existing Conditions
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 636 - Existing Conditions
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 606 - Existing Conditions
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta

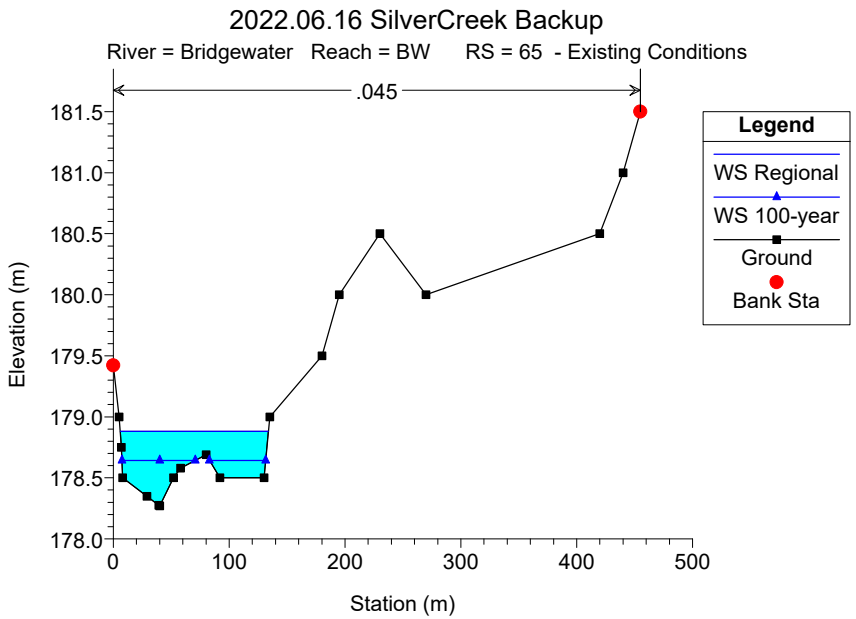

2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 588 - Existing Conditions
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 572 - Existing Conditions
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 545 - Existing Conditions
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 520 - Existing Conditions
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 500 Culv - Existing Conditions
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 475 - Existing Conditions
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 446 - Existing Conditions
.08
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 428 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 416 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 381 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 367 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 361 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 352 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 231 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 192 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 150 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 110 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 65 - Existing Conditions
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta

APPENDIX D

Proposed Conditions HEC-RAS Modelling

HEC-RAS Results Summary – Existing vs. Proposed

D.1: Option A Scenario
Silver Creek HEC-RAS Output Table

Silver Creek HEC-RAS Cross Section Output

Bridgewater Creek HEC-RAS Output Table

Bridgewater Creek HEC-RAS Cross Section Output

D.2: Option B Scenario
Silver Creek HEC-RAS Output Table

Silver Creek HEC-RAS Cross Section Output

Bridgewater Creek HEC-RAS Output Table

Bridgewater Creek HEC-RAS Cross Section Output

CROZIER CONSULTING ENGINEERS

PROJ. NO: 281-2769
PROJECT: Huntingwood East Lands
DESIGN: JE
FILE: Sensitivity Analysis
DATE: Mar 30, 2023

HEC-RAS Results Summary - Existing Conditions vs. Proposed Options A & B

Note: *Italicized* text represents cross sections outside of the Subject Property.

		100-year								Regional Storm							
		Existing Conditions		Option A			Option B			Existing Conditions		Option A			Option B		
River	River Sta	Q Total (m3/s)	W.S. Elev (m)	Q Total (m3/s)	W.S. Elev (m)	Difference in WSE	Q Total (m3/s)	W.S. Elev (m)	Difference in WSE	Q Total (m3/s)	W.S. Elev (m)	Q Total (m3/s)	W.S. Elev (m)	Difference in WSE	Q Total (m3/s)	W.S. Elev (m)	Difference in WSE
Silver Creek	*1971*	*44.5*	*187.8*	*44.5*	*187.8*	*0*	*44.5*	*187.8*	*0*	*78*	*188*	*78*	*188*	*0*	*78*	*188*	*0*
Silver Creek	*1931*	*44.5*	*187.44*	*44.5*	*187.44*	*0*	*44.5*	*187.44*	*0*	*78*	*187.51*	*78*	*187.51*	*0*	*78*	*187.51*	*0*
Silver Creek	*1848*	*44.5*	*187.29*	*44.5*	*187.29*	*0*	*44.5*	*187.29*	*0*	*78*	*187.43*	*78*	*187.43*	*0*	*78*	*187.43*	*0*
Silver Creek	*1835*	*44.5*	*187.29*	*44.5*	*187.29*	*0*	*44.5*	*187.29*	*0*	*78*	*187.43*	*78*	*187.43*	*0*	*78*	*187.43*	*0*
Silver Creek	*1820*	*Bridge*								Bridge							
Silver Creek	*1810*	*44.5*	*186.18*	*44.5*	*186.46*	0.28	44.5	186.4	0.22	78	186.46	78	186.9	0.44	78	186.92	0.46
Silver Creek	*1798*	*44.5*	*186.15*	*44.5*	*186.37*	0.22	44.5	186.29	0.14	78	186.33	78	186.78	0.45	78	186.81	0.48
Silver Creek	*1744*	*44.5*	*185.62*	*44.5*	*186.03*	0.41	44.5	186.18	0.56	78	185.97	78	186.75	0.78	78	186.79	0.82
Silver Creek	*1730*	*Lat Struct*								Lat Struct							
Silver Creek	*1674*	*41.71*	*185.21*	*44.41*	*185*	-0.21	44.5	184.91	-0.3	65.81	185.34	75.17	185.2	-0.14	77.35	185.12	-0.22
Silver Creek	*1516*	*32.16*	*183.66*	*42.71*	*183.63*	-0.03	44.08	183.7	0.04	40.36	183.95	61	183.84	-0.11	64.87	183.94	-0.01
Silver Creek	*1425*	*32.16*	*183.41*	*42.71*	*183.27*	-0.14	44.08	183.33	-0.08	38.13	183.45	61	183.45	0	63.98	183.49	0.04
Silver Creek	*1313*	*32.16*	*182.97*	*41.82*	*182.9*	-0.07	43.97	183.03	0.06	36.71	183.05	58.8	183.04	-0.01	60.27	183.17	0.12
Silver Creek	*1155*	*32.09*	*182.31*	*32.23*	*182.27*	-0.04	43.27	182.45	0.14	35.69	182.22	41.35	182.36	0.14	56.24	182.57	0.35
Silver Creek	*1037*	*31.61*	*181.78*	*23.47*	*181.35*	-0.43	38.54	181.87	0.09	39.7	181.82	25.77	181.37	-0.45	46.84	181.91	0.09
Silver Creek	*978*	*30.83*	*181.48*	*19.68*	*181.31*	-0.17	36.61	181.54	0.06	38.03	181.59	19.33	181.3	-0.29	43.52	181.61	0.02
Silver Creek	*911*	*23.21*	*181.3*	*19.68*	*181.12*	-0.18	24.77	181.42	0.12	25.47	181.47	19.33	181.11	-0.36	26.08	181.51	0.04
Silver Creek	*903*	*23.21*	*181.29*	*19.68*	*181.12*	-0.17	24.77	181.4	0.11	25.47	181.43	19.33	181.1	-0.33	26.08	181.47	0.04
Silver Creek	*875*	*Culvert*								Culvert							
Silver Creek	*858*	*23.21*	*180.87*	*19.68*	*180.8*	-0.07	24.77	180.89	0.02	25.47	180.91	19.33	180.8	-0.11	26.08	180.92	0.01
Silver Creek	*808*	*23.21*	*180.68*	*19.68*	*180.64*	-0.04	24.77	180.7	0.02	25.47	180.71	19.33	180.63	-0.08	26.08	180.72	0.01
Silver Creek	*669*	*23.21*	*180.45*	*19.68*	*180.42*	-0.03	24.77	180.46	0.01	25.47	180.46	19.33	180.42	-0.04	26.08	180.47	0.01
Silver Creek	*562*	*23.21*	*180.11*	*19.68*	*180.08*	*-0.03*	*24.77*	*180.13*	*0.02*	*25.47*	*180.13*	*19.33*	*180.08*	*-0.05*	*26.08*	*180.14*	*0.01*
Silver Creek	*530*	*23.21*	*179.93*	*19.68*	*179.89*	*-0.04*	*24.77*	*179.95*	*0.02*	*25.47*	*179.95*	*19.33*	*179.89*	*-0.06*	*26.08*	*179.96*	*0.01*
Silver Creek	*435*	*23.21*	*179.12*	*19.68*	*179.09*	*-0.03*	*24.77*	*179.13*	*0.01*	*25.47*	*179.13*	*19.33*	*179.08*	*-0.05*	*26.08*	*179.14*	*0.01*
Silver Creek	*348*	*23.21*	*178.15*	*19.68*	*178.12*	*-0.03*	*24.77*	*178.16*	*0.01*	*25.47*	*178.16*	*19.33*	*178.12*	*-0.04*	*26.08*	*178.17*	*0.01*
Silver Creek	*273*	*23.21*	*178.05*	*19.68*	*178.04*	*-0.01*	*24.77*	*178.05*	*0*	*25.47*	*178.06*	*19.33*	*178.03*	*-0.03*	*26.08*	*178.06*	*0*
Silver Creek	*171*	*23.21*	*178.01*	*19.68*	*178.01*	*0*	*24.77*	*178.01*	*0*	*25.47*	*178.01*	*19.33*	*178*	*-0.01*	*26.08*	*178.01*	*0*
Silver Creek	*52*	*23.21*	*178*	*19.68*	*178*	*0*	*24.77*	*178*	*0*	*25.47*	*178*	*19.33*	*178*	*0*	*26.08*	*178*	*0*
Bridgewater	*1478*	*1*	*185.76*	*1*	*185.72*	*-0.04*	*1*	*185.73*	*-0.03*	*1*	*185.7*	*1*	*185.7*	*0*	*1*	*185.7*	*0*
Bridgewater	*1394*	*1*	*185.33*	*1*	*185.17*	*-0.16*	*1*	*185.16*	*-0.17*	*1*	*185.41*	*1*	*185.25*	*-0.16*	*1*	*185.18*	*-0.23*
Bridgewater	*1349*	*1.12*	*184.72*	*1.2*	*184.73*	*0.01*	*1*	*184.72*	*0*	*6.64*	*184.78*	*5.99*	*184.81*	*0.03*	*1.65*	*184.73*	*-0.05*
Bridgewater	*1310*	*4.01*	*183.64*	*2.18*	*183.64*	0	1	183.59	-0.05	13.56	183.84	13.31	183.8	-0.04	1.78	183.59	-0.25
Bridgewater	*1200*	*13.34*	*183.36*	*2.79*	*183.17*	-0.19	1.42	183.13	-0.23	39	183.57	18	183.4	-0.17	14.22	183.37	-0.2
Bridgewater	*1135*	*13.34*	*183.15*	*2.79*	*182.83*	-0.32	1.42	182.75	-0.4	40.87	183.36	18	183.19	-0.17	15.02	183.18	-0.18
Bridgewater	*1069*	*13.34*	*182.65*	*2.79*	*182.54*	-0.11	1.67	182.5	-0.15	42.6	182.81	18	182.68	-0.13	19.64	182.68	-0.13
Bridgewater	*1006*	*13.41*	*182.16*	*3.68*	*181.95*	-0.21	2.69	181.94	-0.22	43.2	182.35	20.2	182.21	-0.14	24.03	182.26	-0.09
Bridgewater	*936*	*13.49*	*181.91*	*3.68*	*181.83*	-0.08	4.82	181.86	-0.05	41.49	182.11	20.2	182.02	-0.09	28.88	182.08	-0.03
Bridgewater	*840*	*22.27*	*181.07*	*14.07*	*180.98*	-0.09	20.61	181.07	0	53.32	181.18	39.08	181.12	-0.06	52.63	181.17	-0.01
Bridgewater	*740*	*22.29*	*180.25*	*21.48*	*180.28*	0.03	20.73	180.23	-0.02	53.53	180.65	52.26	180.73	0.08	52.92	180.64	-0.01
Bridgewater	*685*	*22.29*	*180.1*	*25.8*	*180.16*	0.06	20.73	180.07	-0.03	53.53	180.59	59.65	180.69	0.1	52.92	180.58	-0.01
Bridgewater	*670*	*Lat Struct*								Lat Struct							
Bridgewater	*660*	*9.58*	*180.08*	*11.96*	*180.14*	0.06	8.79	180.05	-0.03	29.65	180.58	32.68	180.68	0.1	29.31	180.57	-0.01
Bridgewater	*636*	*9.58*	*180.07*	*11.96*	*180.13*	0.06	8.79	180.04	-0.03	29.65	180.58	32.68	180.67	0.09	29.31	180.57	-0.01
Bridgewater	*606*	*9.58*	*180.05*	*11.96*	*180.12*	0.07	8.79	180.02	-0.03	29.65	180.57	32.68	180.67	0.1	29.31	180.56	-0.01
Bridgewater	*588*	*9.58*	*180.04*	*11.96*	*180.11*	0.07	8.79	180.01	-0.03	29.65	180.56	32.68	180.66	0.1	29.31	180.55	-0.01
Bridgewater	*572*	*9.58*	*180.03*	*11.96*	*180.09*	0.06	8.79	180	-0.03	29.65	180.55	32.68	180.65	0.1	29.31	180.54	-0.01
Bridgewater	*545*	*9.58*	*180*	*11.96*	*180.06*	0.06	8.79	179.96	-0.04	29.65	180.53	32.68	180.63	0.1	29.31	180.52	-0.01
Bridgewater	*520*	*9.58*	*179.84*	*11.96*	*179.92*	*0.08*	*8.79*	*179.82*	*-0.02*	*29.65*	*180.41*	*32.68*	*180.52*	*0.11*	*29.31*	*180.4*	*-0.01*
Bridgewater	*500*	*Culvert*								Culvert							
Bridgewater	*475*	*9.58*	*179.82*	*11.96*	*179.88*	*0.06*	*8.79*	*179.8*	*-0.02*	*29.65*	*180.15*	*32.68*	*180.2*	*0.05*	*29.31*	*180.15*	*0*
Bridgewater	*446*	*9.58*	*179.71*	*11.96*	*179.76*	*0.05*	*8.79*	*179.69*	*-0.02*	*29.65*	*180.08*	*32.68*	*180.12*	*0.04*	*29.31*	*180.08*	*0*
Bridgewater	*428*	*9.58*	*179.57*	*11.96*	*179.62*	*0.05*	*8.79*	*179.54*	*-0.03*	*29.65*	*179.93*	*32.68*	*179.97*	*0.04*	*29.31*	*179.92*	*-0.01*
Bridgewater	*420*	*Lat Struct*								Lat Struct							
Bridgewater	*416*	*5.09*	*179.56*	*6.95*	*179.61*	*0.05*	*4.29*	*179.54*	*-0.02*	*23.31*	*179.91*	*25.82*	*179.95*	*0.04*	*23.02*	*179.9*	*-0.01*
Bridgewater	*381*	*5.09*	*179.56*	*6.95*	*179.61*	*0.05*	*4.29*	*179.53*	*-0.03*	*23.31*	*179.89*	*25.82*	*179.93*	*0.04*	*23.02*	*179.89*	*0*
Bridgewater	*367*	*5.09*	*179.56*	*6.95*	*179.6*	*0.04*	*4.29*	*179.53*	*-0.03*	*23.31*	*179.87*	*25.82*	*179.9*	*0.03*	*23.02*	*179.87*	*0*
Bridgewater	*361*	*5.09*	*179.54*	*6.95*	*179.58*	*0.04*	*4.29*	*179.52*	*-0.02*	*23.31*	*179.79*	*25.82*	*179.81*	*0.02*	*23.02*	*179.78*	*-0.01*
Bridgewater	*352*	*5.09*	*179.51*	*6.95*	*179.54*	*0.03*	*4.29*	*179.48*	*-0.03*	*23.31*	*179.76*	*25.82*	*179.79*	*0.03*	*23.02*	*179.76*	*0*
Bridgewater	*231*	*5.09*	*178.94*	*6.95*	*179*	*0.06*	*4.29*	*178.91*	*-0.03*	*23.31*	*179.33*	*25.82*	*179.37*	*0.04*	*23.02*	*179.33*	*0*
Bridgewater	*192*	*5.09*	*178.9*	*6.95*	*178.96*	*0.06*	*4.29*	*178.87*	*-0.03*	*23.31*	*179.28*	*25.82*	*179.31*	*0.03*	*23.02*	*179.27*	*-0.01*
Bridgewater	*150*	*5.09*	*178.84*	*6.95*	*178.91*	*0.07*	*4.29*	*178.82*	*-0.02*	*23.31*	*179.19*	*25.82*	*179.22*	*0.03*	*23.02*	*179.18*	*-0.01*
Bridgewater	*110*	*5.09*	*178.74*	*6.95*	*178.79*	*0.05*	*4.29*	*178.72*	*-0.02*	*23.31*	*179*	*25.82*	*179.03*	*0.03*	*23.02*	*179*	*0*
Bridgewater	*65*	*5.09*	*178.64*	*6.95*	*178.68*	*0.04*	*4.29*	*178.63*	*-0.01*	*23.31*	*178.88*	*25.82*	*178.91*	*0.03*	*23.02*	*178.88*	*0*
Bridgewater	*11*	*5.09*	*178.57*	*6.95*	*178.6*	*0.03*	*4.29*	*178.55*	*-0.02*	*23.31*	*178.8*	*25.82*	*178.83*	*0.03*	*23.02*	*178.8*	*0*

APPENDIX D.1

Proposed Conditions HEC-RAS Modelling

Option A Scenario

Silver Creek HEC-RAS Output Table

Silver Creek HEC-RAS Cross Section Output

Bridgewater Creek HEC-RAS Output Table

Bridgewater Creek HEC-RAS Cross Section Output

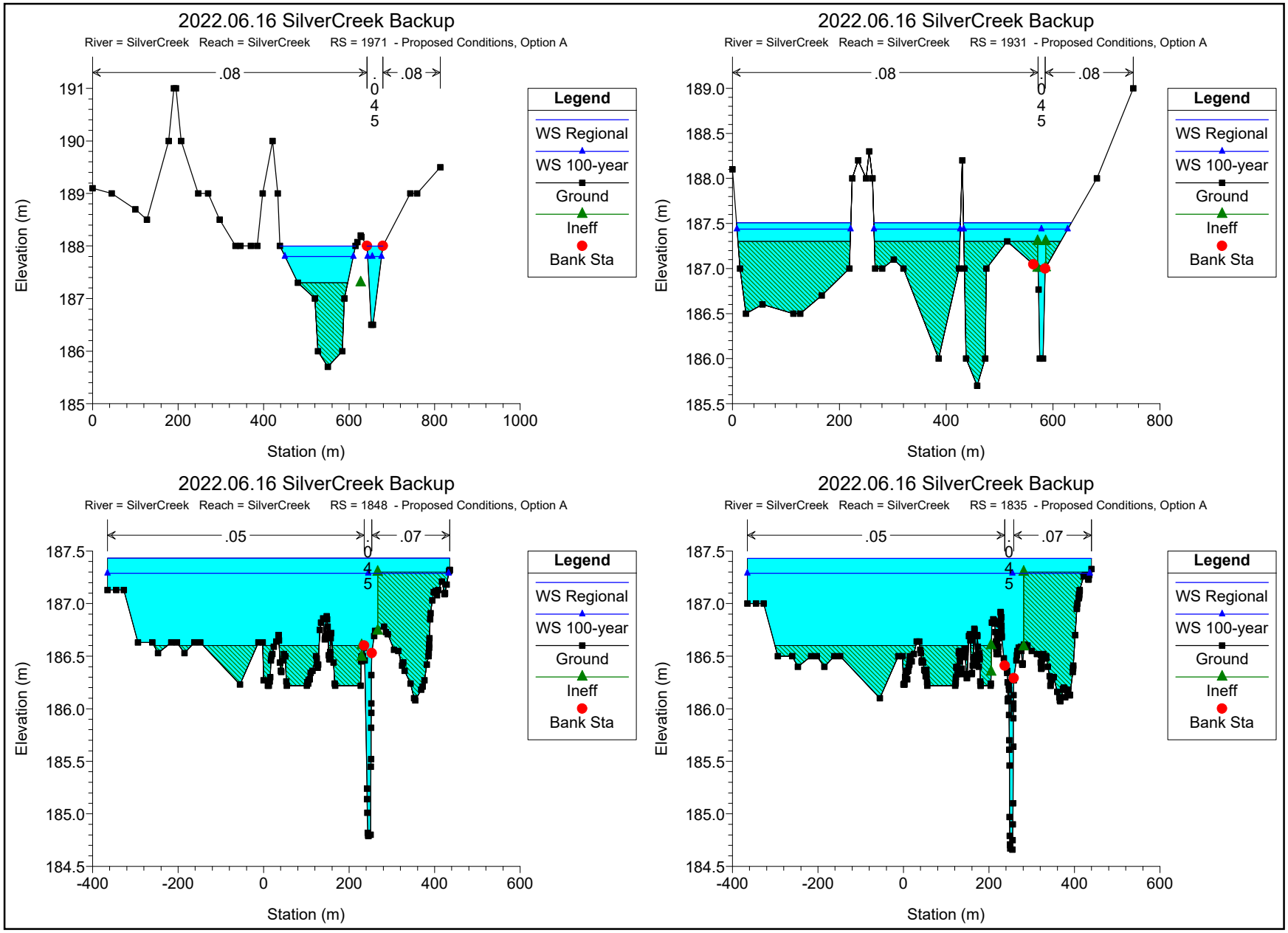
Silver Creek - Proposed Conditions, Option A

HEC-RAS Plan: SC1

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek	1971	Regional	78.00	186.50	188.00	187.63	188.03	0.002736	1.02	133.23	213.82	0.36
SilverCreek	1971	100-year	44.50	186.50	187.80	187.53	187.82	0.002314	0.86	93.22	192.55	0.32
SilverCreek	1931	Regional	78.00	186.00	187.51	187.51	187.60	0.007383	1.96	131.50	578.18	0.69
SilverCreek	1931	100-year	44.50	186.00	187.44	187.44	187.52	0.005214	1.62	90.36	568.95	0.59
SilverCreek	1848	Regional	78.00	184.79	187.43		187.43	0.000074	0.30	528.13	800.30	0.07
SilverCreek	1848	100-year	44.50	184.79	187.29		187.29	0.000045	0.22	415.53	797.82	0.05
SilverCreek	1835	Regional	78.00	184.66	187.43	186.76	187.43	0.000067	0.26	555.51	804.80	0.06
SilverCreek	1835	100-year	44.50	184.66	187.29	186.25	187.29	0.000039	0.19	442.52	800.74	0.05
SilverCreek	1820		Bridge									
SilverCreek	1810	Regional	78.00	184.41	186.90		186.90	0.000213	0.49	370.19	645.97	0.11
SilverCreek	1810	100-year	44.50	184.41	186.46		186.48	0.001008	0.91	109.23	421.29	0.23
SilverCreek-Lowe	1798	Regional	78.00	184.33	186.78	185.94	186.87	0.001753	1.51	73.54	71.44	0.33
SilverCreek-Lowe	1798	100-year	44.50	184.33	186.37	185.49	186.45	0.001851	1.34	44.01	68.86	0.33
SilverCreek-Lowe	1778	Regional	78.00	184.21	186.75	186.34	186.83	0.001943	1.63	78.49	76.29	0.35
SilverCreek-Lowe	1778	100-year	44.50	184.21	186.03	185.77	186.35	0.008969	2.70	24.12	72.76	0.70
SilverCreek-Lowe	1730	Regional	78.00	183.91	186.34	185.81	186.66	0.005694	2.54	32.34	90.88	0.58
SilverCreek-Lowe	1730	100-year	44.50	183.91	185.68	185.29	185.93	0.007848	2.26	20.16	76.77	0.63
SilverCreek-Lowe	1710		Bridge									
SilverCreek-Lowe	1705	Regional	78.00	183.74	185.29	185.22	185.84	0.015927	3.29	23.82	73.87	0.92
SilverCreek-Lowe	1705	100-year	44.50	183.74	185.16	184.83	185.38	0.007215	2.07	21.53	42.27	0.61
SilverCreek-Lowe	1690		Lat Struct									
SilverCreek-Lowe	1674	Regional	75.17	183.52	185.20	185.09	185.32	0.006542	2.53	62.24	110.57	0.63
SilverCreek-Lowe	1674	100-year	44.41	183.52	185.00	184.99	185.12	0.006443	2.31	41.98	101.11	0.61
SilverCreek-Lowe	1516	Regional	61.00	182.32	183.84	183.80	184.09	0.009655	2.88	37.76	69.11	0.75
SilverCreek-Lowe	1516	100-year	42.71	182.32	183.63	183.61	183.86	0.009989	2.64	25.76	44.31	0.74
SilverCreek-Lowe	1425	Regional	61.00	181.89	183.45	183.12	183.54	0.003587	1.77	60.26	105.34	0.46
SilverCreek-Lowe	1425	100-year	42.71	181.89	183.27	183.00	183.35	0.003070	1.51	43.85	79.68	0.41
SilverCreek-Lowe	1313	Regional	58.80	181.52	183.04	182.77	183.12	0.003874	1.83	61.40	112.10	0.47
SilverCreek-Lowe	1313	100-year	41.82	181.52	182.90	182.60	182.96	0.003790	1.69	47.12	88.03	0.46
SilverCreek-Lowe	1155	Regional	41.35	180.70	182.36	181.97	182.49	0.003948	1.95	36.59	59.92	0.48
SilverCreek-Lowe	1155	100-year	32.23	180.70	182.27	181.78	182.38	0.003511	1.77	31.07	59.07	0.45
SilverCreek-Lowe	1037	Regional	25.77	180.38	181.37	181.37	181.73	0.018989	3.03	11.20	17.26	0.97
SilverCreek-Lowe	1037	100-year	23.47	180.38	181.35	181.35	181.67	0.017381	2.85	10.81	17.05	0.93
SilverCreek-Lowe	978	Regional	19.33	180.17	181.30	180.80	181.31	0.001011	0.77	48.98	104.02	0.23
SilverCreek-Lowe	978	100-year	19.68	180.17	181.31	180.80	181.32	0.000972	0.76	50.21	104.18	0.23
SilverCreek-Lowe	911	Regional	19.33	179.61	181.11	180.43	181.20	0.002574	1.46	20.04	53.64	0.38
SilverCreek-Lowe	911	100-year	19.68	179.61	181.12	180.45	181.21	0.002538	1.46	20.90	57.28	0.38
SilverCreek-Lowe	903	Regional	19.33	179.55	181.10	180.37	181.17	0.001815	1.24	21.12	105.15	0.32
SilverCreek-Lowe	903	100-year	19.68	179.55	181.12	180.38	181.19	0.001803	1.25	21.46	108.23	0.32
SilverCreek-Lowe	875		Culvert									
SilverCreek-Lowe	858	Regional	19.33	179.40	180.80		180.88	0.009282	1.46	15.64	192.70	0.43
SilverCreek-Lowe	858	100-year	19.68	179.40	180.80		180.89	0.009438	1.48	15.74	192.70	0.44
SilverCreek-Lowe	808	Regional	19.33	179.40	180.63		180.65	0.002139	0.71	47.55	800.34	0.21
SilverCreek-Lowe	808	100-year	19.68	179.40	180.64		180.65	0.002168	0.71	47.90	802.03	0.22
SilverCreek-Lowe	669	Regional	19.33	179.30	180.42		180.42	0.001296	0.49	126.13	547.72	0.16
SilverCreek-Lowe	669	100-year	19.68	179.30	180.42		180.43	0.001308	0.49	127.55	550.89	0.16
SilverCreek-Lowe	562	Regional	19.33	179.20	180.08	179.92	180.13	0.010965	1.27	38.75	361.44	0.46
SilverCreek-Lowe	562	100-year	19.68	179.20	180.08	179.93	180.13	0.010709	1.26	40.10	363.53	0.45
SilverCreek-Lowe	530	Regional	19.33	179.13	179.89		179.91	0.004263	0.67	50.93	197.83	0.27
SilverCreek-Lowe	530	100-year	19.68	179.13	179.89		179.91	0.004268	0.67	51.74	199.58	0.27
SilverCreek-Lowe	435	Regional	19.33	178.10	179.08	179.08	179.18	0.021315	1.76	26.55	167.75	0.63
SilverCreek-Lowe	435	100-year	19.68	178.10	179.09	179.09	179.18	0.021363	1.77	27.09	169.42	0.63

HEC-RAS Plan: SC1 (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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek-Lowe	348	Regional	19.33	177.20	178.12		178.12	0.001831	0.54	79.32	221.03	0.19
SilverCreek-Lowe	348	100-year	19.68	177.20	178.12		178.12	0.001857	0.54	79.96	221.68	0.19
SilverCreek-Lowe	273	Regional	19.33	177.10	178.03		178.04	0.001213	0.43	107.21	355.08	0.15
SilverCreek-Lowe	273	100-year	19.68	177.10	178.04		178.04	0.001244	0.43	107.63	355.25	0.15
SilverCreek-Lowe	171	Regional	19.33	176.70	178.00		178.01	0.000138	0.19	244.78	540.28	0.06
SilverCreek-Lowe	171	100-year	19.68	176.70	178.01		178.01	0.000143	0.19	244.87	540.29	0.06
SilverCreek-Lowe	52	Regional	19.33	176.00	178.00	176.92	178.00	0.000022	0.10	466.31	625.00	0.02
SilverCreek-Lowe	52	100-year	19.68	176.00	178.00	176.92	178.00	0.000023	0.10	466.31	625.00	0.02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.08
.045
.08
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1931 - Proposed Conditions, Option A
.08
.045
.08
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
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.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
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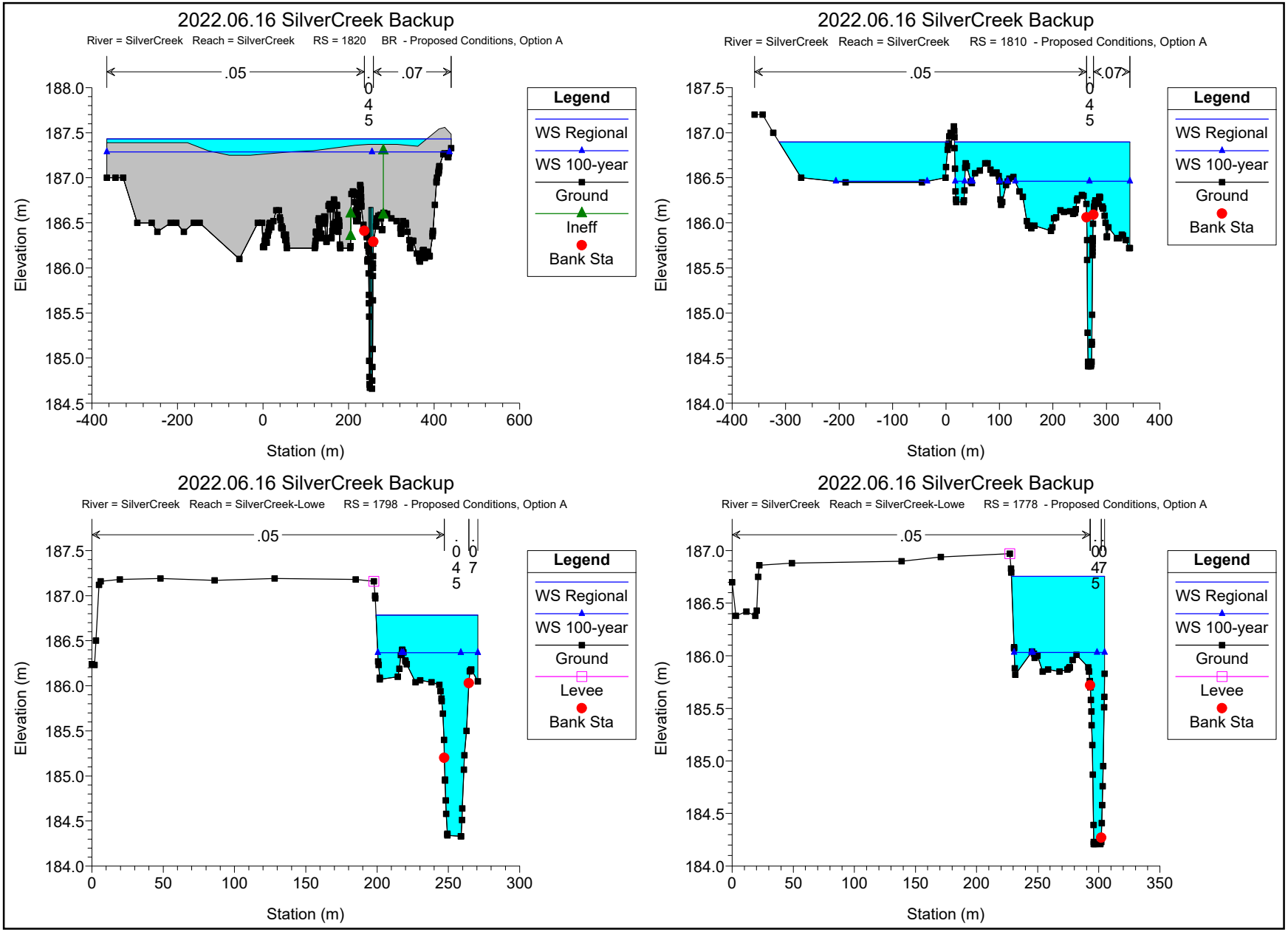
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)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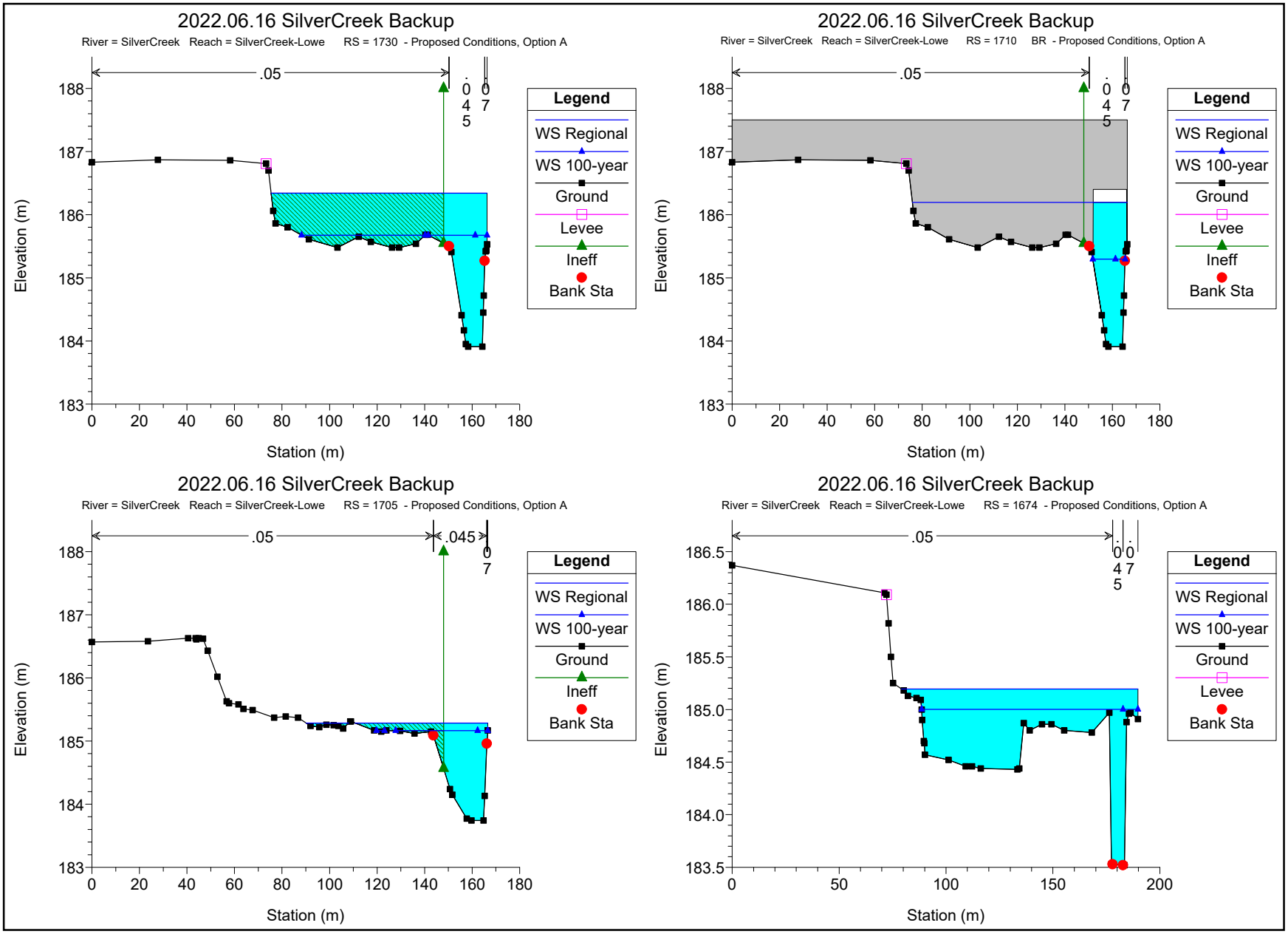
.05
.07
.045
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1810 - Proposed Conditions, Option A
.05
.07
.045
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1798 - Proposed Conditions, Option A
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1778 - Proposed Conditions, Option A
.05
.045
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)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.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Ineff
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1710 BR - Proposed Conditions, Option A
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Ineff
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1705 - Proposed Conditions, Option A
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1674 - Proposed Conditions, Option A
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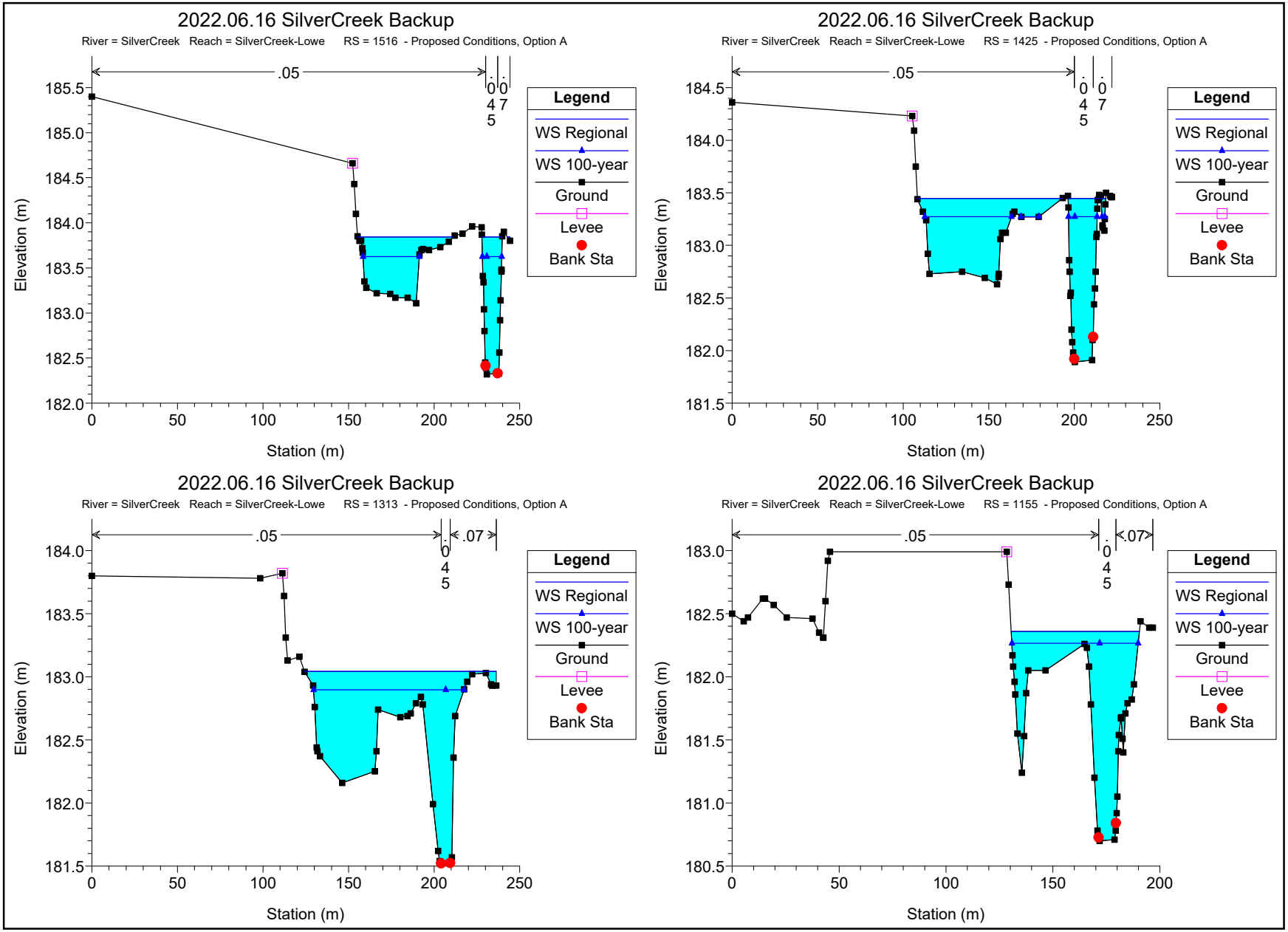
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)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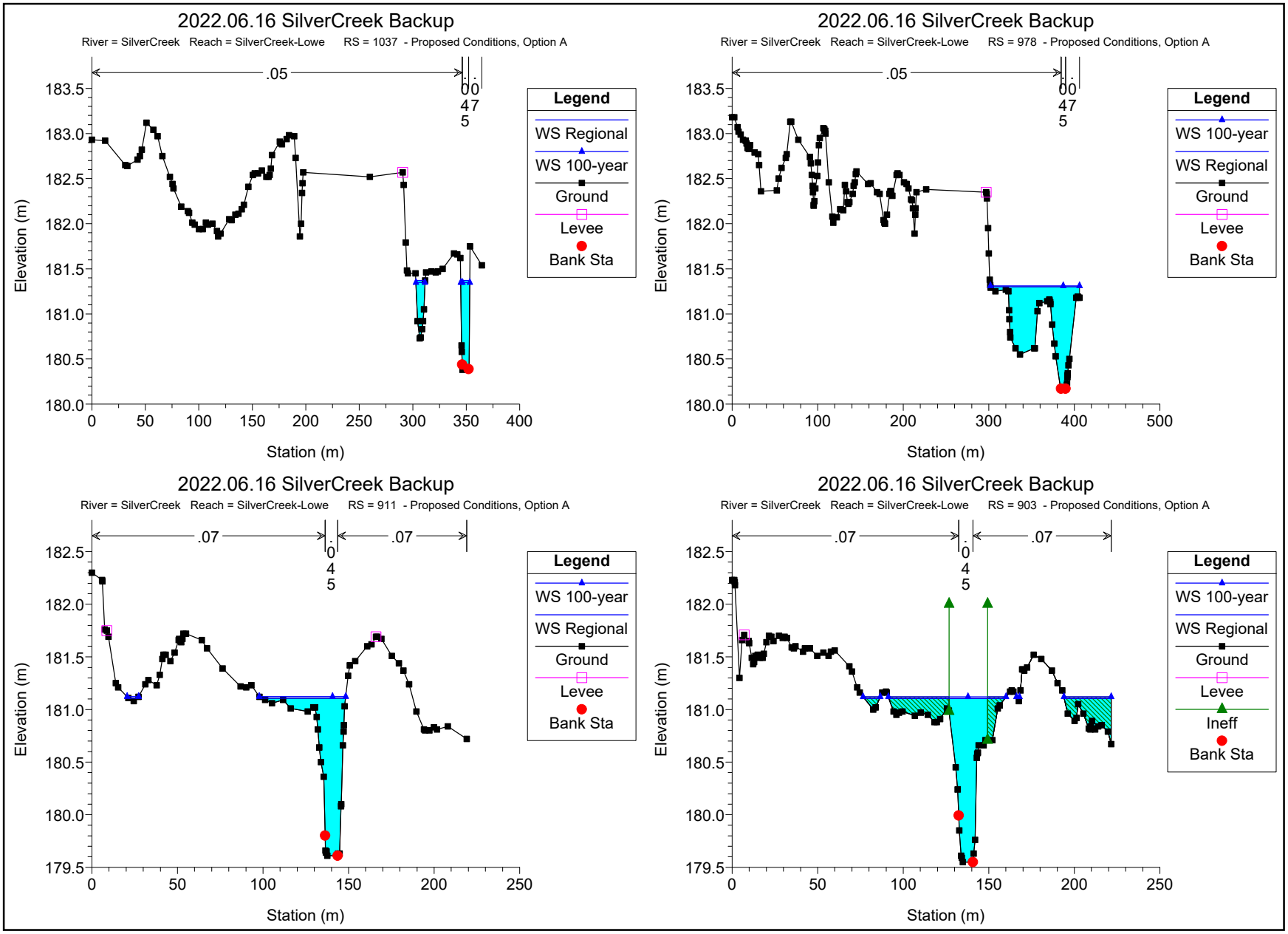
River = SilverCreek Reach = SilverCreek-Lowe RS = 1516 - Proposed Conditions, Option A
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1425 - Proposed Conditions, Option A
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1313 - Proposed Conditions, Option A
.05
.07
.045
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1155 - Proposed Conditions, Option A
.05
.07
.045
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)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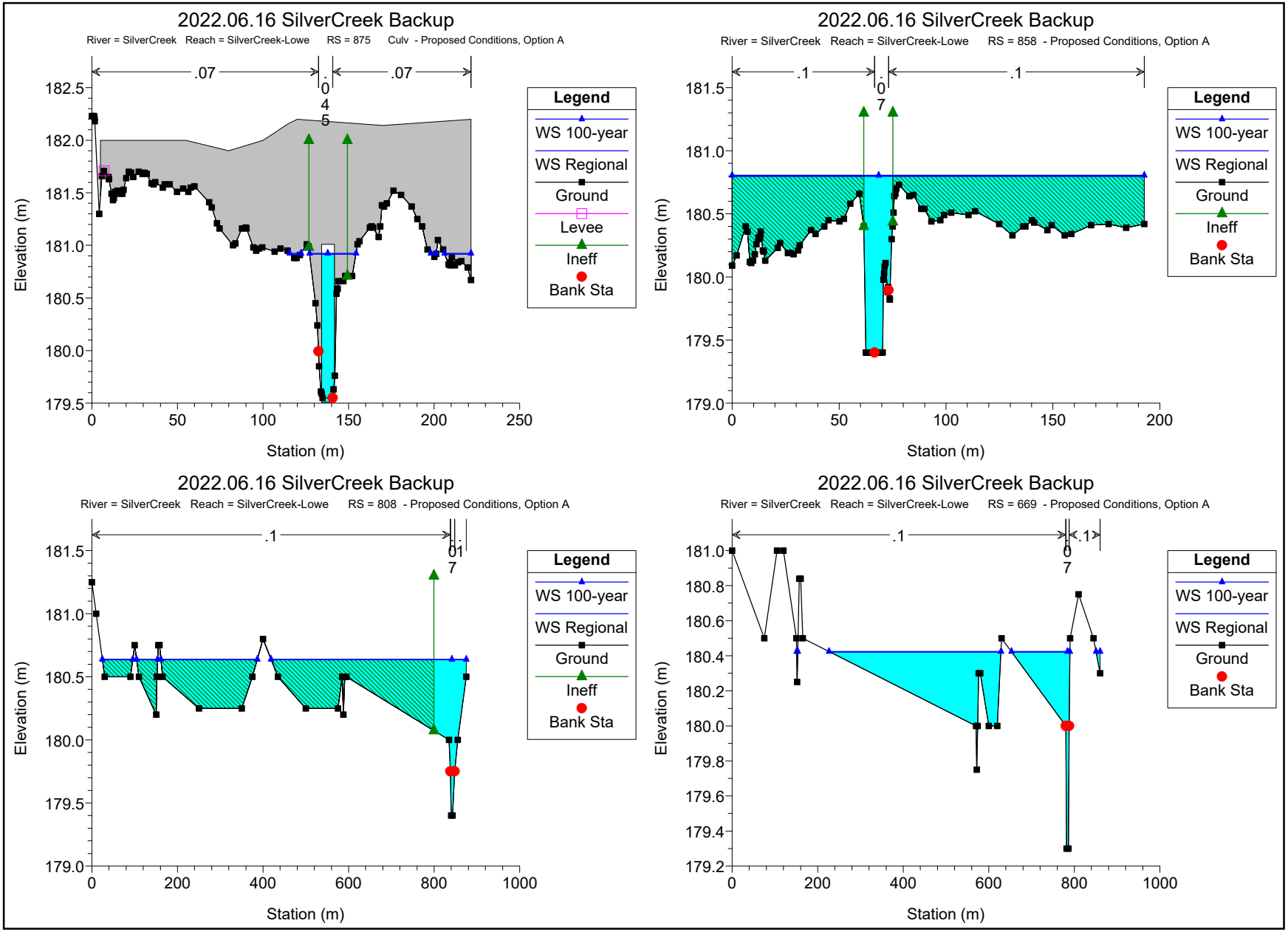
.05
.00475
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 978 - Proposed Conditions, Option A
.05
.00475
Elevation (m)
Station (m)
Legend
WS 100-year
WS Regional
Ground
Levee
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 911 - Proposed Conditions, Option A
.07
.07
.045
Elevation (m)
Station (m)
Legend
WS 100-year
WS Regional
Ground
Levee
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 903 - Proposed Conditions, Option A
.07
.07
.045
Elevation (m)
Station (m)
Legend
WS 100-year
WS Regional
Ground
Levee
Ineff
Bank Sta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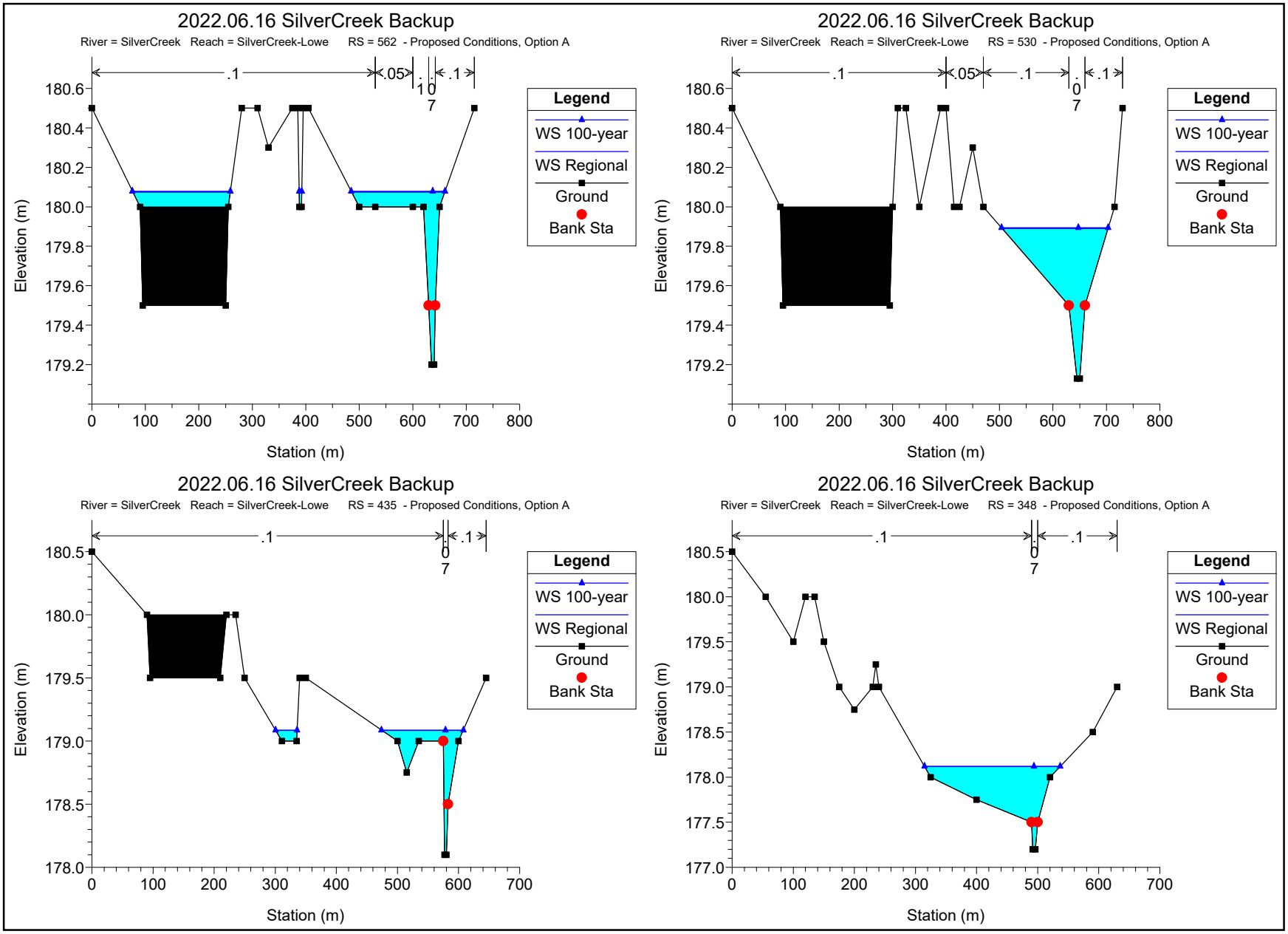
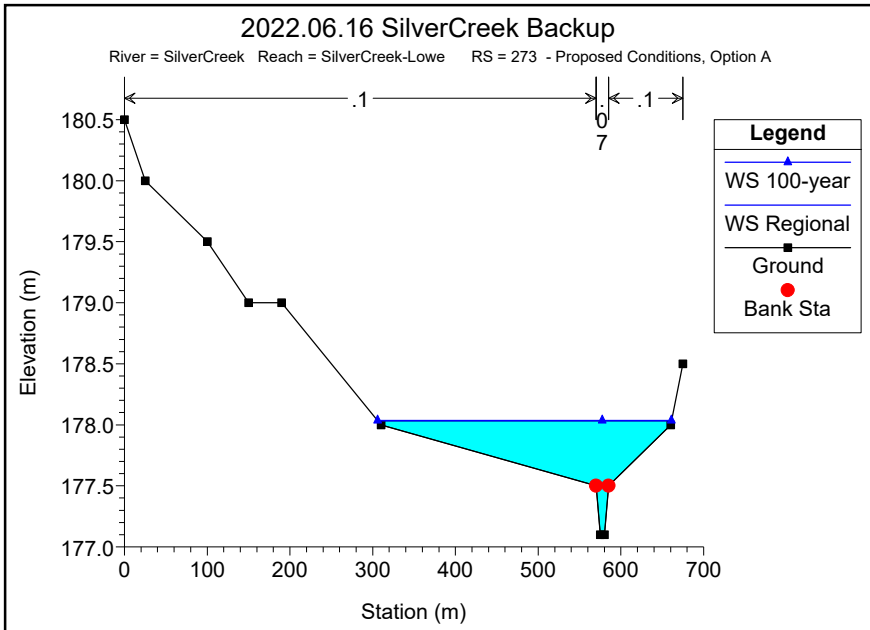
River = SilverCreek Reach = SilverCreek-Lowe RS = 875 Culv - Proposed Conditions, Option A
.07
.045
.07
Elevation (m)
Station (m)
Legend
WS 100-year
WS Regional
Ground
Levee
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 858 - Proposed Conditions, Option A
.1
.07
.1
Elevation (m)
Station (m)
Legend
WS 100-year
WS Regional
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 808 - Proposed Conditions, Option A
.1
.017
Elevation (m)
Station (m)
Legend
WS 100-year
WS Regional
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 669 - Proposed Conditions, Option A
.1
.07
.1
Elevation (m)
Station (m)
Legend
WS 100-year
WS Regional
Ground
Bank Sta


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 562 - Proposed Conditions, Option A
.1
.05
.1
.1
Legend
WS 100-year
WS Regional
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 530 - Proposed Conditions, Option A
.1
.05
.1
.1
Legend
WS 100-year
WS Regional
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 435 - Proposed Conditions, Option A
.1
.1
Legend
WS 100-year
WS Regional
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 348 - Proposed Conditions, Option A
.1
.1
Legend
WS 100-year
WS Regional
Ground
Bank Sta
Elevation (m)
Station (m)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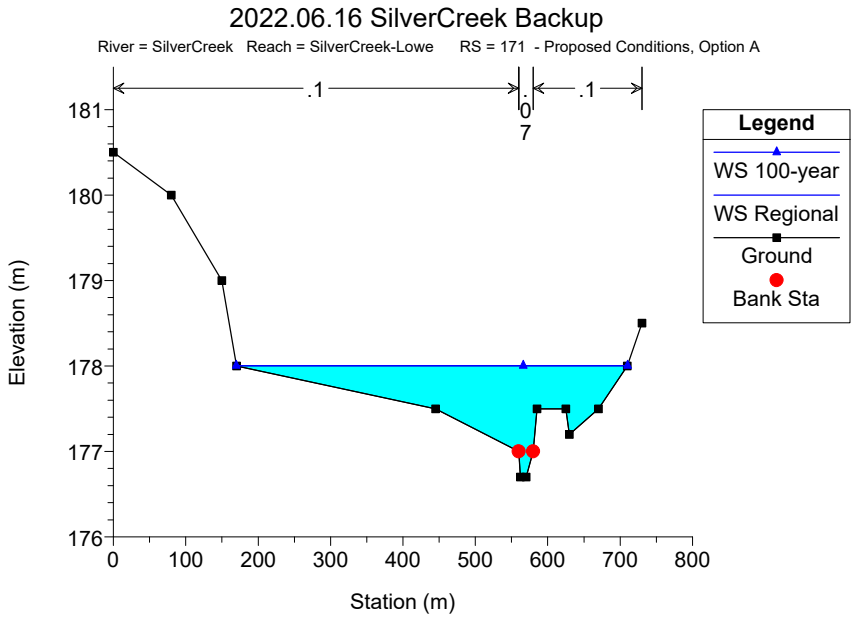
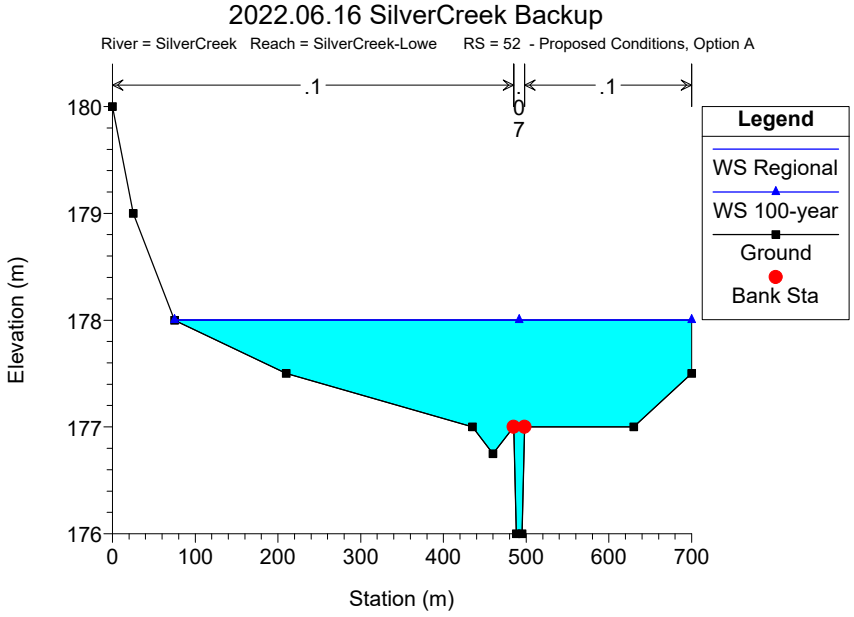
River = SilverCreek Reach = SilverCreek-Lowe RS = 273 - Proposed Conditions, Option A
.1
.1
0
7
Legend
WS 100-year
WS Regional
Ground
Bank Sta
Elevation (m)
Station (m)
180.5
180.0
179.5
179.0
178.5
178.0
177.5
177.0
0
100
200
300
400
500
600
700


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 171 - Proposed Conditions, Option A
.1
.1
0
7
Legend
WS 100-year
WS Regional
Ground
Bank Sta
Elevation (m)
Station (m)
181
180
179
178
177
176
0
100
200
300
400
500
600
700
800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River = SilverCreek Reach = SilverCreek-Lowe RS = 52 - Proposed Conditions, Option A
.1
.1
0
7
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
180
179
178
177
176
0
100
200
300
400
500
600
700

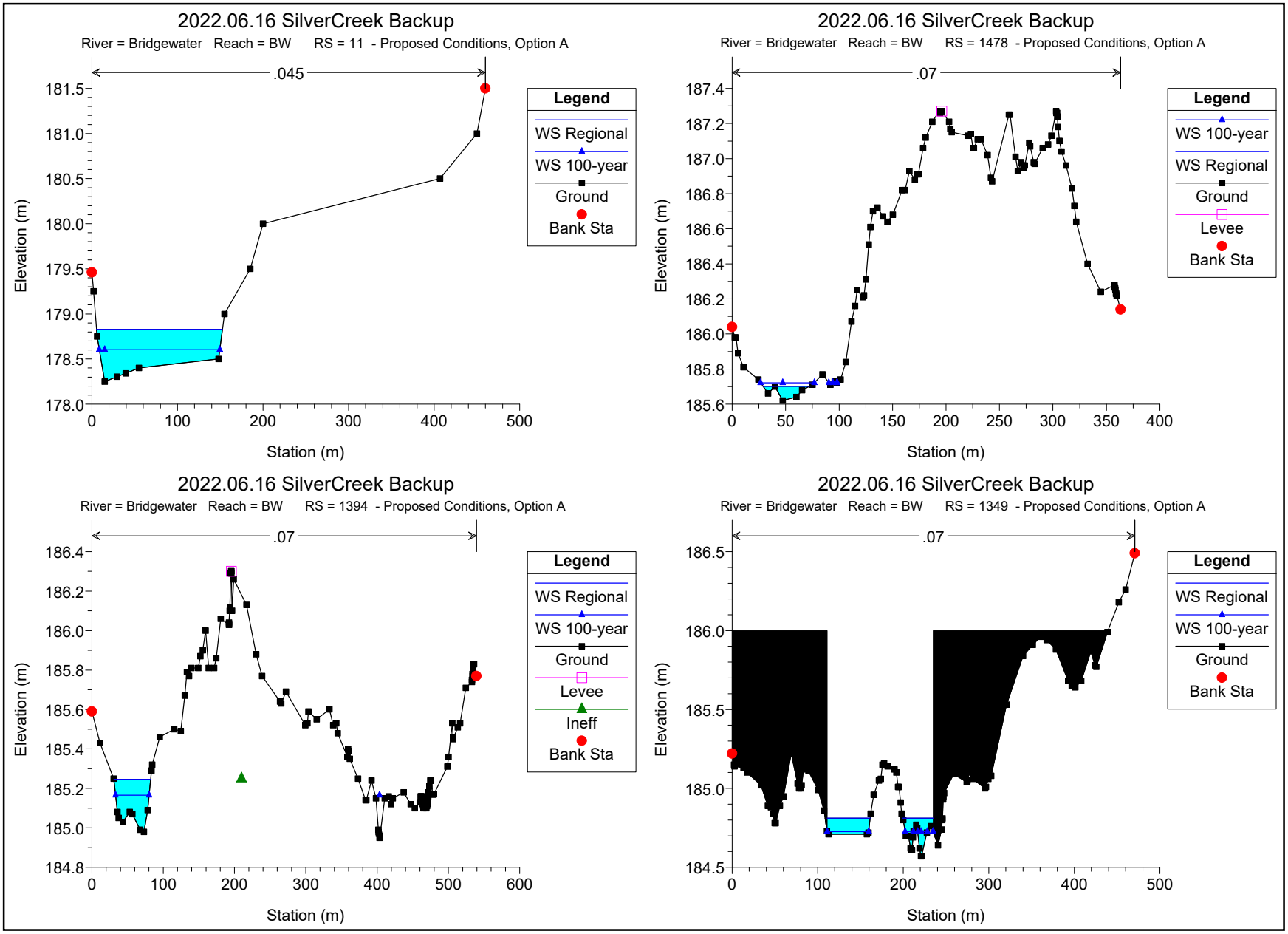
Bridgewater Creek - Proposed Conditions, Option A

HEC-RAS Plan: SC1 River: Bridgewater Reach: BW

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	1478	Regional	1.00	185.62	185.70	185.70	185.72	0.123459	0.58	1.71	43.26	0.94
BW	1478	100-year	1.00	185.62	185.72	185.70	185.73	0.036379	0.37	2.71	54.55	0.53
BW	1394	Regional	1.00	184.95	185.25	185.08	185.25	0.000506	0.10	9.57	51.60	0.08
BW	1394	100-year	1.00	184.95	185.17	185.08	185.17	0.002670	0.18	5.59	46.95	0.17
BW	1349	Regional	5.99	184.57	184.81	184.79	184.83	0.041850	0.66	9.14	85.91	0.64
BW	1349	100-year	1.20	184.57	184.73	184.73	184.74	0.138188	0.54	2.24	69.81	0.96
BW	1310	Regional	13.31	183.43	183.80	183.70	183.84	0.020980	0.89	15.01	53.13	0.53
BW	1310	100-year	2.18	183.43	183.64	183.53	183.65	0.004890	0.31	7.12	41.54	0.24
BW	1200	Regional	18.00	182.84	183.40		183.41	0.001888	0.26	68.89	252.23	0.16
BW	1200	100-year	2.79	182.84	183.17		183.17	0.004034	0.18	15.12	165.14	0.19
BW	1134	Regional	18.00	182.54	183.19		183.20	0.006219	0.41	43.82	199.06	0.28
BW	1134	100-year	2.79	182.54	182.83		182.84	0.006377	0.36	7.79	44.28	0.27
BW	1069	Regional	18.00	182.26	182.68		182.70	0.009768	0.51	35.46	164.49	0.35
BW	1069	100-year	2.79	182.26	182.54		182.54	0.003358	0.20	14.26	124.17	0.18
BW	1006	Regional	20.20	181.70	182.21		182.21	0.006388	0.38	53.38	279.48	0.28
BW	1006	100-year	3.68	181.70	181.95		181.97	0.038828	0.50	7.42	100.55	0.58
BW	936	Regional	20.20	181.50	182.02		182.02	0.001517	0.24	82.71	283.94	0.14
BW	936	100-year	3.68	181.50	181.83		181.83	0.000594	0.10	35.96	225.85	0.08
BW	840	Regional	39.08	180.50	181.12	181.12	181.21	0.090904	1.36	28.77	161.76	1.03
BW	840	100-year	14.07	180.50	180.98	180.98	181.05	0.095111	1.14	12.38	93.94	1.00
BW	740	Regional	52.26	179.49	180.73		180.74	0.000895	0.25	206.58	265.52	0.09
BW	740	100-year	21.48	179.49	180.28		180.28	0.002428	0.25	87.50	248.68	0.13
BW	685	Regional	59.65	179.36	180.69		180.69	0.000755	0.26	227.63	244.07	0.09
BW	685	100-year	25.80	179.36	180.16		180.16	0.001841	0.25	102.22	226.44	0.12
BW	670		Lat Struct									
BW	660	Regional	32.68	179.41	180.68		180.68	0.000212	0.14	235.23	252.05	0.05
BW	660	100-year	11.96	179.41	180.14		180.14	0.000343	0.11	106.80	227.01	0.05
BW	636	Regional	32.68	179.44	180.67	179.76	180.67	0.000252	0.14	228.26	265.97	0.05
BW	636	100-year	11.96	179.44	180.13	179.63	180.13	0.000568	0.14	84.72	211.17	0.07
BW	607	Regional	32.68	179.44	180.67	179.68	180.67	0.000182	0.14	238.78	323.95	0.04
BW	607	100-year	11.96	179.44	180.12	179.60	180.12	0.000345	0.12	98.05	302.66	0.05
BW	588	Regional	32.68	179.43	180.66		180.66	0.000465	0.21	152.88	154.48	0.07
BW	588	100-year	11.96	179.43	180.11		180.11	0.000754	0.17	70.56	145.20	0.08
BW	572	Regional	32.68	179.39	180.65		180.66	0.000483	0.23	143.15	134.75	0.07
BW	572	100-year	11.96	179.39	180.09		180.10	0.000704	0.17	69.03	130.52	0.08
BW	545	Regional	32.68	179.34	180.63		180.64	0.001044	0.31	104.31	107.95	0.10
BW	545	100-year	11.96	179.34	180.06		180.06	0.002633	0.28	42.84	106.07	0.14
BW	520	Regional	32.68	179.09	180.52	179.94	180.58	0.003842	1.06	30.75	100.76	0.32
BW	520	100-year	11.96	179.09	179.92	179.54	179.96	0.007159	0.86	13.84	98.23	0.39
BW	500		Culvert									
BW	475	Regional	32.68	178.92	180.20	179.81	180.21	0.000750	0.36	90.12	126.27	0.14
BW	475	100-year	11.96	178.92	179.88	179.40	179.91	0.003870	0.71	16.80	124.72	0.30
BW	446	Regional	32.68	178.80	180.12	179.66	180.15	0.005202	0.76	42.92	187.49	0.27
BW	446	100-year	11.96	178.80	179.76	179.36	179.78	0.005079	0.51	23.49	148.55	0.25
BW	428	Regional	32.68	178.74	179.97	179.70	180.05	0.005393	1.24	26.29	213.77	0.49
BW	428	100-year	11.96	178.74	179.62	179.49	179.66	0.007580	0.94	12.78	82.93	0.51
BW	420		Lat Struct									
BW	416	Regional	25.82	178.55	179.95		179.99	0.002475	0.92	28.00	36.13	0.33
BW	416	100-year	6.95	178.55	179.61		179.62	0.000876	0.42	16.56	31.90	0.19
BW	381	Regional	25.82	178.53	179.93		179.95	0.000573	0.61	42.02	33.20	0.17
BW	381	100-year	6.95	178.53	179.61		179.61	0.000101	0.22	31.60	31.77	0.07

HEC-RAS Plan: SC1 River: Bridgewater Reach: BW (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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	367	Regional	25.82	178.77	179.90		179.93	0.001143	0.76	33.98	32.96	0.24
BW	367	100-year	6.95	178.77	179.60		179.61	0.000237	0.29	24.26	31.37	0.10
BW	361	Regional	25.82	178.90	179.81		179.91	0.007343	1.42	18.13	27.64	0.56
BW	361	100-year	6.95	178.90	179.58		179.60	0.001699	0.57	12.14	24.36	0.26
BW	352	Regional	25.82	179.30	179.79		179.83	0.006555	0.81	31.82	105.04	0.47
BW	352	100-year	6.95	179.30	179.54	179.49	179.57	0.014404	0.72	9.67	69.10	0.61
BW	231	Regional	25.82	178.15	179.37		179.39	0.002261	0.70	37.11	69.20	0.30
BW	231	100-year	6.95	178.15	179.00		179.01	0.002198	0.46	15.13	51.47	0.27
BW	192	Regional	25.82	178.14	179.31		179.33	0.001202	0.54	47.92	81.73	0.22
BW	192	100-year	6.95	178.14	178.96		178.96	0.000797	0.32	21.46	57.72	0.17
BW	150	Regional	25.82	178.48	179.22		179.25	0.002690	0.82	31.61	52.89	0.34
BW	150	100-year	6.95	178.48	178.91		178.92	0.001761	0.44	15.76	48.45	0.25
BW	110	Regional	25.82	178.37	179.03		179.08	0.008223	1.02	25.38	70.69	0.54
BW	110	100-year	6.95	178.37	178.79		178.81	0.004281	0.60	11.65	44.35	0.37
BW	65	Regional	25.82	178.27	178.91		178.92	0.001729	0.50	51.42	128.31	0.25
BW	65	100-year	6.95	178.27	178.68		178.69	0.001712	0.30	23.00	122.13	0.22
BW	11	Regional	25.82	178.25	178.83	178.56	178.84	0.001302	0.44	59.15	147.24	0.22
BW	11	100-year	6.95	178.25	178.60	178.47	178.61	0.001301	0.26	26.44	140.77	0.19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River = Bridgewater Reach = BW RS = 11 - Proposed Conditions, Option A
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
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.07
Elevation (m)
Station (m)
Legend
WS 100-year
WS Regional
Ground
Levee
Bank Sta
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Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Ineff
Bank Sta
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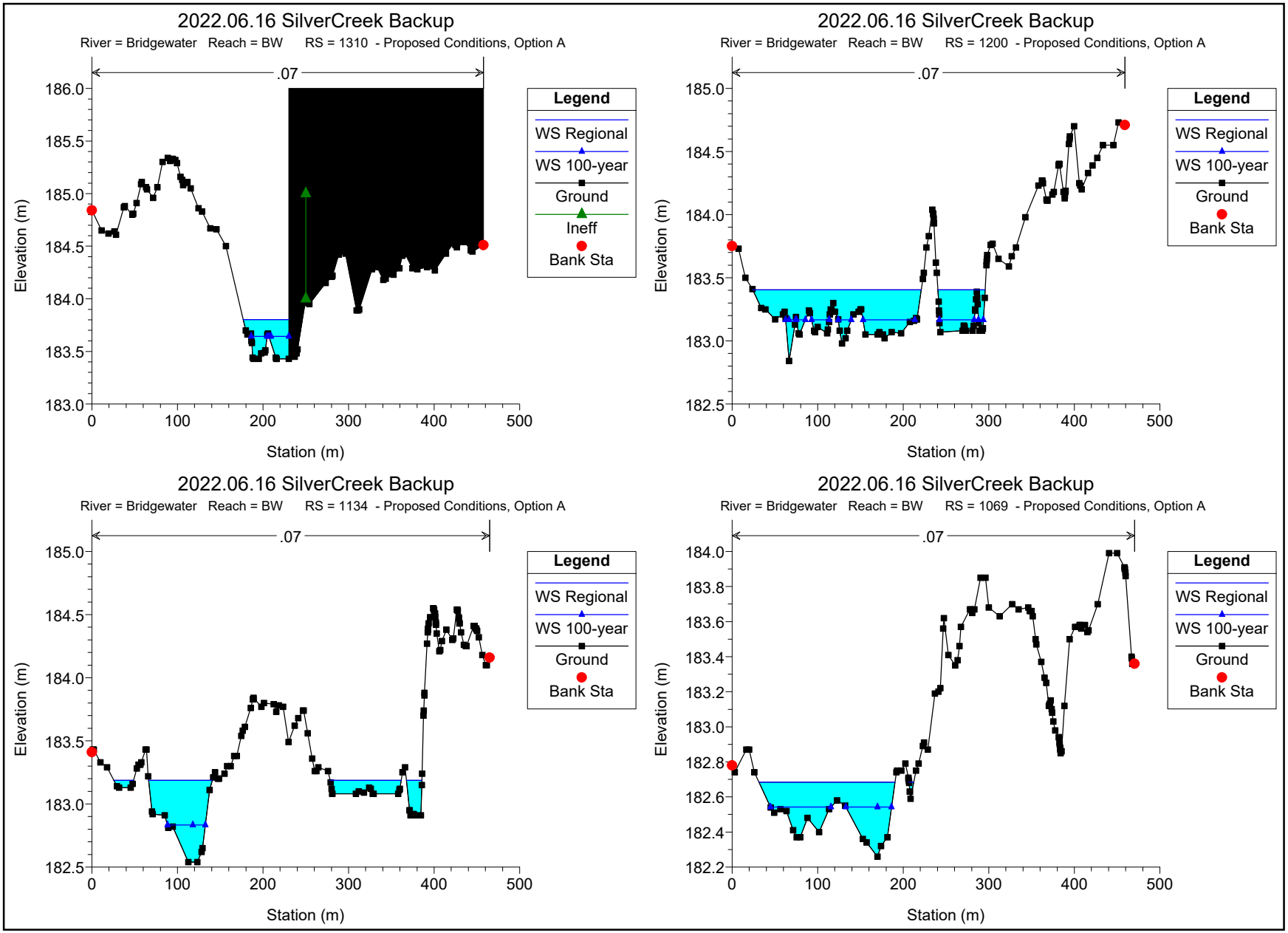
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta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Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1200 - Proposed Conditions, Option A
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1134 - Proposed Conditions, Option A
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
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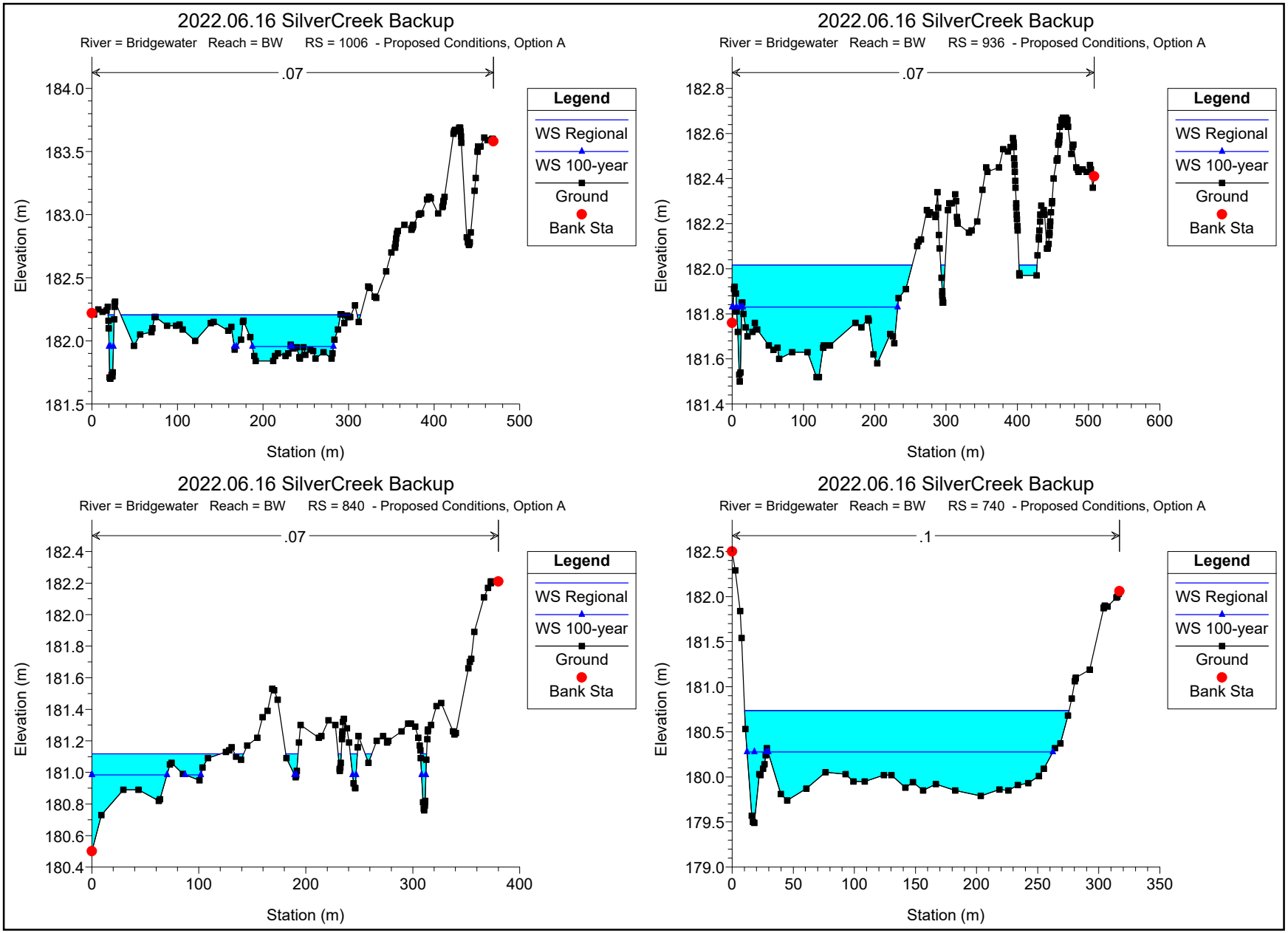
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta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Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
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.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 840 - Proposed Conditions, Option A
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Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
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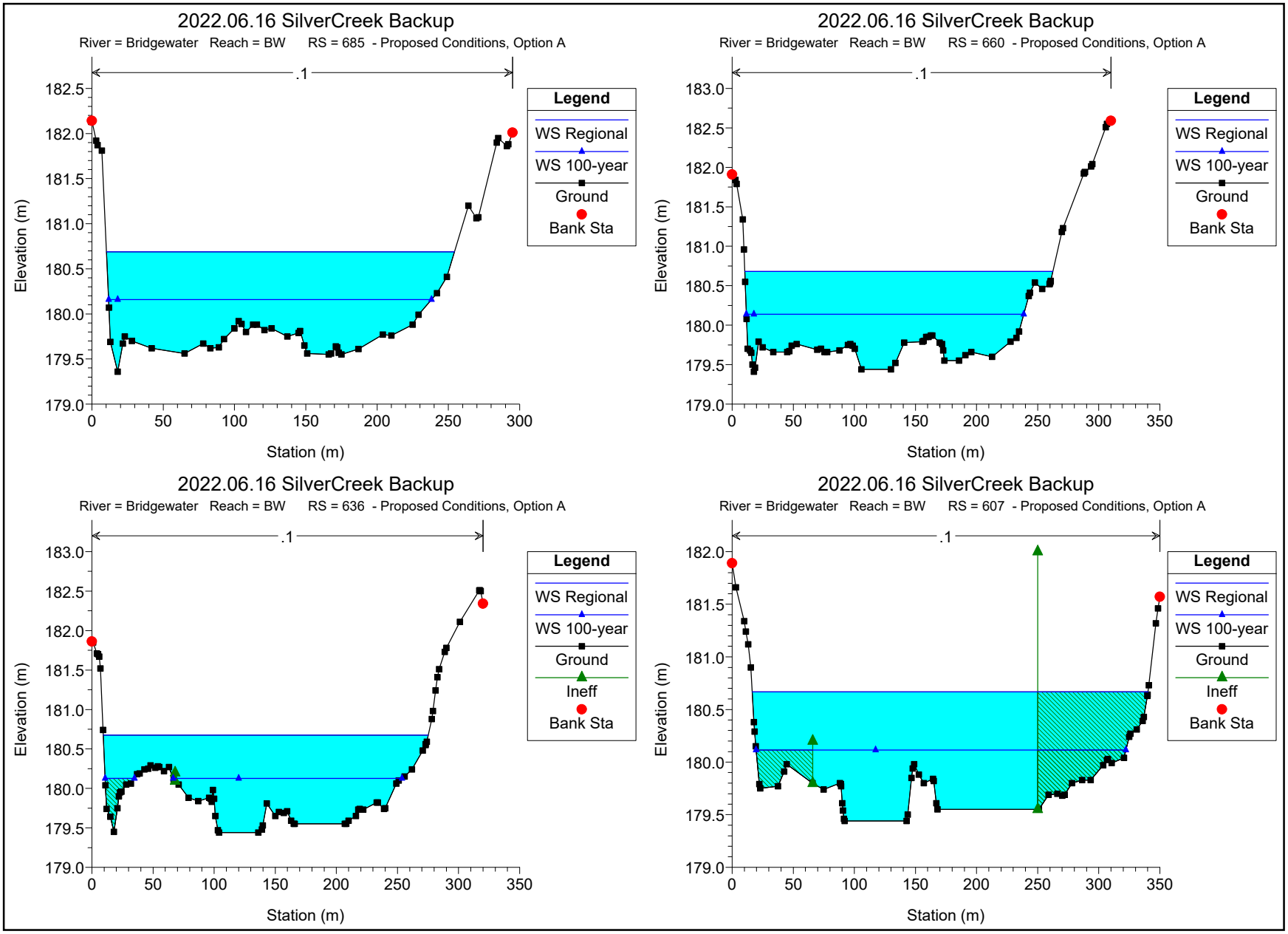
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta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River = Bridgewater Reach = BW RS = 685 - Proposed Conditions, Option A
.1
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
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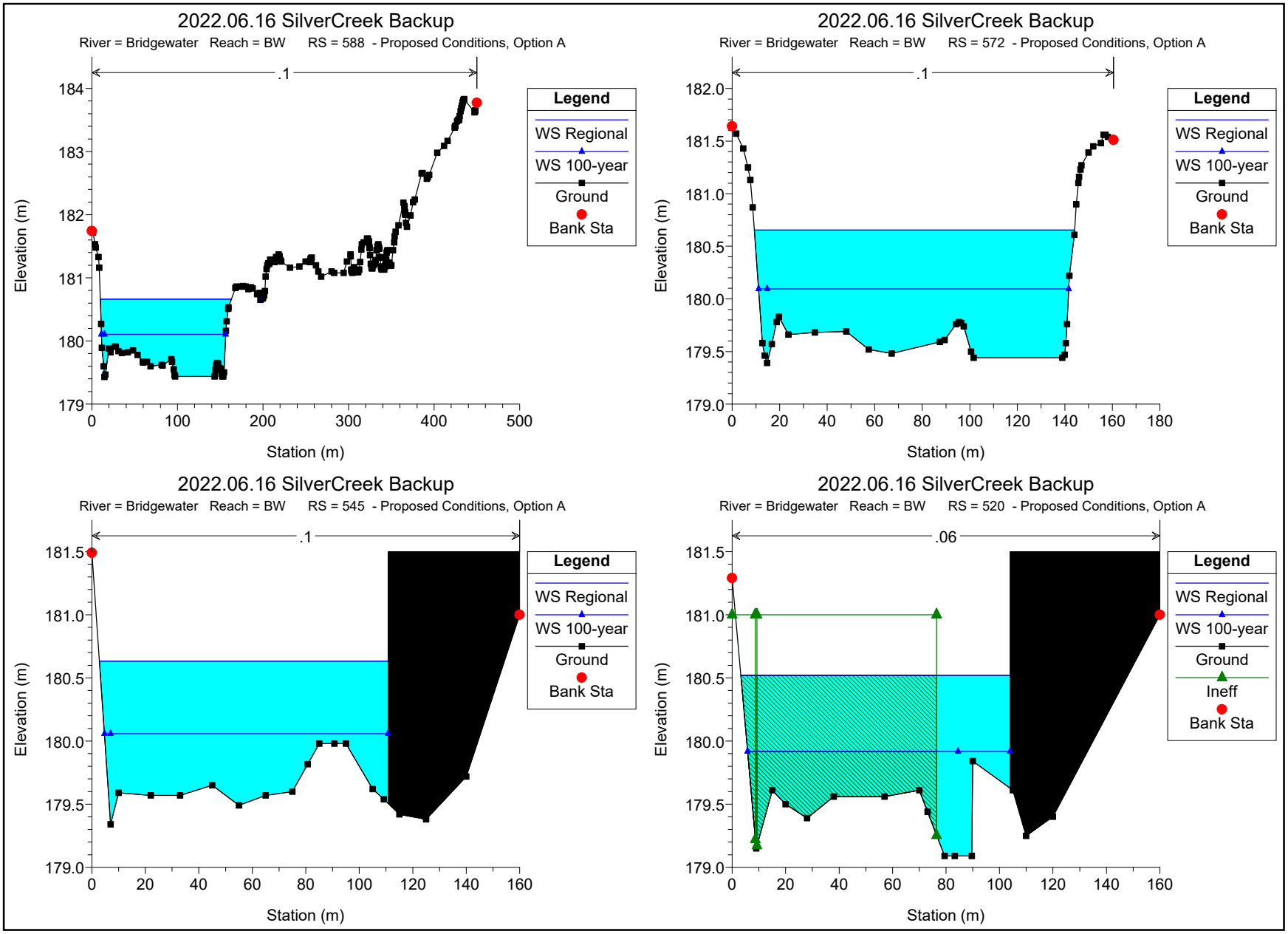
River = Bridgewater Reach = BW RS = 660 - Proposed Conditions, Option A
.1
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 636 - Proposed Conditions, Option A
.1
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 607 - Proposed Conditions, Option A
.1
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)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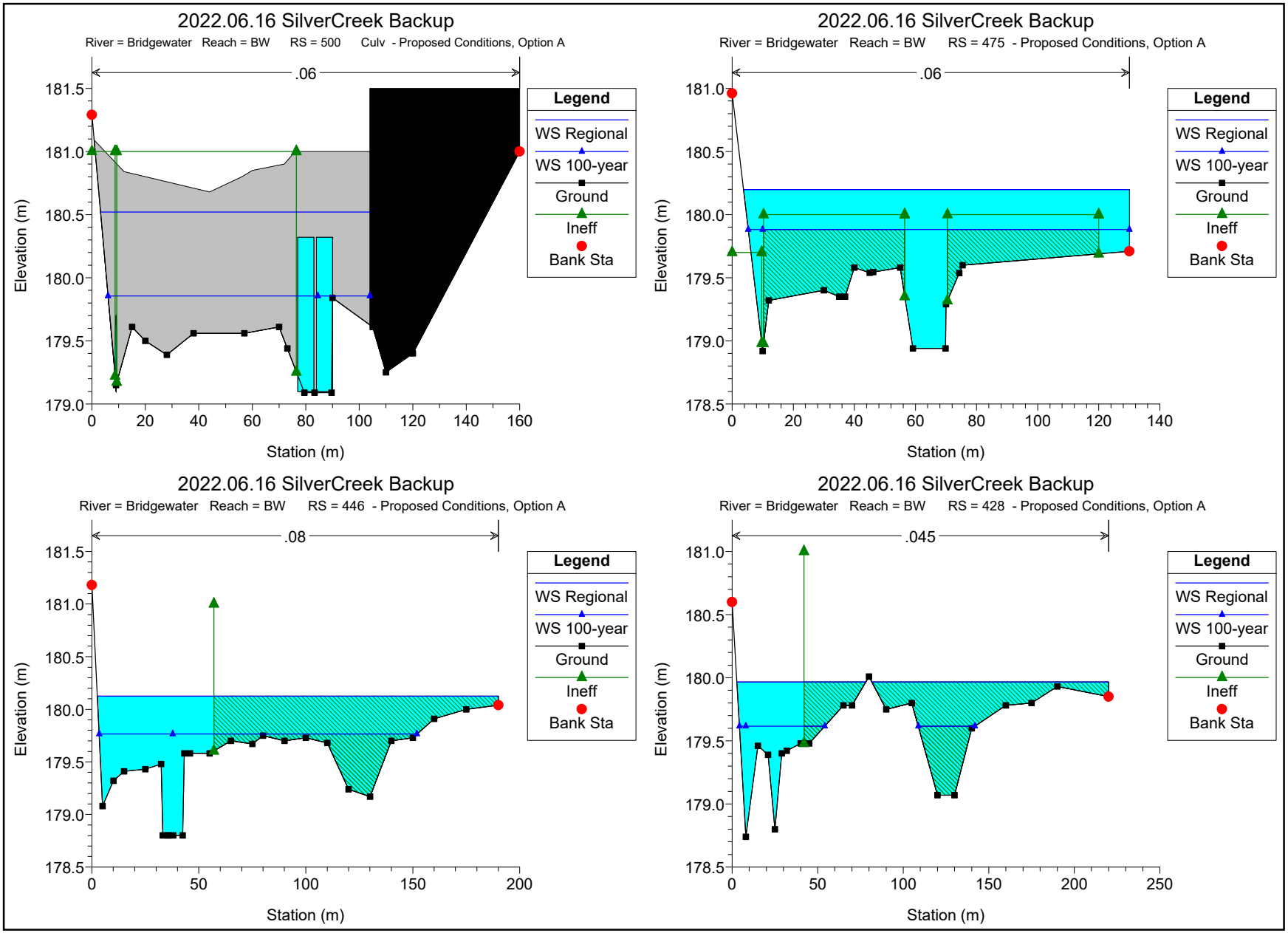
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 572 - Proposed Conditions, Option A
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 545 - Proposed Conditions, Option A
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 520 - Proposed Conditions, Option A
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta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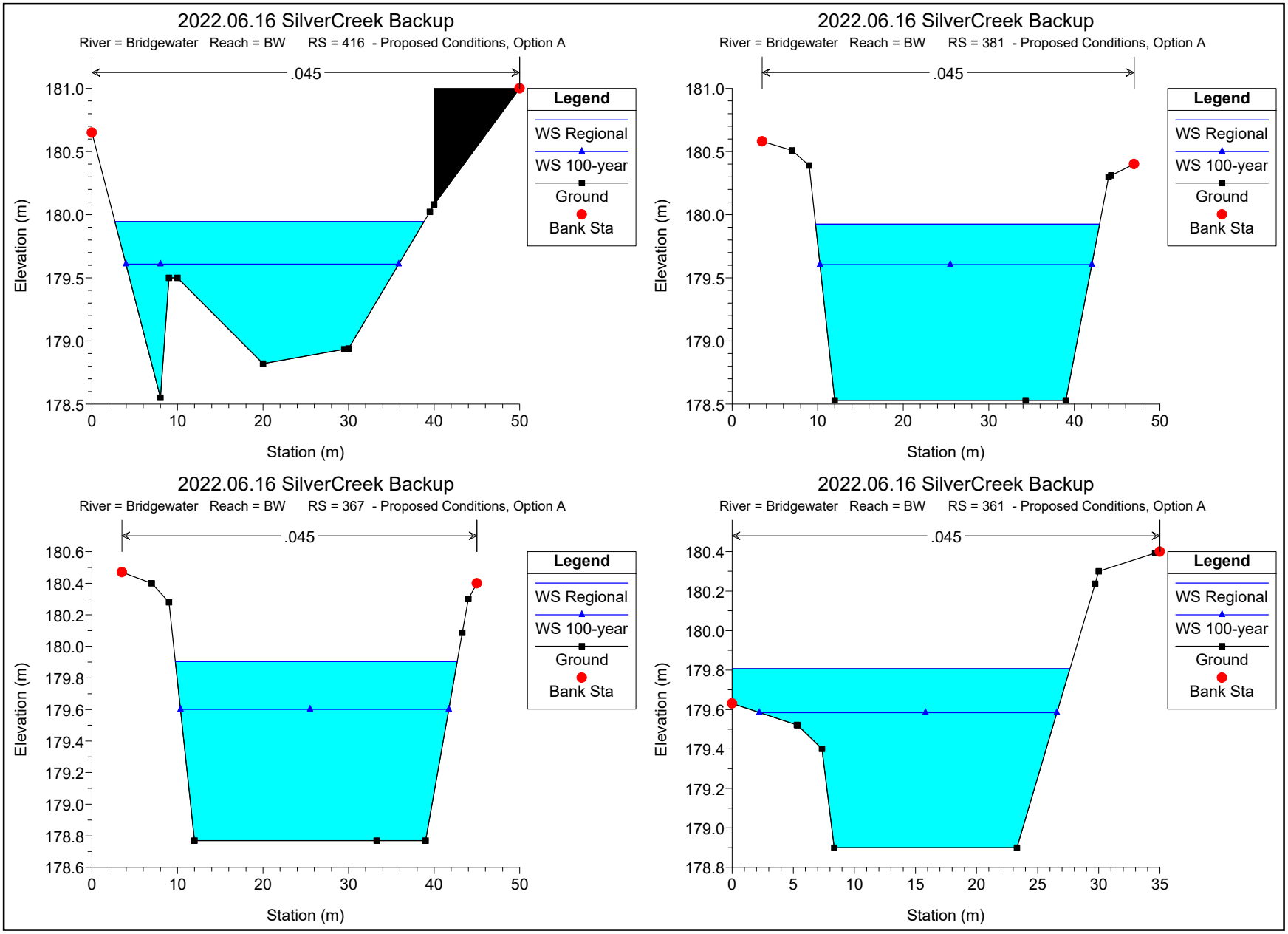
River = Bridgewater Reach = BW RS = 500 Culv - Proposed Conditions, Option A
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 475 - Proposed Conditions, Option A
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 446 - Proposed Conditions, Option A
.08
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 428 - Proposed Conditions, Option A
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta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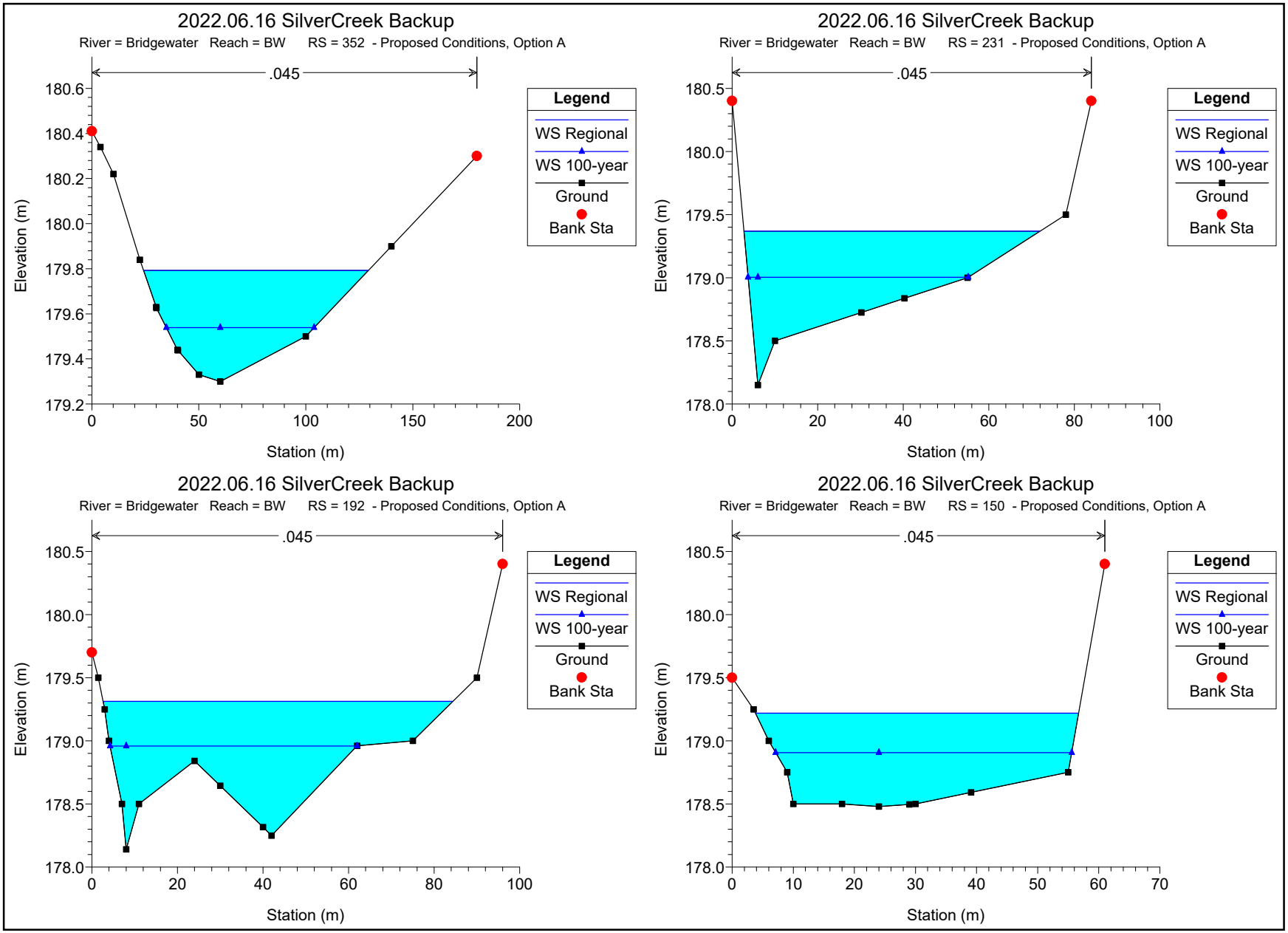
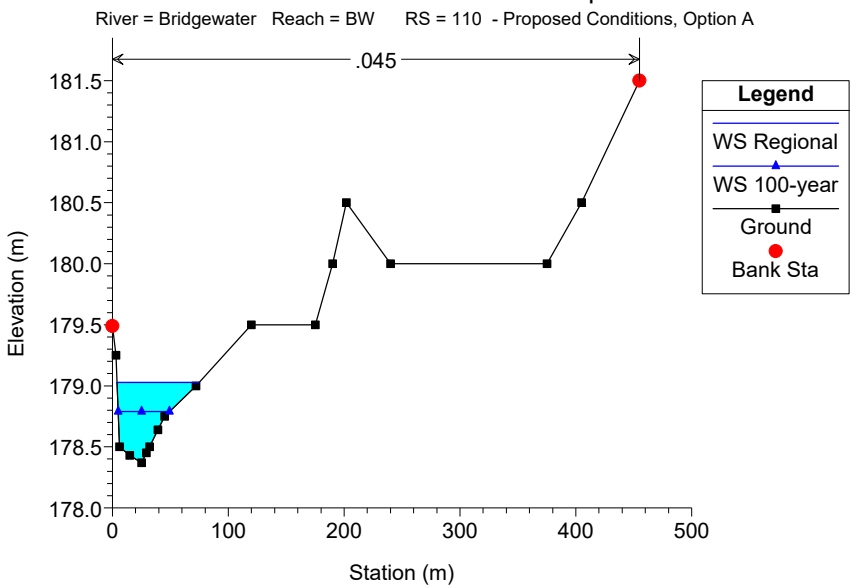
River = Bridgewater Reach = BW RS = 416 - Proposed Conditions, Option A
.045
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 381 - Proposed Conditions, Option A
.045
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 367 - Proposed Conditions, Option A
.045
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 361 - Proposed Conditions, Option A
.045
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 352 - Proposed Conditions, Option A
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 231 - Proposed Conditions, Option A
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 192 - Proposed Conditions, Option A
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 150 - Proposed Conditions, Option A
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 110 - Proposed Conditions, Option A
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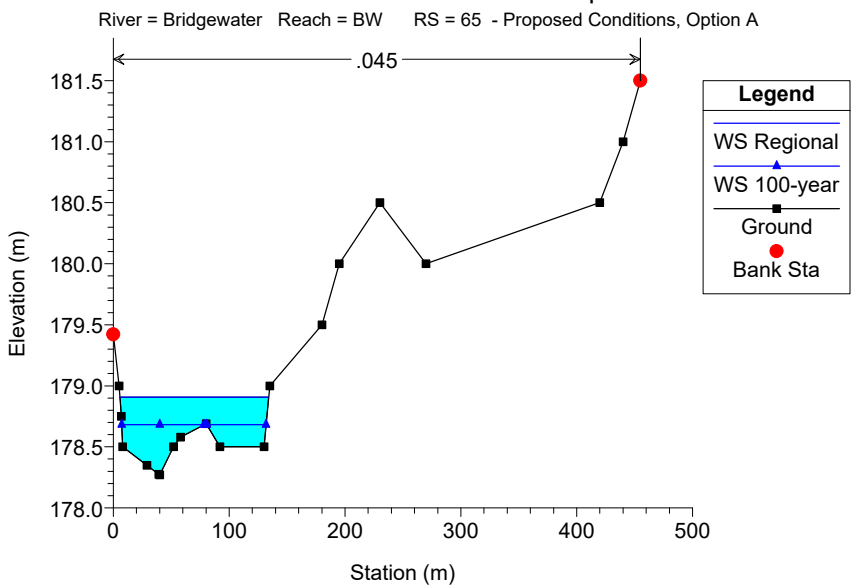
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 65 - Proposed Conditions, Option A
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta

APPENDIX D.2

Proposed Conditions HEC-RAS Modelling

Option B Scenario

Silver Creek HEC-RAS Output Table

Silver Creek HEC-RAS Cross Section Output

Bridgewater Creek HEC-RAS Output Table

Bridgewater Creek HEC-RAS Cross Section Output

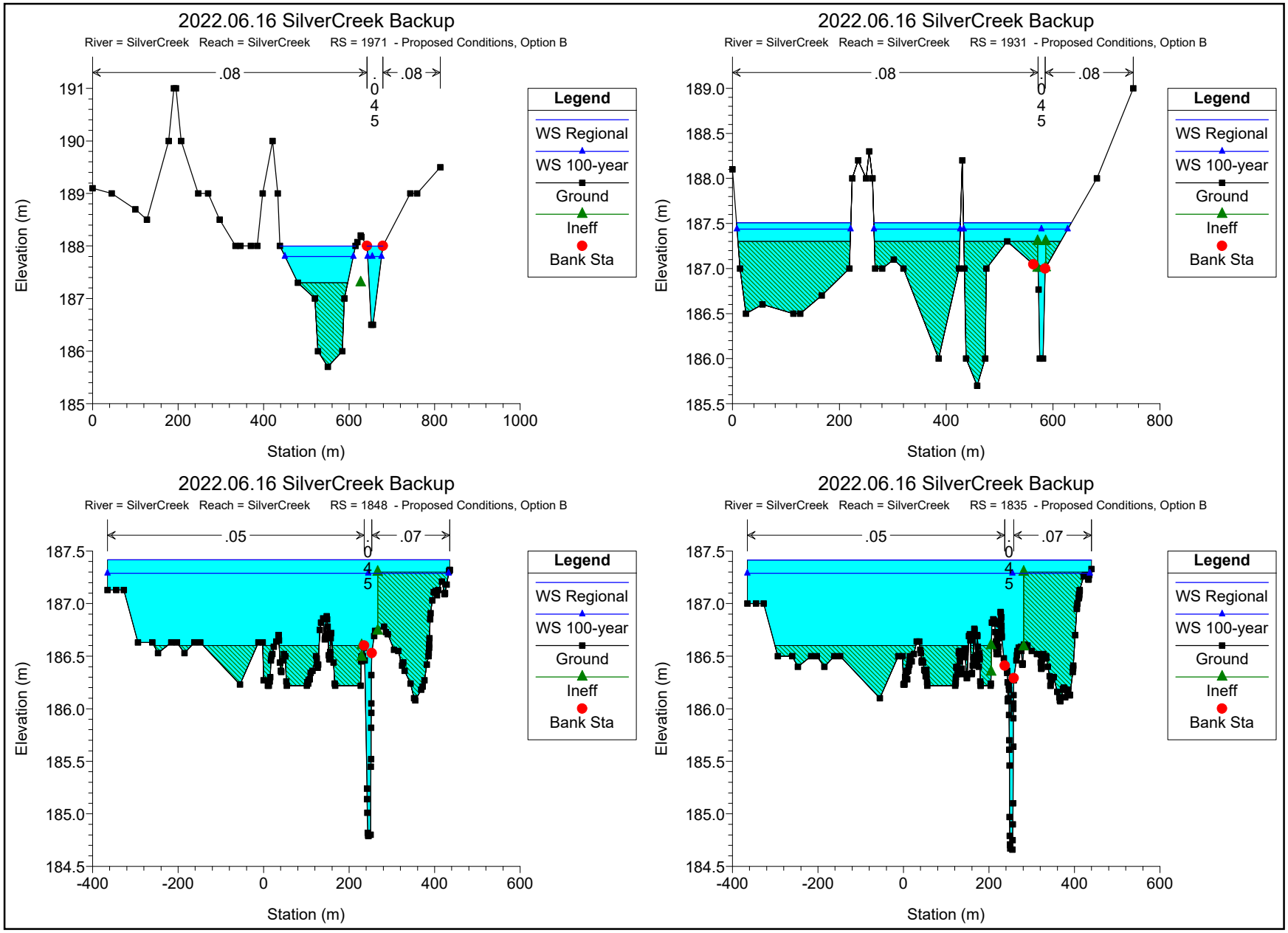
Silver Creek - Proposed Conditions, Option B

HEC-RAS Plan: SC1

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek	1971	Regional	78.00	186.50	188.00	187.63	188.03	0.002729	1.02	133.35	213.88	0.36
SilverCreek	1971	100-year	44.50	186.50	187.80	187.53	187.82	0.002313	0.86	93.25	192.57	0.32
SilverCreek	1931	Regional	78.00	186.00	187.51	187.51	187.60	0.007383	1.96	131.50	578.18	0.69
SilverCreek	1931	100-year	44.50	186.00	187.44	187.44	187.52	0.005228	1.62	90.22	568.92	0.59
SilverCreek	1848	Regional	78.00	184.79	187.42		187.42	0.000079	0.30	515.80	800.30	0.07
SilverCreek	1848	100-year	44.50	184.79	187.29		187.29	0.000045	0.22	415.37	797.81	0.05
SilverCreek	1835	Regional	78.00	184.66	187.42	186.76	187.42	0.000071	0.27	543.07	804.80	0.06
SilverCreek	1835	100-year	44.50	184.66	187.29	186.25	187.29	0.000039	0.19	442.35	800.72	0.05
SilverCreek	1820		Bridge									
SilverCreek	1810	Regional	78.00	184.41	186.69		186.70	0.000720	0.85	239.44	619.62	0.20
SilverCreek	1810	100-year	44.50	184.41	186.29		186.36	0.002766	1.41	68.36	215.61	0.38
SilverCreek-Lowe	1799	Regional	78.00	184.33	186.34	185.94	186.61	0.006121	2.41	42.34	67.91	0.59
SilverCreek-Lowe	1799	100-year	44.50	184.33	186.15	185.49	186.29	0.003541	1.69	30.04	58.83	0.44
SilverCreek-Lowe	1745	Regional	78.00	184.00	185.98	185.98	186.20	0.008488	3.22	52.36	84.92	0.73
SilverCreek-Lowe	1745	100-year	44.50	184.00	185.35	185.35	185.87	0.020528	3.87	15.29	15.20	1.07
SilverCreek-Lowe	1730		Lat Struct									
SilverCreek-Lowe	1675	Regional	71.31	183.52	185.11	184.93	185.19	0.004678	2.06	68.15	112.76	0.52
SilverCreek-Lowe	1675	100-year	44.50	183.52	184.91	184.75	184.99	0.005271	2.00	46.49	103.77	0.54
SilverCreek-Lowe	1517	Regional	62.72	182.32	183.90	183.90	184.16	0.009817	2.97	39.23	79.03	0.76
SilverCreek-Lowe	1517	100-year	44.06	182.32	183.71	183.65	183.92	0.008773	2.57	27.12	46.38	0.70
SilverCreek-Lowe	1426	Regional	62.04	181.89	183.48	183.19	183.58	0.003697	1.82	61.26	112.40	0.46
SilverCreek-Lowe	1426	100-year	44.06	181.89	183.33	183.07	183.41	0.003396	1.63	45.63	91.31	0.44
SilverCreek-Lowe	1314	Regional	58.80	181.52	183.16	182.80	183.22	0.002688	1.60	73.02	122.19	0.40
SilverCreek-Lowe	1314	100-year	43.97	181.52	183.02	182.65	183.07	0.002615	1.49	57.08	106.74	0.39
SilverCreek-Lowe	1156	Regional	55.20	180.70	182.56	182.19	182.70	0.003983	2.11	46.65	66.87	0.50
SilverCreek-Lowe	1156	100-year	43.24	180.70	182.47	182.13	182.59	0.003470	1.90	40.52	66.59	0.46
SilverCreek-Lowe	1038	Regional	45.66	180.38	181.90	181.90	182.09	0.007549	2.55	34.90	71.45	0.66
SilverCreek-Lowe	1038	100-year	38.61	180.38	181.85	181.85	182.03	0.007270	2.44	31.00	71.28	0.64
SilverCreek-Lowe	979	Regional	42.20	180.17	181.62	181.05	181.64	0.001162	0.97	77.20	105.83	0.26
SilverCreek-Lowe	979	100-year	36.84	180.17	181.54	181.01	181.56	0.001299	0.99	68.39	105.51	0.27
SilverCreek-Lowe	912	Regional	26.83	179.61	181.50	180.65	181.56	0.001360	1.25	46.51	85.16	0.29
SilverCreek-Lowe	912	100-year	25.30	179.61	181.39	180.61	181.46	0.001690	1.33	37.76	74.22	0.32
SilverCreek-Lowe	904	Regional	26.83	179.55	181.48	180.54	181.54	0.001371	1.25	29.58	154.58	0.29
SilverCreek-Lowe	904	100-year	25.30	179.55	181.38	180.52	181.44	0.001534	1.28	27.30	137.08	0.30
SilverCreek-Lowe	875		Culvert									
SilverCreek-Lowe	859	Regional	26.83	179.52	180.88		180.89	0.003182	0.93	71.75	185.56	0.27
SilverCreek-Lowe	859	100-year	25.30	179.52	180.86		180.87	0.003272	0.93	67.78	183.45	0.27
SilverCreek-Lowe	808	Regional	26.83	179.40	180.72		180.74	0.002755	0.85	54.34	832.78	0.25
SilverCreek-Lowe	808	100-year	25.30	179.40	180.71		180.72	0.002646	0.82	52.98	826.28	0.24
SilverCreek-Lowe	669	Regional	26.83	179.30	180.47		180.47	0.001515	0.54	154.76	608.39	0.17
SilverCreek-Lowe	669	100-year	25.30	179.30	180.46		180.47	0.001465	0.53	149.58	597.86	0.17
SilverCreek-Lowe	562	Regional	26.83	179.20	180.14		180.17	0.007705	1.13	63.92	398.65	0.39
SilverCreek-Lowe	562	100-year	25.30	179.20	180.13		180.16	0.008144	1.15	59.17	391.90	0.40
SilverCreek-Lowe	530	Regional	26.83	179.13	179.97		179.98	0.004431	0.74	67.15	230.42	0.28
SilverCreek-Lowe	530	100-year	25.30	179.13	179.95		179.97	0.004392	0.72	63.99	224.45	0.28
SilverCreek-Lowe	435	Regional	26.83	178.10	179.14	179.14	179.24	0.021879	1.87	37.62	199.23	0.65
SilverCreek-Lowe	435	100-year	25.30	178.10	179.13	179.13	179.23	0.021829	1.85	35.43	193.40	0.64
SilverCreek-Lowe	348	Regional	26.83	177.20	178.18		178.18	0.002290	0.63	92.85	234.41	0.21
SilverCreek-Lowe	348	100-year	25.30	177.20	178.16		178.17	0.002209	0.61	90.13	231.79	0.21
SilverCreek-Lowe	273	Regional	26.83	177.10	178.06		178.07	0.001819	0.54	117.03	359.20	0.19
SilverCreek-Lowe	273	100-year	25.30	177.10	178.06		178.06	0.001707	0.52	114.87	358.30	0.18
SilverCreek-Lowe	171	Regional	26.83	176.70	178.01		178.01	0.000259	0.26	247.09	540.54	0.08

HEC-RAS Plan: SC1 (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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek-Lowe	171	100-year	25.30	176.70	178.01		178.01	0.000232	0.25	246.57	540.48	0.07
SilverCreek-Lowe	52	Regional	26.83	176.00	178.00	177.09	178.00	0.000043	0.13	466.31	625.00	0.03
SilverCreek-Lowe	52	100-year	25.30	176.00	178.00	177.08	178.00	0.000038	0.13	466.31	625.00	0.03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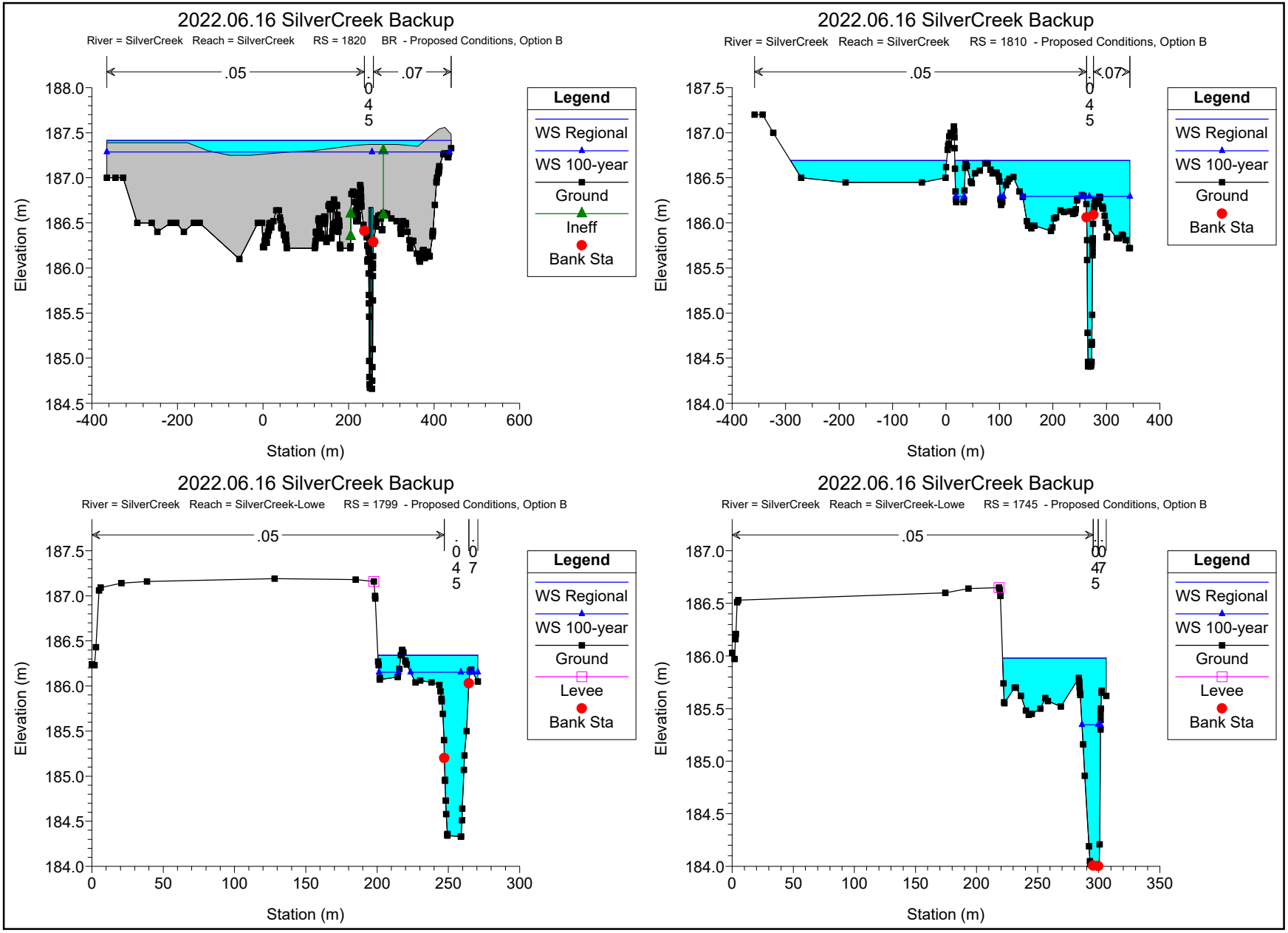
River = SilverCreek Reach = SilverCreek RS = 1971 - Proposed Conditions, Option B
.08
.045
.08
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1931 - Proposed Conditions, Option B
.08
.045
.08
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1848 - Proposed Conditions, Option B
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1835 - Proposed Conditions, Option B
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1820 BR - Proposed Conditions, Option B
.05
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek RS = 1810 - Proposed Conditions, Option B
.05
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1799 - Proposed Conditions, Option B
.05
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1745 - Proposed Conditions, Option B
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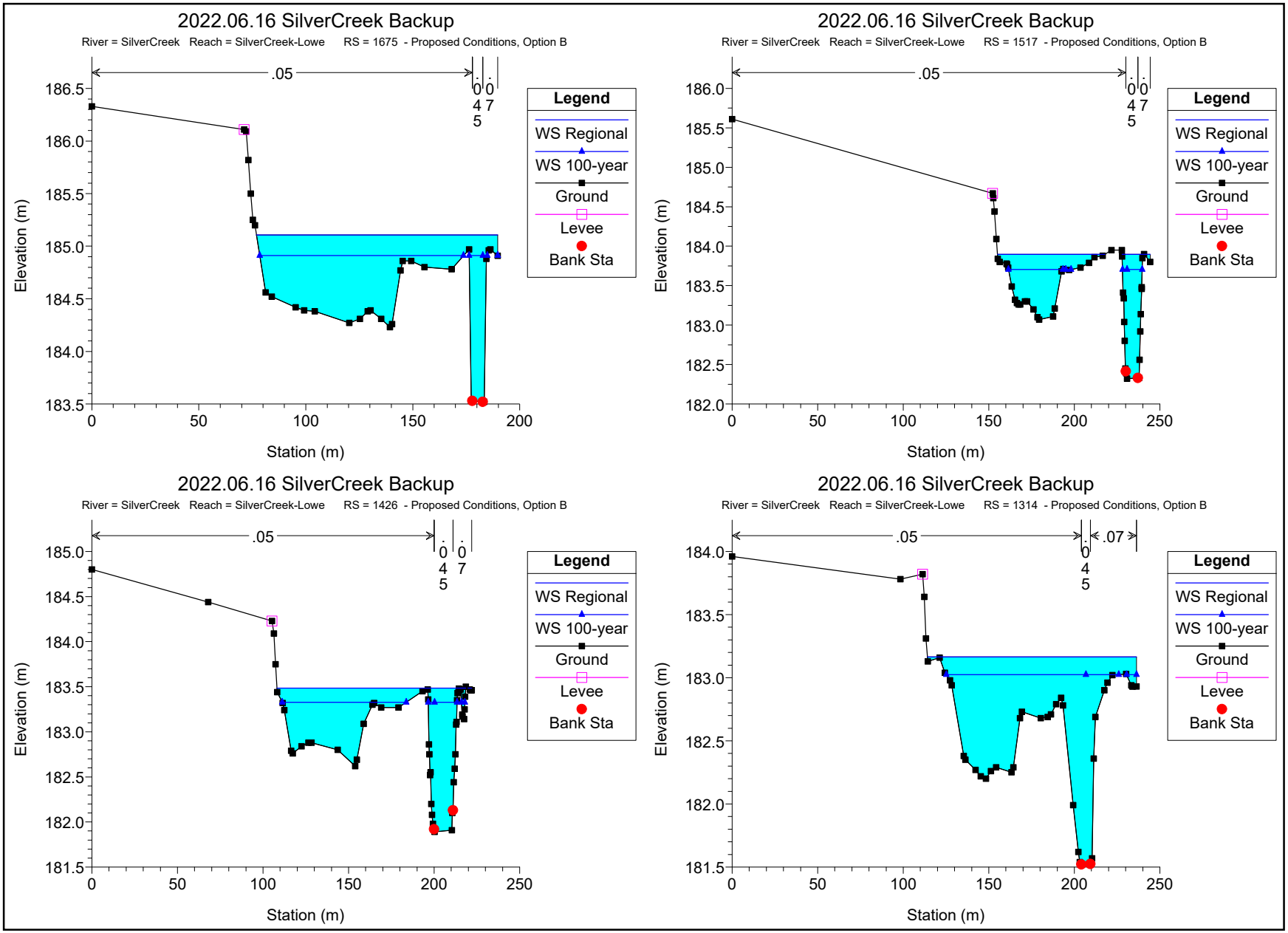
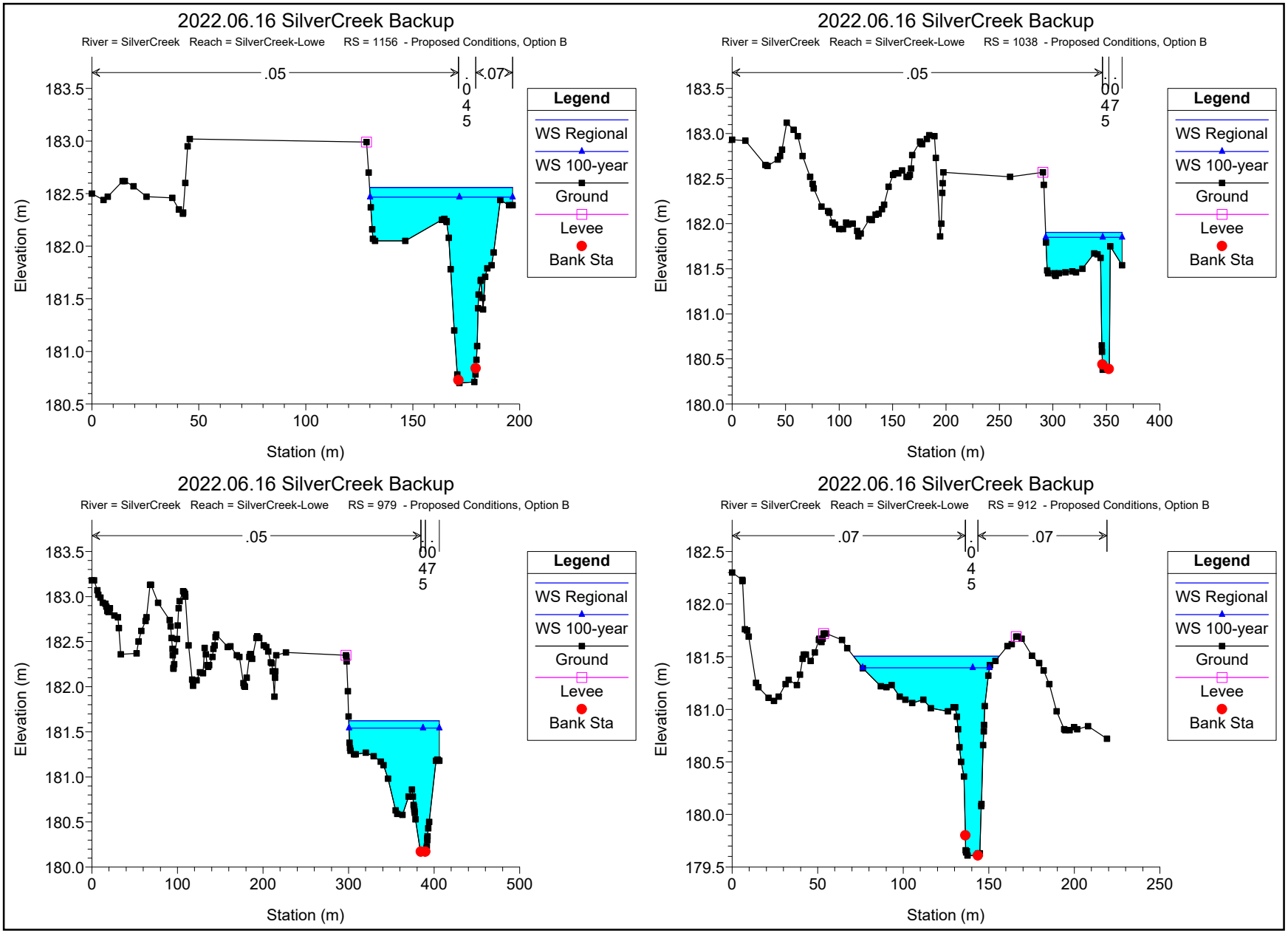
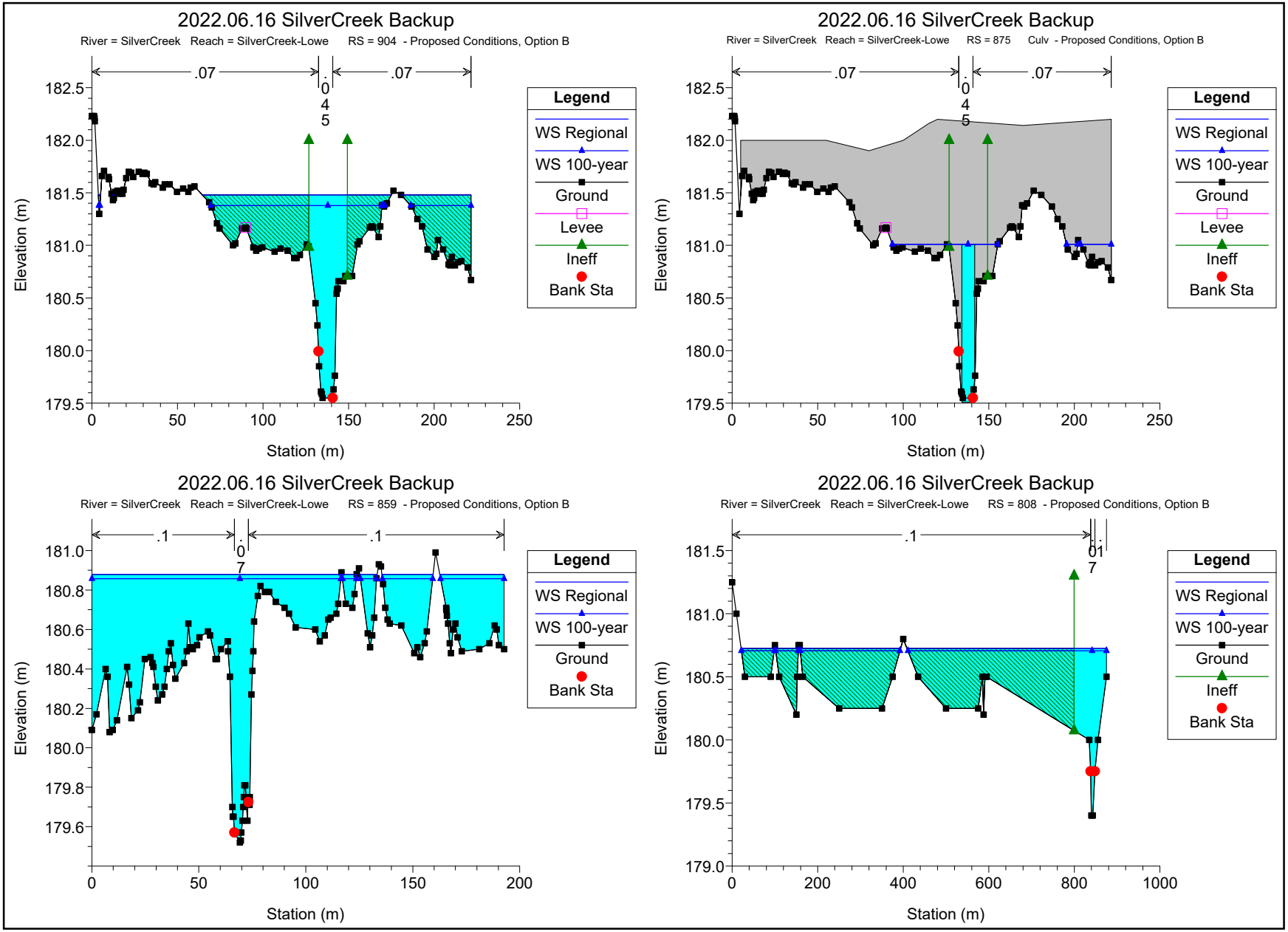
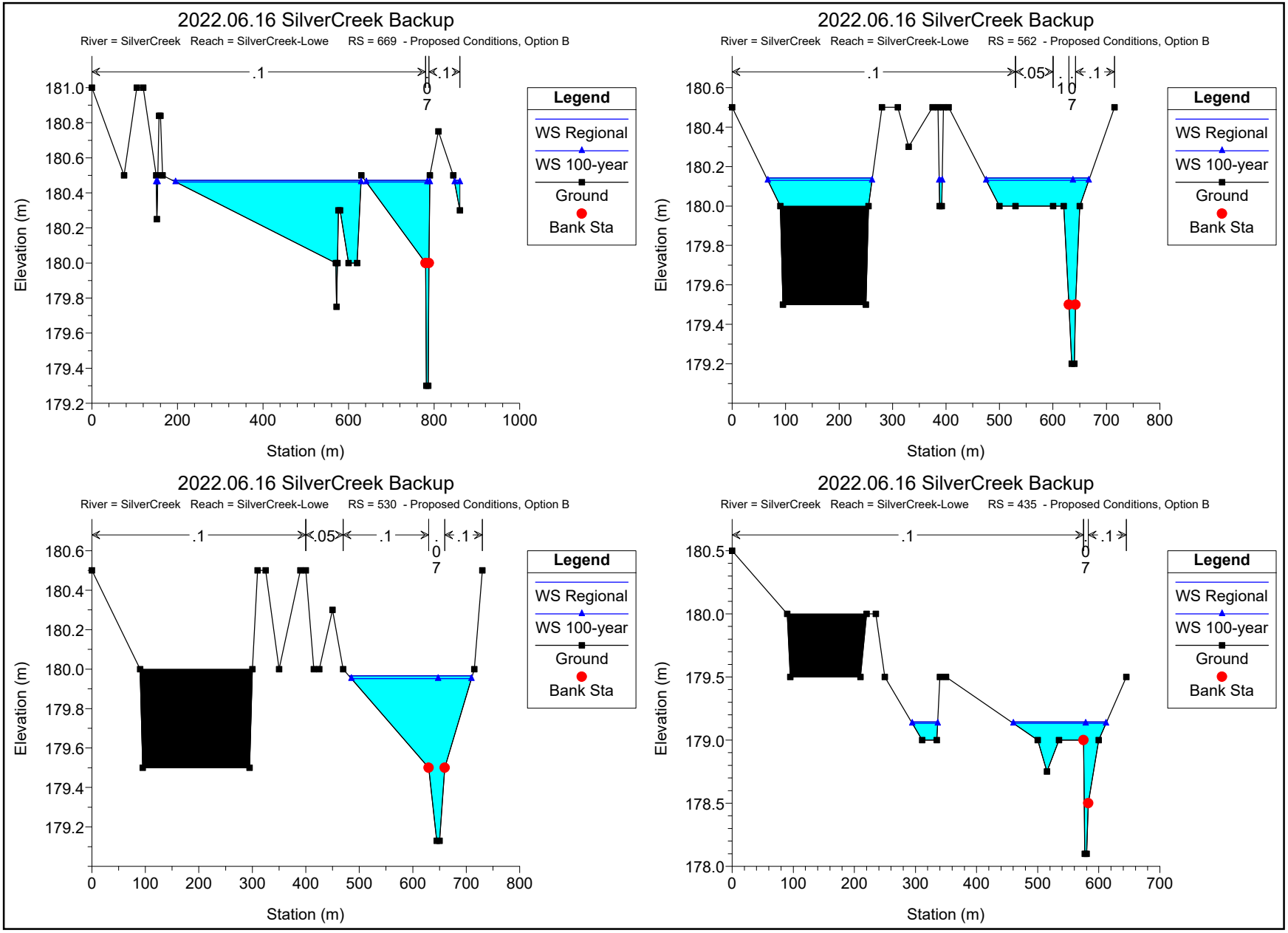
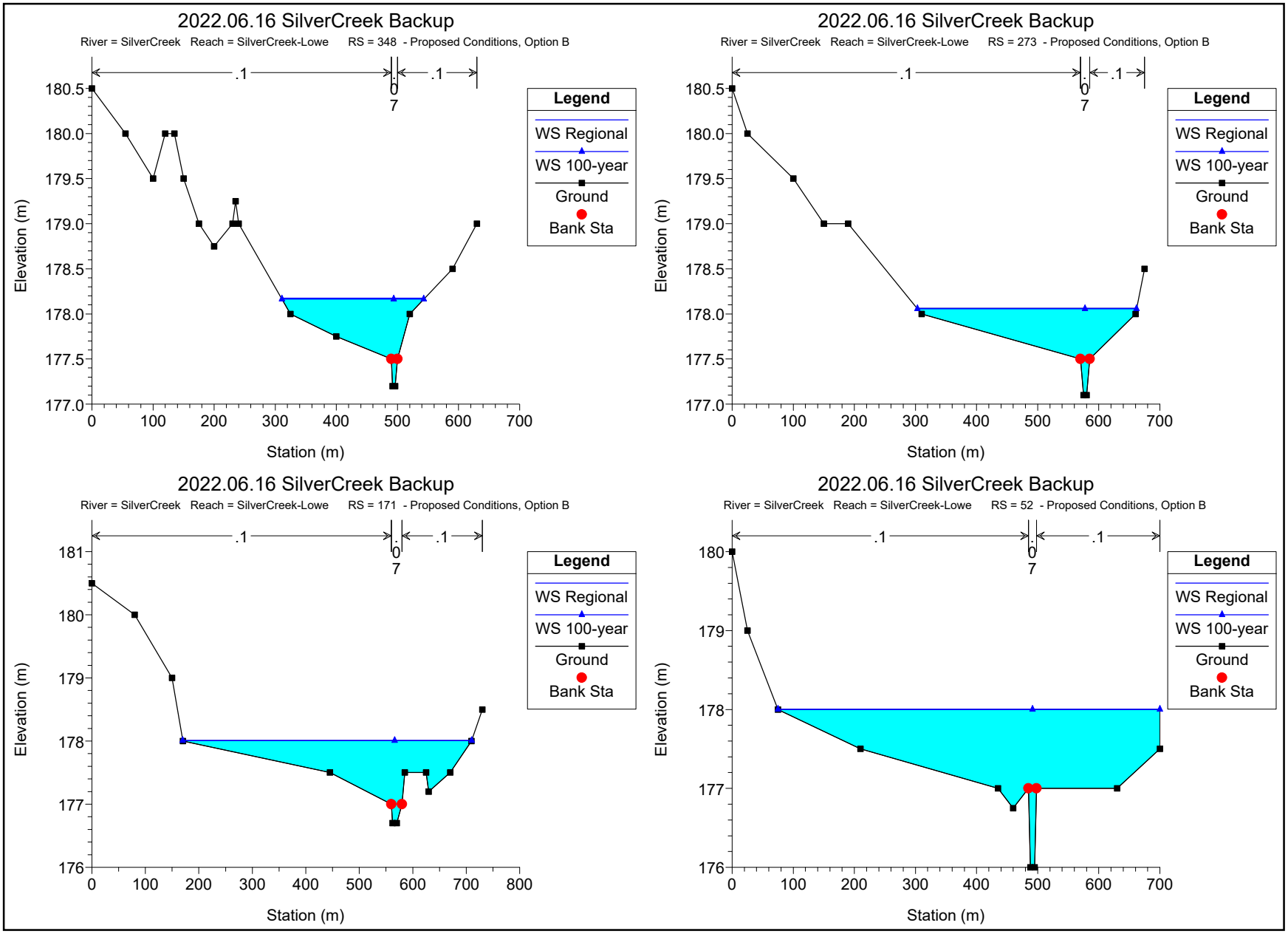
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1675 - Proposed Conditions, Option B
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1517 - Proposed Conditions, Option B
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1426 - Proposed Conditions, Option B
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1314 - Proposed Conditions, Option B
.05
.045
.07
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1156 - Proposed Conditions, Option B
.05
.07
.045
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 1038 - Proposed Conditions, Option B
.05
.0047 5
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 979 - Proposed Conditions, Option B
.05
.0047 5
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 912 - Proposed Conditions, Option B
.07
.07
.045
Legend
WS Regional
WS 100-year
Ground
Levee
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 904 - Proposed Conditions, Option B
.07
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 875 Culv - Proposed Conditions, Option B
.07
.045
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 859 - Proposed Conditions, Option B
.1
.07
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 808 - Proposed Conditions, Option B
.1
.017
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 669 - Proposed Conditions, Option B
.1
.1
0
7
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 562 - Proposed Conditions, Option B
.1
.05
.1
0
7
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 530 - Proposed Conditions, Option B
.1
.05
.1
.1
0
7
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 435 - Proposed Conditions, Option B
.1
.1
0
7
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 348 - Proposed Conditions, Option B
.1
.1
0
7
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 273 - Proposed Conditions, Option B
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 171 - Proposed Conditions, Option B
2022.06.16 SilverCreek Backup
River = SilverCreek Reach = SilverCreek-Lowe RS = 52 - Proposed Conditions, Option B

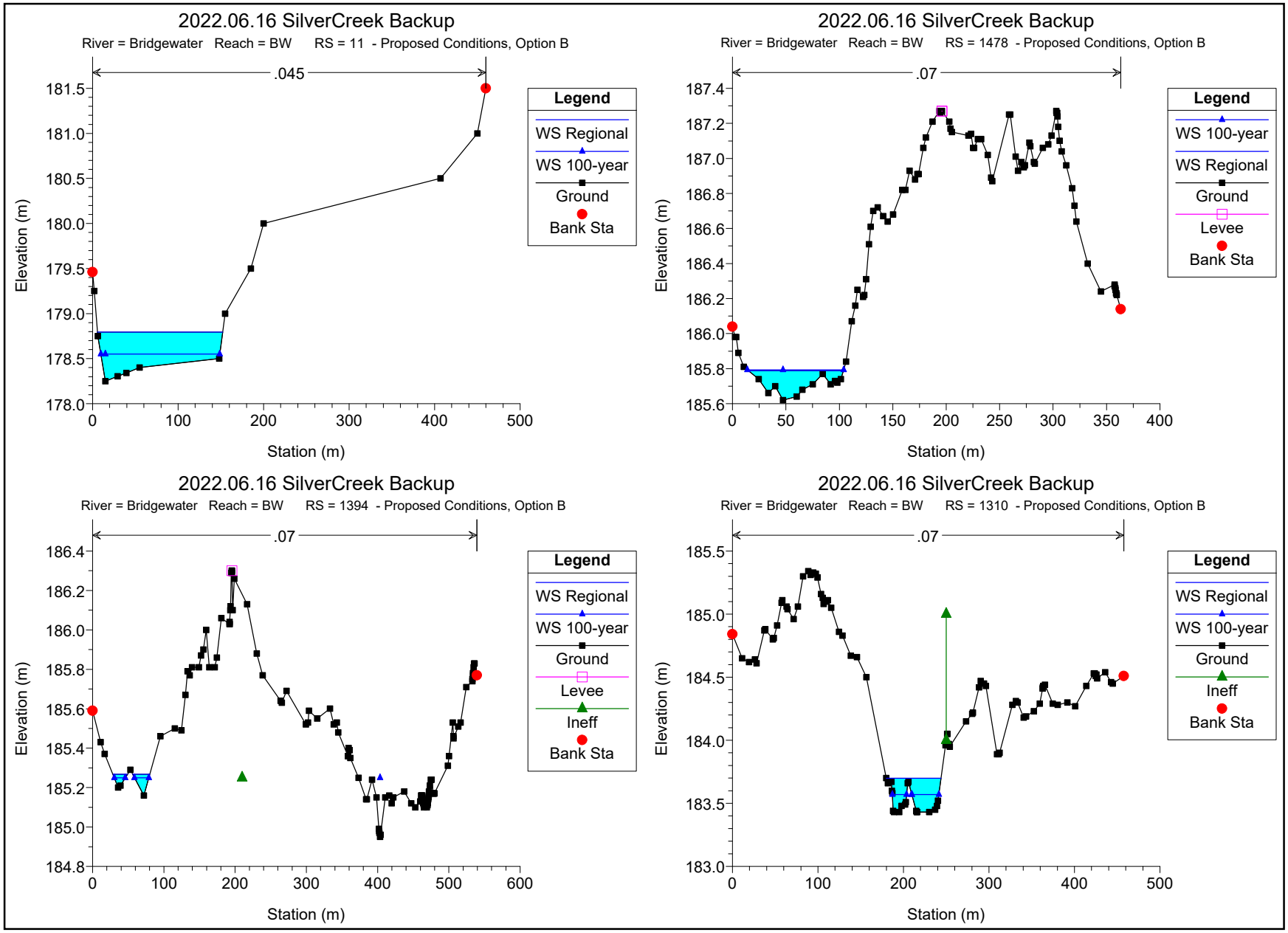
Bridgewater Creek - Proposed Conditions, Option B

HEC-RAS Plan: SC1 River: Bridgewater Reach: BW

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	1478	Regional	1.00	185.62	185.79	185.70	185.79	0.002077	0.13	7.79	89.01	0.14
BW	1478	100-year	1.00	185.62	185.79	185.70	185.79	0.001802	0.12	8.17	90.05	0.13
BW	1394	Regional	1.00	184.95	185.27	185.25	185.28	0.072781	0.49	2.04	44.72	0.74
BW	1394	100-year	1.00	184.95	185.25	185.25	185.28	0.233279	0.76	1.31	35.53	1.27
BW	1310	Regional	7.77	183.43	183.70	183.59	183.72	0.016321	0.62	12.60	64.05	0.44
BW	1310	100-year	1.00	183.43	183.57	183.48	183.57	0.002946	0.18	5.49	48.17	0.17
BW	1200	Regional	16.33	182.84	183.39		183.39	0.001820	0.25	65.55	250.82	0.16
BW	1200	100-year	1.44	182.84	183.13	183.07	183.13	0.005301	0.16	8.86	144.18	0.21
BW	1135	Regional	16.96	182.54	183.21		183.21	0.004486	0.36	47.30	206.13	0.24
BW	1135	100-year	1.44	182.54	182.75		182.76	0.005813	0.30	4.73	32.10	0.25
BW	1069	Regional	20.96	182.26	182.68		182.70	0.013398	0.59	35.32	164.34	0.41
BW	1069	100-year	1.67	182.26	182.50		182.50	0.002910	0.17	9.77	93.33	0.17
BW	1006	Regional	25.14	181.70	182.26		182.27	0.004543	0.36	70.33	310.84	0.24
BW	1006	100-year	2.82	181.70	181.95		181.96	0.028351	0.41	6.90	98.58	0.49
BW	936	Regional	30.17	181.50	182.08		182.08	0.001833	0.30	100.74	293.55	0.16
BW	936	100-year	5.00	181.50	181.85		181.86	0.000688	0.12	41.63	229.37	0.09
BW	840	Regional	51.86	180.50	181.17	181.17	181.27	0.076464	1.35	38.28	189.84	0.96
BW	840	100-year	20.10	180.50	181.07		181.11	0.046817	0.94	21.46	127.98	0.73
BW	740	Regional	52.17	179.49	180.63		180.63	0.001441	0.29	178.29	263.25	0.11
BW	740	100-year	20.20	179.49	180.22		180.23	0.003555	0.27	74.70	244.53	0.16
BW	685	Regional	52.17	179.36	180.56		180.57	0.000911	0.26	197.59	241.36	0.09
BW	685	100-year	20.20	179.36	180.06		180.06	0.002443	0.25	80.26	220.84	0.13
BW	670		Lat Struct									
BW	660	Regional	28.57	179.41	180.55		180.55	0.000259	0.14	203.58	249.81	0.05
BW	660	100-year	8.40	179.41	180.03		180.03	0.000385	0.10	83.16	224.90	0.05
BW	636	Regional	28.57	179.44	180.55	179.73	180.55	0.000324	0.15	194.48	263.33	0.05
BW	636	100-year	8.40	179.44	180.02	179.60	180.02	0.000608	0.13	65.66	191.30	0.07
BW	606	Regional	28.57	179.44	180.54	179.67	180.54	0.000217	0.14	208.69	321.47	0.05
BW	606	100-year	8.40	179.44	180.01	179.58	180.01	0.000357	0.11	78.51	290.83	0.05
BW	588	Regional	28.57	179.43	180.53		180.53	0.000538	0.21	133.21	149.52	0.07
BW	588	100-year	8.40	179.43	180.00		180.00	0.000843	0.15	55.11	144.60	0.08
BW	572	Regional	28.57	179.39	180.52		180.53	0.000566	0.23	125.54	133.75	0.08
BW	572	100-year	8.40	179.39	179.99		179.99	0.000734	0.15	55.05	129.95	0.07
BW	545	Regional	28.57	179.34	180.50		180.50	0.001309	0.32	89.73	107.50	0.11
BW	545	100-year	8.40	179.34	179.95		179.95	0.003072	0.27	31.52	93.96	0.15
BW	520	Regional	28.57	179.09	180.37	179.89	180.43	0.004728	1.07	26.60	100.14	0.35
BW	520	100-year	8.40	179.09	179.81	179.45	179.84	0.007418	0.79	10.70	95.46	0.39
BW	500		Culvert									
BW	475	Regional	28.57	178.92	180.14	179.76	180.14	0.000774	0.35	82.25	125.96	0.14
BW	475	100-year	8.40	178.92	179.79	179.31	179.81	0.003290	0.59	14.17	124.27	0.27
BW	446	Regional	28.57	178.80	180.06	179.63	180.09	0.005158	0.72	39.65	187.34	0.27
BW	446	100-year	8.40	178.80	179.68	179.24	179.69	0.004862	0.44	19.23	96.68	0.23
BW	428	Regional	28.57	178.74	179.91	179.66	179.98	0.005405	1.18	24.18	200.97	0.48
BW	428	100-year	8.40	178.74	179.53	179.37	179.57	0.009709	0.88	9.56	71.96	0.55
BW	420		Lat Struct									
BW	416	Regional	22.29	178.55	179.89		179.93	0.002273	0.85	26.11	35.46	0.32
BW	416	100-year	4.06	178.55	179.53		179.53	0.000499	0.29	14.01	30.88	0.14
BW	381	Regional	22.29	178.53	179.88		179.89	0.000483	0.55	40.37	32.97	0.16
BW	381	100-year	4.06	178.53	179.53		179.53	0.000044	0.14	29.10	31.42	0.05
BW	367	Regional	22.29	178.77	179.86		179.88	0.000982	0.69	32.45	32.71	0.22
BW	367	100-year	4.06	178.77	179.52		179.53	0.000112	0.19	21.86	30.96	0.07

HEC-RAS Plan: SC1 River: Bridgewater Reach: BW (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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	361	Regional	22.29	178.90	179.78		179.86	0.006320	1.29	17.32	27.50	0.52
BW	361	100-year	4.06	178.90	179.52		179.52	0.000737	0.38	10.61	20.85	0.17
BW	352	Regional	22.29	179.30	179.75		179.78	0.007225	0.80	27.69	99.55	0.49
BW	352	100-year	4.06	179.30	179.48		179.50	0.021745	0.71	5.75	57.52	0.71
BW	231	Regional	22.29	178.15	179.32		179.34	0.002223	0.66	33.65	66.72	0.30
BW	231	100-year	4.06	178.15	178.90		178.91	0.002115	0.40	10.20	41.89	0.26
BW	192	Regional	22.29	178.14	179.26		179.28	0.001164	0.51	43.90	79.94	0.22
BW	192	100-year	4.06	178.14	178.86		178.86	0.000692	0.26	15.81	54.27	0.15
BW	150	Regional	22.29	178.48	179.18		179.20	0.002537	0.76	29.33	52.30	0.32
BW	150	100-year	4.06	178.48	178.81		178.82	0.001736	0.36	11.32	46.99	0.23
BW	110	Regional	22.29	178.37	178.99		179.04	0.007904	0.97	23.05	67.22	0.53
BW	110	100-year	4.06	178.37	178.71		178.73	0.003252	0.47	8.61	37.98	0.32
BW	65	Regional	22.29	178.27	178.87		178.88	0.001724	0.47	47.03	127.69	0.25
BW	65	100-year	4.06	178.27	178.62		178.63	0.001489	0.25	16.42	106.13	0.20
BW	11	Regional	22.29	178.25	178.79	178.55	178.80	0.001301	0.41	54.06	146.48	0.22
BW	11	100-year	4.06	178.25	178.55	178.43	178.55	0.001302	0.21	19.04	139.08	0.18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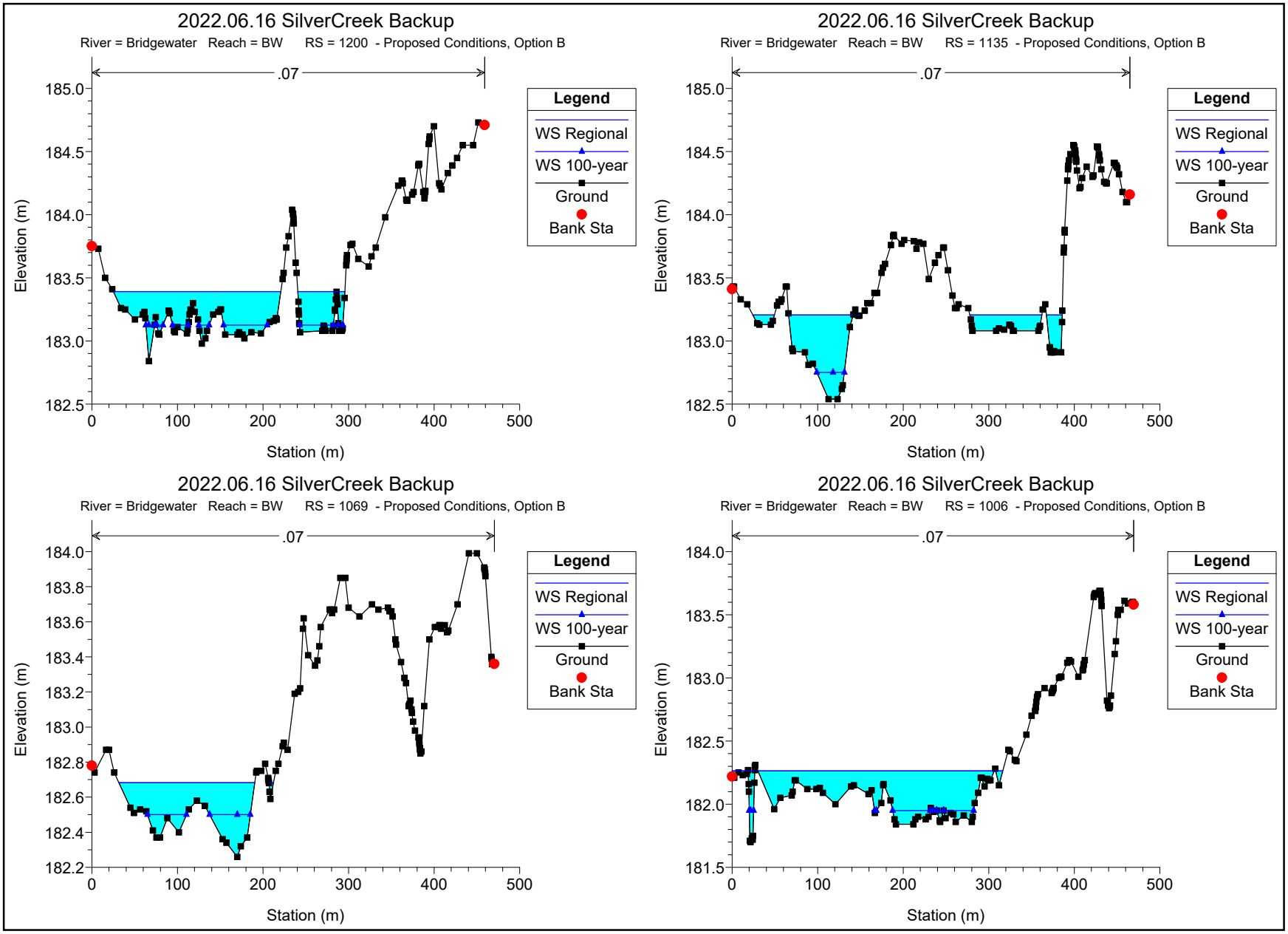
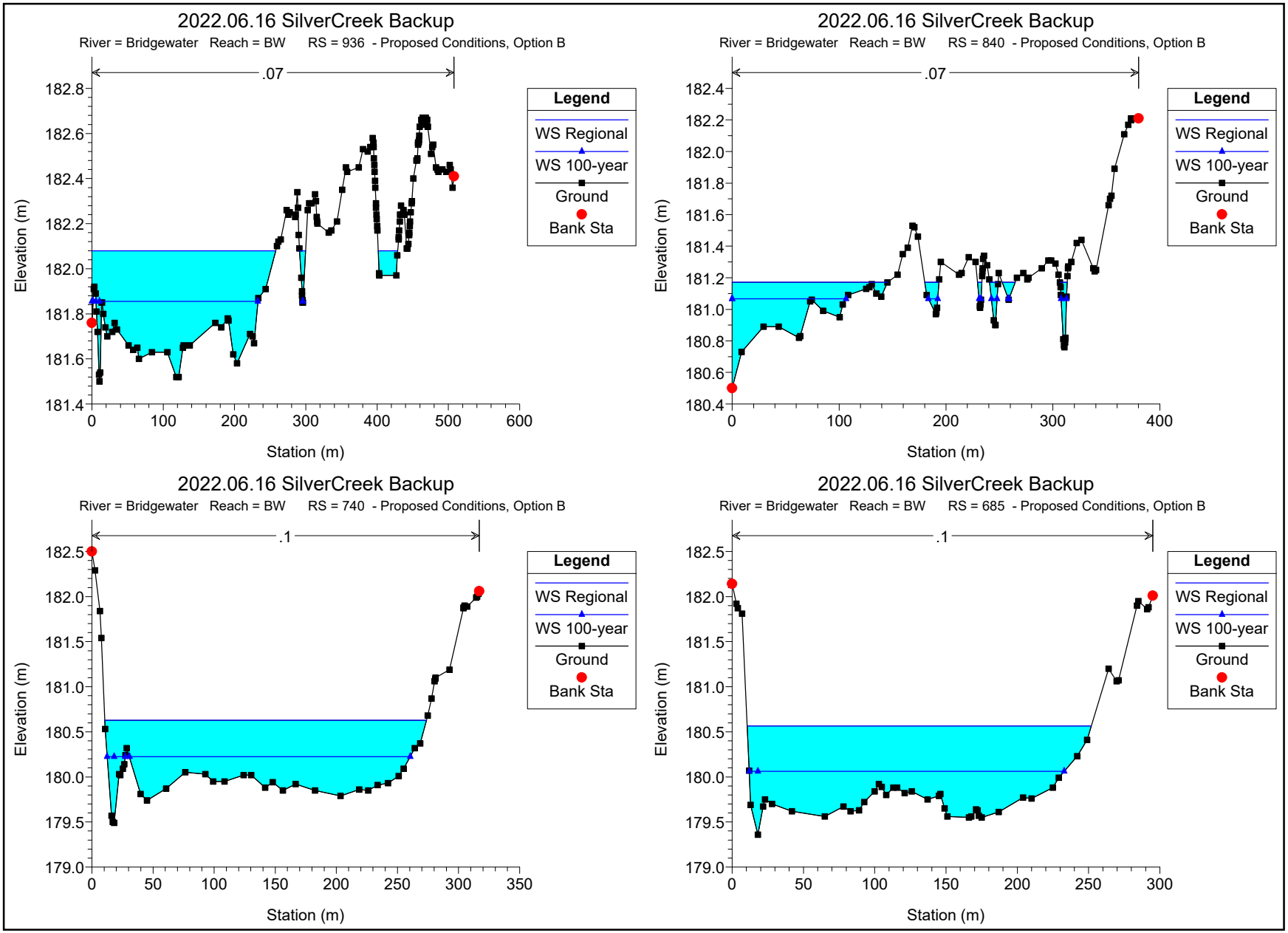
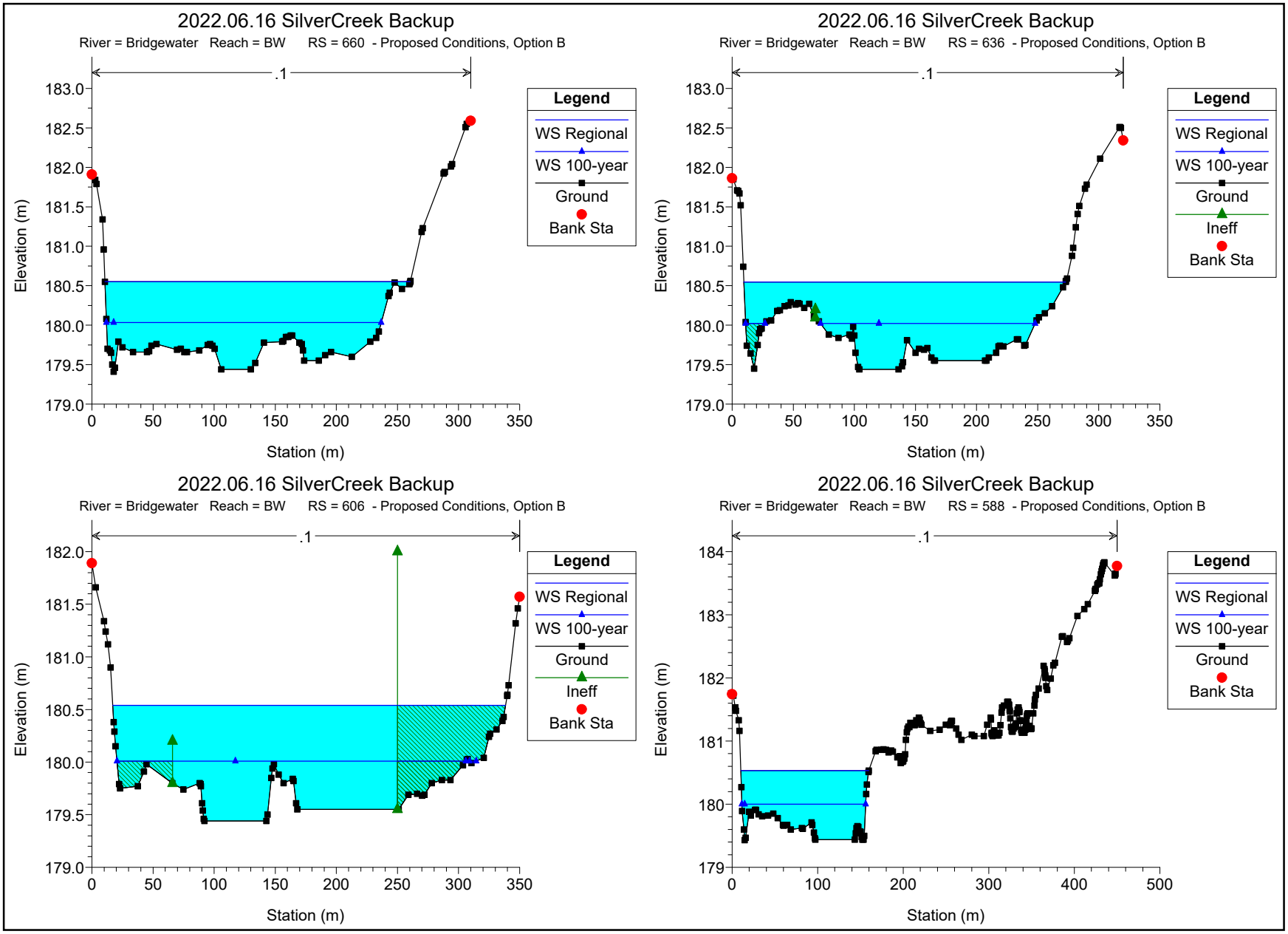
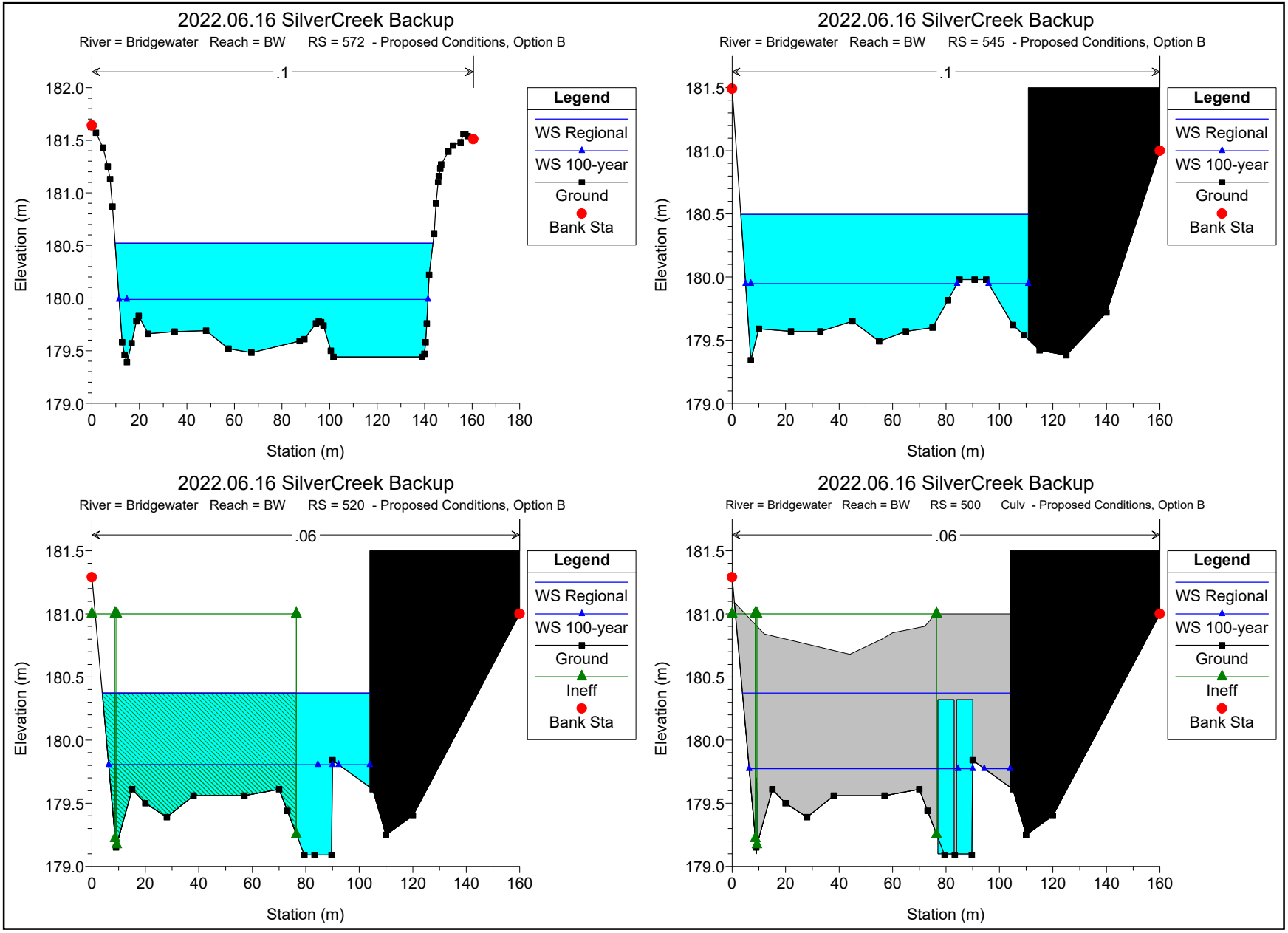
River = Bridgewater Reach = BW RS = 11 - Proposed Conditions, Option B
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1478 - Proposed Conditions, Option B
.07
Elevation (m)
Station (m)
Legend
WS 100-year
WS Regional
Ground
Levee
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1394 - Proposed Conditions, Option B
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Levee
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1310 - Proposed Conditions, Option B
.07
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1200 - Proposed Conditions, Option B
.07
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1135 - Proposed Conditions, Option B
.07
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1069 - Proposed Conditions, Option B
.07
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 1006 - Proposed Conditions, Option B
.07
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 936 - Proposed Conditions, Option B
.07
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 840 - Proposed Conditions, Option B
.07
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 740 - Proposed Conditions, Option B
.1
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 685 - Proposed Conditions, Option B
.1
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 660 - Proposed Conditions, Option B
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 636 - Proposed Conditions, Option B
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 606 - Proposed Conditions, Option B
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 588 - Proposed Conditions, Option B
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta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River = Bridgewater Reach = BW RS = 572 - Proposed Conditions, Option B
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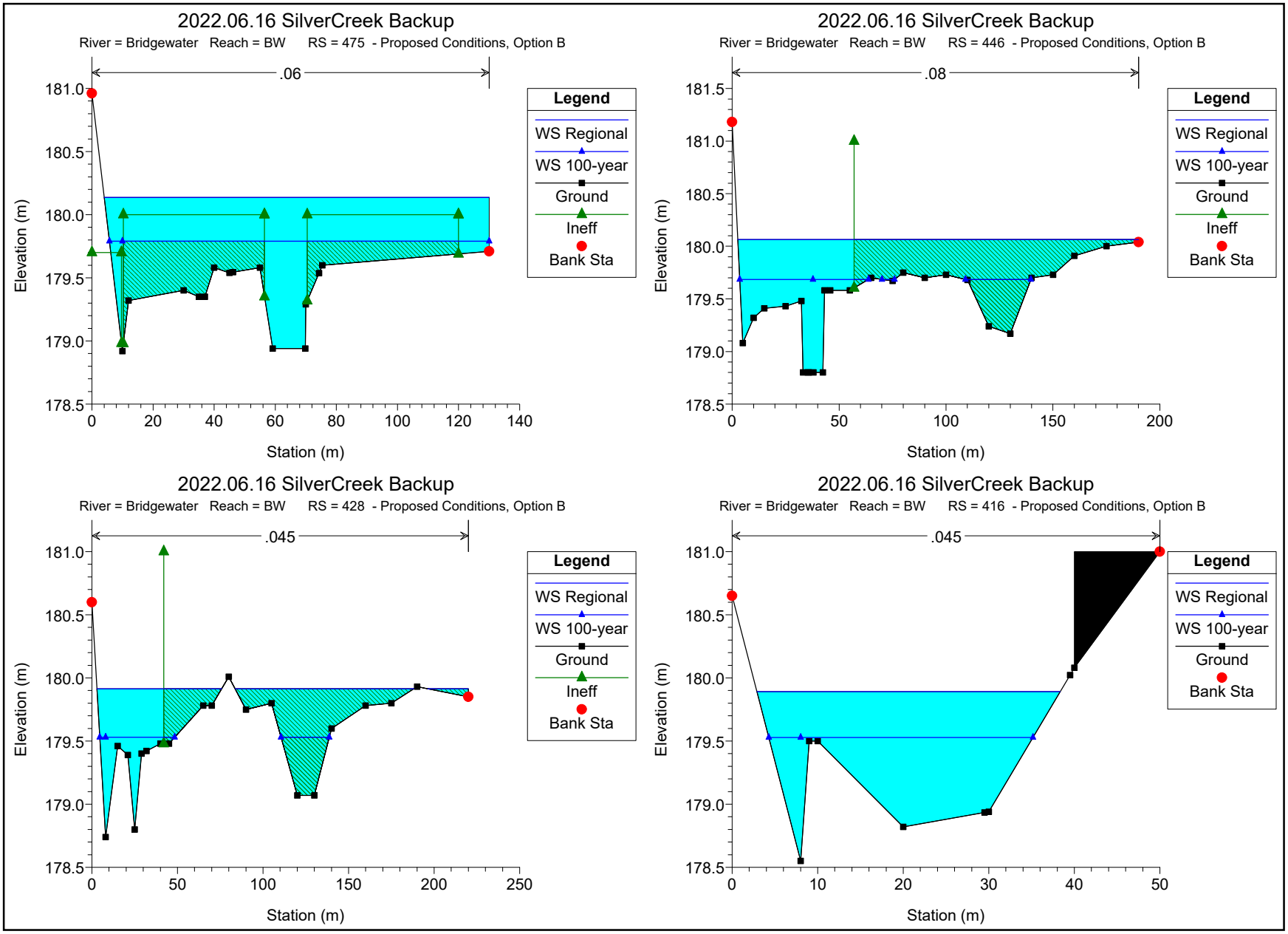
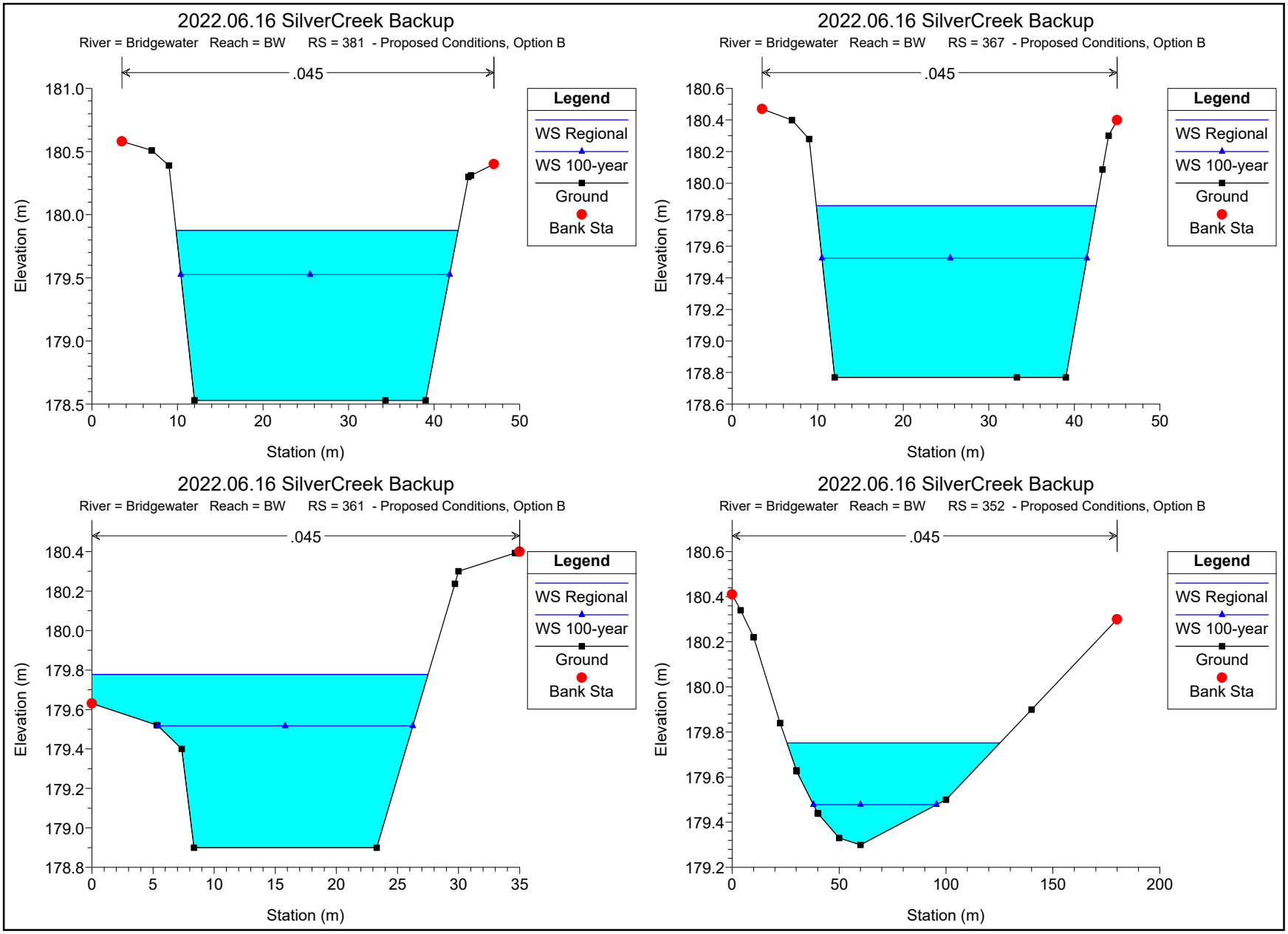
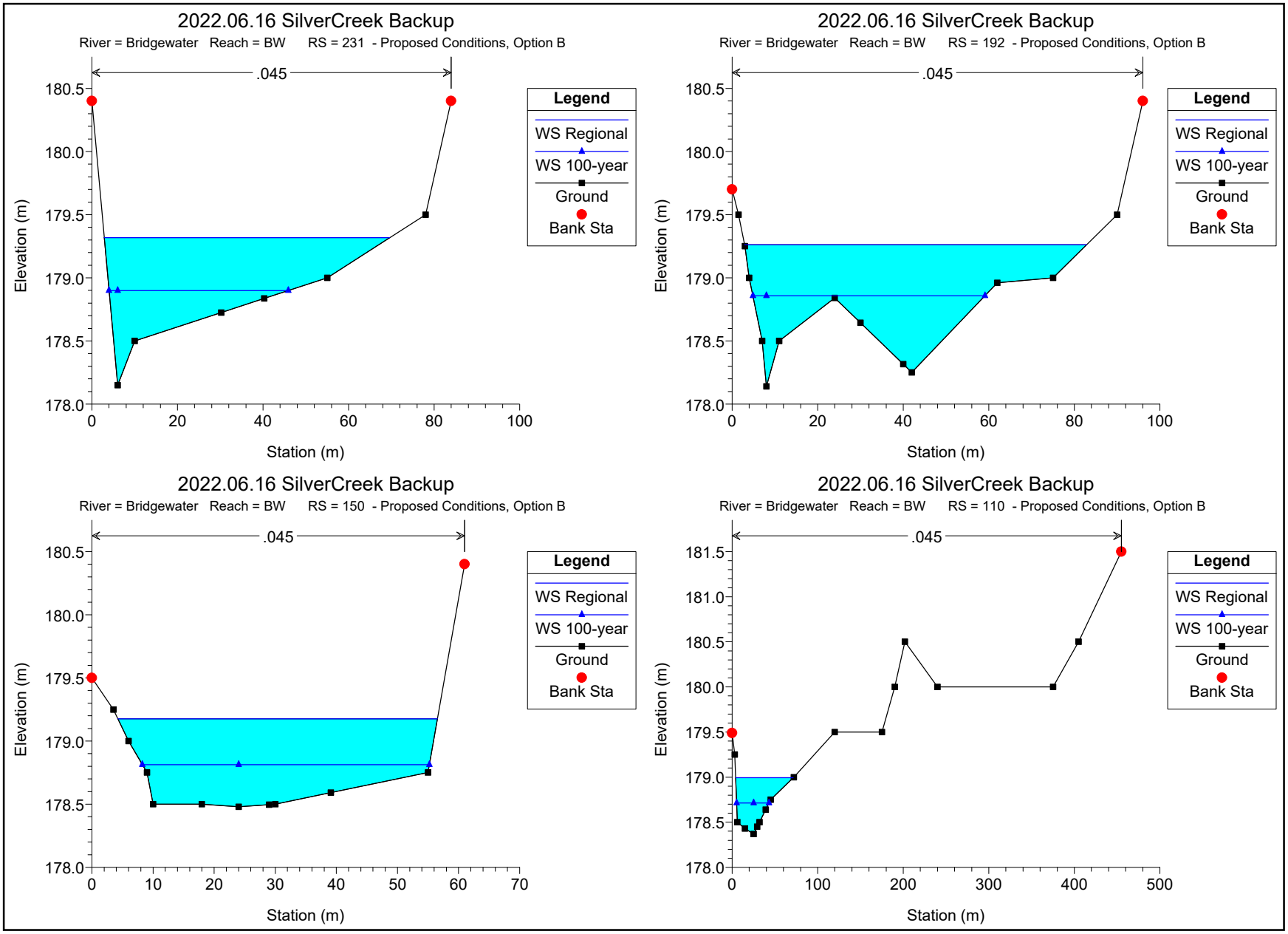
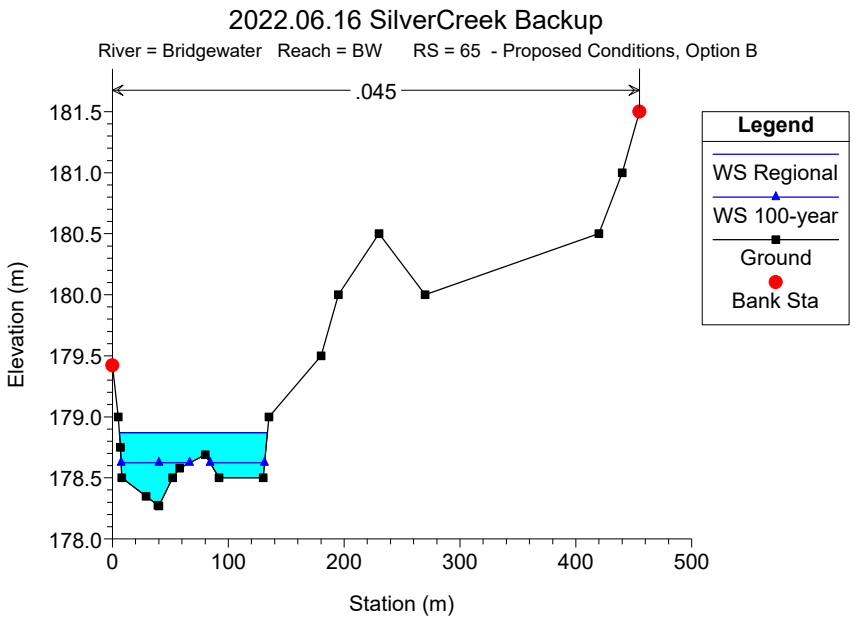
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 545 - Proposed Conditions, Option B
.1
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 520 - Proposed Conditions, Option B
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 500 Culv - Proposed Conditions, Option B
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 475 - Proposed Conditions, Option B
.06
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 446 - Proposed Conditions, Option B
.08
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 428 - Proposed Conditions, Option B
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Ineff
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 416 - Proposed Conditions, Option B
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 381 - Proposed Conditions, Option B
.045
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 367 - Proposed Conditions, Option B
.045
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 361 - Proposed Conditions, Option B
.045
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 352 - Proposed Conditions, Option B
.045
Legend
WS Regional
WS 100-year
Ground
Bank Sta
Elevation (m)
Station (m)


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 231 - Proposed Conditions, Option B
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 192 - Proposed Conditions, Option B
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 150 - Proposed Conditions, Option B
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta
2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 110 - Proposed Conditions, Option B
.045
Elevation (m)
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta


2022.06.16 SilverCreek Backup
River = Bridgewater Reach = BW RS = 65 - Proposed Conditions, Option B
.045
Elevation (m)
181.5
181.0
180.5
180.0
179.5
179.0
178.5
178.0
0
100
200
300
400
500
Station (m)
Legend
WS Regional
WS 100-year
Ground
Bank Sta

APPENDIX E

Sensitivity Analysis

E.1: Flood Proofing Scenario (Flow = 109 cms)
Table 1: Flood Proofing Scenario Comparison

Option A Silver Creek & Bridgewater Creek HEC-RAS Output Table (Flow = 109 cms)

Option B Silver Creek & Bridgewater Creek HEC-RAS Output Table (Flow = 109 cms)

E.2: Silver Glen Culverts 50% Blocked Scenario
Table 2: Silver Glen Boulevard Culvert 50% Blocked

Silver Creek HEC-RAS Output Table (100-yr & Regional)

Bridgewater Creek HEC-RAS Output Table (100-yr & Regional)

E.3: Increased Downstream Boundary Condition Scenario
Table 3: Increased Downstream Boundary Condition Scenario (DSB=179)

Silver Creek HEC-RAS Output Table (DSB=179)

Bridgewater Creek HEC-RAS Output Table (DSB=179)

APPENDIX E.1

Sensitivity Analysis

Increased Flow Scenario

Table 1: Flood Proofing Scenario Comparison

Option A Silver Creek & Bridgewater Creek HEC-RAS Output Table (Flow = 109 cms)

Option B Silver Creek & Bridgewater Creek HEC-RAS Output Table (Flow = 109 cms)

CROZIER CONSULTING ENGINEERS

PROJ. NO: 281-2769
PROJECT: Huntingwood East Lands
DESIGN: JE
FILE: Sensitivity Analysis
DATE: Mar 28, 2023

Table 1: Sensitivity Analysis - Flood Proofing Scenaio - Approach Flow = 109 cms

		OPTION A					OPTION B				
		78 m3/s		109 m3/s			78 m3/s		109 m3/s		
River	River Sta	Q Total (m3/s)	W.S. Elev (m)	Q Total (m3/s)	W.S. Elev (m)	Difference in WSE	Q Total (m3/s)	W.S. Elev (m)	Q Total (m3/s)	W.S. Elev (m)	Difference in WSE
Silver Creek	1971	78	188	109	188.14	0.14	78	188	109	188.14	0.14
Silver Creek	1931	78	187.51	109	187.55	0.04	78	187.51	109	187.55	0.04
Silver Creek	1848	78	187.43	109	187.53	0.1	78	187.43	109	187.53	0.1
Silver Creek	1835	78	187.43	109	187.53	0.1	78	187.43	109	187.53	0.1
Silver Creek	1820	Bridge		Bridge			Bridge		Bridge		
Silver Creek	1810	78	186.9	109	187.42	0.52	78	186.92	109	187.42	0.5
Silver Creek	1798	78	186.78	109	187.31	0.53	78	186.81	109	187.32	0.51
Silver Creek	1778	78	186.75	109	187.34	0.59	78	186.79	109	187.35	0.56
Silver Creek	1730	78	186.34	109	186.9	0.56	78	186.34	109	186.9	0.56
Silver Creek	1710	Bridge		Bridge			Bridge		Bridge		
Silver Creek	1705	78	185.29	109	185.52	0.23	78	185.22	109	185.52	0.3
Silver Creek	1690	Lat Struct		Lat Struct			Lat Struct		Lat Struct		
Silver Creek	1674	75.17	185.2	102.33	185.31	0.11	77.35	185.12	102.49	185.2	0.08
Silver Creek	1516	61	183.84	76.36	184.01	0.17	64.87	183.94	73.79	184.03	0.09
Silver Creek	1425	61	183.45	72.47	183.49	0.04	63.98	183.49	66.91	183.48	-0.01
Silver Creek	1313	58.8	183.04	60.24	183.04	0	60.27	183.17	56.37	183.04	-0.13
Silver Creek	1155	41.35	182.36	40.7	182.37	0.01	56.24	182.57	36.38	182.33	-0.24
Silver Creek	1037	25.77	181.37	26.96	181.4	0.03	46.84	181.91	22.96	181.62	-0.29
Silver Creek	978	19.33	181.3	23.12	181.43	0.13	43.52	181.61	20.59	181.36	-0.25
Silver Creek	911	19.33	181.11	23.12	181.29	0.18	26.08	181.51	20.59	181.17	-0.34
Silver Creek	903	19.33	181.1	23.12	181.28	0.18	26.08	181.47	20.59	181.16	-0.31
Silver Creek	875	Culvert		Culvert			Culvert		Culvert		
Silver Creek	858	19.33	180.8	23.12	180.87	0.07	26.08	180.92	20.59	180.82	-0.1
Silver Creek	808	19.33	180.63	23.12	180.68	0.05	26.08	180.72	20.59	180.65	-0.07
Silver Creek	669	19.33	180.42	23.12	180.45	0.03	26.08	180.47	20.59	180.43	-0.04
Silver Creek	562	19.33	180.08	23.12	180.11	0.03	26.08	180.14	20.59	180.09	-0.05
Silver Creek	530	19.33	179.89	23.12	179.93	0.04	26.08	179.96	20.59	179.9	-0.06
Silver Creek	435	19.33	179.08	23.12	179.12	0.04	26.08	179.14	20.59	179.1	-0.04
Silver Creek	348	19.33	178.12	23.12	178.15	0.03	26.08	178.17	20.59	178.13	-0.04
Silver Creek	273	19.33	178.03	23.12	178.05	0.02	26.08	178.06	20.59	178.04	-0.02
Silver Creek	171	19.33	178	23.12	178.01	0.01	26.08	178.01	20.59	178.01	0
Silver Creek	52	19.33	178	23.12	178	0	26.08	178	20.59	178	0
Bridgewater	1478	1	185.7	1	185.7	0	1	185.7	1	185.7	0
Bridgewater	1394	1	185.25	1	185.29	0.04	1	185.18	1	185.28	0.1
Bridgewater	1349	5.99	184.81	11.15	184.89	0.08	1.65	184.73	10.25	184.88	0.15
Bridgewater	1310	13.31	183.8	22.5	183.89	0.09	1.78	183.59	21.36	183.88	0.29
Bridgewater	1200	18	183.4	33.73	183.54	0.14	14.22	183.37	36.61	183.57	0.2
Bridgewater	1134	18	183.19	36.48	183.35	0.16	15.02	183.18	42.01	183.38	0.2
Bridgewater	1069	18	182.68	40.87	182.8	0.12	19.64	182.68	45.94	182.82	0.14
Bridgewater	1006	20.2	182.21	49.74	182.39	0.18	24.03	182.26	53.63	182.42	0.16
Bridgewater	936	20.2	182.02	50.64	182.18	0.16	28.88	182.08	53.72	182.2	0.12
Bridgewater	840	39.08	181.12	70.44	181.24	0.12	52.63	181.17	74.96	181.24	0.07
Bridgewater	740	52.26	180.73	82.28	181.12	0.39	52.92	180.64	86.62	181.11	0.47
Bridgewater	685	59.65	180.69	86.87	181.09	0.4	52.92	180.58	89.41	181.07	0.49
Bridgewater	670	Lat Struct		Lat Struct			Lat Struct		Lat Struct		
Bridgewater	660	32.68	180.68	50.58	181.09	0.41	29.31	180.57	52.53	181.06	0.49
Bridgewater	636	32.68	180.67	50.58	181.08	0.41	29.31	180.57	52.53	181.06	0.49
Bridgewater	607	32.68	180.67	50.58	181.08	0.41	29.31	180.56	52.53	181.06	0.5
Bridgewater	588	32.68	180.66	50.58	181.07	0.41	29.31	180.55	52.53	181.05	0.5
Bridgewater	572	32.68	180.65	50.58	181.06	0.41	29.31	180.54	52.53	181.04	0.5
Bridgewater	545	32.68	180.63	50.58	181.05	0.42	29.31	180.52	52.53	181.02	0.5
Bridgewater	520	32.68	180.52	50.58	180.92	0.4	29.31	180.4	52.53	181.01	0.61
Bridgewater	500	Culvert		Culvert			Culvert		Culvert		
Bridgewater	475	32.68	180.2	50.58	180.45	0.25	29.31	180.15	52.53	180.47	0.32
Bridgewater	446	32.68	180.12	50.58	180.36	0.24	29.31	180.08	52.53	180.39	0.31
Bridgewater	428	32.68	179.97	50.58	180.19	0.22	29.31	179.92	52.53	180.22	0.3
Bridgewater	420	Lat Struct		Lat Struct			Lat Struct		Lat Struct		
Bridgewater	416	25.82	179.95	42.49	180.17	0.22	23.02	179.9	44.28	180.19	0.29
Bridgewater	381	25.82	179.93	42.49	180.14	0.21	23.02	179.89	44.28	180.16	0.27
Bridgewater	367	25.82	179.9	42.49	180.1	0.2	23.02	179.87	44.28	180.12	0.25
Bridgewater	361	25.82	179.81	42.49	179.9	0.09	23.02	179.78	44.28	179.9	0.12
Bridgewater	352	25.82	179.79	42.49	179.95	0.16	23.02	179.76	44.28	179.97	0.21
Bridgewater	231	25.82	179.37	42.49	179.57	0.2	23.02	179.33	44.28	179.58	0.25
Bridgewater	192	25.82	179.31	42.49	179.51	0.2	23.02	179.27	44.28	179.53	0.26
Bridgewater	150	25.82	179.22	42.49	179.39	0.17	23.02	179.18	44.28	179.4	0.22
Bridgewater	110	25.82	179.03	42.49	179.17	0.14	23.02	179	44.28	179.18	0.18
Bridgewater	65	25.82	178.91	42.49	179.05	0.14	23.02	178.88	44.28	179.06	0.18
Bridgewater	11	25.82	178.83	42.49	178.97	0.14	23.02	178.8	44.28	178.99	0.19

Silver Creek - Proposed Conditions, Option A, Flood Proofing Scenario for sensitivity analysis

HEC-RAS Plan: flow109 Profile: Regional

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek	1971	Regional	109.00	186.50	188.14	187.74	188.17	0.002787	1.15	173.97	306.15	0.37
SilverCreek	1931	Regional	109.00	186.00	187.55	187.55	187.66	0.010146	2.33	152.55	582.84	0.80
SilverCreek	1848	Regional	109.00	184.79	187.53		187.53	0.000097	0.35	608.10	800.30	0.08
SilverCreek	1835	Regional	109.00	184.66	187.53	186.81	187.53	0.000088	0.31	635.72	804.80	0.07
SilverCreek	1820		Bridge									
SilverCreek	1810	Regional	109.00	184.41	187.42		187.43	0.000055	0.29	728.99	702.00	0.06
SilverCreek-Lowe	1798	Regional	109.00	184.33	187.31	186.47	187.40	0.001430	1.58	140.97	270.70	0.31
SilverCreek-Lowe	1778	Regional	109.00	184.21	187.34	186.48	187.36	0.000647	1.10	230.77	304.80	0.21
SilverCreek-Lowe	1730	Regional	109.00	183.91	186.90	186.13	187.26	0.004637	2.71	42.59	166.30	0.54
SilverCreek-Lowe	1710		Bridge									
SilverCreek-Lowe	1705	Regional	109.00	183.74	185.52	185.52	186.29	0.017766	3.88	28.24	103.29	1.00
SilverCreek-Lowe	1690		Lat Struct									
SilverCreek-Lowe	1674	Regional	102.33	183.52	185.31	185.19	185.45	0.007272	2.78	74.75	114.72	0.67
SilverCreek-Lowe	1516	Regional	76.36	182.32	184.01	184.01	184.23	0.008294	2.86	51.34	89.74	0.70
SilverCreek-Lowe	1425	Regional	72.47	181.89	183.49	183.20	183.60	0.004428	2.00	64.66	112.73	0.51
SilverCreek-Lowe	1313	Regional	60.24	181.52	183.04	182.78	183.12	0.004123	1.89	61.07	112.02	0.49
SilverCreek-Lowe	1155	Regional	40.70	180.70	182.37	181.95	182.49	0.003622	1.87	37.42	60.05	0.46
SilverCreek-Lowe	1037	Regional	26.96	180.38	181.40	181.40	181.76	0.018898	3.07	11.63	17.67	0.98
SilverCreek-Lowe	978	Regional	23.12	180.17	181.43	180.84	181.44	0.000668	0.67	62.91	105.10	0.19
SilverCreek-Lowe	911	Regional	23.12	179.61	181.29	180.55	181.36	0.001948	1.38	33.20	92.34	0.34
SilverCreek-Lowe	903	Regional	23.12	179.55	181.28	180.46	181.35	0.001622	1.26	25.10	129.65	0.31
SilverCreek-Lowe	875		Culvert									
SilverCreek-Lowe	858	Regional	23.12	179.40	180.87		180.98	0.010975	1.65	16.58	192.70	0.48
SilverCreek-Lowe	808	Regional	23.12	179.40	180.68		180.70	0.002482	0.78	50.98	816.74	0.23
SilverCreek-Lowe	669	Regional	23.12	179.30	180.45		180.45	0.001408	0.52	141.27	580.59	0.17
SilverCreek-Lowe	562	Regional	23.12	179.20	180.11	179.96	180.15	0.008902	1.18	52.18	381.75	0.42
SilverCreek-Lowe	530	Regional	23.12	179.13	179.93		179.95	0.004338	0.70	59.39	215.44	0.28
SilverCreek-Lowe	435	Regional	23.12	178.10	179.12	179.12	179.21	0.021715	1.82	32.25	184.63	0.64
SilverCreek-Lowe	348	Regional	23.12	177.20	178.15		178.15	0.002087	0.59	86.17	227.91	0.20
SilverCreek-Lowe	273	Regional	23.12	177.10	178.05		178.05	0.001536	0.49	111.91	357.06	0.17
SilverCreek-Lowe	171	Regional	23.12	176.70	178.01		178.01	0.000195	0.23	245.86	540.40	0.07
SilverCreek-Lowe	52	Regional	23.12	176.00	178.00	177.07	178.00	0.000032	0.12	466.31	625.00	0.03

Bridgewater Creek - Proposed Conditions, Option A, Flood Proofing Scenario for sensitivity analysis

HEC-RAS Plan: flow109 River: Bridgewater Reach: BW Profile: Regional

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	1478	Regional	1.00	185.62	185.70	185.70	185.72	0.123459	0.58	1.71	43.26	0.94
BW	1394	Regional	1.00	184.95	185.29	185.08	185.29	0.000269	0.08	12.07	57.43	0.06
BW	1349	Regional	11.15	184.57	184.89		184.91	0.023721	0.69	16.05	90.18	0.53
BW	1310	Regional	22.50	183.43	183.89	183.78	183.96	0.024820	1.13	19.95	55.75	0.60
BW	1200	Regional	33.73	182.84	183.54		183.55	0.001806	0.32	104.19	267.37	0.17
BW	1134	Regional	36.48	182.54	183.35		183.36	0.004823	0.44	82.74	279.21	0.26
BW	1069	Regional	40.87	182.26	182.80		182.82	0.014990	0.74	55.55	203.57	0.45
BW	1006	Regional	49.74	181.70	182.39		182.40	0.004061	0.44	112.24	330.08	0.24
BW	936	Regional	50.64	181.50	182.18		182.18	0.002510	0.39	130.72	327.72	0.20
BW	840	Regional	70.44	180.50	181.24	181.22	181.33	0.068853	1.36	51.88	237.13	0.93
BW	740	Regional	82.28	179.49	181.12		181.13	0.000596	0.26	310.81	274.88	0.08
BW	685	Regional	86.87	179.36	181.09		181.09	0.000506	0.27	327.73	255.77	0.07
BW	670		Lat Struct									
BW	660	Regional	50.58	179.41	181.09		181.09	0.000156	0.15	338.96	258.96	0.04
BW	636	Regional	50.58	179.44	181.08	179.82	181.08	0.000168	0.15	337.98	271.74	0.04
BW	607	Regional	50.58	179.44	181.08	179.75	181.08	0.000144	0.15	334.88	330.82	0.04
BW	588	Regional	50.58	179.43	181.07		181.07	0.000434	0.22	226.97	204.48	0.07
BW	572	Regional	50.58	179.39	181.06		181.07	0.000397	0.25	198.99	137.58	0.07
BW	545	Regional	50.58	179.34	181.05		181.05	0.000774	0.34	149.30	109.29	0.09
BW	520	Regional	50.58	179.09	180.92	180.12	181.00	0.003286	1.20	42.11	102.46	0.31
BW	500		Culvert									
BW	475	Regional	50.58	178.92	180.45	179.98	180.46	0.000668	0.42	121.82	127.49	0.14
BW	446	Regional	50.58	178.80	180.36	179.78	180.41	0.005176	0.90	56.11	188.06	0.29
BW	428	Regional	50.58	178.74	180.19	179.85	180.30	0.005011	1.43	35.28	218.25	0.49
BW	420		Lat Struct									
BW	416	Regional	42.49	178.55	180.17		180.24	0.003037	1.17	36.33	38.16	0.38
BW	381	Regional	42.49	178.53	180.14		180.17	0.000961	0.87	49.08	34.13	0.23
BW	367	Regional	42.49	178.77	180.10		180.15	0.001803	1.05	40.47	33.98	0.31
BW	361	Regional	42.49	178.90	179.90		180.11	0.013227	2.06	20.64	28.07	0.77
BW	352	Regional	42.49	179.30	179.95		179.99	0.004874	0.84	50.53	126.63	0.43
BW	231	Regional	42.49	178.15	179.57		179.60	0.002305	0.82	51.71	76.22	0.32
BW	192	Regional	42.49	178.14	179.51		179.53	0.001339	0.66	64.60	88.61	0.25
BW	150	Regional	42.49	178.48	179.39		179.44	0.003355	1.04	40.74	55.74	0.39
BW	110	Regional	42.49	178.37	179.17		179.24	0.008572	1.17	36.35	84.79	0.57
BW	65	Regional	42.49	178.27	179.05		179.07	0.001769	0.60	70.32	135.18	0.27
BW	11	Regional	42.49	178.25	178.97	178.63	178.99	0.001300	0.53	80.46	150.39	0.23

Silver Creek - Proposed Conditions, Option B, Flood Proofing Scenario for sensitivity analysis

HEC-RAS Plan: Flow109 Profile: Regional

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek	1971	Regional	109.00	186.50	188.14	187.74	188.17	0.002787	1.15	173.97	306.15	0.37
SilverCreek	1931	Regional	109.00	186.00	187.55	187.55	187.66	0.010146	2.33	152.55	582.84	0.80
SilverCreek	1848	Regional	109.00	184.79	187.53		187.53	0.000098	0.35	606.10	800.30	0.08
SilverCreek	1835	Regional	109.00	184.66	187.53	186.81	187.53	0.000089	0.31	633.72	804.80	0.07
SilverCreek	1820		Bridge									
SilverCreek	1810	Regional	109.00	184.41	187.42		187.43	0.000055	0.29	729.57	702.00	0.06
SilverCreek-Lowe	1798	Regional	109.00	184.33	187.32	186.47	187.40	0.001347	1.54	145.59	270.70	0.30
SilverCreek-Lowe	1778	Regional	109.00	184.21	187.35	186.42	187.36	0.000668	0.98	239.65	304.80	0.20
SilverCreek-Lowe	1730	Regional	109.00	183.91	186.90	186.13	187.26	0.004637	2.71	42.59	166.30	0.54
SilverCreek-Lowe	1710		Bridge									
SilverCreek-Lowe	1705	Regional	109.00	183.74	185.52	185.52	186.29	0.017766	3.88	28.24	104.82	1.00
SilverCreek-Lowe	1690		Lat Struct									
SilverCreek-Lowe	1674	Regional	102.49	183.52	185.20	185.06	185.32	0.006136	2.46	79.18	113.56	0.61
SilverCreek-Lowe	1516	Regional	73.79	182.32	184.03	184.03	184.25	0.007869	2.81	50.81	89.79	0.69
SilverCreek-Lowe	1425	Regional	66.91	181.89	183.48	183.22	183.60	0.004323	1.97	61.14	112.31	0.50
SilverCreek-Lowe	1313	Regional	56.37	181.52	183.04	182.79	183.12	0.004028	1.87	58.91	112.03	0.48
SilverCreek-Lowe	1155	Regional	36.38	180.70	182.33	181.91	182.47	0.004043	1.94	31.83	59.69	0.49
SilverCreek-Lowe	1037	Regional	22.96	180.38	181.62	181.62	181.85	0.008812	2.40	15.59	54.50	0.69
SilverCreek-Lowe	978	Regional	20.59	180.17	181.36	180.85	181.37	0.001144	0.84	48.88	104.65	0.25
SilverCreek-Lowe	911	Regional	20.59	179.61	181.17	180.47	181.25	0.002387	1.45	23.57	63.51	0.37
SilverCreek-Lowe	903	Regional	20.59	179.55	181.16	180.40	181.23	0.001755	1.25	22.41	117.28	0.32
SilverCreek-Lowe	875		Culvert									
SilverCreek-Lowe	858	Regional	20.59	179.40	180.82		180.92	0.009842	1.53	15.97	192.70	0.45
SilverCreek-Lowe	808	Regional	20.59	179.40	180.65		180.67	0.002242	0.73	48.82	806.41	0.22
SilverCreek-Lowe	669	Regional	20.59	179.30	180.43		180.43	0.001340	0.50	131.08	558.69	0.16
SilverCreek-Lowe	562	Regional	20.59	179.20	180.09	179.95	180.14	0.010109	1.24	43.50	368.76	0.44
SilverCreek-Lowe	530	Regional	20.59	179.13	179.90		179.92	0.004301	0.68	53.71	203.79	0.28
SilverCreek-Lowe	435	Regional	20.59	178.10	179.10	179.10	179.19	0.021470	1.78	28.48	173.65	0.63
SilverCreek-Lowe	348	Regional	20.59	177.20	178.13		178.13	0.001921	0.55	81.61	223.36	0.19
SilverCreek-Lowe	273	Regional	20.59	177.10	178.04		178.04	0.001323	0.45	108.71	355.71	0.16
SilverCreek-Lowe	171	Regional	20.59	176.70	178.01		178.01	0.000156	0.20	245.12	540.32	0.06
SilverCreek-Lowe	52	Regional	20.59	176.00	178.00	176.94	178.00	0.000025	0.10	466.31	625.00	0.02

Bridgewater Creek - Proposed Conditions, Option B, Flood Proofing Scenario for sensitivity analysis

HEC-RAS Plan: Flow109 River: Bridgewater Reach: BW Profile: Regional

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	1478	Regional	1.00	185.62	185.70	185.70	185.72	0.123459	0.58	1.71	43.26	0.94
BW	1394	Regional	1.00	184.95	185.28	185.08	185.28	0.000306	0.09	11.51	56.09	0.06
BW	1349	Regional	10.25	184.57	184.88		184.90	0.024001	0.68	15.18	89.76	0.52
BW	1310	Regional	21.36	183.43	183.88	183.77	183.94	0.024772	1.11	19.30	55.42	0.60
BW	1200	Regional	36.61	182.84	183.57		183.57	0.001717	0.33	111.43	269.27	0.16
BW	1134	Regional	42.01	182.54	183.38		183.39	0.004894	0.46	90.42	285.13	0.26
BW	1069	Regional	45.94	182.26	182.82		182.85	0.015003	0.76	60.09	208.02	0.45
BW	1006	Regional	53.63	181.70	182.42		182.43	0.003935	0.45	119.07	333.71	0.24
BW	936	Regional	53.72	181.50	182.20		182.21	0.002481	0.39	138.87	345.85	0.19
BW	840	Regional	74.96	180.50	181.24	181.23	181.34	0.072589	1.40	53.43	241.93	0.95
BW	740	Regional	86.62	179.49	181.11		181.11	0.000685	0.28	306.41	272.80	0.09
BW	685	Regional	89.41	179.36	181.07		181.08	0.000560	0.28	322.67	254.22	0.08
BW	670		Lat Struct									
BW	660	Regional	52.53	179.41	181.06		181.07	0.000177	0.16	333.63	258.60	0.04
BW	636	Regional	52.53	179.44	181.06	179.83	181.06	0.000191	0.16	332.24	271.50	0.05
BW	607	Regional	52.53	179.44	181.06	179.76	181.06	0.000163	0.16	329.74	330.41	0.04
BW	588	Regional	52.53	179.43	181.05		181.05	0.000485	0.24	222.42	199.90	0.07
BW	572	Regional	52.53	179.39	181.04		181.04	0.000451	0.27	195.78	137.39	0.07
BW	545	Regional	52.53	179.34	181.02		181.03	0.000889	0.36	146.48	109.21	0.10
BW	520	Regional	52.53	179.09	181.01	180.14	181.02	0.000263	0.35	151.96	102.82	0.09
BW	500		Culvert									
BW	475	Regional	52.53	178.92	180.47	180.00	180.48	0.000662	0.42	125.03	127.62	0.14
BW	446	Regional	52.53	178.80	180.39	179.79	180.43	0.005171	0.91	57.44	188.12	0.29
BW	428	Regional	52.53	178.74	180.22	179.86	180.32	0.004980	1.45	36.19	218.35	0.49
BW	420		Lat Struct									
BW	416	Regional	44.28	178.55	180.19		180.26	0.003061	1.19	37.19	38.25	0.39
BW	381	Regional	44.28	178.53	180.16		180.20	0.000998	0.89	49.82	34.22	0.24
BW	367	Regional	44.28	178.77	180.12		180.18	0.001860	1.08	41.15	34.08	0.31
BW	361	Regional	44.28	178.90	179.90		180.13	0.014031	2.13	20.80	28.10	0.79
BW	352	Regional	44.28	179.30	179.97		180.00	0.004771	0.84	52.46	128.64	0.42
BW	231	Regional	44.28	178.15	179.58		179.62	0.002303	0.83	53.07	76.39	0.32
BW	192	Regional	44.28	178.14	179.53		179.55	0.001347	0.67	66.19	88.86	0.25
BW	150	Regional	44.28	178.48	179.40		179.46	0.003425	1.06	41.59	56.00	0.39
BW	110	Regional	44.28	178.37	179.18		179.25	0.008533	1.18	37.56	86.21	0.57
BW	65	Regional	44.28	178.27	179.06		179.08	0.001781	0.61	72.23	136.62	0.27
BW	11	Regional	44.28	178.25	178.99	178.63	179.00	0.001300	0.54	82.56	150.70	0.23

APPENDIX E.2

Sensitivity Analysis

Silver Glen Culverts 50% Blocked Scenario
Table 2: Silver Glen Boulevard Culvert 50% Blocked

Silver Creek HEC-RAS Output Table (100-yr & Regional)

Bridgewater Creek HEC-RAS Output Table (100-yr & Regional)

CROZIER CONSULTING ENGINEERS

PROJ. NO: 281-2769
PROJECT: Huntingwood East Lands
DESIGN: JE
FILE: Sensitivity Analysis
DATE: Mar 30, 2023

Table 2: Sensitivity Analysis - Silver Glen Boulevard Culvert 50% Blocked

		EXISTING CONDITIONS (100-year)					EXISTING CONDITIONS (Regional Storm)				
		Full Culvert Flow		Culvert 50% Blocked			Full Culvert Flow		Culvert 50% Blocked		
River	River Sta	Q Total (m3/s)	W.S. Elev (m)	Q Total (m3/s)	W.S. Elev (m)	Difference in WSE	Q Total (m3/s)	W.S. Elev (m)	Q Total (m3/s)	W.S. Elev (m)	Difference in WSE
SilverCreek	1971	44.5	187.8	44.5	187.8	0	78	188	78	188	0
SilverCreek	1931	44.5	187.44	44.5	187.44	0	78	187.51	78	187.51	0
SilverCreek	1848	44.5	187.29	44.5	187.29	0	78	187.43	78	187.43	0
SilverCreek	1835	44.5	187.29	44.5	187.29	0	78	187.43	78	187.43	0
SilverCreek	1820	Bridge		Bridge			Bridge		Bridge		
SilverCreek	1810	44.5	186.18	44.5	186.18	0	78	186.46	78	186.46	0
SilverCreek	1798	44.5	186.15	44.5	186.15	0	78	186.33	78	186.33	0
SilverCreek	1744	44.5	185.62	44.5	185.62	0	78	185.97	78	185.97	0
SilverCreek	1730	Lat Struct		Lat Struct			Lat Struct		Lat Struct		
SilverCreek	1674	41.71	185.21	41.71	185.21	0	65.81	185.34	62.99	185.33	-0.01
SilverCreek	1516	32.16	183.66	32.14	183.66	0	40.36	183.95	39.86	183.93	-0.02
SilverCreek	1425	32.16	183.41	32.14	183.41	0	38.13	183.45	39.78	183.46	0.01
SilverCreek	1313	32.16	182.97	32.14	182.97	0	36.71	183.05	39.14	183.1	0.05
SilverCreek	1155	32.09	182.31	32.08	182.3	-0.01	35.69	182.22	38.36	182.28	0.06
SilverCreek	1037	31.61	181.78	31.59	181.78	0	39.7	181.82	43.73	181.82	0
SilverCreek	978	30.83	181.48	30.81	181.48	0	38.03	181.59	41.63	181.6	0.01
SilverCreek	911	23.21	181.3	23.22	181.3	0	25.47	181.47	25.68	181.48	0.01
SilverCreek	903	23.21	181.29	23.22	181.29	0	25.47	181.43	25.68	181.45	0.02
SilverCreek	875	Culvert		Culvert			Culvert		Culvert		
SilverCreek	858	23.21	180.87	23.22	180.87	0	25.47	180.91	25.68	180.91	0
SilverCreek	808	23.21	180.68	23.22	180.68	0	25.47	180.71	25.68	180.71	0
SilverCreek	669	23.21	180.45	23.22	180.45	0	25.47	180.46	25.68	180.46	0
SilverCreek	562	23.21	180.11	23.22	180.11	0	25.47	180.13	25.68	180.13	0
SilverCreek	530	23.21	179.93	23.22	179.93	0	25.47	179.95	25.68	179.96	0.01
SilverCreek	435	23.21	179.12	23.22	179.12	0	25.47	179.13	25.68	179.14	0.01
SilverCreek	348	23.21	178.15	23.22	178.15	0	25.47	178.16	25.68	178.17	0.01
SilverCreek	273	23.21	178.05	23.22	178.05	0	25.47	178.06	25.68	178.06	0
SilverCreek	171	23.21	178.01	23.22	178.01	0	25.47	178.01	25.68	178.01	0
SilverCreek	52	23.21	178	23.22	178	0	25.47	178	25.68	178	0
Bridgewater	1478	1	185.76	1	185.76	0	1	185.7	1	185.7	0
Bridgewater	1394	1	185.33	1	185.33	0	1	185.41	1	185.43	0.02
Bridgewater	1349	1.12	184.72	1.12	184.72	0	6.64	184.78	8.08	184.8	0.02
Bridgewater	1310	4.01	183.64	4.02	183.63	-0.01	13.56	183.84	16.45	183.87	0.03
Bridgewater	1200	13.34	183.36	13.36	183.36	0	39	183.57	39.14	183.56	-0.01
Bridgewater	1135	13.34	183.15	13.36	183.15	0	40.87	183.36	39.22	183.35	-0.01
Bridgewater	1069	13.34	182.65	13.36	182.65	0	42.6	182.81	40.1	182.8	-0.01
Bridgewater	1006	13.41	182.16	13.42	182.15	-0.01	43.2	182.35	40.47	182.33	-0.02
Bridgewater	936	13.49	181.91	13.51	181.93	0.02	41.49	182.11	38.14	182.1	-0.01
Bridgewater	840	22.27	181.07	22.26	181.04	-0.03	53.32	181.18	53.07	181.18	0
Bridgewater	740	22.29	180.25	22.28	180.3	0.05	53.53	180.65	53.32	180.89	0.24
Bridgewater	685	22.29	180.1	22.28	180.23	0.13	53.53	180.59	53.32	180.87	0.28
Bridgewater	670	Lat Struct		Lat Struct			Lat Struct		Lat Struct		
Bridgewater	660	9.58	180.08	6.5	180.22	0.14	29.65	180.58	21.64	180.87	0.29
Bridgewater	636	9.58	180.07	6.5	180.22	0.15	29.65	180.58	21.64	180.87	0.29
Bridgewater	606	9.58	180.05	6.5	180.22	0.17	29.65	180.57	21.64	180.87	0.3
Bridgewater	588	9.58	180.04	6.5	180.22	0.18	29.65	180.56	21.64	180.86	0.3
Bridgewater	572	9.58	180.03	6.5	180.21	0.18	29.65	180.55	21.64	180.86	0.31
Bridgewater	545	9.58	180	6.5	180.21	0.21	29.65	180.53	21.64	180.86	0.33
Bridgewater	520	9.58	179.84	6.5	180.19	0.35	29.65	180.41	21.64	180.83	0.42
Bridgewater	500	Culvert		Culvert			Culvert		Culvert		
Bridgewater	475	9.58	179.82	6.5	179.74	-0.08	29.65	180.15	21.64	180.02	-0.13
Bridgewater	446	9.58	179.71	6.5	179.63	-0.08	29.65	180.08	21.64	179.95	-0.13
Bridgewater	428	9.58	179.57	6.5	179.45	-0.12	29.65	179.93	21.64	179.8	-0.13
Bridgewater	420	Lat Struct		Lat Struct			Lat Struct		Lat Struct		
Bridgewater	416	5.09	179.56	2.14	179.46	-0.1	23.31	179.91	15.8	179.79	-0.12
Bridgewater	381	5.09	179.56	2.14	179.46	-0.1	23.31	179.89	15.8	179.77	-0.12
Bridgewater	367	5.09	179.56	2.14	179.46	-0.1	23.31	179.87	15.8	179.76	-0.11
Bridgewater	361	5.09	179.54	2.14	179.46	-0.08	23.31	179.79	15.8	179.71	-0.08
Bridgewater	352	5.09	179.51	2.14	179.42	-0.09	23.31	179.76	15.8	179.67	-0.09
Bridgewater	231	5.09	178.94	2.14	178.8	-0.14	23.31	179.33	15.8	179.21	-0.12
Bridgewater	192	5.09	178.9	2.14	178.77	-0.13	23.31	179.28	15.8	179.16	-0.12
Bridgewater	150	5.09	178.84	2.14	178.73	-0.11	23.31	179.19	15.8	179.08	-0.11
Bridgewater	110	5.09	178.74	2.14	178.64	-0.1	23.31	179	15.8	178.92	-0.08
Bridgewater	65	5.09	178.64	2.14	178.57	-0.07	23.31	178.88	15.8	178.8	-0.08
Bridgewater	11	5.09	178.57	2.14	178.51	-0.06	23.31	178.8	15.8	178.72	-0.08

Silver Creek - Existing Conditions, 50% blocked for sensitivity analysis

HEC-RAS Plan: SC50%B

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek	1971	Regional	78.00	186.50	188.00	187.63	188.03	0.002734	1.02	133.26	213.83	0.36
SilverCreek	1971	100-year	44.50	186.50	187.80	187.53	187.82	0.002314	0.86	93.22	192.55	0.32
SilverCreek	1931	Regional	78.00	186.00	187.51	187.51	187.60	0.007383	1.96	131.50	578.18	0.69
SilverCreek	1931	100-year	44.50	186.00	187.44	187.44	187.52	0.005214	1.62	90.36	568.95	0.59
SilverCreek	1848	Regional	78.00	184.79	187.43		187.43	0.000075	0.30	524.93	800.30	0.07
SilverCreek	1848	100-year	44.50	184.79	187.29		187.29	0.000045	0.22	416.15	797.86	0.05
SilverCreek	1835	Regional	78.00	184.66	187.43	186.76	187.43	0.000068	0.26	552.29	804.80	0.06
SilverCreek	1835	100-year	44.50	184.66	187.29	186.25	187.29	0.000039	0.19	443.14	800.84	0.05
SilverCreek	1820		Bridge									
SilverCreek	1810	Regional	78.00	184.41	186.46		186.52	0.003063	1.60	110.00	426.43	0.40
SilverCreek	1810	100-year	44.50	184.41	186.18	186.13	186.31	0.005270	1.84	47.72	163.61	0.51
SilverCreek-Lowe	1798	Regional	78.00	184.33	186.33	186.22	186.46	0.003744	1.88	76.28	193.97	0.46
SilverCreek-Lowe	1798	100-year	44.50	184.33	186.15	185.49	186.25	0.002803	1.51	45.22	143.09	0.39
SilverCreek-Lowe	1744	Regional	78.00	184.00	185.97	185.97	186.17	0.008001	3.12	59.80	119.16	0.71
SilverCreek-Lowe	1744	100-year	44.50	184.00	185.62	185.36	185.95	0.011180	3.23	19.62	17.26	0.81
SilverCreek-Lowe	1730		Lat Struct									
SilverCreek-Lowe	1674	Regional	62.99	183.52	185.33	185.33	185.49	0.006791	2.71	55.49	127.03	0.65
SilverCreek-Lowe	1674	100-year	41.71	183.52	185.21	185.21	185.36	0.005601	2.36	41.79	111.81	0.58
SilverCreek-Lowe	1516	Regional	39.86	182.32	183.93	183.93	184.17	0.006861	2.52	28.96	82.45	0.64
SilverCreek-Lowe	1516	100-year	32.14	182.32	183.66	183.52	184.04	0.011735	2.92	13.71	26.82	0.81
SilverCreek-Lowe	1425	Regional	39.78	181.89	183.46	182.94	183.58	0.003334	1.72	38.09	109.76	0.44
SilverCreek-Lowe	1425	100-year	32.14	181.89	183.41	182.80	183.50	0.002762	1.52	32.16	100.41	0.40
SilverCreek-Lowe	1313	Regional	39.14	181.52	183.10	182.83	183.18	0.003660	1.82	47.98	113.45	0.46
SilverCreek-Lowe	1313	100-year	32.14	181.52	182.97	182.60	183.08	0.005224	2.06	34.24	96.21	0.55
SilverCreek-Lowe	1155	Regional	38.36	180.70	182.28	181.94	182.47	0.005386	2.20	29.49	61.64	0.56
SilverCreek-Lowe	1155	100-year	32.08	180.70	182.30	181.83	182.42	0.003451	1.78	30.80	62.29	0.45
SilverCreek-Lowe	1037	Regional	43.73	180.38	181.82	181.82	181.89	0.004087	1.81	58.68	169.99	0.48
SilverCreek-Lowe	1037	100-year	31.59	180.38	181.78	181.78	181.91	0.005744	2.10	32.01	94.50	0.57
SilverCreek-Lowe	978	Regional	41.63	180.17	181.60	181.15	181.64	0.002065	1.28	64.52	111.49	0.34
SilverCreek-Lowe	978	100-year	30.81	180.17	181.48	181.05	181.51	0.002288	1.27	50.84	110.31	0.36
SilverCreek-Lowe	911	Regional	25.68	179.61	181.48	180.61	181.53	0.001167	1.15	52.82	114.43	0.27
SilverCreek-Lowe	911	100-year	23.22	179.61	181.30	180.55	181.37	0.001931	1.37	33.60	92.72	0.34
SilverCreek-Lowe	903	Regional	25.68	179.55	181.45	180.52	181.51	0.001348	1.23	28.86	147.68	0.29
SilverCreek-Lowe	903	100-year	23.22	179.55	181.29	180.47	181.35	0.001621	1.26	25.19	129.85	0.31
SilverCreek-Lowe	875		Culvert									
SilverCreek-Lowe	858	Regional	25.68	179.40	180.91		181.04	0.012068	1.77	17.17	192.70	0.50
SilverCreek-Lowe	858	100-year	23.22	179.40	180.87		180.98	0.011001	1.66	16.61	192.70	0.48
SilverCreek-Lowe	808	Regional	25.68	179.40	180.71		180.73	0.002673	0.83	53.32	827.91	0.24
SilverCreek-Lowe	808	100-year	23.22	179.40	180.68		180.70	0.002464	0.78	51.25	818.03	0.23
SilverCreek-Lowe	669	Regional	25.68	179.30	180.46		180.47	0.001478	0.53	150.82	600.41	0.17
SilverCreek-Lowe	669	100-year	23.22	179.30	180.45		180.45	0.001378	0.51	142.98	584.19	0.17
SilverCreek-Lowe	562	Regional	25.68	179.20	180.13		180.16	0.008032	1.14	60.34	393.57	0.40
SilverCreek-Lowe	562	100-year	23.22	179.20	180.11		180.15	0.008862	1.18	52.51	382.23	0.42
SilverCreek-Lowe	530	Regional	25.68	179.13	179.96		179.97	0.004399	0.73	64.79	225.97	0.28
SilverCreek-Lowe	530	100-year	23.22	179.13	179.93		179.95	0.004340	0.70	59.60	215.87	0.28
SilverCreek-Lowe	435	Regional	25.68	178.10	179.14	179.14	179.23	0.021854	1.86	35.96	194.83	0.64
SilverCreek-Lowe	435	100-year	23.22	178.10	179.12	179.12	179.21	0.021718	1.83	32.40	185.05	0.64
SilverCreek-Lowe	348	Regional	25.68	177.20	178.17		178.17	0.002230	0.62	90.80	232.43	0.21
SilverCreek-Lowe	348	100-year	23.22	177.20	178.15		178.15	0.002091	0.59	86.38	228.11	0.20
SilverCreek-Lowe	273	Regional	25.68	177.10	178.06		178.06	0.001735	0.52	115.39	358.52	0.18
SilverCreek-Lowe	273	100-year	23.22	177.10	178.05		178.05	0.001543	0.49	112.05	357.12	0.17
SilverCreek-Lowe	171	Regional	25.68	176.70	178.01		178.01	0.000238	0.25	246.69	540.49	0.07

HEC-RAS Plan: SC50%B (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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek-Lowe	171	100-year	23.22	176.70	178.01		178.01	0.000197	0.23	245.90	540.40	0.07
SilverCreek-Lowe	52	Regional	25.68	176.00	178.00	177.09	178.00	0.000039	0.13	466.31	625.00	0.03
SilverCreek-Lowe	52	100-year	23.22	176.00	178.00	177.07	178.00	0.000032	0.12	466.31	625.00	0.03

Bridgewater Creek - Existing Conditions, 50% blocked for sensitivity analysis

HEC-RAS Plan: SC50%B River: Bridgewater Reach: BW

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	1478	Regional	1.00	185.62	185.70	185.70	185.72	0.123459	0.58	1.71	43.26	0.94
BW	1478	100-year	1.00	185.62	185.76	185.70	185.76	0.006633	0.19	5.22	78.18	0.24
BW	1394	Regional	1.00	184.95	185.43	185.25	185.43	0.000361	0.08	12.69	81.06	0.06
BW	1394	100-year	1.00	184.95	185.33	185.25	185.33	0.003932	0.18	5.63	63.89	0.19
BW	1349	Regional	8.08	184.57	184.80	184.80	184.84	0.090495	0.89	9.13	97.53	0.92
BW	1349	100-year	1.12	184.57	184.72	184.72	184.73	0.187714	0.55	2.02	75.32	1.08
BW	1310	Regional	16.45	183.43	183.87	183.69	183.89	0.009846	0.68	24.14	72.33	0.38
BW	1310	100-year	4.02	183.43	183.63	183.55	183.65	0.011406	0.46	8.80	53.62	0.36
BW	1200	Regional	39.14	182.84	183.56		183.57	0.002031	0.36	110.23	268.96	0.18
BW	1200	100-year	13.36	182.84	183.36		183.36	0.001937	0.24	56.60	246.00	0.16
BW	1135	Regional	39.22	182.54	183.35		183.36	0.005421	0.47	83.51	279.82	0.27
BW	1135	100-year	13.36	182.54	183.15		183.16	0.006097	0.37	36.10	188.86	0.27
BW	1069	Regional	40.10	182.26	182.80		182.83	0.013272	0.70	57.13	205.14	0.42
BW	1069	100-year	13.36	182.26	182.65		182.66	0.009314	0.45	29.61	158.07	0.33
BW	1006	Regional	40.47	181.70	182.33		182.34	0.004971	0.44	92.06	319.04	0.26
BW	1006	100-year	13.42	181.70	182.15		182.16	0.007177	0.35	38.47	248.35	0.28
BW	936	Regional	38.14	181.50	182.10		182.11	0.002369	0.35	108.28	299.87	0.19
BW	936	100-year	13.51	181.50	181.93		181.93	0.001802	0.23	58.42	247.84	0.15
BW	840	Regional	53.07	180.50	181.18	181.18	181.27	0.075571	1.36	39.10	191.63	0.96
BW	840	100-year	22.26	180.50	181.04	181.04	181.12	0.094053	1.26	17.70	114.47	1.02
BW	740	Regional	53.32	179.49	180.89		180.90	0.000505	0.21	249.40	268.53	0.07
BW	740	100-year	22.28	179.49	180.30		180.30	0.002124	0.24	93.37	250.58	0.12
BW	685	Regional	53.32	179.36	180.87		180.87	0.000337	0.20	272.82	248.08	0.06
BW	685	100-year	22.28	179.36	180.23		180.23	0.000877	0.19	117.71	230.30	0.08
BW	670		Lat Struct									
BW	660	Regional	21.64	179.41	180.87		180.87	0.000051	0.08	283.42	255.27	0.02
BW	660	100-year	6.50	179.41	180.22		180.22	0.000060	0.05	125.44	228.64	0.02
BW	636	Regional	21.64	179.44	180.87	179.70	180.87	0.000057	0.08	280.25	269.17	0.02
BW	636	100-year	6.50	179.44	180.22	179.59	180.22	0.000089	0.06	111.05	226.96	0.03
BW	606	Regional	21.64	179.44	180.87	179.65	180.87	0.000044	0.08	285.36	326.98	0.02
BW	606	100-year	6.50	179.44	180.22	179.57	180.22	0.000049	0.05	133.92	305.50	0.02
BW	588	Regional	21.64	179.43	180.86		180.87	0.000138	0.12	186.75	190.21	0.04
BW	588	100-year	6.50	179.43	180.22		180.22	0.000113	0.08	86.55	146.02	0.03
BW	572	Regional	21.64	179.39	180.86		180.86	0.000117	0.13	171.49	135.97	0.04
BW	572	100-year	6.50	179.39	180.21		180.21	0.000106	0.08	84.64	131.15	0.03
BW	545	Regional	21.64	179.34	180.86		180.86	0.000230	0.17	128.73	108.68	0.05
BW	545	100-year	6.50	179.34	180.21		180.21	0.000271	0.11	58.88	106.57	0.05
BW	520	Regional	21.64	179.09	180.83	179.81	180.85	0.000743	0.55	39.47	102.07	0.15
BW	520	100-year	6.50	179.09	180.19	179.40	180.20	0.000485	0.30	21.61	99.39	0.11
BW	500		Culvert									
BW	475	Regional	21.64	178.92	180.02	179.60	180.02	0.000848	0.32	67.59	125.39	0.14
BW	475	100-year	6.50	178.92	179.74	179.25	179.75	0.002860	0.52	12.61	124.00	0.25
BW	446	Regional	21.64	178.80	179.95	179.55	179.97	0.005175	0.65	33.45	163.64	0.26
BW	446	100-year	6.50	178.80	179.63	179.18	179.64	0.004832	0.39	16.49	83.48	0.23
BW	428	Regional	21.64	178.74	179.80	179.60	179.86	0.005861	1.09	19.87	154.81	0.48
BW	428	100-year	6.50	178.74	179.45	179.31	179.50	0.013982	0.95	6.83	56.27	0.65
BW	420		Lat Struct									
BW	416	Regional	15.80	178.55	179.79		179.81	0.001813	0.71	22.38	34.12	0.28
BW	416	100-year	2.14	178.55	179.46		179.46	0.000205	0.18	12.05	28.44	0.09
BW	381	Regional	15.80	178.53	179.77		179.78	0.000317	0.43	37.04	32.52	0.13
BW	381	100-year	2.14	178.53	179.46		179.46	0.000016	0.08	27.07	31.13	0.03

HEC-RAS Plan: SC50%B River: Bridgewater Reach: BW (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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	367	Regional	15.80	178.77	179.76		179.78	0.000674	0.54	29.37	32.21	0.18
BW	367	100-year	2.14	178.77	179.46		179.46	0.000042	0.11	19.89	30.63	0.04
BW	361	Regional	15.80	178.90	179.71		179.76	0.004517	1.02	15.50	27.18	0.43
BW	361	100-year	2.14	178.90	179.46		179.46	0.000280	0.23	9.42	19.58	0.10
BW	352	Regional	15.80	179.30	179.67		179.70	0.009581	0.80	19.70	87.95	0.54
BW	352	100-year	2.14	179.30	179.42	179.42	179.45	0.035773	0.71	3.01	43.19	0.86
BW	231	Regional	15.80	178.15	179.21		179.23	0.002147	0.59	26.78	61.51	0.29
BW	231	100-year	2.14	178.15	178.80		178.81	0.001900	0.33	6.50	32.68	0.24
BW	192	Regional	15.80	178.14	179.16		179.17	0.001094	0.44	35.73	76.36	0.21
BW	192	100-year	2.14	178.14	178.77		178.77	0.000480	0.19	11.28	46.32	0.12
BW	150	Regional	15.80	178.48	179.08		179.10	0.002245	0.64	24.50	51.03	0.30
BW	150	100-year	2.14	178.48	178.73		178.74	0.001705	0.28	7.56	44.13	0.22
BW	110	Regional	15.80	178.37	178.92		178.96	0.006905	0.85	18.57	59.29	0.49
BW	110	100-year	2.14	178.37	178.64		178.65	0.002450	0.35	6.11	34.09	0.26
BW	65	Regional	15.80	178.27	178.80		178.81	0.001724	0.41	38.11	126.42	0.24
BW	65	100-year	2.14	178.27	178.57		178.57	0.001246	0.19	11.17	92.66	0.18
BW	11	Regional	15.80	178.25	178.72	178.52	178.73	0.001301	0.36	43.76	144.66	0.21
BW	11	100-year	2.14	178.25	178.51	178.38	178.51	0.001300	0.17	12.92	137.66	0.17

APPENDIX E.3

Sensitivity Analysis

Increased Downstream Boundary Condition Scenario

Table 3: Increased Downstream Boundary Condition Scenario (DSB=179)

Silver Creek HEC-RAS Output Table (DSB=179)

Bridgewater Creek HEC-RAS Output Table (DSB=179)

CROZIER CONSULTING ENGINEERS

PROJ. NO: 281-2769
PROJECT: Huntingwood East Lands
DESIGN: JE
FILE: Sensitivity Analysis
DATE: Mar 30, 2023

Table 3: Sensitivity Analysis - Increased Downstream Boundary Condition (+1m = 179)

		EXISTING CONDITIONS (Regional Storm)				
		DSBC=178		DSBC=179		
River	River Sta	Q Total (m3/s)	W.S. Elev (m)	Q Total (m3/s)	W.S. Elev (m)	Difference in WSE
SilverCreek	1971	78	188	78	188	0
SilverCreek	1931	78	187.51	78	187.51	0
SilverCreek	1848	78	187.43	78	187.43	0
SilverCreek	1835	78	187.43	78	187.43	0
SilverCreek	1820	Bridge		Bridge		
SilverCreek	1810	78	186.46	78	186.46	0
SilverCreek	1798	78	186.33	78	186.33	0
SilverCreek	1744	78	185.97	78	185.97	0
SilverCreek	1730	Lat Struct		Lat Struct		
SilverCreek	1674	65.81	185.34	65.81	185.34	0
SilverCreek	1516	40.36	183.95	40.36	183.95	0
SilverCreek	1425	38.13	183.45	38.13	183.45	0
SilverCreek	1313	36.71	183.05	36.71	183.05	0
SilverCreek	1155	35.69	182.22	35.69	182.22	0
SilverCreek	1037	39.7	181.82	39.7	181.82	0
SilverCreek	978	38.03	181.59	38.03	181.59	0
SilverCreek	911	25.47	181.47	25.47	181.47	0
SilverCreek	903	25.47	181.43	25.47	181.43	0
SilverCreek	875	Culvert		Culvert		
SilverCreek	858	25.47	180.91	25.47	180.91	0
SilverCreek	808	25.47	180.71	25.47	180.71	0
SilverCreek	669	25.47	180.46	25.47	180.46	0
SilverCreek	562	25.47	180.13	25.47	180.13	0
SilverCreek	530	25.47	179.95	25.47	179.95	0
SilverCreek	435	25.47	179.13	25.47	179.13	0
SilverCreek	348	25.47	178.16	25.47	179	0.84
SilverCreek	273	25.47	178.06	25.47	179	0.94
SilverCreek	171	25.47	178.01	25.47	179	0.99
SilverCreek	52	25.47	178	25.47	179	1.00
Bridgewater	1478	1	185.7	1	185.7	0
Bridgewater	1394	1	185.41	1	185.41	0
Bridgewater	1349	6.64	184.78	6.64	184.78	0
Bridgewater	1310	13.56	183.84	13.56	183.84	0
Bridgewater	1200	39	183.57	39	183.57	0
Bridgewater	1135	40.87	183.36	40.87	183.36	0
Bridgewater	1069	42.6	182.81	42.6	182.81	0
Bridgewater	1006	43.2	182.35	43.2	182.35	0
Bridgewater	936	41.49	182.11	41.49	182.11	0
Bridgewater	840	53.32	181.18	53.32	181.18	0
Bridgewater	740	53.53	180.65	53.53	180.65	0
Bridgewater	685	53.53	180.59	53.53	180.59	0
Bridgewater	670	Lat Struct		Lat Struct		
Bridgewater	660	29.65	180.58	29.65	180.58	0
Bridgewater	636	29.65	180.58	29.65	180.58	0
Bridgewater	606	29.65	180.57	29.65	180.57	0
Bridgewater	588	29.65	180.56	29.65	180.56	0
Bridgewater	572	29.65	180.55	29.65	180.55	0
Bridgewater	545	29.65	180.53	29.65	180.53	0
Bridgewater	520	29.65	180.41	29.65	180.41	0
Bridgewater	500	Culvert		Culvert		
Bridgewater	475	29.65	180.15	29.65	180.15	0
Bridgewater	446	29.65	180.08	29.65	180.08	0
Bridgewater	428	29.65	179.93	29.65	179.93	0
Bridgewater	420	Lat Struct		Lat Struct		
Bridgewater	416	23.31	179.91	23.31	179.91	0
Bridgewater	381	23.31	179.89	23.31	179.89	0
Bridgewater	367	23.31	179.87	23.31	179.87	0
Bridgewater	361	23.31	179.79	23.31	179.79	0
Bridgewater	352	23.31	179.76	23.31	179.76	0
Bridgewater	231	23.31	179.33	23.31	179.33	0
Bridgewater	192	23.31	179.28	23.31	179.28	0
Bridgewater	150	23.31	179.19	23.31	179.19	0
Bridgewater	110	23.31	179	23.31	179	0
Bridgewater	65	23.31	178.88	23.31	178.88	0
Bridgewater	11	23.31	178.8	23.31	178.8	0

Silver Creek - Existing Conditions, Increased Downstream Boundary Condition for sensitivity analysis

HEC-RAS Plan: SC1DSB179 Profile: Regional

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
SilverCreek	1971	Regional	78.00	186.50	188.00	187.63	188.03	0.002734	1.02	133.26	213.83	0.36
SilverCreek	1931	Regional	78.00	186.00	187.51	187.51	187.60	0.007383	1.96	131.50	578.18	0.69
SilverCreek	1848	Regional	78.00	184.79	187.43		187.43	0.000075	0.30	524.93	800.30	0.07
SilverCreek	1835	Regional	78.00	184.66	187.43	186.76	187.43	0.000068	0.26	552.29	804.80	0.06
SilverCreek	1820		Bridge									
SilverCreek	1810	Regional	78.00	184.41	186.46		186.52	0.003063	1.60	110.00	426.43	0.40
SilverCreek-Lowe	1798	Regional	78.00	184.33	186.33	186.22	186.46	0.003744	1.88	76.28	193.97	0.46
SilverCreek-Lowe	1744	Regional	78.00	184.00	185.97	185.97	186.17	0.008001	3.12	59.80	119.16	0.71
SilverCreek-Lowe	1730		Lat Struct									
SilverCreek-Lowe	1674	Regional	65.81	183.52	185.34	185.34	185.51	0.006780	2.73	57.51	128.02	0.65
SilverCreek-Lowe	1516	Regional	40.36	182.32	183.95	183.95	184.17	0.006501	2.47	30.32	83.83	0.62
SilverCreek-Lowe	1425	Regional	38.13	181.89	183.45	182.91	183.56	0.003206	1.68	36.92	106.52	0.43
SilverCreek-Lowe	1313	Regional	36.71	181.52	183.05	182.83	183.14	0.004222	1.92	42.99	112.34	0.50
SilverCreek-Lowe	1155	Regional	35.69	180.70	182.22	181.89	182.39	0.005230	2.11	25.87	56.19	0.55
SilverCreek-Lowe	1037	Regional	39.70	180.38	181.82	181.82	181.88	0.003368	1.64	58.68	169.99	0.44
SilverCreek-Lowe	978	Regional	38.03	180.17	181.59	181.15	181.62	0.001872	1.21	62.76	111.34	0.33
SilverCreek-Lowe	911	Regional	25.47	179.61	181.47	180.61	181.51	0.001225	1.17	50.86	111.03	0.27
SilverCreek-Lowe	903	Regional	25.47	179.55	181.43	180.52	181.50	0.001367	1.23	28.56	145.10	0.29
SilverCreek-Lowe	875		Culvert									
SilverCreek-Lowe	858	Regional	25.47	179.40	180.91		181.03	0.011980	1.76	17.12	192.70	0.50
SilverCreek-Lowe	808	Regional	25.47	179.40	180.71		180.73	0.002658	0.82	53.13	827.01	0.24
SilverCreek-Lowe	669	Regional	25.47	179.30	180.46		180.47	0.001471	0.53	150.13	599.00	0.17
SilverCreek-Lowe	562	Regional	25.47	179.20	180.13		180.16	0.008091	1.15	59.70	392.66	0.40
SilverCreek-Lowe	530	Regional	25.47	179.13	179.95		179.97	0.004397	0.72	64.35	225.12	0.28
SilverCreek-Lowe	435	Regional	25.47	178.10	179.13	179.13	179.23	0.021825	1.85	35.69	194.08	0.64
SilverCreek-Lowe	348	Regional	25.47	177.20	179.00		179.00	0.000051	0.15	363.40	445.27	0.04
SilverCreek-Lowe	273	Regional	25.47	177.10	179.00		179.00	0.000023	0.10	517.14	525.14	0.02
SilverCreek-Lowe	171	Regional	25.47	176.70	179.00		179.00	0.000006	0.06	807.35	580.03	0.01
SilverCreek-Lowe	52	Regional	25.47	176.00	179.00	177.09	179.00	0.000003	0.04	1116.15	675.00	0.01

Bridgewater Creek - Existing Conditions, Increased Downstream Boundary Condition for sensitivity analysis

HEC-RAS Plan: SC1DSB179 River: Bridgewater Reach: BW Profile: Regional

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
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
BW	1478	Regional	1.00	185.62	185.70	185.70	185.72	0.123459	0.58	1.71	43.26	0.94
BW	1394	Regional	1.00	184.95	185.41	185.25	185.41	0.000484	0.09	11.46	78.47	0.07
BW	1349	Regional	6.64	184.57	184.78	184.78	184.82	0.100604	0.85	7.82	96.28	0.95
BW	1310	Regional	13.56	183.43	183.84	183.66	183.86	0.008423	0.61	22.37	71.13	0.35
BW	1200	Regional	39.00	182.84	183.57		183.57	0.001933	0.35	111.69	269.34	0.17
BW	1135	Regional	40.87	182.54	183.36		183.37	0.005301	0.47	86.47	282.13	0.27
BW	1069	Regional	42.60	182.26	182.81		182.84	0.013742	0.72	58.82	206.79	0.43
BW	1006	Regional	43.20	181.70	182.35		182.36	0.004735	0.44	97.51	322.04	0.26
BW	936	Regional	41.49	181.50	182.11		182.12	0.002587	0.37	111.26	302.15	0.20
BW	840	Regional	53.32	180.50	181.18	181.18	181.27	0.075447	1.36	39.26	191.99	0.96
BW	740	Regional	53.53	179.49	180.65		180.66	0.001346	0.29	184.98	263.83	0.11
BW	685	Regional	53.53	179.36	180.59		180.60	0.000856	0.26	204.68	242.00	0.09
BW	670		Lat Struct									
BW	660	Regional	29.65	179.41	180.58		180.58	0.000248	0.14	211.09	250.42	0.05
BW	636	Regional	29.65	179.44	180.58	179.74	180.58	0.000306	0.15	202.48	264.13	0.05
BW	606	Regional	29.65	179.44	180.57	179.68	180.57	0.000209	0.14	215.83	322.07	0.05
BW	588	Regional	29.65	179.43	180.56		180.56	0.000522	0.22	137.84	150.39	0.07
BW	572	Regional	29.65	179.39	180.55		180.56	0.000548	0.23	129.71	134.01	0.07
BW	545	Regional	29.65	179.34	180.53		180.53	0.001244	0.32	93.22	107.61	0.11
BW	520	Regional	29.65	179.09	180.41	179.91	180.47	0.004521	1.08	27.58	100.29	0.35
BW	500		Culvert									
BW	475	Regional	29.65	178.92	180.15	179.77	180.16	0.000765	0.35	84.42	126.05	0.14
BW	446	Regional	29.65	178.80	180.08	179.64	180.11	0.005155	0.73	40.57	187.38	0.27
BW	428	Regional	29.65	178.74	179.93	179.68	180.00	0.005357	1.20	24.81	210.26	0.48
BW	420		Lat Struct									
BW	416	Regional	23.31	178.55	179.91		179.95	0.002336	0.87	26.66	35.66	0.32
BW	381	Regional	23.31	178.53	179.89		179.91	0.000509	0.57	40.85	33.04	0.16
BW	367	Regional	23.31	178.77	179.87		179.90	0.001029	0.71	32.90	32.78	0.23
BW	361	Regional	23.31	178.90	179.79		179.88	0.006614	1.33	17.57	27.54	0.53
BW	352	Regional	23.31	179.30	179.76		179.80	0.006999	0.81	28.91	101.21	0.48
BW	231	Regional	23.31	178.15	179.33		179.36	0.002234	0.67	34.67	67.47	0.30
BW	192	Regional	23.31	178.14	179.28		179.29	0.001175	0.52	45.10	80.48	0.22
BW	150	Regional	23.31	178.48	179.19		179.22	0.002582	0.78	30.01	52.48	0.33
BW	110	Regional	23.31	178.37	179.00		179.05	0.008010	0.98	23.74	68.32	0.53
BW	65	Regional	23.31	178.27	178.88		178.89	0.001720	0.48	48.38	127.88	0.25
BW	11	Regional	23.31	178.25	178.80	178.55	178.81	0.001301	0.42	55.57	146.70	0.22

APPENDIX F

Meander Belt Calculations

Meander Belt Analysis

Parish Geomorphic - Meander Belt Width Assessment Technical Review

CROZIER & ASSOCIATES ENGINEERS

Project:	Huntingwood Development
Project No.:	281-2769
File:	Meander Belt
Design by:	JMP / NM
Date:	January 23, 2009
Updated:	January 2011

HUNTINGWOOD - MEANDER BELT ANALYSIS

Reach Characteristics

Reach # 1

Upper Elevation	181.45 m	Entrenchment Ratio	31.3
Lower Elevation	179.85 m	Width / Depth Ratio	5.3
Reach Length	285 m	Sinuosity	1.05
Channel Length	298 m	Valley Slope	0.0056
Bankfull Channel Width	6.4 m	Channel Slope	0.0054
Bankfull Channel Depth	1.2 m		
Flood Prone Width	200 m		

Rosgen Classification **E**

Meander Belt Width $\Gamma = AW_b^B$

Type E

A =	6.69	
B =	1.43	
W_b	6.4	m
Γ =	**95.1**	m

Reach # 2

Upper Elevation	183.85 m	Entrenchment Ratio	12.0
Lower Elevation	181.45 m	Width / Depth Ratio	3.8
Reach Length	284 m	Sinuosity	1.51
Channel Length	430 m	Valley Slope	0.0085
Bankfull Channel Width	7.5 m	Channel Slope	0.0056
Bankfull Channel Depth	2 m		
Flood Prone Width	90 m		

Rosgen Classification **E**

Meander Belt Width $\Gamma = AW_b^B$

Type E

A =	6.69	
B =	1.43	
W_b	7.5	m
Γ =	**119.3**	m

Reach # 3

Upper Elevation	185.5 m	Entrenchment Ratio	23.1
Lower Elevation	183.85 m	Width / Depth Ratio	4.6
Reach Length	163 m	Sinuosity	1.10
Channel Length	180 m	Valley Slope	0.0101
Bankfull Channel Width	6.5 m	Channel Slope	0.0092
Bankfull Channel Depth	1.4 m		
Flood Prone Width	150 m		

Rosgen Classification **E**

Meander Belt Width $\Gamma = AW_b^B$

Type E

A =	6.69	
B =	1.43	
W_b	6.5	m
Γ =	**97.3**	m

PARISH geomorphic

2500 Meadowpine Blvd.
Suite 200
Mississauga, ON L5N 6C4
Phone: (905) 877-9531
Fax: (905) 877-4143

July 20, 2011 PGL Ref: 01-11-48

Chris Crozier, P.Eng.
C.F.Crozier & Associates Inc
110 Pine Street
Collingwood, Ontario L9Y 2N9

Dear Chris,

RE: Huntingwood Trails – Meander Belt Width Assessment
Technical Review

As requested, I have reviewed the Natural Hazards Study for the proposed Huntingwood Trails development. Specifically, the review focused on the hazard assessment of Silver Creek. The hazards, in this context, include erosion and channel migration, which were assessed through a meander belt width procedure. The results of the meander belt width assessment were then applied, in conjunction with the regulatory floodplain, to determine the width and configuration of the corridor/valley of the creek for the development. In this instance, it appears that the meander belt width was the governing parameter and resulted in a corridor width varying from approximately 95m to 120m. While the resulting values are appropriate, it is worth noting that the approach and methods are not necessarily the standard, typical approach. First of all, the author divided Silver Creek into 3 reaches although the rational for the reach delineation was not provided. Additionally, although not noted, it is apparent from the maps that the creek had likely been altered in the past, as the downstream section Reach 1 had been straightened. However, subsequent discussions with the author revealed that more exhaustive analyses were completed including a historic evaluation of the creek.

The standard methodology for the meander belt width delineation normally relies on measurements from topographic mapping and aerial imagery, instead of empirical equations. In the case of Reach 1, the meander bend width of the unaltered reach (Reach 2) would be used as a surrogate for the downstream altered reach. However, the end result is appropriate as the author's approach produced a reasonable and conservative value. If the traditional approach was used, the meander belt width for Reach 2 would be

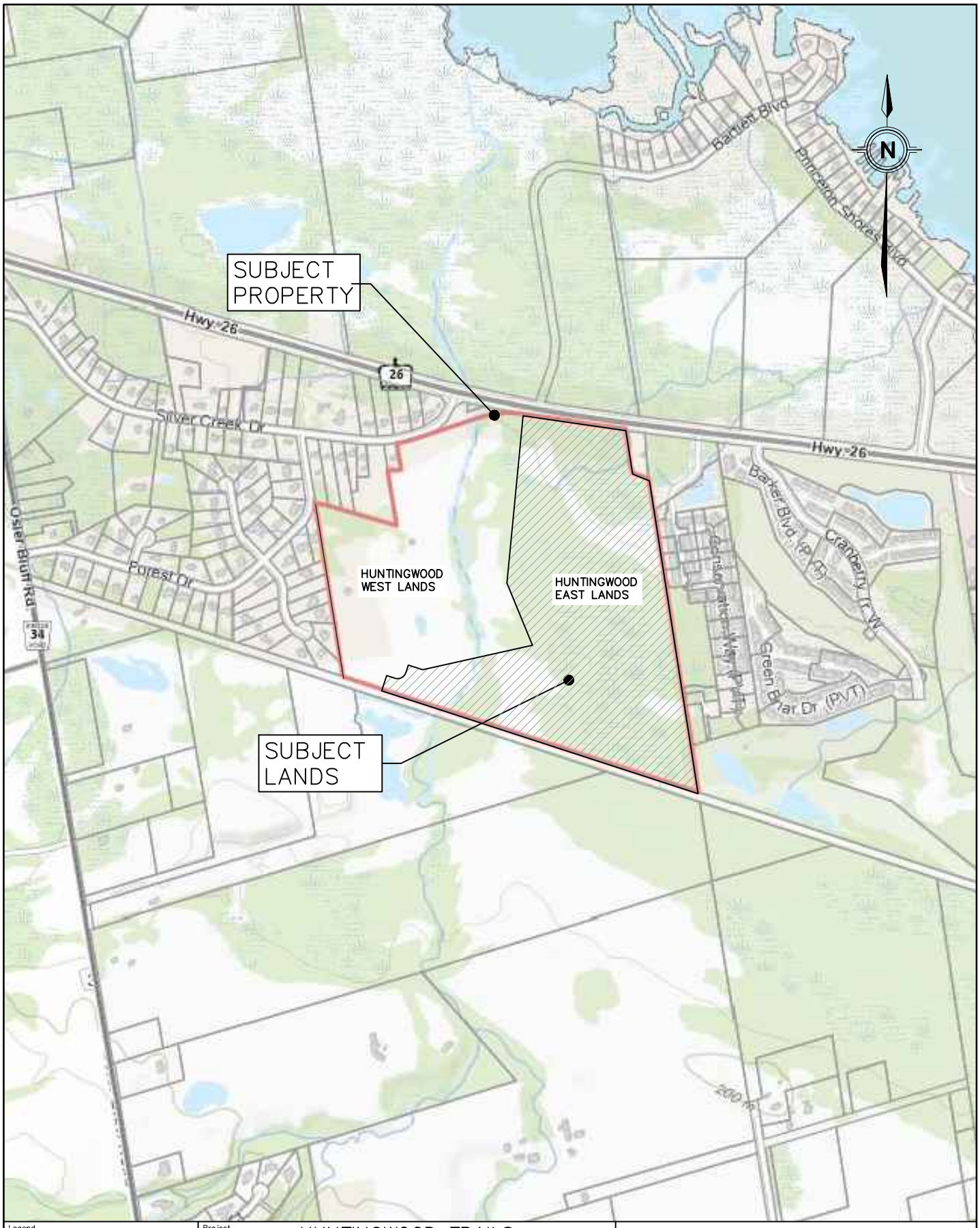
75m. A factor of safety /setback would then be applied, which would typically be 10% of the meander belt width on both sides, resulting in a final corridor width of 90m. This value would be used for both Reach 1 and Reach 2. The values presented by the author are 120m and 95 m, respectively. Thus, while the applied methods were not typical, they resulted in a conservative result that is appropriate for this site.

I trust you'll find this review to be beneficial and satisfactory for submission to the NVCA. If there any questions, please do not hesitate to call.

Respectfully submitted,

(digitally signed)
John Parish, M.A., P.Geo.
PARISH Geomorphic Ltd.

FIGURES



Legend

= SUBJECT LANDS

Project

HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

Drawing

SITE LOCATION

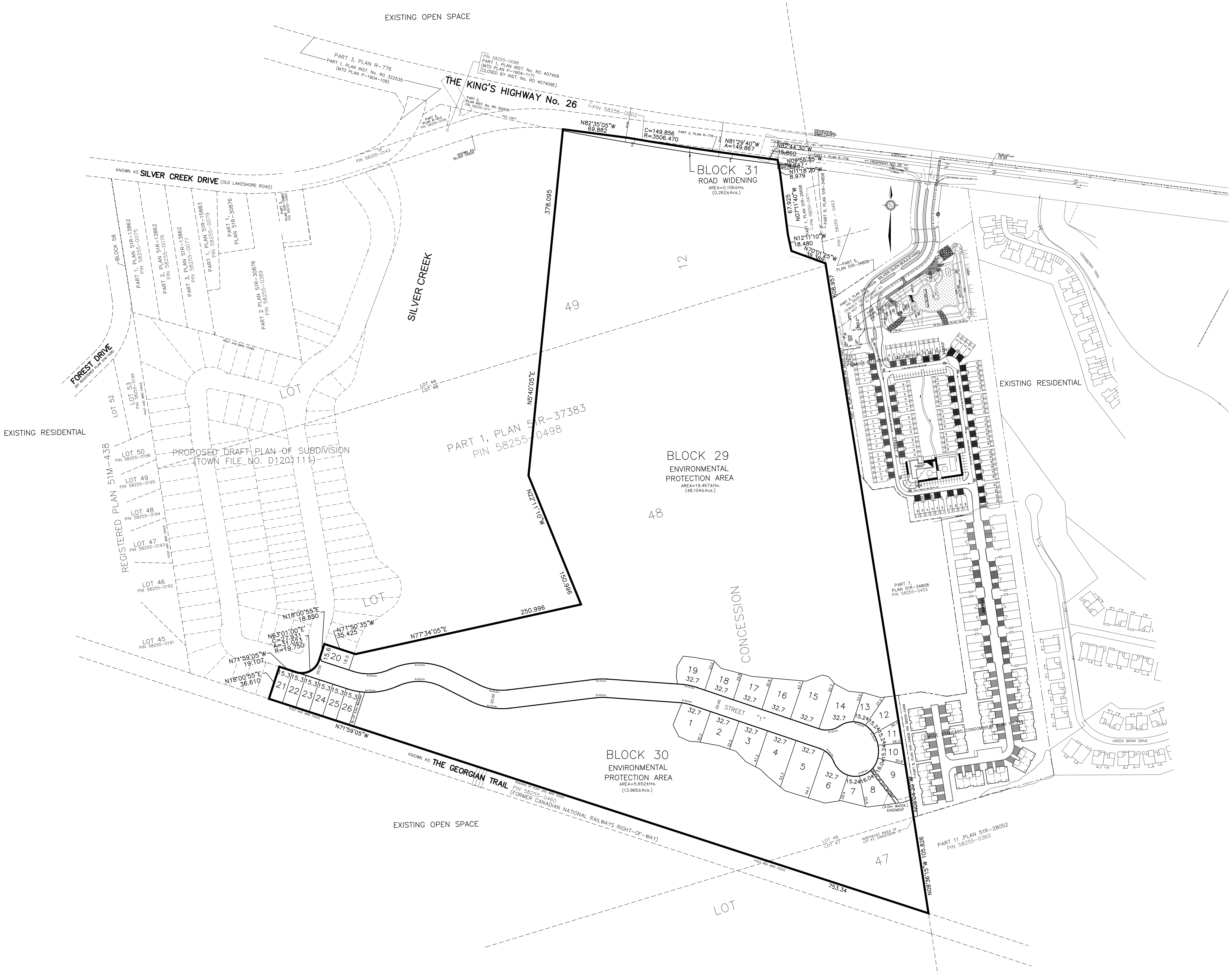
CROZIER CONSULTING ENGINEERS
Admiral Building
1 First Street, Suite 200
Collingwood, ON, L9Y 1A1
705-446-3510 T
705-446-3520 F
www.cfcrozier.ca
info@cfcrozier.ca

Drawn By	Design By	Project
P.N.R.	P.N.R.	281-2769

Scale	Date	Check By	Drawing
N.T.S.	03/30/2023	J.P.	FIG1

J:\200\281 - Huntingwood - Skelton Farm\2769\Cad_Civil_Sheets\2769_700 SITE LOCATION.dwg, FIG1, 2023-07-21 3:46:34 PM, tmills

DRAFT PLAN OF SUBDIVISION
PART OF LOTS 47, 48 AND 49, CONCESSION 12
TOWN OF COLLINGWOOD
(GEOGRAPHIC TOWNSHIP OF NOTTAWASAGA)
COUNTY OF SIMCOE



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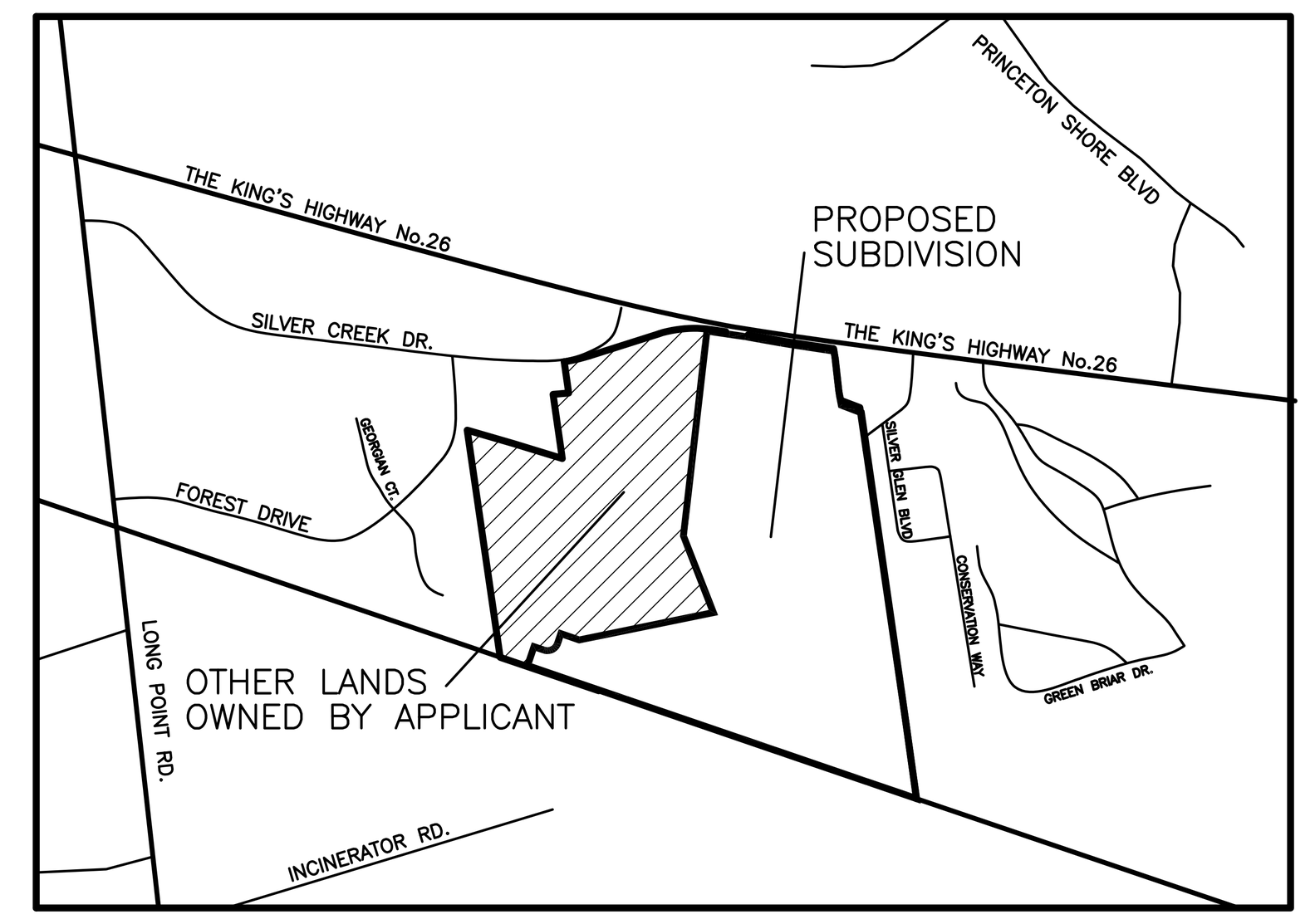


KEY PLAN

SCALE: NTS

SECTION 51, PLANNING ACT, ADDITIONAL INFORMATION

A. AS SHOWN ON DRAFT PLAN
B. AS SHOWN ON DRAFT PLAN
C. AS SHOWN ON DRAFT PLAN
D. SEE SCHEDULE OF LAND USE
E. AS SHOWN ON DRAFT PLAN
F. AS SHOWN ON DRAFT PLAN
F.1 NOT APPLICABLE
G. AS SHOWN ON DRAFT PLAN
H. MUNICIPAL PIPED WATER AVAILABLE AT TIME OF DEVELOPMENT
I. CLAY-LOAM
J. AS SHOWN ON DRAFT PLAN
K. SANITARY AND STORM SEWERS, GARBAGE COLLECTION, FIRE PROTECTION
L. AS SHOWN ON DRAFT PLAN

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED AS SHOWN ON THIS PLAN, AND THEIR RELATIONSHIP TO THE ADJACENT LAND ARE ACCURATELY AND CORRECTLY SHOWN.

DATE OCTOBER 6, 2022

DAN DZALDOV
SCHAEFFER DZALDOV PURCELL LTD.
ONTARIO LAND SURVEYORS
64 JARDIN DRIVE, UNIT 1
CONCORD, ONTARIO L4K 3P3
TEL: (416) 987-0101

OWNER'S CERTIFICATE

I AUTHORIZE KLM PLANNING PARTNERS INC. TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION TO THE TOWN OF COLLINGWOOD FOR APPROVAL.

OWNER

HUNTINGWOOD TRAILS (COLLINGWOOD) LTD.

152 DALEMOUNT AVENUE
TORONTO
ONTARIO
M6B 3C9

EDWARD WEISZ
A.S.O.

SCHEDULE OF LAND USE

TOTAL AREA OF LAND TO BE SUBDIVIDED = 29.163±Ha. (72.063±Acs.)

SINGLE DETACHED DWELLINGS	BLOCKS	LOTS	UNITS	±Ha.	±Acs.
LOTS 20–26 MIN. LOT FRONTAGE=15.3m. MIN LOT AREA=560sq.m.		7	7	0.400	0.988
SEMI-DETACHED DWELLINGS					
LOTS 7–13 MIN. LOT FRONTAGE=15.24m. MIN LOT AREA=528sq.m.		7	14	0.502	1.240
STREET TOWNHOUSES					
BLOCKS 1–6, & 14–19 MIN. FRONTAGE 8.1m. (END UNITS) MIN. FRONTAGE 6.7m. (INTERIOR UNITS)	12		48	1.571	3.882
SUBTOTAL	12	14	69	2.473	6.111
BLOCKS 27 and 28 – WALKWAY	2			0.043	0.106
BLOCKS 29 and 30 – ENVIRONMENTAL PROTECTION AREA	2			25.120	62.073
BLOCK 31 – ROAD WIDENING	1			0.106	0.262
STREET 20.0m. WIDE TOTAL LENGTH= 711±m. AREA= 1.421±Ha.				1.421	3.511
TOTAL	17	14	69	29.163	72.063

FIGURE 2

NOTE – ELEVATIONS RELATED TO CANADIAN GEODETIC DATUM

PROJECT No. P-3083

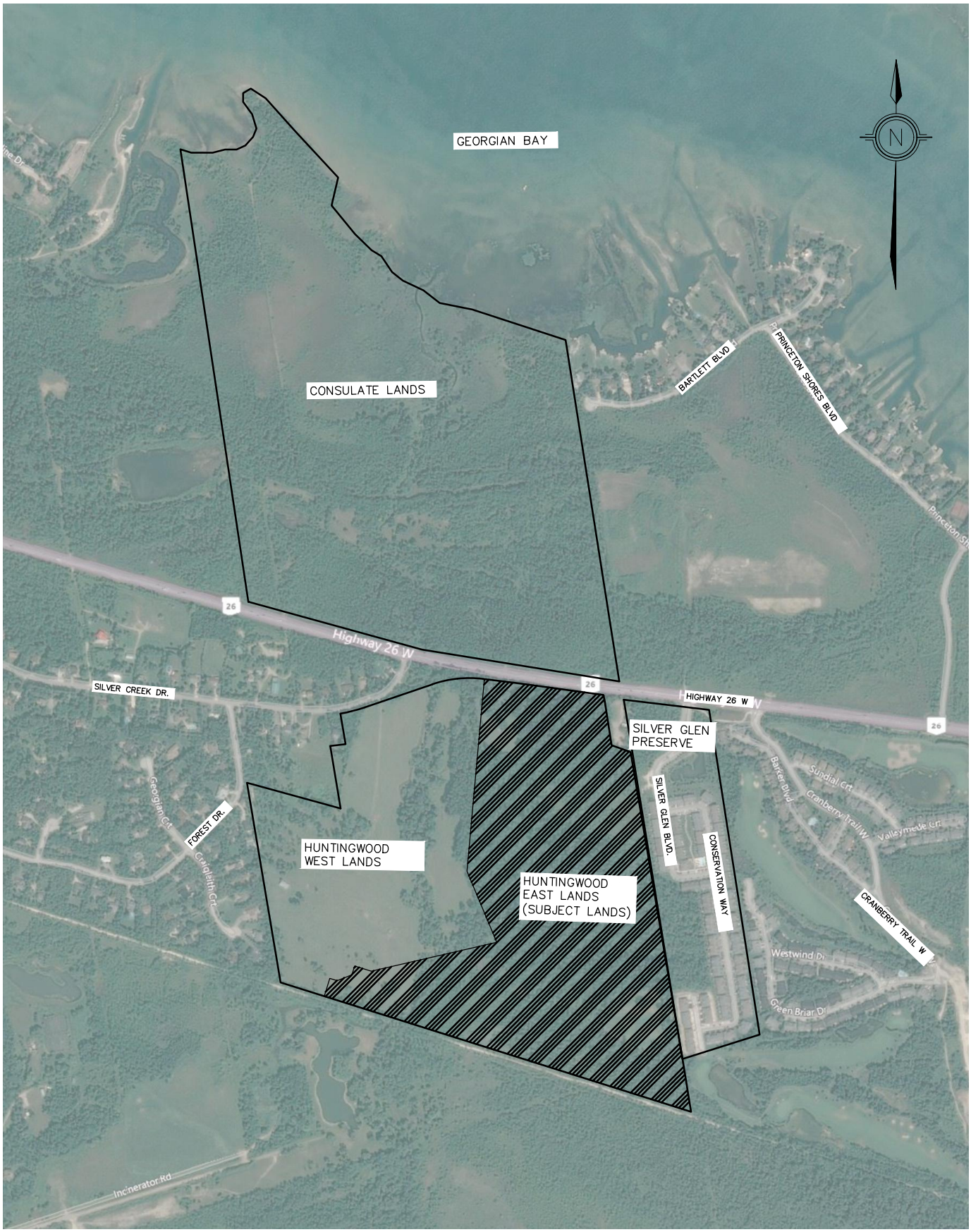
SCALE 1:1500 JANUARY 10, 2023

(3083(E)DES7) X-REF: (3083MAS5 & 3083TOPO1)

DWG. No. - 23:7

KLM PLANNING PARTNERS INC.
64 JARDIN DRIVE - UNIT 1B, CONCORD ONTARIO L4K 3P3
TEL: (905) 669-4055 FAX: (905) 669-0097 design@klmplanning.com

Planning • Design • Development



Legend

= SUBJECT LANDS

Project

HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

Drawing

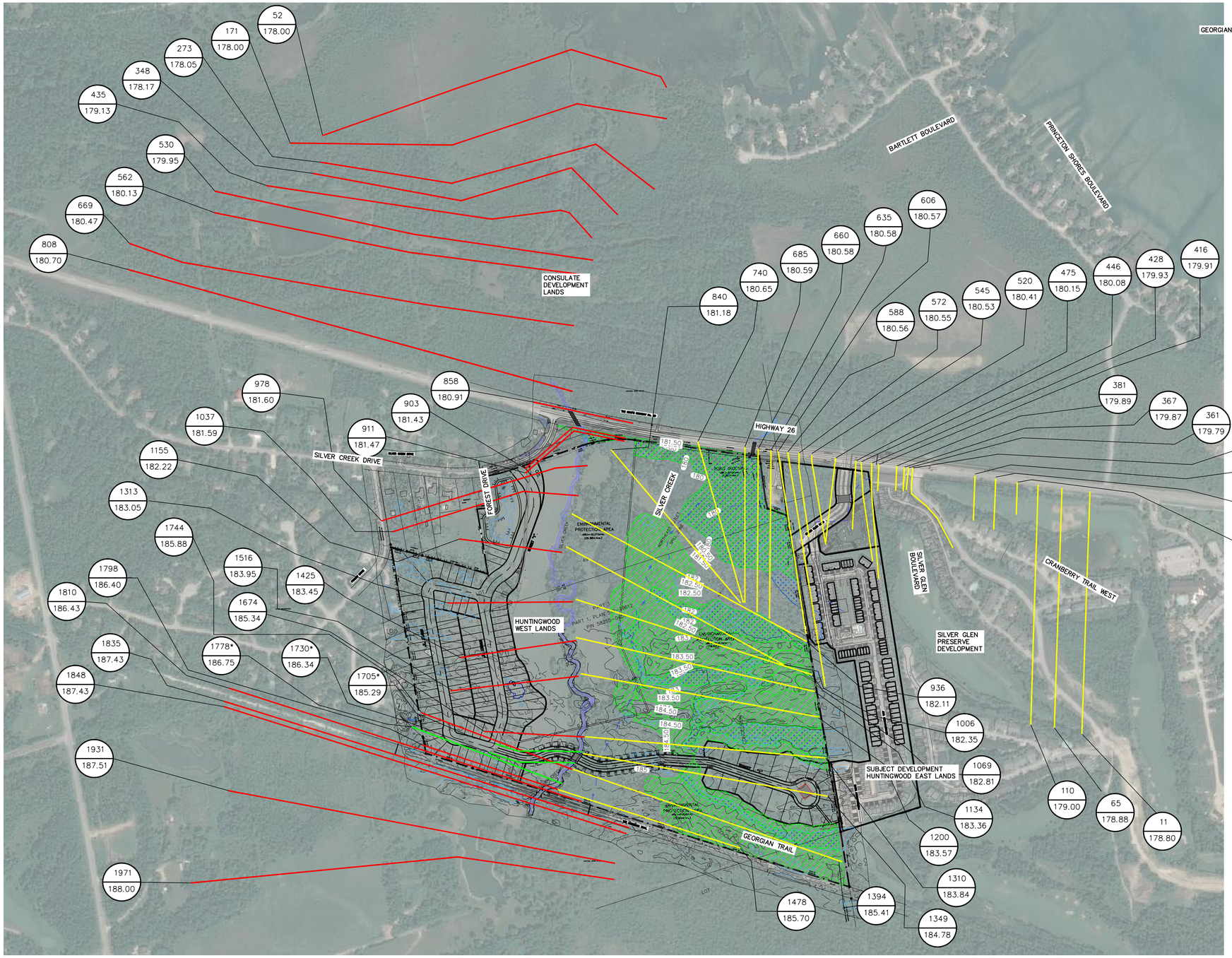
DEVELOPMENT LOCATIONS PLAN

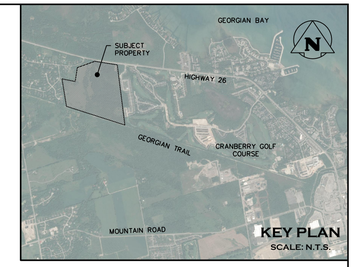
CROZIER
CONSULTING ENGINEERS

Drawn By	Design By	Project
T.M.	T.M.	281-2769

Scale	Date	Check By	Drawing
N.T.S.	11/08/2022	J.E.	FIG. 3

J:\200\281 - Huntingwood - Skelton Farm\2769\Cad_Civil_Sheets\FIGURES\East Land Submission\Development Locations Plan.dwg, 8.5x11, 2023-09-08 2:25:22 PM, je





LEGEND

- EXISTING WATERCOURSE
- HECRAS SECTION (SILVER CREEK)
- PROPOSED CROSS SECTION
- HEC-RAS SECTION (BRIDGEWATER CREEK)

HECRAS DATA
RIVER STATION — 102(*) — ASTERISK (*) DENOTES PROPOSED CROSS SECTION
REGIONAL WATER SURFACE ELEV. — 182.55

SCALE: 1:4000

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TEMPORARY BENCHMARKS

TBM#1–
TBM#2–
TBM#3–

***ADD REFERENCE TO SURVEY/SOURCE

Town

No.	ISSUE	DATE: MMM/DD/YYYY
1.	ISSUED FOR FIRST SUBMISSION FLOODPLAIN STUDY	7/21/2023

Engineer

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

Engineer

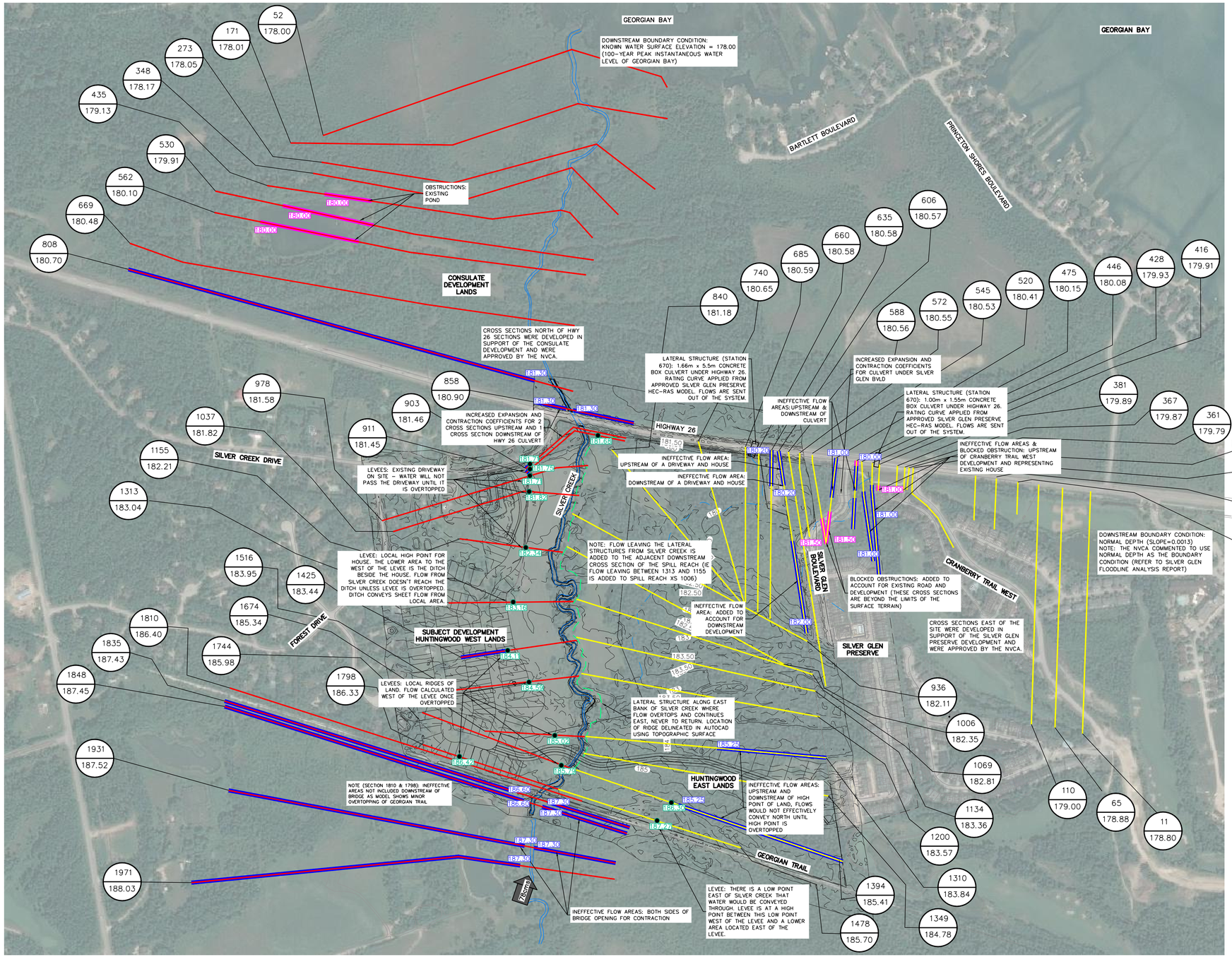
Project
HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

Drawing
HEC–RAS CROSS SECTION LOCATION PLAN

CROZIER CONSULTING ENGINEERS
ADMIRAL BUILDING
1 FIRST STREET, SUITE 200
COLLINGWOOD, ON, L9Y 1A1
705-446-3510 T
705-446-3520 F
WWW.CFCROZIER.CA
INFO@CFCROZIER.CA

Drawn By	Design By	Project
DE	DE	281–2769
Check By	Check By	Scale / Drawing
AW/JE	JP	1:4000 / FIG 3

J:\200\281 - Huntingwood - Skelton Farm\2769\Cad_Civil_Sheets\FIGURES\East Land Submission\2769-HECRAS Sections.dwg, FIG 3, 2023-07-21 3:55:22 PM, tmills



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TEMPORARY BENCHMARKS

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TBM#2-
TBM#3-

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Town

No.	ISSUE	DATE: MMM/DD/YYYY
1.	ISSUED FOR FIRST SUBMISSION FLOODPLAIN STUDY	7/21/2023

Engineer

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

Engineer

PROFESSIONAL ENGINEER PROVINCE OF ONTARIO

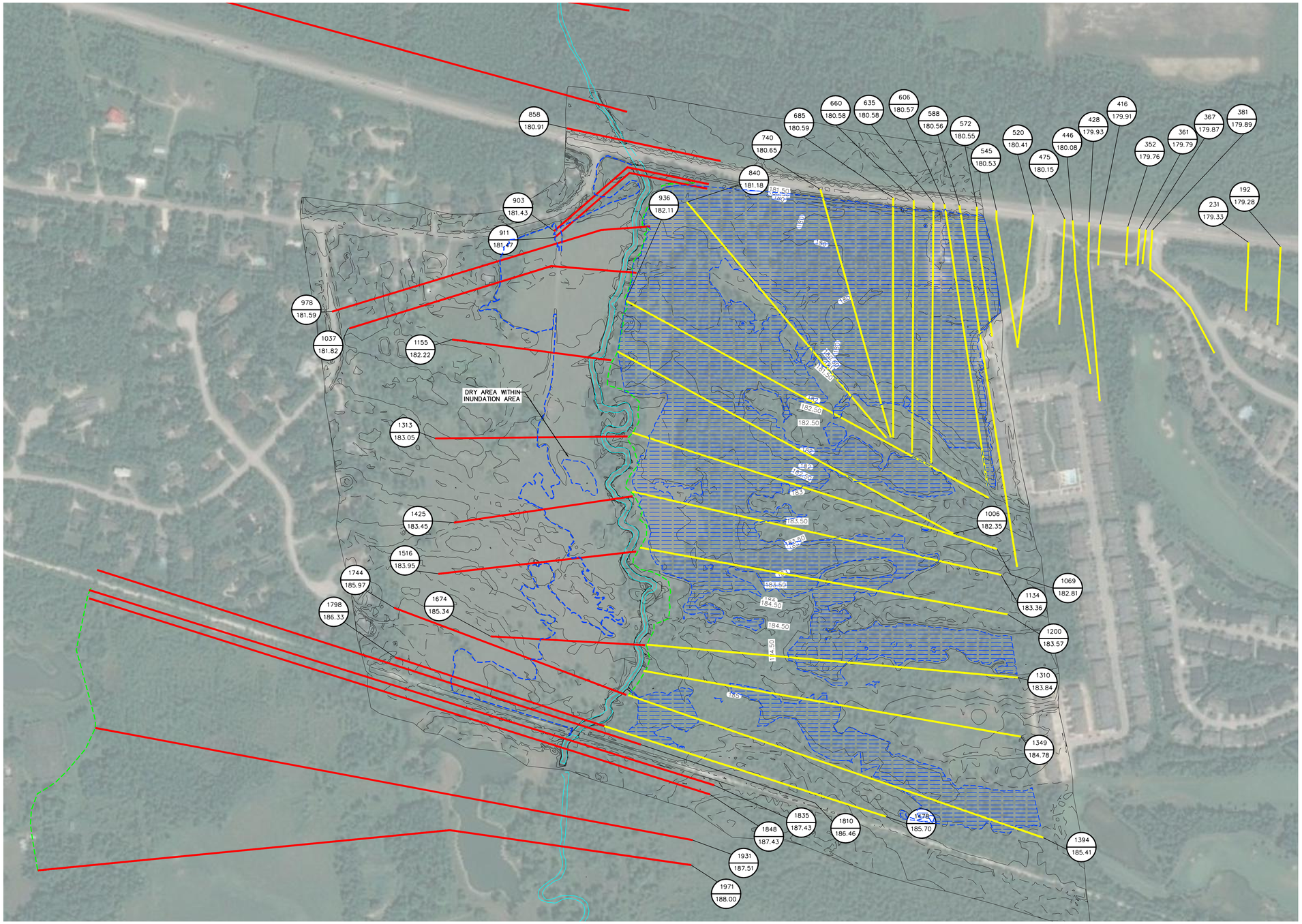
Project: HUNTINGWOOD TRAILS EAST DEVELOPMENT TOWN OF COLLINGWOOD

Drawing: HEC-RAS CROSS SECTION EXPLANATION PLAN EXISTING CONDITION

CROZIER CONSULTING ENGINEERS
ADMIRAL BUILDING
1 FIRST STREET, SUITE 200
COLLINGWOOD, ON, L9Y 1A1
705-446-3510 T
705-446-3520 F
WWW.CFCROZIER.CA
INFO@CFCROZIER.CA

Drawn By	Design By	Project	
DE	DE		281-2769
Check By	Check By	Scale	Drawing
AW/JE	JP	1: 4000	FIG 4

J:\200\281 - Huntingwood - Skelton Farm\2769\Cad_Civil_Sheets\FIGURES\East Land Submission\2769-HECRAS Sections Explanations EAST LANDS.dwg, FIG 4, 2023-07-25 2:32:18 PM, tmills



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TEMPORARY BENCHMARKS

TBM#1-
TBM#2-
TBM#3-

***ADD REFERENCE TO SURVEY/SOURCE

Town

No.	ISSUE	DATE: MMM/DD/YYYY
1.	ISSUED FOR FIRST SUBMISSION FLOODPLAIN STUDY	7/21/2023

Engineer

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

Engineer

PROFESSIONAL ENGINEERS PROVINCE OF ONTARIO

Project

HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

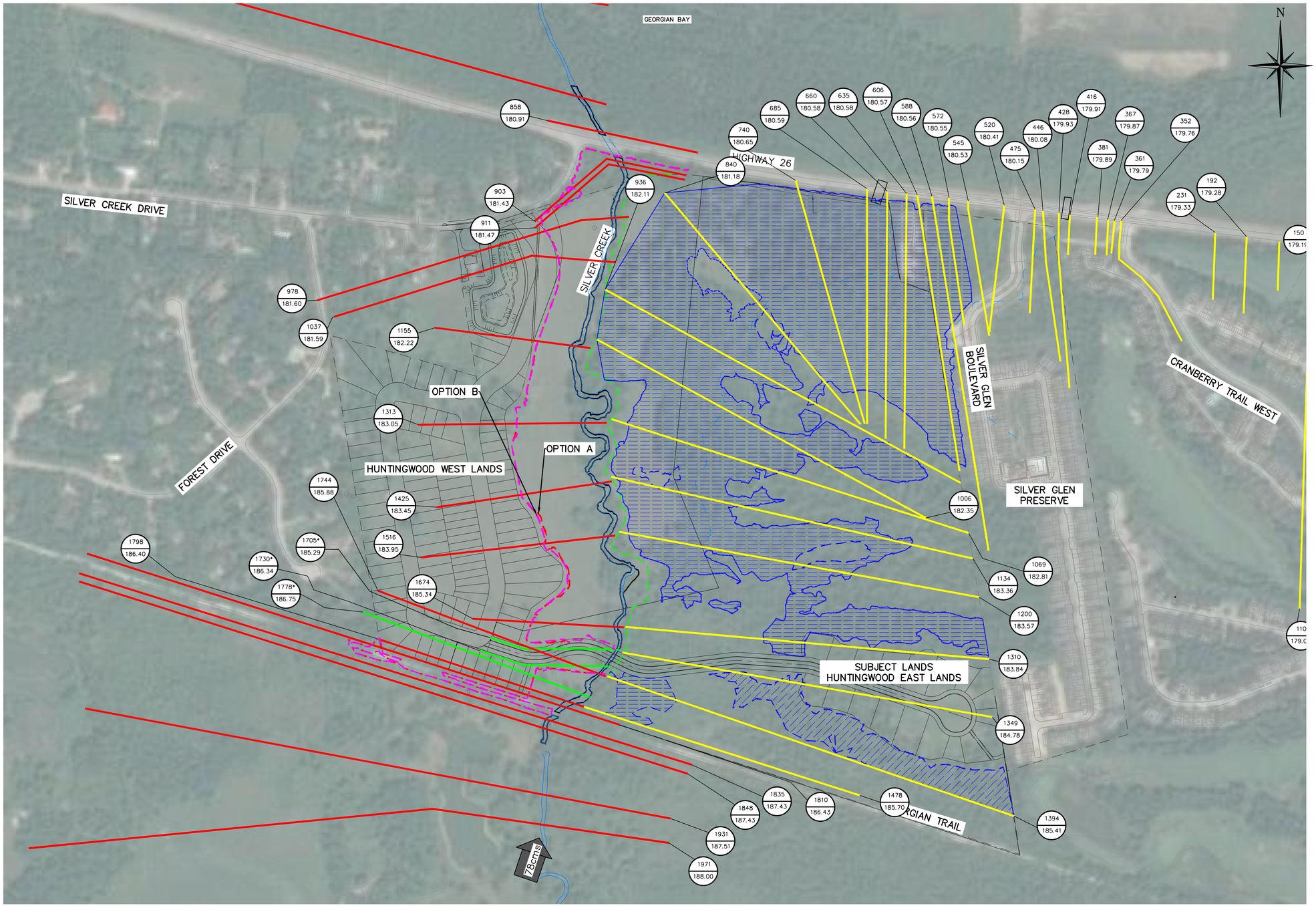
Drawing

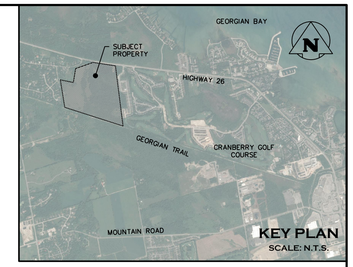
EXISTING CONDITIONS NATURAL HAZARDS

CROZIER CONSULTING ENGINEERS
ADMIRAL BUILDING
1 FIRST STREET, SUITE 200
COLLINGWOOD, ON, L9Y 1A1
705-446-3510 T
705-446-3520 F
WWW.CFCROZIER.CA
INFO@CFCROZIER.CA

Drawn By	Design By	Project	
DE	DE		281-2769
Check By	Check By	Scale	Drawing
AW/JE	JP	1: 4000	FIG 5

J:\200\281 - Huntingwood - Skelton Farm\2769\Cad_Civil_Sheets\FIGURES\East Land Submission\2769-EXISTING CONDITIONS NATURAL HAZARDS.dwg, Fig 5, 2023-07-25 2:45:52 PM, tmills





LEGEND

- EXISTING WATERCOURSE
- HECRAS SECTION (SILVER CREEK)
- HEC-RAS SECTION (BRIDGEWATER CREEK)
- PROPOSED HECRAS SECTION
- SPILL FLOW INTERFACE (LATERAL STRUCTURE)
- PROPOSED OPTION A FLOODLNE
- PROPOSED OPTION B FLOODLINE
- REGION FLOOD INUNDATION LIMIT

HECRAS DATA
RIVER STATION
REGIONAL WATER SURFACE ELEV.
102(*) / 182.55
ASTERISK (*) DENOTES PROPOSED CROSS SECTION

100 0m 100 200 300
SCALE: 1:4000

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PROFESSIONAL ENGINEERS PROVINCE OF ONTARIO

Project
HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

Drawing
PROPOSED CONDITIONS NATURAL HAZARDS

CROZIER CONSULTING ENGINEERS
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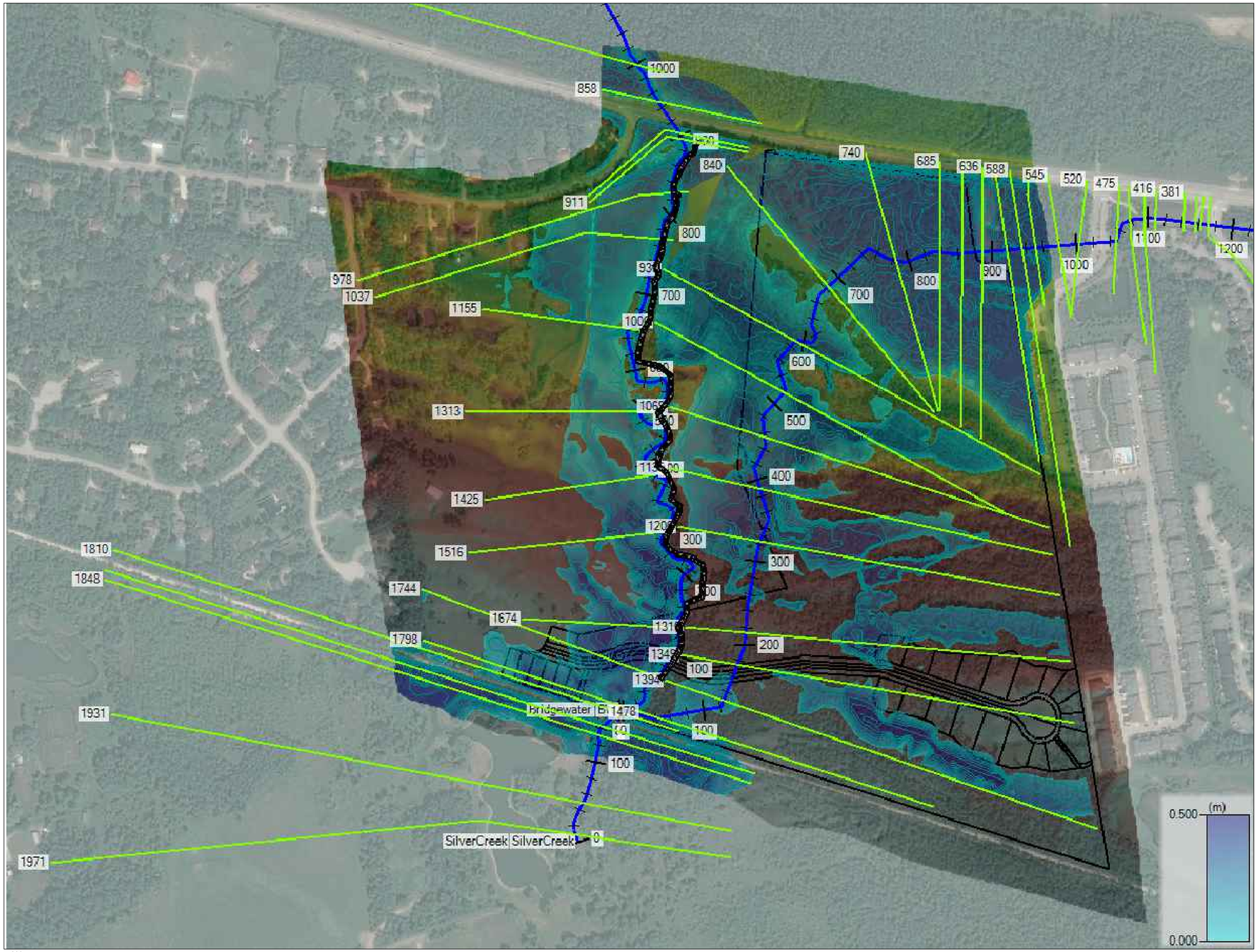
DE	DE	281–2769	AW/JE	JP	1: 4000	FIG 6

J:\200\281 - Huntingwood - Skelton Farm\2769\Cad_Civil_Sheets\FIGURES\East Land Submission\2769-PROPOSED CONDITION NATURAL HAZARDS.dwg, FIG 6, 2023-07-25 2:49:33 PM, tmills



N

50 0m 50 100 150 200

SCALE: 1:2500

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Project
HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

Drawing
RAS MAPPER OUTPUT REGIONAL
STORM: EXISTING CONDITIONS

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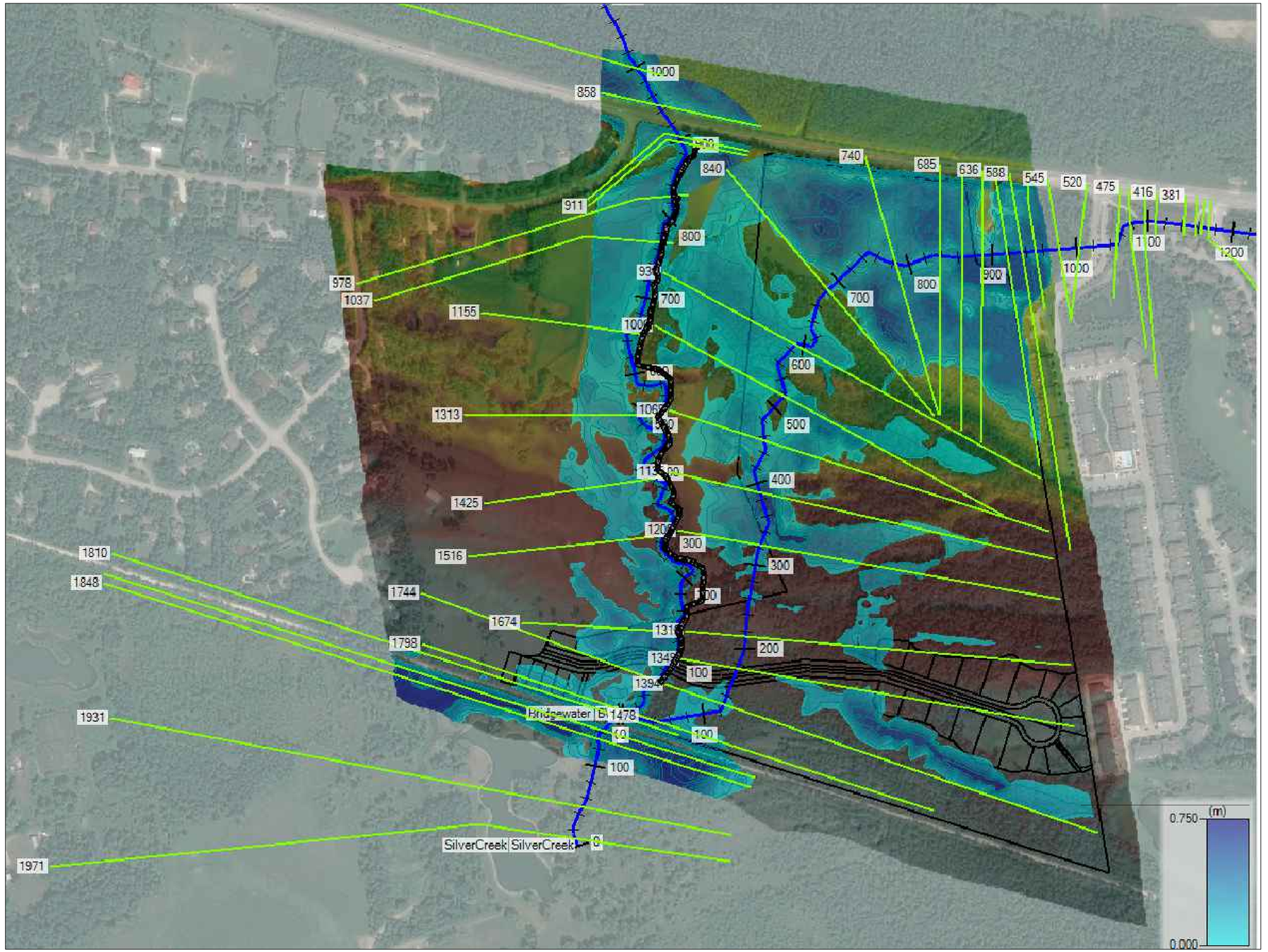
Check By	Check By	Scale	Drawing
J.P.	J.P.	1: 2500	FIG. 7



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Project
HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

Drawing
RAS MAPPER OUTPUT
100-YEAR: EXISTING CONDITIONS

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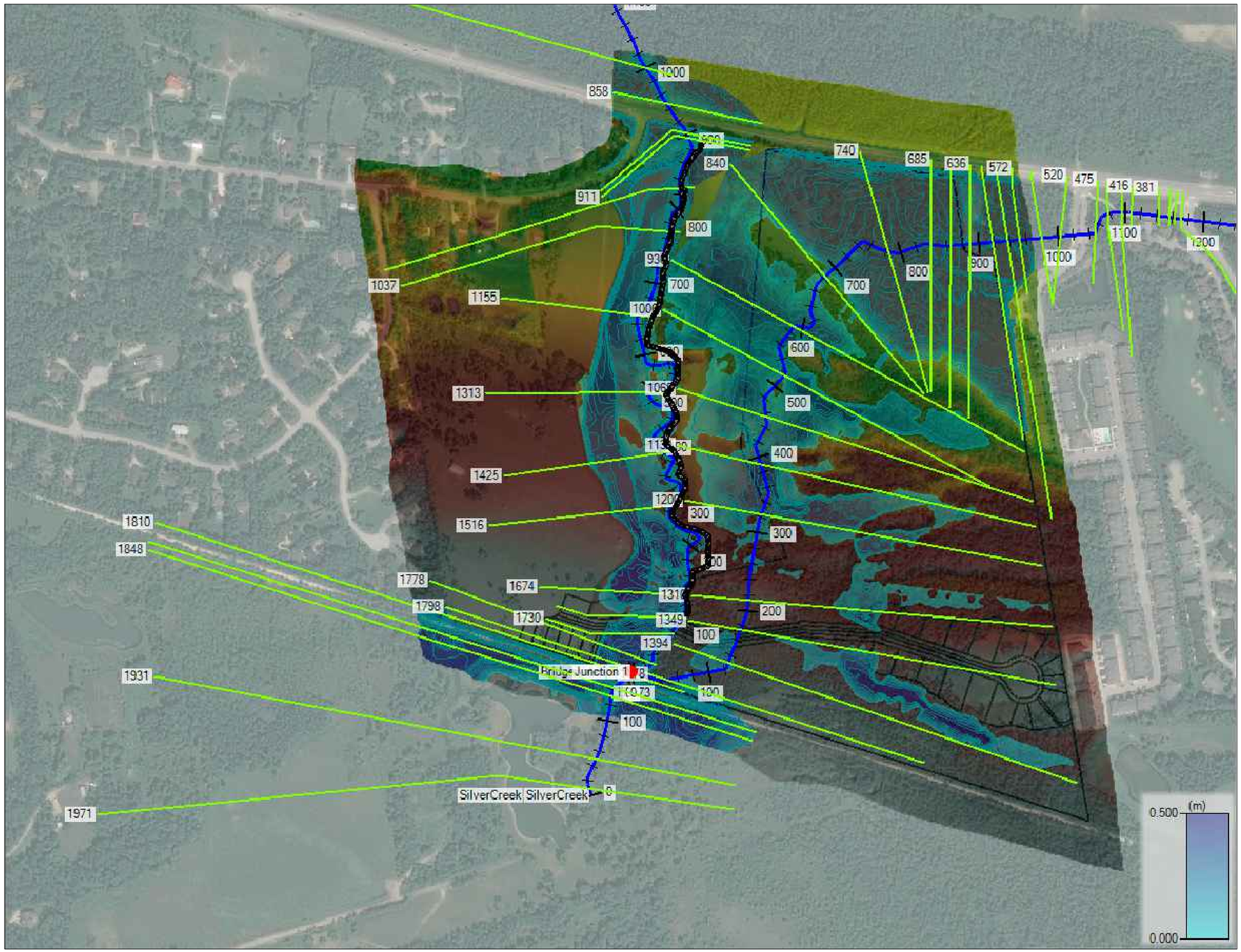
Check By	Check By	Scale	Drawing
J.P.	J.P.	1:2500	FIG. 8



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50 0m 50 100 150 200
SCALE: 1:2500

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Engineer

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Engineer

Project
HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

Drawing
RAS MAPPER OUTPUT REGIONAL STORM:
PROPOSED CONDITIONS – OPTION A

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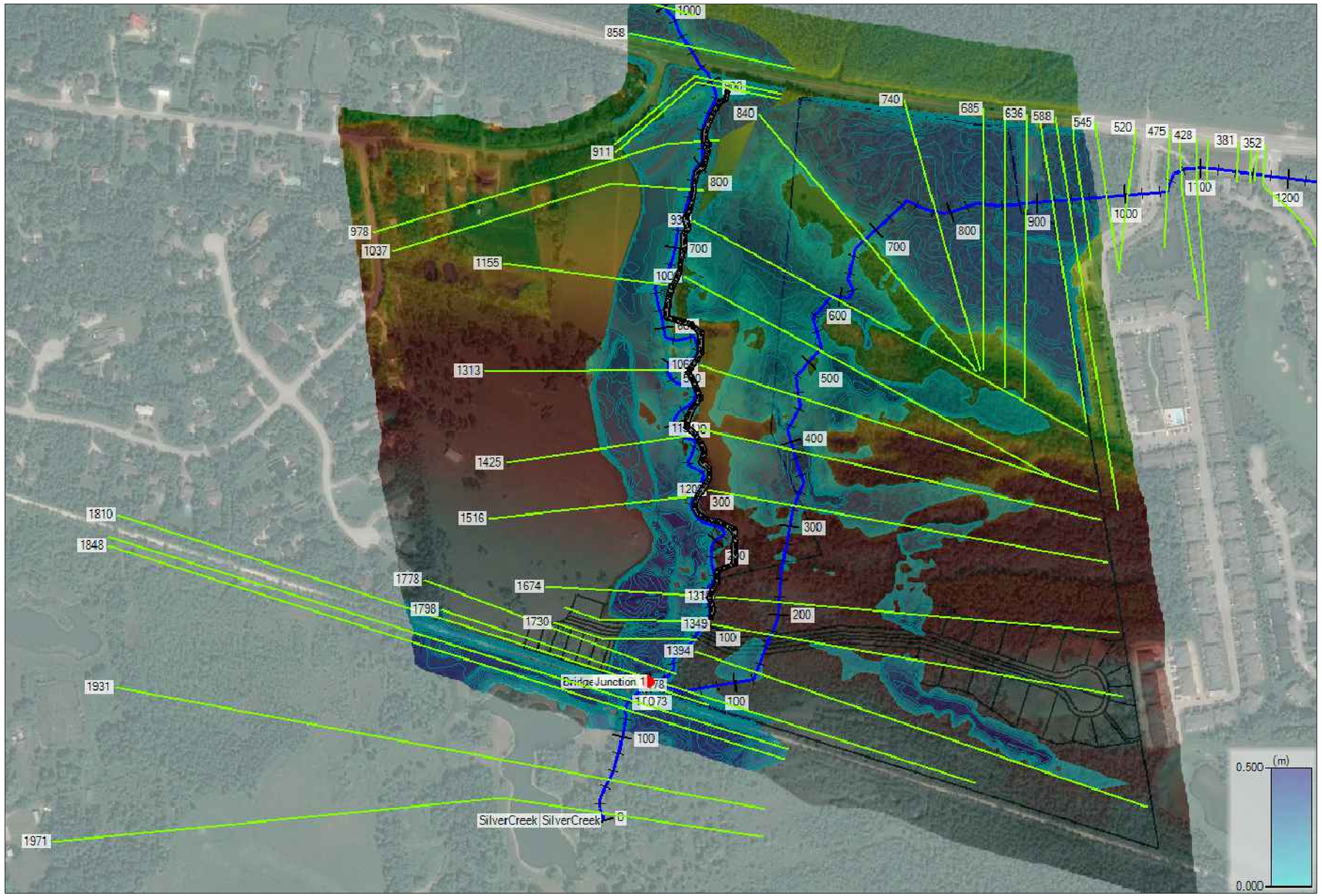
Drawn By	Design By	Project	
N.R./N.R.	P.N./P.N.		281–2769
Check By	Check By	Scale	Drawing
J.P.	J.P.	1: 2500	FIG. 9

J:\200\281 - Huntingwood - Skelton Farm\2769\Cad_Civil_Sheets\FIGURES\East Land Submission\RAS Mapping Fig.dwg, Fig. 9, 2023-07-21 4:07:08 PM, tmills



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50 0m 50 100 150 200
SCALE: 1:2500

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2	ISSUED FOR FIRST SUBMISSION FLOODPLAIN STUDY	07/21/2023

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Engineer

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Project
HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

Drawing
RAS MAPPER OUTPUT REGIONAL STORM:
PROPOSED CONDITION – OPTION B

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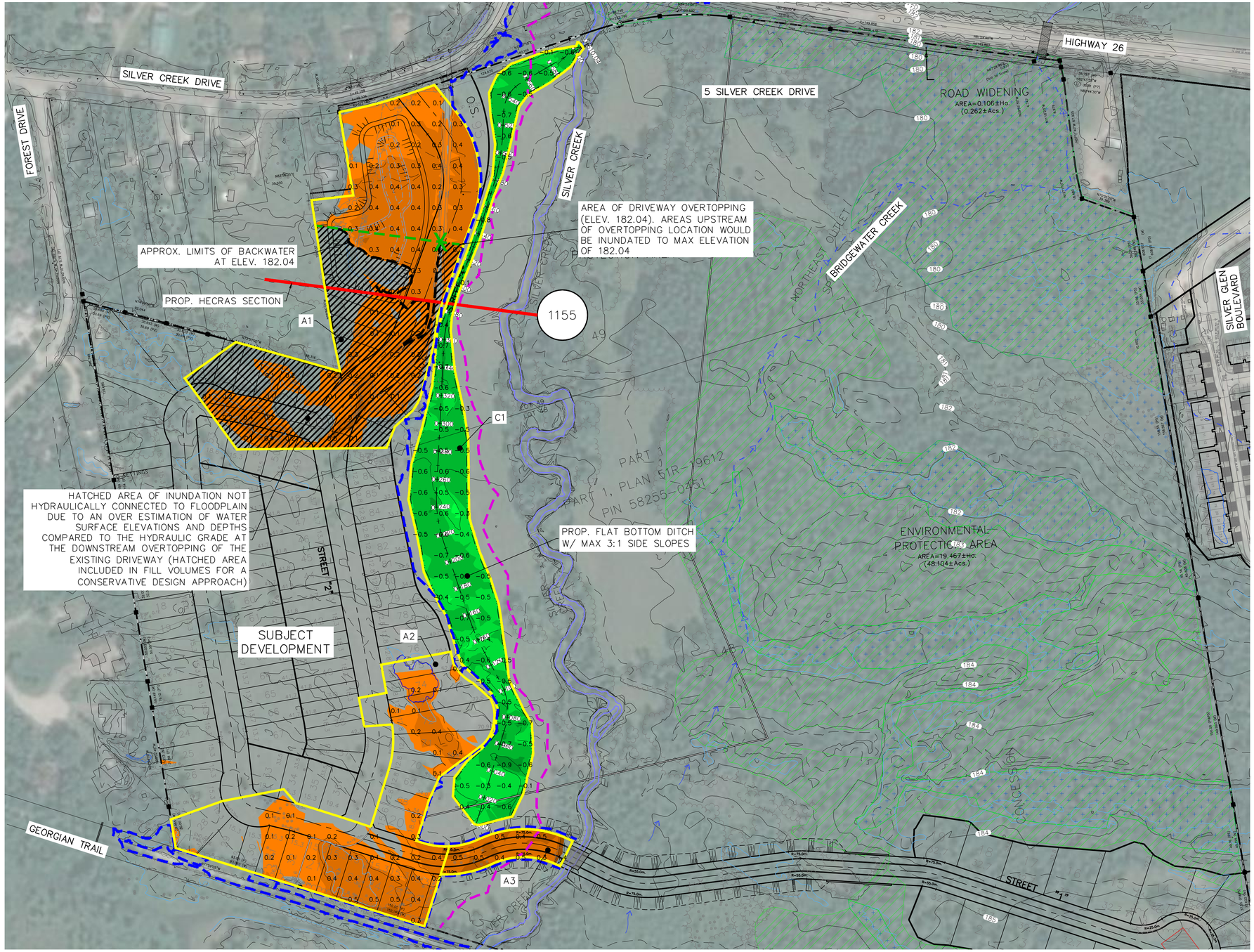
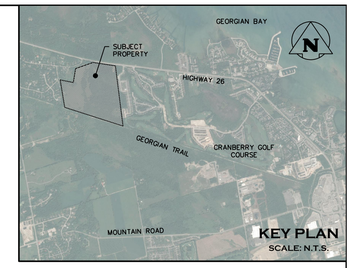
Check By	Check By	Scale	Drawing
J.P.	J.P.	1:2500	FIG. 10





N

LEGEND

0.00–0.25m FILL	EXISTING WATERCOURSE
0.25–0.50m FILL	30m GRADING BUFFER
0.50–0.75m FILL	POST–DEVELOPMENT FLOODPLAIN LIMIT
0.75–1.00m FILL	CUT/FILL ZONES
0.00–0.25m CUT	
0.25–0.50m CUT	
0.50–0.75m CUT	
0.75–1.00m CUT	
1.00–1.50m CUT	

CUT AND FILL SUMMARY TABLE

FILL ZONE	FILL QUANTITY (m^3)	CUT ZONE	CUT QUANTITY (m^3)
A1 – NORTH AREA	4370	C1	7875
A2 – SOUTH AREA	2191		
A3 – EAST ROAD ALLOWANCE	901		
TOTAL FILL	7462	TOTAL CUT	7875

50 0m 50 100
SCALE: 1:1500

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Engineer

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Project: HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

Drawing: CUT AND FILL PLAN
SILVER CREEK FLOODPLAIN – OPTION A

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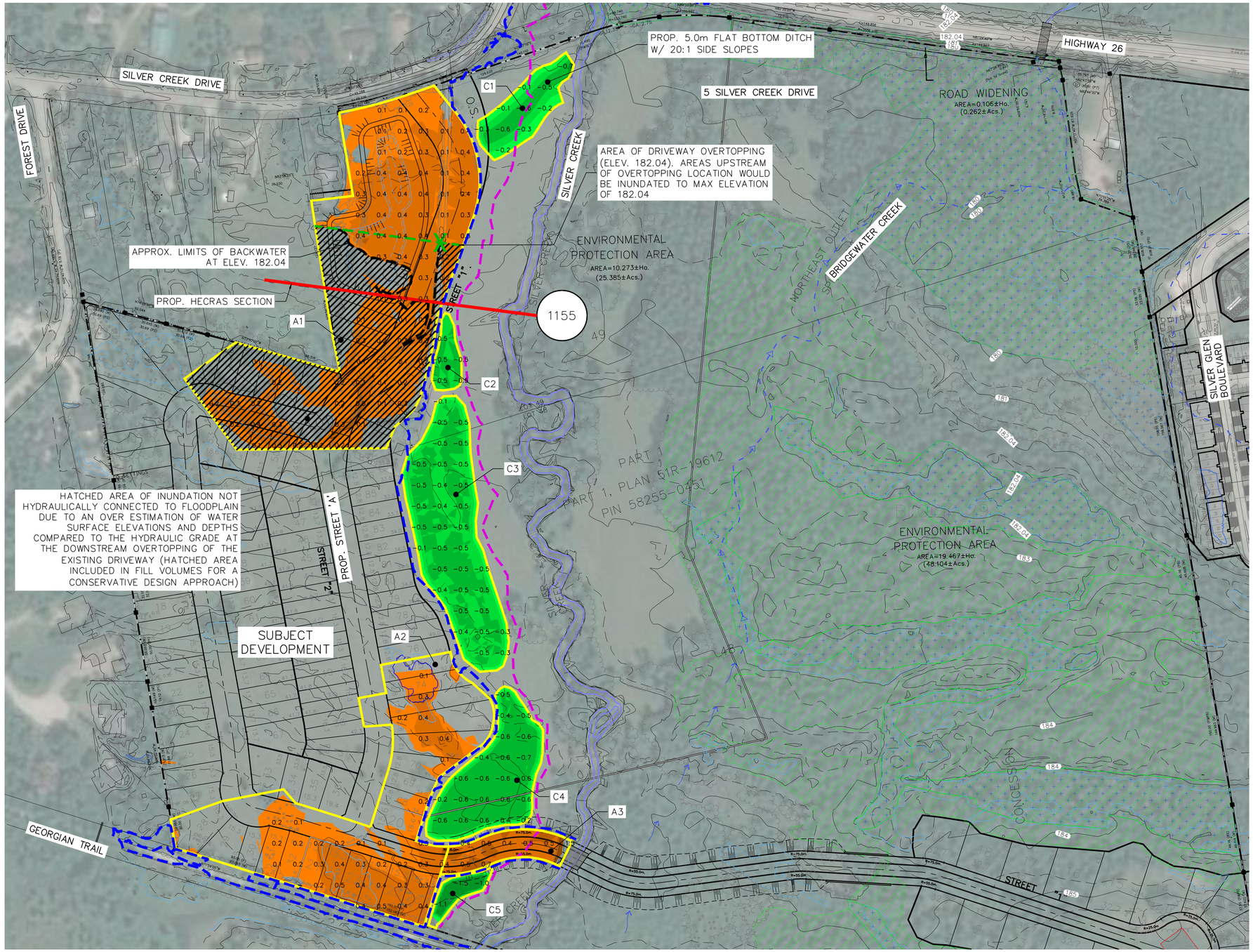
Check By	Check By	Scale / Drawing
AW/JE	JP	1:1500 / FIG. 11

J:\200\281 - Huntingwood - Skelton Farm\2769\Cad_Civil_Sheets\FIGURES\East Land Submission\2769-Cut and Fill Design (Channel Option - West Lands).dwg, FIG. 11, 2023-07-31 3:21:56 PM, tmills



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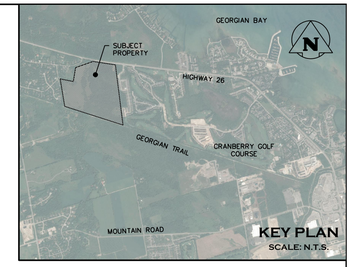

LEGEND

0.00–0.25m FILL	EXISTING WATERCOURSE
0.25–0.50m FILL	30m GRADING BUFFER
0.50–0.75m FILL	POST–DEVELOPMENT FLOODPLAIN LIMIT
0.75–1.00m FILL	CUT/FILL ZONES
0.00–0.25m CUT	
0.25–0.50m CUT	
0.50–0.75m CUT	
0.75–1.00m CUT	
1.00–1.50m CUT	

CUT AND FILL SUMMARY TABLE

FILL ZONE	FILL QUANTITY (m^3)	CUT ZONE	CUT QUANTITY (m^3)
A1 – NORTH AREA	4370	C1 – DITCH	820
A2 – SOUTH AREA	2191	C2	392
A3 – EAST ROAD ALLOWANCE	901	C3	3408
		C4	2480
		C5	593
TOTAL FILL	7462	TOTAL CUT	7693

50 0m 50 100
SCALE: 1:1500

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Engineer

Engineer

Project: HUNTINGWOOD TRAILS EAST DEVELOPMENT TOWN OF COLLINGWOOD

Drawing: CUT AND FILL PLAN SILVER CREEK FLOODPLAIN – OPTION B

CROZIER CONSULTING ENGINEERS
ADMIRAL BUILDING
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COLLINGWOOD, ON, L9Y 1A1
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Drawn By	Design By	Project	
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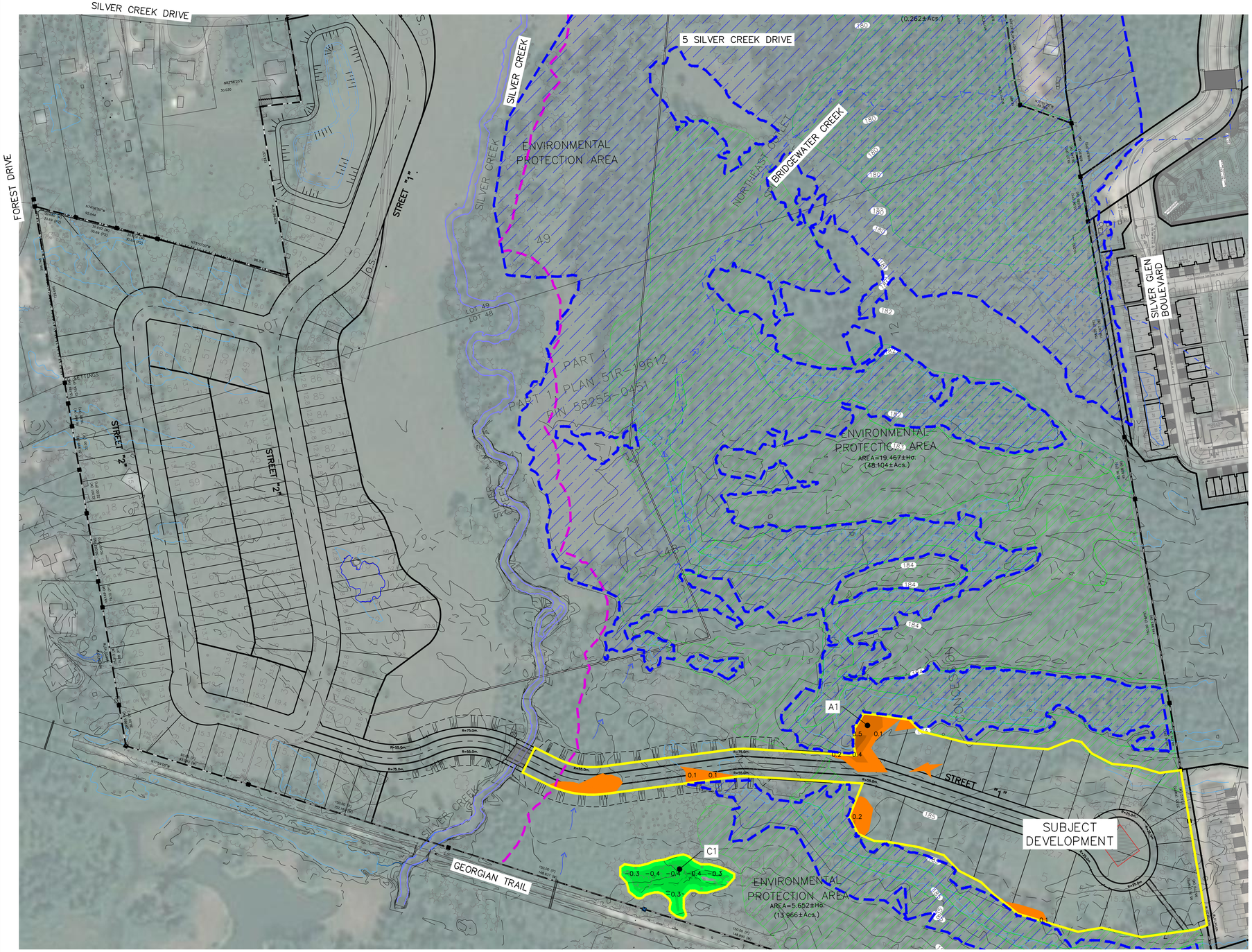
Check By	Check By	Scale	Drawing
AW/JE	JP	1:1500	FIG. 12

J:\200\281 - Huntingwood - Skelton Farm\2769\Cad_Civil_Sheets\FIGURES\East Land Submission\2769-Cut and Fill Design (Flattening Option - West Lands).dwg, FIG. 12, 2023-07-21 4:24:01 PM, tmills



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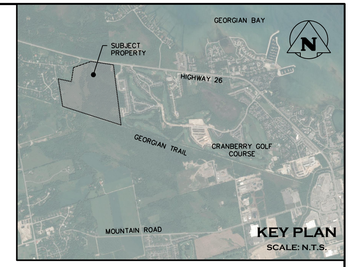

LEGEND

- 0.00–0.25m FILL
- 0.25–0.50m FILL
- 0.50–0.75m FILL
- 0.75–1.00m FILL
- 0.00–0.25m CUT
- 0.25–0.50m CUT
- 0.50–0.75m CUT
- 0.75–1.00m CUT
- 1.00–1.50m CUT
- EXISTING WATERCOURSE
- 30m GRADING BUFFER
- POST–DEVELOPMENT AREA OF INUNDATION
- CUT/FILL ZONES

CUT AND FILL SUMMARY TABLE

FILL ZONE	FILL QUANTITY (m^3)	CUT ZONE	CUT QUANTITY (m^3)
A1 – EAST LANDS	334	C1	480
TOTAL FILL	334	TOTAL CUT	480

50 0m 50 100
SCALE: 1:1500

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Engineer

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Engineer

Project: HUNTINGWOOD TRAILS
EAST DEVELOPMENT
TOWN OF COLLINGWOOD

Drawing: CUT AND FILL PLAN
BRIDGEWATER CREEK INUNDATION

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