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Technical Memorandum

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Subject: **Stevens Creek Flood Risk Mapping from Malakoff Road to Rideau River**

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Executive Summary

This report provides a summary of the analytical methods used and underlying assumptions applied in the preparation of flood plain mapping for Stevens Creek from Malakoff Road to the Rideau River. The project has been completed in accordance with the technical guidelines set out under the Canada-Ontario Flood Damage Reduction Program (FDRP) (MNR, 1986), and the technical guide for the flood hazard delineation in Ontario (MNR, 2002) as laid out by the Ontario Ministry of Natural Resources. The 1:100 year flood lines delineated here are suitable for use in the RVCA's regulation limits mapping (as per Ontario Regulation 174/06) and in municipal land use planning and development approval processes under the Planning Act.

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1. Introduction

In September 2017, The City of Ottawa and three conservation authorities (Mississippi, Rideau and South Nation) initiated the second phase of the flood risk mapping program within the boundary of the City (the first phase ran from 2012 through 2018). A multi-year plan for mapping a number of high priority rivers and streams was made. As part of this program, the RVCA has identified four streams, where the existing mapping would be updated or mapping will be created for the first time. Stevens Creek is one of them.

There were three studies related to delineating flood risk within the Stevens Creek Basin. The first one was by J. L. Richards and Associates Limited (1972), undertaken many years before the Flood Damage Reduction Program (MNR, 1986). This study included all the essential components of a mapping study, e.g., estimation of the 100-year flow, calculation of water levels along the river and plotting of the 100-year flood line on a topographical map. The spring snowmelt and summer (Timmins Storm) floods were estimated at 3040 and 5950 cfs respectively (86 and 168 cms). Finally, the spring flood was used for floodplain mapping, while recognizing that a higher summer floods is conceivable. This was done mainly because available data at that time was not considered sufficient to accurately calculate the summer flood. Hydraulic calculations on the Stevens Creek from North Gower to the Rideau River were manually done via estimating head loss over river reaches and bridges. The flood lines were plotted on a '1 inch = 200 feet' or 1:2400 scale topographical map with 1 foot (or 30 cm) contour lines.

The second mapping was done in early 1990s and is documented in several reports (A. J. Robinson 1994; Robinson Consultants 1995). The objective was to re-do the mapping to the FDRP standard (MNR, 1984). The hydrological analysis involved continuous QUALHYMO simulation of spring freshet for 26 years (from 1968 through 1993) and then conducting a flood frequency to estimate the 100 year and other flood quantiles[1] (Robinson, 1994). The 1:100 flood flow of Stevens Creek was estimated at 65.9 cms. A HEC-2 model was used to compute the water surface profile along the creeks. The estimated spring water levels of the Rideau River was used as the downstream boundary condition. It was found that the backwater effect propagates a long

[1] The frequency analysis was conducted using 23 annual peaks; the other 3 were considered outliers.

way (up to North Gower, some 9.5 km upstream from the confluence). It was decided that the 100 year Rideau River/2 year Stevens Creek would be used within the backwater effect area and the 2 year Rideau River/100 year Stevens Creek elsewhere. The flood lines were plotted on a 1:20,000 scale map with 0.5 m contour lines.

Minor modifications were made to the Robinson mapping by RVCA (2006). First, a new tributary (now known as Tributary C) was mapped for the first time. Flows estimated by Robinson (1994) was used and a new HEC-2 model was built for the hydraulic calculation. Second, the 20 m long culvert along the Dillon-Wallace Drain, diagonally crossing the Roger Stevens Road and 3rd Line Road, was re-analyzed and the floodplain upstream of it was replotted. Flood lines were drawn on a 1:5000 scale map with 0.5 m contour lines.

Engineered flood risk mapping is available for the Rideau River (RVCA, 2017a). Information from this study, when found useful, is used in the present study. Summary of available information has recently been compiled by RVCA in a catchment report card of Stevens Creek (RVCA, 2013).

This report provides a summary of the analytical methods used and underlying assumptions applied in the preparation of flood plain mapping for Stevens Creek from Malakoff Road to the confluence with the Rideau River (Figures 1 and 2). The project has been done in accordance with the technical guidelines set out under the Canada-Ontario Flood Damage Reduction Program (FDRP) (MNR, 1986), and the technical guide for the flood hazard delineation in Ontario (MNR, 2002) as laid out by the Ontario Ministry of Natural Resources. It also conforms to the 'generic regulation' guidelines of Conservation Ontario (2005). The 1:100 year flood lines delineated here are suitable for use in the RVCA's regulation limits mapping (as per Ontario Regulation 174/06) and in municipal land use planning and development approval processes under the Planning Act.

The 1995 Robinson mapping is currently being used by RVCA for regulatory purposes. The present mapping, when endorsed by RVCA's Board of Directors, will supersede the Robinson mapping.

2. Study Area

In total, about 28 km of Stevens Creek and its tributaries has been mapped (Figures 2 and 17). The study area is partially urbanized and is a part of southern Ottawa (Figure 4). About 7.2% of the area is developed (residential, commercial, institutional, streets, and recreational). About 34.6% is agricultural, about 35.7% is forest, and 22.2% is wetland.

The following streams were modeled and mapped:

- Stevens Creek (16 km)
- Tributary A or Dillon-Wallace Drain (4 km)
- Tributary B or Taylor Creek (7 km)
- Tributary C (2 km)

3. Data Used

LIDAR: High quality topography is the key to high quality flood risk mapping. Digital Elevation Models (DEM) were derived from LIDAR data procured by the City of Ottawa. The Stevens Creek watershed was covered by one LIDAR data set, flown in November 15-22, 2012. The 2012 data set has a density of about 4 to 5 points per square meter, and an estimated consolidated vertical accuracy (CVA) of 25.5 cm (Airborne Imagery, 2013). The spatial extent of the data set is shown in Figure C.3 in Appendix C. The City also provided 0.25 m contour lines that were derived from LIDAR data. However, we only used the LIDAR points directly for this study, and the contour lines were never used.

The accuracy of the LIDAR data was checked in the field by RVCA staff in August 2016. The true elevations of on-the-ground features that are identifiable on the mapping were determined using RVCA's survey grade GPS equipment (Trimble R8) and were compared with the elevations indicated by the LIDAR spot heights, to determine that any differences between mapped and true elevations were within the accuracy prescribed by the FDRP standards.

In total, 306 spot heights were verified (see Table C.1 and Figure C.1 in Appendix C). As described in the FDRP guidelines (MNR 1986), the spot height checks are considered satisfactory when 90% of the data points are within 0.33 m of the field measurement. As shown in Table C.1, this criterion has been adequately met[2]. On average, the spot heights are within 4.5 cm (Table C.1).

Watercourses: A GIS-based watercourse layer was obtained from the City of Ottawa. It was a flow network generated by the City using their LIDAR topography, augmented by culvert and bridge overrides to ensure hydraulic connectivity. This layer was modified by RVCA's GIS staff using the DRAPE 2014 imagery (Fugro, 2015) and following the procedures outline by the MNR (2011). The resultant watercourses were integrated into a jurisdiction-wide dataset maintained by RVCA's GIS department.

Catchment Delineation: Catchments were derived using the ArcHydro and Spatial Analyst extensions in ESRI's ArcMap. The City of Ottawa's LIDAR topography was

[2] FDRP (1986) Manual also specifies criteria for checking contour crossings. However, in this study we used only LIDAR spot heights, not contour lines. Therefore, we did not check the accuracy of contour lines supplied by the City of Ottawa.

processed into a 2m DEM and then augmented by the RVCA watercourse layer. The augmentation involved 'burning down' the watercourses into the LIDAR surface and then filling the areas back up, along with all other depressions, to form a cohesive surface devoid of localized sinks. This hydrologically-corrected DEM ensures hydraulic connectivity throughout the analysis surface. The subcatchments of Stevens Creek were generated off this surface via pour points placed at key stream confluences and road crossings. The resulting catchments were validated via the LIDAR topography and visual interpretation using DRAPE 2014 imagery (Fugro, 2015).

Drape Imagery: The Drape imagery was collected during a period from 28 April through 7 June 2014 with a horizontal accuracy of ±0.5 metre (Fugro, 2015). This high-quality colored photo clearly shows the rivers, creeks, land use, houses, buildings, roads, infrastructure, vegetation and other details.

2017 Aerial photo: The 2017 aerial photo was captured during May 16-20, 2017. It was provided to us by the City of Ottawa. It is accurate, sharp and in colour, and shows various natural and man-made features clearly.

Building footprint: The 'building footprint' layer was provided by the City of Ottawa for the area inside the urban boundary (Figure 6). It enables us to accurately draw flood lines around buildings. This data layer contained information collected over a number of years.

Land use: A GIS-based land use data set, largely based on information up to 2014, was recently compiled by RVCA staff. It has 38 categories of land use (see Table 4 and Figure 4). This data set was used in the hydrologic parameter estimation. Vector data originally obtained during approximately the early to late 1990s by the Ministry of Natural Resources and Forests (MNRF) were used to produce a pre-classification of the area. This pre-classification provided a historical overview of the spatial distribution of transportation, settled areas, aggregate sites, evaluated and unevaluated wetlands, wooded areas and water. Updates to this land cover vector data were based on 20cm ortho-imagery acquired through the Digital Raster Acquisition Project for the East (DRAPE), a program lead by the MNRF in 2008 and 2014. DRAPE imagery was also used to incorporate crop and pasture and meadow/thicket as additional land cover classes. Currently RVCA houses two spatially continuous land cover datasets representing the

Lower Rideau subwatershed in 2008 and 2014 using 10 land cover classes, which are further divided in to 33 subclasses. This vector data was produced through heads up digitizing to represent the landscape at a 1:4000 scale. Industry standard techniques were used to ensure topological integrity (remove gaps and overlaps).

The 2017 imagery provided by the city of Ottawa, as well as municipal official plan mapping, helped to integrate predicted land use changes reflecting 2020 conditions. The most recent imagery available, as well as Google street view, helped to digitize the space designated for development. Some developments have already commenced, as indicated by the 2017 imagery, and were mapped accordingly. Other developments are still in the planning phase. Official plan mapping helped to estimate the land use changes in the data to provide an estimate of land use for 2020 for Steven's creek catchment within the Lower Rideau subwatershed.

Imperviousness: We derived the imperviousness values from the land cover classes as presented in Table 4; the values were conservatively adapted from TR-55. Designs for areas of future development were compared against the surrounding community and conservatively correlated to TR-55 cover types: rural residential correlated to 1 acre lots (20% impervious), low density residential correlated to 1/3 acre lots (30% impervious), high-density residential correlated to town houses (65% impervious), and commercial (85% impervious). The imperviousness varied in the range from 1% to 19% for the sub-catchments, with an average of 4% for the entire Stevens catchment (Table 3a). This data set was used in the hydrologic analysis.

Soil classification: A soils classification layer was obtained from MNRF's LIO (Land Information Ontario) database, details of which are documented in a report by MNR (2012). Soil is classified into four categories (A, B, C and D) based on infiltration capacity.

Group A soils have a high infiltration rate (low runoff potential) when thoroughly wet; these consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B soils have a moderate infiltration rate and consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture; these soils have a moderate rate of water transmission.

Group C soils have a slow infiltration rate and consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture; these soils have a slow rate of water transmission.

Group D soils have a very slow infiltration rate (high runoff potential) and consist chiefly of clays that have high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material; these soils have a very slow rate of water transmission.

This report (MNR, 2012) describes the infiltration rate in qualitative terms without giving numerical values. However, it appears to be based on the SCS's original classification. USDA-SCS (1986) gives specific range of infiltration or transmission rate (Group A: greater than 0.30 inch/hour; Group B: 0.15-0.30 inch/hour; Group C: 0.05-0.15 inch/hour; Group D: 0-0.05 inch/hour). This soil information was used in hydrological parameter estimation.

As shown in Table 2a and Figure 3a, Soil Groups B and D are predominant, covering about 45% and 38% of the watershed area respectively), followed by Group C (14%) and Group A (3%). Thus, the soil in this area has both a low and a moderate infiltration rate. It consists both well and poorly drained soils. The texture is also both course and fine with moderate to low rates of water transmission.

About 0.4% of the watershed area, mainly near North Gower, is 'unclassified' or has missing soil group information (Table 2a). Based on the location and development history, we surmise that it would be similar to Group D soil in terms of compaction and transmissibility. So, in the computation, the unclassified soil was assumed to be the same as Group D soil[3].

<u>Soil Permeability</u>: A GIS-based data layer showing the soil permeability was obtained from the Ontario Geological Survey (2010). Four categories of soil permeability were identified: high, low-medium, variable and low. These categories roughly coincided

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[3] This is only a reasonable assumption based on available information. The correlation of unclassified soil with Group D is only an approximation and not perfect.

with the soil groups (A, B, C and D). Table 2b and Figure 3b show soil permeability information in Stevens catchment. This information was not directly used in the present analysis but was only used for corroborating soil classification data.

4. Hydrological Computations

4.1 Overall Methodology

In the absence of any streamflow measurement – a common situation in many small catchments – we have used a single-event hydrological model to estimate flood flows at key locations along Stevens Creek. This approach is sometimes referred to as the 'return period design storm' method and is one of the acceptable flow estimation procedures discussed in the provincial guidelines (MNR, 1986, 2002). In this method, a synthetic design storm (hyetograph) of specified return period is fed into a rainfall-runoff model to generate the corresponding peak flow, which is generally assumed to have the same return period. This procedure is quite popular and is regularly used in studies related to drainage, stormwater, flooding, and so on. This method is also accepted by FEMA (2009) for flood risk mapping, although they call it simply 'rainfall-runoff modeling'.

For small catchments of this size, floods generated by summer storms are expected to be larger compared to spring freshet and should therefore be used in flood risk mapping. Past studies in this area support this notion[4].

Suitable data for calibrating the hydrologic model (HEC-HMS) was not available. Therefore, we have estimated the flood quantiles based on theoretical (or synthetic) storms and uncalibrated hydrologic modeling as the best available methodology at the present time. As described later in the report, lack of data also prevented calibration of the hydraulic model.

Synthetic storms of various types and durations were first used to estimate the 1:100 year flood flows. Based largely on engineering judgement, one of the storms was selected as suitable for the flood mapping purposes within the Stevens Creek basin. The selected storm was then used to estimate the flood quantiles for various return periods (2, 5, 10, 20, 50, 100, 200, 350 and 500 years).

[4] For example, the 1:100 year summer and spring floods of Flowing Creek (with an area of about 52 km^2) were estimated at 51 and 46 cms respectively by PRS/JFSA (2005) during a larger mapping study on the Jock watershed; it was recommended that the summer flows be used for flood mapping. A subsequent study by RVCA (2017) estimated the summer flood of Flowing Creek at 74.5 cms. For the Stevens Creek itself, J. L. Richard (1972) estimated the summer flood to be much higher than the spring flood (168 cms vs. 86 cms). Robinson (1994) estimated the spring flood at 65.5 cms. So, it appears that the summer flood will prevail in the Stevens Creek.

4.2 HEC-HMS Model

We have used version 4.2.1 of HEC-HMS model (USACE, 2016, 2017a) for estimating the summer floods. The technical basis of this model is described in USACE (2000), and application guidance in USACE (2017b). This model can be used for both urban and rural catchments. The HEC-HMS model simulates precipitation-runoff and channel routing processes, both natural and controlled. It is the successor of the widely used HEC-1 model (USACE, 1998), but provides additional capabilities of distributed modeling and long-term continuous simulation.

As shown in Figures 2 and 7, the Stevens Creek basin has been divided into ten catchments, and flood quantiles have been estimated at thirteen nodes and ten catchment outlets along the creek and its tributaries (Figure 13). A schematic of the HEC-HMS model is shown in Figure 8, where both the rainfall-runoff ('SUBBASIN') and channel routing ('REACH') components are included.

The Stevens catchment is within the periphery of the City urban core and is partially developed. The City of Ottawa Official Plan (2003) indicates no significant additional change in this area in the foreseeable future. However, an amended OPA released in 2018 envisages an urban limit expansion of the Village of North Gower and associated land use change (City of Ottawa, 2018). We have used this information for the hydrologic analysis. The hydrologic analysis therefore is based on the future condition as required by the provincial guideline (MNR, 2002).

The rainfall-runoff component in HEC-HMS model is called SUBBASIN, which is used to represent the hydrologic response of watersheds. Given a rainfall input, it calculates runoff by first accounting for the losses and then transforming the excess rainfall into runoff at the catchment outlet. For single event simulations as used here, a rainfall hyetograph of short duration (3 to 24 hours) is given as input and a runoff hydrograph (duration of several days) is calculated as the output.

Among the eleven options for calculating the loss (or calculating the runoff volume), we have chosen the SCS curve number method, because this is widely used and requires only one parameter (CN) that can be determined from land use and soils information. Moreover, many of the past studies within the RVCA have used the SCS CN procedure for computing flows, thus ensuring a degree of consistency. For the same reasons, the SCS Unit Hydrograph Transform method has been chosen for calculating the runoff hydrograph from the seven available options. Since a short-duration, single event (summer rainfall event) is simulated here, canopy storage and baseflows are inconsequential and have not been prescribed; thus, these elements were not added to the SUBBASIN components. In the absence of any measurement, a default value of 484 for the peak rate factor (PKF) was used. The watershed parameters used as inputs to this model are listed in Table 3a.

Two parameters (curve number and time to peak) are very important in HEC-HMS modeling and therefore require elaborate discussion.

Curve Number Method: The curve number (CN) method of estimating runoff was first introduced by US Department of Agriculture's Soil Conservation Service (USDA-SCS 1986) and is widely used in North America and elsewhere. This method is used in the many commercially available hydrologic models including HEC-HMS. The curve number (CN) was calculated based on land cover and soil type (Tables 1 and 2a). Equivalent land use and associated CN from TR-55 were first selected for each of the 38 land cover and 4 soils types found in this region (Table 4). For each elemental area with a particular land cover-soil combination, the appropriate CN value was chosen; these CN values were then area-averaged over the whole catchment to find the aggregate CN for the catchment. CN values varied from 71 to 82 for different sub-catchments, with an average value of 77 for the entire Stevens catchment (Table 3a). For parameter estimation and calculation procedures, we have closely followed the original SCS manual (USDA-SCS, 1986).

Both the original SCS curve number method and its 'conjugate' or modified version can be used in hydrologic calculation. They are expected to yield similar results, as discussed in a recent, comprehensive state-of-the-art review done by a task committee (Hawkins et al., 2009). Many models refer to and allow for the use of both methods. The HEC-HMS model, however, refers only to the CN method, without any reference to the $CN*$ method. We have, therefore, used the CN method here.

The first step is estimating the CN value based on land use and soil type as given in the SCS manual (USDA-SCS, 1986). We have used the following information:

- 2012 soil classification by LIO/OMAFRA/MNR (MNR, 2012)
- 2014 land cover data compiled by RVCA staff
- 2010 land use data set from the City of Ottawa (used only for corroboration)

Both data sets were available in digital format. Tables 1, 2a and 4 summarizes parameters related to the estimation of CN and $CN*$. This process was automated in the GIS system.

Once CN was estimated, then the initial abstraction (IA) in mm was calculated as:

$$IA = 0.2S$$

where the soil storage capacity (S) in mm is related to CN and by the relation:

$$CN = \frac{25400}{254 + S}$$

The 'conjugate' or modified curve number $CN*$ was calculated using the following equation:

$$CN* = \frac{100}{1.879(\frac{100}{CN} - 1)^{1.15} + 1}$$

The corresponding soil storage capacity ($S*$) in mm was related to $CN*$ by the relation:

$$CN* = \frac{25400}{254 + S*}$$

And the corresponding initial abstraction ($IA*$) in mm was calculated as:

$$IA* = 0.05S*$$

The above equations were taken from Hawkins et al. (2009; page 35, 9 and 34 respectively).

While the original CN was estimated based on the assumption of an initial abstraction equal to 20% of the soil moisture capacity, later research revealed that the initial abstraction equal to 5% of the soil moisture capacity may be more appropriate, the new curve number was called $CN*$, and the relationship between CN and $CN*$ was established. At present, both the original and the modified methods are widely used, with more and more practitioners preferring the latter. However, given that they can be readily converted to each other, one has the option to use any of them.

In this study, we have used the original CN method, which means we have used the CN and (IA) combination as input to the hydrologic model. Parameters for the conjugate CN method, namely $CN*$ and associated $IA*$, were calculated and presented in Table 3a for information only but were not used in the hydrologic calculations.

Time to Peak: The time of concentration (T_c) of a watershed is defined as the time required for water to move from the most remote part of the watershed to its outlet. Many methods are available, mostly empirical and developed for specific conditions, to estimate T_c. Here, we have used the 'velocity method' originally introduced by Soil Conservation Service (USDA-SCS, 1986) and later elaborated by Natural Resources Conservation Service (USDA-NRCS, 2010). This method has a sound physical basis[5],

[5] The SCS velocity method is generally considered to have a sound physical basis and is often used as a yardstick to evaluate other methods (see, for instance, McCuen et al. 1984; Grimaldi et al. 2012; and Sharifi and Hosseini 2011). Grimaldi et al. found that as much as 500% variation is quite common when using different methods to estimate time of concentration. They also made an interesting remark: "Indeed, it a paradox that advanced hydraulic models, such as 2-D flood propagation models for hydraulic risk mapping based on very expensive topographic and remote sensing data, are actually limited by design hydrographs based on anachronistic parameters, such as Tc." This is consistent with the commonly observed fact that hydraulic calculations are much more accurate than hydrologic calculations. Also, from the practitioner's point of view, "as a general rule, methods that compute individual travel times for various types of flow segments (for example, overland flows and channelized flows), and then sum the individual travel times to estimate the total travel time, are thought to be the most reliable" (Bentley Systems 2007b).

i.e., the movement of water over the land and along the channel, although estimating parameters – as the case frequently is in hydrology – is at best an approximation.

The time to peak (T_p) is defined as the time between rainfall event and the corresponding peak flow. It is related to the time of concentration as (USDA-CSC 1986, page 15-3):

$$T_p = 0.6T_c$$

Both T_c and T_p were calculated using the method detailed in the USDA-NRCS (2010) manual. The time to peak (T_p) was an input to HEC-HMS model (Table 3a). It varied from 0.45 to 27.5 hours for different sub-catchments.

All estimated parameters necessary for the HEC-HMS modeling of the Stevens Creek catchment are listed in Tables 3a-b.

Channel Routing: The REACH element of the HEC-HMS model can be used for routing flows through rivers. Out of the six channel routing methods available (all of them approximate), the Muskingum-Cunge and the Lag methods were chosen for this project. The M-C method was used for five channels (Table 3b). It combines the conservation of mass and a diffusion representation of momentum equation, thus providing both translation and attenuation features of flood wave propagation. Channel length, slope and roughness (Manning's n) are required in addition to a simplified (eight point) cross-section. Pertinent parameters are given in Table 3a. Figure 8 shows how the channels fit within the overall model structure. Typical cross-section for each channel was based on the characteristic main channel and adjacent floodplains where applicable. Manning's roughness coefficients for the main channel and floodplain were also assigned based on vegetation cover and expected flow conditions. Care was taken to ensure that parameter values used in HEC-HMS were consistent with those used in HEC-RAS model.

The Lag method was used in one short reaches (C2; Table 3b), where M-C method yielded unreasonable results. Along this reach, the time lag was estimated form the flow velocity from the HEC-RAS model. Attenuation along such a short reach was considered to be insignificant (especially in the presence of lateral inflows) and therefore a simple translation of the hydrograph was deemed sufficient for flood mapping purposes.

4.3 Selection of Design Storm

A wide variety of design (or synthetic) storms are available. However, a particular storm is generally selected for flood mapping purposes after appropriate scrutiny. For this study, synthetic storms of two types (Chicago and SCS Type II) and four durations (3, 6, 12 and 24 hours) were considered for hydrologic modeling (Table 5). These storms are routinely used in Canada for both stormwater management and flood risk studies. Recent studies in neighboring conservation authorities (SNCA 2014; MVCA 2015) as well as within the RVCA (RVCA 2016, 2017a, 2017b, 2017c, 2017d, 2018a, 2018b, 2018c) confirm the suitability of these storms for the purposes of floodplain mapping in small basins.

The following synthetic storms were considered:

- 3 hour SCS Type II storm
- 6 hour SCS Type II storm
- 12 hour SCS Type II storm
- 24 hour SCS Type II storm
- 3 hour Chicago storm
- 6 hour Chicago storm
- 12 hour Chicago storm
- 24 hour Chicago storm

Hyetographs corresponding to these storms were generated from the most recent IDF curve at Ottawa Airport (Station ID 6106000), obtained from Environment Canada[6]. This IDF curve was based on the most recent analysis using 39 years of data from 1967

[6] Information on IDF curve was obtained from Environment Canada's website [http://climate.weather.gc.ca/prods_servs/engineering_e.html].

to 2007 (with 2001 and 2005 data missing)[7]. Generally, the curve for a certain return period follows an equation like:

$$I = \frac{a}{(b+t)^c}$$

where,

I = rainfall intensity (mm/hour), and

a, b, c = constants.

From the EC IDF curve (Figure 9), equations were fitted via the STORM software and constants determined for all return periods (Figure 10). These equations were then used to generate rainfall hyetographs, for which we used the STORMS 2010 utility software (version 3.0.1) from JFSA (2011). Figure 11 shows the storm hyetographs. Hyetographs were input to HEC-RAS model, where they drive the rainfall-runoff computation. This procedure was followed for all Chicago storms and the SCS 24 hour storm. For all other SCS storms (3, 6, 12 hour durations), the distribution was taken from the City Sewer Guidelines (2012; page 5.18).

Using the eight synthetic storms, the 1:100 year flows were computed for all sub-catchments and at key locations along the stream (Table 6), which were then scrutinized to select an appropriate storm for the purposes of flood mapping. This step is somewhat subjective and requires engineering judgement. As expected, the longer duration storms produced higher flows; usually the flow corresponding to a 3 hour storm was about 50-70% of that produced by a 24 hour storm. The SCS storms produced slightly higher flows (by about 1-15%) compared to Chicago storms. The estimated flows from various storms were thus within the typical variation associated with hydrologic computation; no storm produced extremely high or low flows. This appears to endorse the notion that all storms considered here and associated flows were within the realm of hydrological plausibility. No storm stood out as an outlier or as unrealistic. In the selection of a storm for flood mapping purposes, we wanted to be as close as possible to reality with a slight degree of

[7] City of Ottawa's Sewer Design Guidelines (2012) contain an old IDF curve based on 1961-1990 data, which yields somewhat smaller storm depths than the more recent IDF curve (based on 1967-2007 data). We have opted to use the most recent IDF curve because it reflects recent climatic conditions, is based on more data (39 years as opposed to 31 years), and is slightly conservative (produces bigger storms). The FDRP Manual (MNR 1986) also recommends the use of most recent IDF information.

conservatism. Considering all, we selected the 24 hour SCS Type II storm as the most suitable for Stevens Creek flood mapping[8]. As can be seen in Table 6 and Figure 12, it produced the higher flows, but only marginally so (1-15% higher than those produced by the Chicago storm). This selection was consistent with our philosophy of being as close as possible to reality, with only a slight degree of conservatism to account for the uncertainty.

4.4 Estimated Flood Quantiles

After the 24 hour SCS Type II storm was selected for the flood mapping purposes, the HEC-HMS model was run for all events with return periods from 2 to 500 years (Table 7). Selected screen shots from the HEC-HMS model are included in Appendix D. Estimated flood quantiles at key locations were tabulated (Table 8 and Figures 13 and 14). Flood flows from this table were then used in the hydraulic modeling; thus, this table is the link between hydrologic and hydraulic computations.

The flows calculated by Robinson (1994, 1995) are about 65% of the flood quantiles we have estimated in this study, while those calculated by J L Richards (1972) are about 85%. There are several reasons for this variation. First, it can partly be attributed to the use of different IDF curves; we used the latest IDF curve which translates into a 10-15% higher rainfall. Another reason is the details of land use and soil information used; the basin-averaged CN values used in 1972 and 1995 were 69.1 and 62.6, compared to 77.2 in this study. We believe our land use, soil and thus the CN value are more accurate than those previously used. All these factors contribute to the difference in flow estimates. However, at the end, based on the more detailed and better quality of the data we used, we concluded that our estimate of flood quantiles is more appropriate for flood mapping purposes.

[8] The hydrological analyses done here and the results obtained therefrom are considered suitable for the purposes of floodplain mapping of Stevens Creek only, and for no other purpose. It should be emphasized that the methodology, storms considered and selected, modeling, and the estimated flood quantiles may not be suitable for any other purpose, including land drainage, stormwater management and infrastructure design. Any subsequent use of the data, model and other information contained in this report should be made only after independent verification and scrutiny by qualified engineers/hydrologists.

4.5 Comparison with Other Methods

In order to assess the reasonableness of the flood quantiles computed here (with SCS Type II 24 hour storm), a comparison was made to those computed at other small catchments elsewhere (Figures 15 and 16). Besides comparing the data points to each other, three lines were drawn to provide the context. They are:

- Area pro-rating: based on Jock River at Moodie Drive; 1:100 year spring flood of 196 cms based on measured data (PSR/JFSA 2004a)
- 1:100 year floods computed by the Index Flood Method (MNR, 1986)
- Creager envelope curve with a coefficient of 30 (Watt et al. 1989)

Figures 15 and 16 show that, in general, the Stevens Creek flows are in the same range as other catchments within the RVCA (taken from PSR/JFSA 2005; JFSA 2009; RVCA 2016, 2017a, 2017b, 2017c, 2017d, 2018a, 2018b, 2018c, 2019) and from adjacent conservation authorities (SNCA, 2014; MVCA, 2015). One notable exception is Bilberry Creek, which is fully urbanized with soils composed clay with low infiltration rate and shows higher flows. Some of the urban catchments within the Jock watershed also have higher flows comparable to those in Bilberry basin.

We note that all of the estimated floods within the Stevens basin are higher than those given by the Index Flood Method, which was based on measured streamflow data and was prescribed by MNR (1986) for estimating floods in the absence of better information. All data points are below the Creager envelope curve, which is the upper-most limit of extreme flood flows in Canada. On the balance, we found that the estimated Stevens flows are congruent with other information and are within the confines of pertinent estimation methods.

5. Hydraulic Computations

5.1 HEC-RAS Model

Following standard procedures (MNR, 1986; USACE, 1990, 2010), a steady-state hydraulic model of Stevens Creek was built. The HEC-RAS software (version 4.1.0) developed by the US Army Corps of Engineers (USACE, 2010) was used. It uses the same back water calculation procedure as HEC-2 (USACE, 1990), which has been the industry standard since the 1970s, but with improved data processing and graphical capabilities. About 28 km of Stevens Creek and its tributaries was included in the HEC-RAS model.

Cross-Sections: The cross-sections used in the modeling were generated from the latest topography (2012 LIDAR) using GIS tools. While the above-water part of the cross-sections generated from LIDAR is accurate, the under-water portion of the channel is sometimes not adequate. For this reason, the channel bathymetry at HEC-RAS cross-sectional lines were collected by a consultant retained by the RVCA (Water's Edge, 2019; see Appendix F). This bathymetry was collected during the week of 27 May 2019 using state-of-the-art survey and GPS system. The vertical datum was CGVD1928 HT2.0.

The complete cross-sections were prepared by combining the LIDAR and bathymetry data. In total, 229 cross-sections were used in our HEC-RAS model. Figure 17 shows a schematic of the HEC-RAS model. Drawing ST-1 in Appendix G shows the cross-sections in greater detail, along with the computed Regulatory Flood Levels (RFLs) and flood risk limits. The location and alignment of river cross-sections within the model were based on engineering judgment as related to the expected flow during high flood events.

For the Taylor Drain, which is a municipal drain, we have used the current channel configuration, after consultation with the City of Ottawa. It may be noted that this drain is repaired or restored by the City from time to time.

Channel Roughness: Based on our best understanding of the expected channel, flow and vegetation conditions, the Manning's roughness coefficient was estimated to be

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0.035-0.050 in the main channel and 0.035-0.10 for the overbank areas[9] (Table B.1 in Appendix B). These values were consistent with standard values, such as those recommended by Chow (1959).

Bridges/Culverts: Within the study area there are 22 road crossings (Table 11). As-built drawings were obtained from the City. Moreover, field survey by RVCA technicians during Spring 2018 were used for determining bridge/culvert dimensions. Road crossings and associated cross-sections were updated to match the as-built information. In modeling bridges in HEC-RAS, we meticulously followed the guidance provided by USACE (2010).

Flood Quantiles: The estimated design flows from the hydrologic analysis (discussed above), with return periods ranging from 2 to 500 years (Table 8), were used in the HEC-RAS model. Table 9 shows the flows that were input to the HEC-RAS model.

For each channel reach, flows at both upstream and downstream ends were estimated form the HEC-HMS model, as listed in Table 8. As is the usual practice, the higher of these two flows – almost always the downstream one – was used for the hydraulic calculation in the HEC-RAS model.

Downstream Boundary Condition: Known or estimated water levels are usually used as downstream boundary conditions in HEC-RAS models. In this case, Stevens Creek drains into the Rideau River. So, the water level prevailing in the Rideau River during summer months (the Stevens Creek floods are assumed to occur during this time) constitutes the most appropriate boundary condition. The summer water levels in the Rideau River are expected to be much lower than the spring flood levels as computed in a recent study (RVCA, 2017a); see Figure 20 and Table 10. However, the summer water levels were neither measured nor estimated at this location. Therefore, the summer navigation level (85.5 m), taken from DFO-CHS (2005), provides a practical boundary condition. We used this level as the boundary condition for all summer flood events in Stevens Creek.

[9] We note that for the cross-sections downstream of the Rideau River Valley Drive, low roughness values were used. This is because this area is affected by the backwater and we do not expect any head loss of Stevens Creek in this area.

Once the model was set up, the computed profiles and other parameters were scrutinized to assess the reasonableness of model outputs. Special attention was given to the computed water level and energy profiles near road crossings. Adjustments of model parameters – mainly the channel resistance and contraction and expansion coefficients – were made as necessary.

Suitable data to calibrate or validate the HEC-RAS model was not available. Therefore, no calibration was done[10]. However, we exercised professional judgement and tried to be slightly on the conservative side. Our approach of slight conservatism (a combination of hydrologic and hydraulic computations) is also congruent with the current notion of the Precautionary Principle, which applies when there exist considerable scientific uncertainties about causality, magnitude, probability, and consequences of different course of action (UNESCO 2005). The Precautionary Principle is also a key policy of Environment Canada[11].

5.2 Computed Water Surface Profiles

The HEC-RAS model was run with the design floods. The 1:100 year computed water surface elevations and other parameters are shown in Table 13. Typical water surface profiles and all cross-sections are included in Appendix B.

Computed water surface elevations for various flood events with return periods ranging from 2 to 500 years are presented in Tables 14 and 15. It should be pointed out that the model has been built for the expected conditions prevailing during intense rainfall-generated flood events in the summer. Caution should be used when applying this

[10] Given the constraints, this HEC-RAS model is the best we could build for the limited purpose of floodplain mapping at this time. We recognize that this model may not be suitable for other purposes. Further model improvement/adjustment/modification may be necessary for other purposes; it all depends on the purpose of the modeling and the features and phenomena a model is meant to capture. We therefore caution against using this model for other purposes without first confirming its suitability.

[11] Canada's environmental policy is also guided by the precautionary principle and is reflected in the Federal Sustainable Development Act (2008), which states that the Minister of Environment must "develop a Federal Sustainable Development Strategy based on the precautionary principle". The precautionary principle states that: "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation". In other words, the absence of complete scientific evidence to take precautions does not mean that precautions should not be taken – especially when there is a possibility of irreversible damage (Environment Canada, 2010).

model to simulate water surface profiles for events of other magnitude and during other seasons of the year.

Computed head losses across road crossings are listed in Table 12.

In cold climate areas like Ontario, spring floods may also be accompanied by ice jams. Here we have only analyzed the summer floods, not the spring floods. We are unaware of any ice-related flooding that caused significant concern in this area.

5.3 Sensitivity Analysis

Flood quantiles have the highest degree of uncertainty in our computation and is most likely to affect the water surface profile. Therefore, we decided to test the sensitivity of water surface profile to a wide variation in flow.

The sensitivity analysis was conducted to determine how much the computed water surface elevations will vary with changes in the value used for the 1:100 year discharge. Six flow conditions were tested:

- 1:100 year flow increased by 10%
- 1:100 year flow increased by 25%
- 1:100 year flow increased by 50%
- 1:100 year flows decreased by 10%
- 1:100 year flow decreased by 25%
- 1:100 year flow decreased by 50%

Figures 18 and 19 show the computed water surface profiles and the differences in computed water levels for each condition. Figure 18 indicates that the computed water surface elevations are less sensitive to the discharge value in the steeper portions of the reach and more sensitive upstream of road crossings. The sensitivity analysis indicates that the computed water level can vary by about 0.10 m for a 10% variation in flow along most of the river reach, which is typical in the hydrologic estimation of design flow. For a 25% increase in flow, the water level, on average, can go up by about 0.25 m.

The sensitivity analysis provides an indication of the potential implications of inaccuracies in flow estimation, and changes in the expected flood flows that might result from urbanization and climate change.

6. Selection of Regulatory Flood Levels

As per Section 3 of the Provincial Policy Statement under the Planning Act (MMAH, 2005, 2014), the regulatory flood in Zone 2, which includes the RVCA, is the 1:100 year flood. Depending on the local hydraulic conditions, the computed water surface elevation, the energy grade or a value in between is generally taken as the Regulatory Flood Level (RFL). Engineering judgment is applied to recommend an appropriate value for the regulatory flood level at each cross-section, using the model outputs and considering hydraulic characteristics of the river reach, and the inherent limitations of numerical modeling.

When the stream velocity is relatively low and varies only gradually over relatively long river reaches, the water surface can generally be taken as the RFL.

However, near bridges, culverts and other water control structures and on steeper reaches where streamflow velocities are higher, and may change more abruptly, the computed water surface elevation may be substantially lower than the energy grade level, with the possibility that the water level may rise to the energy grade near obstacles and irregularities in the channel profile or cross-section which may not be represented in the hydraulic model. In such cases, the regulatory flood level is generally based on the computed energy grade as a conservative approach, given that the model-generated water surface elevation is less likely to be a true representation of flood risk in such situations.

Another possible situation arises when the computed water surface profile is undulating, with downstream water levels occasionally higher than upstream levels. When this occurs, it is more often an artifact from the simplifying assumptions of the modeling scheme than a reliable prediction of the actual differences in streamflow velocity and depth (and hence energy grade) from one cross-section to the next. Accordingly, the regulatory flood level at the upstream cross-section is taken to be equivalent to the downstream water surface elevation in these situations.

In all cases, the RFL is always between the computed water level and energy grade line. Hence, for the sake of simplicity and consistency, the energy grade elevation is often used as the RFL as a standard practice in delineating flood hazard areas.

For the present study, the regulatory flood levels were set equal to the computed energy grade and are tabulated in Table 13, along with the computed water surface elevations and energy grades at each cross-section in the model.

7. Flood Line Delineation

7.1 General

Once the RFLs are established, the plotting of 1:100 year flood lines or flood risk limits is a relatively straightforward matter. Given the topographical information in the form of LIDAR spot heights, the inundated area below the RFLs can be easily delineated manually or by using automated computer programs. In the present case, it was done manually with a focus on areas with complex topography, infrastructure, and overbank flow paths. The raw LIDAR spot heights were extensively used in the plotting the flood risk limit.

Field surveys were conducted by RVCA staff on 28 September and 2 November 2018 to verify hydraulic connectivity through culvert openings and flood prone areas. This information is summarized in Table 17.

The record of site-specific information associated with RVCA's regulatory approval process since 2010 was checked (Table 16). It was found that none of the site-specific work affects the flood risk lines.

Drawings ST-1 and ST-2 in Appendix G depict the delineated floodplain.

7.2 Buildings in the Floodplain

Presence of existing buildings within the floodplain and associated variation in the way a building could be exposed to flood risk required special attention. Recently, RVCA has consolidated a few rules for drawing flood lines in the vicinity of buildings (Appendix A), which have been followed in this study. Due to the limitations of the data and methodology used in the current mapping done at a large scale, and the small degree of (inevitable) subjectivity in drawing flood lines around buildings at a smaller scale, RVCA recommends that, should the need arise for accurate flood line delineation near buildings, site-specific information be taken into account when dealing with flood risk at these locations. It is the practice of RVCA to refine flood lines when more accurate information becomes available.

7.3 Islands in the Floodplain

Presence of small islands, especially those associated with septic beds, within the floodplain also requires special attention. Recently, RVCA has decided to show small islands with an area less than 1000 m^2 as flood risk area (Appendix A) This guidance was followed during this study.

7.4 Spill Sections

Four spill sections were identified during this study (see Drawing ST-1). They were minor in nature and had water depth in the order of 25-50 cm. During exceptionally large flood events, water is expected to spill over to adjacent areas.

Because of the minor nature of the spills and the flows escaping therethrough, no adjustment was made to the flow values. In other words, the current HEC-RAS modeling uses an assumption that all flow is retained in the creek, i.e., no water escapes the creek. Therefore, the floodplain delineated here is conservative.

7.5 Flood Mapping Data in GIS

The regulatory flood lines and cross-sections have been incorporated as separate layers in RVCA's Geographical Information System (GIS). In this system, one can view the flood lines, cross-sections, design flow, water level, energy grade, RFL, and other computed parameters. The flood lines can be overlain on the aerial photography or any other base mapping layers that are in the system and at any scale that suits the user's need.

The regulatory flood line layer is maintained and updated as required according to the established procedures of the RVCA (RVCA 2005).

Drawings ST-1 and ST-2 show the flood risk limits as delineated in this study. At all cross-section locations, the RFL is indicated. The general surroundings and landmarks are also included for easy referencing.

8. Project Deliverables

The key information or knowledge products generated from this project are:

1) The Flood Mapping Report (this Technical Memorandum) – which summarizes the analytical methods that were used and the underlying assumptions
2) HEC-HMS model files
3) HEC-RAS model files
4) The flood risk limit lines in GIS format (shape files) – identifying the extent of lands which are considered to be vulnerable to flooding during a regulatory flood event (1:100 year flood)
5) The position and orientation of cross-sections used in the HEC-RAS model, in GIS format (shape files) – which, when used in conjunction with the HEC-RAS model output files, informs the user as to the estimated 1:100 year water surface elevation and the regulatory flood level for any location in the study area

A "documentation folder" containing working notes and relevant background information accumulated during the study process is maintained by the water resources engineering unit within RVCA's Watershed Science and Engineering Services department.

9. Closure

The hydrotechnical and cartographic procedures used in this study generally conform to present day standards for flood hazard delineation, as set out in the MNR's Natural Hazards Technical Guide (MNR, 2002). The resulting 1:100 year flood lines are suitable for use in the RVCA's regulation limits mapping (as per Ontario Regulation 174/06) and in municipal land use planning and development approval processes under the Planning Act.

[redacted]

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Table 1a: Land cover breakdown in the Stevens basin*

	Catchment	M1		M2		M3		M4	
	Land Cover Description	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
1	Aggregate Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Aggregate Site - Pit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Aggregate Site - Quarry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Crop and Pasture	0.10	0.25	1.15	4.59	0.00	0.00	6.87	35.01
5	Crop and Pasture - Cultivated	2.04	5.13	15.54	62.14	0.05	34.89	7.20	36.69
6	Crop and Pasture - Fallow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Evaluated Wetland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	Evaluated Wetland - Bog	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	Evaluated Wetland - Fen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Evaluated Wetland - Marsh	6.41	16.08	0.00	0.00	0.00	0.00	0.00	0.00
11	Evaluated Wetland - Open Water	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
12	Evaluated Wetland - Swamp	5.98	15.01	0.00	0.00	0.00	0.00	0.00	0.00
13	Meadow/Thicket	1.90	4.76	0.84	3.36	0.00	0.00	0.49	2.51
14	Settlement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	Settlement - Commercial	0.00	0.00	0.03	0.13	0.01	3.50	0.07	0.37
16	Settlement - Industrial	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
17	Settlement - Pervious	0.01	0.02	0.02	0.07	0.03	17.81	0.08	0.40
18	Settlement - Pervious Homestead	0.23	0.59	0.84	3.34	0.00	0.38	0.62	3.17
19	Settlement - Residential	0.00	0.01	0.89	3.56	0.03	19.97	0.45	2.31
20	Settlement - Estate	0.13	0.32	0.71	2.85	0.00	2.49	0.21	1.07
21	Settlement - Townhouse	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00
22	Transportation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	Transportation - Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	Transportation - Major Road	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.96
25	Transportation - Minor Road	0.19	0.48	0.66	2.63	0.01	7.71	0.31	1.58
26	Transportation - Unpaved Road	0.15	0.37	0.05	0.22	0.00	0.00	0.26	1.35
27	Unevaluated Wetland	3.99	10.02	0.45	1.80	0.00	0.00	0.20	1.04
28	Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	Water - Buffer around wetland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	Water - Lake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	Water - Pond	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00
32	Water - River	0.02	0.05	0.12	0.49	0.01	5.79	0.14	0.70
33	Wooded Area	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00
34	Wooded Area - Fallow	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
35	Wooded Area - Hedgerow	0.12	0.30	0.43	1.71	0.00	0.00	0.33	1.66
36	Wooded Area - Island	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00
37	Wooded Area - Plantation	0.10	0.25	0.12	0.48	0.00	0.00	0.12	0.61
38	Wooded Area - Treed	18.45	46.28	3.14	12.58	0.01	7.44	2.07	10.55
	Total	39.87	100.00	25.00	100.00	0.16	100.00	19.61	100.00

Note: Land cover is based on DRAPE 2014 imagery and the Official Plan of 2003, updated to Official Plan Amendment #211 in 2018, guided projections for land cover changes. Further refinements to the projection were made when suitable development information was available, as was the case with the Maple Forest Estates and Williams Farm subdivisions.

Table 1b: Land cover breakdown in the Stevens basin*

	Catchment	M5		TA1		TA2		TB1	
	Land Cover Description	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
1	Aggregate Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Aggregate Site - Pit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Aggregate Site - Quarry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Crop and Pasture	0.00	0.00	0.08	2.15	0.01	0.20	1.68	3.68
5	Crop and Pasture - Cultivated	1.28	58.45	2.73	71.32	2.60	65.37	1.50	3.27
6	Crop and Pasture - Fallow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Evaluated Wetland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	Evaluated Wetland - Bog	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
9	Evaluated Wetland - Fen	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
10	Evaluated Wetland - Marsh	0.00	0.00	0.00	0.00	0.00	0.00	0.71	1.56
11	Evaluated Wetland - Open Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	Evaluated Wetland - Swamp	0.00	0.00	0.00	0.00	0.00	0.00	12.97	28.36
13	Meadow/Thicket	0.08	3.46	0.05	1.33	0.32	8.03	3.54	7.73
14	Settlement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	Settlement - Commercial	0.04	2.00	0.02	0.49	0.00	0.00	0.00	0.00
16	Settlement - Industrial	0.00	0.00	0.01	0.18	0.00	0.00	0.00	0.00
17	Settlement - Pervious	0.13	5.84	0.01	0.14	0.00	0.00	0.01	0.02
18	Settlement - Pervious Homestead	0.07	3.16	0.17	4.46	0.10	2.52	0.27	0.59
19	Settlement - Residential	0.18	8.16	0.08	2.04	0.00	0.06	0.01	0.03
20	Settlement - Estate	0.04	1.79	0.12	3.24	0.09	2.30	0.06	0.14
21	Settlement - Townhouse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	Transportation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	Transportation - Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	Transportation - Major Road	0.00	0.00	0.00	0.00	0.09	2.33	0.00	0.00
25	Transportation - Minor Road	0.09	4.08	0.14	3.73	0.13	3.36	0.17	0.38
26	Transportation - Unpaved Road	0.02	1.08	0.00	0.00	0.03	0.77	0.47	1.02
27	Unevaluated Wetland	0.00	0.00	0.00	0.00	0.00	0.00	3.57	7.80
28	Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	Water - Buffer around wetland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	Water - Lake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	Water - Pond	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
32	Water - River	0.06	2.61	0.00	0.00	0.00	0.00	0.00	0.00
33	Wooded Area	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.33
34	Wooded Area - Fallow	0.00	0.00	0.01	0.23	0.02	0.47	0.04	0.10
35	Wooded Area - Hedgerow	0.04	1.71	0.01	0.25	0.06	1.57	0.03	0.08
36	Wooded Area - Island	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07
37	Wooded Area - Plantation	0.00	0.09	0.00	0.00	0.00	0.04	0.25	0.55
38	Wooded Area - Treed	0.17	7.58	0.40	10.45	0.52	12.97	20.24	44.25
	Total	2.19	100.00	3.83	100.00	3.98	100.00	45.73	100.00

Note: Land cover is based on DRAPE 2014 imagery and the Official Plan of 2003, updated to Official Plan Amendment #211 in 2018, guided projections for land cover changes. Further refinements to the projection were made when suitable development information was available, as was the case with the Maple Forest Estates and Williams Farm subdivisions.

Table 1c: Land cover breakdown in the Stevens basin*

	Catchment	TB2		TC1		Total Stevens	
	Land Cover Description	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
1	Aggregate Site	0.00	0.00	0.00	0.00	0.00	0.00
2	Aggregate Site - Pit	0.00	0.00	0.00	0.00	0.00	0.00
3	Aggregate Site - Quarry	0.00	0.00	0.00	0.00	0.00	0.00
4	Crop and Pasture	2.66	21.48	0.01	0.20	12.56	8.07
5	Crop and Pasture - Cultivated	6.38	51.39	1.98	69.89	41.31	26.54
6	Crop and Pasture - Fallow	0.00	0.00	0.00	0.00	0.00	0.00
7	Evaluated Wetland	0.00	0.00	0.00	0.00	0.00	0.00
8	Evaluated Wetland - Bog	0.00	0.00	0.00	0.00	0.01	0.01
9	Evaluated Wetland - Fen	0.00	0.00	0.00	0.00	0.01	0.01
10	Evaluated Wetland - Marsh	0.00	0.00	0.00	0.00	7.12	4.58
11	Evaluated Wetland - Open Water	0.00	0.00	0.00	0.00	0.00	0.00
12	Evaluated Wetland - Swamp	0.00	0.00	0.00	0.00	18.95	12.18
13	Meadow/Thicket	0.09	0.73	0.06	2.16	7.37	4.73
14	Settlement	0.00	0.00	0.00	0.00	0.00	0.00
15	Settlement - Commercial	0.03	0.20	0.03	0.99	0.23	0.15
16	Settlement - Industrial	0.22	1.76	0.00	0.00	0.23	0.15
17	Settlement - Pervious	0.03	0.20	0.00	0.16	0.30	0.19
18	Settlement - Pervious Homestead	0.37	3.01	0.10	3.46	2.77	1.78
19	Settlement - Residential	0.61	4.94	0.22	7.80	2.49	1.60
20	Settlement - Estate	0.31	2.51	0.03	1.17	1.72	1.10
21	Settlement - Townhouse	0.00	0.00	0.00	0.00	0.01	0.01
22	Transportation	0.00	0.00	0.00	0.00	0.00	0.00
23	Transportation - Rail	0.00	0.00	0.00	0.00	0.00	0.00
24	Transportation - Major Road	0.00	0.00	0.00	0.00	0.28	0.18
25	Transportation - Minor Road	0.30	2.42	0.14	4.78	2.15	1.38
26	Transportation - Unpaved Road	0.07	0.53	0.00	0.00	1.06	0.68
27	Unevaluated Wetland	0.22	1.78	0.00	0.00	8.43	5.42
28	Water	0.00	0.00	0.00	0.00	0.00	0.00
29	Water - Buffer around wetland	0.00	0.00	0.00	0.00	0.00	0.00
30	Water - Lake	0.00	0.00	0.00	0.00	0.00	0.00
31	Water - Pond	0.00	0.00	0.00	0.00	0.02	0.01
32	Water - River	0.03	0.24	0.00	0.00	0.38	0.24
33	Wooded Area	0.00	0.00	0.00	0.00	0.16	0.10
34	Wooded Area - Fallow	0.00	0.00	0.00	0.00	0.07	0.05
35	Wooded Area - Hedgerow	0.19	1.55	0.05	1.76	1.26	0.81
36	Wooded Area - Island	0.00	0.00	0.00	0.00	0.04	0.02
37	Wooded Area - Plantation	0.07	0.55	0.04	1.57	0.71	0.45
38	Wooded Area - Treed	0.83	6.72	0.17	6.06	46.00	29.56
	Total	12.41	100.00	2.84	100.00	155.63	100

Note: Land cover is based on DRAPE 2014 imagery and the Official Plan of 2003, updated to Official Plan Amendment #211 in 2018, guided projections for land cover changes. Further refinements to the projection were made when suitable development information was available, as was the case with the Maple Forest Estates and Williams Farm subdivisions.

Table 2a Hydrological Soil Groups in Stevens Basin

		Soil Group area (km^2)					as percent (%) of catchment area				
Catchment	Area (km^2)	A	B	C	D	Unclassified	A	B	C	D	Unclassified
M1	39.89	0.14	23.76	2.92	13.00	0.04	0.36	59.57	7.33	32.59	0.10
M2	25.02	0.60	9.87	5.85	8.62	0.07	2.39	39.44	23.39	34.44	0.28
M3	0.16	0.00	0.05	0.00	0.00	0.11	0.00	32.20	0.00	0.00	67.74
M4	19.63	0.24	5.00	2.85	11.46	0.07	1.20	25.45	14.51	58.40	0.38
M5	2.19	0.38	1.67	0.06	0.01	0.07	17.20	76.27	2.78	0.66	3.02
TA1	3.83	0.06	1.25	0.00	2.52	0.00	1.69	32.49	0.00	65.75	0.00
TA2	3.99	0.01	1.23	0.11	2.63	0.00	0.23	30.82	2.83	66.06	0.00
TB1	45.76	2.89	21.58	8.53	12.73	0.00	6.32	47.16	18.64	27.81	0.00
TB2	12.41	0.22	4.78	1.64	5.62	0.15	1.75	38.53	13.24	45.23	1.19
TC1	2.84	0.02	0.79	0.00	1.97	0.07	0.54	27.74	0.00	69.33	2.33
Entire Stevens	155.72	4.55	69.97	21.97	58.56	0.57	2.93	44.94	14.11	37.61	0.37

Note: Based on MNRF's LIO (Land Information System) database and documentation by MNR (2012)

Note: Unclassified soils were treated as HSG D. This was guided by an inspection of Figure 3, where such soils are generally surrounded by HSG D and the areas also coincided with built landscapes such North Gower. Development activities will compact and degrade the hydraulic properties of the soil.

Table 2b Permeability in Stevens Basin

		Permeability area (km^2)				as percent (%) of catchment area			
Catchment	Area (km^2)	High	Low-medium	Variable	Low	High	Low-medium	Variable	Low
M1	39.89	17.08	3.80	19.01	0.00	42.82	9.53	47.64	0.00
M2	25.02	1.72	11.33	1.07	10.89	6.88	45.29	4.28	43.55
M3	0.16	0.00	0.00	0.00	0.16	0.00	0.00	0.00	100.00
M4	19.63	0.79	3.64	0.00	15.20	4.01	18.54	0.00	77.46
M5	2.19	0.44	0.19	0.00	1.56	20.05	8.55	0.00	71.40
TA1	3.83	0.04	1.22	0.00	2.56	1.16	31.95	0.00	66.88
TA2	3.99	0.09	1.10	0.00	2.80	2.25	27.58	0.00	70.17
TB1	45.76	18.35	3.68	23.62	0.10	40.10	8.05	51.63	0.22
TB2	12.41	1.07	5.68	0.00	5.67	8.60	45.73	0.00	45.67
TC1	2.84	0.01	0.79	0.00	2.04	0.39	27.74	0.00	71.87
Entire Stevens	155.72	39.59	31.43	43.70	40.99	25.43	20.19	28.06	26.32

Note: Based on Ontario Geological Survey surficial geology layer (OGS 2010)

Table 3a Hydrologic parameters for rural catchments (Stevens Creek)

Catchment	Area (km^2)	Imperviousness [1] (%)	CN [1]	IA [3] (mm)	CN* [2]	IA* [3] (mm)	Tc [4] (hr)	T_{lag} [5] (hr)
M1	39.89	0.9	75.9	16.11	66.6	6.37	45.51	27.30
M2	25.02	5.8	77.6	14.64	69.0	5.71	7.51	4.50
M3	0.16	18.6	81.1	11.85	74.0	4.47	0.33	0.20
M4	19.63	7.1	80.7	12.19	73.3	4.62	4.43	2.66
M5	2.19	9.7	71.2	20.54	60.1	8.42	6.29	3.77
TA1	3.83	7.5	79.8	12.85	72.1	4.91	5.52	3.31
TA2	3.99	16.1	81.0	11.92	73.8	4.50	3.16	1.90
TB1	45.76	1.2	75.3	16.69	65.7	6.63	32.49	19.49
TB2	12.41	7.4	80.0	12.67	72.4	4.83	7.65	4.59
TC1	2.84	12.2	81.5	11.55	74.5	4.34	2.88	1.73
Entire Stevens	155.72	4.0	77.2	15.06	68.4	5.90	---	---

1) Calculated from land cover and TR-55 Curve Number tables (Urban Hydrology for Small Watersheds by USDA-SCS, 1986)

2) Calculated based on equation $CN^*=100/(1.879((100/CN)-1)^{1.15}+1)$ (Curve Number Hydrology by Hawkins et al., 2009)

3) Calculated based $IA=((25400/CN_{\lambda})-254)*\lambda$, where λ=0.2 for CN and λ=0.05 for CN* (Curve Number Hydrology by Hawkins et al., 2009)

4) Calculated based on the velocity method (National engineering handbook Chapter 15 by USDA-NRCS, 2010)

5) Calculated based on $T_{lag} = 0.6 \times Tc$ (HEC-HMS Technical Reference Manual by USACE, 2000)

6) Hydrologic calculations used CN and IA, not CN* and IA*. The latter are included for information purposes only.

Table 3b Estimated channel parameters (Stevens Creek)

Channel	Length [1]	Slope [2]	Manning's "n" [3]		
	(m)	(%)	LOB	Channel	ROB
C1 [4]	5210	0.0453	0.054	0.041	0.055
C2 [5]	640	0.0126	0.050	0.044	0.055
C3	6130	0.0323	0.048	0.040	0.051
C4	1670	0.0250 [6]	0.050	0.038	0.054
C5	6690	0.0932	0.044	0.048	0.048
C6	3330	0.0529	0.045	0.050	0.046
Entire Stevens	23670	0.0525	0.048	0.044	0.050

1) Length of HEC-RAS centerline flowpath for the 100-yr event, within associated routing catchment.

2) Slope = Rise/Run, where Rise was the difference in minimum channel elevations of HEC-RAS cross-sections closest to channel ends.

3) Obtained by averaging the HEC-RAS values within each channel, which themselves were determined from site visits and DRAPE (2014) photography using roughness coefficients outlined by Chow (1959).

4) C1 is considered to start at XS 1480, as upstream is steeper and more confined.

5) A lag time of 15 minutes, determined through analysis of HEC-RAS results, was used for C2 in HEC-HMS.

5) The slope of C4 was increased to offset potential overestimation of attenuation by mildly sloped reaches.

Table 4 Curve number for different land covers and soil groups

	RVCA Land Cover [1]	Corresponding TR-55 land cover category [2]		Assigned Curve Number (CN) [2]				Average [3] Percent Impervious
		Cover description		Soil group				
	Land cover description	Cover type	Hydrologic condition	A	B	C	D	
1	Aggregate Site	Industrial	N/A	81	88	91	93	0
2	Aggregate Site - Pit	Industrial	N/A	81	88	91	93	0
3	Aggregate Site - Quarry	Industrial	N/A	81	88	91	93	0
4	Crop and Pasture	Row crops (SR + CR)	Good	64	75	82	85	0
5	Crop and Pasture - Cultivated	Row crops (SR + CR)	Good	64	75	82	85	0
6	Crop and Pasture - Fallow	Fallow (Crop residue cover)	Good	76	85	90	93	0
7	Evaluated Wetland	N/A	N/A	98	98	98	98	0
8	Evaluated Wetland - Bog	N/A	N/A	98	98	98	98	0
9	Evaluated Wetland - Fen	N/A	N/A	98	98	98	98	0
10	Evaluated Wetland - Marsh	N/A	N/A	98	98	98	98	0
11	Evaluated Wetland - Open Water	N/A	N/A	98	98	98	98	0
12	Evaluated Wetland - Swamp	N/A	N/A	98	98	98	98	0
13	Meadow/Thicket	Pasture, grassland, or range - continuous forage for grazing	Good (>75% ground cover, lightly grazed)	39	61	74	80	0
14	Settlement	Residential district (average lot size 1/4 acre)	N/A	61	75	83	87	38
15	Settlement - Commercial	Urban district (Commercial and business)	N/A	89	92	94	95	85
16	Settlement - Industrial	Urban district (Industrial)	N/A	81	88	91	93	72
17	Settlement - Pervious	Open space (lawns, parks, golf courses, cemeteries, etc)	Good (>75% ground cover)	39	61	74	80	0
18	Settlement - Townhouse	Residential district (average lot size 1/8 acre or less (town houses))	N/A	77	85	90	82	65
19	Settlement - Pervious Homestead	Residential district (average lot size 1/4 acre)	N/A	61	75	83	87	38
20	Settlement - Residential	Residential district (average lot size 1/3 acre)	N/A	57	72	81	86	30
21	Settlement - Estate	Residential district (average lot size 1 acre)	N/A	51	68	79	84	20
22	Transportation	Streets and roads (Paved; curbs and sewers, excluding right of way)	N/A	98	98	98	98	100
23	Transportation - Rail	Streets and roads (Gravel, including right of way)	N/A	76	85	89	91	65
24	Transportation - Major Road	Streets and roads (Paved; curbs and sewers, excluding right of way)	N/A	98	98	98	98	100
25	Transportation - Minor Road	Streets and roads (Paved; open ditches, including right of way)	N/A	83	89	92	93	75
26	Transportation - Unpaved Road	Streets and roads (Gravel, including right of way)	N/A	76	85	89	91	65
27	Unevaluated Wetland	N/A	N/A	98	98	98	98	0
28	Water	N/A	N/A	98	98	98	98	0
29	Water - Buffer around wetland	N/A	N/A	98	98	98	98	0
30	Water - Lake	N/A	N/A	98	98	98	98	0
31	Water - Pond	N/A	N/A	98	98	98	98	0
32	Water - River	N/A	N/A	98	98	98	98	0
33	Wooded Area	Woods	Good	30	55	70	77	0
34	Wooded Area - Fallow	Pasture, grassland, or range - continuous forage for grazing	Fair (50-75% ground cover, grazed)	49	69	79	84	0
35	Wooded Area - Hedgerow	Woods	Poor	45	66	77	83	0
36	Wooded Area - Island	Woods	Good	30	55	70	77	0
37	Wooded Area - Plantation	Woods	Poor	45	66	77	83	0
38	Wooded Area - Treed	Woods	Good	30	55	70	77	0

1) Land cover classes inferred from DRAPE 2014 imagery

2) Values and descriptors extracted from TR-55 "Urban Hydrology for Small Watersheds", USDA, Natural Resources Conservation Service, June 1986

3) Values extracted from TR-55 "Urban Hydrology for Small Watersheds" (USDA-NRCS, 1986) for Settlement classes and inferred for Transportation classes based on CN values and visual assessment.

Table 5 Characteristics of design storms

	Duration (hour)	Total volume (mm)	Peak intensity (mm/hr)	Time step (minutes)	Source of hyetograph shape
Chicago 3 hour	3	74.43	168.71	10	Generated by STORMS software
Chicago 6 hour	6	88.42	168.71	10	Generated by STORMS software
Chicago 12 hour	12	104.44	168.71	10	Generated by STORMS software
Chicago 24 hour	24	123.02	168.71	10	Generated by STORMS software
SCS 3 hour	3	74.47	80.87	30	City of Ottawa Sewer Design Guidelines 2012
SCS 6 hour	6	88.43	85.25	30	City of Ottawa Sewer Design Guidelines 2012
SCS 12 hour	12	104.44	89.40	30	City of Ottawa Sewer Design Guidelines 2012
SCS 24 hour	24	123.01	93.49	30	Generated by STORMS software

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Table 6 Estimated peak flows generated by various storms

Storm	3H Chicago	6H Chicago	12H Chicago	24H Chicago	3H SCS	6H SCS	12H SCS	**24H SCS**
Return Period	100 year	100 year	100 year	100 year	100 year	100 year	100 year	**100 year**
Flow	(cms)	(cms)	(cms)	(cms)	(cms)	(cms)	(cms)	**(cms)**
Catchments								
M1	7.43	10.37	13.91	17.68	7.44	10.38	13.98	**18.10**
M2	29.96	37.56	42.21	47.25	30.35	39.73	46.80	**53.40**
M3	1.74	2.06	2.37	2.66	1.52	1.93	2.32	**2.69**
M4	43.56	49.83	55.70	62.35	45.21	54.53	62.35	**70.62**
M5	2.12	2.71	3.09	3.53	2.17	2.93	3.50	**4.13**
TA1	6.78	7.98	8.90	9.96	6.94	8.64	9.93	**11.27**
TA2	11.58	13.04	14.65	16.42	12.29	14.42	16.51	**18.69**
TB1	11.52	16.14	21.52	26.36	11.53	16.17	21.77	**27.64**
TB2	16.57	20.51	22.91	25.48	16.77	21.62	25.24	**28.49**
TC1	9.03	10.16	11.42	12.79	9.65	11.24	12.87	**14.52**
Nodes								
N1	7.43	10.37	13.91	17.68	7.44	10.38	13.98	**18.10**
N2	29.97	37.57	42.22	47.27	30.36	39.74	46.81	**53.42**
N3	31.45	40.63	45.80	51.11	31.77	42.24	50.41	**57.25**
N4	44.20	61.05	75.83	83.43	45.22	60.37	80.15	**90.51**
N5	49.42	68.65	84.70	93.27	49.42	68.61	89.53	**101.63**
N6	9.03	10.16	11.42	12.79	9.65	11.24	12.87	**14.52**
N7	11.52	16.14	21.52	26.36	11.53	16.17	21.77	**27.64**
N8	16.58	20.52	22.92	26.40	16.78	21.63	25.25	**28.49**
N9	6.78	7.98	8.90	9.96	6.94	8.64	9.93	**11.27**
N10	11.58	13.04	14.66	16.43	12.30	14.43	16.52	**18.89**
J1	31.45	40.63	45.70	51.00	31.77	42.24	50.32	**57.17**
J2	48.03	61.15	68.72	76.60	48.54	63.87	75.66	**85.74**
J3	53.67	70.33	85.95	94.55	55.79	69.18	91.14	**102.55**
Channels								
C1	7.42	10.35	13.87	17.59	7.43	10.36	13.95	**18.02**
C2	31.45	40.63	45.70	51.00	31.77	42.24	50.32	**57.17**
C3	39.36	51.06	59.09	65.46	39.65	52.53	64.10	**72.54**
C4	48.58	67.01	82.87	91.21	48.62	67.03	87.48	**99.34**
C5	11.28	15.98	21.31	26.21	11.29	16.03	21.58	**27.44**
C6	5.73	7.07	7.90	8.82	5.82	7.50	8.74	**9.91**

Table 7 SCS Type II 24 hour design storms for different return periods

Return Period (year)	Total volume (mm)	Peak intensity (mm/hr)	Time step (minutes)	hyetograph generated by
2	50.48	38.08	30	STORMS software
5	70.01	53.21	30	STORMS software
10	82.57	62.75	30	STORMS software
20	95.07	72.25	30	STORMS software
50	110.92	84.3	30	STORMS software
100	**123.01**	**93.49**	**30**	**STORMS software**
200	134.57	102.27	30	STORMS software
350	144.20	109.59	30	STORMS software
500	150.84	114.64	30	STORMS software

Table 8 Estimated peak flows for SCS Type II 24 hour design storm

Storm	24 hour SCS Type II								
Return Period	2 year	5 year	10 year	20 year	50 year	**100 year**	200 year	350year	500 year
Flow	(cms)	(cms)	(cms)	(cms)	(cms)	**(cms)**	(cms)	(cms)	(cms)
Catchments									
M1	2.98	6.40	8.91	11.60	15.22	**18.10**	20.94	23.37	25.07
M2	8.48	18.60	26.12	34.09	44.85	**53.40**	61.78	68.90	73.88
M3	0.54	1.07	1.43	1.81	2.30	**2.69**	3.05	3.36	3.58
M4	12.88	26.55	36.33	46.52	60.00	**70.62**	80.92	89.61	95.66
M5	0.43	1.17	1.77	2.44	3.37	**4.13**	4.89	5.54	6.00
TA1	1.98	4.14	5.71	7.36	9.54	**11.27**	12.95	14.37	15.36
TA2	3.45	7.09	9.67	12.36	15.90	**18.69**	21.39	23.67	25.25
TB1	4.39	9.59	13.44	17.58	23.18	**27.64**	32.04	35.81	38.46
TB2	5.14	10.59	14.53	18.66	24.15	**28.49**	32.71	36.28	38.77
TC1	2.75	5.58	7.58	9.65	12.38	**14.52**	16.58	18.32	19.53
Nodes									
N1	2.98	6.40	8.91	11.60	15.22	**18.10**	20.94	23.37	25.07
N2	8.49	18.61	26.13	34.10	44.87	**53.42**	61.81	68.93	73.92
N3	9.34	20.21	28.23	36.73	48.17	**57.25**	66.14	73.69	78.98
N4	15.70	33.39	46.30	58.81	76.41	**90.51**	104.44	116.37	124.73
N5	16.74	36.33	51.05	65.58	85.57	**101.63**	117.55	131.21	140.83
N6	2.75	5.58	7.58	9.65	12.38	**14.52**	16.58	18.32	19.53
N7	4.39	9.59	13.44	17.58	23.18	**27.64**	32.04	35.81	38.46
N8	5.15	10.60	14.54	18.67	24.15	**28.49**	32.72	36.29	38.78
N9	1.98	4.14	5.71	7.36	9.54	**11.27**	12.95	14.37	15.36
N10	3.45	7.09	9.68	12.37	15.93	**18.89**	21.83	24.32	26.03
J1	9.32	20.17	28.18	36.67	48.09	**57.17**	66.05	73.59	78.87
J2	14.49	30.81	42.78	55.39	72.32	**85.74**	98.85	109.98	117.76
J3	17.82	37.91	52.68	66.70	86.59	**102.55**	118.35	131.92	141.48
Channels									
C1	2.97	6.38	8.87	11.55	15.16	**18.02**	20.83	23.23	24.93
C2	9.32	20.17	28.18	36.67	48.09	**57.17**	66.05	73.59	78.87
C3	12.27	26.36	36.70	47.07	61.23	**72.54**	83.67	93.16	99.80
C4	16.51	35.73	50.12	64.30	83.74	**99.34**	114.77	127.99	137.30
C5	4.37	9.54	13.27	17.38	22.96	**27.44**	31.83	35.61	38.31
C6	1.64	3.58	4.97	6.42	8.37	**9.91**	11.41	12.68	13.57

Table 9 Estimated flows for hydraulic modeling (HEC-RAS)

			Return Period (year)	2	5	10	20	50	100	200	350	500
Stream	Reach	Nearest Cross Section	Distance from Rideau Confluence (m)	Flow (cms)								
Stevens Creek	Reach 4	1525	15318	2.98	6.40	8.91	11.60	15.22	**18.10**	20.94	23.37	25.07
Stevens Creek	Reach 4	1500	14702	6.08	13.25	18.55	24.19	31.80	**37.84**	43.78	48.84	52.38
Stevens Creek	Reach 4	1465	13162	7.45	16.28	22.84	29.79	39.19	**46.65**	53.98	60.20	64.56
Stevens Creek	Reach 4	1415	10875	8.49	18.61	26.13	34.10	44.87	**53.42**	61.81	68.93	73.92
Stevens Creek	Reach 3	1350	8489	9.34	20.21	28.23	36.73	48.17	**57.25**	66.14	73.69	78.98
Stevens Creek	Reach 2	1300	7854	15.05	32.01	44.42	56.99	74.24	**87.98**	101.48	112.98	121.04
Stevens Creek	Reach 2	1225	5094	15.70	33.39	46.30	58.81	76.41	**90.51**	104.44	116.37	124.73
Stevens Creek	Reach 1	1145	1667	17.82	37.91	52.68	66.70	86.59	**102.55**	118.35	131.92	141.48
Tributary A	Reach 1	2225	5376	1.98	4.14	5.71	7.36	9.54	**11.27**	12.95	14.37	15.36
Tributary A	Reach 1	2210	5050	2.36	4.92	6.77	8.69	11.25	**13.30**	15.31	17.01	18.19
Tributary A	Reach 1	2175	3576	2.59	5.36	7.36	9.44	12.21	**14.45**	16.65	18.51	19.79
Tributary A	Reach 1	2125	2434	3.45	7.09	9.68	12.37	15.93	**18.89**	21.83	24.32	26.03
Tributary B	Reach 1	3355	14865	4.39	9.59	13.44	17.58	23.18	**27.64**	32.04	35.81	38.46
Tributary B	Reach 1	3330	14501	5.15	10.60	14.54	18.67	24.15	**28.49**	32.72	36.29	38.78
Tributary C	Reach 1	4145	10070	2.75	5.58	7.58	9.65	12.38	**14.52**	16.58	18.32	19.53

Table 10 Computed water level and energy grade of the Rideau River

Return Period (years)	Rideau River Water Level at Cross Section 1700 (m)	Rideau River Energy Grade at Cross Section 1700 (m)
2	86.08	86.09
5	86.49	86.49
10	86.71	86.71
20	86.89	86.9
50	87.10	87.11
100	87.25	87.25
200	87.38	87.39
350	87.46	87.47
500	87.54	87.55

Source: RVCA (2017) Rideau River Flood Risk Mapping from Kars to Burritts Rapids, 18 July 2017. (https://www.rvca.ca/media/k2/attachments/RideauMappingKarstoBR.pdf)

The Navigation Level of the Rideau River at the outlet of Stevens Creek is 85.5m during the summer months and was taken as the downstream boundary condition for the Stevens Creek HEC-RAS model.

Table 11 Structures on Stevens Creek (used in the HEC-RAS model)

Stream	Location	Bridge or Culvert	Bounding Cross Sections	Width[1] (m)	Height[1] (m)	Length[2] (m)	Upstream Invert[1] (m)	Downstream Invert[1] (m)	Upstream Obvert[1] (m)	Downstream Obvert[1] (m)	Source(s)
Stevens Creek	Rideau Valley Drive	B	1110 & 1115	23.22	3.66	12.04	83.67	83.67	87.09	87.33	RVCA Survey June 6th 2018, and City of Ottawa drawing: Steven Creek Bridge Rehabilitation, Drawing # B87301005-001,-002,-003 DM Wills Associates. June 2006.
Stevens Creek	Roger Stevens Drive near Kars	B	1150 & 1155	33.22	3.59	14.33	83.74	83.84	87.33	87.29	RVCA Survey June 6th 2018, and City of Ottawa drawing: Steven Creek Bridge Rehabilitation, Drawing # B-7302007-004,-006 McCormick Rankin. June 2005.
Stevens Creek	2nd Line Road South	B	1185 & 1190	13.96	4.05	6.30	84.27	82.95	86.98	87.00	RVCA Survey June 6th 2018, and City of Ottawa drawing: Structures No. 7303 & No. 8234 Bridge Rehabilitation, Drawing # B-730301-001 Remisz Consulting Engineers. August 2002.
Stevens Creek	HWY 416 Northbound	B	1205 & 1207	23.00	5.01	13.50	84.30	84.27	89.28	89.28	Ministry of Transportation drawing: Steven Creek Bridge, CONT No 83-15, WP No 145-74-04, McNeely Engineering & Structures, January 1983.
Stevens Creek	HWY 416 Southbound	B	1208 & 1210	23.00	4.97	12.96	84.32	84.31	89.28	89.28	Ministry of Transportation drawing: Steven Creek Bridge HWY 416 Southbound Lanes, CONT No 96-07, WP No 187-89-03, UMA Engineering, April 1996.
Stevens Creek	3rd Line Road South	B	1240 & 1245	14.04	3.58	6.25	85.18	84.45	88.06	88.03	RVCA Survey June 6th 2018, and City of Ottawa drawing: Plan for rigid frame bridge over Stevens Creek, Drawing # B-730401-1.
Stevens Creek	6530 3rd Line Road South	B	1260 & 1245	9.70	3.65	4.68	85.11	84.46	88.13	88.11	RVCA Survey November 11th 2019
Stevens Creek	Roger Stevens Drive in North Gower	B	1310 & 1315	16.61	2.93	16.50	86.08	85.98	88.93	88.91	RVCA Survey June 5th 2018, and City of Ottawa drawing: Structural Repairs - Four Locations, Drawing # B87305008 Dessau. July 2014.
Stevens Creek	4th Line Road in North Gower	B	1345 & 1350	21.95	4.67	15.04	85.46	86.21	90.13	90.07	RVCA Survey June 5th 2018, and City of Ottawa drawing: Stevens Creek Bridge Rehabilitation Fourth Line Road, Drawing # B87309003-001, Dillon Consulting. February 2007
Stevens Creek	Church Street	B	1360 & 1365	15.30	3.50	11.60	86.66	86.57	90.04	90.07	RVCA Survey June 5th 2018
Stevens Creek	McCordick Road Near Church Street	B	1420 & 1425	12.05	2.94	9.54	86.51	86.51	89.45	89.39	RVCA Survey June 5th 2018
Stevens Creek	Malakoff Road Near Pierce Road	B	1510 & 1515	9.24	1.59	10.33	92.07	91.96	93.56	93.55	RVCA Survey May 25th 2018, and City of Ottawa drawing: Malakoff Road Bridge, Drawing # B-631203-00,-01,-02 Totten Sims Hubicki Associates. October 1987.
Tributary A (Dillon-Wallace)	Roger Stevens Drive at 2nd Line Road South	C	2130 & 2135	2.69	1.85	21.60	85.27	85.38	87.22	87.28	RVCA Survey June 6th 2018
Tributary A (Dillon-Wallace)	2nd Line Road South at Roger Stevens Drive	C	2145 & 2150	2.61	1.80	15.90	85.27	85.33	87.22	87.03	RVCA Survey June 6th 2018
Tributary A (Dillon-Wallace)	HWY 416	C	2175 & 2180	3.80	2.40	105.80	85.22	85.43	87.62	87.83	RVCA Survey June 24th 2019
Tributary A (Dillon-Wallace)	Roger Stevens Drive and 3rd Line Road South	C	2210 & 2215	3.05	1.44	22.80	86.76	86.71	88.20	88.15	RVCA Survey June 6th 2018, and City of Ottawa drawing: Steven Creek Bridge Extension Structure No. 7702, Drawing # B-770203-001 Wyllie & Ufnal. January 2000.
Tributary B (Taylor Drain)	James Craig Street	B	3115 & 3120	6.10	2.21	9.10	86.48	86.44	88.64	88.65	RVCA Survey June 5th 2018, and City of Ottawa drawing: Craig Street Bridge, Drawing # B-774101-01, -02 Totten Sims Hubicki Associates. August 1986.
Tributary B (Taylor Drain)	Prince of Wales Drive	B	3135 & 3140	19.81	3.08	17.37	86.41	86.56	89.49	89.46	RVCA Survey June 5th 2018, and City of Ottawa drawing: North Gower Bridge Rehabilitation, Drawing # B-87742004-001 Dillon Consulting. June 2006.
Tributary B (Taylor Drain)	Edward Kidd Park Ped Bridge	B	3175 & 3180	17.93	1.88	2.40	87.14	87.12	88.97	89.00	RVCA Survey June 5th 2018, and City of Ottawa drawing: Edward Kidd Park Pedestrian Bridge #1, Drawing # B87104002-001. October 2012.
Tributary B (Taylor Drain)	4th Line Road Near Shellstar Drive	B	3210 & 3215	10.36	3.18	10.78	88.25	88.26	91.40	91.44	RVCA Survey June 5th 2018, and City of Ottawa drawing: Hodgins Bridge Rehabilitation, Drawing # B-774307-001 Harmer Podolak. March 2005.
Tributary B (Taylor Drain)	McCordick Road North of Roger Stevens Drive	C	3285 & 3290	6.55	1.90	9.75	89.76	89.83	91.20	91.27	RVCA Survey June 5th 2018, and City of Ottawa drawing: Concrete Rigid Frame Culvert, Drawing # B-674401.
Tributary B (Taylor Drain)	Malakoff Road Near Pollock Road	C	3340 & 6645	4.25	2.60	11.60	92.58	92.60	94.02	94.04	RVCA Survey May 2th 2018, and City of Ottawa drawing: Malakoff Road over Taylor Drain, McIntosh Perry. March 2010.

1) RVCA Surveys 2018/2019 as well as design drawings
2) From DRAPE imagery as well as GPS coordinates from RVCA Survey 2013/2015

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Table 12 Calculated head loss at road crossings (during 1:100 Year flood]

Stream	Location	Chainage (m)	Bounding Cross Sections	Upstream Energy Grade (m)	Downstream Energy Grade (m)	Head Loss (cm)	Road Overtopped
Stevens Creek	Rideau Valley Drive	139	1110 & 1115	86.39	86.22	17	No
Stevens Creek	Roger Stevens Drive near Kars	1840	1150 & 1155	87.24	87.14	10	No
Stevens Creek	2nd Line Road South	3372	1185 & 1190	87.97	87.60	37	Yes
Stevens Creek	HWY 416 Northbound	3814	1205 & 1207	88.31	88.27	4	No
Stevens Creek	HWY 416 Southbound	3872	1208 & 1210	88.37	88.33	4	No
Stevens Creek	3rd Line Road South	5807	1240 & 1245	88.64	88.62	2	Yes
Stevens Creek	6530 3rd Line Road South	6458	1260 & 1265	88.79	88.68	11	Yes
Stevens Creek	Roger Stevens Drive in North Gower	8017	1310 & 1315	89.31	89.20	11	No
Stevens Creek	4th Line Road in North Gower	8472	1345 & 1350	89.49	89.48	1	No
Stevens Creek	Church Street	8595	1360 & 1365	89.62	89.59	3	No
Stevens Creek	McCordick Road Near Church Street	10964	1420 & 1425	90.09	89.92	17	Yes
Stevens Creek	Malakoff Road Near Pierce Road	14948	1510 & 1515	93.58	93.39	19	No
Tributary A (Dillon-Wallace)	Roger Stevens Drive at 2nd Line Road South	2597	2130 & 2135	87.95	87.36	59	Yes
Tributary A (Dillon-Wallace)	2nd Line Road South at Roger Stevens Drive	2719	2145 & 2150	88.00	87.95	5	Yes
Tributary A (Dillon-Wallace)	HWY 416	3634	2175 & 2180	89.36	88.12	124	No
Tributary A (Dillon-Wallace)	Roger Stevens Drive and 3rd Line Road South	5067	2210 & 2215	89.67	89.37	30	Yes
Tributary B (Taylor Drain)	James Craig Street	8068	3115 & 3120	89.55	89.30	25	Yes
Tributary B (Taylor Drain)	Prince of Wales Drive	8261	3135 & 3140	89.67	89.59	8	Yes
Tributary B (Taylor Drain)	Edward Kidd Park Ped Bridge	9085	3175 & 3180	89.94	89.93	1	Yes
Tributary B (Taylor Drain)	4th Line Road Near Shellstar Drive	9543	3210 & 3215	90.84	90.76	8	No
Tributary B (Taylor Drain)	McCordick Road North of Roger Stevens Drive	12170	3285 & 3290	92.66	92.36	30	Yes
Tributary B (Taylor Drain)	Malakoff Road Near Pollock Road	14730	3340 & 3345	95.75	95.35	40	Yes

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Table 13 Regulatory Flood Levels for 100 Year Flood Event

River	Reach	Xsec ID #	Q (total) (cms)	Computed WSEL (m)	EGL (m)	RFL (m)
Stevens Creek	Reach 1	1100	102.55	85.50	85.75	---
	Reach 1	1105	102.55	85.93	86.12	---
	Reach 1	1110	102.55	85.98	86.22	---
	Reach 1	1113	Rideau Valley Drive			
	Reach 1	1115	102.55	86.34	86.39	86.39
	Reach 1	1120	102.55	86.51	86.53	86.53
	Reach 1	1125	102.55	86.58	86.61	86.61
	Reach 1	1130	102.55	86.67	86.69	86.69
	Reach 1	1135	102.55	86.71	86.75	86.75
	Reach 1	1140	102.55	86.84	86.88	86.88
	Reach 1	1145	102.55	86.99	87.04	87.04
	Reach 2	1150	90.51	87.10	87.14	87.14
	Reach 2	1151	Roger Stevens Drive near Kars			
	Reach 2	1155	90.51	87.22	87.24	87.24
	Reach 2	1160	90.51	87.26	87.27	87.27
	Reach 2	1165	90.51	87.31	87.32	87.32
	Reach 2	1170	90.51	87.38	87.39	87.39
	Reach 2	1175	90.51	87.41	87.44	87.44
	Reach 2	1180	90.51	87.49	87.56	87.56
	Reach 2	1185	90.51	87.60	87.60	87.60
	Reach 2	1186	2nd Line Road South			
	Reach 2	1190	90.51	87.95	87.97	87.97
	Reach 2	1195	90.51	87.93	88.09	88.09
	Reach 2	1200	90.51	88.18	88.21	88.21
	Reach 2	1205	90.51	88.21	88.27	88.27
	Reach 2	1206	HWY 416 Northbound			
	Reach 2	1207	90.51	88.24	88.31	88.31
	Reach 2	1207.5	90.51	88.24	88.32	88.32
	Reach 2	1208	90.51	88.23	88.33	88.33
	Reach 2	1209	HWY 416 Southbound			
	Reach 2	1210	90.51	88.35	88.37	88.37
	Reach 2	1215	90.51	88.38	88.40	88.40
	Reach 2	1220	90.51	88.46	88.47	88.47
	Reach 2	1225	90.51	88.52	88.57	88.57
	Reach 2	1230	87.98	88.61	88.62	88.62
	Reach 2	1235	87.98	88.62	88.62	88.62
	Reach 2	1240	87.98	88.62	88.62	88.62
	Reach 2	1241	3rd Line Road South			
	Reach 2	1245	87.98	88.64	88.64	88.64
	Reach 2	1250	87.98	88.65	88.65	88.65
	Reach 2	1255	87.98	88.66	88.67	88.67
	Reach 2	1260	87.98	88.67	88.68	88.68
	Reach 2	1263	6530 3rd Line Road South			
	Reach 2	1265	87.98	88.78	88.79	88.79
	Reach 2	1270	87.98	88.80	88.81	88.81
	Reach 2	1275	87.98	88.84	88.86	88.86
	Reach 2	1280	87.98	88.86	88.92	88.92
	Reach 2	1285	87.98	88.97	88.97	88.97
	Reach 2	1290	87.98	88.99	89.00	89.00
	Reach 2	1295	87.98	89.02	89.11	89.11
	Reach 2	1300	87.98	89.15	89.16	89.16

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River	Reach	Xsec ID #	Q (total) (cms)	Computed WSEL (m)	EGL (m)	RFL (m)
Stevens Creek	Reach 3	1305	57.25	89.15	89.17	89.17
	Reach 3	1310	57.25	89.15	89.20	89.20
	Reach 3	1313	Roger Stevens Drive in North Gower			
	Reach 3	1315	57.25	89.29	89.31	89.31
	Reach 3	1320	57.25	89.31	89.32	89.32
	Reach 3	1325	57.25	89.32	89.32	89.32
	Reach 3	1330	57.25	89.32	89.33	89.33
	Reach 3	1335	57.25	89.33	89.34	89.34
	Reach 3	1340	57.25	89.27	89.41	89.41
	Reach 3	1345	57.25	89.44	89.48	89.48
	Reach 3	1348	4th Line Road in North Gower			
	Reach 3	1350	57.25	89.47	89.49	89.49
	Reach 4	1355	53.42	89.48	89.54	89.54
	Reach 4	1360	53.42	89.49	89.59	89.59
	Reach 4	1363	Church Street			
	Reach 4	1365	53.42	89.55	89.62	89.62
	Reach 4	1370	53.42	89.62	89.66	89.66
	Reach 4	1375	53.42	89.66	89.68	89.68
	Reach 4	1380	53.42	89.69	89.70	89.70
	Reach 4	1385	53.42	89.70	89.71	89.71
	Reach 4	1390	53.42	89.73	89.73	89.73
	Reach 4	1395	53.42	89.74	89.74	89.74
	Reach 4	1400	53.42	89.75	89.75	89.75
	Reach 4	1405	53.42	89.75	89.79	89.79
	Reach 4	1410	53.42	89.88	89.89	89.89
	Reach 4	1415	53.42	89.91	89.91	89.91
	Reach 4	1420	46.65	89.92	89.92	89.92
	Reach 4	1423	McCordick Road near Church Street			
	Reach 4	1425	46.65	90.09	90.09	90.09
	Reach 4	1430	46.65	90.10	90.10	90.10
	Reach 4	1435	46.65	90.10	90.12	90.12
	Reach 4	1440	46.65	90.15	90.16	90.16
	Reach 4	1445	46.65	90.18	90.19	90.19
	Reach 4	1450	46.65	90.21	90.22	90.22
	Reach 4	1455	46.65	90.26	90.26	90.26
	Reach 4	1460	46.65	90.26	90.27	90.27
	Reach 4	1465	46.65	90.28	90.29	90.29
	Reach 4	1470	37.84	90.31	90.31	90.31
	Reach 4	1475	37.84	90.34	90.34	90.34
	Reach 4	1480	37.84	90.41	90.43	90.43
	Reach 4	1485	37.84	90.50	90.62	90.62
	Reach 4	1490	37.84	91.05	91.31	91.31
	Reach 4	1495	37.84	91.84	92.07	92.07
	Reach 4	1500	37.84	92.73	92.90	92.90
	Reach 4	1505	18.10	93.12	93.19	93.19
	Reach 4	1510	18.10	93.31	93.39	93.39
	Reach 4	1513	Malakoff road near Pierce Road			
	Reach 4	1515	18.10	93.52	93.58	93.58
	Reach 4	1520	18.10	93.68	93.69	93.69
	Reach 4	1525	18.10	93.84	93.90	93.90

River	Reach	Xsec ID #	Q (total) (cms)	Computed WSEL (m)	EGL (m)	RFL (m)
Tributary A	Reach 1	2100	18.89	87.16	87.17	87.17
	Reach 1	2105	18.89	87.19	87.19	87.19
	Reach 1	2110	18.89	87.21	87.22	87.22
	Reach 1	2115	18.89	87.23	87.23	87.23
	Reach 1	2120	18.89	87.23	87.23	87.23
	Reach 1	2125	18.89	87.24	87.24	87.24
	Reach 1	2130	14.45	87.21	87.36	87.36
	Reach 1	2133	Roger Stevens Drive at 2nd Line Road South			
	Reach 1	2135	14.45	87.95	87.95	87.95
	Reach 1	2140	14.45	87.95	87.95	87.95
	Reach 1	2145	14.45	87.95	87.95	87.95
	Reach 1	2148	2nd Line Road South at Roger Stevens Drive			
	Reach 1	2150	14.45	88.00	88.00	88.00
	Reach 1	2151	14.45	88.00	88.00	88.00
	Reach 1	2155	14.45	88.00	88.00	88.00
	Reach 1	2160	14.45	88.00	88.00	88.00
	Reach 1	2165	14.45	88.01	88.01	88.01
	Reach 1	2170	14.45	88.04	88.04	88.04
	Reach 1	2171	14.45	88.05	88.06	88.06
	Reach 1	2175	14.45	88.04	88.12	88.12
	Reach 1	2178	HWY 416			
	Reach 1	2180	13.30	89.36	89.36	89.36
	Reach 1	2181	13.30	89.36	89.37	89.37
	Reach 1	2185	13.30	89.37	89.37	89.37
	Reach 1	2190	13.30	89.37	89.37	89.37
	Reach 1	2195	13.30	89.37	89.37	89.37
	Reach 1	2200	13.30	89.37	89.37	89.37
	Reach 1	2205	13.30	89.37	89.37	89.37
	Reach 1	2210	13.30	89.37	89.37	89.37
	Reach 1	2213	Roger Stevens Drive and 3rd Line Road South			
	Reach 1	2215	11.27	89.66	89.67	89.67
	Reach 1	2220	11.27	89.67	89.67	89.67
	Reach 1	2221	11.27	89.67	89.67	89.67
	Reach 1	2225	11.27	89.67	89.67	89.67
Tributary B	Reach 1	3100	28.49	89.16	89.16	89.16
	Reach 1	3105	28.49	89.16	89.17	89.17
	Reach 1	3110	28.49	89.12	89.24	89.24
	Reach 1	3115	28.49	89.26	89.30	89.30
	Reach 1	3118	James Craig Street			
	Reach 1	3120	28.49	89.53	89.55	89.55
	Reach 1	3125	28.49	89.57	89.57	89.57
	Reach 1	3130	28.49	89.58	89.58	89.58
	Reach 1	3135	28.49	89.58	89.59	89.59
	Reach 1	3138	Prince of Wales Drive			
	Reach 1	3140	28.49	89.66	89.67	89.67
	Reach 1	3145	28.49	89.68	89.68	89.68
	Reach 1	3150	28.49	89.69	89.69	89.69
	Reach 1	3155	28.49	89.69	89.69	89.69
	Reach 1	3160	28.49	89.71	89.72	89.72
	Reach 1	3165	28.49	89.80	89.83	89.83
	Reach 1	3170	28.49	89.85	89.90	89.90
	Reach 1	3175	28.49	89.92	89.93	89.93

River	Reach	Xsec ID #	Q (total) (cms)	Computed WSEL (m)	EGL (m)	RFL (m)
Tributary B	Reach 1	3178	Edward Kidd Park Ped Bridge			
	Reach 1	3180	28.49	89.93	89.94	89.94
	Reach 1	3185	28.49	89.93	89.96	89.96
	Reach 1	3190	28.49	89.93	90.06	90.06
	Reach 1	3195	28.49	90.15	90.17	90.17
	Reach 1	3200	28.49	90.15	90.29	90.29
	Reach 1	3205	28.49	90.48	90.62	90.62
	Reach 1	3210	28.49	90.68	90.76	90.76
	Reach 1	3213	4th Line Road near Shellstar Drive			
	Reach 1	3215	28.49	90.78	90.84	90.84
	Reach 1	3220	28.49	90.88	90.90	90.90
	Reach 1	3225	28.49	90.93	90.96	90.96
	Reach 1	3230	28.49	91.08	91.13	91.13
	Reach 1	3235	28.49	91.30	91.32	91.32
	Reach 1	3240	28.49	91.36	91.37	91.37
	Reach 1	3245	28.49	91.47	91.50	91.50
	Reach 1	3250	28.49	91.58	91.61	91.61
	Reach 1	3255	28.49	91.72	91.76	91.76
	Reach 1	3260	28.49	91.79	91.84	91.84
	Reach 1	3265	28.49	91.94	91.96	91.96
	Reach 1	3270	28.49	92.04	92.06	92.06
	Reach 1	3275	28.49	92.16	92.19	92.19
	Reach 1	3280	28.49	92.31	92.32	92.32
	Reach 1	3285	28.49	92.36	92.36	92.36
	Reach 1	3288	McCordick Road North of Roger Stevens Drive			
	Reach 1	3290	28.49	92.66	92.66	92.66
	Reach 1	3295	28.49	92.66	92.66	92.66
	Reach 1	3300	28.49	92.67	92.67	92.67
	Reach 1	3301	28.49	92.59	92.77	92.77
	Reach 1	3305	28.49	93.21	93.26	93.26
	Reach 1	3306	28.49	93.45	93.51	93.51
	Reach 1	3310	28.49	93.66	93.66	93.66
	Reach 1	3315	28.49	93.71	93.72	93.72
	Reach 1	3320	28.49	93.78	93.78	93.78
	Reach 1	3321	28.49	93.86	93.88	93.88
	Reach 1	3325	28.49	94.36	94.42	94.42
	Reach 1	3326	28.49	94.79	94.82	94.82
	Reach 1	3330	28.49	94.92	94.93	94.93
	Reach 1	3335	27.64	95.11	95.14	95.14
	Reach 1	3340	27.64	95.16	95.35	95.35
	Reach 1	3343	Malakoff Road near Pollock Road			
	Reach 1	3345	27.64	95.75	95.75	95.75
	Reach 1	3350	27.64	95.76	95.76	95.76
	Reach 1	3355	27.64	95.76	95.77	95.77

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River	Reach	Xsec ID #	Q (total) (cms)	Computed WSEL (m)	EGL (m)	RFL (m)
Tributary C	Reach 1	4100	14.52	89.51	89.51	89.51
	Reach 1	4105	14.52	89.51	89.51	89.51
	Reach 1	4110	14.52	89.52	89.52	89.52
	Reach 1	4115	14.52	89.53	89.53	89.53
	Reach 1	4120	14.52	89.53	89.53	89.53
	Reach 1	4125	14.52	89.53	89.53	89.53
	Reach 1	4130	14.52	89.54	89.54	89.54
	Reach 1	4135	14.52	89.54	89.55	89.55
	Reach 1	4140	14.52	89.61	89.62	89.62
	Reach 1	4145	14.52	89.85	89.87	89.87

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Table 14 Flows and computed water levels for the 2, 5, 10, and 20 year flood events

River	Reach	Xsec ID #	Flow (m^3/s) and Computed WSEL (m) for Different Flood Events							
			Q2	WL2	Q5	WL5	Q10	WL10	Q20	WL20
Stevens Creek	Reach 1	1100	17.82	85.50	37.91	85.50	52.68	85.50	66.70	85.50
	Reach 1	1105	17.82	85.52	37.91	85.57	52.68	85.64	66.70	85.70
	Reach 1	1110	17.82	85.52	37.91	85.59	52.68	85.67	66.70	85.75
	Reach 1	1113	Rideau Valley Drive							
	Reach 1	1115	17.82	85.54	37.91	85.68	52.68	85.81	66.70	85.95
	Reach 1	1120	17.82	85.57	37.91	85.77	52.68	85.94	66.70	86.11
	Reach 1	1125	17.82	85.61	37.91	85.86	52.68	86.05	66.70	86.21
	Reach 1	1130	17.82	85.64	37.91	85.92	52.68	86.12	66.70	86.30
	Reach 1	1135	17.82	85.66	37.91	85.98	52.68	86.18	66.70	86.35
	Reach 1	1140	17.82	85.71	37.91	86.07	52.68	86.30	66.70	86.48
	Reach 1	1145	17.82	85.77	37.91	86.20	52.68	86.44	66.70	86.62
	Reach 2	1150	15.70	85.81	33.39	86.27	46.30	86.53	58.81	86.73
	Reach 2	1151	Roger Stevens Drive near Kars							
	Reach 2	1155	15.70	85.82	33.39	86.30	46.30	86.58	58.81	86.80
	Reach 2	1160	15.70	85.85	33.39	86.35	46.30	86.63	58.81	86.84
	Reach 2	1165	15.70	85.90	33.39	86.43	46.30	86.70	58.81	86.90
	Reach 2	1170	15.70	86.01	33.39	86.54	46.30	86.80	58.81	87.00
	Reach 2	1175	15.70	86.09	33.39	86.60	46.30	86.85	58.81	87.05
	Reach 2	1180	15.70	86.14	33.39	86.67	46.30	86.93	58.81	87.12
	Reach 2	1185	15.70	86.17	33.39	86.72	46.30	87.00	58.81	87.20
	Reach 2	1186	2nd Line Road South							
	Reach 2	1190	15.70	86.18	33.39	86.76	46.30	87.06	58.81	87.39
	Reach 2	1195	15.70	86.21	33.39	86.79	46.30	87.09	58.81	87.41
	Reach 2	1200	15.70	86.37	33.39	86.97	46.30	87.29	58.81	87.62
	Reach 2	1205	15.70	86.39	33.39	87.00	46.30	87.32	58.81	87.65
	Reach 2	1206	HWY 416 Northbound							
	Reach 2	1207	15.70	86.40	33.39	87.01	46.30	87.34	58.81	87.66
	Reach 2	1207.5	15.70	86.40	33.39	87.01	46.30	87.34	58.81	87.66
	Reach 2	1208	15.70	86.40	33.39	87.01	46.30	87.33	58.81	87.66
	Reach 2	1209	HWY 416 Southbound							
	Reach 2	1210	15.70	86.44	33.39	87.07	46.30	87.41	58.81	87.74
	Reach 2	1215	15.70	86.46	33.39	87.09	46.30	87.43	58.81	87.77
	Reach 2	1220	15.70	86.58	33.39	87.22	46.30	87.56	58.81	87.88
	Reach 2	1225	15.70	86.82	33.39	87.44	46.30	87.76	58.81	88.01
	Reach 2	1230	15.05	86.93	32.01	87.57	44.42	87.90	56.99	88.16
	Reach 2	1235	15.05	86.95	32.01	87.59	44.42	87.93	56.99	88.17
	Reach 2	1240	15.05	86.97	32.01	87.61	44.42	87.94	56.99	88.17
	Reach 2	1241	3rd Line Road South							
	Reach 2	1245	15.05	86.98	32.01	87.65	44.42	88.00	56.99	88.34
	Reach 2	1250	15.05	87.01	32.01	87.67	44.42	88.04	56.99	88.35
	Reach 2	1255	15.05	87.08	32.01	87.74	44.42	88.07	56.99	88.37
	Reach 2	1260	15.05	87.10	32.01	87.77	44.42	88.09	56.99	88.37
	Reach 2	1263	6530 3rd Line Road South							
	Reach 2	1265	15.05	87.12	32.01	87.81	44.42	88.29	56.99	88.57
	Reach 2	1270	15.05	87.18	32.01	87.89	44.42	88.32	56.99	88.58
	Reach 2	1275	15.05	87.29	32.01	87.96	44.42	88.36	56.99	88.62
	Reach 2	1280	15.05	87.39	32.01	88.00	44.42	88.38	56.99	88.63
	Reach 2	1285	15.05	87.53	32.01	88.10	44.42	88.46	56.99	88.70
	Reach 2	1290	15.05	87.66	32.01	88.15	44.42	88.48	56.99	88.72
	Reach 2	1295	15.05	87.77	32.01	88.23	44.42	88.52	56.99	88.75
	Reach 2	1300	15.05	87.81	32.01	88.30	44.42	88.60	56.99	88.84

River	Reach	Xsec ID #	Flow (m³/s) and Computed WSEL (m) for Different Flood Events							
			Q2	WL2	Q5	WL5	Q10	WL10	Q20	WL20
Stevens Creek	Reach 3	1305	9.34	87.82	20.21	88.31	28.23	88.61	36.73	88.84
	Reach 3	1310	9.34	87.82	20.21	88.31	28.23	88.61	36.73	88.84
	Reach 3	1313	Roger Stevens Drive in North Gower							
	Reach 3	1315	9.34	87.83	20.21	88.33	28.23	88.64	36.73	88.88
	Reach 3	1320	9.34	87.84	20.21	88.34	28.23	88.65	36.73	88.90
	Reach 3	1325	9.34	87.84	20.21	88.35	28.23	88.66	36.73	88.90
	Reach 3	1330	9.34	87.86	20.21	88.36	28.23	88.67	36.73	88.91
	Reach 3	1335	9.34	87.91	20.21	88.38	28.23	88.68	36.73	88.92
	Reach 3	1340	9.34	87.92	20.21	88.37	28.23	88.66	36.73	88.89
	Reach 3	1345	9.34	87.95	20.21	88.46	28.23	88.76	36.73	89.01
	Reach 3	1348	4th Line Road in North Gower							
	Reach 3	1350	9.34	87.96	20.21	88.46	28.23	88.77	36.73	89.02
	Reach 4	1355	8.49	87.96	18.61	88.47	26.13	88.77	34.10	89.03
	Reach 4	1360	8.49	87.98	18.61	88.49	26.13	88.80	34.10	89.05
	Reach 4	1363	Church Street							
	Reach 4	1365	8.49	87.99	18.61	88.51	26.13	88.82	34.10	89.08
	Reach 4	1370	8.49	88.01	18.61	88.55	26.13	88.86	34.10	89.13
	Reach 4	1375	8.49	88.02	18.61	88.56	26.13	88.88	34.10	89.15
	Reach 4	1380	8.49	88.05	18.61	88.60	26.13	88.92	34.10	89.19
	Reach 4	1385	8.49	88.09	18.61	88.63	26.13	88.94	34.10	89.21
	Reach 4	1390	8.49	88.15	18.61	88.68	26.13	88.98	34.10	89.24
	Reach 4	1395	8.49	88.22	18.61	88.72	26.13	89.00	34.10	89.26
	Reach 4	1400	8.49	88.31	18.61	88.76	26.13	89.02	34.10	89.27
	Reach 4	1405	8.49	88.39	18.61	88.85	26.13	89.08	34.10	89.31
	Reach 4	1410	8.49	88.48	18.61	88.96	26.13	89.21	34.10	89.43
	Reach 4	1415	8.49	88.51	18.61	89.00	26.13	89.25	34.10	89.47
	Reach 4	1420	7.45	88.53	16.28	89.01	22.84	89.26	29.79	89.49
	Reach 4	1423	McCordick Road near Church Street							
	Reach 4	1425	7.45	88.53	16.28	89.03	22.84	89.29	29.79	89.54
	Reach 4	1430	7.45	88.55	16.28	89.06	22.84	89.32	29.79	89.58
	Reach 4	1435	7.45	88.57	16.28	89.07	22.84	89.33	29.79	89.59
	Reach 4	1440	7.45	88.60	16.28	89.11	22.84	89.38	29.79	89.64
	Reach 4	1445	7.45	88.64	16.28	89.15	22.84	89.42	29.79	89.68
	Reach 4	1450	7.45	88.69	16.28	89.19	22.84	89.45	29.79	89.70
	Reach 4	1455	7.45	88.76	16.28	89.25	22.84	89.52	29.79	89.77
	Reach 4	1460	7.45	88.78	16.28	89.27	22.84	89.53	29.79	89.78
	Reach 4	1465	7.45	88.82	16.28	89.30	22.84	89.56	29.79	89.80
	Reach 4	1470	6.08	88.91	13.25	89.36	18.55	89.61	24.19	89.84
	Reach 4	1475	6.08	89.04	13.25	89.42	18.55	89.66	24.19	89.88
	Reach 4	1480	6.08	89.33	13.25	89.60	18.55	89.80	24.19	89.99
	Reach 4	1485	6.08	89.53	13.25	89.88	18.55	90.03	24.19	90.17
	Reach 4	1490	6.08	90.26	13.25	90.46	18.55	90.64	24.19	90.78
	Reach 4	1495	6.08	91.07	13.25	91.34	18.55	91.46	24.19	91.58
	Reach 4	1500	6.08	91.81	13.25	92.09	18.55	92.26	24.19	92.42
	Reach 4	1505	2.98	92.25	6.40	92.50	8.91	92.66	11.60	92.81
	Reach 4	1510	2.98	92.49	6.40	92.74	8.91	92.88	11.60	93.02
	Reach 4	1513	Malakoff road near Pierce Road							
	Reach 4	1515	2.98	92.70	6.40	92.92	8.91	93.06	11.60	93.21
	Reach 4	1520	2.98	92.87	6.40	93.12	8.91	93.25	11.60	93.38
	Reach 4	1525	2.98	93.10	6.40	93.36	8.91	93.48	11.60	93.60

River	Reach	Xsec ID #	Flow (m^3/s) and Computed WSEL (m) for Different Flood Events							
			Q2	WL2	Q5	WL5	Q10	WL10	Q20	WL20
Tributary A	Reach 1	2100	3.45	85.82	7.09	86.31	9.68	86.59	12.37	86.78
	Reach 1	2105	3.45	85.92	7.09	86.36	9.68	86.62	12.37	86.82
	Reach 1	2110	3.45	85.99	7.09	86.39	9.68	86.65	12.37	86.84
	Reach 1	2115	3.45	86.13	7.09	86.44	9.68	86.68	12.37	86.86
	Reach 1	2120	3.45	86.22	7.09	86.48	9.68	86.69	12.37	86.87
	Reach 1	2125	3.45	86.30	7.09	86.53	9.68	86.72	12.37	86.89
	Reach 1	2130	2.59	86.43	5.36	86.63	7.36	86.76	9.44	86.90
	Reach 1	2133	Roger Stevens Drive at 2nd Line Road South							
	Reach 1	2135	2.59	86.54	5.36	86.97	7.36	87.30	9.44	87.71
	Reach 1	2140	2.59	86.55	5.36	86.97	7.36	87.30	9.44	87.71
	Reach 1	2145	2.59	86.56	5.36	86.97	7.36	87.30	9.44	87.71
	Reach 1	2148	2nd Line Road South at Roger Stevens Drive							
	Reach 1	2150	2.59	86.62	5.36	87.19	7.36	87.71	9.44	87.89
	Reach 1	2151	2.59	86.68	5.36	87.23	7.36	87.71	9.44	87.89
	Reach 1	2155	2.59	86.69	5.36	87.23	7.36	87.72	9.44	87.89
	Reach 1	2160	2.59	86.77	5.36	87.24	7.36	87.72	9.44	87.89
	Reach 1	2165	2.59	86.86	5.36	87.26	7.36	87.72	9.44	87.89
	Reach 1	2170	2.59	87.03	5.36	87.34	7.36	87.74	9.44	87.91
	Reach 1	2171	2.59	87.12	5.36	87.40	7.36	87.75	9.44	87.92
	Reach 1	2175	2.59	87.18	5.36	87.45	7.36	87.76	9.44	87.92
	Reach 1	2178	HWY 416							
	Reach 1	2180	2.36	87.23	4.92	87.63	6.77	88.11	8.69	88.49
	Reach 1	2181	2.36	87.24	4.92	87.63	6.77	88.11	8.69	88.49
	Reach 1	2185	2.36	87.27	4.92	87.64	6.77	88.11	8.69	88.49
	Reach 1	2190	2.36	87.34	4.92	87.65	6.77	88.11	8.69	88.49
	Reach 1	2195	2.36	87.87	4.92	87.99	6.77	88.12	8.69	88.49
	Reach 1	2200	2.36	88.04	4.92	88.21	6.77	88.26	8.69	88.50
	Reach 1	2205	2.36	88.14	4.92	88.29	6.77	88.35	8.69	88.54
	Reach 1	2210	2.36	88.18	4.92	88.35	6.77	88.41	8.69	88.57
	Reach 1	2213	Roger Stevens Drive and 3rd Line Road South							
	Reach 1	2215	1.98	88.19	4.14	88.42	5.71	88.55	7.36	88.81
	Reach 1	2220	1.98	88.23	4.14	88.46	5.71	88.60	7.36	88.85
	Reach 1	2221	1.98	88.23	4.14	88.47	5.71	88.61	7.36	88.85
	Reach 1	2225	1.98	88.24	4.14	88.47	5.71	88.61	7.36	88.85
Tributary B	Reach 1	3100	5.15	87.81	10.60	88.30	14.54	88.60	18.67	88.84
	Reach 1	3105	5.15	87.88	10.60	88.32	14.54	88.61	18.67	88.85
	Reach 1	3110	5.15	87.92	10.60	88.36	14.54	88.63	18.67	88.84
	Reach 1	3115	5.15	87.96	10.60	88.42	14.54	88.69	18.67	88.92
	Reach 1	3118	James Craig Street							
	Reach 1	3120	5.15	87.97	10.60	88.45	14.54	88.78	18.67	89.08
	Reach 1	3125	5.15	88.02	10.60	88.51	14.54	88.84	18.67	89.13
	Reach 1	3130	5.15	88.06	10.60	88.55	14.54	88.86	18.67	89.15
	Reach 1	3135	5.15	88.10	10.60	88.57	14.54	88.87	18.67	89.15
	Reach 1	3138	Prince of Wales Drive							
	Reach 1	3140	5.15	88.14	10.60	88.61	14.54	88.91	18.67	89.19
	Reach 1	3145	5.15	88.16	10.60	88.63	14.54	88.93	18.67	89.21
	Reach 1	3150	5.15	88.28	10.60	88.71	14.54	88.96	18.67	89.22
	Reach 1	3155	5.15	88.39	10.60	88.78	14.54	88.99	18.67	89.23
	Reach 1	3160	5.15	88.52	10.60	88.93	14.54	89.10	18.67	89.28
	Reach 1	3165	5.15	88.68	10.60	89.12	14.54	89.29	18.67	89.45
	Reach 1	3170	5.15	88.74	10.60	89.18	14.54	89.35	18.67	89.51
	Reach 1	3175	5.15	88.77	10.60	89.23	14.54	89.41	18.67	89.58

River	Reach	Xsec ID #	Flow (m^3/s) and Computed WSEL (m) for Different Flood Events							
			Q2	WL2	Q5	WL5	Q10	WL10	Q20	WL20
Tributary B	Reach 1	3178	Edward Kidd Park Ped Bridge							
	Reach 1	3180	5.15	88.77	10.60	89.23	14.54	89.42	18.67	89.58
	Reach 1	3185	5.15	88.78	10.60	89.24	14.54	89.42	18.67	89.58
	Reach 1	3190	5.15	88.82	10.60	89.28	14.54	89.46	18.67	89.61
	Reach 1	3195	5.15	88.97	10.60	89.43	14.54	89.63	18.67	89.80
	Reach 1	3200	5.15	89.08	10.60	89.52	14.54	89.70	18.67	89.84
	Reach 1	3205	5.15	89.25	10.60	89.72	14.54	89.93	18.67	90.12
	Reach 1	3210	5.15	89.38	10.60	89.85	14.54	90.08	18.67	90.29
	Reach 1	3213	4th Line Road near Shellstar Drive							
	Reach 1	3215	5.15	89.43	10.60	89.89	14.54	90.13	18.67	90.34
	Reach 1	3220	5.15	89.55	10.60	90.01	14.54	90.24	18.67	90.46
	Reach 1	3225	5.15	89.69	10.60	90.17	14.54	90.39	18.67	90.57
	Reach 1	3230	5.15	89.83	10.60	90.34	14.54	90.56	18.67	90.75
	Reach 1	3235	5.15	90.00	10.60	90.54	14.54	90.78	18.67	90.97
	Reach 1	3240	5.15	90.09	10.60	90.63	14.54	90.86	18.67	91.04
	Reach 1	3245	5.15	90.28	10.60	90.88	14.54	91.07	18.67	91.20
	Reach 1	3250	5.15	90.36	10.60	90.98	14.54	91.18	18.67	91.32
	Reach 1	3255	5.15	90.50	10.60	91.11	14.54	91.31	18.67	91.45
	Reach 1	3260	5.15	90.56	10.60	91.16	14.54	91.36	18.67	91.51
	Reach 1	3265	5.15	90.70	10.60	91.27	14.54	91.48	18.67	91.64
	Reach 1	3270	5.15	90.85	10.60	91.39	14.54	91.59	18.67	91.75
	Reach 1	3275	5.15	90.97	10.60	91.51	14.54	91.72	18.67	91.88
	Reach 1	3280	5.15	91.15	10.60	91.72	14.54	91.94	18.67	92.10
	Reach 1	3285	5.15	91.26	10.60	91.87	14.54	92.11	18.67	92.28
	Reach 1	3288	McCordick Road North of Roger Stevens Drive							
	Reach 1	3290	5.15	91.27	10.60	91.91	14.54	92.20	18.67	92.44
	Reach 1	3295	5.15	91.51	10.60	92.02	14.54	92.26	18.67	92.48
	Reach 1	3300	5.15	91.73	10.60	92.08	14.54	92.28	18.67	92.50
	Reach 1	3301	5.15	91.95	10.60	92.06	14.54	92.14	18.67	92.41
	Reach 1	3305	5.15	92.38	10.60	92.76	14.54	92.93	18.67	93.02
	Reach 1	3306	5.15	92.66	10.60	93.01	14.54	93.15	18.67	93.25
	Reach 1	3310	5.15	93.07	10.60	93.32	14.54	93.42	18.67	93.50
	Reach 1	3315	5.15	93.22	10.60	93.41	14.54	93.49	18.67	93.57
	Reach 1	3320	5.15	93.38	10.60	93.51	14.54	93.58	18.67	93.65
	Reach 1	3321	5.15	93.51	10.60	93.65	14.54	93.70	18.67	93.75
	Reach 1	3325	5.15	93.95	10.60	94.14	14.54	94.21	18.67	94.27
	Reach 1	3326	5.15	94.26	10.60	94.49	14.54	94.58	18.67	94.65
	Reach 1	3330	5.15	94.39	10.60	94.62	14.54	94.71	18.67	94.78
	Reach 1	3335	4.39	94.55	9.59	94.79	13.44	94.89	17.58	94.97
	Reach 1	3340	4.39	94.59	9.59	94.83	13.44	94.94	17.58	95.02
	Reach 1	3343	Malakoff Road near Pollock Road							
	Reach 1	3345	4.39	94.61	9.59	94.92	13.44	95.10	17.58	95.29
	Reach 1	3350	4.39	94.67	9.59	95.00	13.44	95.18	17.58	95.36
	Reach 1	3355	4.39	94.71	9.59	95.03	13.44	95.20	17.58	95.38

River	Reach	Xsec ID #	Flow (m^3/s) and Computed WSEL (m) for Different Flood Events							
			Q2	WL2	Q5	WL5	Q10	WL10	Q20	WL20
Tributary C	Reach 1	4100	2.75	87.96	5.58	88.47	7.58	88.78	9.65	89.05
	Reach 1	4105	2.75	87.98	5.58	88.48	7.58	88.79	9.65	89.05
	Reach 1	4110	2.75	88.08	5.58	88.54	7.58	88.82	9.65	89.07
	Reach 1	4115	2.75	88.45	5.58	88.71	7.58	88.86	9.65	89.09
	Reach 1	4120	2.75	88.65	5.58	88.83	7.58	88.94	9.65	89.11
	Reach 1	4125	2.75	88.83	5.58	88.91	7.58	88.99	9.65	89.13
	Reach 1	4130	2.75	88.93	5.58	88.99	7.58	89.04	9.65	89.15
	Reach 1	4135	2.75	89.01	5.58	89.11	7.58	89.16	9.65	89.21
	Reach 1	4140	2.75	89.36	5.58	89.44	7.58	89.49	9.65	89.52
	Reach 1	4145	2.75	89.60	5.58	89.69	7.58	89.74	9.65	89.78

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Table 15 Flows and computed water levels for the 50, 100, 200, 350, and 500 year flood events

River	Reach	Xsec ID	Flow (m^3/s) and Computed WSEL (m) for Different Flood Events									
			Q50	WL50	Q100	WL100	Q200	WL200	Q350	WL350	Q500	WL500
Stevens Creek	Reach 1	1100	86.59	85.50	102.55	85.50	118.35	85.50	131.92	85.50	141.48	85.50
	Reach 1	1105	86.59	85.82	102.55	85.93	118.35	86.04	131.92	86.14	141.48	86.22
	Reach 1	1110	86.59	85.87	102.55	85.98	118.35	86.09	131.92	86.19	141.48	86.26
	Reach 1	1113	Rideau Valley Drive									
	Reach 1	1115	86.59	86.16	102.55	86.34	118.35	86.51	131.92	86.66	141.48	86.77
	Reach 1	1120	86.59	86.33	102.55	86.51	118.35	86.68	131.92	86.83	141.48	86.93
	Reach 1	1125	86.59	86.42	102.55	86.58	118.35	86.74	131.92	86.88	141.48	86.98
	Reach 1	1130	86.59	86.51	102.55	86.67	118.35	86.83	131.92	86.96	141.48	87.06
	Reach 1	1135	86.59	86.56	102.55	86.71	118.35	86.87	131.92	87.00	141.48	87.10
	Reach 1	1140	86.59	86.69	102.55	86.84	118.35	86.99	131.92	87.12	141.48	87.23
	Reach 1	1145	86.59	86.84	102.55	86.99	118.35	87.13	131.92	87.25	141.48	87.35
	Reach 2	1150	76.41	86.95	90.51	87.10	104.44	87.24	116.37	87.36	124.73	87.46
	Reach 2	1151	Roger Stevens Drive near Kars									
	Reach 2	1155	76.41	87.05	90.51	87.22	104.44	87.38	116.37	87.56	124.73	87.69
	Reach 2	1160	76.41	87.09	90.51	87.26	104.44	87.42	116.37	87.60	124.73	87.72
	Reach 2	1165	76.41	87.14	90.51	87.31	104.44	87.47	116.37	87.64	124.73	87.76
	Reach 2	1170	76.41	87.22	90.51	87.38	104.44	87.53	116.37	87.69	124.73	87.81
	Reach 2	1175	76.41	87.26	90.51	87.41	104.44	87.56	116.37	87.72	124.73	87.83
	Reach 2	1180	76.41	87.33	90.51	87.49	104.44	87.63	116.37	87.78	124.73	87.89
	Reach 2	1185	76.41	87.44	90.51	87.60	104.44	87.75	116.37	87.90	124.73	88.01
	Reach 2	1186	2nd Line Road South									
	Reach 2	1190	76.41	87.77	90.51	87.95	104.44	88.06	116.37	88.15	124.73	88.20
	Reach 2	1195	76.41	87.78	90.51	87.93	104.44	88.03	116.37	88.11	124.73	88.15
	Reach 2	1200	76.41	88.00	90.51	88.18	104.44	88.33	116.37	88.44	124.73	88.52
	Reach 2	1205	76.41	88.02	90.51	88.21	104.44	88.35	116.37	88.47	124.73	88.54
	Reach 2	1206	HWY 416 Northbound									
	Reach 2	1207	76.41	88.05	90.51	88.24	104.44	88.39	116.37	88.51	124.73	88.59
	Reach 2	1207.5	76.41	88.04	90.51	88.24	104.44	88.39	116.37	88.51	124.73	88.59
	Reach 2	1208	76.41	88.04	90.51	88.23	104.44	88.38	116.37	88.50	124.73	88.58
	Reach 2	1209	HWY 416 Southbound									
	Reach 2	1210	76.41	88.14	90.51	88.35	104.44	88.52	116.37	88.66	124.73	88.75
	Reach 2	1215	76.41	88.16	90.51	88.38	104.44	88.55	116.37	88.70	124.73	88.79
	Reach 2	1220	76.41	88.25	90.51	88.46	104.44	88.64	116.37	88.78	124.73	88.88
	Reach 2	1225	76.41	88.33	90.51	88.52	104.44	88.69	116.37	88.82	124.73	88.91
	Reach 2	1230	74.24	88.42	87.98	88.61	101.48	88.79	112.98	88.92	121.04	89.02
	Reach 2	1235	74.24	88.43	87.98	88.62	101.48	88.79	112.98	88.93	121.04	89.02
	Reach 2	1240	74.24	88.43	87.98	88.62	101.48	88.79	112.98	88.93	121.04	89.02
	Reach 2	1241	3rd Line Road South									
	Reach 2	1245	74.24	88.52	87.98	88.64	101.48	88.83	112.98	88.95	121.04	89.04
	Reach 2	1250	74.24	88.53	87.98	88.65	101.48	88.84	112.98	88.95	121.04	89.04
	Reach 2	1255	74.24	88.54	87.98	88.66	101.48	88.85	112.98	88.96	121.04	89.05
	Reach 2	1260	74.24	88.55	87.98	88.67	101.48	88.85	112.98	88.97	121.04	89.06
	Reach 2	1263	6530 3rd Line Road South									
	Reach 2	1265	74.24	88.71	87.98	88.78	101.48	88.88	112.98	88.98	121.04	89.06
	Reach 2	1270	74.24	88.73	87.98	88.80	101.48	88.90	112.98	89.00	121.04	89.08
	Reach 2	1275	74.24	88.77	87.98	88.84	101.48	88.95	112.98	89.05	121.04	89.13
	Reach 2	1280	74.24	88.78	87.98	88.86	101.48	88.96	112.98	89.05	121.04	89.13
	Reach 2	1285	74.24	88.87	87.98	88.97	101.48	89.08	112.98	89.19	121.04	89.27
	Reach 2	1290	74.24	88.89	87.98	88.99	101.48	89.11	112.98	89.22	121.04	89.30
	Reach 2	1295	74.24	88.92	87.98	89.02	101.48	89.13	112.98	89.23	121.04	89.30
	Reach 2	1300	74.24	89.03	87.98	89.15	101.48	89.28	112.98	89.39	121.04	89.48
	Reach 3	1305	48.17	89.03	57.25	89.15	66.14	89.28	73.69	89.40	78.98	89.48
	Reach 3	1310	48.17	89.03	57.25	89.15	66.14	89.27	73.69	89.39	78.98	89.49
	Reach 3	1313	Roger Stevens Drive in North Gower									
	Reach 3	1315	48.17	89.13	57.25	89.29	66.14	89.46	73.69	89.64	78.98	89.75
	Reach 3	1320	48.17	89.15	57.25	89.31	66.14	89.49	73.69	89.64	78.98	89.75
	Reach 3	1325	48.17	89.15	57.25	89.32	66.14	89.49	73.69	89.64	78.98	89.75
	Reach 3	1330	48.17	89.16	57.25	89.32	66.14	89.50	73.69	89.65	78.98	89.76
	Reach 3	1335	48.17	89.17	57.25	89.33	66.14	89.50	73.69	89.65	78.98	89.76

River	Reach	Xsec ID	Flow (m^3/s) and Computed WSEL (m) for Different Flood Events									
			Q50	WL50	Q100	WL100	Q200	WL200	Q350	WL350	Q500	WL500
Stevens Creek	Reach 3	1340	48.17	89.12	57.25	89.27	66.14	89.44	73.69	89.58	78.98	89.69
	Reach 3	1345	48.17	89.27	57.25	89.44	66.14	89.62	73.69	89.77	78.98	89.88
	Reach 3	1348	4th Line Road in North Gower									
	Reach 3	1350	48.17	89.29	57.25	89.47	66.14	89.65	73.69	89.81	78.98	89.92
	Reach 4	1355	44.87	89.30	53.42	89.48	61.81	89.66	68.93	89.82	73.92	89.94
	Reach 4	1360	44.87	89.32	53.42	89.49	61.81	89.67	68.93	89.82	73.92	89.93
	Reach 4	1363	Church Street									
	Reach 4	1365	44.87	89.36	53.42	89.55	61.81	89.74	68.93	89.91	73.92	90.01
	Reach 4	1370	44.87	89.42	53.42	89.62	61.81	89.83	68.93	90.01	73.92	90.12
	Reach 4	1375	44.87	89.45	53.42	89.66	61.81	89.87	68.93	90.05	73.92	90.16
	Reach 4	1380	44.87	89.49	53.42	89.69	61.81	89.90	68.93	90.07	73.92	90.18
	Reach 4	1385	44.87	89.50	53.42	89.70	61.81	89.91	68.93	90.08	73.92	90.19
	Reach 4	1390	44.87	89.53	53.42	89.73	61.81	89.94	68.93	90.10	73.92	90.20
	Reach 4	1395	44.87	89.54	53.42	89.74	61.81	89.94	68.93	90.10	73.92	90.21
	Reach 4	1400	44.87	89.55	53.42	89.75	61.81	89.95	68.93	90.10	73.92	90.21
	Reach 4	1405	44.87	89.56	53.42	89.75	61.81	89.94	68.93	90.09	73.92	90.19
	Reach 4	1410	44.87	89.69	53.42	89.88	61.81	90.07	68.93	90.21	73.92	90.32
	Reach 4	1415	44.87	89.73	53.42	89.91	61.81	90.09	68.93	90.24	73.92	90.34
	Reach 4	1420	39.19	89.74	46.65	89.92	53.98	90.10	60.20	90.24	64.56	90.35
	Reach 4	1423	McCordick Road near Church Street									
	Reach 4	1425	39.19	89.84	46.65	90.09	53.98	90.24	60.20	90.34	64.56	90.41
	Reach 4	1430	39.19	89.89	46.65	90.10	53.98	90.25	60.20	90.34	64.56	90.42
	Reach 4	1435	39.19	89.89	46.65	90.10	53.98	90.25	60.20	90.34	64.56	90.42
	Reach 4	1440	39.19	89.94	46.65	90.15	53.98	90.31	60.20	90.41	64.56	90.48
	Reach 4	1445	39.19	89.98	46.65	90.18	53.98	90.34	60.20	90.44	64.56	90.51
	Reach 4	1450	39.19	90.00	46.65	90.21	53.98	90.36	60.20	90.46	64.56	90.52
	Reach 4	1455	39.19	90.05	46.65	90.26	53.98	90.41	60.20	90.51	64.56	90.57
	Reach 4	1460	39.19	90.06	46.65	90.26	53.98	90.42	60.20	90.51	64.56	90.57
	Reach 4	1465	39.19	90.08	46.65	90.28	53.98	90.43	60.20	90.52	64.56	90.58
	Reach 4	1470	31.80	90.11	37.84	90.31	43.78	90.46	48.84	90.53	52.38	90.59
	Reach 4	1475	31.80	90.15	37.84	90.34	43.78	90.49	48.84	90.55	52.38	90.61
	Reach 4	1480	31.80	90.23	37.84	90.41	43.78	90.56	48.84	90.59	52.38	90.65
	Reach 4	1485	31.80	90.35	37.84	90.50	43.78	90.63	48.84	90.67	52.38	90.71
	Reach 4	1490	31.80	90.94	37.84	91.05	43.78	91.15	48.84	91.25	52.38	91.31
	Reach 4	1495	31.80	91.73	37.84	91.84	43.78	91.93	48.84	92.00	52.38	92.05
	Reach 4	1500	31.80	92.60	37.84	92.73	43.78	92.85	48.84	92.94	52.38	93.00
	Reach 4	1505	15.22	92.99	18.10	93.12	20.94	93.23	23.37	93.31	25.07	93.36
	Reach 4	1510	15.22	93.19	18.10	93.31	20.94	93.41	23.37	93.49	25.07	93.55
	Reach 4	1513	Malakoff road near Pierce Road									
	Reach 4	1515	15.22	93.39	18.10	93.52	20.94	93.64	23.37	93.74	25.07	93.80
	Reach 4	1520	15.22	93.55	18.10	93.68	20.94	93.79	23.37	93.89	25.07	93.95
	Reach 4	1525	15.22	93.74	18.10	93.84	20.94	93.94	23.37	94.01	25.07	94.07
Tributary A	Reach 1	2100	15.93	87.00	18.89	87.16	21.83	87.30	24.32	87.43	26.03	87.52
	Reach 1	2105	15.93	87.03	18.89	87.19	21.83	87.33	24.32	87.45	26.03	87.55
	Reach 1	2110	15.93	87.06	18.89	87.21	21.83	87.35	24.32	87.47	26.03	87.57
	Reach 1	2115	15.93	87.07	18.89	87.23	21.83	87.37	24.32	87.49	26.03	87.58
	Reach 1	2120	15.93	87.08	18.89	87.23	21.83	87.37	24.32	87.49	26.03	87.58
	Reach 1	2125	15.93	87.09	18.89	87.24	21.83	87.38	24.32	87.50	26.03	87.59
	Reach 1	2130	12.21	87.08	14.45	87.21	16.65	87.33	18.51	87.51	19.79	87.60
	Reach 1	2133	Roger Stevens Drive at 2nd Line Road South									
	Reach 1	2135	12.21	87.91	14.45	87.95	16.65	87.99	18.51	88.04	19.79	88.05
	Reach 1	2140	12.21	87.91	14.45	87.95	16.65	87.99	18.51	88.04	19.79	88.05
	Reach 1	2145	12.21	87.91	14.45	87.95	16.65	87.99	18.51	88.04	19.79	88.05
	Reach 1	2148	2nd Line Road South at Roger Stevens Drive									
	Reach 1	2150	12.21	87.96	14.45	88.00	16.65	88.03	18.51	88.06	19.79	88.07
	Reach 1	2151	12.21	87.96	14.45	88.00	16.65	88.03	18.51	88.06	19.79	88.07
	Reach 1	2155	12.21	87.97	14.45	88.00	16.65	88.03	18.51	88.06	19.79	88.07
	Reach 1	2160	12.21	87.97	14.45	88.00	16.65	88.03	18.51	88.07	19.79	88.07
	Reach 1	2165	12.21	87.97	14.45	88.01	16.65	88.03	18.51	88.07	19.79	88.08
	Reach 1	2170	12.21	87.99	14.45	88.04	16.65	88.07	18.51	88.11	19.79	88.12

River	Reach	Xsec ID	Flow (m^3/s) and Computed WSEL (m) for Different Flood Events									
			Q50	WL50	Q100	WL100	Q200	WL200	Q350	WL350	Q500	WL500
Tributary A	Reach 1	2171	12.21	88.00	14.45	88.05	16.65	88.08	18.51	88.13	19.79	88.14
	Reach 1	2175	12.21	88.00	14.45	88.04	16.65	88.07	18.51	88.11	19.79	88.12
	Reach 1	2178	HWY 416									
	Reach 1	2180	11.25	88.95	13.30	89.36	15.31	89.83	17.01	90.13	18.19	90.16
	Reach 1	2181	11.25	88.95	13.30	89.36	15.31	89.83	17.01	90.13	18.19	90.16
	Reach 1	2185	11.25	88.95	13.30	89.37	15.31	89.83	17.01	90.13	18.19	90.16
	Reach 1	2190	11.25	88.95	13.30	89.37	15.31	89.83	17.01	90.13	18.19	90.16
	Reach 1	2195	11.25	88.95	13.30	89.37	15.31	89.83	17.01	90.13	18.19	90.16
	Reach 1	2200	11.25	88.95	13.30	89.37	15.31	89.83	17.01	90.13	18.19	90.16
	Reach 1	2205	11.25	88.95	13.30	89.37	15.31	89.83	17.01	90.13	18.19	90.16
	Reach 1	2210	11.25	88.96	13.30	89.37	15.31	89.83	17.01	90.13	18.19	90.16
	Reach 1	2213	Roger Stevens Drive and 3rd Line Road South									
	Reach 1	2215	9.54	89.39	11.27	89.66	12.95	89.85	14.37	90.13	15.36	90.16
	Reach 1	2220	9.54	89.41	11.27	89.67	12.95	89.85	14.37	90.13	15.36	90.16
	Reach 1	2221	9.54	89.41	11.27	89.67	12.95	89.85	14.37	90.13	15.36	90.17
	Reach 1	2225	9.54	89.41	11.27	89.67	12.95	89.85	14.37	90.13	15.36	90.17
Tributary B	Reach 1	3100	24.15	89.03	28.49	89.16	32.72	89.29	36.29	89.40	38.78	89.49
	Reach 1	3105	24.15	89.03	28.49	89.16	32.72	89.29	36.29	89.40	38.78	89.49
	Reach 1	3110	24.15	89.01	28.49	89.12	32.72	89.24	36.29	89.34	38.78	89.42
	Reach 1	3115	24.15	89.12	28.49	89.26	32.72	89.40	36.29	89.52	38.78	89.60
	Reach 1	3118	James Craig Street									
	Reach 1	3120	24.15	89.37	28.49	89.53	32.72	89.61	36.29	89.68	38.78	89.75
	Reach 1	3125	24.15	89.42	28.49	89.57	32.72	89.65	36.29	89.73	38.78	89.79
	Reach 1	3130	24.15	89.43	28.49	89.58	32.72	89.66	36.29	89.73	38.78	89.79
	Reach 1	3135	24.15	89.43	28.49	89.58	32.72	89.66	36.29	89.74	38.78	89.80
	Reach 1	3138	Prince of Wales Drive									
	Reach 1	3140	24.15	89.47	28.49	89.66	32.72	89.77	36.29	89.86	38.78	89.94
	Reach 1	3145	24.15	89.49	28.49	89.68	32.72	89.79	36.29	89.86	38.78	89.94
	Reach 1	3150	24.15	89.50	28.49	89.69	32.72	89.80	36.29	89.87	38.78	89.95
	Reach 1	3155	24.15	89.51	28.49	89.69	32.72	89.80	36.29	89.88	38.78	89.95
	Reach 1	3160	24.15	89.53	28.49	89.71	32.72	89.81	36.29	89.89	38.78	89.96
	Reach 1	3165	24.15	89.65	28.49	89.80	32.72	89.90	36.29	89.98	38.78	90.05
	Reach 1	3170	24.15	89.70	28.49	89.85	32.72	89.95	36.29	90.02	38.78	90.09
	Reach 1	3175	24.15	89.78	28.49	89.92	32.72	90.02	36.29	90.10	38.78	90.16
	Reach 1	3178	Edward Kidd Park Ped Bridge									
	Reach 1	3180	24.15	89.78	28.49	89.93	32.72	90.03	36.29	90.10	38.78	90.16
	Reach 1	3185	24.15	89.78	28.49	89.93	32.72	90.03	36.29	90.10	38.78	90.16
	Reach 1	3190	24.15	89.80	28.49	89.93	32.72	90.03	36.29	90.09	38.78	90.15
	Reach 1	3195	24.15	90.01	28.49	90.15	32.72	90.27	36.29	90.35	38.78	90.42
	Reach 1	3200	24.15	90.02	28.49	90.15	32.72	90.25	36.29	90.34	38.78	90.40
	Reach 1	3205	24.15	90.33	28.49	90.48	32.72	90.59	36.29	90.68	38.78	90.74
	Reach 1	3210	24.15	90.52	28.49	90.68	32.72	90.82	36.29	90.92	38.78	90.99
	Reach 1	3213	4th Line Road near Shellstar Drive									
	Reach 1	3215	24.15	90.60	28.49	90.78	32.72	90.94	36.29	91.05	38.78	91.13
	Reach 1	3220	24.15	90.71	28.49	90.88	32.72	91.03	36.29	91.15	38.78	91.23
	Reach 1	3225	24.15	90.79	28.49	90.93	32.72	91.07	36.29	91.18	38.78	91.26
	Reach 1	3230	24.15	90.96	28.49	91.08	32.72	91.19	36.29	91.28	38.78	91.34
	Reach 1	3235	24.15	91.18	28.49	91.30	32.72	91.41	36.29	91.49	38.78	91.51
	Reach 1	3240	24.15	91.24	28.49	91.36	32.72	91.47	36.29	91.55	38.78	91.55
	Reach 1	3245	24.15	91.36	28.49	91.47	32.72	91.57	36.29	91.64	38.78	91.66
	Reach 1	3250	24.15	91.47	28.49	91.58	32.72	91.67	36.29	91.75	38.78	91.77
	Reach 1	3255	24.15	91.61	28.49	91.72	32.72	91.82	36.29	91.90	38.78	91.93
	Reach 1	3260	24.15	91.68	28.49	91.79	32.72	91.89	36.29	91.97	38.78	92.01
	Reach 1	3265	24.15	91.82	28.49	91.94	32.72	92.04	36.29	92.13	38.78	92.17
	Reach 1	3270	24.15	91.93	28.49	92.04	32.72	92.13	36.29	92.22	38.78	92.26
	Reach 1	3275	24.15	92.06	28.49	92.16	32.72	92.26	36.29	92.34	38.78	92.38
	Reach 1	3280	24.15	92.28	28.49	92.31	32.72	92.40	36.29	92.48	38.78	92.53
	Reach 1	3285	24.15	92.33	28.49	92.36	32.72	92.44	36.29	92.52	38.78	92.56
	Reach 1	3288	McCordick Road North of Roger Stevens Drive									
	Reach 1	3290	24.15	92.61	28.49	92.66	32.72	92.71	36.29	92.74	38.78	92.76

River	Reach	Xsec ID	Flow (m^3/s) and Computed WSEL (m) for Different Flood Events									
			Q50	WL50	Q100	WL100	Q200	WL200	Q350	WL350	Q500	WL500
Tributary B	Reach 1	3295	24.15	92.61	28.49	92.66	32.72	92.71	36.29	92.74	38.78	92.76
	Reach 1	3300	24.15	92.62	28.49	92.67	32.72	92.72	36.29	92.75	38.78	92.77
	Reach 1	3301	24.15	92.55	28.49	92.59	32.72	92.62	36.29	92.64	38.78	92.66
	Reach 1	3305	24.15	93.13	28.49	93.21	32.72	93.28	36.29	93.34	38.78	93.37
	Reach 1	3306	24.15	93.37	28.49	93.45	32.72	93.51	36.29	93.56	38.78	93.59
	Reach 1	3310	24.15	93.59	28.49	93.66	32.72	93.72	36.29	93.77	38.78	93.80
	Reach 1	3315	24.15	93.65	28.49	93.71	32.72	93.77	36.29	93.82	38.78	93.85
	Reach 1	3320	24.15	93.72	28.49	93.78	32.72	93.83	36.29	93.88	38.78	93.91
	Reach 1	3321	24.15	93.82	28.49	93.86	32.72	93.91	36.29	93.95	38.78	93.97
	Reach 1	3325	24.15	94.33	28.49	94.36	32.72	94.39	36.29	94.41	38.78	94.43
	Reach 1	3326	24.15	94.74	28.49	94.79	32.72	94.84	36.29	94.87	38.78	94.89
	Reach 1	3330	24.15	94.87	28.49	94.92	32.72	94.96	36.29	94.99	38.78	95.01
	Reach 1	3335	23.18	95.06	27.64	95.11	32.04	95.16	35.81	95.20	38.46	95.23
	Reach 1	3340	23.18	95.11	27.64	95.16	32.04	95.20	35.81	95.23	38.46	95.25
	Reach 1	3343	Malakoff Road near Pollock Road									
	Reach 1	3345	23.18	95.55	27.64	95.75	32.04	95.82	35.81	95.86	38.46	95.88
	Reach 1	3350	23.18	95.62	27.64	95.76	32.04	95.83	35.81	95.87	38.46	95.89
	Reach 1	3355	23.18	95.62	27.64	95.76	32.04	95.83	35.81	95.88	38.46	95.90
Tributary C	Reach 1	4100	12.38	89.32	14.52	89.51	16.58	89.69	18.32	89.85	19.53	89.96
	Reach 1	4105	12.38	89.33	14.52	89.51	16.58	89.70	18.32	89.85	19.53	89.97
	Reach 1	4110	12.38	89.34	14.52	89.52	16.58	89.70	18.32	89.86	19.53	89.97
	Reach 1	4115	12.38	89.35	14.52	89.53	16.58	89.71	18.32	89.86	19.53	89.97
	Reach 1	4120	12.38	89.35	14.52	89.53	16.58	89.71	18.32	89.86	19.53	89.98
	Reach 1	4125	12.38	89.36	14.52	89.53	16.58	89.71	18.32	89.87	19.53	89.98
	Reach 1	4130	12.38	89.37	14.52	89.54	16.58	89.71	18.32	89.87	19.53	89.98
	Reach 1	4135	12.38	89.38	14.52	89.54	16.58	89.72	18.32	89.87	19.53	89.98
	Reach 1	4140	12.38	89.56	14.52	89.61	16.58	89.73	18.32	89.88	19.53	89.98
	Reach 1	4145	12.38	89.83	14.52	89.85	16.58	89.88	18.32	89.95	19.53	90.03

Table 16 List of RVCA Planning and Regulation Permit Files (2010 to 31 May, 2019)

RVCA File #	Location	Year of Application	Flood Line Change Required?	Breif Description
RV4-0119	Rideau Lot 6 Concession 7	2019	No	ALTERWATER. - Replacement Of Culvert 868380
RV4-0219	Rideau Lot 8 Concession 5/6	2019	No	ALTERWATER. - Replacement Of Culvert A864080
RV4-0319	Rideau Lot 20/21 Concession 3	2019	No	ALTERWATER. - Replacement Of Culvert A872220
RV4-0419	Rideau Lot 21 Concession 2/3	2019	No	ALTERWATER. - Replacement Of Culvert L871715
RV4-0519	Rideau Lot 13 Concession 4	2019	No	ALTERWATER. - Replacement Of Culvert L874830
RV4-0619	15 Ralph Jago Way	2019	As-Built Details Required	GRADING.STRUCTURE. - New Septic System In Regulated Area For New Single Family Dwelling
RV4-0719	17 Ralph Jago Way	2019	As-Built Details Required	GRADING.STRUCTURE. - New Single Family Dwelling With Septic System
RV4-0819	Phelan Rd W	2019	No	ALTERWATER. - Replacement Of Phelan Rd Culvert Sn878480
RV4-0919	6738 Rideau Valley Dr S	2019	No	STRUCTURE. - Construction Of Attached Garage
RV4-1019	6765 Mccordick Rd	2019	No	ALTERWATER. - Relocation Of Existing Farmstead Ridge Drainage Easement Ditch
RV4-1119	RIDEAU Lot 21 Concession 3	2019	No	ALTERWATER.GRADING. PROPOSAL TO REMOVE AND REPLACE THE FIRST SECTION OF AN EXISTING STORM SEWER FROM A CATCH BASIN ALONG FOURTH LINE RD DOWNSTREAM TO THE OUTFALL LOCATION AT STEVENS CREEK AND THE CONSTRUCTION OF A NEW HEADWALL
RV4-1219	Rideau Lot 21 Concession 4	2019	No	ALTERWATER. - Cleanout Of Droogh Municipal Drain And Replacement Of Culverts On All Drain Types
RV4-1419	Roger Stevens Dr	2019	No	ALTERWATER.WETLAND. - Replacement Of Existing Culvert On Roger Stevens Dr.
RV4-1519	Second Line Rd S	2019	No	ALTERWATER. - Replacement Of Existing Culvert On Second Line Rd S
RV4-1619	3611 Paden Rd	2019	No	STRUCTURE.WETLAND. - Construction Of A Detached Garage
18-RID-MVA-0184	1610, 1622 ROGER STEVENS DRIVE	2018	No	MINOR VARIANCE
18-RID-SEV-0079	6765 MCCORDICK RD (2504, 2510, 2516, 2522) CHURCH ST	2018	No	CONSENT
18-RID-SEV-0080	6765 MCCORDICK RD (2504, 2510, 2516, 2522) CHURCH ST	2018	No	CONSENT
18-RID-SEV-0081	6765 MCCORDICK RD (2504, 2510, 2516, 2522) CHURCH ST	2018	No	CONSENT
18-RID-SEV-0082	6765 MCCORDICK RD (2504, 2510, 2516, 2522) CHURCH ST	2018	No	CONSENT
18-RID-SEV-0083	6765 MCCORDICK RD (2504, 2510, 2516, 2522) CHURCH ST	2018	No	CONSENT
18-RID-SEV-0084	2492 CHURCH ST	2018	No	CONSENT
18-RID-SEV-0137	2368, 2372 CHURCH STREET	2018	No	CONSENT
18-RID-SEV-0186	1610, 1622 ROGER STEVENS DRIVE	2018	No	CONSENT
18-RID-SEV-0194	1610, 1622 ROGER STEVENS DRIVE	2018	No	CONSENT
18-RID-SPC-0112	1618 - 1622 ROGER STEVENS DRIVE	2018	No	SITE PLAN CONTROL
18-RID-ZBA-0196	2368 CHURCH STREET	2018	No	ZONING BY-LAW AMENDMENT
RV4-0118	Rideau Lot 1 Concession 5	2018	No	ALTERATION TO AN EXISTING WATERCOURSE - Culvert Replacement On A Municipal Drain
RV4-0218	Rideau Lot 25 & 26 Concession 5 & 6	2018	No	ALTERATION TO AN EXISTING WATERCOURSE - 4 Culvert Replacements
RV4-0318	1640 BONTREY PLACE	2018	No	DEVELOPMENT - STRUCTURE CONSTRUCT SEWAGE SYSTEM & DWELLING
RV4-0418	6623 Fourth Line Rd	2018	No	STRUCTURE. - Replacement Septic System - Fill In Regulated Area
RV4-0518	6441 Fourth Line Rd	2018	No	GRADING. - New Driveway To New Dwelling
RV4-0618	6574 Fourth Line Rd	2018	No	STRUCTURE. - Removal Of Existing Front Room To Be Replaced
RV4-0718	1640 Bontrey Pl	2018	No	GRADING. - Excavate A Pond To Improve Habitat Quality For A Variety Of Species
RV4-0818	13 Ralph Jago Way	2018	As-Built Details Required	GRADING.STRUCTURE. - Construction Of Septic System For New Single Family Dwelling
RV4-0918	6570 Prince Of Wales Dr	2018	No	GRADING.STRUCTURE. - Replacement Septic
RV4-1018	11 Ralph Jago Way	2018	As-Built Details Required	GRADING.STRUCTURE. - New Residential Construction
RV4-1118	2392 Roger Stevens Dr	2018	No	ALTERWATER. - Combine Sections Of Land Separated By Existing Watercourse To Improve Land Accessibility
RV4-1218	2355 Roger Stevens Dr	2018	No	STRUCTURE. - Replace Existing Septic System
RV4-0117	3275 Pierce Rd	2017	No	DEVELOPMENT - STRUCTURE - New Dwelling With Septic System Installation
RV4-0217	Rideau Lot 6 Concession 7	2017	No	ALTERATION TO AN EXISTING WATERCOURSE - Culvert Replacement
RV4-0317	Rideau Lot 15 Concession 2	2017	No	ALTERATION TO AN EXISTING WATERCOURSE - Replace Culvert Sn878390
RV4-0417	North Gower Lot 22 Concession 4	2017	No	ALTERATION TO AN EXISTING WATERCOURSE - Infill Of A Waterway With Drainage Tile

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Table 16 List of RVCA Planning and Regulation Permit Files (2010 to 31 May, 2019)

RVCA File #	Location	Year of Application	Flood Line Change Required?	Breif Description
RV3-1016	North Gower Lot 10 Concession 4	2016	No	Drain Maintenance - Thompson Branch Drain
RV4-0116	3457 Roger Stevens Drive	2016	No	INTERFERENCE TO A WETLAND - Reconstruct House (burnt Down)
RV4-0216	2364 Roger Stevens Dr	2016	No	DEVELOPMENT - STRUCTURE - Replacement Class 4 Septic System
RV4-0316	2300 James Craig St	2016	No	DEVELOPMENT - STRUCTURE - Replace And Construct New Equipment Drive Shed
RV4-0416	Marlborough Lot 1 Concession 5	2016	No	Drain Maintenance - Stevens Creek
RV4-0516	6748 Rideau Valley Dr S	2016	No	ALTERATION TO AN EXISTING WATERCOURSE - New T Dock
RV4-0616	6658 Carolin Crt	2016	As-Built Details Required	DEVELOPMENT - GRADING - Replacement Of Onsite Septic System
RV4-0716	6646 Fourth Line Rd	2016	No	DEVELOPMENT - STRUCTURE - Constructing A Canopy Shelter
RV4-0816	Marlborough Lot 17 Concession 5	2016	No	ALTERATION TO AN EXISTING WATERCOURSE - Culvert Replacement
RV4-0916	2240 ROGER STEVENS DR	2016	As-Built Details Required	ALTERATION TO AN EXISTING WATERCOURSE CONSTRUCT OUTLET DITCH FOR ROAD DRAINAGE OF SUBDIVISION
RV4-0215	NORTH GOWER Lot 24 Concession 1	2015	No	ALTERATION TO AN EXISTING WATERCOURSE TO REPLACE THE EXISTING STORM SEWER OUTLET
RV4-0315	6680 DORACK DR	2015	No	DEVELOPMENT - GRADING CUT & FILL WITH GRADING FOR SOCCER FIELD & TRACK
RV4-0415	1625 Mardick Crt	2015	No	DEVELOPMENT - STRUCTURE - Construct Inground Pool Outside Of Flood Plain
RV4-0515	2341 Roger Stevens Dr	2015	No	DEVELOPMENT - STRUCTURE - New Crawl Space Under Roadside Portion Of Existing Dwelling
RV4-0615	North Gower Lot 21 Concession 4	2015	No	Notification Of Drain Maintenance Or Repair - Perkins Drive Municipal Drain
RV6-2215	6790 Rideau Valley Dr	2015	No	DEVELOPMENT - STRUCTURE - Horse Barn
RV4-0114	Rideau Lot 22 Concession 3	2014	No	Drain Maintenance - Dillon-wallace Drain
RV4-0314	Rideau Lot 5, 6 Concession 7, 8	2014	No	Drain Maintenance - John Taylor Drain, Todd Branch
RV4-0414	Rideau Lot 4, 5, 6 Concession 8	2014	No	Drain Maintenance - John Taylor Drain, Main Drain
RV4-0514	Rideau Lot 15 Concession 3	2014	No	Drain Maintenance - Presley Municipal Drain
RV4-0614	6623 Third Line Rd S	2014	No	CONSTRUCTION/RECONSTRUCTION - Installation Of A Pool
RV4-0714	1980 Phelan Rd W	2014	No	ALTERATION TO AN EXISTING WATERCOURSE - A Storm Water Storage Area And A Drainage Swale Are To Outlet Into The Municipal Drain
RV4-0814	6668 Fourth Line Rd	2014	No	PLACE OR REMOVE FILL - Mantel Of Septic System
RV4-0914	6395 Second Line Rd S	2014	No	ALTERATION TO AN EXISTING WATERCOURSE - Culvert Replacement And Clean Out
RV5-1414	3849 Roger Stevens	2014	No	CONSTRUCTION/RECONSTRUCTION - Construction Of A New Single Family Dwelling & Septic System
RV4-0113	Rideau Lot 22 Concession 3	2013	No	Drain Maintenance Or Repair Subject - Dillon-wallace Municipal Drain
RV4-0213	RIDEAU Lot 6 Concession 4	2013	No	ALTERATION TO AN EXISTING WATERCOURSE REPLACE EXISTING CULVERT WITH SIMILAR CULVERT
RV4-0313	6576 Fourth Line Road	2013	No	CONSTRUCTION/RECONSTRUCTION - Septic & Addition To Accomodate A Dental And Office Facility
RV4-0613	Rideau Lot 7, 8 Concession 8	2013	No	Drain Maintenance Or Repair Subject - Purdy Branch, John Taylor Municipal Drain
RV4-0813	6654 CAROLIN CRT, BOX 601	2013	No	CONSTRUCTION/RECONSTRUCTION INSTALLATION OF A SWIMMING POOL WITHIN FLOOD PLAIN
RV4-0913	1640 Bontrey Place	2013	No	CONSTRUCTION/RECONSTRUCTION - Construct New Dwelling And Septic
RV4-1013	2343 Church St	2013	No	PLACE OR REMOVE FILL - Fill For Septic
RV5-1713	Marlborough Lot 15 Concession 5	2013	No	CONSTRUCTION/RECONSTRUCTION - Construct New Dwelling And Septic
RV3-3712T	North Gower Lot 21 Concession 1+	2012	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Only Cleanout And Brushing Of Top Bank -comments Field From Old Database: Maint
RV4-0112T	Marlborough Lot 3 Concession 7+	2012	No	BRIDGE, CULVERT, ROAD CROSSING, MAJOR WORKS - Culvert Replacement -comments Field From Old Database: Culvert
RV4-0212T	North Gower Lot 22 Concession 3	2012	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Only Cleanout
RV4-0312T	Marlborough Lot 5+ Concession 6	2012	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Only Cleanout And Brushing Of Top Bank
RV4-0412T	NORTH GOWER Lot 23 Concession 3	2012	No	ALTER, REPAIR, OR REPLACE EXISTING STRUCTURE EMERGENCY REPLACEMENT OF CULVERT DUE TO SINK HOLE -COMMENTS FIELD FROM OLD DATABASE: CULVERT
RV4-0111	6713 Second Line R	2011	No	BRIDGE, CULVERT, ROAD CROSSING, MAJOR WORKS - Drain Clean Out Farm -comments Field From Old Database: Drain

Table 16 List of RVCA Planning and Regulation Permit Files (2010 to 31 May, 2019)

RVCA File #	Location	Year of Application	Flood Line Change Required?	Breif Description
RV4-0311T	North Gower Lot 20++ Concession 1++	2011	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Clean Out And Vegetation Removal On The Dillon-wallace Municipal Drain. Ont Reg. 174/06 Application Submitted As Well
RV4-0411T	Marlborough Lot 3 Concession 7+	2011	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Clean Out On The John Taylor Municipal Drain - Wammas-clarke Branch
RV4-0511T	Marlborough Lot 4++ Concession 6	2011	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Clean Out On The Morrision Municipal Drain - Main Drain And Moore Branch
RV4-0611T	Marlborough Lot 4+ Concession 5++	2011	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Clean Out And Vegetation Removal On Alternate Sides On Pettapiece Municipal Drain
RV4-0711T	Marlborough Lot 4 Concession 7	2011	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Clean Out And Vegetation Removal On Alternate Sides On The Schouten Branch Of Pettapiece Municipal Drain
RV4-0811T	Marlborough Lot 3 Concession 7	2011	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Clean Out And Vegetation Removal On Alternate Sides On The Clarke Branch Of Pettapiece Municipal Drain
RV4-0911T	Marlborough Lot 7 Concession 7	2011	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Drain Clean Out And Removal Of Vegetation On Alternate Sides On Mokievsky-zubok Branch Of Morrison Municipal Drain
RV4-1011T	Marlborough Lot 3 Concession 6	2011	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Drain Clean Out And Removal Of Vegetation On Alternate Sides On Pratt Branch Of Pettapiece Municipal Drain
RV4-1311T	Marlborough Lot 6 Concession 7	2011	No	MUNICIPAL DRAIN CLEAN OUT (SECTION 35) - Bottom Drain Clean Out And Removal Of Vegetation On Alternate Sides
RV4-1411	6714 Mccordick Rd	2011	No	FILL SEPTIC - Replace Septic System -comments Field From Old Database: Septic
RV4-1511T	Marlborough Lot 18 Concession 4	2011	No	BRIDGE, CULVERT, ROAD CROSSING, MAJOR WORKS - Replace Culvert -comments Field From Old Database: Culvert
RV5-0511	6030 Proven Line R	2011	No	CONSTRUCTION ADDITION (RESIDENTIAL) - Addition To Existing Structure And Proposed New Garage And Grade Changes -comments Field From Old Database: Additio
RV5-2511	3186 Harbison	2011	No	CONSTRUCTION NEW (RESIDENTIAL) - 20 X 28 Proposed Garage Within 120 Metre Psw Buffer -comments Field From Old Database: Garage
RV4-0110	1625 Mardick Crt	2010	No	FILL OTHER - -comments Field From Old Database: Pool
RV4-0210	6574 Michelangelo	2010	No	CONSTRUCTION OTHER - Construct Hobby Shop
RV4-0310	1625 Mardick Crt	2010	No	FILL SEPTIC - Septic System Replacement -comments Field From Old Database: Stamp
RV4-0410	2240 Roger Stevens	2010	No	CUT AND FILL - Waiting For Revised Balanced Cut/fill Design. -comments Field From Old Database: Cut & F
RV6-7510T	North Gower Lot 16 Concession 2+	2010	No	BRIDGE, CULVERT, ROAD CROSSING, MAJOR WORKS - Culvert Replacement

Table 17: Culvert data used for floodline plotting (Stevens Creek)

Serial	SN# *	Location	Draining to Watercourse	Downstream Invert (m)	Upstream Invert (m)	Downstream Obvert (m)	Upstream Obvert (m)	Shape	Survey Date ** (dd/mm/yyyy)
1	867020	Pettapiece Drain at Roger Stevens Drive	Stevens Creek	88.82	88.78	91.46	91.48	Box	12/12/2019
2	868410	Pierce Road west of McCordick Road	Stevens Creek	89.44	89.35	90.18	90.17	Circular	12/12/2019
3	L872930	Church Street east of McCordick Road	Stevens Creek	88.33	88.48	88.99	89.07	Circular	4/11/2019
4	A872160	Roger Stevens Drive east of McCordick Road	Stevens Creek	89.15	89.17	89.71	89.72	Circular	4/11/2019
5	878040	Droogh Drain at Roger Stevens Drive	Stevens Creek	87.21	87.34	88.82	88.94	Circular	4/11/2019
6	A872180	Roger Stevens Drive west of Craighurst Drive	Stevens Creek	87.79	87.80	88.33	88.44	Circular	4/11/2019
7	878060	Prince of Wales Drive south of Russvern Drive	Stevens Creek	88.71	88.77	90.05	90.35	Box	12/12/2019
8	A872200	Roger Stevens Drive east of James Craig Street	Stevens Creek	86.40	86.48	87.18	87.25	Circular	4/11/2019
9	A872220	Roger Stevens Drive west of Ralph Jago Way	Stevens Creek	86.98	87.05	87.44	87.65	Circular	4/11/2019
10	L874590	Presley Drain (Sims Branch) at Phelan Road West	Stevens Creek	87.08	87.04	87.44	87.55	Circular	12/12/2019
11	878480	Phelan Road West east of Sims Branch	Stevens Creek	86.36	86.62	88.26	88.42	Circular	12/12/2019
12	878670-1,-2	Highway 416 south of Stevens Creek	Stevens Creek	86.85	86.91	87.54	87.66	Circular	4/11/2019
13	L873070	2nd Line Road South south of Stevens Creek	Stevens Creek	87.04	86.98	87.42	87.36	Circular	12/12/2019
14	A871370	Rideau Valley Drive South south of Stevens Creek	Stevens Creek	86.40	86.28	86.66	86.68	Circular	12/12/2019
15	L867150	Stevens Creek @ McCordick and Lockhead road west	Tributary C	89.72	89.86	90.31	90.39	Circular	5/6/2018
16	L872510	Stevens Creek @ Lockhead Road west	Tributary C	89.71	89.63	90.30	90.23	Circular	5/6/2018
17	L872550	Dillon-Wallace Drain (Branch A) at Lockhead Road West	Tributary C	88.71	88.77	89.38	89.24	Circular	4/11/2019
18	878050	4th Line Road south of Willisbrook Drive	Tributary C	88.84	88.89	89.85	89.93	Box	4/11/2019
19	868330	Wammes-Clarke Branch at Malakoff Road	Tributary B	93.31	93.47	94.97	95.23	Circular	12/12/2019
20	6442_4th	Driveway of 6442 4th Line Road	Tributary B	---†	89.91	---	91.37	Circular	4/11/2019
21	6526_4th	Driveway of 6526 4th Line Road	Tributary B	88.88	88.98	89.35	89.31	Circular	4/11/2019
22	L871710	3rd Line Road South south of Roger Stevens Drive	Tributary A	89.43	89.51	89.88	89.96	Circular	12/12/2019
23	A872260	Roger Stevens Drive east of 3rd Line Road South	Tributary A	87.13	87.20	87.88	87.94	Circular	4/11/2019
24	A872300	Roger Stevens Drive west of Highway 416	Tributary A	87.50	87.60	88.263	88.244	Circular	4/11/2019
25	878620-1,-2	Johnston Drain at Highway 416	Tributary A	86.27	86.65	87.849	87.793	Circular	4/11/2019
26	878570	Johnston Drain at 2nd Line Road South	Tributary A	85.41	85.42	86.864	86.969	Circular	4/11/2019
27	L873050	2nd Line Sourth south of Johnston Drain	Tributary A	86.49	86.57	86.983	87.084	Circular	4/11/2019

* City of Ottawa Structure Numbers that were obtained from GIS and confirmed onsite during survey, except for driveways which were given an address reference.
** Surveys conducted by RVCA staff.
† 6442 4th Line Road's downstream values could not be accurately obtained due to rocky and vegetative obstructions. Hydrauliuc flow capability was confirmed, and elevations were assumed to match upstream.

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Rideau Valley Conservation Authority

Base-mapping and GIS services provided courtesy of the Rideau Valley Conservation Authority, under License with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2019.

Projection note:	U.T.M. Zone 18 - NAD 83 Datum
File name: Figure 1: Location Map	
Date Modified: 04/Oct/2019	
Created by: TBAUMAN	

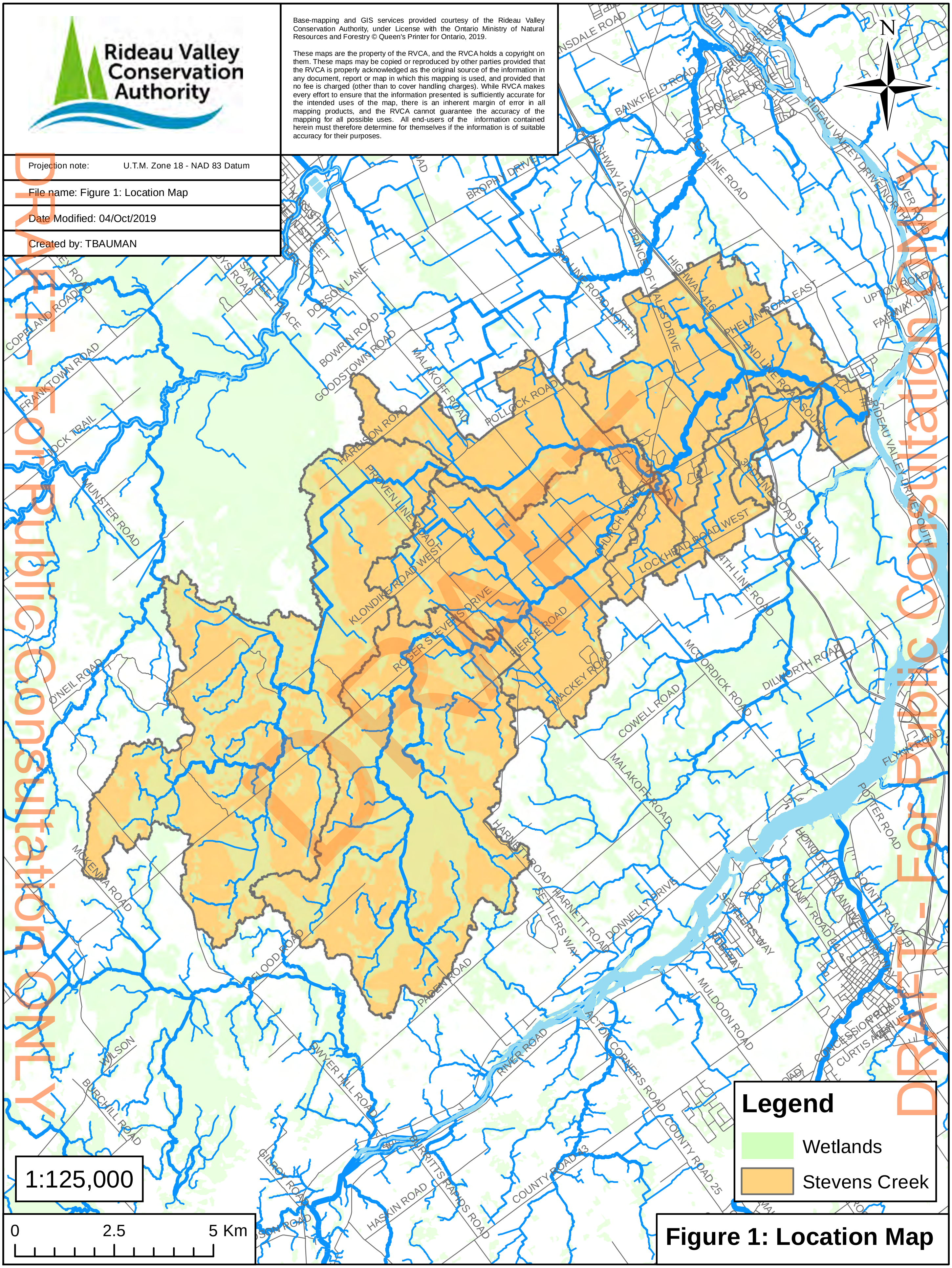


Figure 1: Location Map

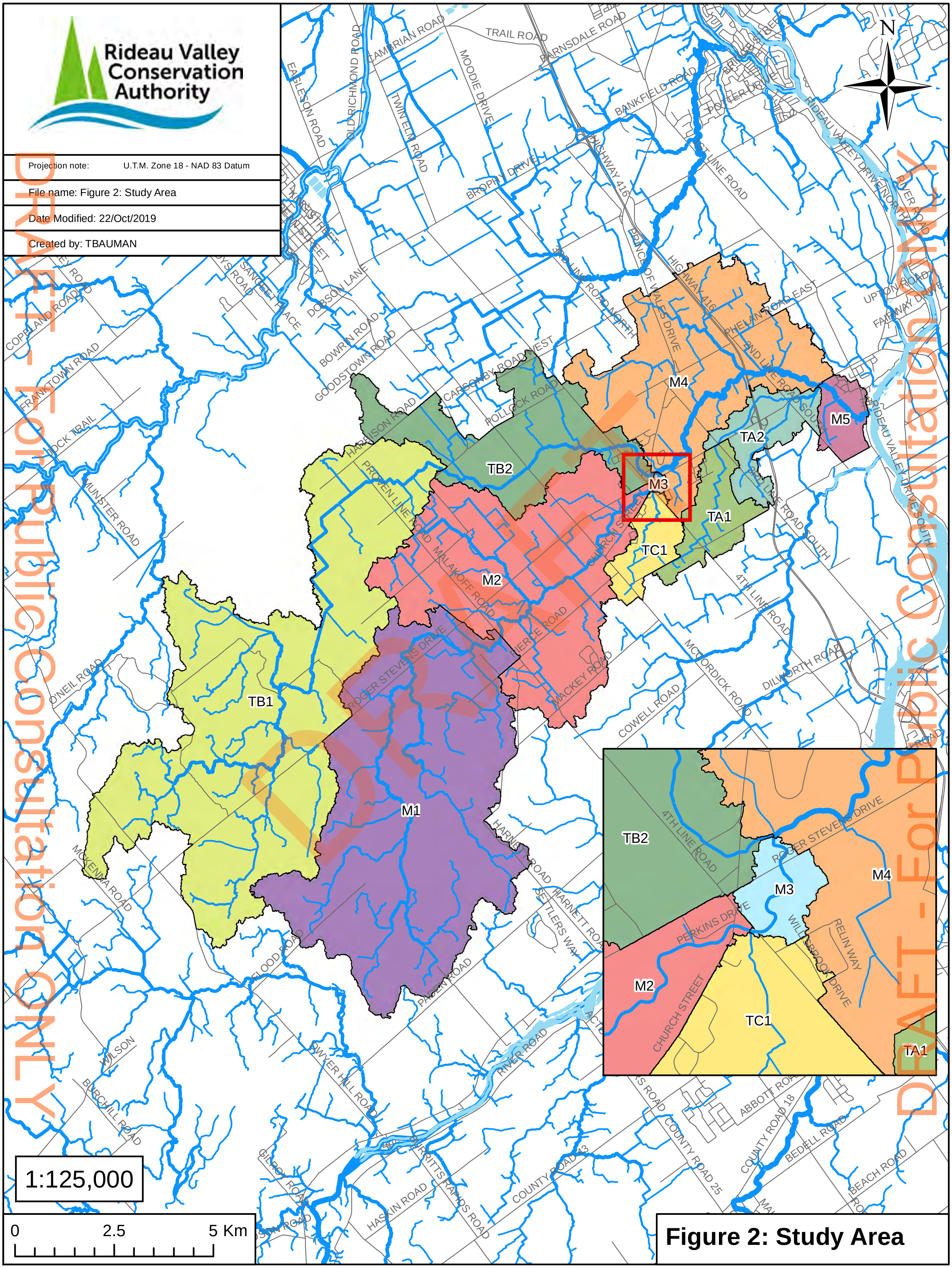


Figure 2: Study Area

Rideau Valley Conservation Authority

Projection note: U.T.M. Zone 18 - NAD 83 Datum

File name: Figure 3a: Hydrologic Soil Group

Date Modified: 12/Mar/2020

Created by: TBAUMAN

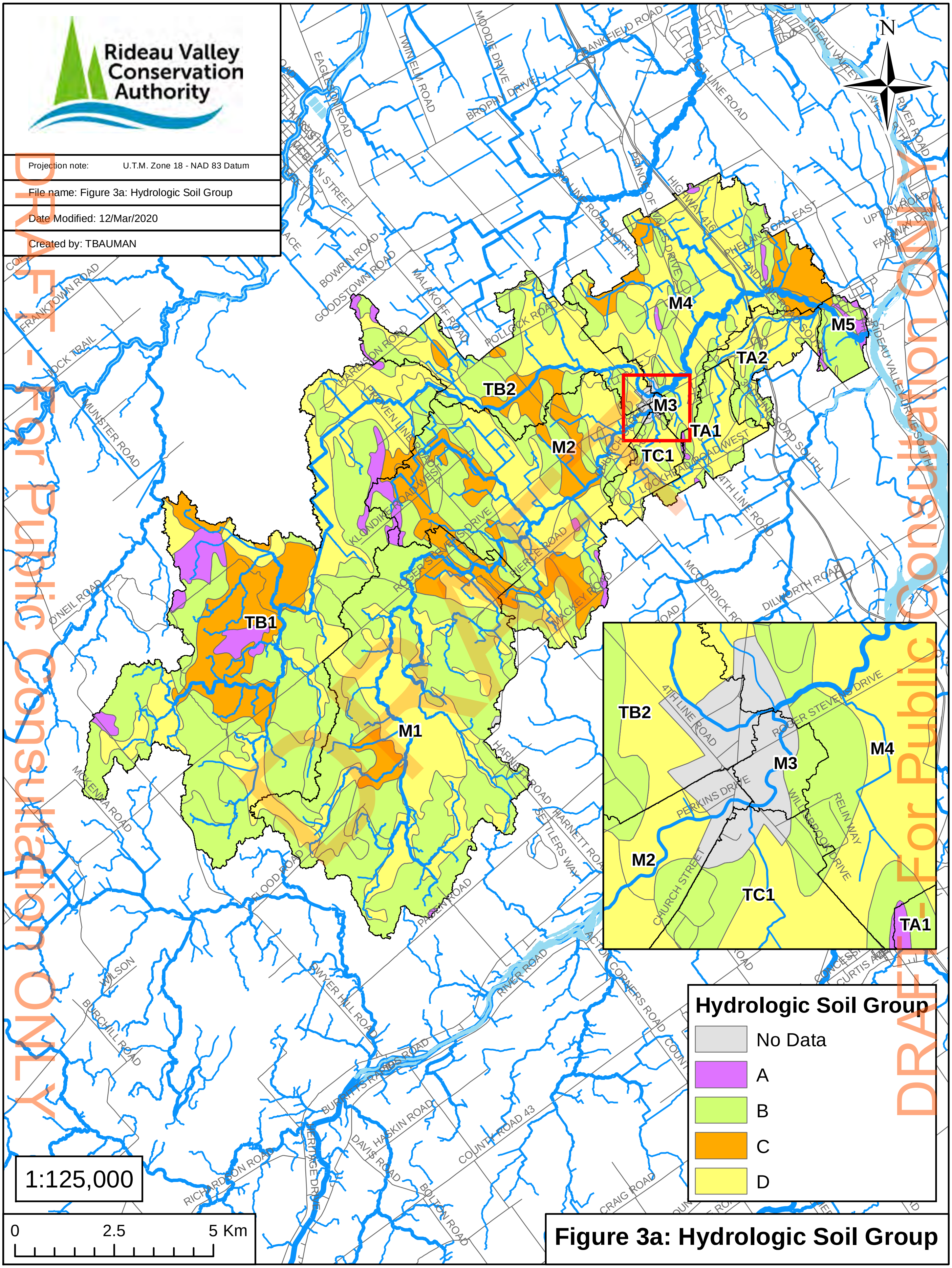


Figure 3a: Hydrologic Soil Group

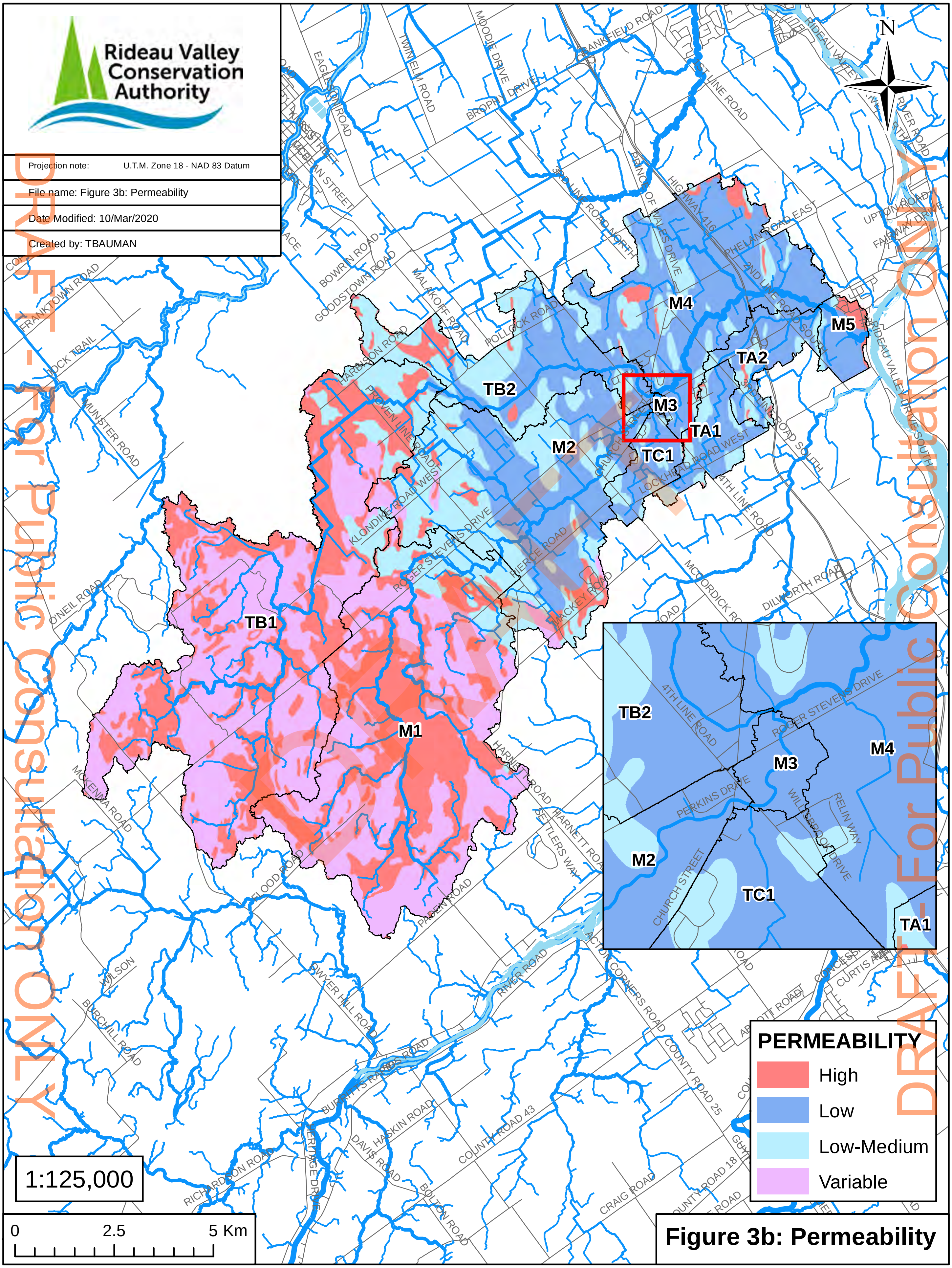


Figure 3b: Permeability

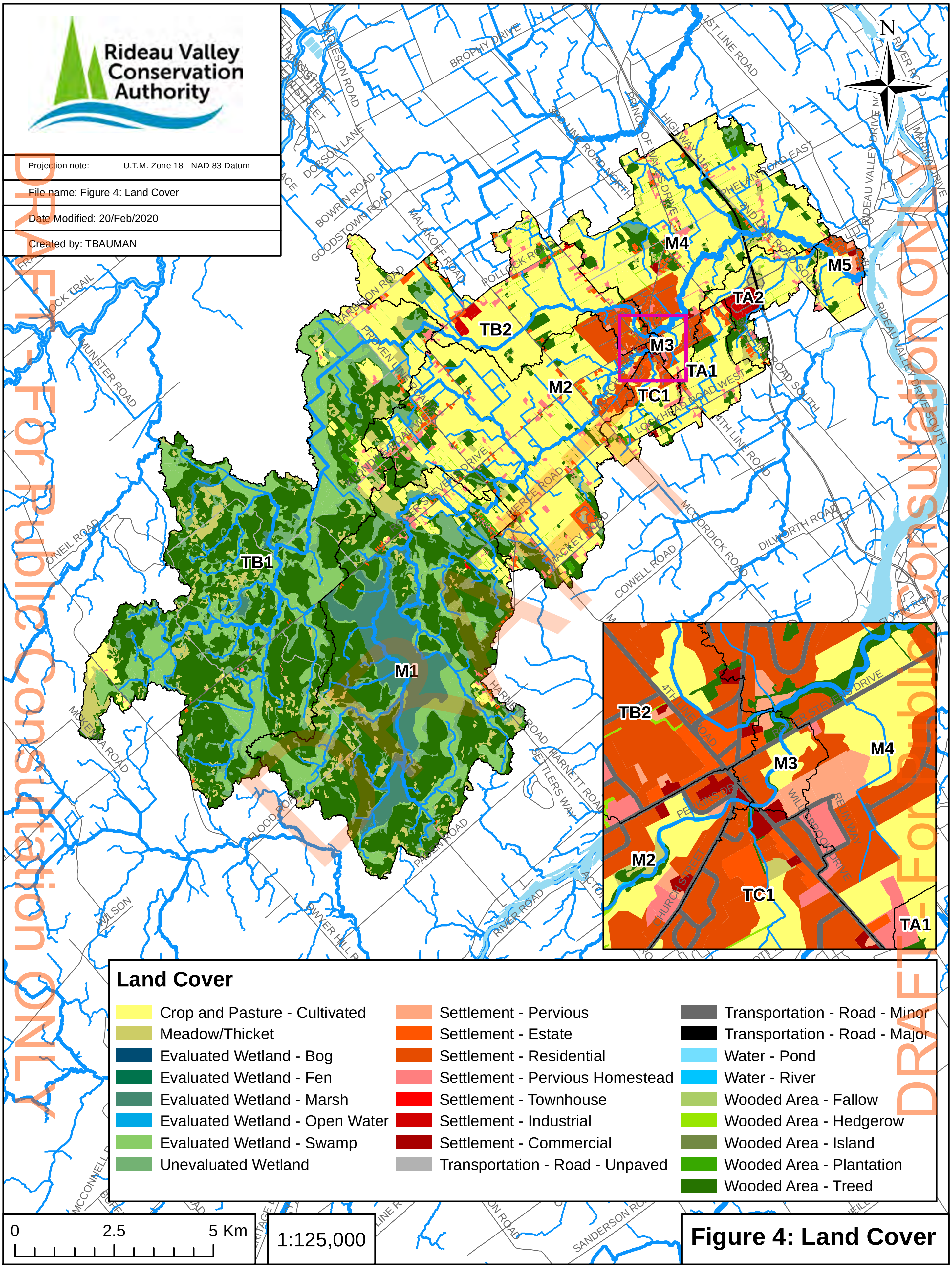


Figure 4: Land Cover

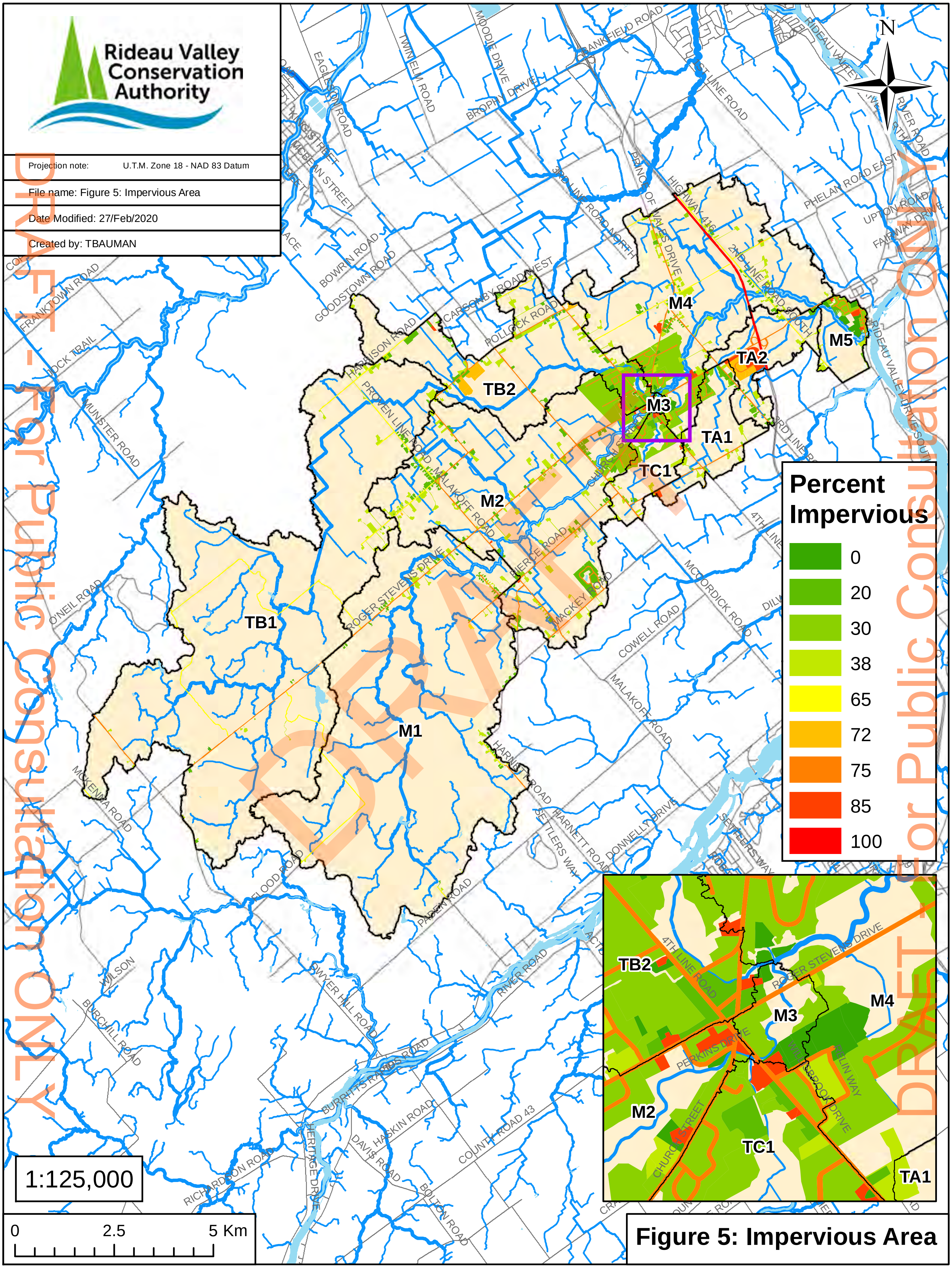


Figure 5: Impervious Area

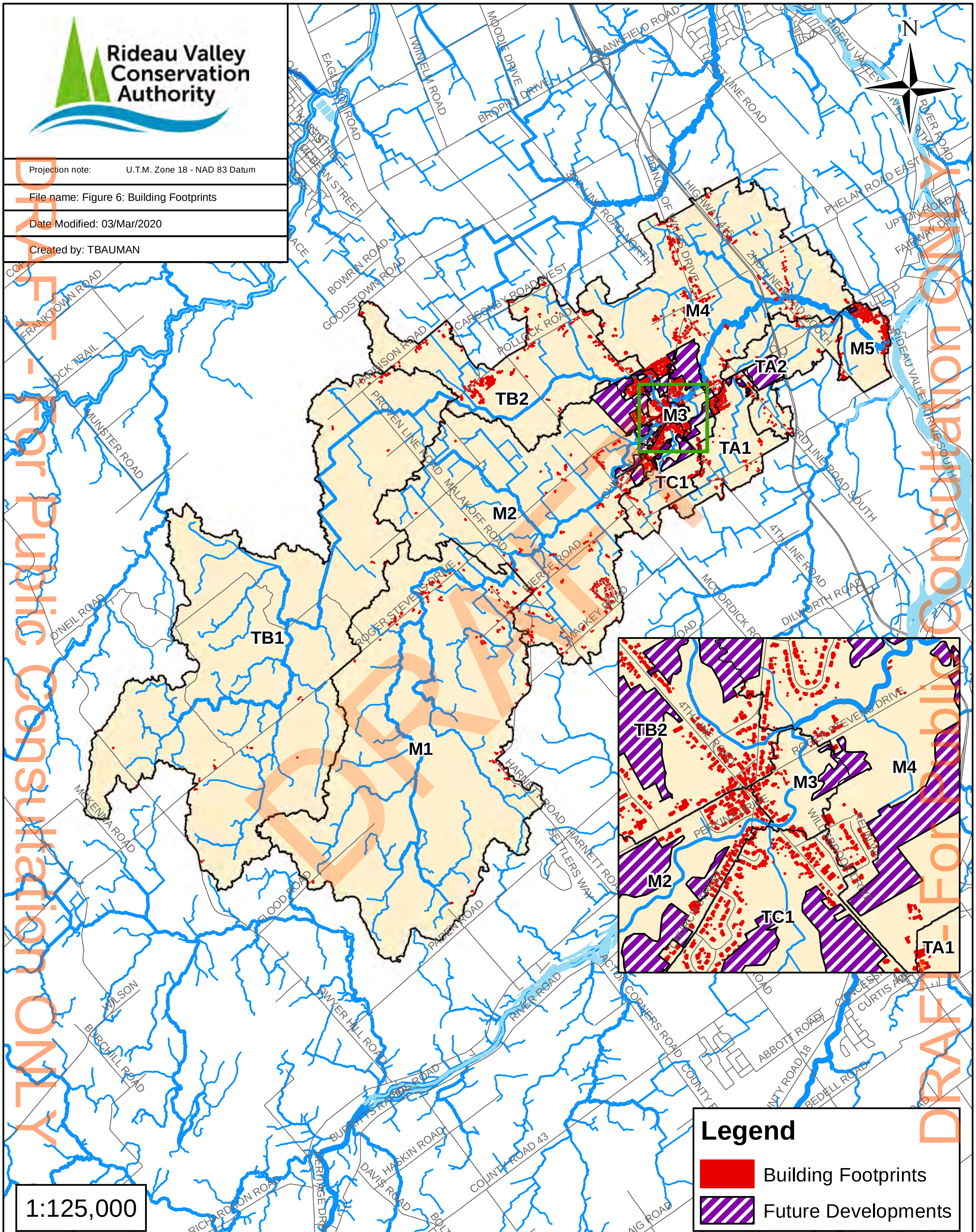


Figure 6: Building Footprints

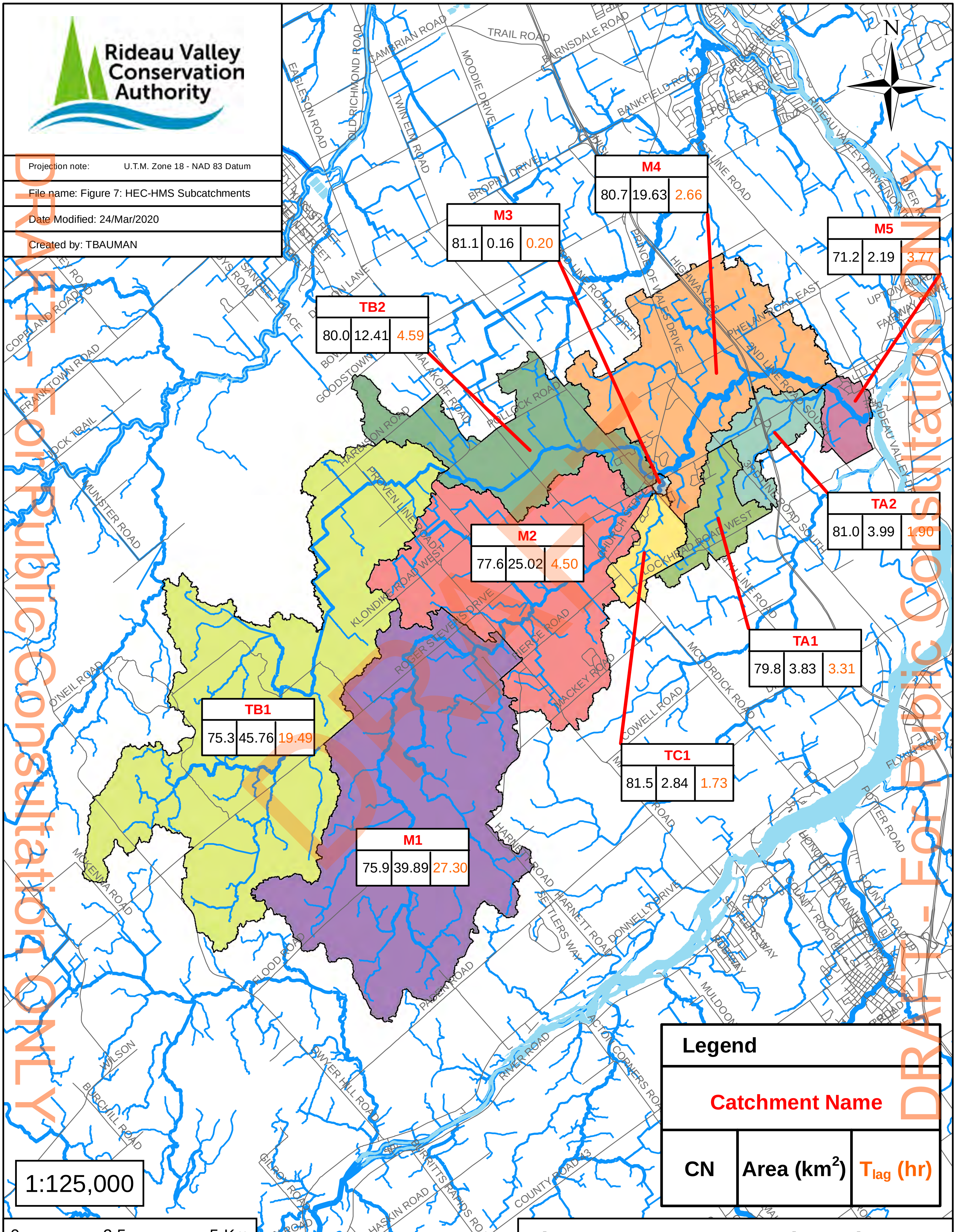
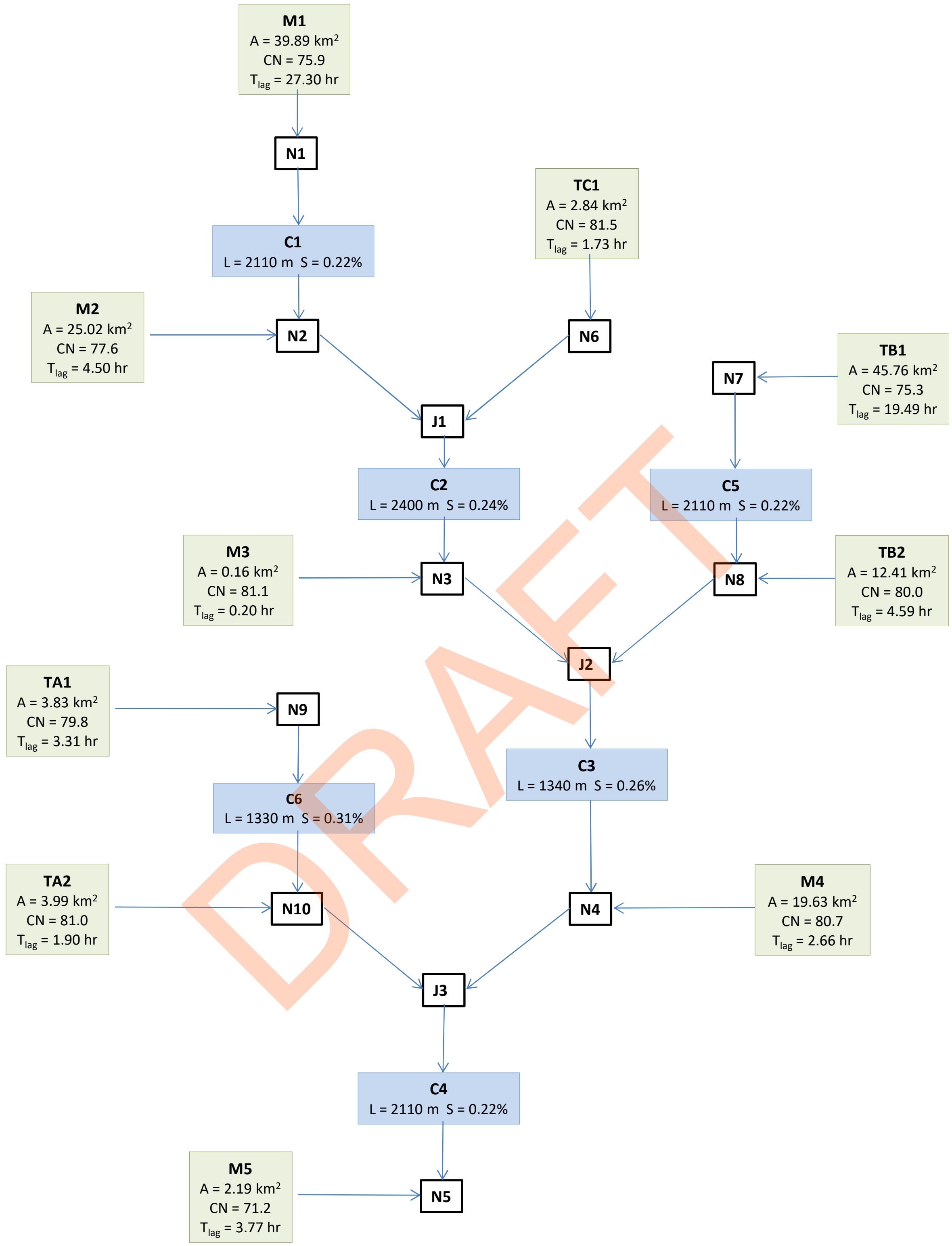


Figure 7: HEC-HMS Subcatchments



Transform Method

SCS Unit Hydrograph

Kinematic Wave

Figure 8 HEC-HMS Schematic

Figure 9   IDF curve for Ottawa Airport based on 1967-2007 data

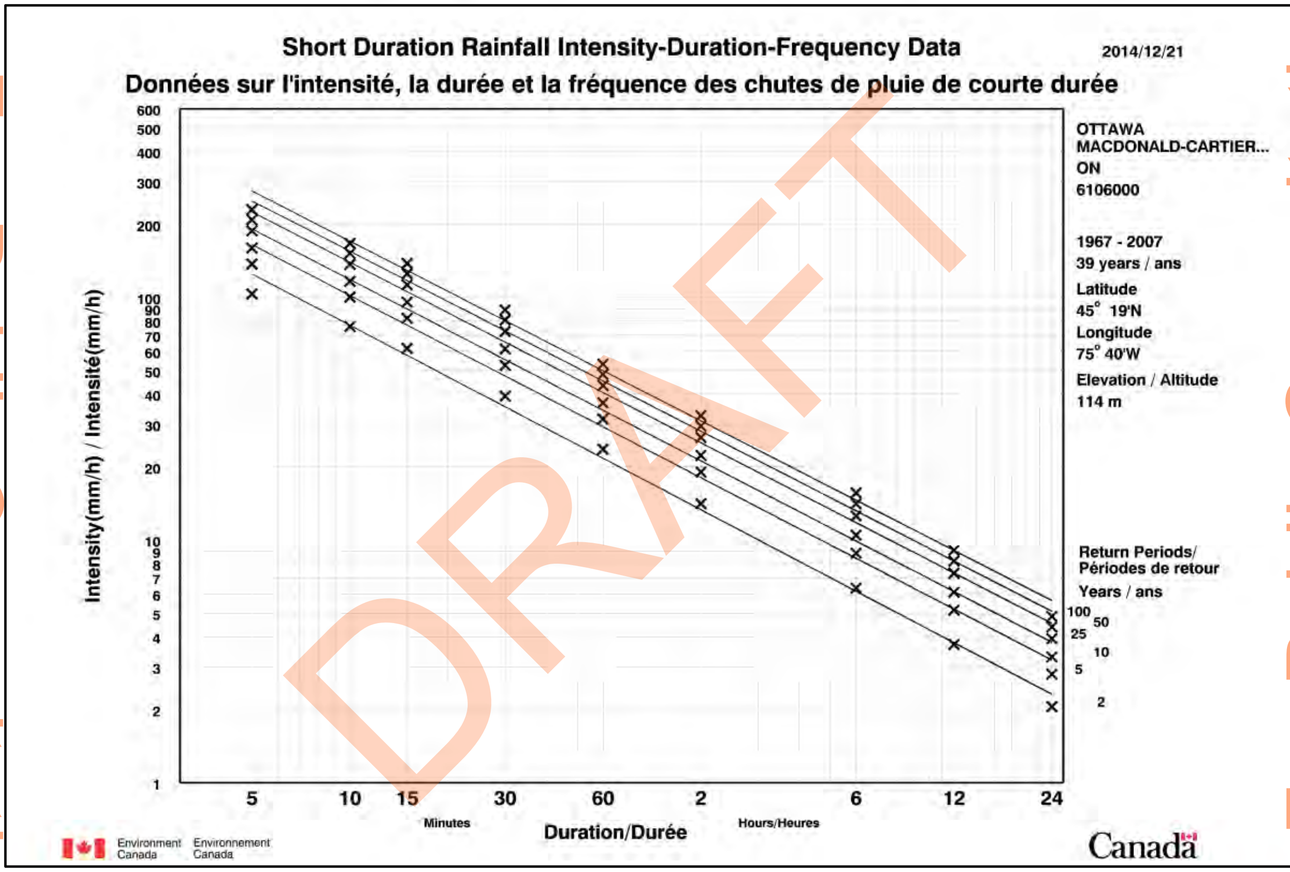


Figure 10 Fitted IDF curves for Ottawa Airport generated by STORMS software

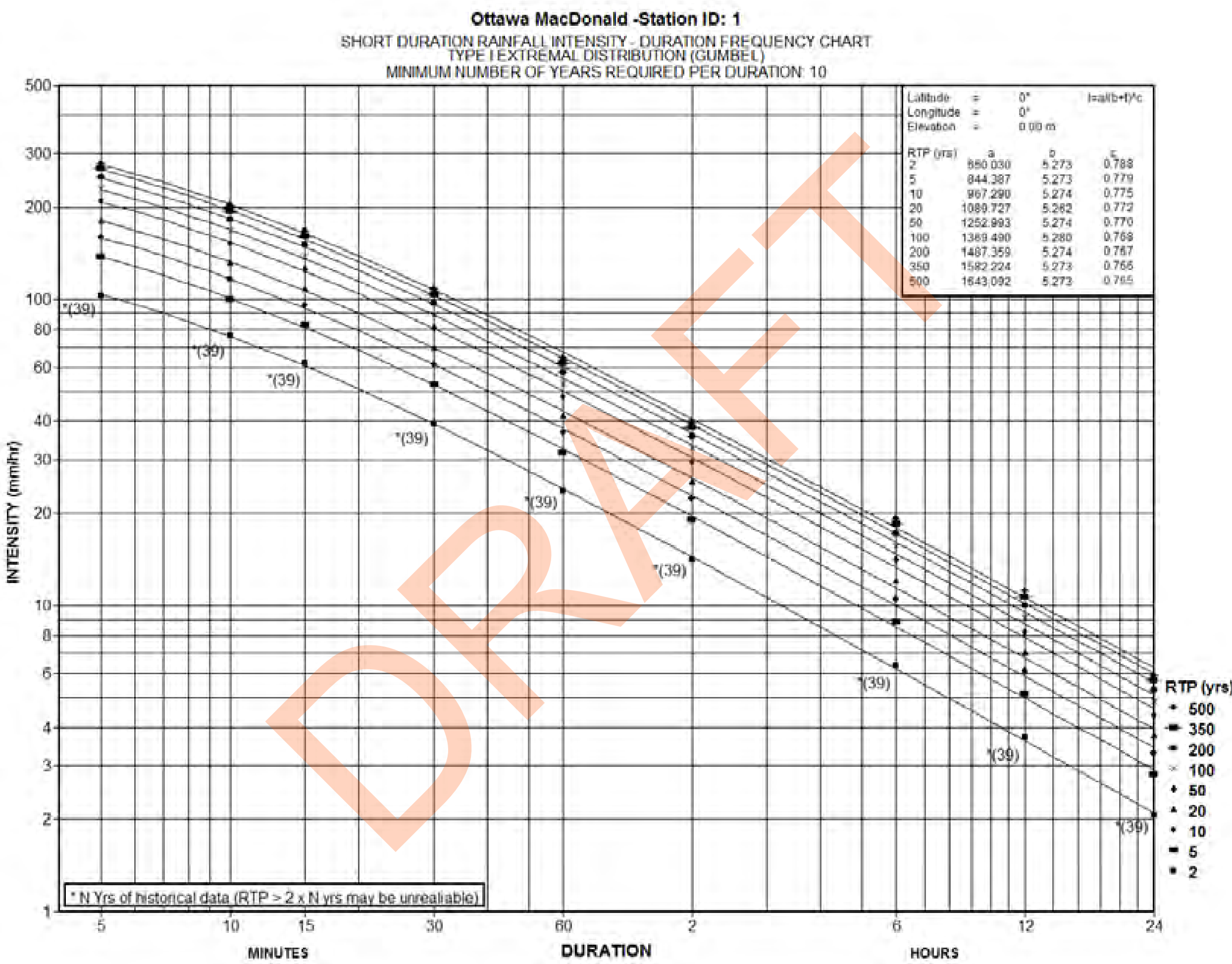


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Figure 11 Hyetographs of various design storms

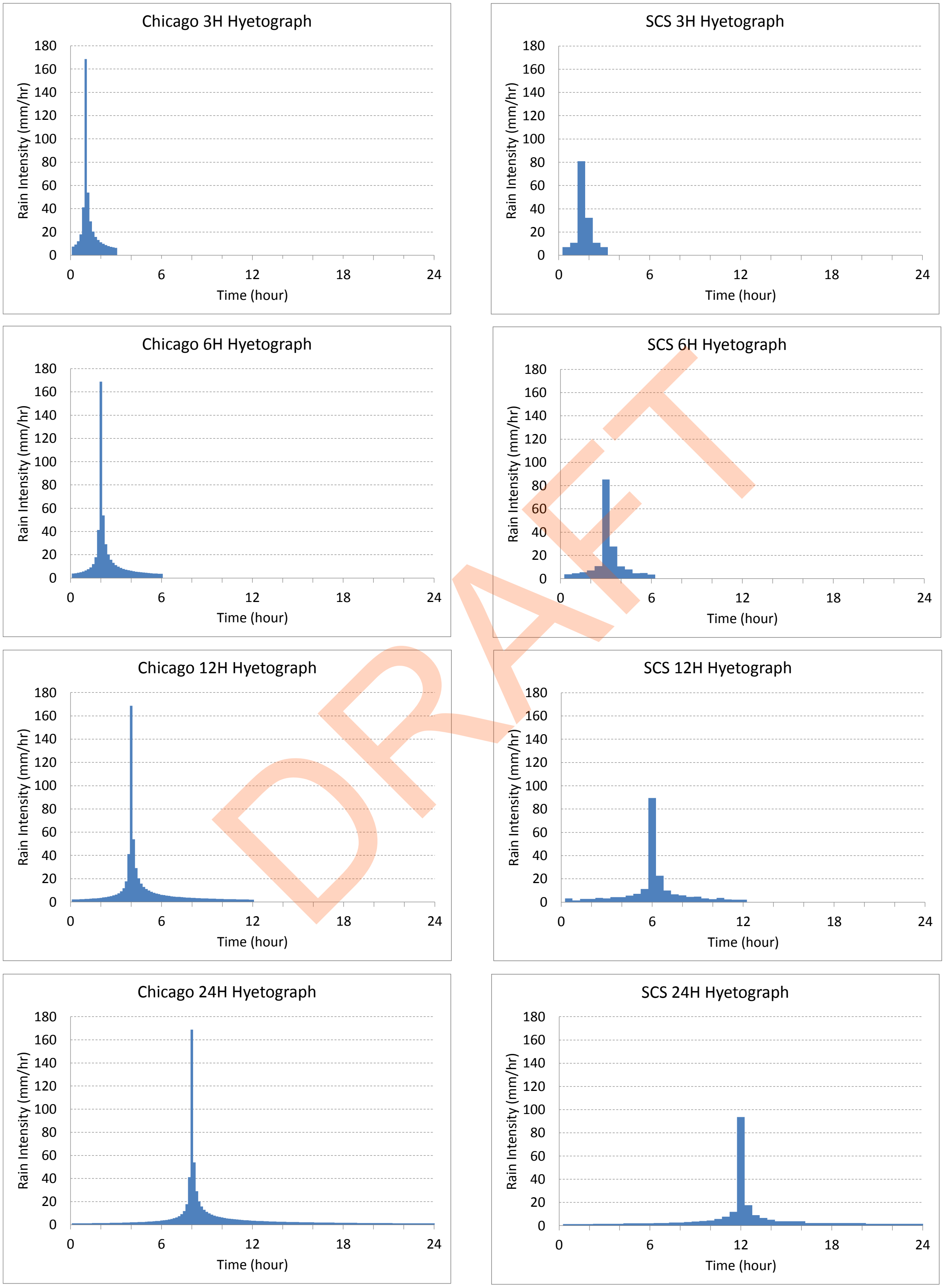
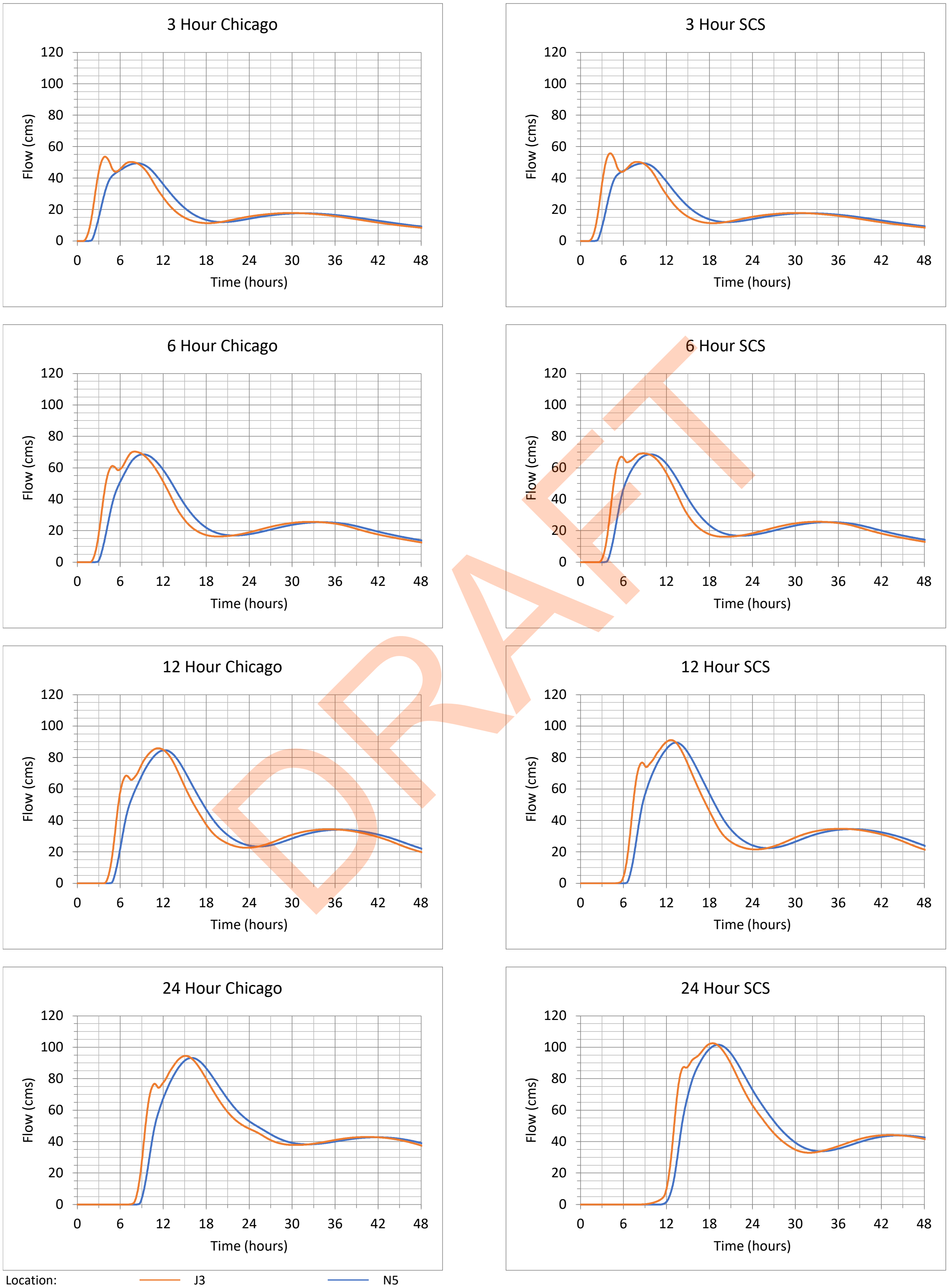


Figure 12 HEC-HMS generated flows at J3 and N5 for different design storms



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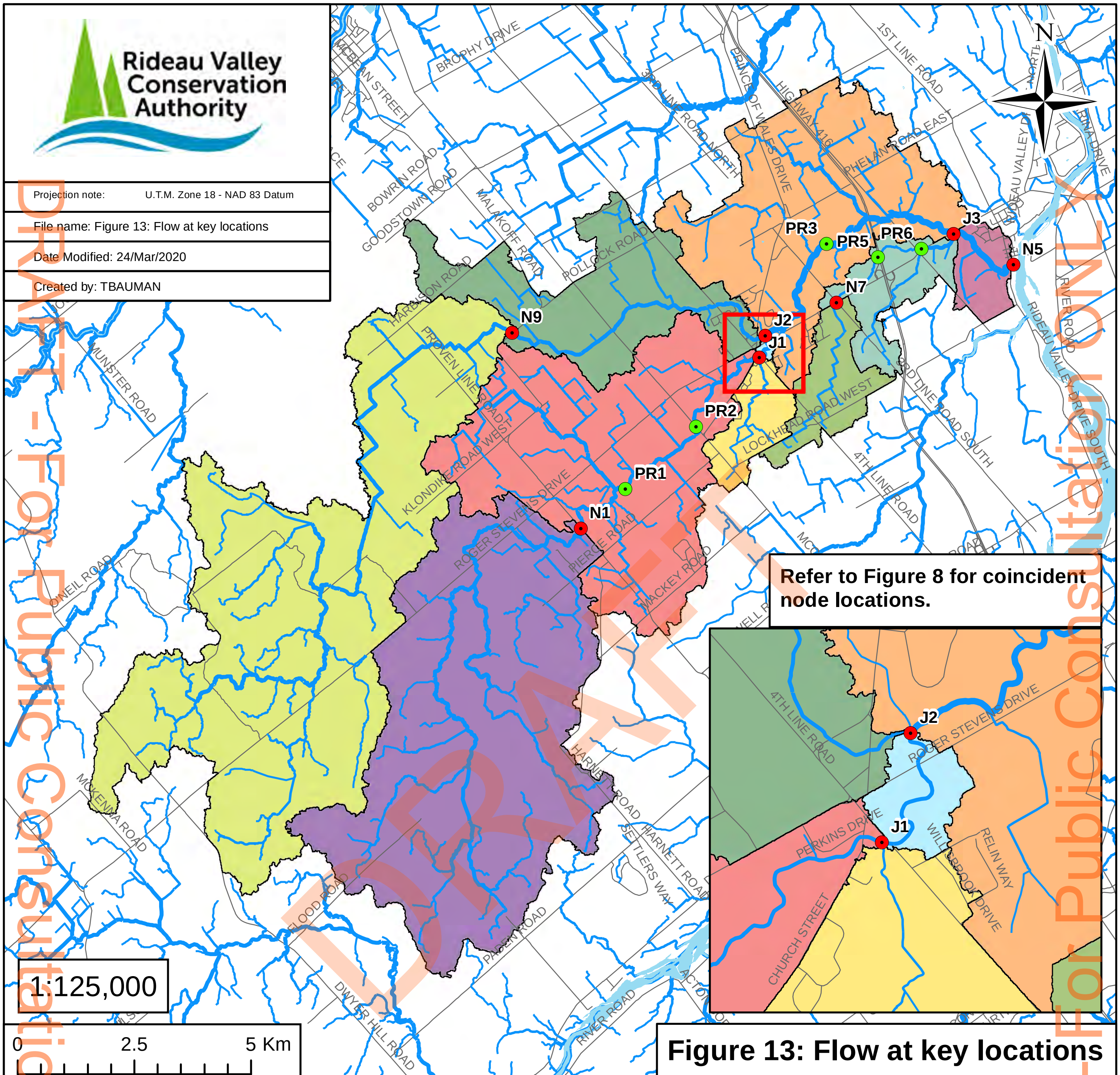
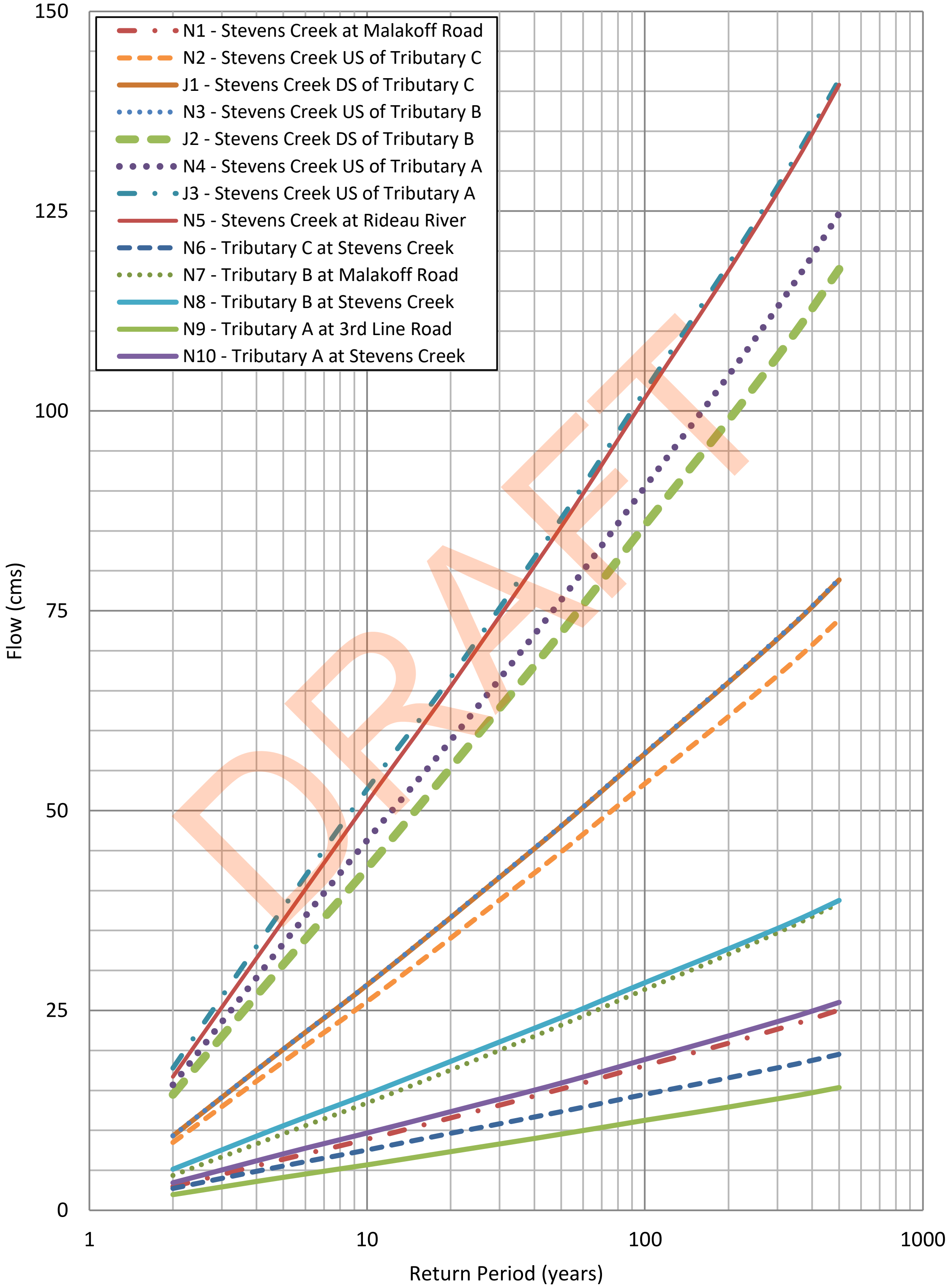


Figure 13: Flow at key locations

Return Period (year)	2	5	10	20	50	100	200	350	500
Nodes	Flow (cms)								
N1	2.98	6.40	8.91	11.60	15.22	18.10	20.94	23.37	25.07
PR1	6.08	13.25	18.55	24.19	31.80	37.84	43.78	48.84	52.38
PR2	7.45	16.28	22.84	29.79	39.19	46.65	53.98	60.20	64.56
N2	8.49	18.61	26.13	34.10	44.87	53.42	61.81	68.93	73.92
N3	9.34	20.21	28.23	36.73	48.17	57.25	66.14	73.69	78.98
PR3	15.05	32.01	44.42	56.99	74.24	87.98	101.48	112.98	121.04
N4	15.70	33.39	46.30	58.81	76.41	90.51	104.44	116.37	124.73
N5	16.74	36.33	51.05	65.58	85.57	101.63	117.55	131.21	140.83
N6	2.75	5.58	7.58	9.65	12.38	14.52	16.58	18.32	19.53
N7	4.39	9.59	13.44	17.58	23.18	27.64	32.04	35.81	38.46
N8	5.15	10.60	14.54	18.67	24.15	28.49	32.72	36.29	38.78
N9	1.98	4.14	5.71	7.36	9.54	11.27	12.95	14.37	15.36
PR5	2.36	4.92	6.77	8.69	11.25	13.30	15.31	17.01	18.19
PR6	2.59	5.36	7.36	9.44	12.21	14.45	16.65	18.51	19.79
N10	3.45	7.09	9.68	12.37	15.93	18.89	21.83	24.32	26.03
J1	9.32	20.17	28.18	36.67	48.09	57.17	66.05	73.59	78.87
J2	14.49	30.81	42.78	55.39	72.32	85.74	98.85	109.98	117.76
J3	17.82	37.91	52.68	66.70	86.59	102.55	118.35	131.92	141.48

Figure 14a Estimated 1:100 year flows along Stevens Creek



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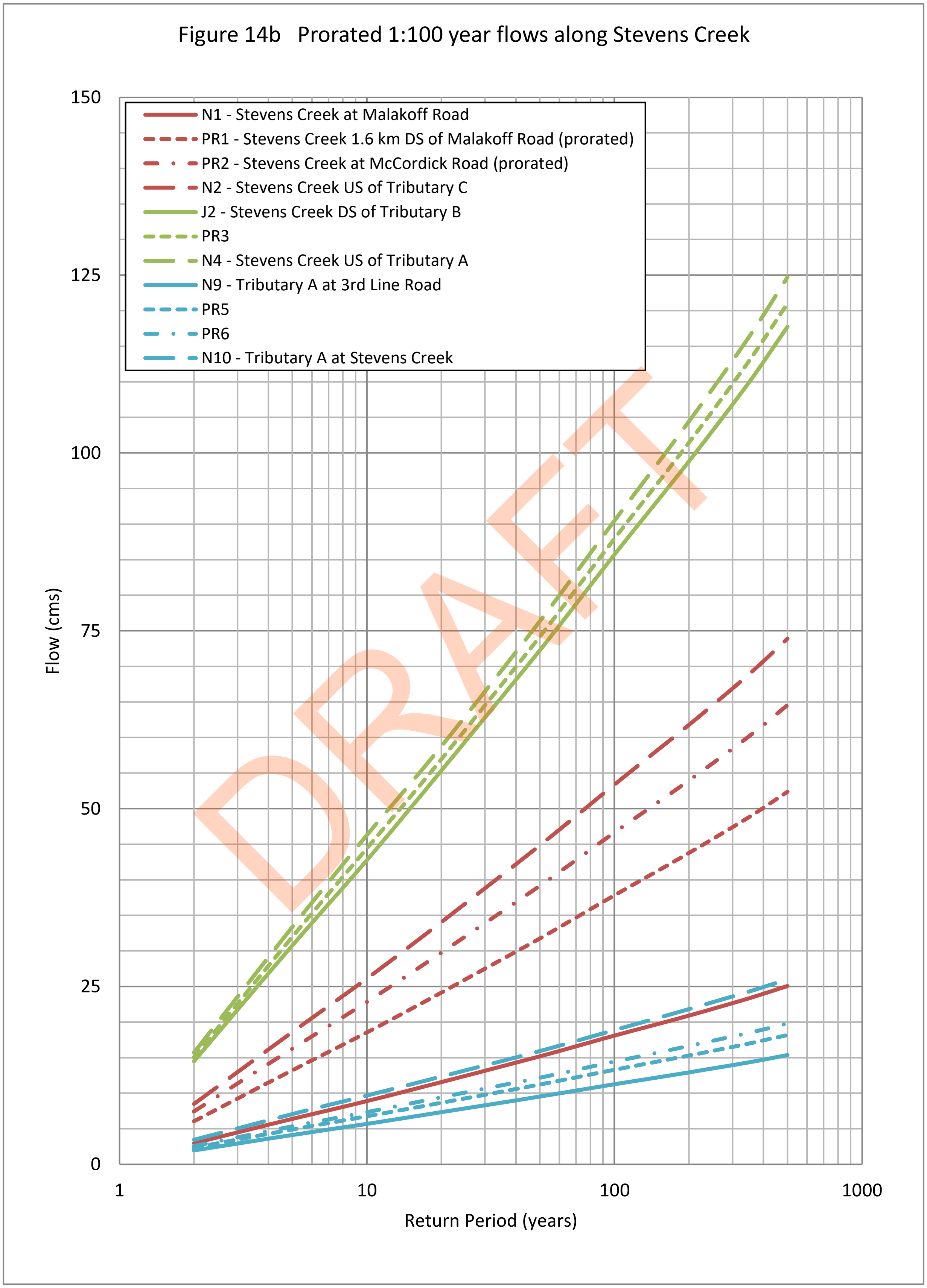

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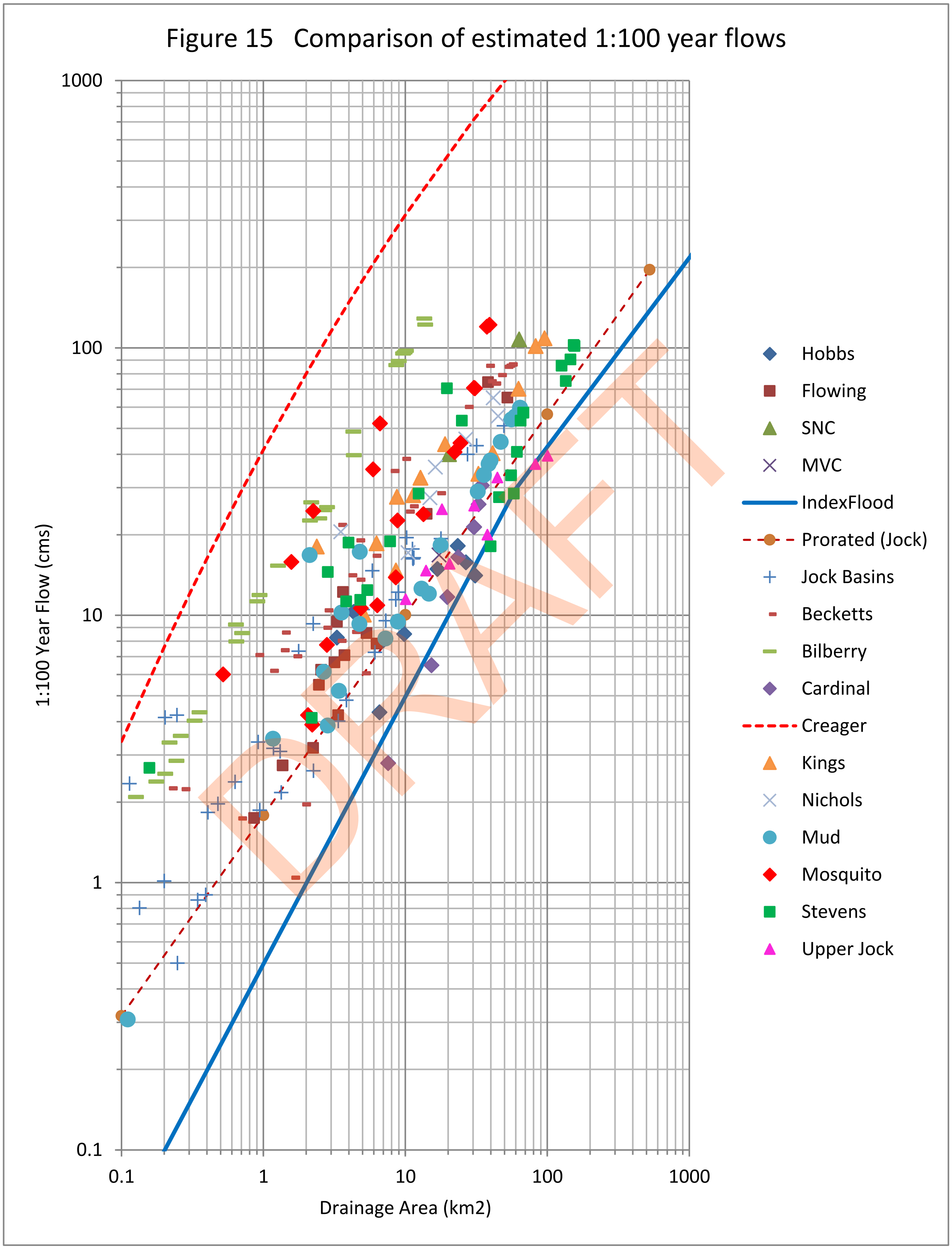
Figure 15 Comparison of estimated 1:100 year flows
1:100 Year Flow (cms)
Drainage Area (km2)
1000
100
10
1
0.1
0.1
1
10
100
1000
Hobbs
Flowing
SNC
MVC
IndexFlood
Prorated (Jock)
Jock Basins
Becketts
Bilberry
Cardinal
Creager
Kings
Nichols
Mud
Mosquito
Stevens
Upper Jock
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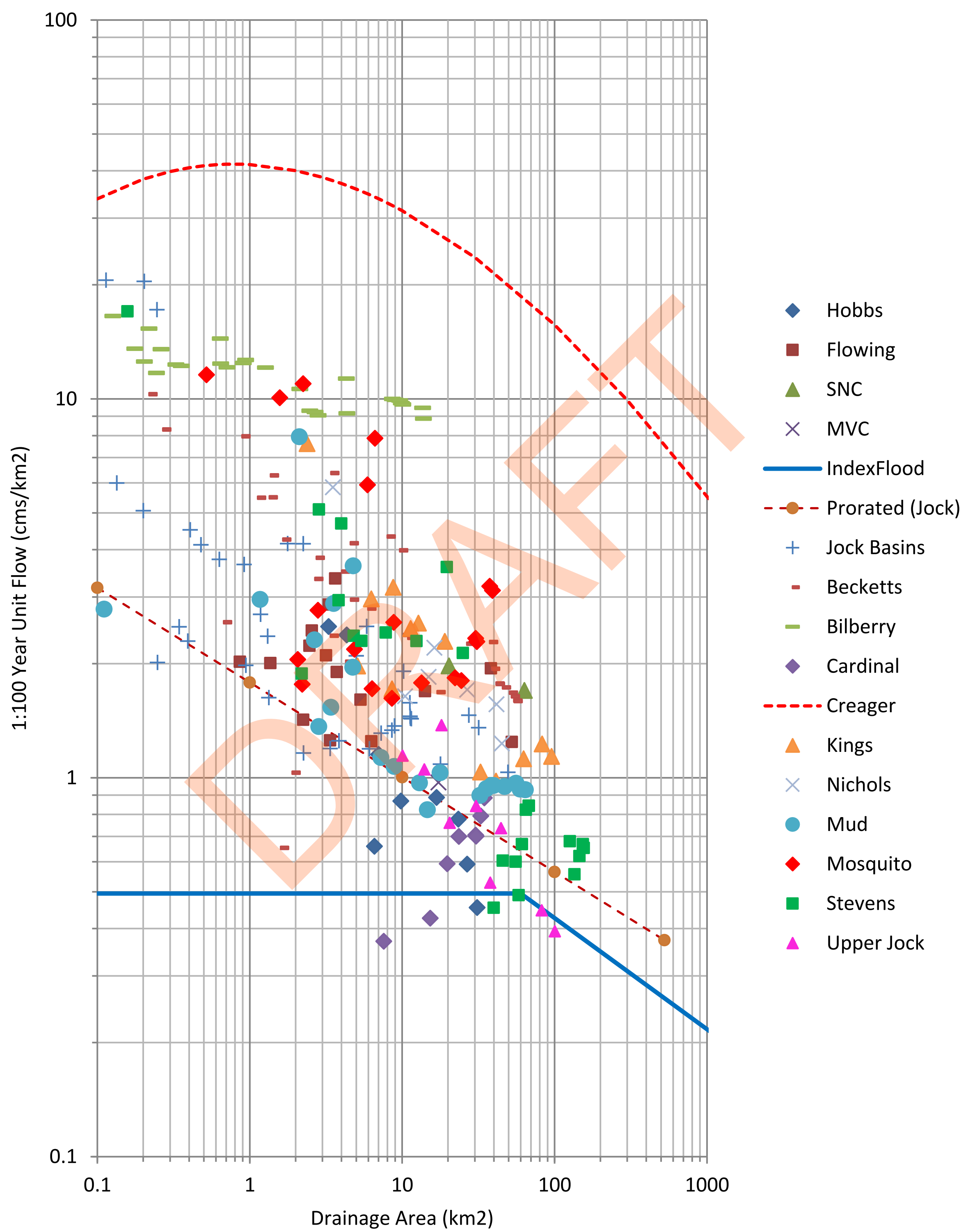
Figure 16 Comparison of 1:100 year flows per unit area



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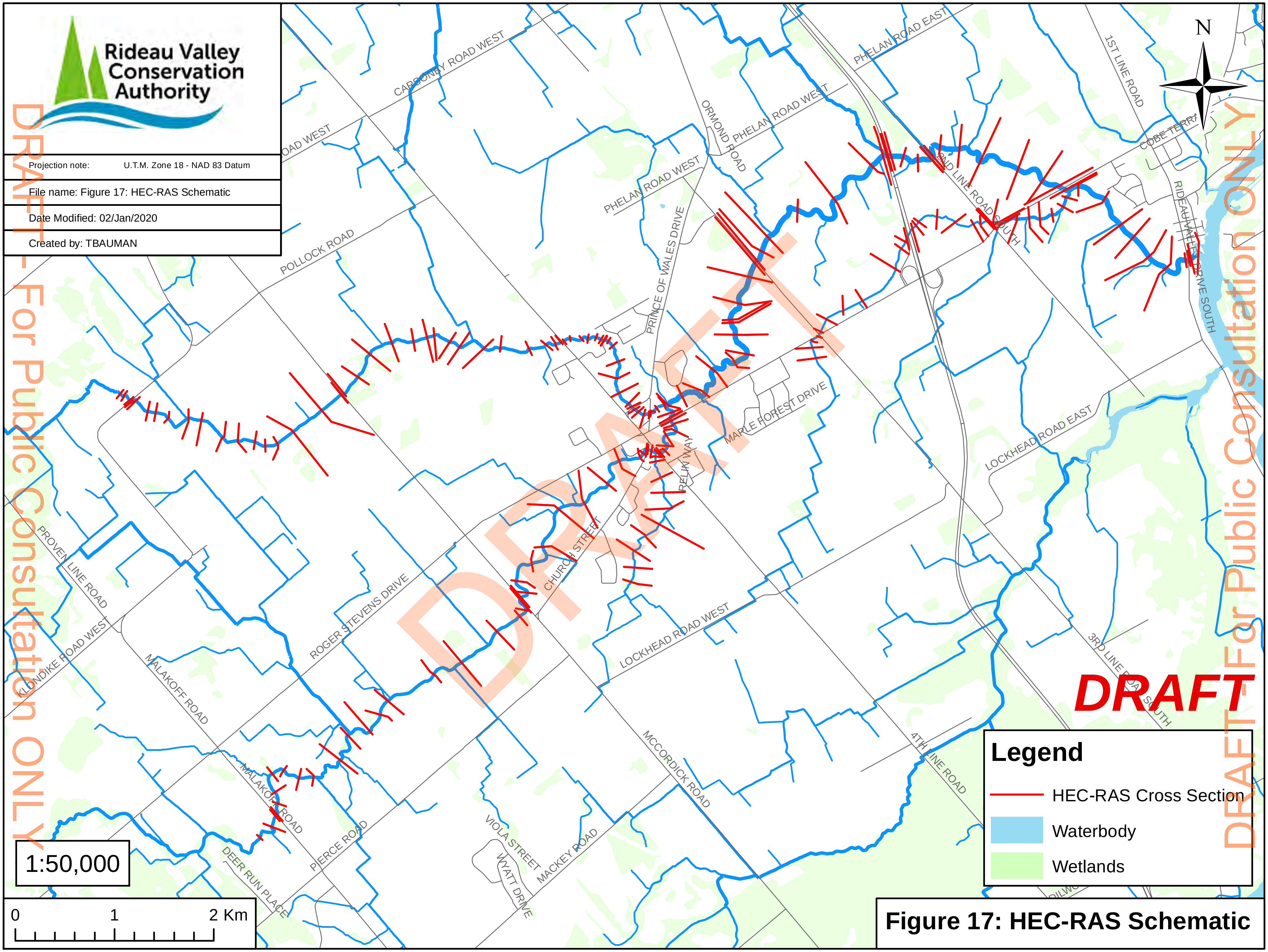
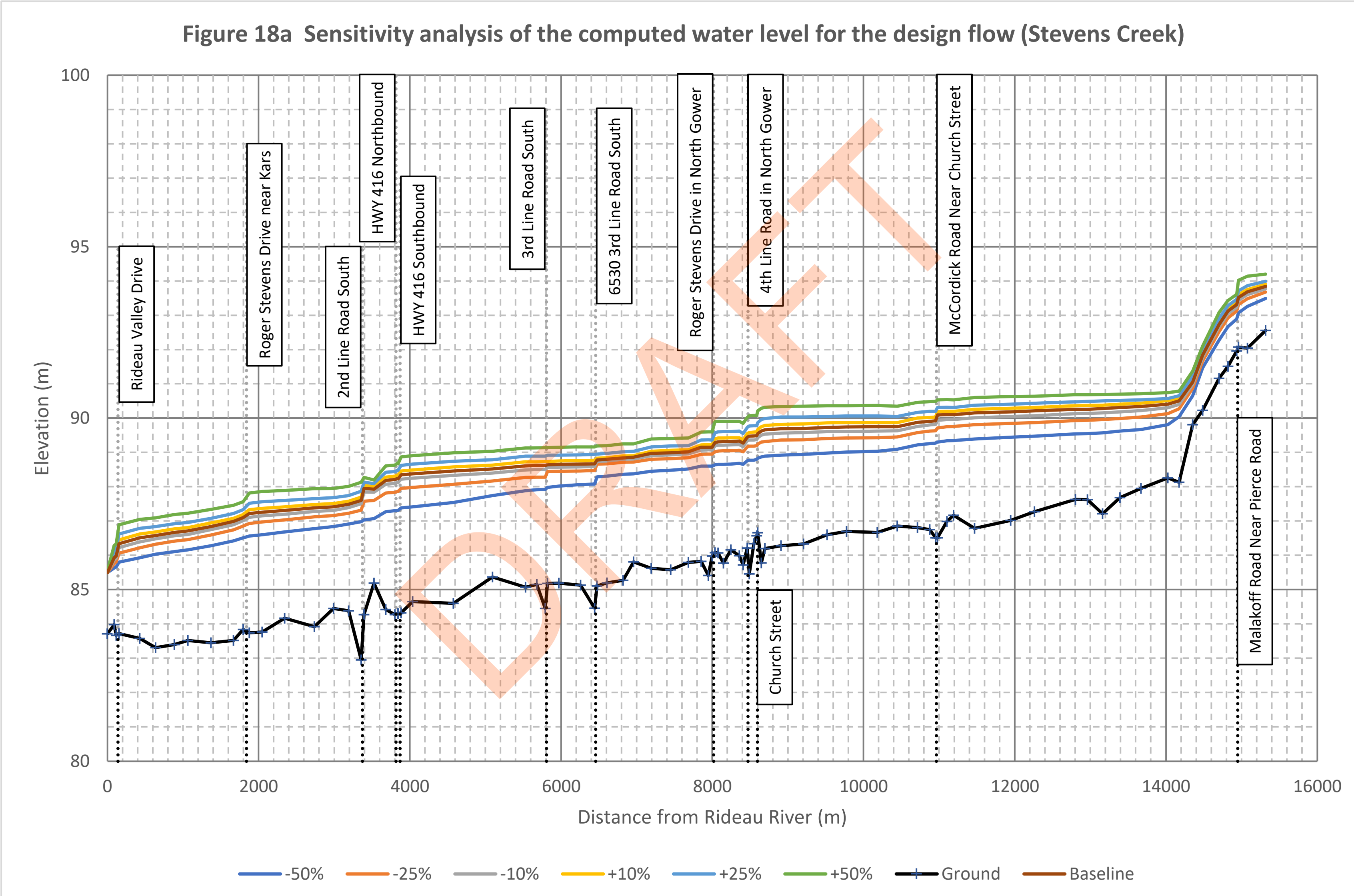


Figure 17: HEC-RAS Schematic



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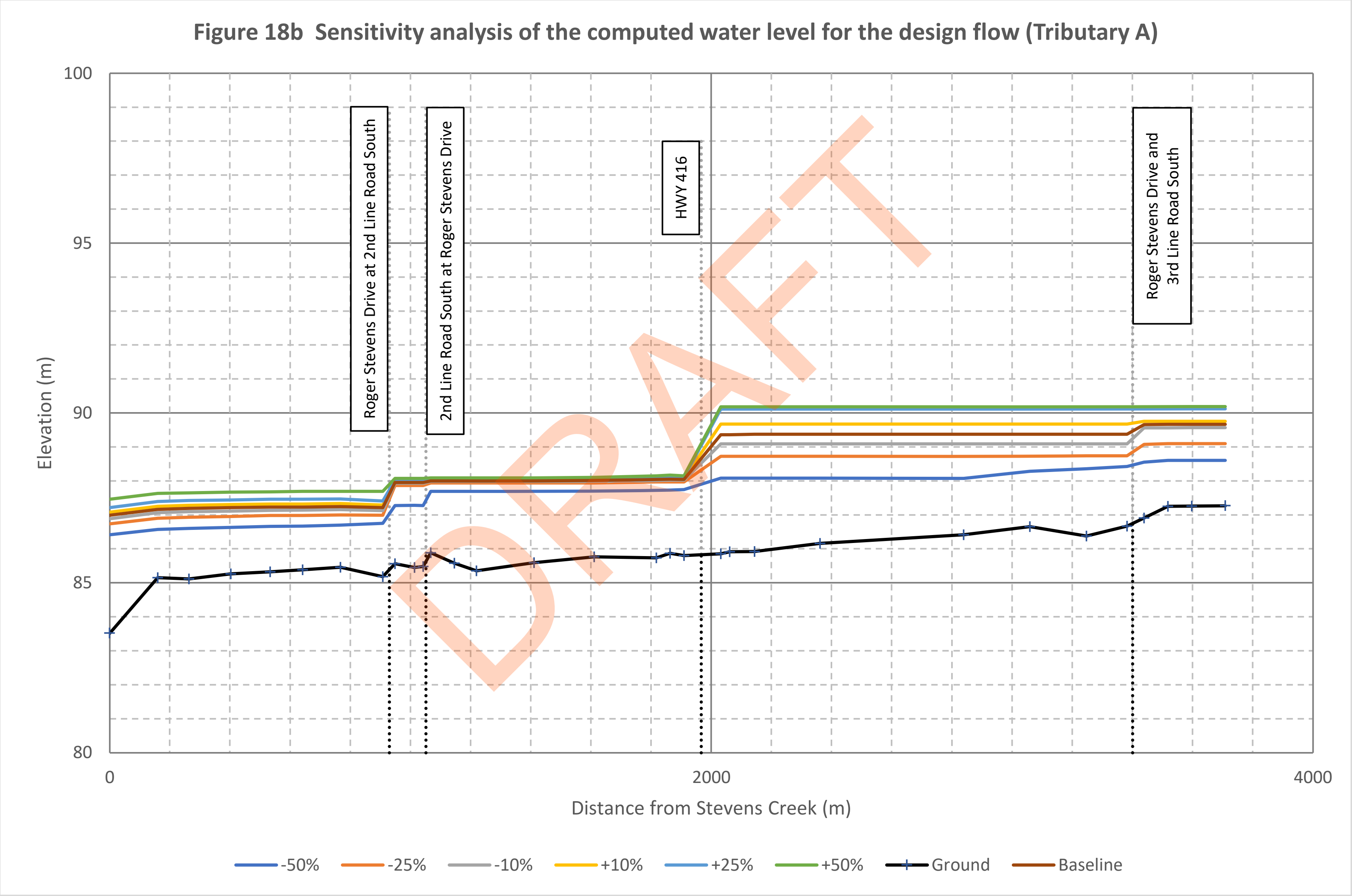
Figure 18b Sensitivity analysis of the computed water level for the design flow (Tributary A)
100
95
90
85
80
Elevation (m)
0
2000
4000
Distance from Stevens Creek (m)
Roger Stevens Drive at 2nd Line Road South
2nd Line Road South at Roger Stevens Drive
HWY 416
Roger Stevens Drive and 3rd Line Road South
-50%
-25%
-10%
+10%
+25%
+50%
Ground
Baseline

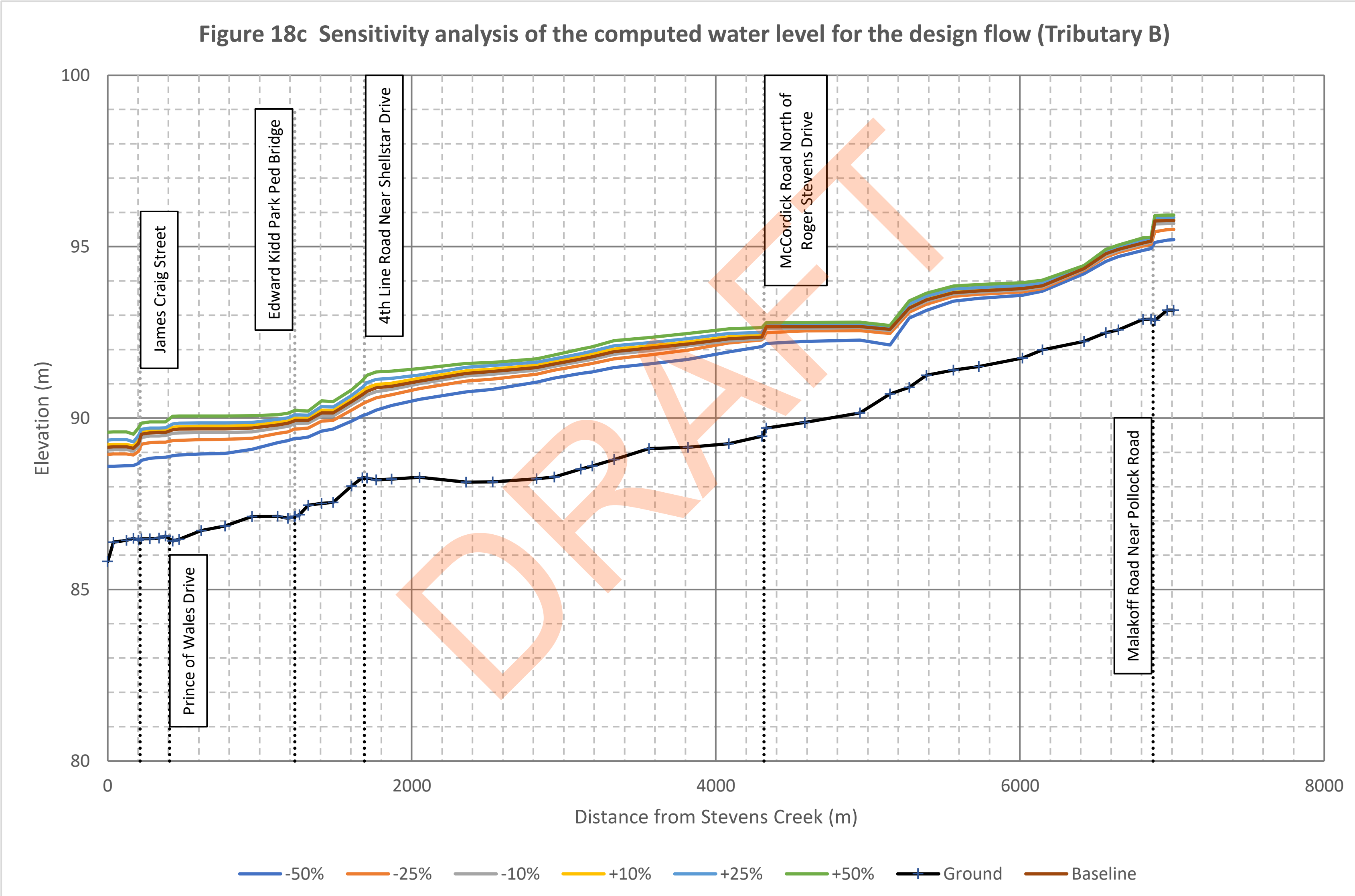

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Figure 18d Sensitivity analysis of the computed water level for the design flow (Tributary C)

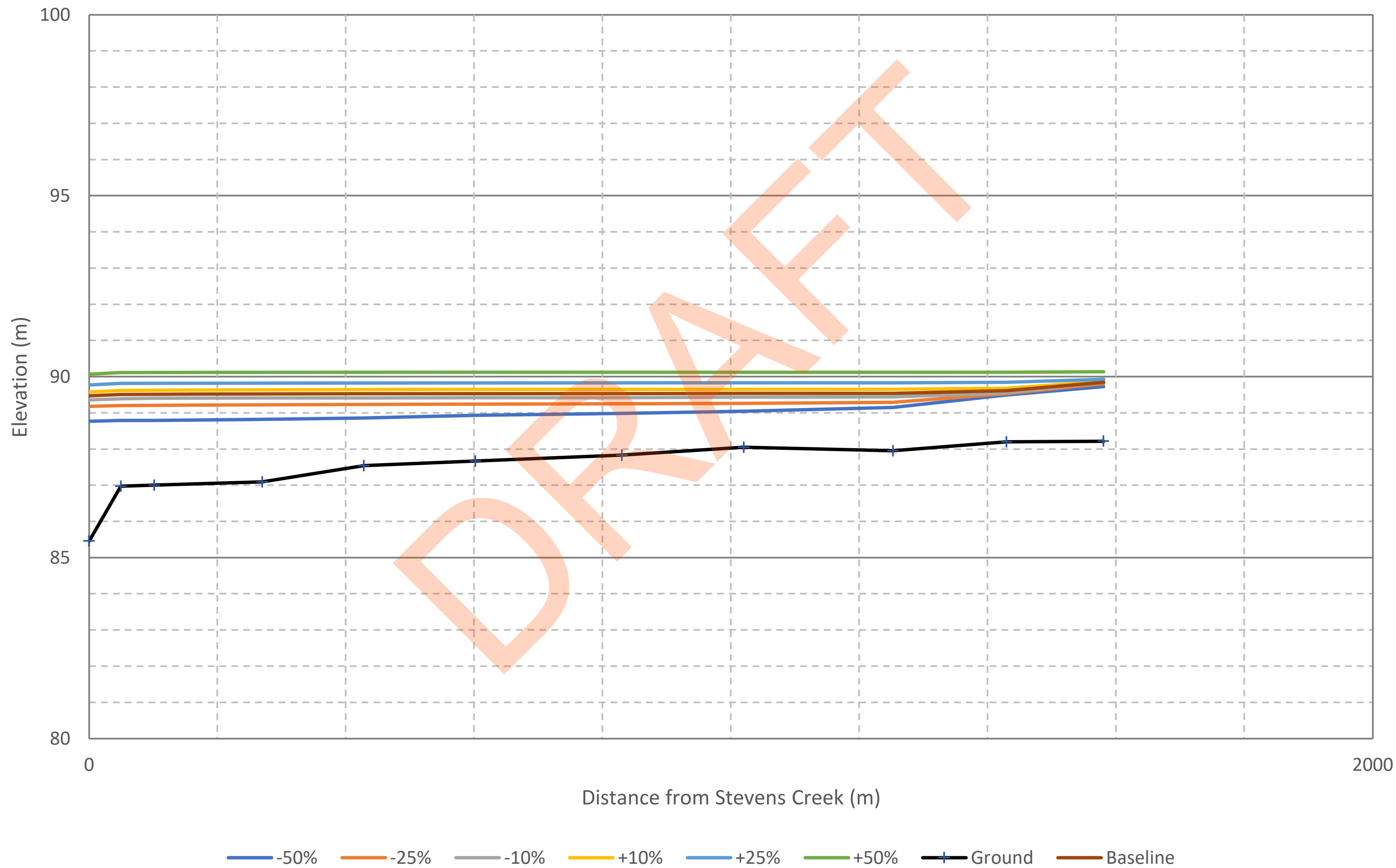

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Figure 19a Sensitivity analysis of water level differences (Stevens Creek)

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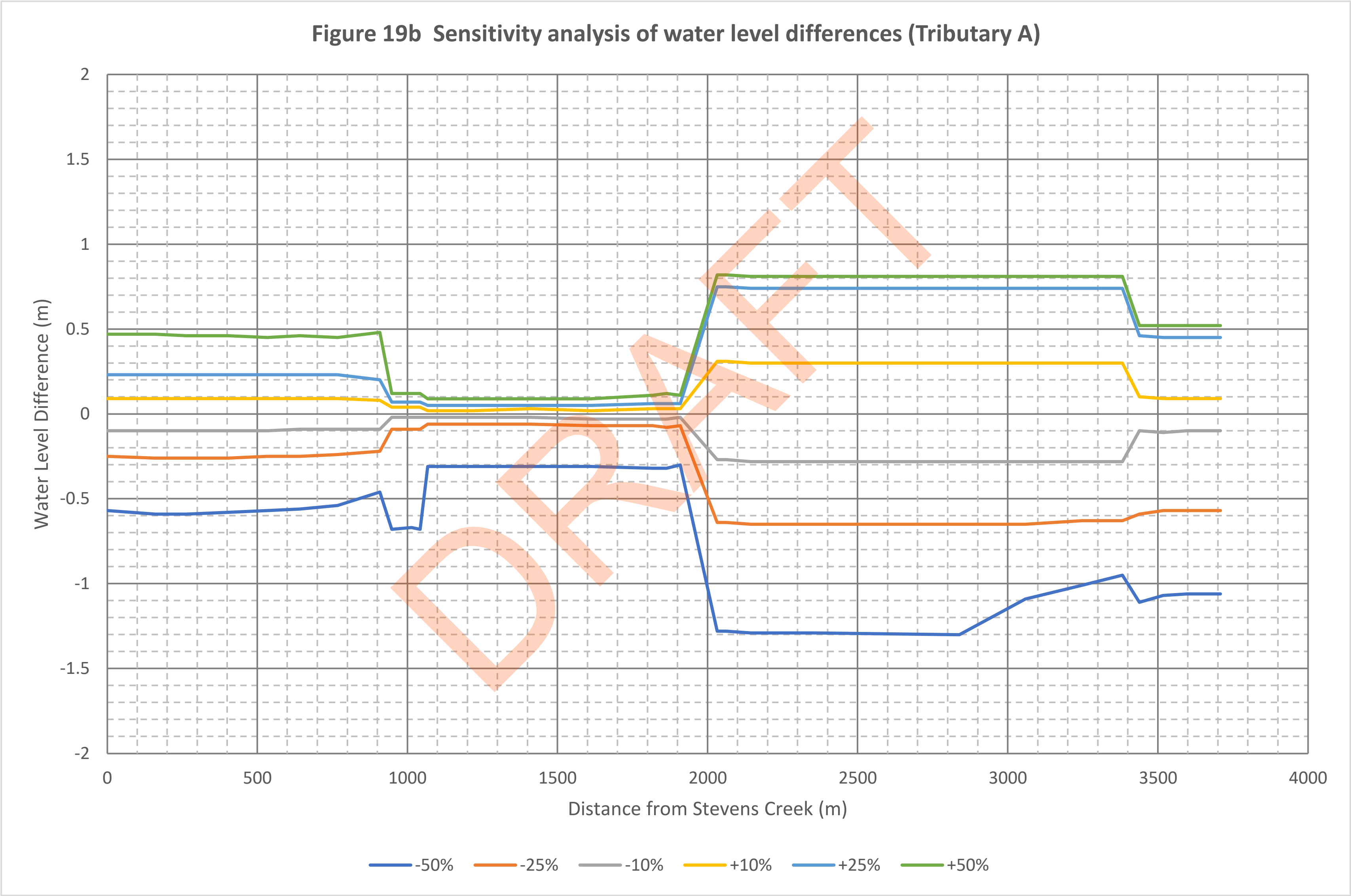

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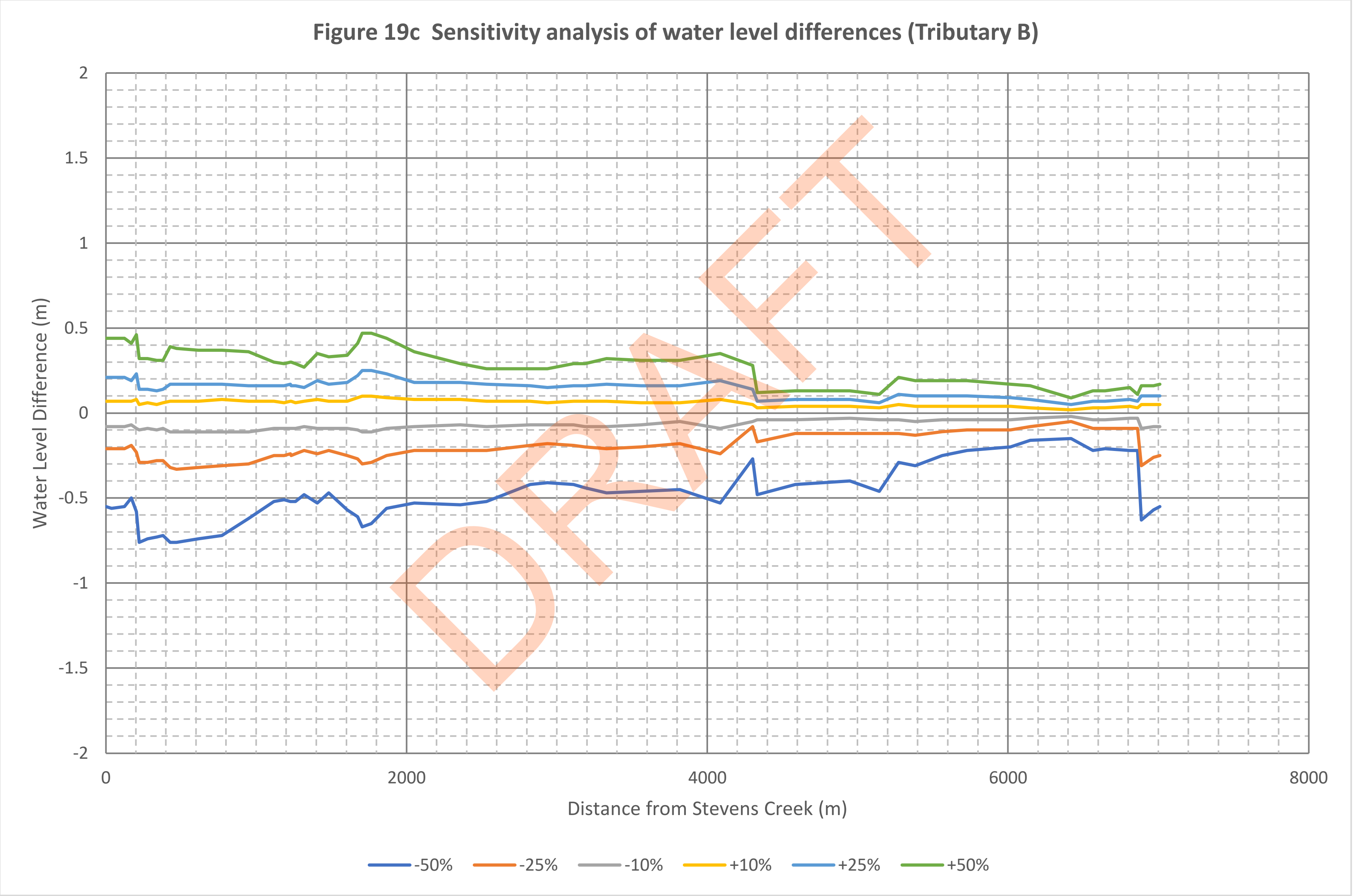

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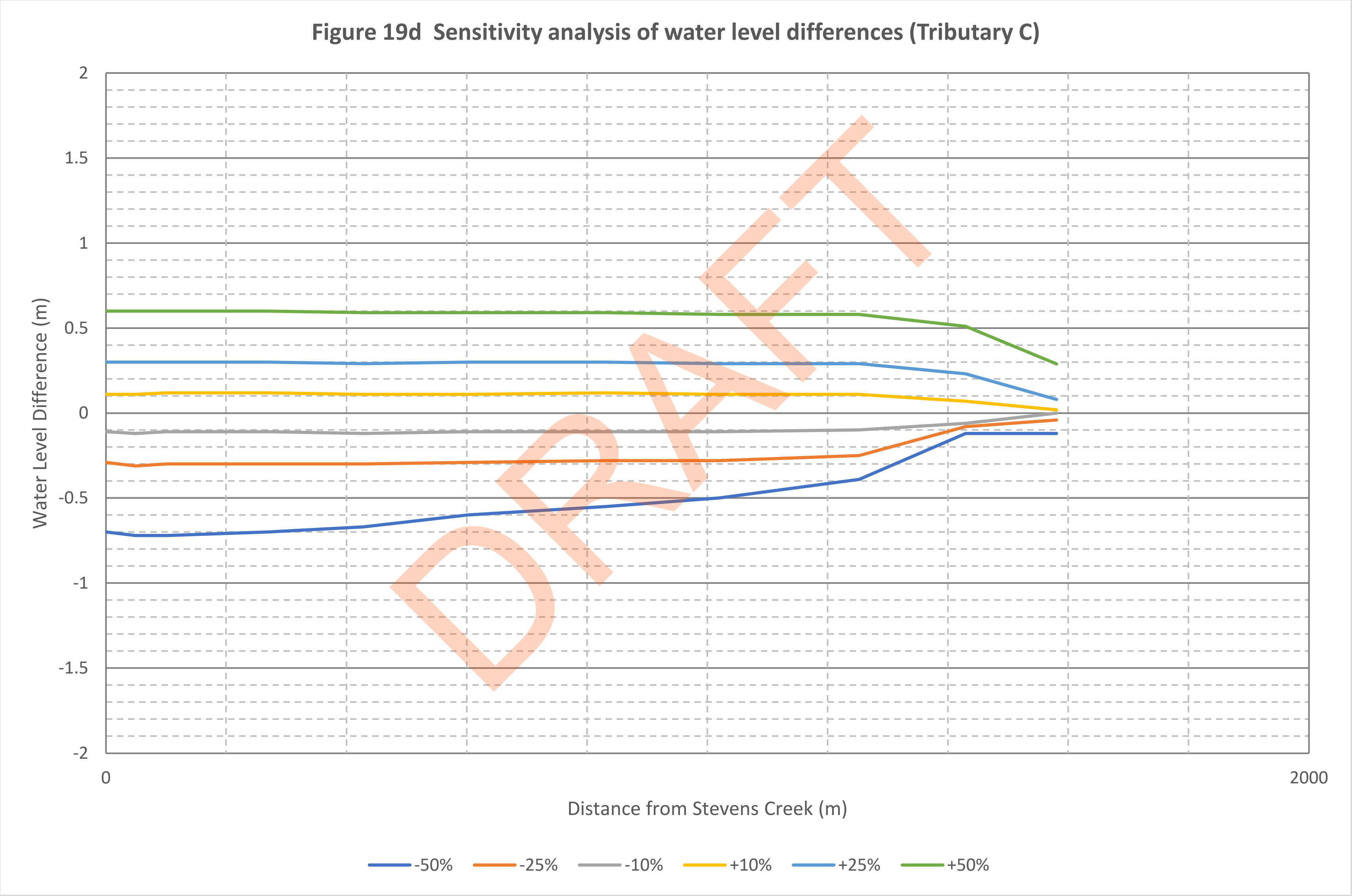
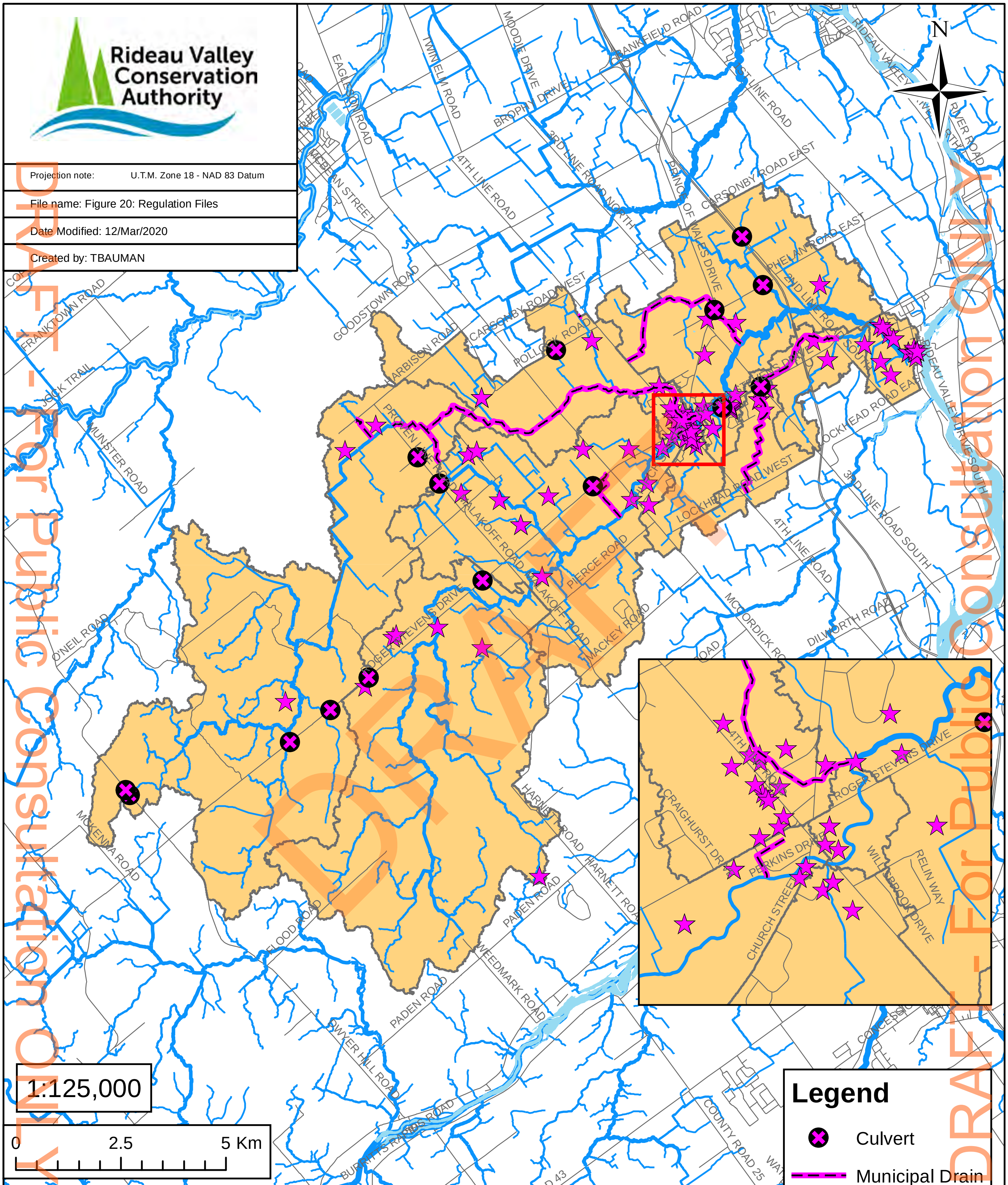


Figure 19d Sensitivity analysis of water level differences (Tributary C)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Water Level Difference (m)
0
2000
Distance from Stevens Creek (m)
-50%
-25%
-10%
+10%
+25%
+50%
DRAFT



The regulation files shown are related to the permitting of Section 28 applications submitted to the RVCA between January 1, 2010 and May 31, 2019. Table 16 contains accompanying details for the files. This figure does not, and is not intended to, display all culverts and municipal drains within the Stevens Creek watershed.

Figure 20: Regulation Permit Files

Appendix A

Buildings and Islands in Floodplain – RVCA Policy

Ferdous Ahmed

From: Ewan Hardie
Sent: Wednesday, June 29, 2016 10:35 AM
To: Ferdous Ahmed
Subject: Buildings in the Floodplain Guidelines

Hi Ferdous,
As discussed at recent meetings please consider the following guidelines when undertaking floodplain mapping projects

Effective June 13th 2016, when plotting floodlines RVCA staff will use the following guidelines in order to apply a conservative approach to the delineation of the regulatory floodplain, specifically in areas that have buildings that are in the floodplain or affected by the floodplain:

1. Include any buildings in the floodplain that have any part of the footprint touching the floodplain. This is done to be conservative based on the lack of knowledge on the conditions around the buildings: soil conditions, window wells, walk out doors, building egress are all not known at the time of a floodplain mapping study so it is wise to adopt a conservative approach and include building footprints in the floodplain.
2. With regards to dry islands in and around buildings, islands will be removed if they did not meet the minimum mapping unit acceptable for the data. An envelope of 2 metres around building footprints is to be considered. If the floodplain comes close to or is in this 2m building envelope the entire envelope should be included in the floodplain. This approach is also consistent with the above approach (building footprints) in that the lack of knowledge of the conditions around the building forces the uses of a conservative approach, which is to remove the islands
3. In cases where a building has been included in the floodplain (because of the above criteria), the adjacent building will need to be included in the floodplain as well because of a lack of data in between the buildings and/or the 2m building envelope rule.
4. In the case of townhome or connected type buildings and the floodplain touching the foundations, the building footprint should be included up to the next visible unit partition where the elevation changes

Thanks

Ewan Hardie

Director
Watershed Science and Engineering Services
Rideau Valley Conservation Authority
ewan.hardie@rvca.ca
Tel: 613 692-3571 ext 1130
Fax: 613 692-0334

Rideau Valley Conservation Authority
3889 Rideau Valley Drive, Manotick, ON
K4M 1A5
www.rvca.ca

Ferdous Ahmed

From: Ewan Hardie
Sent: Thursday, July 6, 2017 5:12 PM
To: Ferdous Ahmed
Cc: Brian Stratton
Subject: Floodplain delineation guidance

Good Afternoon Ferdous,

As discussed here is the documentation of the guidance that was given to RVCA staff when it comes to plotting floodlines using LiDAR data for this most recent project.

Guidance:

When delineating the regulatory flood water levels, RVCA staff will follow a precautionary principle to include island areas in the floodplain that are up to 1000 square metres.

Ewan Hardie

Director
Watershed Science and Engineering Services
Rideau Valley Conservation Authority
ewan.hardie@rvca.ca
Tel: 613 692-3571 ext 1130
Fax: 613 692-0334

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K4M 1A5
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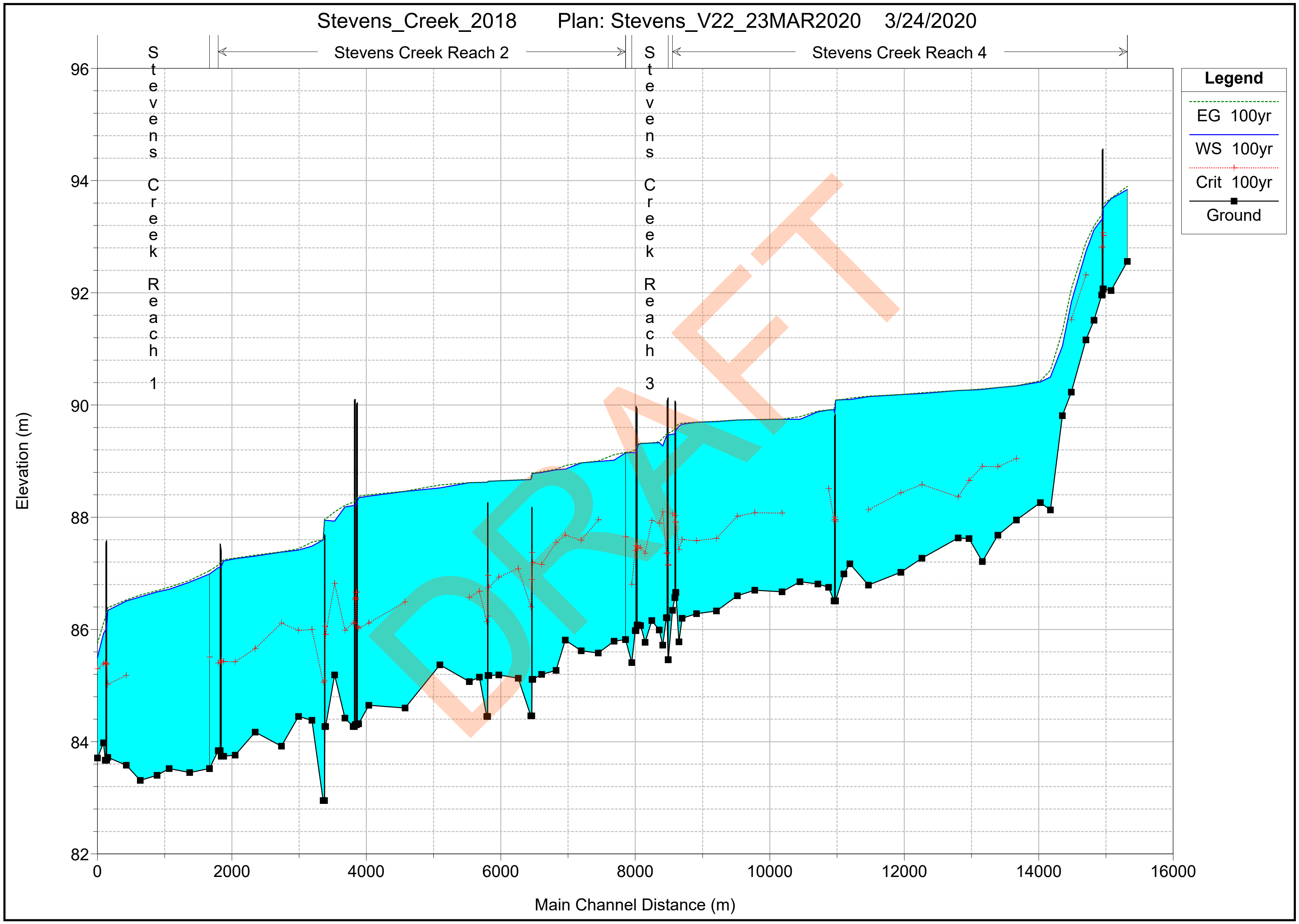
Appendix B

HEC-RAS Profiles and Cross-Sections



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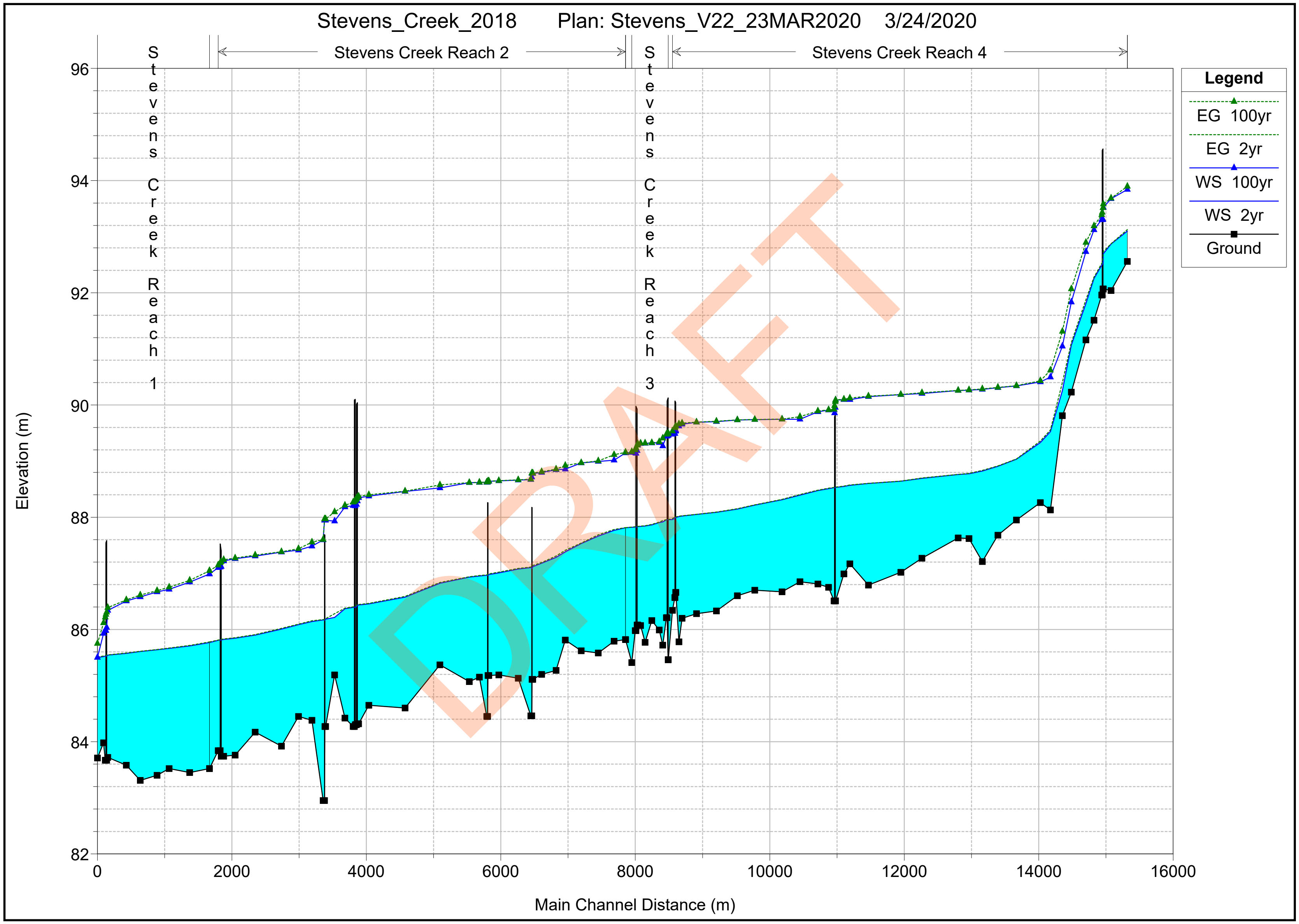

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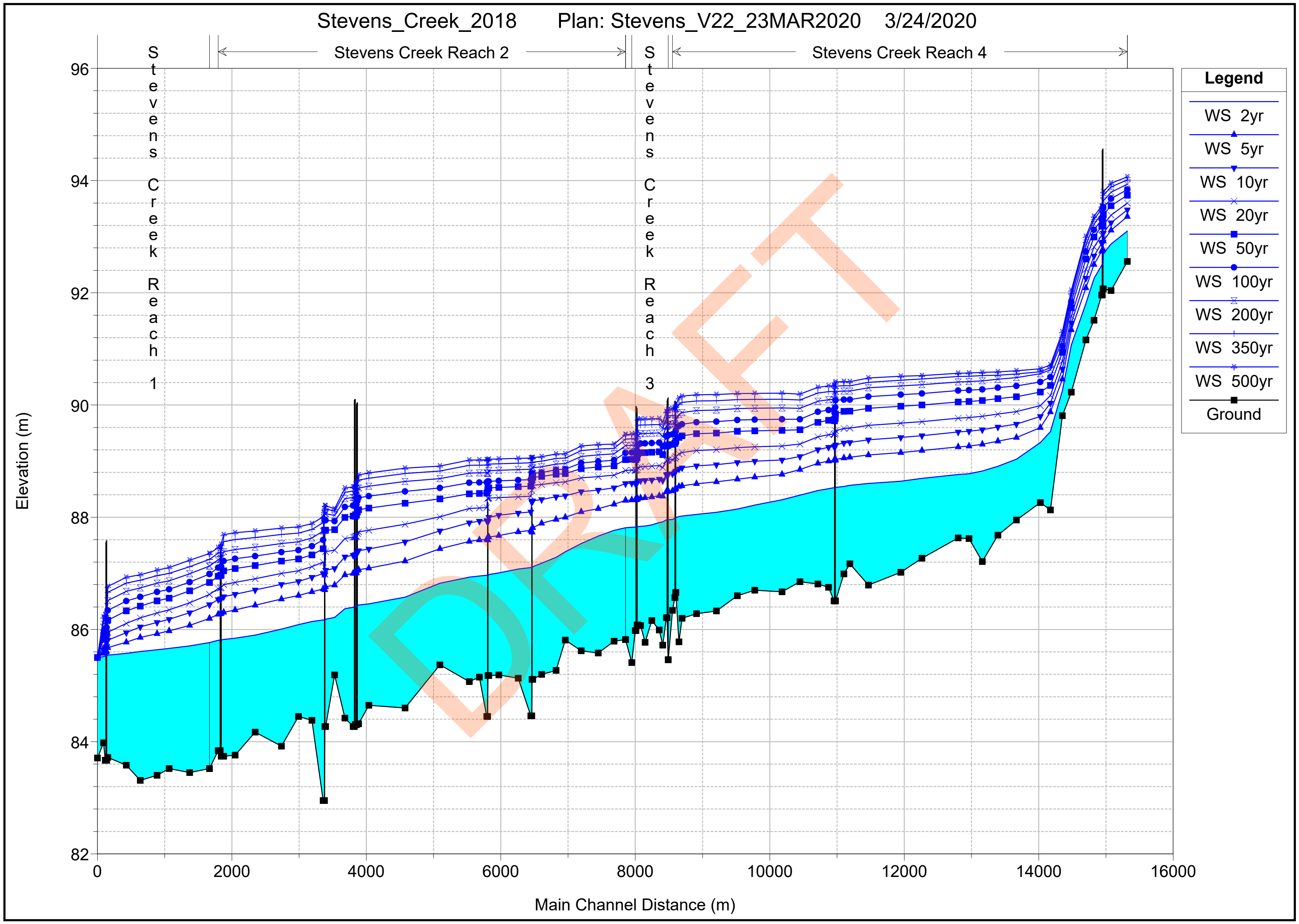

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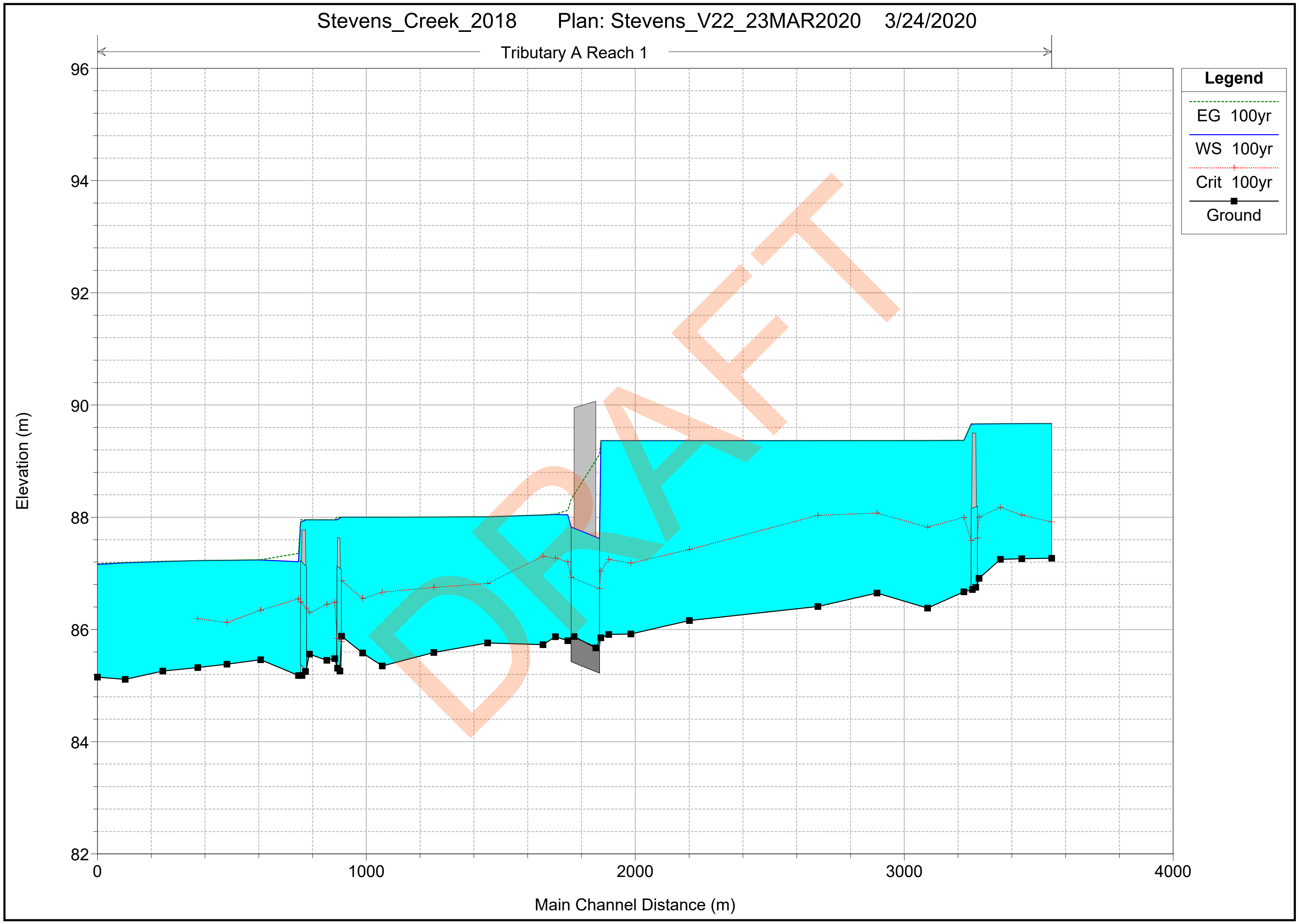

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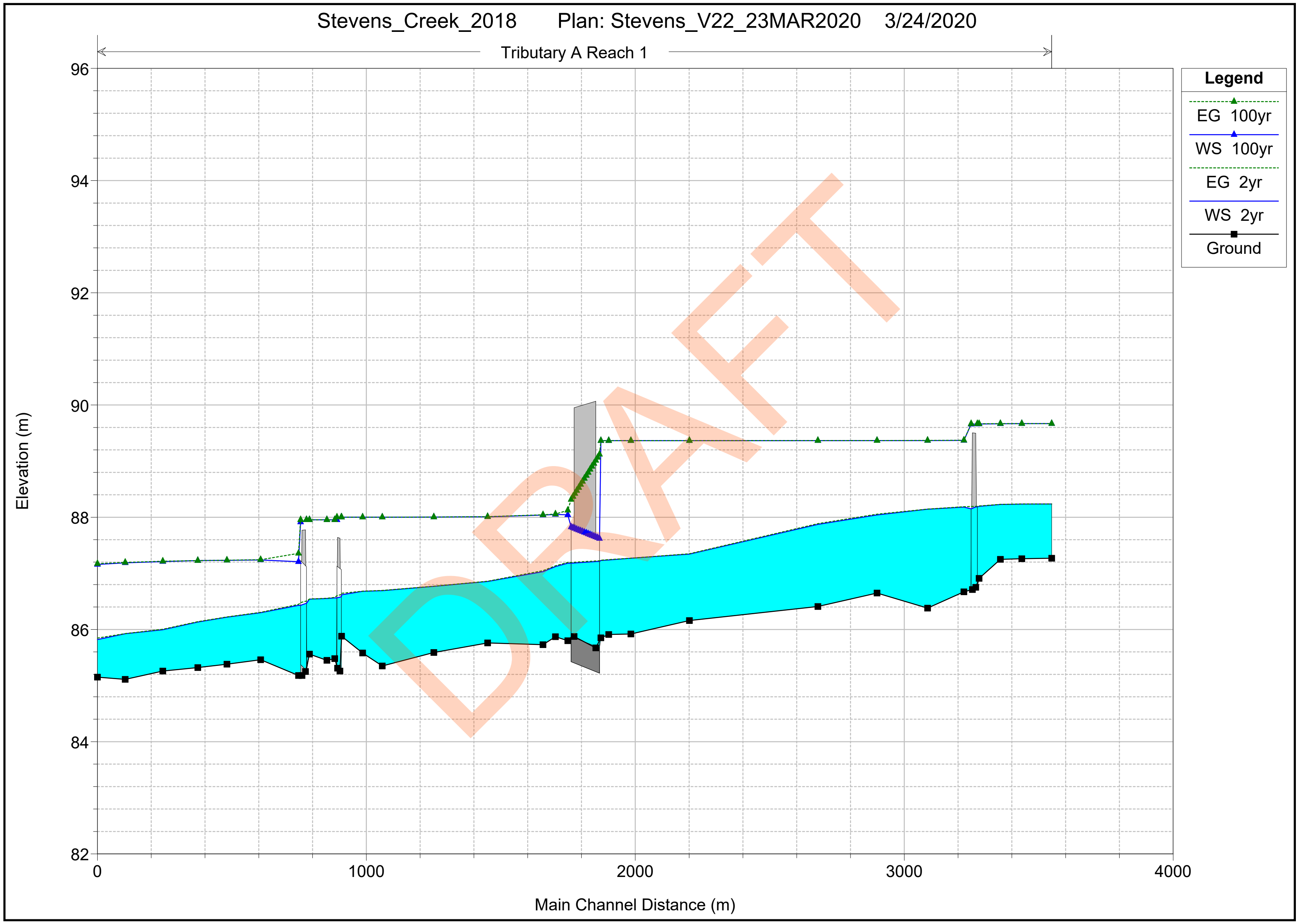

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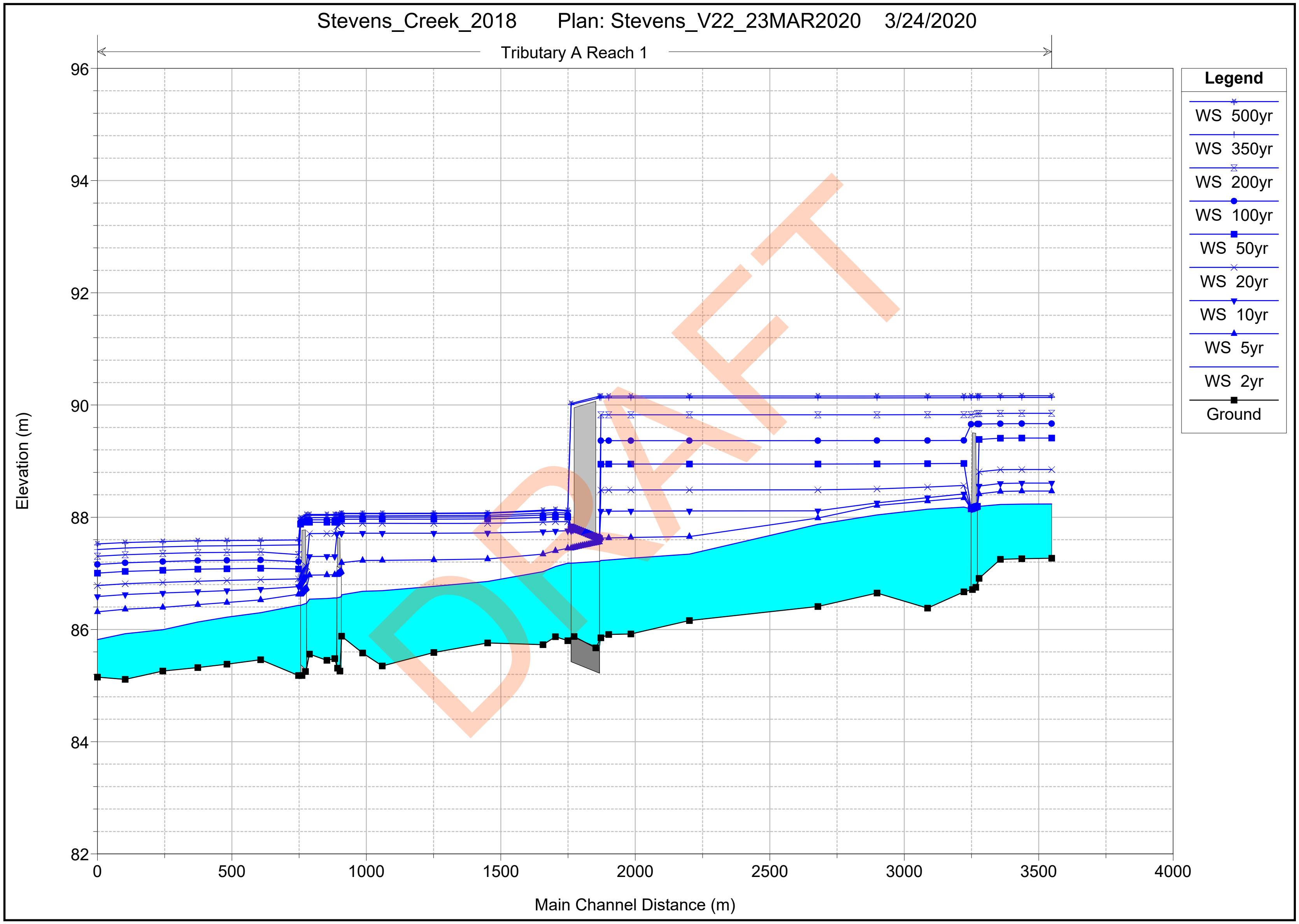

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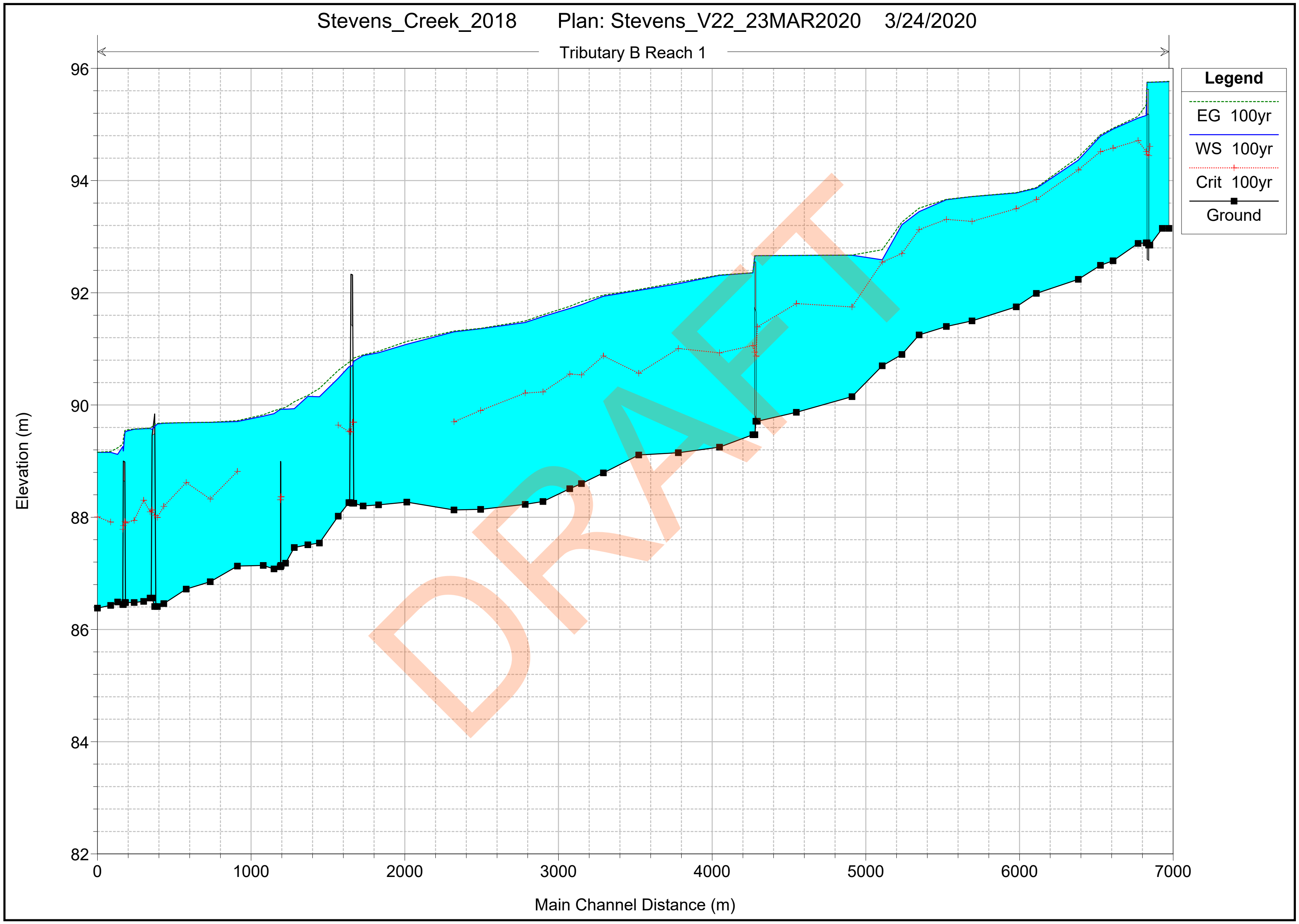
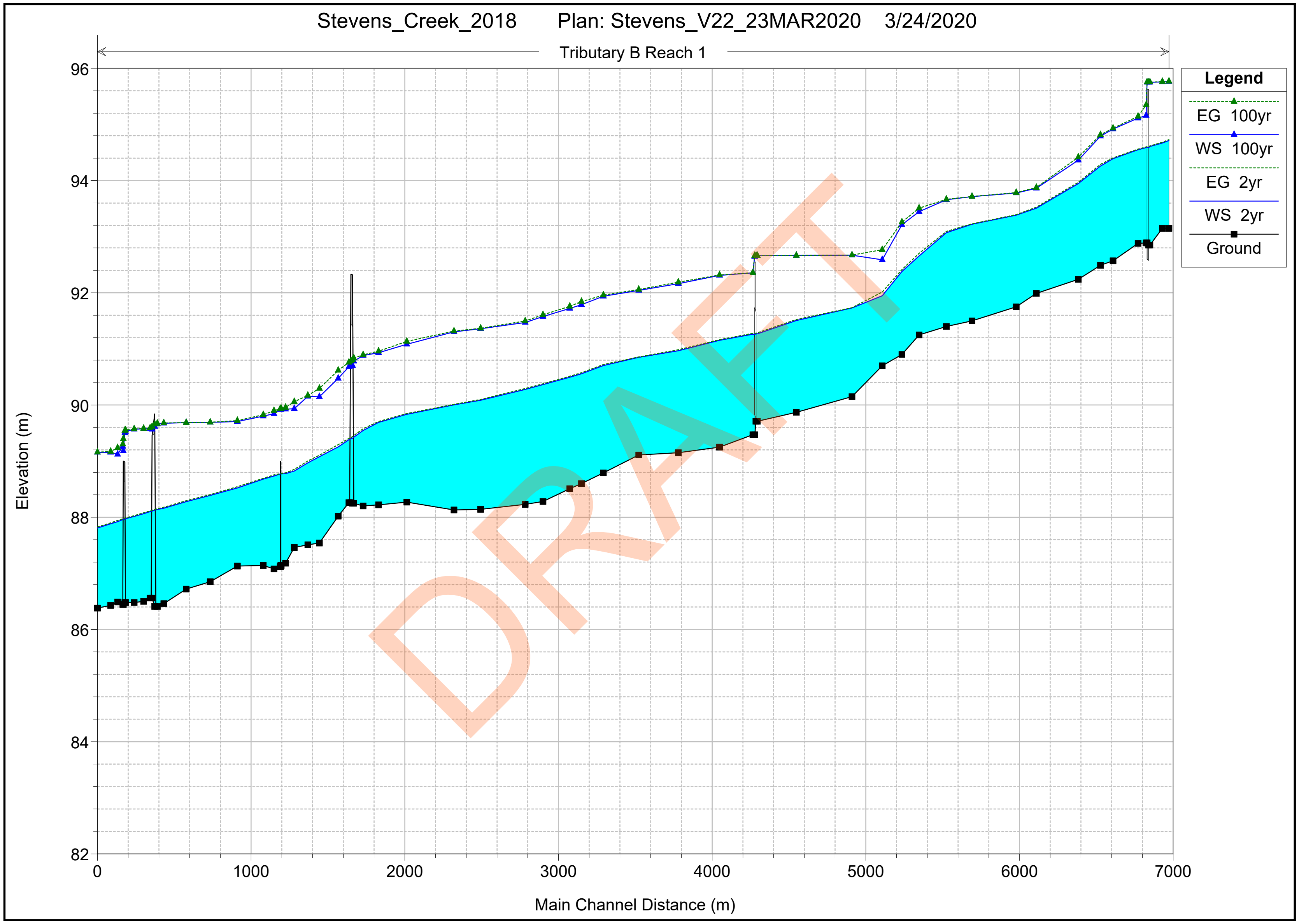
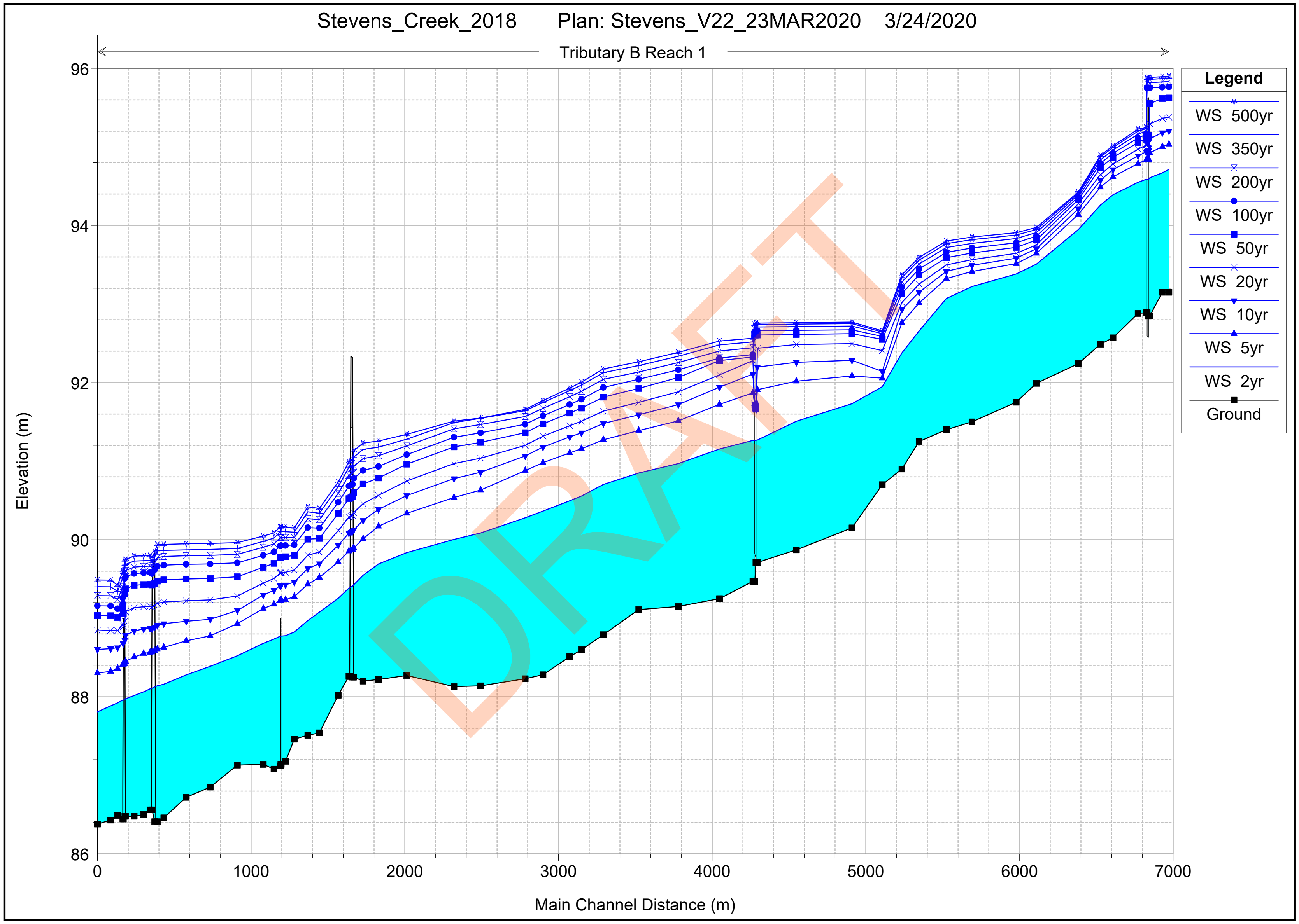


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
Tributary B Reach 1
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Elevation (m)
Main Channel Distance (m)
96
94
92
90
88
86
84
82
0
1000
2000
3000
4000
5000
6000
7000



Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
Tributary B Reach 1
Legend
EG 100yr
WS 100yr
EG 2yr
WS 2yr
Ground
Elevation (m)
Main Channel Distance (m)
96
94
92
90
88
86
84
82
0
1000
2000
3000
4000
5000
6000
7000



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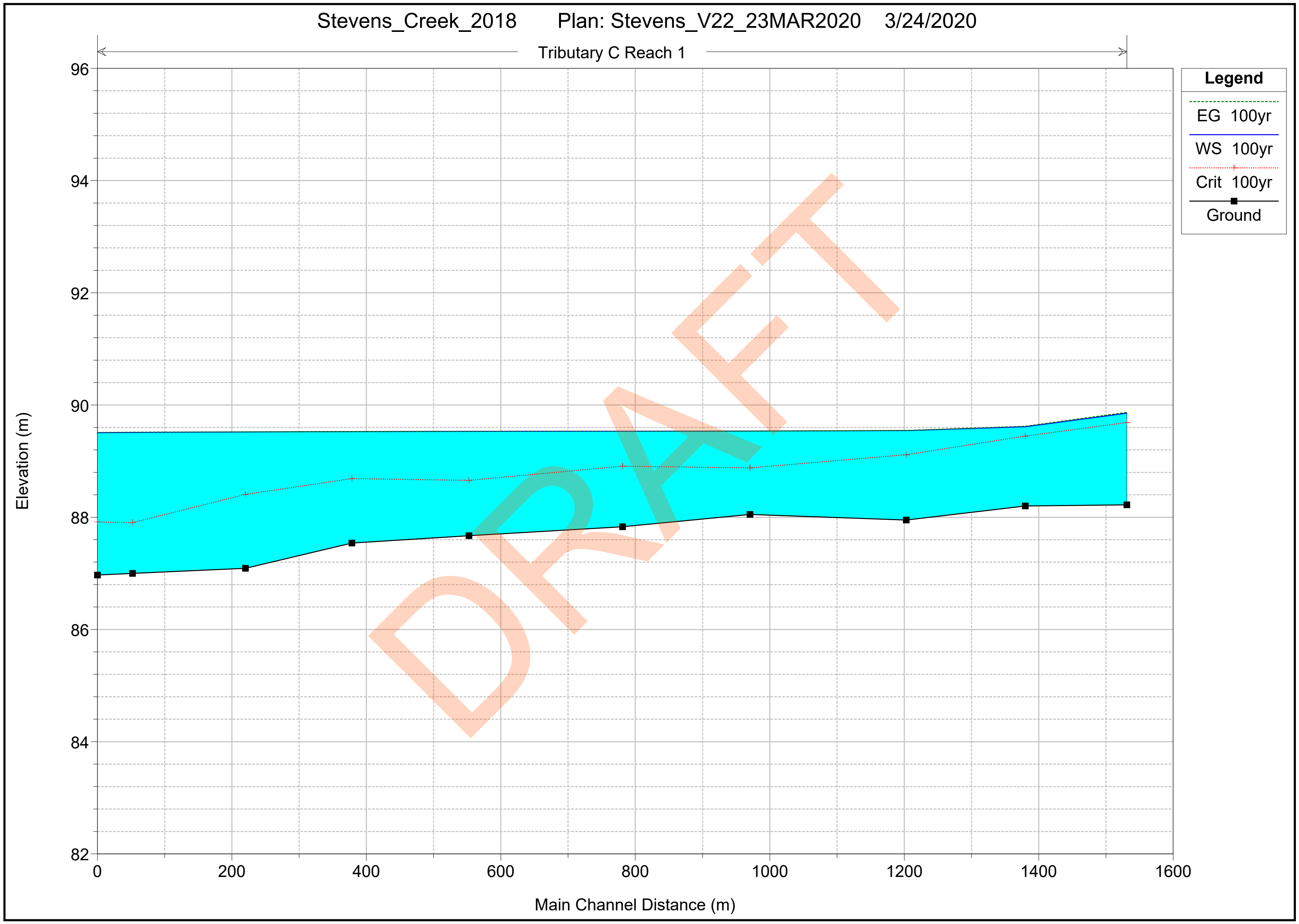

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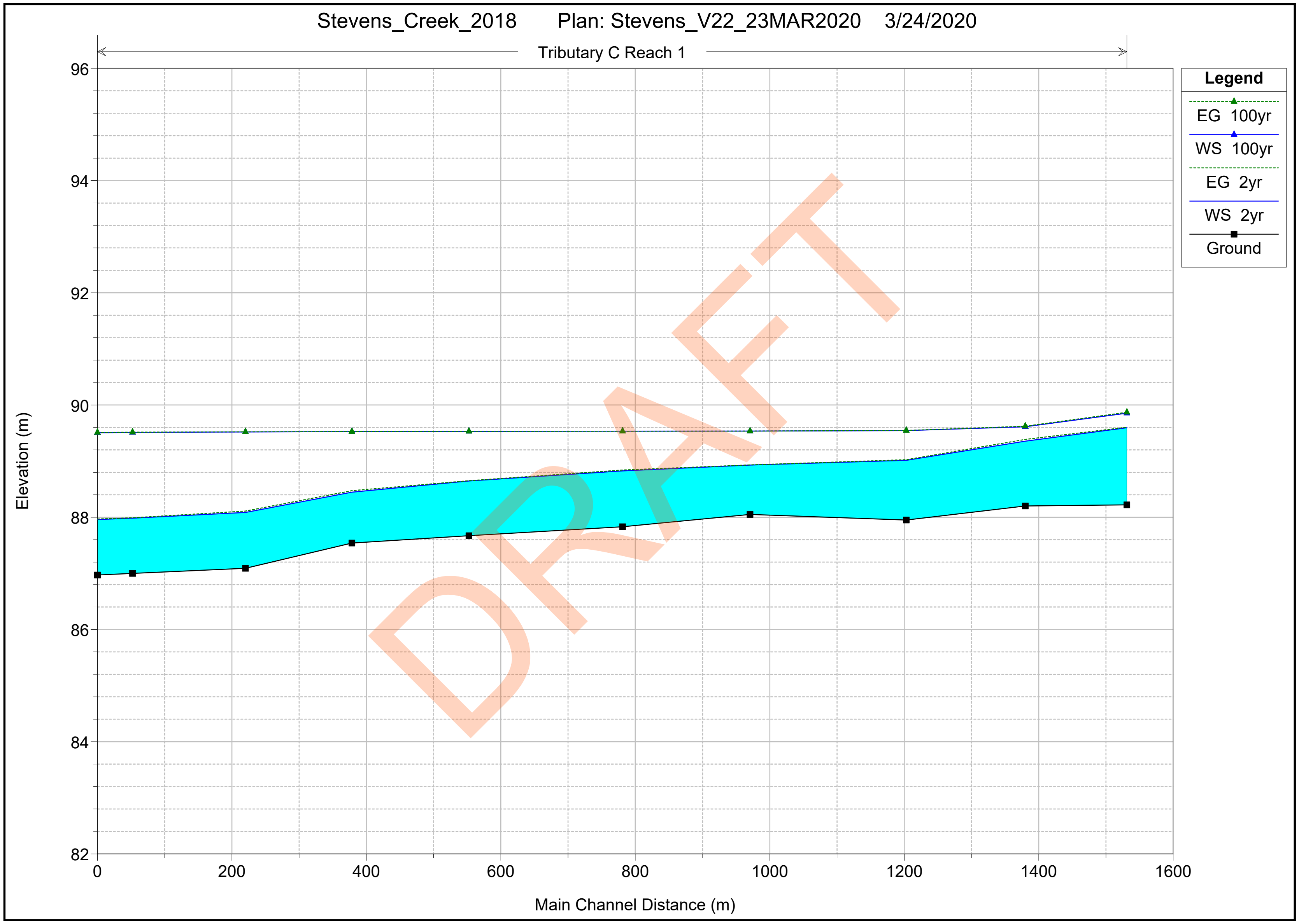

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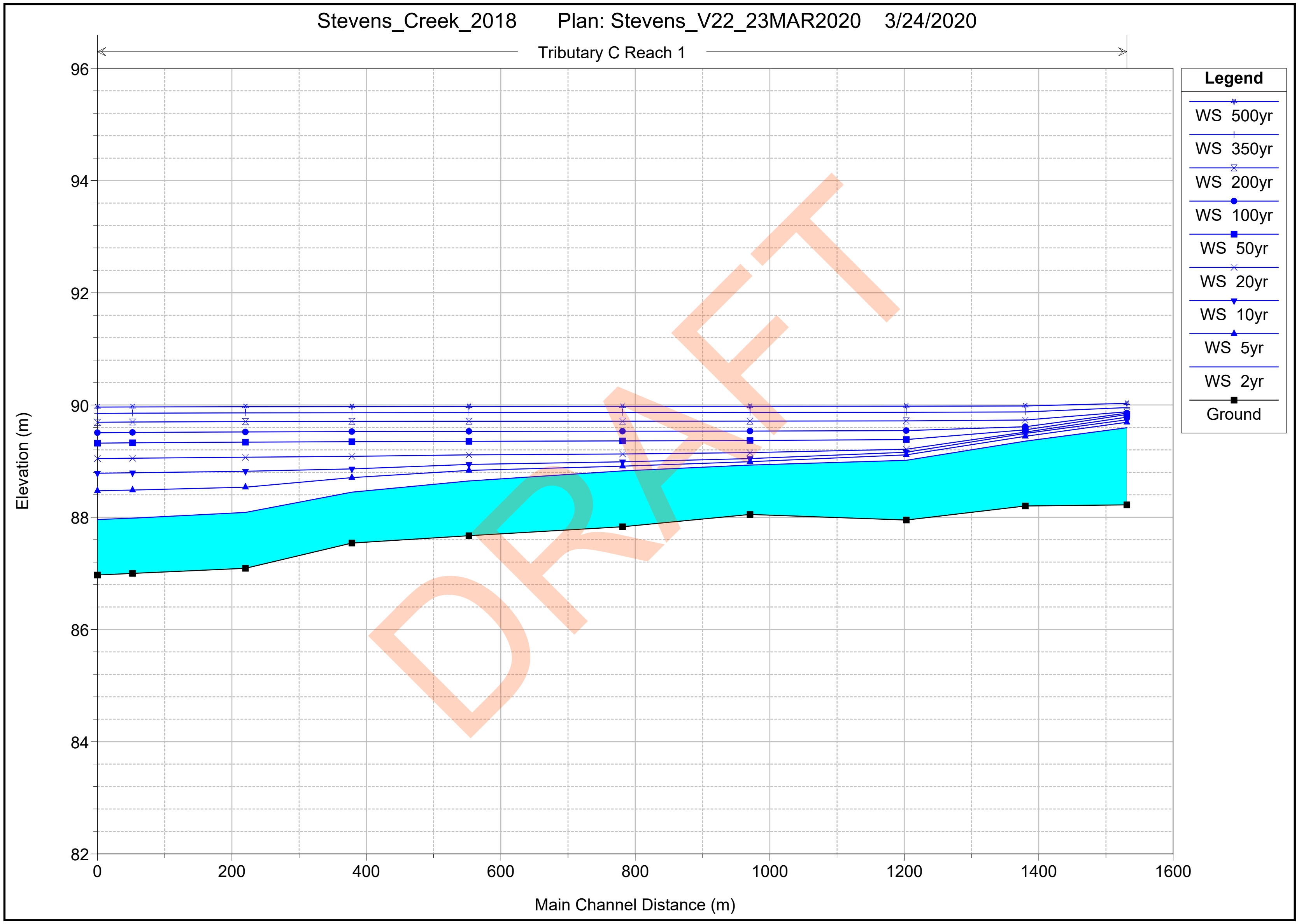

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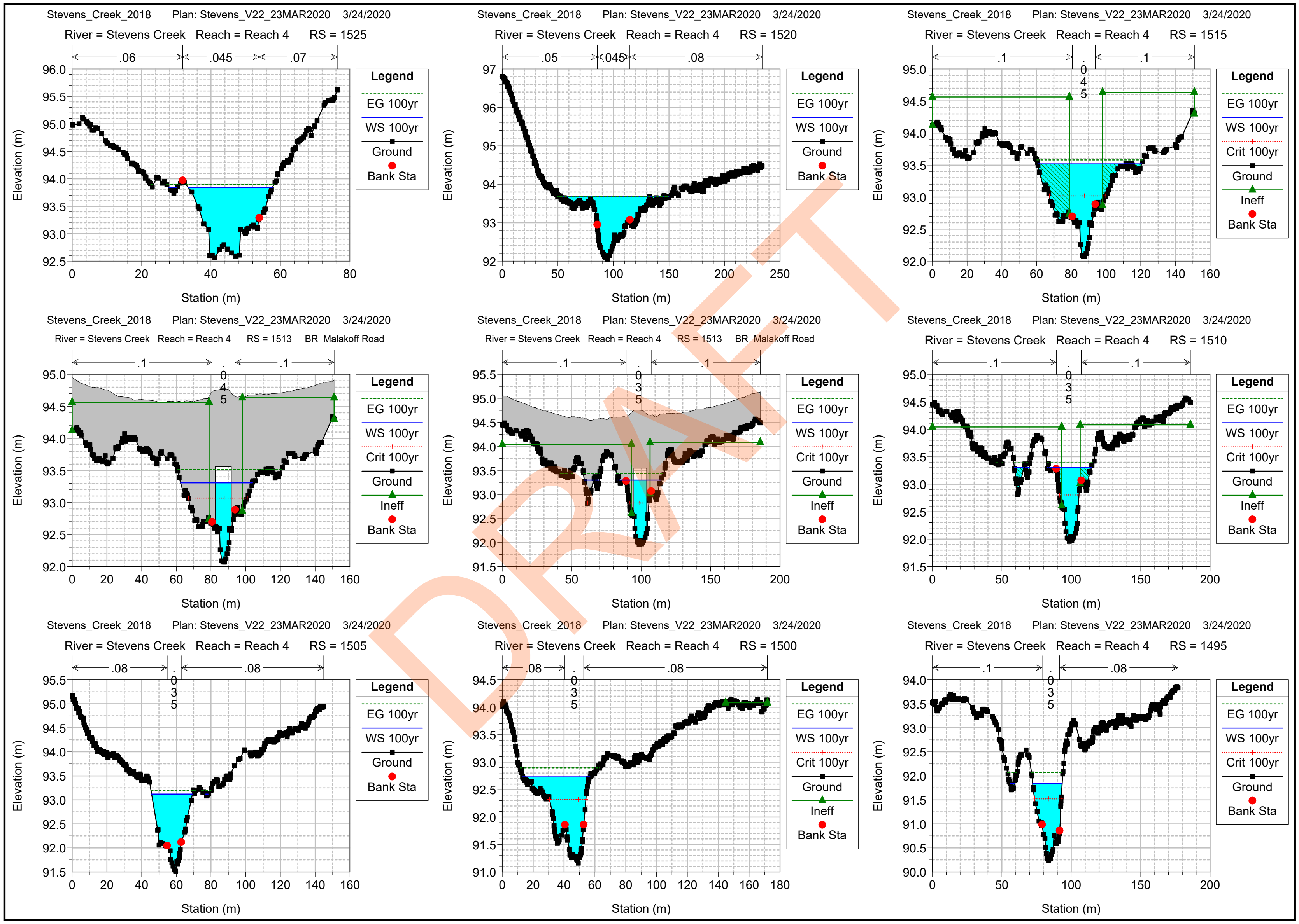
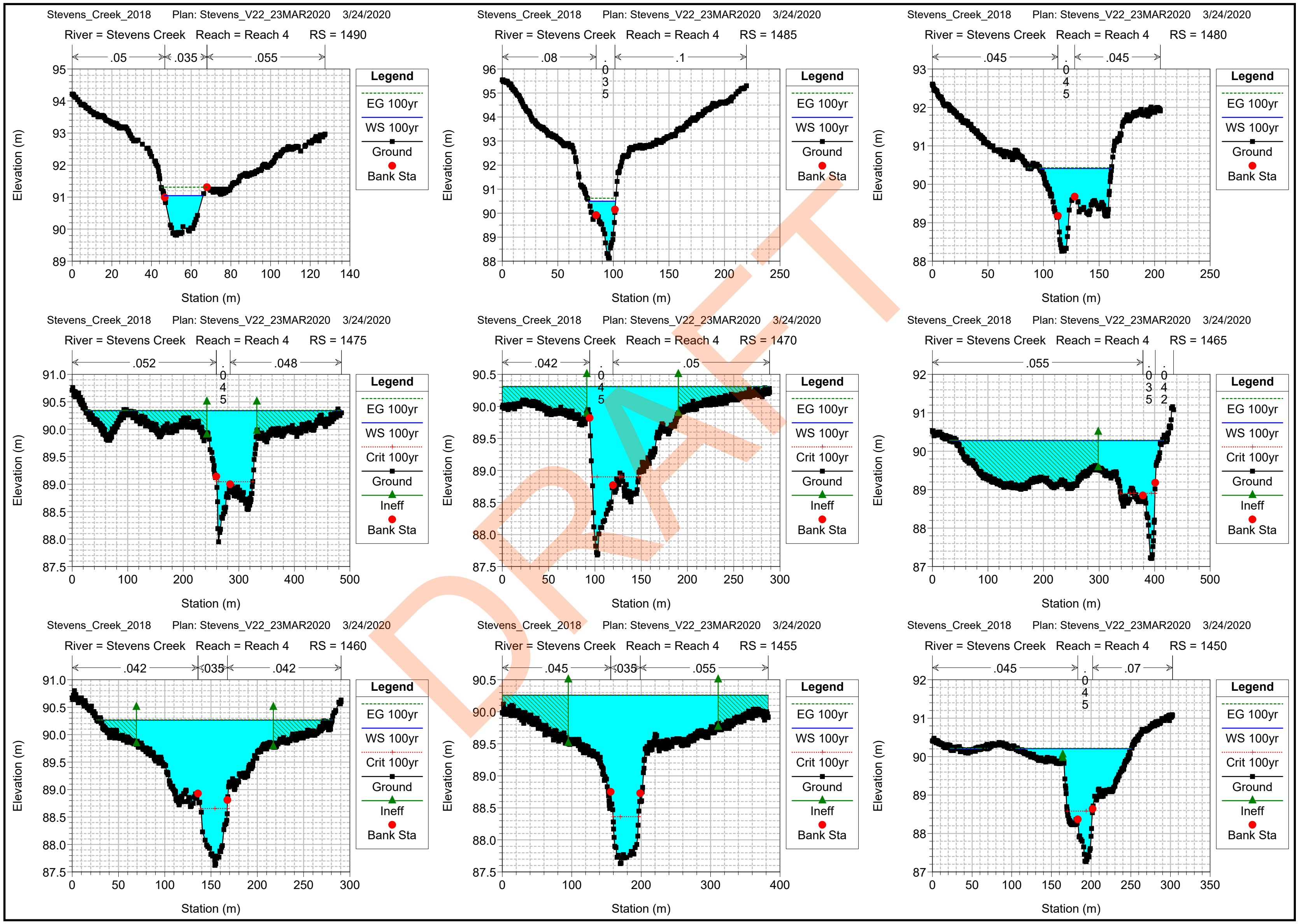
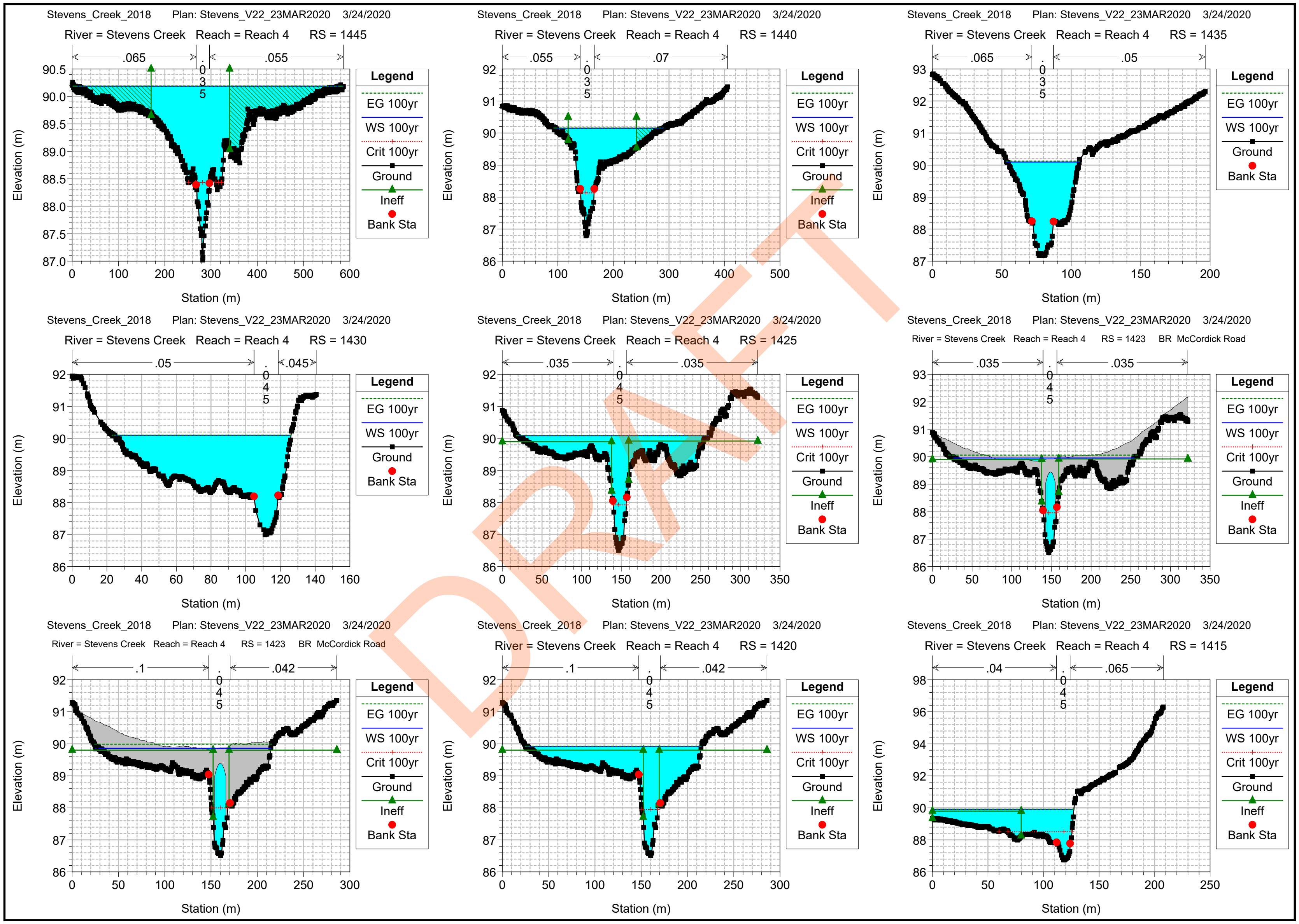
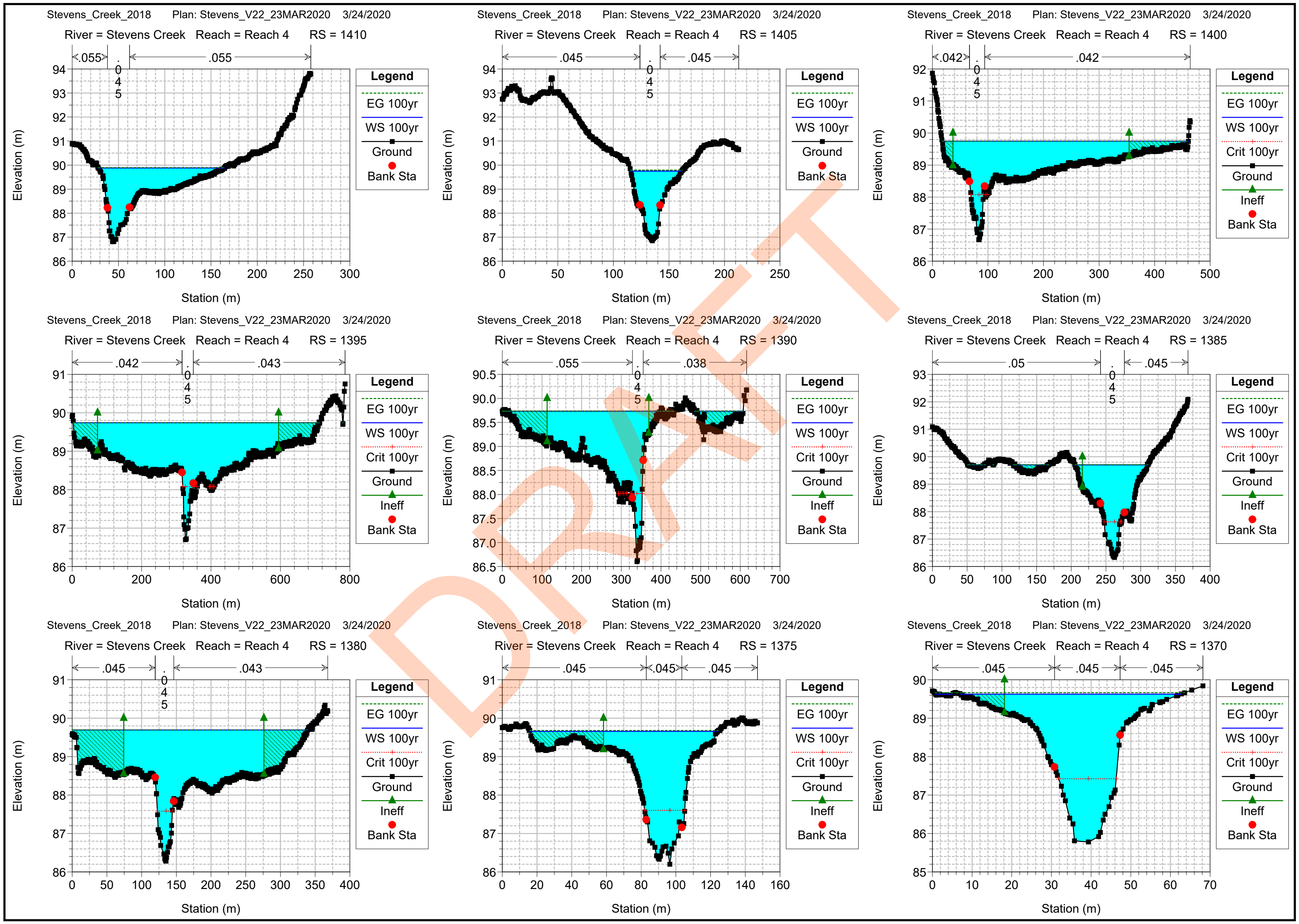
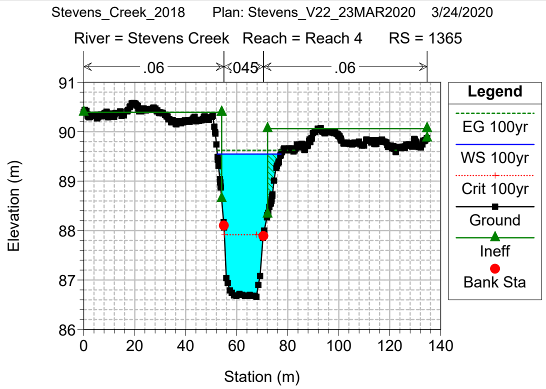


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1525
.06 .045 .07
Legend
EG 100yr
WS 100yr
Ground
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1520
.05 .045 .08
Legend
EG 100yr
WS 100yr
Ground
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1515
.1 .045 .1
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1513 BR Malakoff Road
.1 .045 .1
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1513 BR Malakoff Road
.1 .035 .1
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1510
.1 .035 .1
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1505
.08 .035 .08
Legend
EG 100yr
WS 100yr
Ground
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1500
.08 .035 .08
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1495
.1 .035 .08
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Bank Sta
Elevation (m)
Station (m)
DRAFT

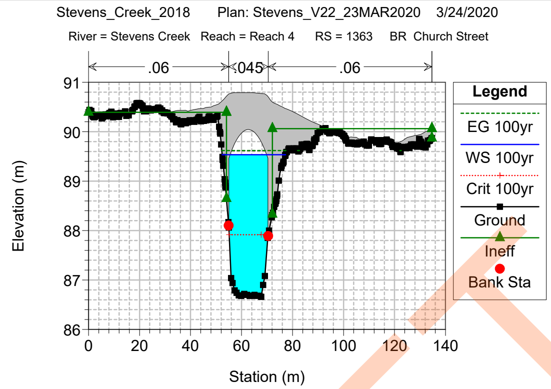

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1490
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1485
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1480
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1475
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1470
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1465
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1460
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1455
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1450
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
DRAFT


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1445
River = Stevens Creek Reach = Reach 4 RS = 1440
River = Stevens Creek Reach = Reach 4 RS = 1435
River = Stevens Creek Reach = Reach 4 RS = 1430
River = Stevens Creek Reach = Reach 4 RS = 1425
River = Stevens Creek Reach = Reach 4 RS = 1423 BR McCordick Road
River = Stevens Creek Reach = Reach 4 RS = 1423 BR McCordick Road
River = Stevens Creek Reach = Reach 4 RS = 1420
River = Stevens Creek Reach = Reach 4 RS = 1415
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
DRAFT

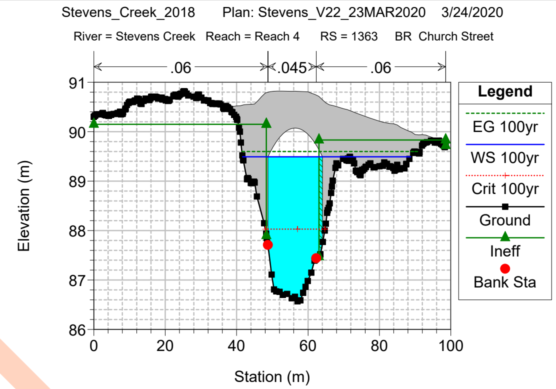

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1410
River = Stevens Creek Reach = Reach 4 RS = 1405
River = Stevens Creek Reach = Reach 4 RS = 1400
River = Stevens Creek Reach = Reach 4 RS = 1395
River = Stevens Creek Reach = Reach 4 RS = 1390
River = Stevens Creek Reach = Reach 4 RS = 1385
River = Stevens Creek Reach = Reach 4 RS = 1380
River = Stevens Creek Reach = Reach 4 RS = 1375
River = Stevens Creek Reach = Reach 4 RS = 1370
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
DRAFT



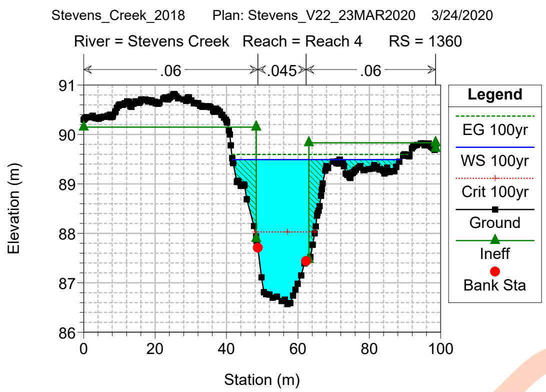
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1365
.06
.045
.06
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta



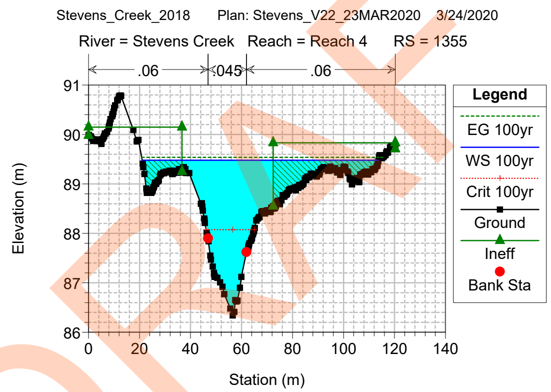
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1363 BR Church Street
.06
.045
.06
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta



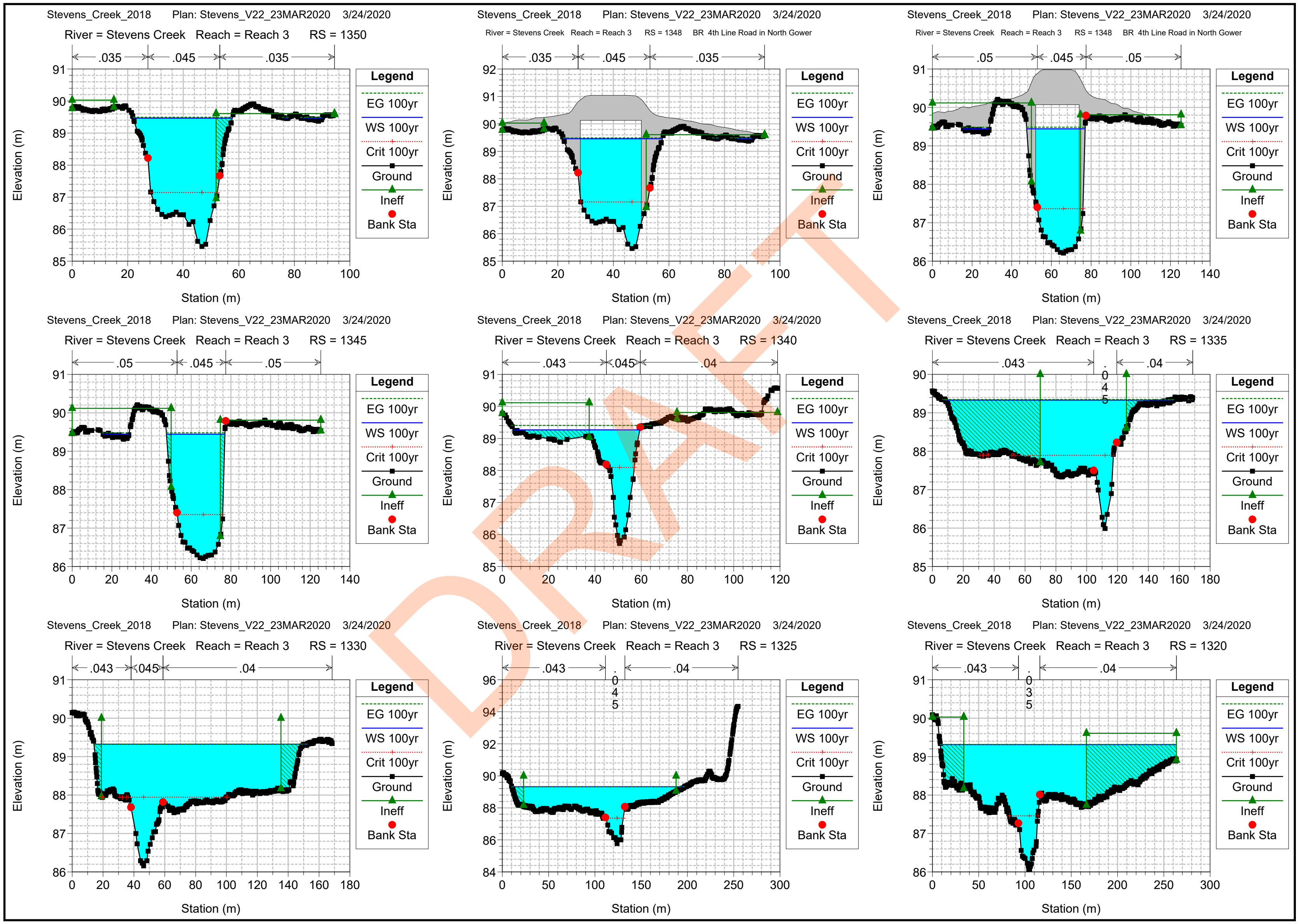
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1363 BR Church Street
.06
.045
.06
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta

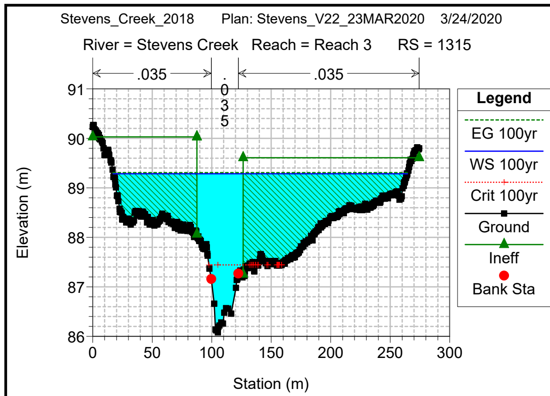


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1360
.06
.045
.06
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta

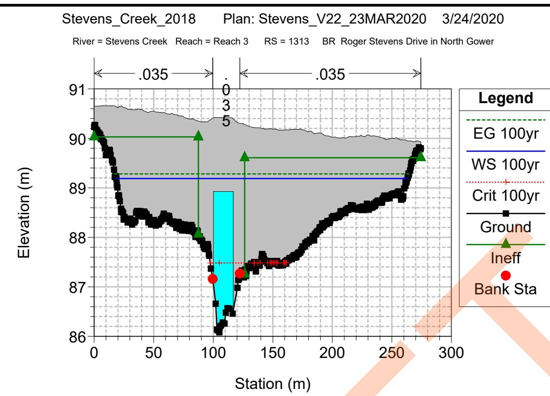


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 4 RS = 1355
.06
.045
.06
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta

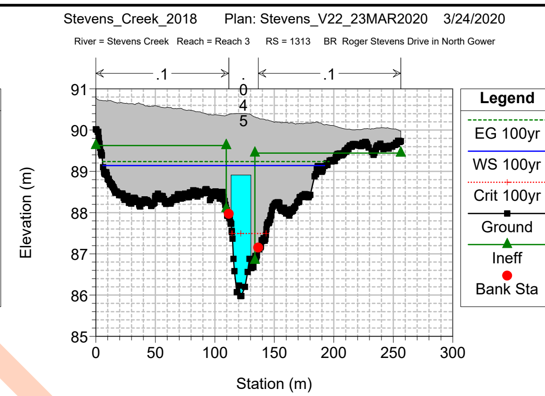

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1350
.035 .045 .035
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1348 BR 4th Line Road in North Gower
.035 .045 .035
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1348 BR 4th Line Road in North Gower
.05 .045 .05
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1345
.05 .045 .05
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1340
.043 .045 .04
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1335
.043 .045 .04
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1330
.043 .045 .04
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1325
.043 .045 .04
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1320
.043 .035 .04
DRAFT



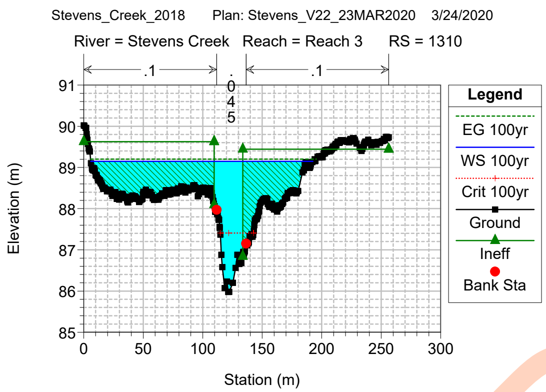
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1315
.035
.035
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)



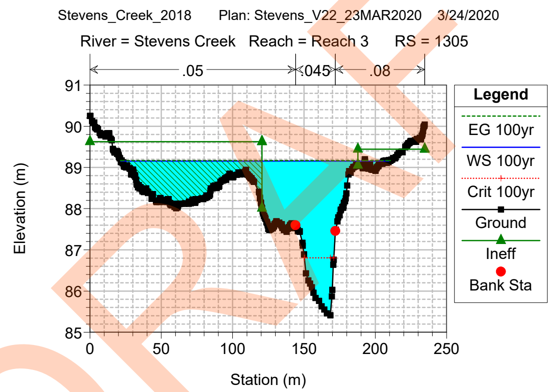
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1313 BR Roger Stevens Drive in North Gower
.035
.035
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)



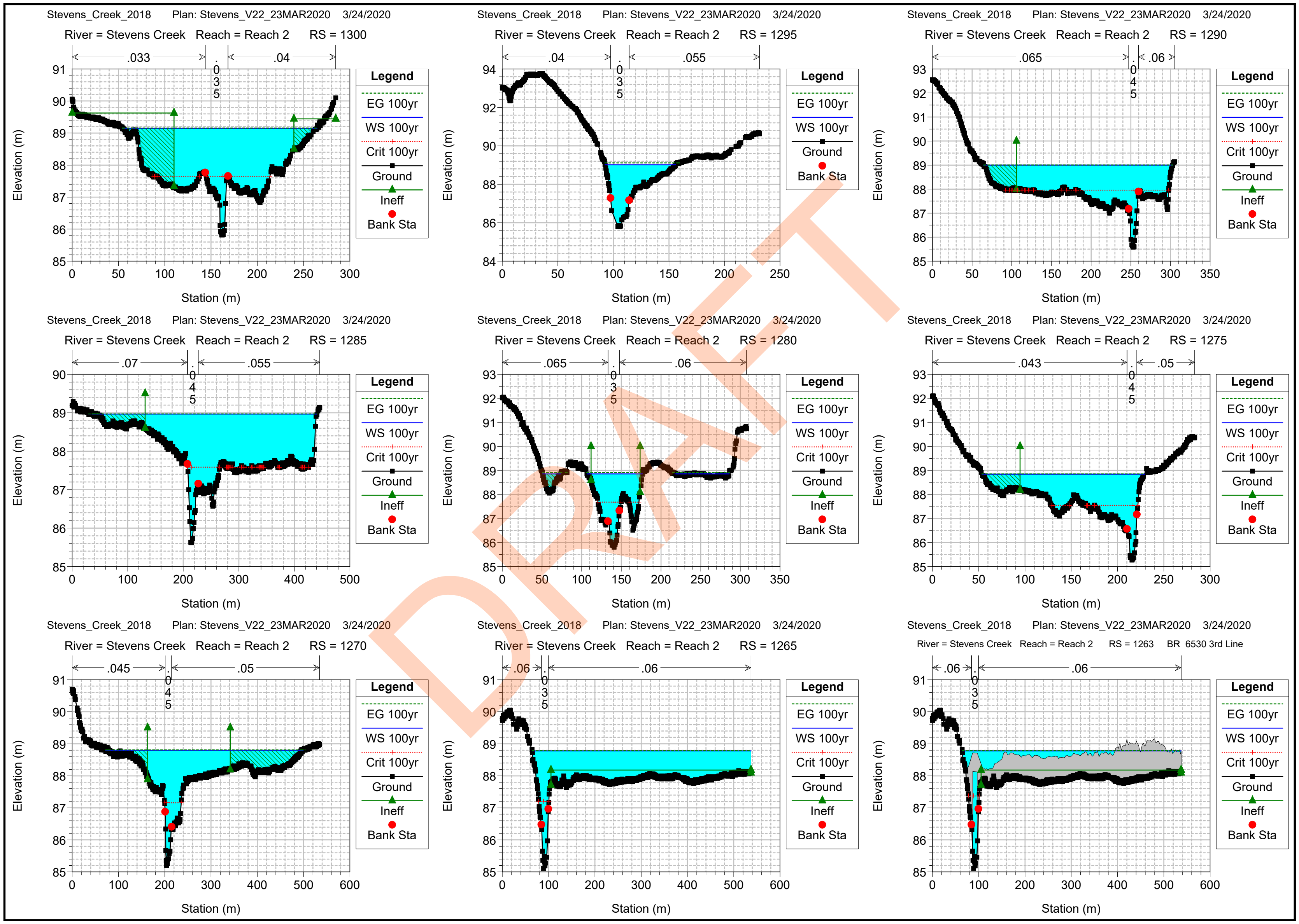
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1313 BR Roger Stevens Drive in North Gower
.1
.1
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

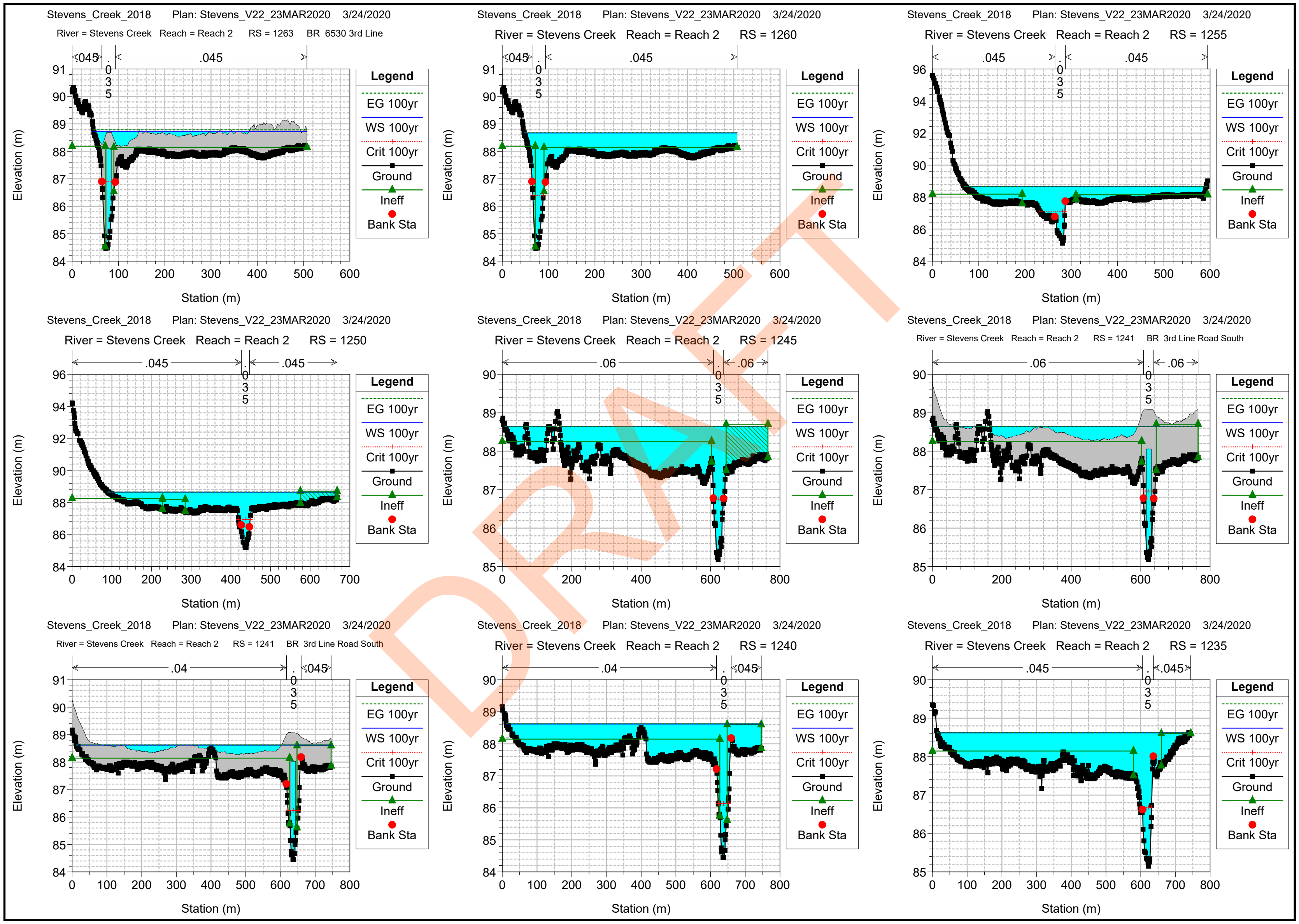


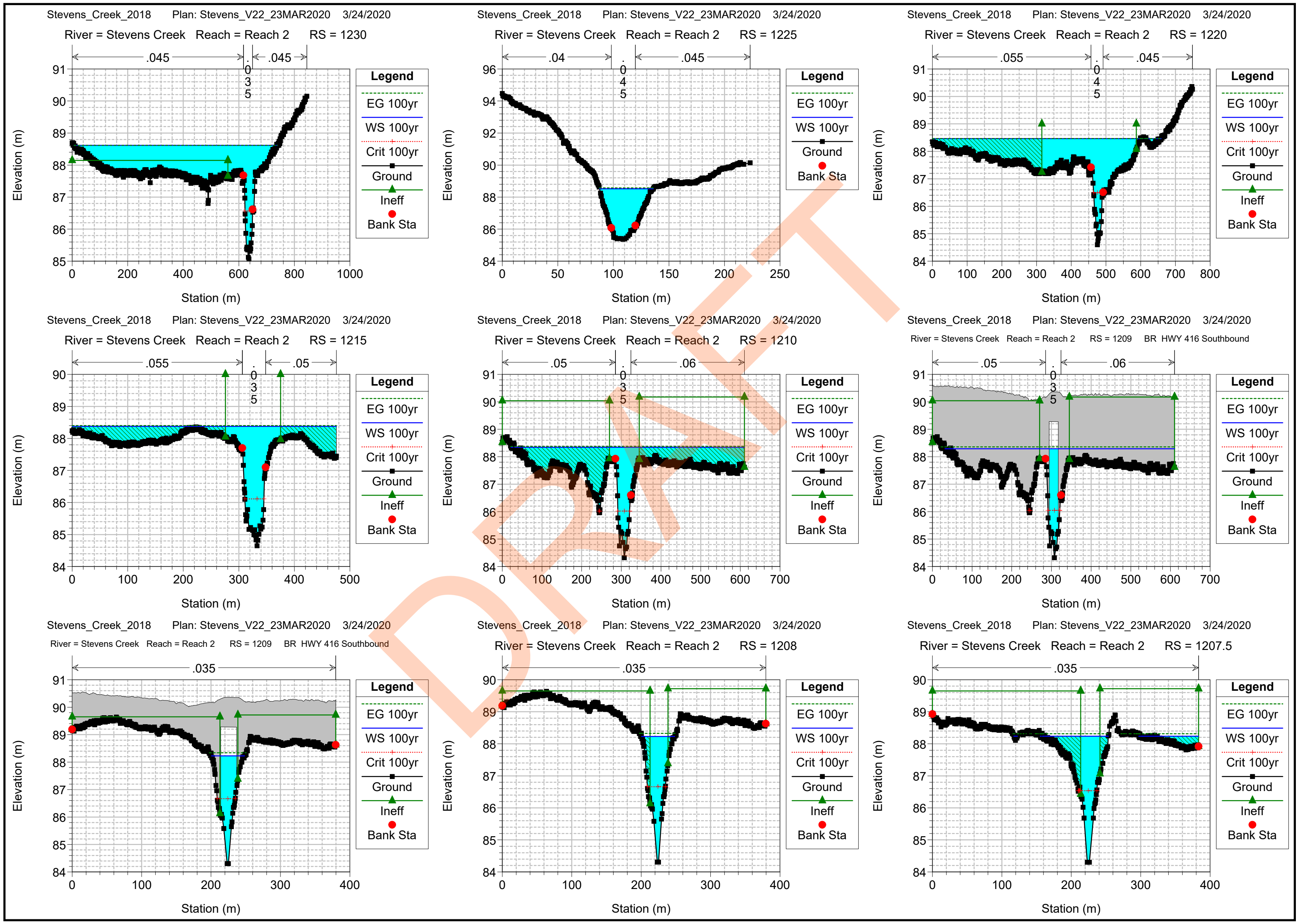
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1310
.1
.1
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

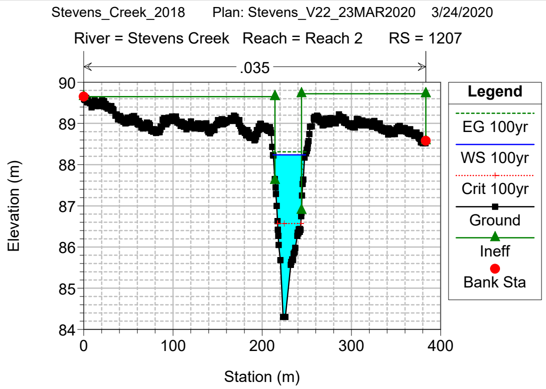


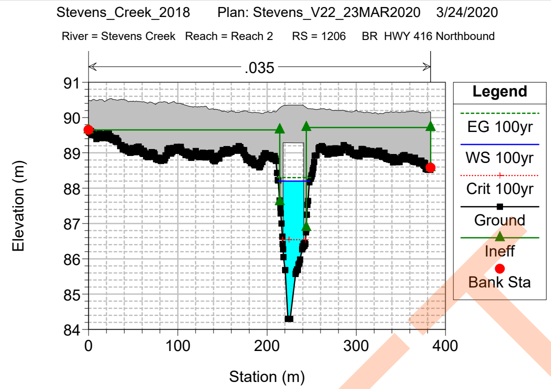
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 3 RS = 1305
.05
.045
.08
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

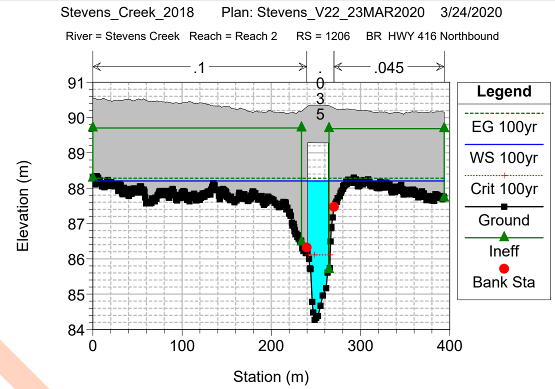

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1300
River = Stevens Creek Reach = Reach 2 RS = 1295
River = Stevens Creek Reach = Reach 2 RS = 1290
River = Stevens Creek Reach = Reach 2 RS = 1285
River = Stevens Creek Reach = Reach 2 RS = 1280
River = Stevens Creek Reach = Reach 2 RS = 1275
River = Stevens Creek Reach = Reach 2 RS = 1270
River = Stevens Creek Reach = Reach 2 RS = 1265
River = Stevens Creek Reach = Reach 2 RS = 1263 BR 6530 3rd Line
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
DRAFT

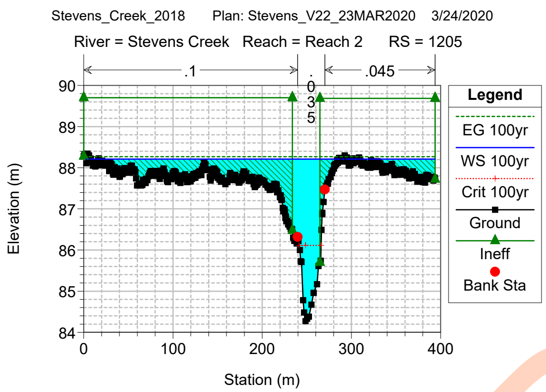

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1263 BR 6530 3rd Line
River = Stevens Creek Reach = Reach 2 RS = 1260
River = Stevens Creek Reach = Reach 2 RS = 1255
River = Stevens Creek Reach = Reach 2 RS = 1250
River = Stevens Creek Reach = Reach 2 RS = 1245
River = Stevens Creek Reach = Reach 2 RS = 1241 BR 3rd Line Road South
River = Stevens Creek Reach = Reach 2 RS = 1241 BR 3rd Line Road South
River = Stevens Creek Reach = Reach 2 RS = 1240
River = Stevens Creek Reach = Reach 2 RS = 1235
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
DRAFT

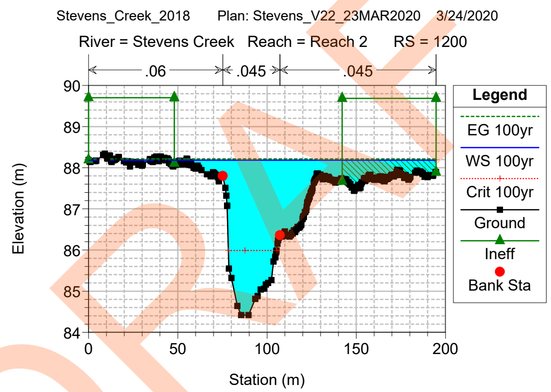

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1230
.045
.035
.045
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1225
.04
.045
.045
Legend
EG 100yr
WS 100yr
Ground
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1220
.055
.045
.045
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1215
.055
.035
.05
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1210
.05
.035
.06
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1209 BR HWY 416 Southbound
.05
.035
.06
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1209 BR HWY 416 Southbound
.035
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1208
.035
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1207.5
.035
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
DRAFT

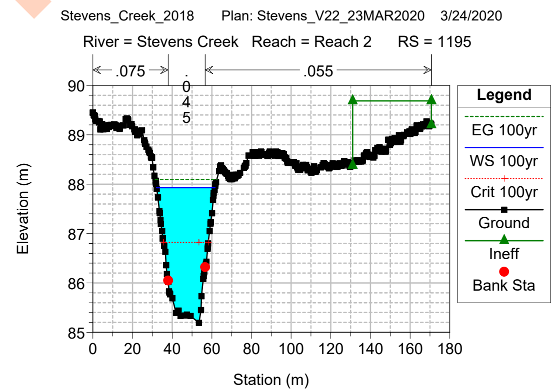

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1207
.035
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

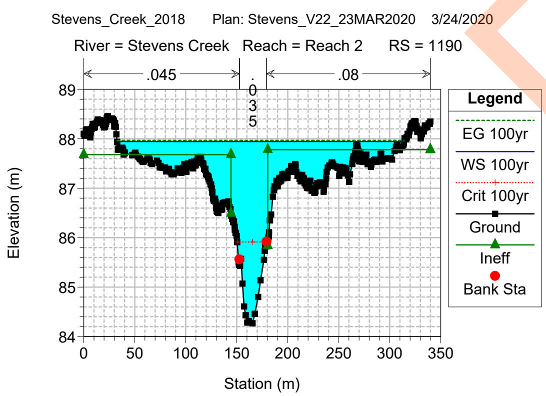

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1206 BR HWY 416 Northbound
.035
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

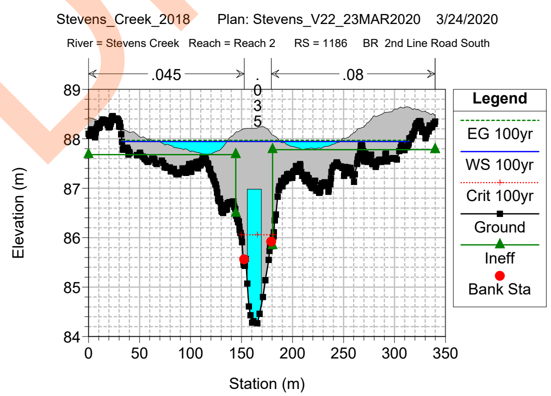

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1206 BR HWY 416 Northbound
.1
.035
.045
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

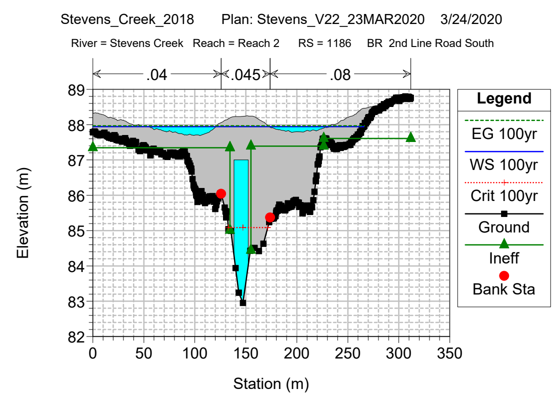

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1205
.1
.035
.045
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

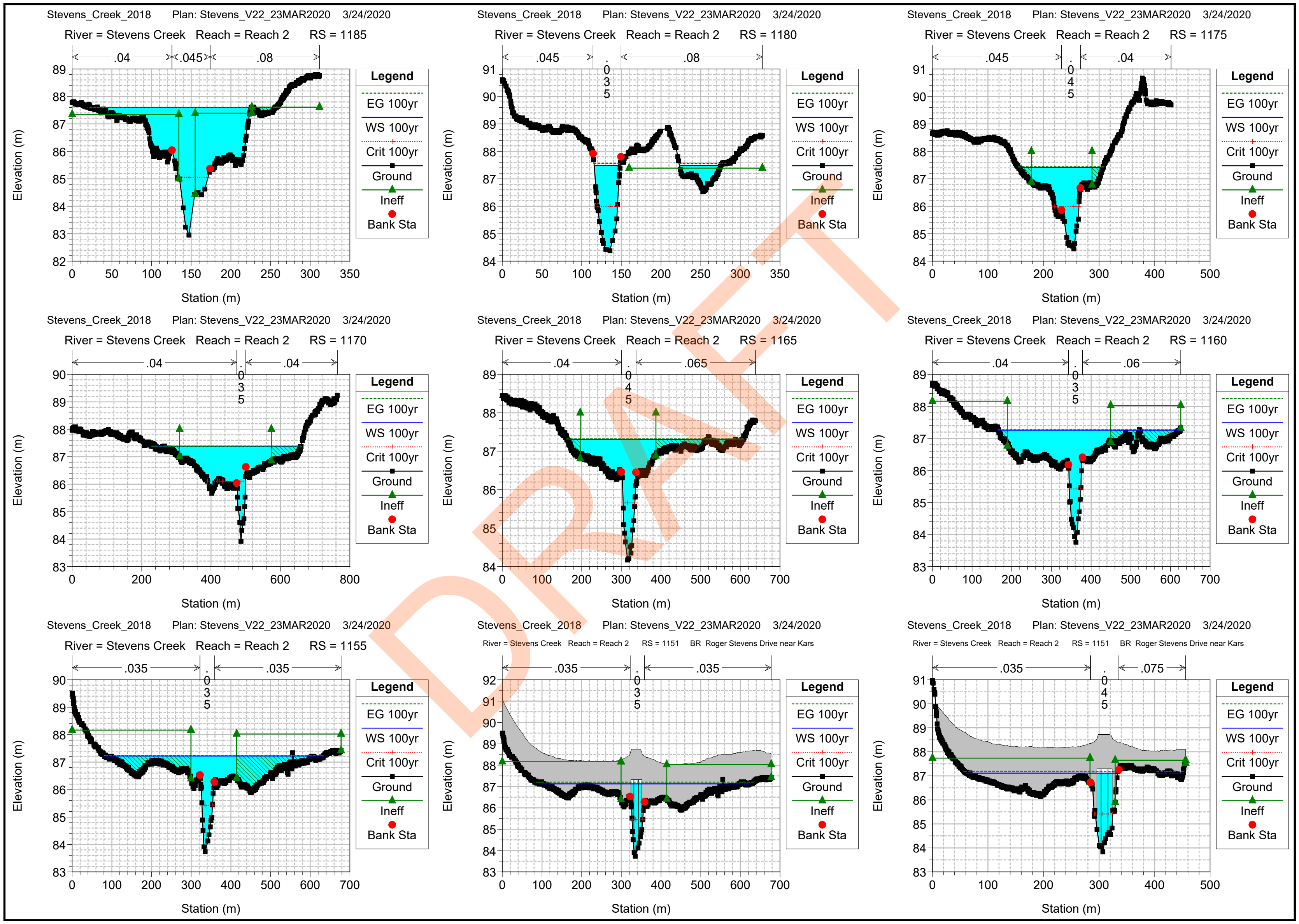

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1200
.06
.045
.045
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1195
.075
.045
.055
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

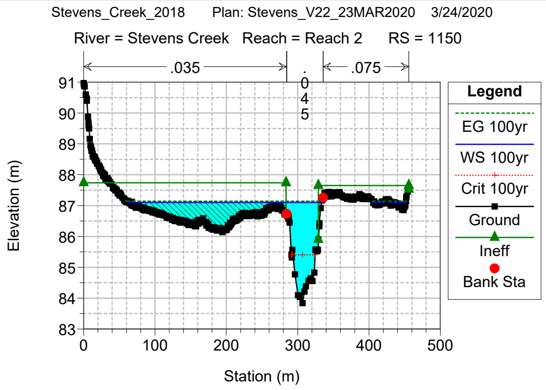

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1190
.045
.035
.08
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1186 BR 2nd Line Road South
.045
.035
.08
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

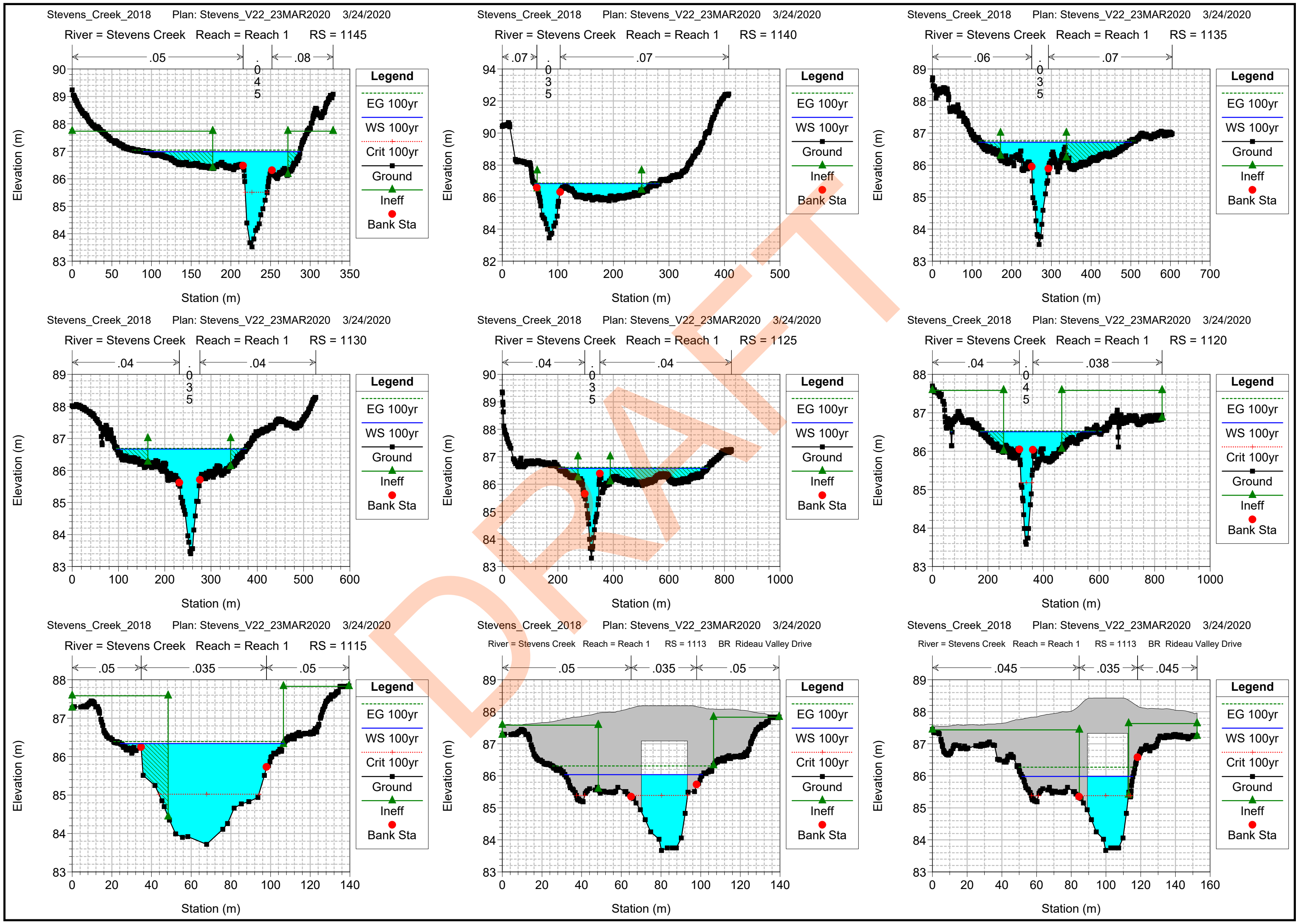

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1186 BR 2nd Line Road South
.04
.045
.08
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

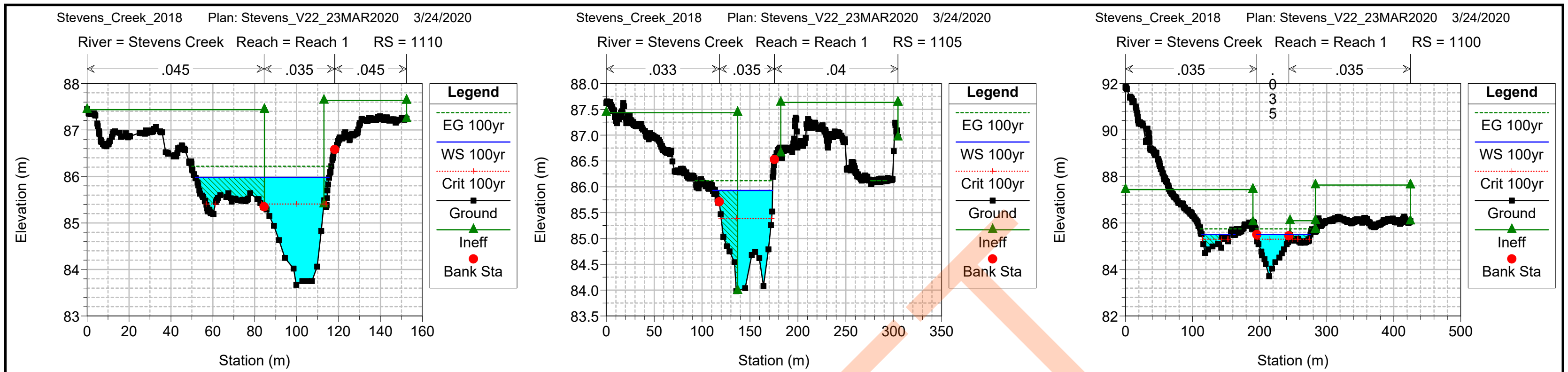


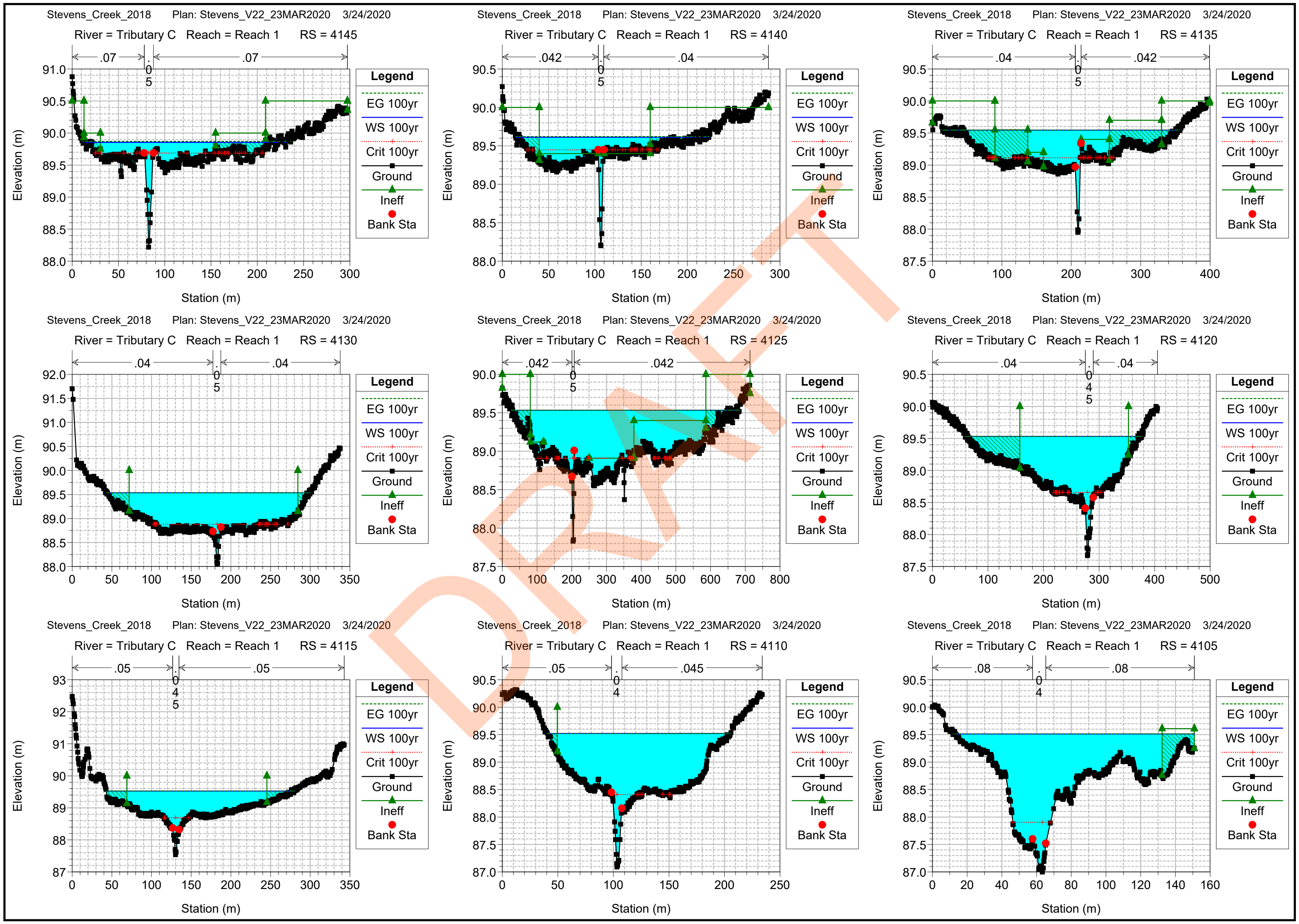
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1185
.04 .045 .08
River = Stevens Creek Reach = Reach 2 RS = 1180
.045 .035 .08
River = Stevens Creek Reach = Reach 2 RS = 1175
.045 .045 .04
River = Stevens Creek Reach = Reach 2 RS = 1170
.04 .035 .04
River = Stevens Creek Reach = Reach 2 RS = 1165
.04 .045 .065
River = Stevens Creek Reach = Reach 2 RS = 1160
.04 .035 .06
River = Stevens Creek Reach = Reach 2 RS = 1155
.035 .035 .035
River = Stevens Creek Reach = Reach 2 RS = 1151 BR Roger Stevens Drive near Kars
.035 .035 .035
.035 .045 .075
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

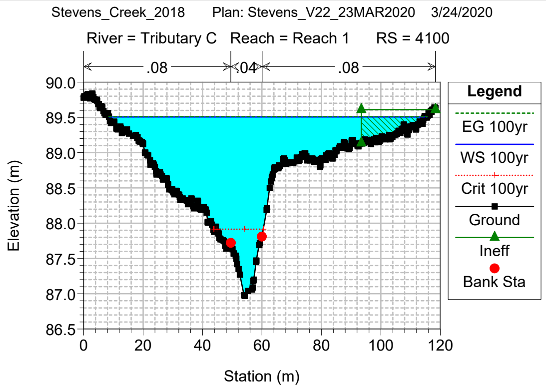


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 2 RS = 1150
.035
.045
.075
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
91
90
89
88
87
86
85
84
83
0
100
200
300
400
500

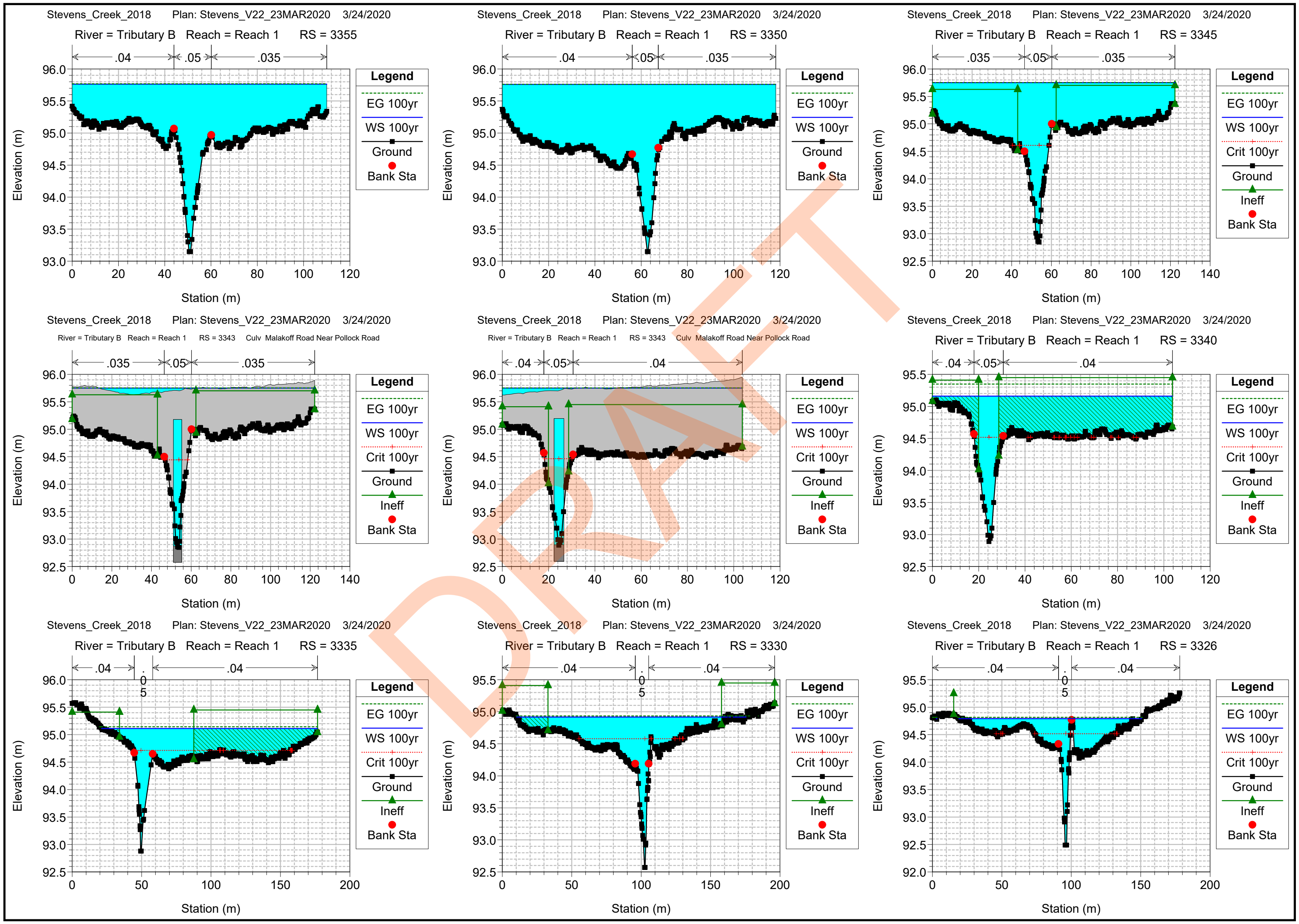

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 1 RS = 1145
River = Stevens Creek Reach = Reach 1 RS = 1140
River = Stevens Creek Reach = Reach 1 RS = 1135
River = Stevens Creek Reach = Reach 1 RS = 1130
River = Stevens Creek Reach = Reach 1 RS = 1125
River = Stevens Creek Reach = Reach 1 RS = 1120
River = Stevens Creek Reach = Reach 1 RS = 1115
River = Stevens Creek Reach = Reach 1 RS = 1113 BR Rideau Valley Drive
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

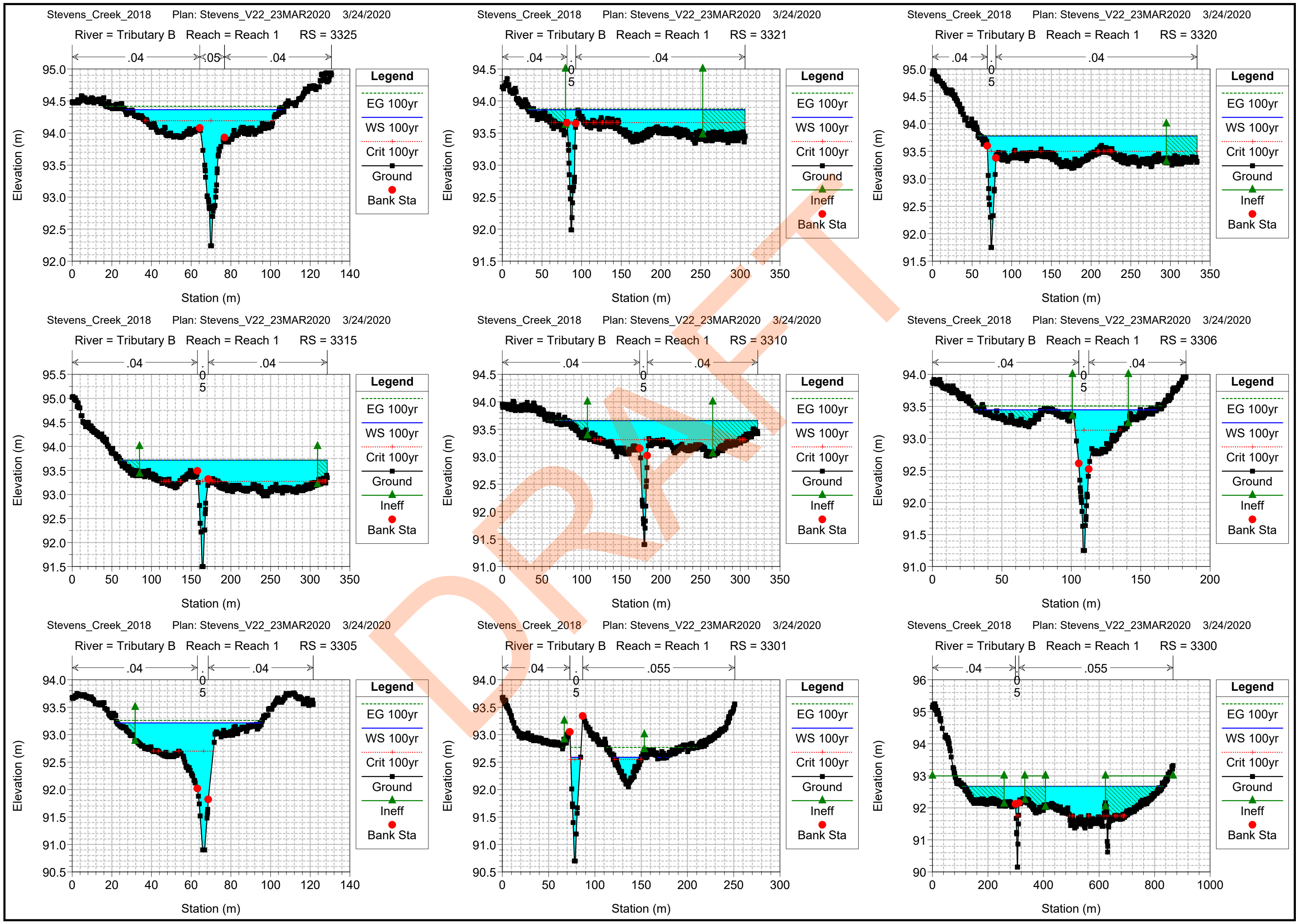

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 1 RS = 1110
.045
.035
.045
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 1 RS = 1105
.033
.035
.04
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Stevens Creek Reach = Reach 1 RS = 1100
.035
.035
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary C Reach = Reach 1 RS = 4145
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary C Reach = Reach 1 RS = 4140
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary C Reach = Reach 1 RS = 4135
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary C Reach = Reach 1 RS = 4130
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary C Reach = Reach 1 RS = 4125
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary C Reach = Reach 1 RS = 4120
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary C Reach = Reach 1 RS = 4115
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary C Reach = Reach 1 RS = 4110
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary C Reach = Reach 1 RS = 4105
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
DRAFT

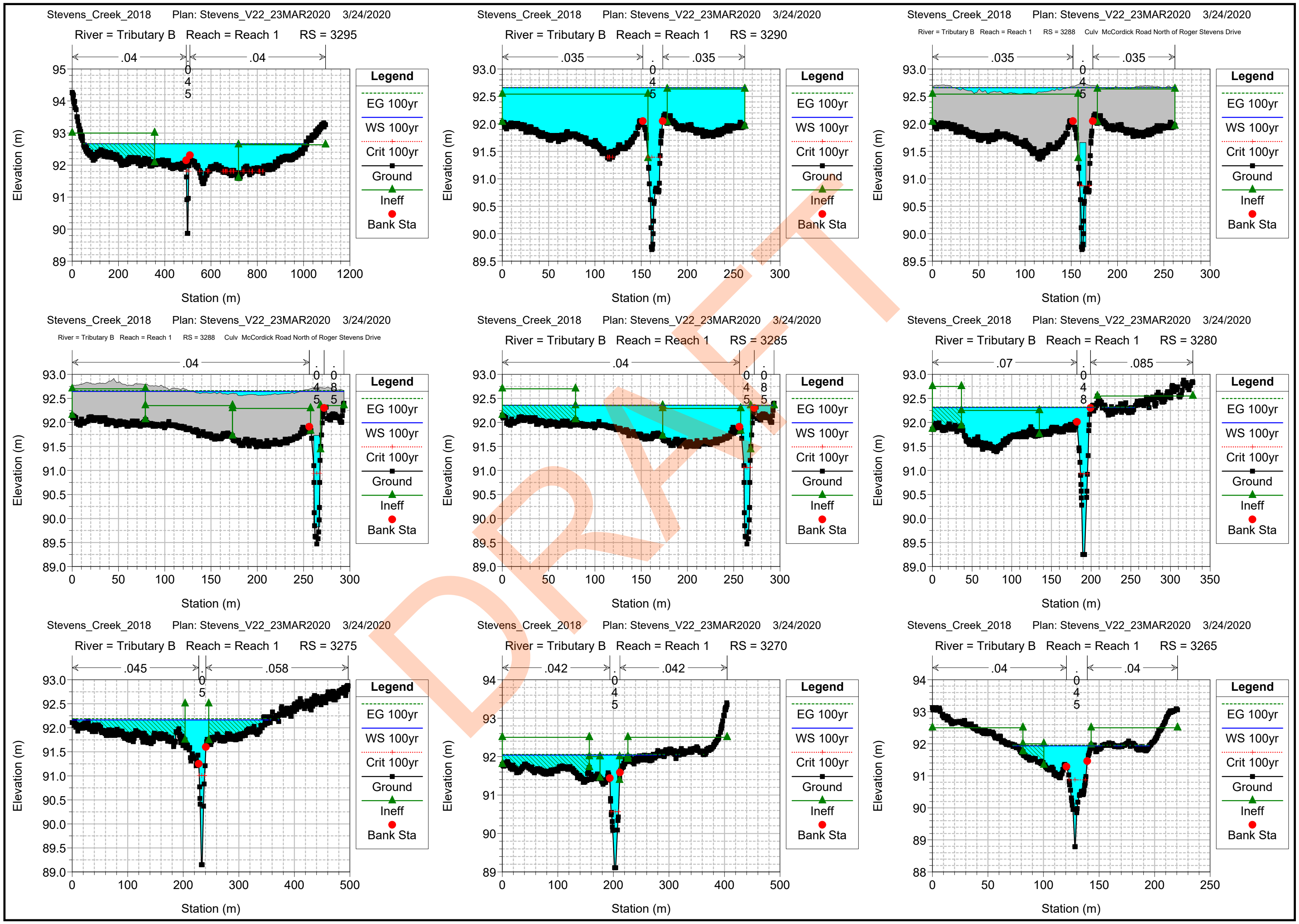


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary C Reach = Reach 1 RS = 4100
.08
.04
.08
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta

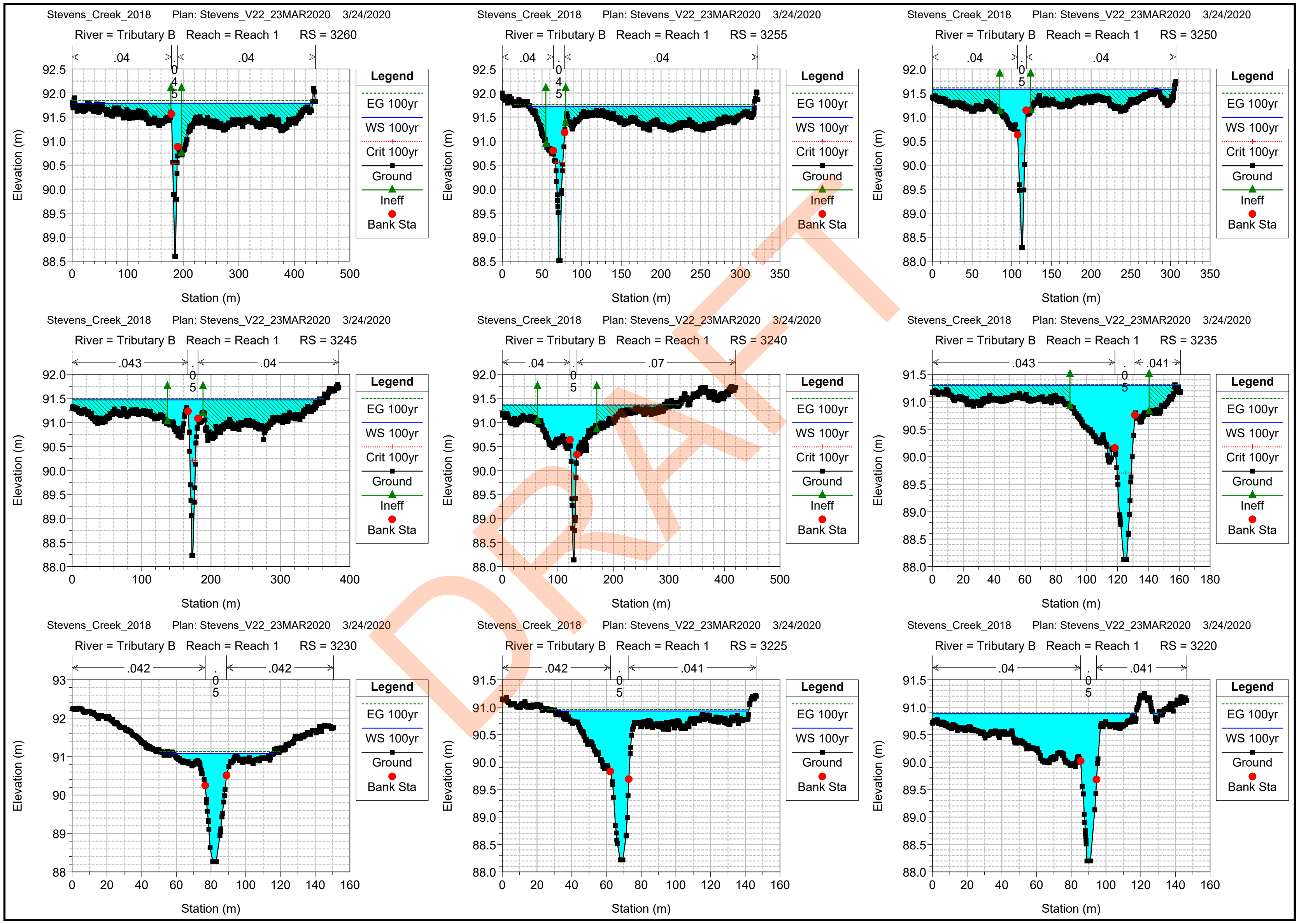

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3355
.04 .05 .035
Legend
EG 100yr
WS 100yr
Ground
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3350
.04 .05 .035
Legend
EG 100yr
WS 100yr
Ground
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3345
.035 .05 .035
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3343 Culv Malakoff Road Near Pollock Road
.035 .05 .035
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3343 Culv Malakoff Road Near Pollock Road
.04 .05 .04
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3340
.04 .05 .04
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3335
.04 0 5 .04
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3330
.04 0 5 .04
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3326
.04 0 5 .04
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)



Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3325
.04 .05 .04
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3321
.04 0 5 .04
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3320
.04 0 5 .04
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3315
.04 0 5 .04
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3310
.04 0 5 .04
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3306
.04 0 5 .04
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3305
.04 0 5 .04
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3301
.04 0 5 .055
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3300
.04 0 5 .055
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta



Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3295
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3290
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3288 Culv McCordick Road North of Roger Stevens Drive
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3288 Culv McCordick Road North of Roger Stevens Drive
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3285
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3280
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3275
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3270
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3265
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)



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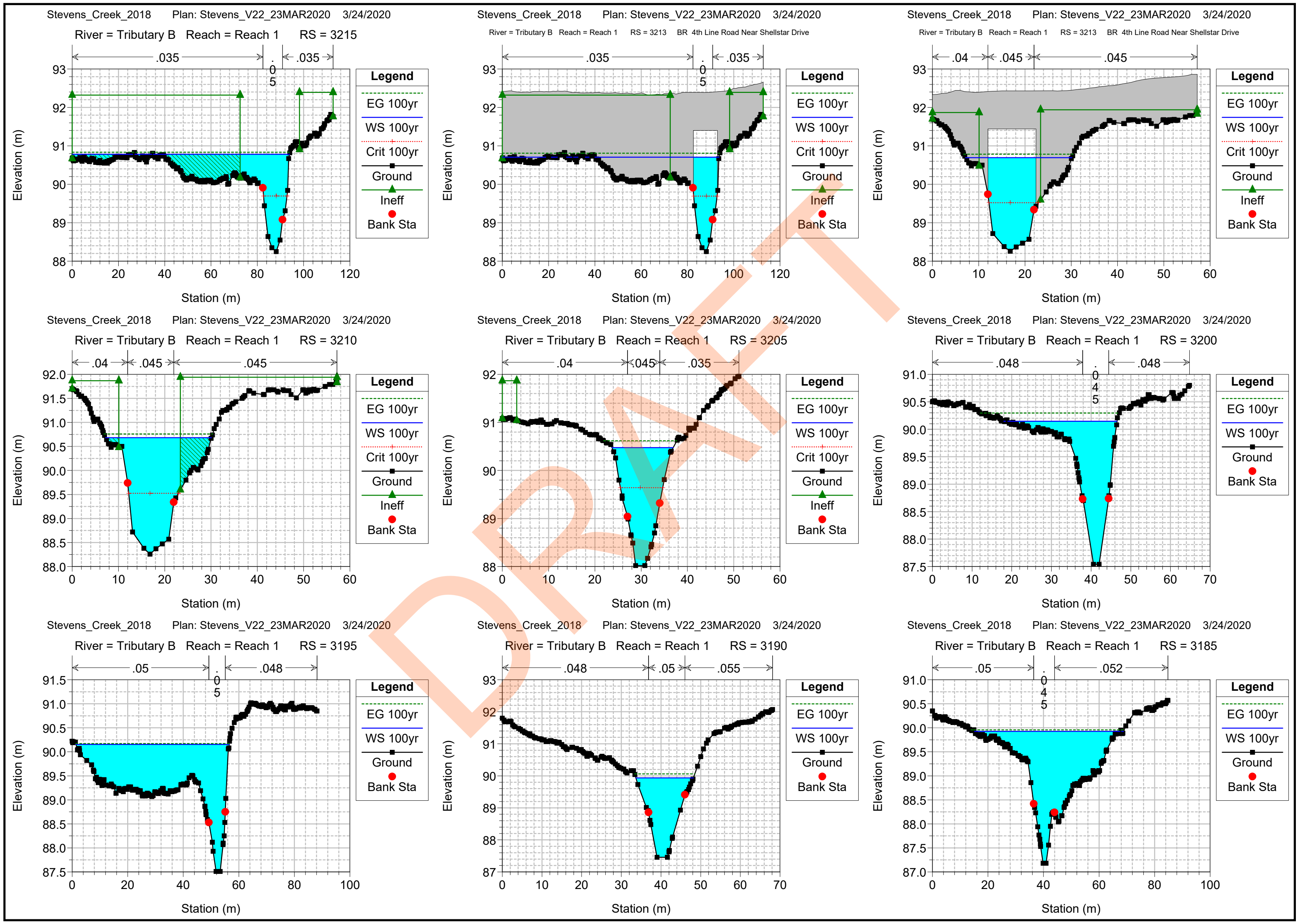
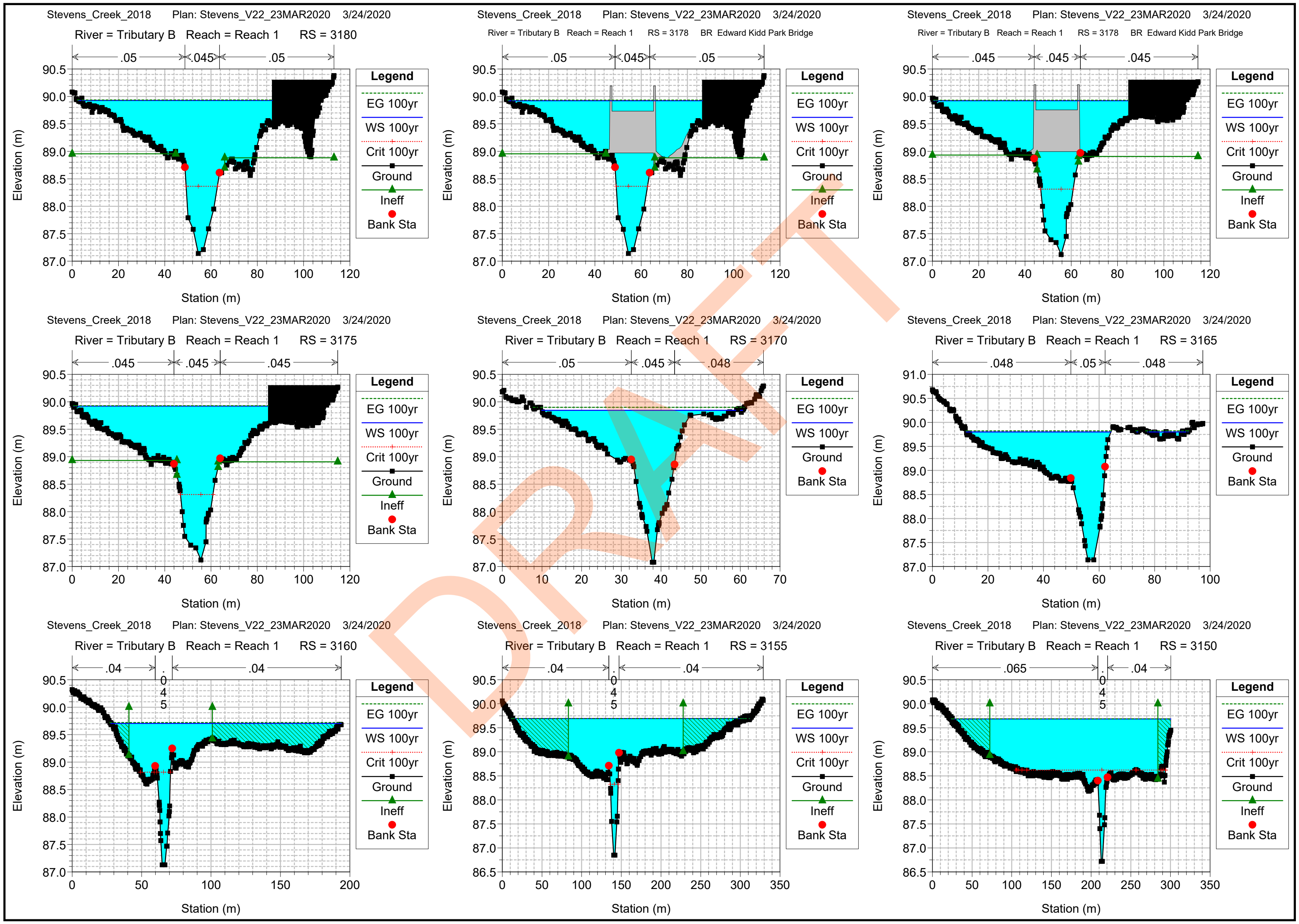
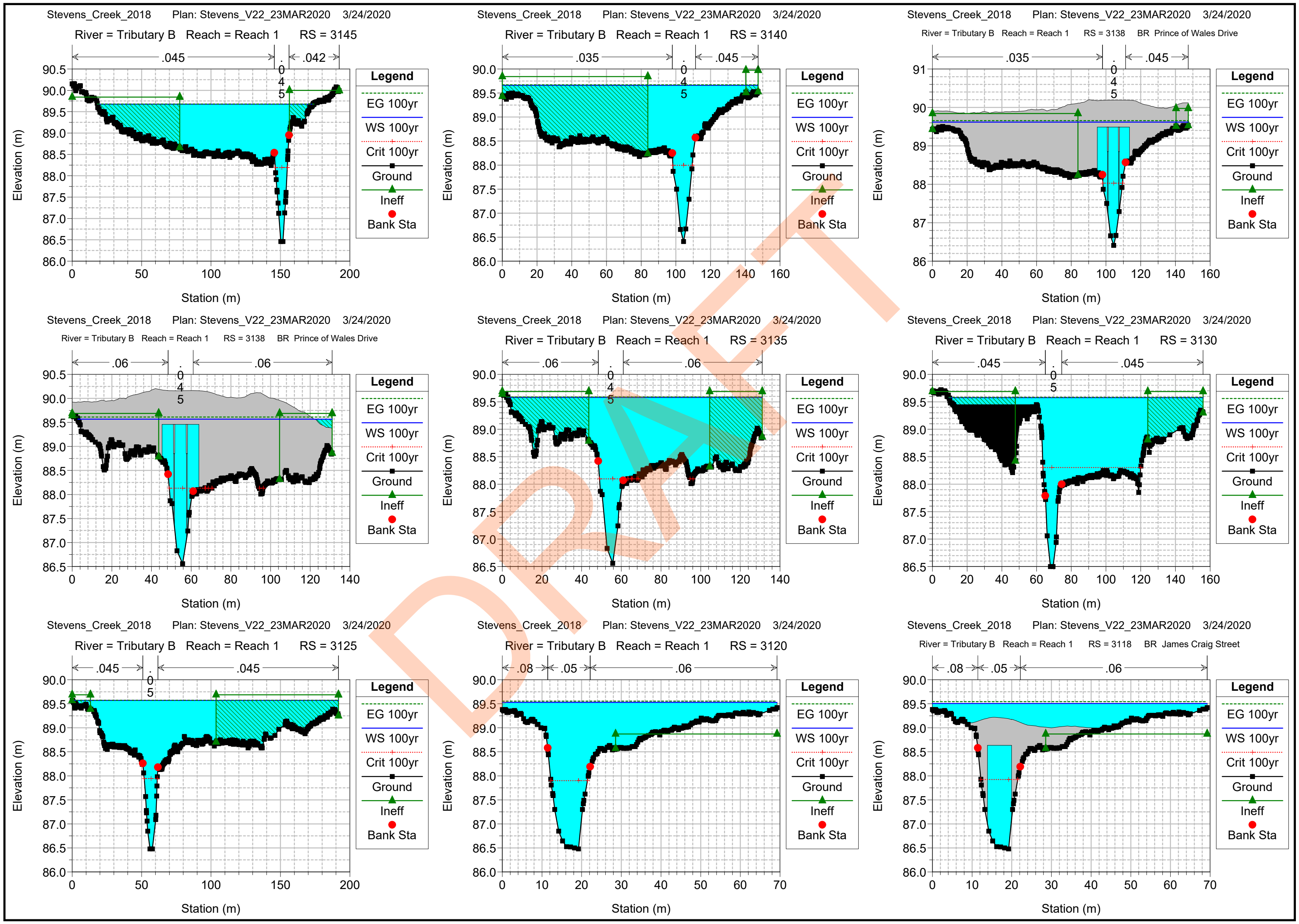
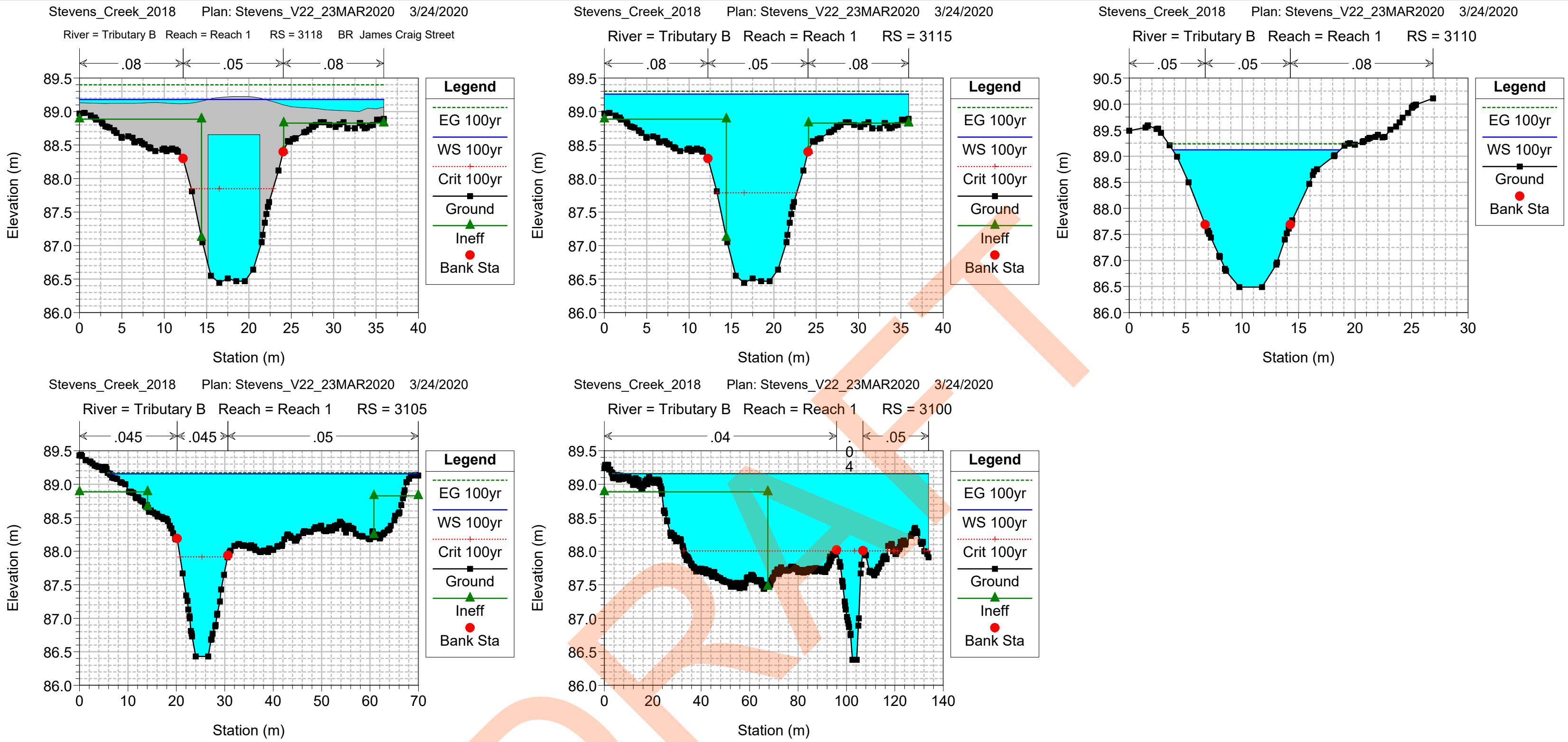

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3215
River = Tributary B Reach = Reach 1 RS = 3213 BR 4th Line Road Near Shellstar Drive
River = Tributary B Reach = Reach 1 RS = 3210
River = Tributary B Reach = Reach 1 RS = 3205
River = Tributary B Reach = Reach 1 RS = 3200
River = Tributary B Reach = Reach 1 RS = 3195
River = Tributary B Reach = Reach 1 RS = 3190
River = Tributary B Reach = Reach 1 RS = 3185
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
DRAFT

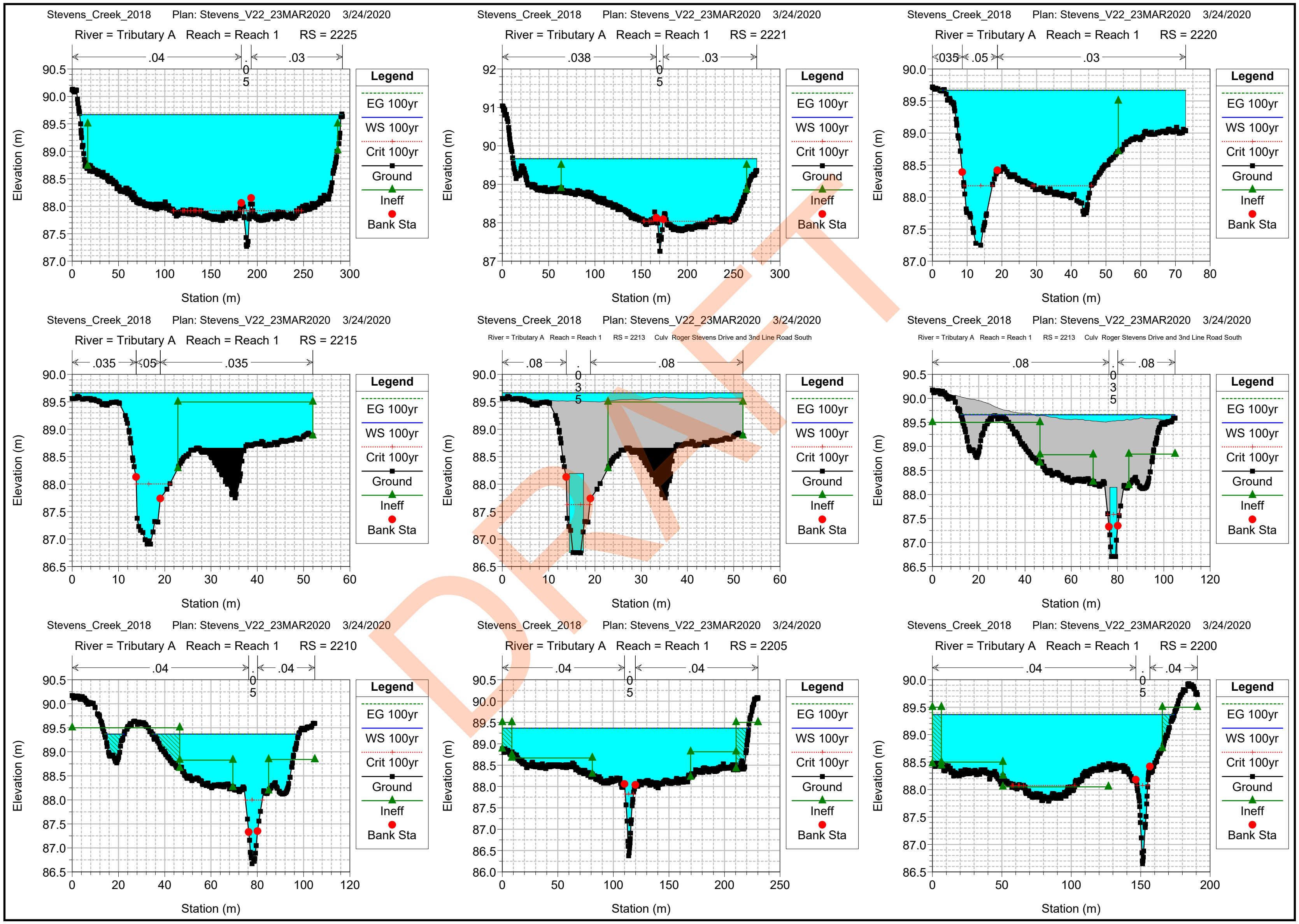

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3180
River = Tributary B Reach = Reach 1 RS = 3178 BR Edward Kidd Park Bridge
River = Tributary B Reach = Reach 1 RS = 3175
River = Tributary B Reach = Reach 1 RS = 3170
River = Tributary B Reach = Reach 1 RS = 3165
River = Tributary B Reach = Reach 1 RS = 3160
River = Tributary B Reach = Reach 1 RS = 3155
River = Tributary B Reach = Reach 1 RS = 3150
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)



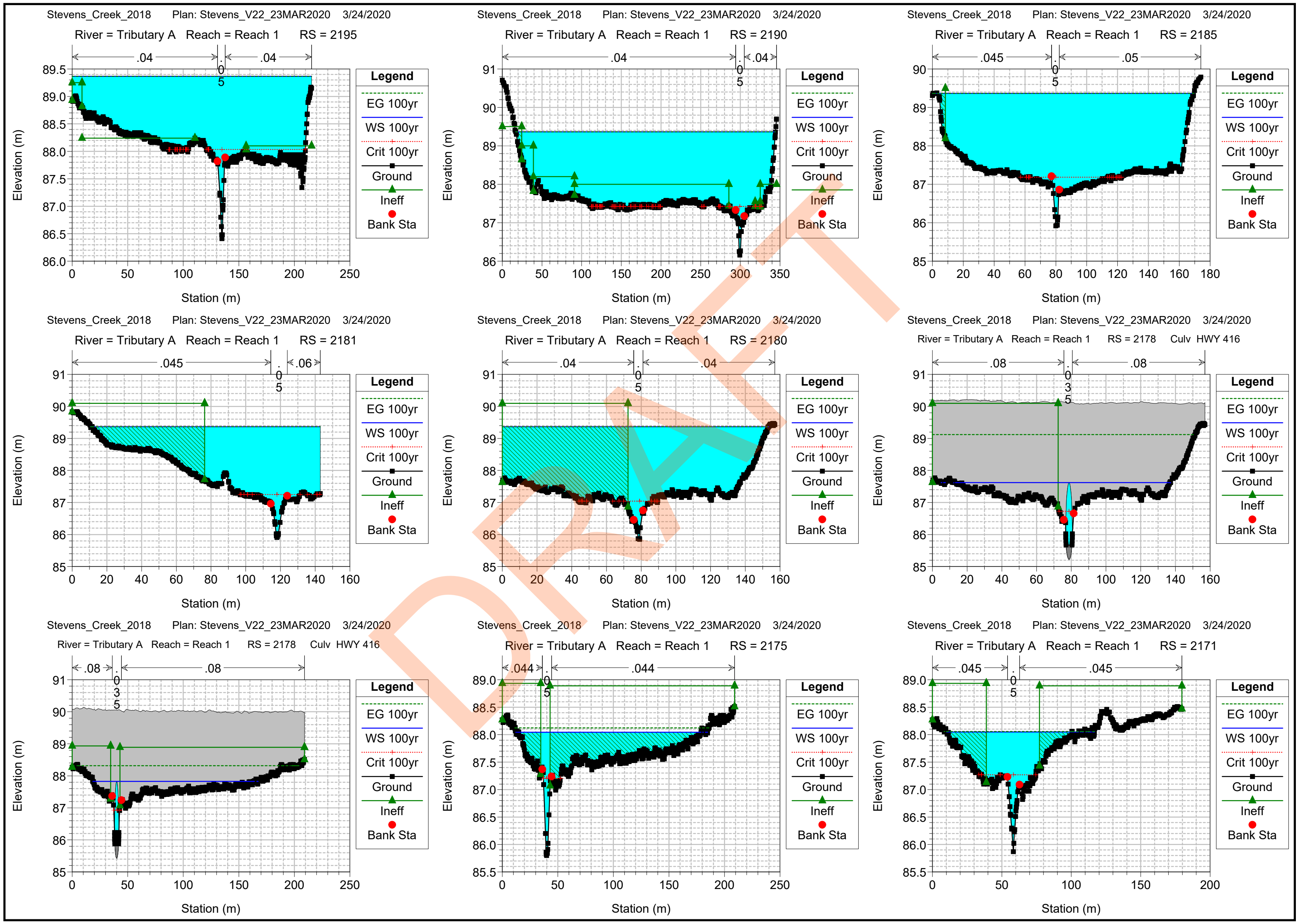
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3145
River = Tributary B Reach = Reach 1 RS = 3140
River = Tributary B Reach = Reach 1 RS = 3138 BR Prince of Wales Drive
River = Tributary B Reach = Reach 1 RS = 3135
River = Tributary B Reach = Reach 1 RS = 3130
River = Tributary B Reach = Reach 1 RS = 3125
River = Tributary B Reach = Reach 1 RS = 3120
River = Tributary B Reach = Reach 1 RS = 3118 BR James Craig Street
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
DRAFT

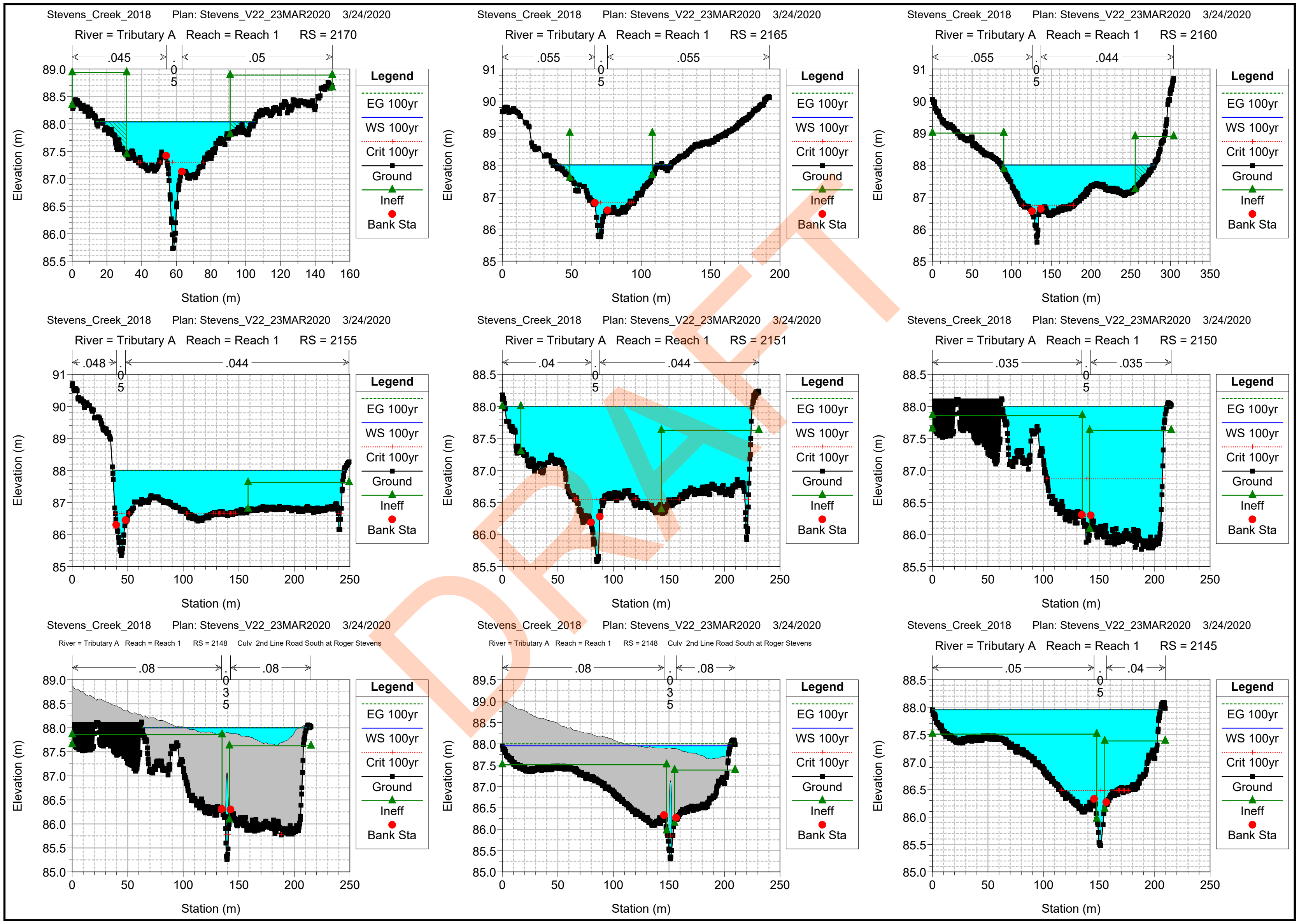


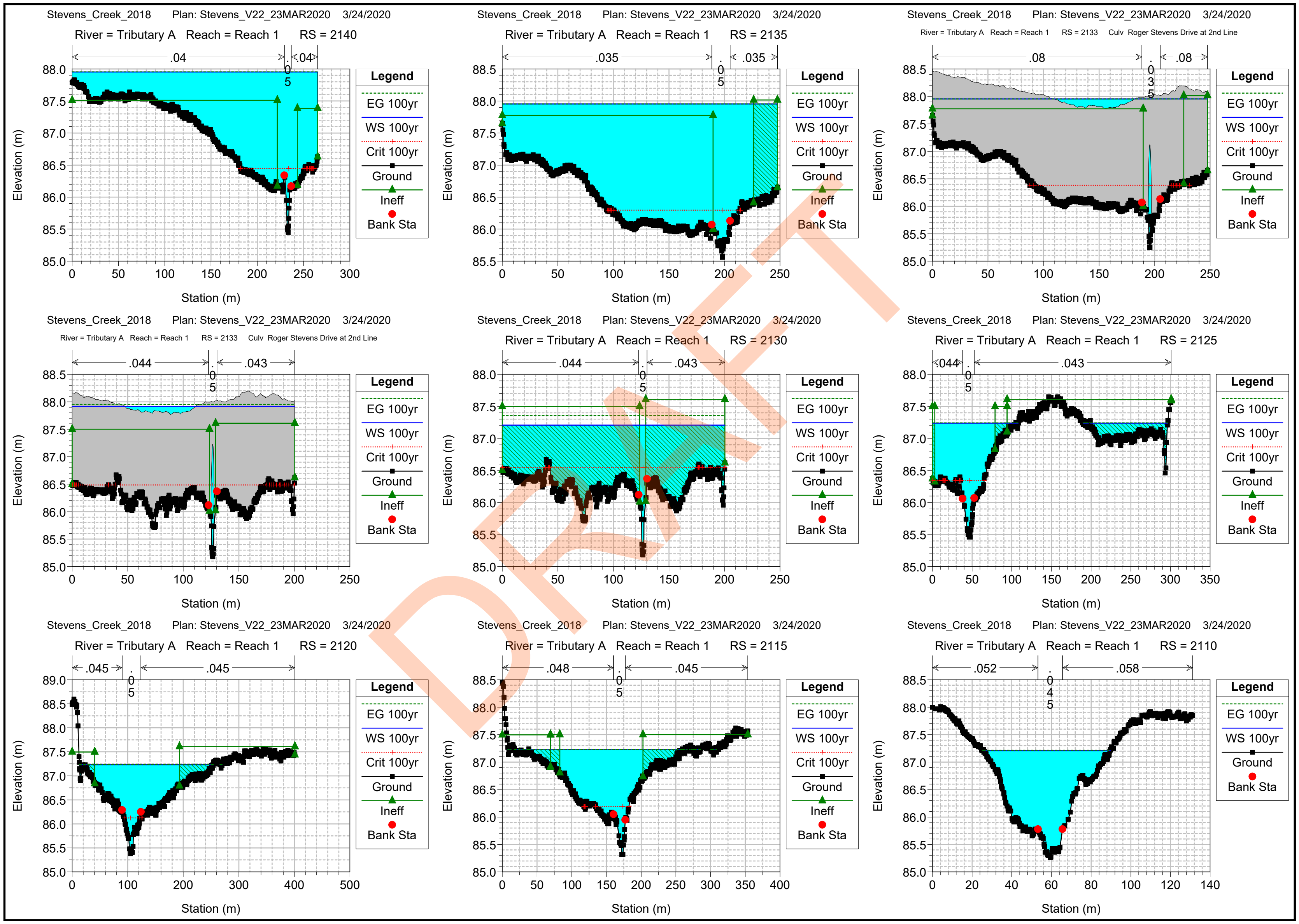
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3118 BR James Craig Street
.08 .05 .08
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3115
.08 .05 .08
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3110
.05 .05 .08
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3105
.045 .045 .05
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary B Reach = Reach 1 RS = 3100
.04 0 4 .05

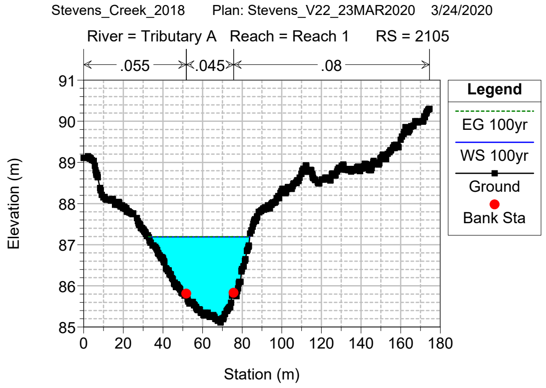


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2225
River = Tributary A Reach = Reach 1 RS = 2221
River = Tributary A Reach = Reach 1 RS = 2220
River = Tributary A Reach = Reach 1 RS = 2215
River = Tributary A Reach = Reach 1 RS = 2213 Culv Roger Stevens Drive and 3nd Line Road South
River = Tributary A Reach = Reach 1 RS = 2210
River = Tributary A Reach = Reach 1 RS = 2205
River = Tributary A Reach = Reach 1 RS = 2200
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2195
River = Tributary A Reach = Reach 1 RS = 2190
River = Tributary A Reach = Reach 1 RS = 2185
River = Tributary A Reach = Reach 1 RS = 2181
River = Tributary A Reach = Reach 1 RS = 2180
River = Tributary A Reach = Reach 1 RS = 2178 Culv HWY 416
River = Tributary A Reach = Reach 1 RS = 2178 Culv HWY 416
River = Tributary A Reach = Reach 1 RS = 2175
River = Tributary A Reach = Reach 1 RS = 2171
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2170
.045
.05
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2165
.055
.055
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2160
.055
.044
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2155
.048
.044
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2151
.04
.044
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2150
.035
.035
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2148 Culv 2nd Line Road South at Roger Stevens
.08
.08
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2148 Culv 2nd Line Road South at Roger Stevens
.08
.08
Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2145
.05
.04


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2140
River = Tributary A Reach = Reach 1 RS = 2135
River = Tributary A Reach = Reach 1 RS = 2133 Culv Roger Stevens Drive at 2nd Line
River = Tributary A Reach = Reach 1 RS = 2133 Culv Roger Stevens Drive at 2nd Line
River = Tributary A Reach = Reach 1 RS = 2130
River = Tributary A Reach = Reach 1 RS = 2125
River = Tributary A Reach = Reach 1 RS = 2120
River = Tributary A Reach = Reach 1 RS = 2115
River = Tributary A Reach = Reach 1 RS = 2110
Elevation (m)
Station (m)
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
Ineff
Bank Sta


Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2105
.055
.045
.08
Legend
EG 100yr
WS 100yr
Ground
Bank Sta
Elevation (m)
Station (m)

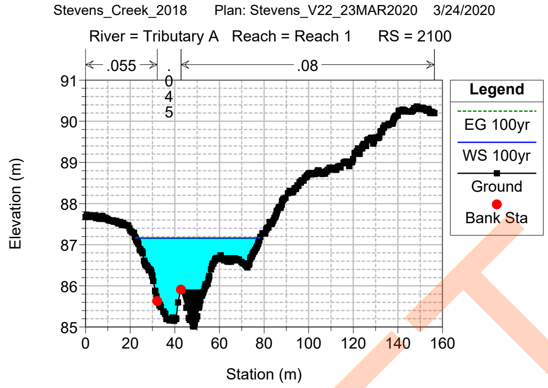

Stevens_Creek_2018 Plan: Stevens_V22_23MAR2020 3/24/2020
River = Tributary A Reach = Reach 1 RS = 2100
.055
.045
.08
Legend
EG 100yr
WS 100yr
Ground
Bank Sta
Elevation (m)
Station (m)

Table B1 Manning n values

River	Reach	Xsec ID #	Left Bank n	Left Bank Description	Channel n	Channel Description	Right Bank n	Right Bank Description
Stevens Creek	Reach 1	1100	0.035	high grass	0.035	Clean, straight, some stones and weeds	0.035	high grass
	Reach 1	1105	0.033	Short/high Grass	0.035	Clean, straight, some stones and weeds	0.040	Grass/scattered brush
	Reach 1	1110	0.045	Grass/scattered brush	0.035	Clean, straight, some stones and weeds	0.045	Grass/scattered brush
	Reach 1	1113				Rideau Valley Drive		
	Reach 1	1115	0.050	Scattered/light brush	0.035	Clean, straight, some stones and weeds	0.050	Scattered/light brush
	Reach 1	1120	0.040	Short grass/light brush	0.045	Clean, winding, some stones and weeds	0.038	High grass/field crop
	Reach 1	1125	0.040	Short grass/light brush	0.035	Clean, straight, some stones and weeds	0.040	Field crop
	Reach 1	1130	0.040	Short grass/light brush	0.035	Clean, straight, some stones and weeds	0.040	Field crop
	Reach 1	1135	0.060	High grass/med brush	0.035	Clean, straight, some stones and weeds	0.070	Field crop/med brush
	Reach 1	1140	0.070	High grass/med brush	0.035	Clean, straight, some stones and weeds	0.070	Field crop/med brush
	Reach 1	1145	0.050	Short grass/light brush	0.045	Clean, winding, some stones and weeds	0.080	Medium brush
	Reach 2	1150	0.035	High grass	0.045	Clean, winding, some stones and weeds	0.075	Short grass/med brush
	Reach 2	1151				Roger Stevens Drive near Kars		
	Reach 2	1155	0.035	High grass	0.035	Clean, straight, some stones and weeds	0.035	High grass
	Reach 2	1160	0.040	Field crop	0.035	Clean, straight, some stones and weeds	0.060	Field crop/dense brush
	Reach 2	1165	0.040	Field crop	0.045	Clean, winding, some stones and weeds	0.065	Field crop/dense brush
	Reach 2	1170	0.040	Field crop	0.035	Clean, straight, some stones and weeds	0.040	Field crop
	Reach 2	1175	0.045	Field crop/scattered brush	0.045	Clean, winding, some stones and weeds	0.040	Field crop
	Reach 2	1180	0.045	Field crop/scattered brush	0.035	Clean, straight, some stones and weeds	0.080	Medium brush
	Reach 2	1185	0.040	Short grass/light brush	0.045	Clean, winding, some stones and weeds	0.080	Medium brush
	Reach 2	1186				2nd Line Road South		
	Reach 2	1190	0.045	High grass/light brush	0.035	Clean, straight, some stones and weeds	0.080	Medium brush
	Reach 2	1195	0.075	Scattered/dense brush	0.045	Clean, winding, some stones and weeds	0.055	Scattered/light brush
	Reach 2	1200	0.060	High grass/medium brush	0.045	Clean, winding, some stones and weeds	0.045	High grass/scattered brush
	Reach 2	1205	0.100	Dense brush	0.035	Clean, straight, some stones and weeds	0.045	High grass/scattered brush
	Reach 2	1206				HWY 416 Northbound		
	Reach 2	1207	0.035	High grass	0.035	Clean, straight, some stones and weeds	0.035	High grass
	Reach 2	1207.5	0.035	High grass	0.035	Clean, straight, some stones and weeds	0.035	High grass
	Reach 2	1208	0.035	High grass	0.035	Clean, straight, some stones and weeds	0.035	High grass
	Reach 2	1209				HWY 416 Southbound		
	Reach 2	1210	0.050	Scattered brush	0.035	Clean, straight, some stones and weeds	0.060	Light brush
	Reach 2	1215	0.055	Field crop/med brush	0.035	Clean, straight, some stones and weeds	0.050	Field crop/light brush
	Reach 2	1220	0.055	Field crop/med brush	0.045	Clean, winding, some stones and weeds	0.045	Field crop/light brush
	Reach 2	1225	0.040	Field crop/high grass	0.045	Clean, winding, some stones and weeds	0.045	Field crop/scattered brush
	Reach 2	1230	0.045	High grass/scattered brush	0.035	Clean, straight, some stones and weeds	0.045	High grass/scattered brush
	Reach 2	1235	0.045	Field crop/scattered brush	0.035	Clean, straight, some stones and weeds	0.045	High grass/scattered brush
	Reach 2	1240	0.040	Field crop/high grass	0.035	Clean, straight, some stones and weeds	0.045	High grass/scattered brush
	Reach 2	1241				3rd Line Road South		
	Reach 2	1245	0.060	Light brush	0.035	Clean, straight, some stones and weeds	0.060	Light brush
	Reach 2	1250	0.045	Field crop/scattered brush	0.035	Clean, straight, some stones and weeds	0.045	Field crop/scattered brush
	Reach 2	1255	0.045	Field crop/scattered brush	0.035	Clean, straight, some stones and weeds	0.045	Field crop/scattered brush
	Reach 2	1260	0.045	Field crop/scattered brush	0.035	Clean, straight, some stones and weeds	0.045	Field crop/scattered brush
	Reach 2	1263				6530 3rd Line Road South		
	Reach 2	1265	0.060	Light brush	0.035	Clean, straight, some stones and weeds	0.060	Light brush
	Reach 2	1270	0.045	Field crop/scattered brush	0.045	Clean, winding, some stones and weeds	0.050	Field crop/light brush
	Reach 2	1275	0.043	High grass/scattered brush	0.045	Clean, winding, some stones and weeds	0.050	Field crop/light brush
	Reach 2	1280	0.065	Scattered/med brush	0.035	Clean, straight, some stones and weeds	0.060	Field crop/med brush
	Reach 2	1285	0.070	Field crop/med brush	0.045	Clean, winding, some stones and weeds	0.055	Field crop/med brush
	Reach 2	1290	0.065	Field crop/med brush	0.045	Clean, winding, some stones and weeds	0.060	Field crop/med brush
	Reach 2	1295	0.040	Short grass/light brush	0.035	Clean, straight, some stones and weeds	0.055	Short grass/med brush
	Reach 2	1300	0.033	Short/high grass	0.035	Clean, straight, some stones and weeds	0.040	Short grass/scattered brush
	Reach 3	1305	0.050	Scattered brush	0.045	Clean, winding, some stones and weeds	0.080	Medium brush
	Reach 3	1310	0.100	Dense brush	0.045	Clean, winding, some stones and weeds	0.100	Dense brush
	Reach 3	1313				Roger Stevens Drive in North Gower		
	Reach 3	1315	0.035	High grass	0.035	Clean, straight, some stones and weeds	0.035	High grass
	Reach 3	1320	0.043	High grass/scattered brush	0.035	Clean, straight, some stones and weeds	0.040	Short grass/scattered brush
	Reach 3	1325	0.043	High grass/scattered brush	0.045	Clean, winding, some stones and weeds	0.040	Short grass/scattered brush
	Reach 3	1330	0.043	High grass/scattered brush	0.045	Clean, winding, some stones and weeds	0.040	Short grass/scattered brush
	Reach 3	1335	0.043	High grass/scattered brush	0.045	Clean, winding, some stones and weeds	0.040	Short grass/scattered brush
	Reach 3	1340	0.043	High grass/scattered brush	0.045	Clean, winding, some stones and weeds	0.040	Short grass/scattered brush
	Reach 3	1345	0.050	Scattered brush	0.045	Clean, winding, some stones and weeds	0.050	Scattered brush
	Reach 3	1348				4th Line Road in North Gower		
	Reach 3	1350	0.035	High grass	0.045	Clean, winding, some stones and weeds	0.035	High grass
	Reach 4	1355	0.060	Light brush	0.045	Clean, winding, some stones and weeds	0.060	Light brush
	Reach 4	1360	0.060	Light brush	0.045	Clean, winding, some stones and weeds	0.060	Light brush
	Reach 4	1363				Church Street		
	Reach 4	1365	0.060	Light brush	0.045	Clean, winding, some stones and weeds	0.060	Light brush
	Reach 4	1370	0.045	Short grass/light brush	0.045	Clean, winding, some stones and weeds	0.045	Short grass/light brush
	Reach 4	1375	0.045	Short grass/light brush	0.045	Clean, winding, some stones and weeds	0.045	Short grass/light brush
	Reach 4	1380	0.045	Field crop/scattered brush	0.045	Clean, winding, some stones and weeds	0.043	Field crop/scattered brush
	Reach 4	1385	0.050	Field crop/light brush	0.045	Clean, winding, some stones and weeds	0.045	Field crop/scattered brush
	Reach 4	1390	0.055	Field crop/light brush	0.045	Clean, winding, some stones and weeds	0.038	Short grass/scattered brush
	Reach 4	1395	0.042	Field crop/scattered brush	0.045	Clean, winding, some stones and weeds	0.043	Field crop/scattered brush
	Reach 4	1400	0.042	Field crop/scattered brush	0.045	Clean, winding, some stones and weeds	0.042	Field crop/scattered brush
	Reach 4	1405	0.045	Field crop/scattered brush	0.045	Clean, winding, some stones and weeds	0.045	Field crop/scattered brush
	Reach 4	1410	0.055	Field crop/light brush	0.045	Clean, winding, some stones and weeds	0.055	Field crop/light brush
	Reach 4	1415	0.040	Short grass/scattered brush	0.045	Clean, winding, some stones and weeds	0.065	Scattered/med brush
	Reach 4	1420	0.100	Dense brush	0.045	Clean, winding, some stones and weeds	0.042	High grass/Light brush
	Reach 4	1423				McCordick Road near Church Street		
	Reach 4	1425	0.035	High grass	0.045	Clean, winding, some stones and weeds	0.035	High grass
	Reach 4	1430	0.050	Short grass/light brush	0.045	Clean, winding, some stones and weeds	0.045	High grass/light brush
	Reach 4	1435	0.065	Light/med brush	0.035	Clean, straight, some stones and weeds	0.050	Field crop/light brush
	Reach 4	1440	0.055	Field crop/light brush	0.035	Clean, straight, some stones and weeds	0.070	Field crop/med brush

River	Reach	Xsec ID #	Left Bank n	Left Bank Description	Channel n	Channel Description	Right Bank n	Right Bank Description
	Reach 4	1445	0.065	Field crop/med brush	0.035	Clean, straight, some stones and weeds	0.055	Field crop/light brush
Stevens Creek	Reach 4	1450	0.045	Field crop/scattered brush	0.045	Clean, winding, some stones and weeds	0.070	Field crop/med brush
	Reach 4	1455	0.045	Field crop/scattered brush	0.035	Clean, straight, some stones and weeds	0.055	Field crop/light brush
	Reach 4	1460	0.042	Field crop/scattered brush	0.035	Clean, straight, some stones and weeds	0.042	Field crop/scattered brush
	Reach 4	1465	0.055	Field crop/light brush	0.035	Clean, straight, some stones and weeds	0.042	Field crop/scattered brush
	Reach 4	1470	0.042	Field crop/scattered brush	0.045	Clean, winding, some stones and weeds	0.050	Field crop/light brush
	Reach 4	1475	0.052	Field crop/light brush	0.045	Clean, winding, some stones and weeds	0.048	Field crop/scattered brush
	Reach 4	1480	0.045	Field crop/scattered brush	0.045	Clean, winding, some stones and weeds	0.045	Field crop/scattered brush
	Reach 4	1485	0.080	Medium brush	0.035	Clean, straight, some stones and weeds	0.100	Dense brush
	Reach 4	1490	0.050	High grass/Light brush	0.035	Clean, straight, some stones and weeds	0.055	Scattered/light brush
	Reach 4	1495	0.100	Dense brush	0.035	Clean, straight, some stones and weeds	0.080	Medium brush
	Reach 4	1500	0.080	Medium brush	0.035	Clean, straight, some stones and weeds	0.080	Medium brush
	Reach 4	1505	0.080	Medium brush	0.035	Clean, straight, some stones and weeds	0.080	Medium brush
	Reach 4	1510	0.100	Dense brush	0.035	Clean, straight, some stones and weeds	0.100	Dense brush
	Reach 4	1513				Malakoff road near Pierce Road		
	Reach 4	1515	0.100	Dense brush	0.045	Clean, winding, some stones and weeds	0.100	Dense brush
	Reach 4	1520	0.050	Field crop/light brush	0.045	Clean, winding, some stones and weeds	0.080	Medium brush
	Reach 4	1525	0.060	Field crop/med brush	0.045	Clean, winding, some stones and weeds	0.070	Light/med brush
Tributary A	Reach 1	2100	0.055	Short grass/light brush	0.045	Clean, winding, some stones and weeds	0.080	Medium brush
	Reach 1	2105	0.055	Short grass/light brush	0.045	Clean, winding, some stones and weeds	0.080	Medium brush
	Reach 1	2110	0.052	Short grass/light brush	0.045	Clean, winding, some stones and weeds	0.058	Field crop/light brush
	Reach 1	2115	0.048	High grass/light brush	0.050	Channel not maintained, clean bottom, brush on sides	0.045	Field crop/scattered brush
	Reach 1	2120	0.045	High grass/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.045	Field crop/scattered brush
	Reach 1	2125	0.044	High grass/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.043	Field crop/scattered brush
	Reach 1	2130	0.044	High grass/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.043	Field crop/scattered brush
	Reach 1	2133				Roger Stevens Drive at 2nd Line Road South		
	Reach 1	2135	0.035	High grass	0.050	Channel not maintained, clean bottom, brush on sides	0.035	High grass
	Reach 1	2140	0.040	Field crop	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crop
	Reach 1	2145	0.040	Field crop	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crop
	Reach 1	2148				2nd Line Road South at Roger Stevens Drive		
	Reach 1	2150	0.035	High grass	0.050	Channel not maintained, clean bottom, brush on sides	0.035	High grass
	Reach 1	2151	0.040	Short grass/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.044	Field crop/scattered brush
	Reach 1	2155	0.048	High grass/light brush	0.050	Channel not maintained, clean bottom, brush on sides	0.044	Field crop/scattered brush
	Reach 1	2160	0.055	High grass/med brush	0.050	Channel not maintained, clean bottom, brush on sides	0.044	Field crop/scattered brush
	Reach 1	2165	0.055	High grass/med brush	0.050	Channel not maintained, clean bottom, brush on sides	0.055	High grass/med brush
	Reach 1	2170	0.045	Field crop/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.050	Field crop/lightbrush
	Reach 1	2171	0.045	Field crop/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.045	Field crop/scattered brush
	Reach 1	2175	0.044	Field crop/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.044	Field crop/scattered brush
	Reach 1	2178				HWY 416		
	Reach 1	2180	0.040	High grass/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.040	High grass/scattered brush
	Reach 1	2181	0.045	Field crop/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.060	Light brush
	Reach 1	2185	0.045	Field crop/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.050	Field crop/light brush
	Reach 1	2190	0.040	Field crop	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crop
	Reach 1	2195	0.040	Field crop	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crop
	Reach 1	2200	0.040	Field crop	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crop
	Reach 1	2205	0.040	Field crop	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crop
	Reach 1	2210	0.040	Field crop	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crop
	Reach 1	2213				Roger Stevens Drive and 3rd Line Road South		
	Reach 1	2215	0.035	High grass	0.050	Channel not maintained, clean bottom, brush on sides	0.035	High grass
	Reach 1	2220	0.035	High grass	0.050	Channel not maintained, clean bottom, brush on sides	0.030	Short grass
	Reach 1	2221	0.038	Field crop/high grass	0.050	Channel not maintained, clean bottom, brush on sides	0.030	Short grass
	Reach 1	2225	0.040	Field crop	0.050	Channel not maintained, clean bottom, brush on sides	0.030	Short grass
Tributary B	Reach 1	3100	0.040	Short grass/scattered brush	0.040	Channel not maintained, clean bottom, brush on sides	0.050	Scattered brush
	Reach 1	3105	0.045	Short grass/scattered brush	0.045	Channel not maintained, clean bottom, brush on sides	0.050	Short grass/light brush
	Reach 1	3110	0.050	Short grass/light brush	0.050	Channel not maintained, clean bottom, brush on sides	0.080	Medium brush
	Reach 1	3115	0.080	Medium brush	0.050	Channel not maintained, clean bottom, brush on sides	0.080	Medium brush
	Reach 1	3118				James Craig Street		
	Reach 1	3120	0.080	Medium brush	0.050	Channel not maintained, clean bottom, brush on sides	0.060	Light brush
	Reach 1	3125	0.045	Short grass/light brush	0.050	Channel not maintained, clean bottom, brush on sides	0.045	Short grass/light brush
	Reach 1	3130	0.045	Short grass/light brush	0.050	Channel not maintained, clean bottom, brush on sides	0.045	Short grass/light brush
	Reach 1	3135	0.060	Light brush	0.045	Channel not maintained, clean bottom, brush on sides	0.060	Light brush
	Reach 1	3138				Prince of Wales Drive		
	Reach 1	3140	0.035	High grass	0.045	Channel not maintained, clean bottom, brush on sides	0.045	Short grass/scattered brush
	Reach 1	3145	0.045	Field crops/med brush	0.045	Channel not maintained, clean bottom, brush on sides	0.042	Short grass/scattered brush
	Reach 1	3150	0.065	Field crops/med brush	0.045	Channel not maintained, clean bottom, brush on sides	0.040	Short grass/scattered brush
	Reach 1	3155	0.040	Field crops	0.045	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
	Reach 1	3160	0.040	Field crops	0.045	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
	Reach 1	3165	0.048	Field crops/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.048	Field crops/scattered brush
	Reach 1	3170	0.050	Short grass/light brush	0.045	Channel not maintained, clean bottom, brush on sides	0.048	Short grass/scattered brush
	Reach 1	3175	0.045	Short grass/scattered brush	0.045	Channel not maintained, clean bottom, brush on sides	0.045	Short grass/scattered brush
	Reach 1	3178				Edward Kidd Park Ped Bridge		
	Reach 1	3180	0.050	Short grass/light brush	0.045	Channel not maintained, clean bottom, brush on sides	0.050	Short grass/light brush
	Reach 1	3185	0.050	Short grass/light brush	0.045	Channel not maintained, clean bottom, brush on sides	0.052	High grass/light brush
	Reach 1	3190	0.048	Short grass/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.055	High grass/light brush
	Reach 1	3195	0.050	Short grass/light brush	0.050	Channel not maintained, clean bottom, brush on sides	0.048	Field crops/scattered brush
	Reach 1	3200	0.048	Field crops/scattered brush	0.045	Channel not maintained, clean bottom, brush on sides	0.048	High grass/scattered brush
	Reach 1	3205	0.040	Field crops	0.045	Channel not maintained, clean bottom, brush on sides	0.035	Short grass
	Reach 1	3210	0.040	Short grass/scattered brush	0.045	Channel not maintained, clean bottom, brush on sides	0.045	High grass/scattered brush
	Reach 1	3213				4th Line Road near Shellstar Drive		
	Reach 1	3215	0.035	High grass	0.050	Channel not maintained, clean bottom, brush on sides	0.035	High grass
	Reach 1	3220	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.041	Field crops/scattered brush
	Reach 1	3225	0.042	Field crops/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.041	Field crops/scattered brush
	Reach 1	3230	0.042	Field crops/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.042	Field crops/scattered brush
	Reach 1	3235	0.043	Field crops/light brush	0.050	Channel not maintained, clean bottom, brush on sides	0.041	Field crops/scattered brush

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River	Reach	Xsec ID	Left Bank		Channel		Right Bank	
		#	n	Description	n	Description	n	Description
	Reach 1	3240	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.070	Field crops/dense brush
	Reach 1	3245	0.043	Field crops/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3250	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3255	0.040	Field crops	0.045	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3260	0.040	Field crops	0.045	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3265	0.040	Field crops	0.045	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3270	0.042	Field crops/scattered brush	0.045	Channel not maintained, clean bottom, brush on sides	0.042	Field crops/scattered brush
Tributary B	Reach 1	3275	0.045	Field crops/scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.058	Field crops/dense brush
Tributary B	Reach 1	3280	0.070	Field crops/dense brush	0.048	Channel not maintained, clean bottom, brush on sides	0.085	High grass/dense brush
Tributary B	Reach 1	3285	0.040	Field crops	0.045	Channel not maintained, clean bottom, brush on sides	0.085	High grass/dense brush
Tributary B	Reach 1	3288	McCordick Road North of Roger Stevens Drive					
Tributary B	Reach 1	3290	0.035	High grass	0.045	Channel not maintained, clean bottom, brush on sides	0.035	High grass
Tributary B	Reach 1	3295	0.040	Field crops	0.045	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3300	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.055	Field crops/med brush
Tributary B	Reach 1	3301	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.055	Field crops/med brush
Tributary B	Reach 1	3305	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3306	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3310	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3315	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3320	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3321	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3325	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3326	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3330	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3335	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3340	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary B	Reach 1	3343	Malakoff Road near Pollock Road					
Tributary B	Reach 1	3345	0.035	High grass	0.050	Channel not maintained, clean bottom, brush on sides	0.035	High grass
Tributary B	Reach 1	3350	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.035	High grass
Tributary B	Reach 1	3355	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.035	High grass
Tributary C	Reach 1	4100	0.080	Medium brush	0.040	Channel not maintained, clean bottom, brush on sides	0.080	Medium brush
Tributary C	Reach 1	4105	0.080	Medium brush	0.040	Channel not maintained, clean bottom, brush on sides	0.080	Medium brush
Tributary C	Reach 1	4110	0.050	Field crops/light brush	0.040	Channel not maintained, clean bottom, brush on sides	0.045	Short grass/light brush
Tributary C	Reach 1	4115	0.050	Field crops/light brush	0.045	Channel not maintained, clean bottom, brush on sides	0.050	Field crops/light brush
Tributary C	Reach 1	4120	0.040	Field crops	0.045	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary C	Reach 1	4125	0.042	Field crops/ scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.042	Field crops/ scattered brush
Tributary C	Reach 1	4130	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary C	Reach 1	4135	0.040	Field crops	0.050	Channel not maintained, clean bottom, brush on sides	0.042	Field crops/ scattered brush
Tributary C	Reach 1	4140	0.042	Field crops/ scattered brush	0.050	Channel not maintained, clean bottom, brush on sides	0.040	Field crops
Tributary C	Reach 1	4145	0.070	Field crops/dense brush	0.050	Channel not maintained, clean bottom, brush on sides	0.070	Field crops/dense brush

Table B2 HEC-RAS Detailed Output

HEC-RAS Plan: V22 Profile: 100yr

River	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)	
Stevens Creek	Reach 1	1100	100yr	102.55	83.71	85.50	85.30	85.75	0.006259	2.21	46.47	123.70	0.72
Stevens Creek	Reach 1	1105	100yr	102.55	83.98	85.93	85.39	86.12	0.002777	1.93	53.23	62.16	0.51
Stevens Creek	Reach 1	1110	100yr	102.55	83.67	85.98	85.41	86.22	0.002963	2.17	47.33	63.83	0.54
Stevens Creek	Reach 1	1113		Bridge									
Stevens Creek	Reach 1	1115	100yr	102.55	83.72	86.34	85.02	86.39	0.000493	1.01	103.14	82.29	0.23
Stevens Creek	Reach 1	1120	100yr	102.55	83.58	86.51	85.18	86.53	0.000403	0.69	192.40	404.50	0.16
Stevens Creek	Reach 1	1125	100yr	102.55	83.31	86.58		86.61	0.000375	0.86	141.91	533.22	0.20
Stevens Creek	Reach 1	1130	100yr	102.55	83.40	86.67		86.69	0.000258	0.76	189.67	278.76	0.17
Stevens Creek	Reach 1	1135	100yr	102.55	83.52	86.71		86.75	0.000412	0.96	163.18	377.13	0.21
Stevens Creek	Reach 1	1140	100yr	102.55	83.45	86.84		86.88	0.000374	0.90	195.51	223.89	0.20
Stevens Creek	Reach 1	1145	100yr	102.55	83.52	86.99	85.51	87.04	0.000913	1.12	115.92	196.01	0.24
Stevens Creek	Reach 2	1150	100yr	90.51	83.84	87.10	85.40	87.14	0.000610	0.92	98.47	305.92	0.20
Stevens Creek	Reach 2	1151		Bridge									
Stevens Creek	Reach 2	1155	100yr	90.51	83.74	87.22	85.43	87.24	0.000204	0.72	158.90	548.05	0.15
Stevens Creek	Reach 2	1160	100yr	90.51	83.76	87.26	85.42	87.27	0.000111	0.56	278.14	458.09	0.11
Stevens Creek	Reach 2	1165	100yr	90.51	84.17	87.31	85.66	87.32	0.000296	0.67	196.82	439.57	0.14
Stevens Creek	Reach 2	1170	100yr	90.51	83.92	87.38	86.11	87.39	0.000094	0.50	303.70	420.55	0.10
Stevens Creek	Reach 2	1175	100yr	90.51	84.45	87.41	85.98	87.44	0.000423	0.79	144.55	151.84	0.17
Stevens Creek	Reach 2	1180	100yr	90.51	84.38	87.49	86.00	87.56	0.000660	1.20	96.78	85.38	0.26
Stevens Creek	Reach 2	1185	100yr	90.51	82.95	87.60	85.06	87.60	0.000078	0.42	311.76	230.16	0.08
Stevens Creek	Reach 2	1186		Bridge									
Stevens Creek	Reach 2	1190	100yr	90.51	84.27	87.95	85.91	87.97	0.000165	0.77	244.08	281.37	0.14
Stevens Creek	Reach 2	1195	100yr	90.51	85.19	87.93	86.82	88.09	0.002146	1.85	55.23	29.41	0.38
Stevens Creek	Reach 2	1200	100yr	90.51	84.42	88.18	85.99	88.21	0.000327	0.80	135.29	172.14	0.15
Stevens Creek	Reach 2	1205	100yr	90.51	84.27	88.21	86.11	88.27	0.000328	1.10	90.82	378.68	0.20
Stevens Creek	Reach 2	1206		Bridge									
Stevens Creek	Reach 2	1207	100yr	90.51	84.30	88.24	86.57	88.31	0.000524	1.19	75.87	36.37	0.24
Stevens Creek	Reach 2	1207.5	100yr	90.51	84.30	88.24	86.54	88.32	0.000543	1.25	72.59	181.33	0.25
Stevens Creek	Reach 2	1208	100yr	90.51	84.30	88.23	86.66	88.33	0.000702	1.39	65.32	47.49	0.28
Stevens Creek	Reach 2	1209		Bridge									
Stevens Creek	Reach 2	1210	100yr	90.51	84.32	88.35	86.02	88.37	0.000180	0.76	140.78	584.25	0.14
Stevens Creek	Reach 2	1215	100yr	90.51	84.65	88.38	86.11	88.40	0.000157	0.71	153.70	475.64	0.13
Stevens Creek	Reach 2	1220	100yr	90.51	84.60	88.46	86.49	88.47	0.000089	0.40	355.29	650.18	0.08
Stevens Creek	Reach 2	1225	100yr	90.51	85.37	88.52		88.57	0.000601	1.10	95.38	48.42	0.21
Stevens Creek	Reach 2	1230	100yr	87.98	85.07	88.61	86.57	88.62	0.000030	0.30	659.76	730.87	0.06
Stevens Creek	Reach 2	1235	100yr	87.98	85.15	88.62	86.68	88.62	0.000031	0.30	654.70	729.93	0.06
Stevens Creek	Reach 2	1240	100yr	87.98	84.45	88.62	86.14	88.62	0.000022	0.26	683.60	734.16	0.05
Stevens Creek	Reach 2	1241		Bridge									
Stevens Creek	Reach 2	1245	100yr	87.98	85.18	88.64	86.75	88.64	0.000045	0.38	608.37	740.35	0.07
Stevens Creek	Reach 2	1250	100yr	87.98	85.19	88.65	86.93	88.65	0.000046	0.40	499.74	577.94	0.07
Stevens Creek	Reach 2	1255	100yr	87.98	85.13	88.66	87.09	88.67	0.000052	0.40	491.41	520.38	0.08
Stevens Creek	Reach 2	1260	100yr	87.98	84.46	88.67	86.40	88.68	0.000057	0.47	414.87	459.85	0.08
Stevens Creek	Reach 2	1263		Bridge									
Stevens Creek	Reach 2	1265	100yr	87.98	85.11	88.78	87.19	88.79	0.000096	0.58	449.41	472.62	0.11
Stevens Creek	Reach 2	1270	100yr	87.98	85.20	88.80	87.16	88.81	0.000226	0.69	221.56	421.50	0.12
Stevens Creek	Reach 2	1275	100yr	87.98	85.27	88.84	87.55	88.86	0.000234	0.67	189.87	175.59	0.12
Stevens Creek	Reach 2	1280	100yr	87.98	85.81	88.86	87.68	88.92	0.000712	1.40	103.84	153.12	0.28
Stevens Creek	Reach 2	1285	100yr	87.98	85.62	88.97	87.59	88.97	0.000081	0.36	414.99	403.74	0.07
Stevens Creek	Reach 2	1290	100yr	87.98	85.58	88.99	87.95	89.00	0.000237	0.62	271.07	237.95	0.12
Stevens Creek	Reach 2	1295	100yr	87.98	85.79	89.02		89.11	0.000769	1.53	84.93	63.60	0.29
Stevens Creek	Reach 2	1300	100yr	87.98	85.82	89.15	87.65	89.16	0.000089	0.45	232.08	209.69	0.10
Stevens Creek	Reach 3	1305	100yr	57.25	85.41	89.15	86.80	89.17	0.000149	0.54	129.07	186.26	0.10
Stevens Creek	Reach 3	1310	100yr	57.25	85.98	89.15	87.41	89.20	0.000626	1.02	57.98	186.73	0.20
Stevens Creek	Reach 3	1313		Bridge									
Stevens Creek	Reach 3	1315	100yr	57.25	86.08	89.29	87.44	89.31	0.000160	0.70	88.97	247.24	0.14
Stevens Creek	Reach 3	1320	100yr	57.25	86.07	89.31	87.46	89.32	0.000045	0.37	226.55	255.03	0.07
Stevens Creek	Reach 3	1325	100yr	57.25	85.77	89.32	87.36	89.32	0.000059	0.33	235.93	186.66	0.06
Stevens Creek	Reach 3	1330	100yr	57.25	86.16	89.32	87.95	89.33	0.000088	0.37	184.01	138.40	0.08
Stevens Creek	Reach 3	1335	100yr	57.25	85.99	89.33	87.89	89.34	0.000233	0.59	105.61	147.62	0.12
Stevens Creek	Reach 3	1340	100yr	57.25	85.72	89.27	88.10	89.41	0.002467	1.71	35.99	54.39	0.37
Stevens Creek	Reach 3	1345	100yr	57.25	86.21	89.44	87.35	89.48	0.000337	0.84	70.13	42.02	0.16
Stevens Creek	Reach 3	1348		Bridge									
Stevens Creek	Reach 3	1350	100yr	57.25	85.46	89.47	87.14	89.49	0.000253	0.74	79.70	43.23	0.13
Stevens Creek	Reach 4	1355	100yr	53.42	86.34	89.48	88.07	89.54	0.000824	1.16	57.54	92.66	0.23
Stevens Creek	Reach 4	1360	100yr	53.42	86.57	89.49	88.03	89.59	0.001204	1.45	37.87	47.08	0.28
Stevens Creek	Reach 4	1363		Bridge									
Stevens Creek	Reach 4	1365	100yr	53.42	86.66	89.55	87.92	89.62	0.000881	1.23	45.13	24.96	0.24
Stevens Creek	Reach 4	1370	100yr	53.42	85.78	89.62	87.42	89.66	0.000406	0.91	69.16	59.57	0.16
Stevens Creek	Reach 4	1375	100yr	53.42	86.20	89.66	87.60	89.68	0.000251	0.71	95.57	107.94	0.13
Stevens Creek	Reach 4	1380	100yr	53.42	86.28	89.69	87.58	89.70	0.000031	0.24	305.19	338.98	0.05
Stevens Creek	Reach 4	1385	100yr	53.42	86.33	89.70	87.62	89.71	0.000108	0.43	154.40	178.12	0.09
Stevens Creek	Reach 4	1390	100yr	53.42	86.60	89.73	88.02	89.73	0.000055	0.29	306.42	543.12	0.06
Stevens Creek	Reach 4	1395	100yr	53.42	86.70	89.74	88.08	89.74	0.000010	0.12	630.38	709.32	0.03
Stevens Creek	Reach 4	1400	100yr	53.42	86.67	89.75	88.07	89.75	0.000042	0.25	325.41	443.23	0.05
Stevens Creek	Reach 4	1405	100yr	53.42	86.85	89.75		89.79	0.000692	1.02	62.93	45.84	0.21
Stevens Creek	Reach 4	1410	100yr	53.42	86.81	89.88		89.89	0.000226	0.60	140.21	136.48	0.12
Stevens Creek	Reach 4	1415	100yr	53.42	86.75	89.91	88.51	89.91	0.000091	0.41	179.11	127.46	0.08
Stevens Creek	Reach 4	1420	100yr	46.65	86.51	89.92	87.95	89.92	0.000131	0.46	178.97	188.81	0.09
Stevens Creek	Reach 4	1423		Bridge									
Stevens Creek	Reach 4	1425	100yr	46.65	86.51	90.09	87.92	90.09	0.000074	0.39	194.80	240.98	0.07
Stevens Creek	Reach 4	1430	100yr	46.65	86.99	90.10		90.10	0.000116	0.46	151.46	101.85	0.09
Stevens Creek	Reach 4	1435	100yr	46.65	87.17	90.10		90.12	0.000230	0.81	83.22	52.51	0.16
Stevens Creek	Reach 4	1440	100yr	46.65	86.79	90.15	88.13	90.16	0.000079	0.49	167.60	195.72	0.09
Stevens Creek	Reach 4	1445	100yr	46.65	87.02	90.18	88.43	90.19	0.000046	0.35	242.26	581.20	0.07
Stevens Creek	Reach 4	1450	100yr	46.65	87.27	90.21	88.58	90.22	0.000227	0.61	133.50	170.91	0.12
Stevens Creek	Reach 4	1455	100yr	46.65	87.63	90.26	88.36	90.26	0.000039	0.31	239.86	382.97	0.07
Stevens Creek	Reach 4	1460	100yr	46.65	87.62	90.26	88.66	90.27	0.000066	0.39	176.14	251.44	0.08
Stevens Creek	Reach 4	1465	100yr	46.65	87.21	90.28	88.91	90.29	0.000116	0.51	149.46	377.26	0.11

HEC-RAS Plan: V22 Profile: 100yr (Continued)

River	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)	
Stevens Creek	Reach 4	1470	100yr	37.84	87.68	90.31	88.90	90.31	0.000116	0.37	132.28	288.68	0.08
Stevens Creek	Reach 4	1475	100yr	37.84	87.95	90.34	89.05	90.34	0.000115	0.35	127.75	459.37	0.08
Stevens Creek	Reach 4	1480	100yr	37.84	88.26	90.41		90.43	0.000619	0.72	64.97	64.88	0.19
Stevens Creek	Reach 4	1485	100yr	37.84	88.13	90.50		90.62	0.002092	1.57	26.80	24.46	0.43
Stevens Creek	Reach 4	1490	100yr	37.84	89.81	91.05		91.31	0.007946	2.28	16.61	19.59	0.78
Stevens Creek	Reach 4	1495	100yr	37.84	90.23	91.84	91.52	92.07	0.004298	2.20	21.12	24.20	0.62
Stevens Creek	Reach 4	1500	100yr	37.84	91.16	92.73	92.32	92.90	0.003268	1.95	30.62	43.54	0.54
Stevens Creek	Reach 4	1505	100yr	18.10	91.51	93.12		93.19	0.001433	1.31	21.35	24.77	0.36
Stevens Creek	Reach 4	1510	100yr	18.10	91.96	93.31	92.80	93.39	0.001924	1.28	14.12	40.24	0.40
Stevens Creek	Reach 4	1513		Bridge									
Stevens Creek	Reach 4	1515	100yr	18.10	92.07	93.52	93.02	93.58	0.002499	1.15	18.42	59.13	0.35
Stevens Creek	Reach 4	1520	100yr	18.10	92.04	93.68		93.69	0.000373	0.47	49.85	96.62	0.14
Stevens Creek	Reach 4	1525	100yr	18.10	92.56	93.84		93.90	0.002932	1.04	18.24	26.48	0.37
Tributary A	Reach 1	2100	100yr	18.89	85.15	87.16		87.17	0.000372	0.62	52.34	55.69	0.15
Tributary A	Reach 1	2105	100yr	18.89	85.11	87.19		87.19	0.000122	0.36	64.65	50.96	0.09
Tributary A	Reach 1	2110	100yr	18.89	85.26	87.21		87.22	0.000200	0.45	61.69	63.81	0.11
Tributary A	Reach 1	2115	100yr	18.89	85.32	87.23	86.19	87.23	0.000054	0.19	120.66	264.39	0.05
Tributary A	Reach 1	2120	100yr	18.89	85.38	87.23	86.12	87.23	0.000044	0.17	137.46	244.30	0.04
Tributary A	Reach 1	2125	100yr	18.89	85.46	87.24	86.34	87.24	0.000114	0.28	77.54	209.85	0.07
Tributary A	Reach 1	2130	100yr	14.45	85.18	87.21	86.55	87.36	0.004645	1.71	8.45	200.37	0.44
Tributary A	Reach 1	2133		Culvert									
Tributary A	Reach 1	2135	100yr	14.45	85.56	87.95	86.30	87.95	0.000001	0.04	345.28	247.60	0.01
Tributary A	Reach 1	2140	100yr	14.45	85.45	87.95	86.45	87.95	0.000005	0.07	253.95	265.22	0.02
Tributary A	Reach 1	2145	100yr	14.45	85.48	87.95	86.49	87.95	0.000009	0.10	213.11	205.31	0.02
Tributary A	Reach 1	2148		Culvert									
Tributary A	Reach 1	2150	100yr	14.45	85.88	88.00	86.87	88.00	0.000003	0.05	225.02	148.10	0.01
Tributary A	Reach 1	2151	100yr	14.45	85.58	88.00	86.55	88.00	0.000003	0.06	285.85	222.69	0.01
Tributary A	Reach 1	2155	100yr	14.45	85.35	88.00	86.66	88.00	0.000005	0.07	258.76	208.43	0.02
Tributary A	Reach 1	2160	100yr	14.45	85.59	88.00	86.75	88.00	0.000013	0.11	174.21	192.53	0.03
Tributary A	Reach 1	2165	100yr	14.45	85.76	88.01	86.82	88.01	0.000106	0.29	67.14	82.20	0.07
Tributary A	Reach 1	2170	100yr	14.45	85.73	88.04	87.30	88.04	0.000262	0.39	48.07	89.36	0.10
Tributary A	Reach 1	2171	100yr	14.45	85.87	88.05	87.27	88.06	0.000285	0.42	39.08	100.81	0.11
Tributary A	Reach 1	2175	100yr	14.45	85.80	88.04	87.21	88.12	0.002562	1.27	11.69	168.12	0.33
Tributary A	Reach 1	2178		Culvert									
Tributary A	Reach 1	2180	100yr	13.30	85.85	89.36	87.04	89.36	0.000005	0.09	160.79	153.43	0.02
Tributary A	Reach 1	2181	100yr	13.30	85.91	89.36	87.25	89.37	0.000008	0.11	143.31	132.15	0.02
Tributary A	Reach 1	2185	100yr	13.30	85.92	89.37	87.18	89.37	0.000001	0.04	331.11	168.66	0.01
Tributary A	Reach 1	2190	100yr	13.30	86.16	89.37	87.42	89.37	0.000000	0.02	582.15	327.25	0.00
Tributary A	Reach 1	2195	100yr	13.30	86.41	89.37	88.04	89.37	0.000003	0.06	261.94	215.48	0.01
Tributary A	Reach 1	2200	100yr	13.30	86.65	89.37	88.07	89.37	0.000006	0.07	190.56	174.17	0.02
Tributary A	Reach 1	2205	100yr	13.30	86.38	89.37	87.82	89.37	0.000005	0.07	222.23	221.79	0.02
Tributary A	Reach 1	2210	100yr	13.30	86.67	89.37	88.00	89.37	0.000067	0.28	59.70	71.76	0.06
Tributary A	Reach 1	2213		Culvert									
Tributary A	Reach 1	2215	100yr	11.27	86.91	89.66	88.00	89.67	0.000059	0.25	51.34	51.98	0.05
Tributary A	Reach 1	2220	100yr	11.27	87.25	89.67	88.18	89.67	0.000014	0.11	85.87	70.43	0.03
Tributary A	Reach 1	2221	100yr	11.27	87.26	89.67	88.04	89.67	0.000001	0.03	325.15	263.49	0.01
Tributary A	Reach 1	2225	100yr	11.27	87.27	89.67	87.92	89.67	0.000000	0.02	449.86	283.52	0.00
Tributary B	Reach 1	3100	100yr	28.49	86.38	89.16	88.00	89.16	0.000044	0.25	156.75	130.61	0.06
Tributary B	Reach 1	3105	100yr	28.49	86.43	89.16	87.92	89.17	0.000377	0.68	62.15	63.69	0.15
Tributary B	Reach 1	3110	100yr	28.49	86.49	89.12		89.24	0.002228	1.55	21.34	14.83	0.33
Tributary B	Reach 1	3115	100yr	28.49	86.44	89.26	87.79	89.30	0.000897	0.96	39.72	35.92	0.21
Tributary B	Reach 1	3118		Bridge									
Tributary B	Reach 1	3120	100yr	28.49	86.48	89.53	87.90	89.55	0.000558	0.81	56.02	69.26	0.16
Tributary B	Reach 1	3125	100yr	28.49	86.48	89.57	87.94	89.57	0.000130	0.40	100.70	191.41	0.08
Tributary B	Reach 1	3130	100yr	28.49	86.50	89.58	88.30	89.58	0.000103	0.35	98.57	146.34	0.07
Tributary B	Reach 1	3135	100yr	28.49	86.56	89.58	88.10	89.59	0.000154	0.46	90.61	128.33	0.10
Tributary B	Reach 1	3138		Bridge									
Tributary B	Reach 1	3140	100yr	28.49	86.41	89.66	88.00	89.67	0.000176	0.50	68.23	147.37	0.10
Tributary B	Reach 1	3145	100yr	28.49	86.46	89.68	88.19	89.68	0.000096	0.35	105.78	155.50	0.07
Tributary B	Reach 1	3150	100yr	28.49	86.72	89.69	88.62	89.69	0.000026	0.18	255.02	276.37	0.04
Tributary B	Reach 1	3155	100yr	28.49	86.85	89.69	88.33	89.69	0.000066	0.28	139.95	293.28	0.06
Tributary B	Reach 1	3160	100yr	28.49	87.13	89.71	88.82	89.72	0.000489	0.67	53.67	165.86	0.16
Tributary B	Reach 1	3165	100yr	28.49	87.14	89.80		89.83	0.000724	0.81	47.76	65.36	0.18
Tributary B	Reach 1	3170	100yr	28.49	87.08	89.85		89.90	0.001262	1.14	34.13	49.52	0.27
Tributary B	Reach 1	3175	100yr	28.49	87.12	89.92	88.31	89.93	0.000184	0.47	81.82	83.60	0.11
Tributary B	Reach 1	3178		Bridge									
Tributary B	Reach 1	3180	100yr	28.49	87.14	89.93	88.36	89.94	0.000197	0.52	81.02	83.26	0.11
Tributary B	Reach 1	3185	100yr	28.49	87.18	89.93		89.96	0.000713	0.96	46.06	52.98	0.21
Tributary B	Reach 1	3190	100yr	28.49	87.46	89.93		90.06	0.003196	1.60	19.21	14.51	0.38
Tributary B	Reach 1	3195	100yr	28.49	87.51	90.15		90.17	0.000608	0.79	54.57	55.17	0.17
Tributary B	Reach 1	3200	100yr	28.49	87.54	90.15		90.29	0.002669	1.80	20.56	27.89	0.39
Tributary B	Reach 1	3205	100yr	28.49	88.02	90.48	89.64	90.62	0.002584	1.74	18.20	13.23	0.39
Tributary B	Reach 1	3210	100yr	28.49	88.26	90.68	89.53	90.76	0.001332	1.27	23.43	22.84	0.28
Tributary B	Reach 1	3213		Bridge									
Tributary B	Reach 1	3215	100yr	28.49	88.25	90.78	89.69	90.84	0.001248	1.12	28.00	92.26	0.25
Tributary B	Reach 1	3220	100yr	28.49	88.20	90.88		90.90	0.000506	0.68	66.13	122.06	0.15
Tributary B	Reach 1	3225	100yr	28.49	88.22	90.93		90.96	0.000722	0.85	52.40	111.65	0.19
Tributary B	Reach 1	3230	100yr	28.49	88.27	91.08		91.13	0.001190	1.05	34.06	60.82	0.24
Tributary B	Reach 1	3235	100yr	28.49	88.13	91.30	89.70	91.32	0.000353	0.60	58.61	160.45	0.13
Tributary B	Reach 1	3240	100yr	28.49	88.14	91.36	89.90	91.37	0.000236	0.46	91.69	303.08	0.10
Tributary B	Reach 1	3245	100yr	28.49	88.23	91.47	90.21	91.50	0.001089	0.84	41.56	361.81	0.21
Tributary B	Reach 1	3250	100yr	28.49	88.28	91.58	90.23	91.61	0.000817	0.86	40.04	304.42	0.19
Tributary B	Reach 1	3255	100yr	28.49	88.51	91.72	90.55	91.76	0.000890	0.90	33.81	283.19	0.22
Tributary B	Reach 1	3260	100yr	28.49	88.60	91.79	90.54	91.84	0.001165	1.08	28.03	429.37	0.25
Tributary B	Reach 1	3265	100yr	28.49	88.79	91.94	90.87	91.96	0.000570	0.69	46.09	97.74	0.18
Tributary B	Reach 1	3270	100yr	28.49	89.11	92.04	90.57	92.06	0.000330	0.61	60.54	281.12	0.14
Tributary B	Reach 1	3275	100yr	28.49	89.15	92.16	91.01	92.19	0.000798	0.81	43.56	353.04	0.19
Tributary B	Reach 1	3280	100yr	28.49	89.25	92.31	90.93	92.32	0.000309	0.47	115.44	234.81	0.12

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HEC-RAS Plan: V22   Profile: 100yr (Continued)

River	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)	
Tributary B	Reach 1	3285	100yr	28.49	89.47	92.36	91.06	92.36	0.000120	0.29	136.82	292.91	0.08
Tributary B	Reach 1	3288		Culvert									
Tributary B	Reach 1	3290	100yr	28.49	89.71	92.66	91.39	92.66	0.000021	0.13	237.10	261.96	0.03
Tributary B	Reach 1	3295	100yr	28.49	89.87	92.66	91.81	92.66	0.000009	0.08	467.18	962.79	0.02
Tributary B	Reach 1	3300	100yr	28.49	90.15	92.67	91.75	92.67	0.000042	0.16	252.23	716.72	0.04
Tributary B	Reach 1	3301	100yr	28.49	90.70	92.59	92.55	92.77	0.012898	2.11	18.29	46.00	0.69
Tributary B	Reach 1	3305	100yr	28.49	90.90	93.21	92.70	93.26	0.001751	1.20	34.87	72.72	0.28
Tributary B	Reach 1	3306	100yr	28.49	91.25	93.45	93.13	93.51	0.002761	1.32	27.73	120.20	0.34
Tributary B	Reach 1	3310	100yr	28.49	91.40	93.66	93.31	93.66	0.000438	0.50	82.64	249.64	0.13
Tributary B	Reach 1	3315	100yr	28.49	91.50	93.71	93.27	93.72	0.000183	0.29	124.13	261.46	0.09
Tributary B	Reach 1	3320	100yr	28.49	91.75	93.78	93.50	93.78	0.000396	0.44	98.61	274.60	0.13
Tributary B	Reach 1	3321	100yr	28.49	91.99	93.86	93.66	93.88	0.001230	0.69	62.23	271.27	0.22
Tributary B	Reach 1	3325	100yr	28.49	92.24	94.36	94.19	94.42	0.003850	1.22	31.75	78.99	0.38
Tributary B	Reach 1	3326	100yr	28.49	92.49	94.79	94.52	94.82	0.002092	0.92	46.65	132.03	0.27
Tributary B	Reach 1	3330	100yr	28.49	92.57	94.92	94.58	94.93	0.001021	0.76	56.85	161.29	0.20
Tributary B	Reach 1	3335	100yr	27.64	92.88	95.11	94.71	95.14	0.001565	0.87	36.70	155.51	0.25
Tributary B	Reach 1	3340	100yr	27.64	92.89	95.16	94.52	95.35	0.005052	1.93	14.35	103.69	0.48
Tributary B	Reach 1	3343		Culvert									
Tributary B	Reach 1	3345	100yr	27.64	92.85	95.75	94.61	95.75	0.000086	0.27	114.98	122.27	0.06
Tributary B	Reach 1	3350	100yr	27.64	93.15	95.76		95.76	0.000109	0.30	108.89	118.18	0.07
Tributary B	Reach 1	3355	100yr	27.64	93.15	95.76		95.77	0.000196	0.36	88.94	109.99	0.09
Tributary C	Reach 1	4100	100yr	14.52	86.97	89.51	87.92	89.51	0.000085	0.38	81.02	106.48	0.08
Tributary C	Reach 1	4105	100yr	14.52	87.00	89.51	87.90	89.51	0.000070	0.35	109.38	137.65	0.08
Tributary C	Reach 1	4110	100yr	14.52	87.09	89.52	88.41	89.52	0.000023	0.17	141.78	164.93	0.04
Tributary C	Reach 1	4115	100yr	14.52	87.54	89.53	88.69	89.53	0.000045	0.20	128.22	235.31	0.05
Tributary C	Reach 1	4120	100yr	14.52	87.67	89.53	88.66	89.53	0.000018	0.12	157.13	310.29	0.03
Tributary C	Reach 1	4125	100yr	14.52	87.83	89.53	88.91	89.53	0.000007	0.06	322.86	648.66	0.02
Tributary C	Reach 1	4130	100yr	14.52	88.05	89.54	88.88	89.54	0.000025	0.10	149.70	254.90	0.03
Tributary C	Reach 1	4135	100yr	14.52	87.95	89.54	89.11	89.55	0.000185	0.27	64.76	329.42	0.08
Tributary C	Reach 1	4140	100yr	14.52	88.20	89.61	89.45	89.62	0.001302	0.60	35.65	193.95	0.21
Tributary C	Reach 1	4145	100yr	14.52	88.22	89.85	89.69	89.87	0.002084	0.77	38.74	204.33	0.27

Appendix C

Field Verification of LIDAR Data

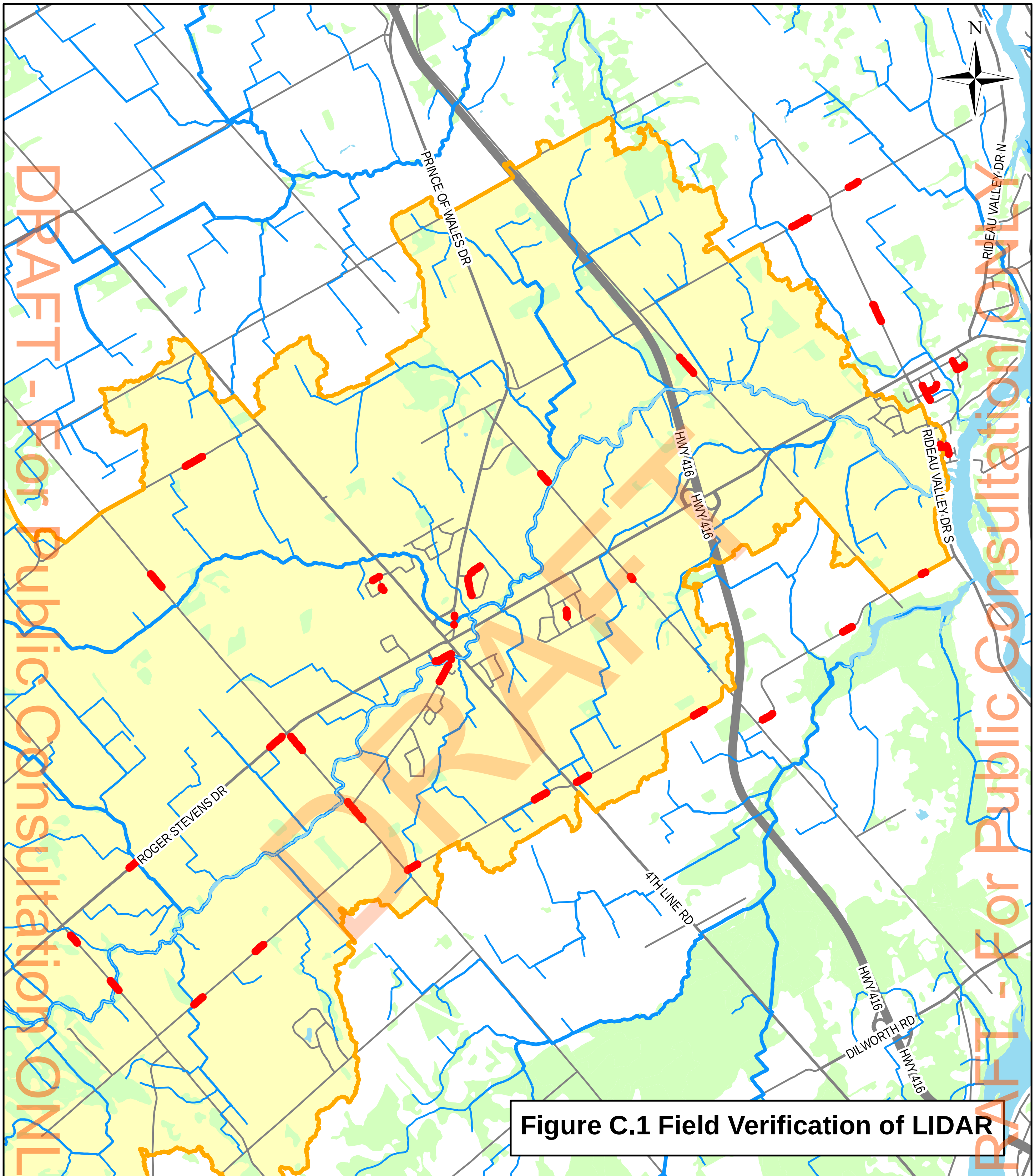

Figure C.1 Field Verification of LIDAR

Rideau Valley Conservation Authority

- Trimble Points
- Wetlands
- Stevens Creek

0 0.5 1 2 Kilometers

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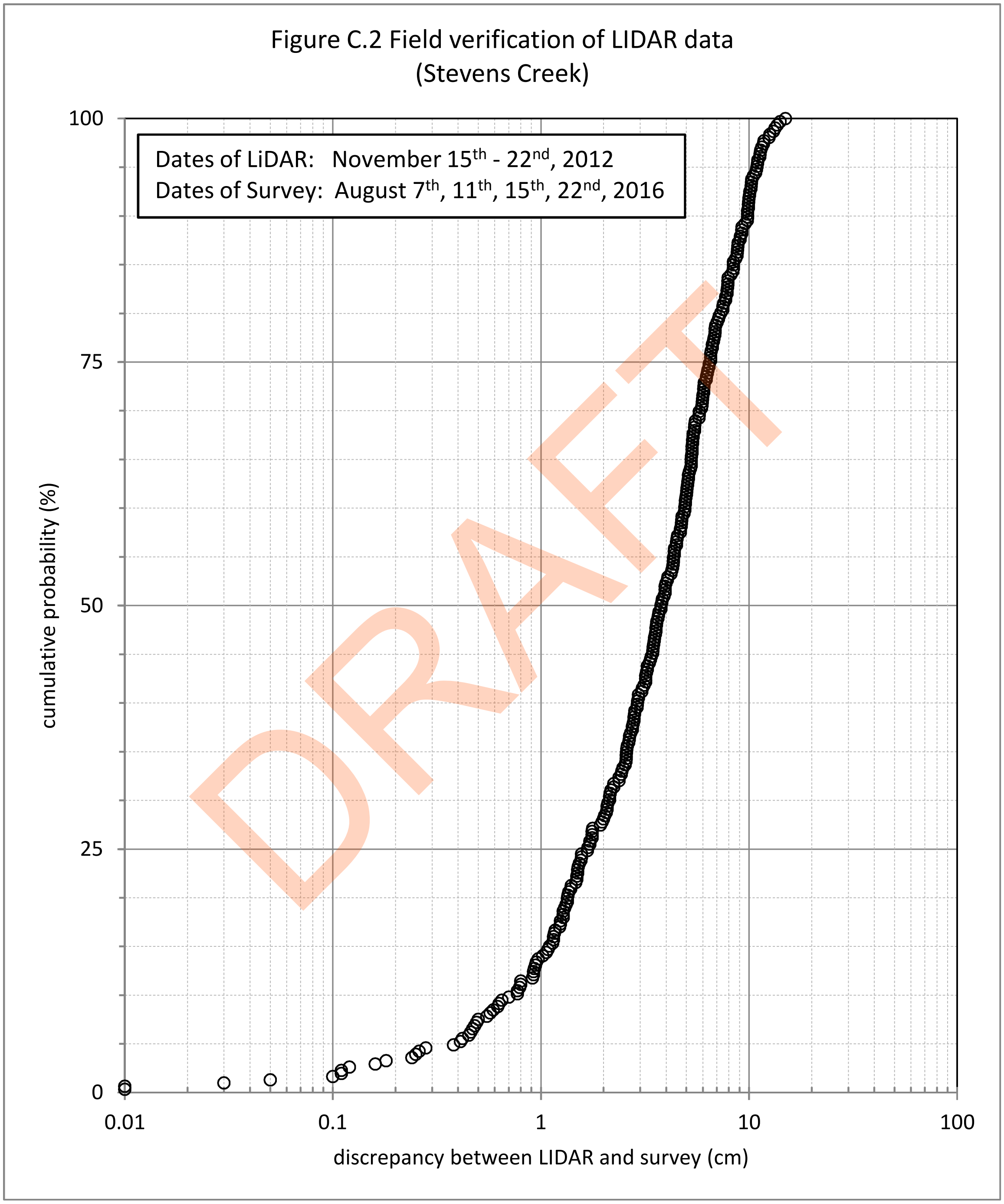
Map Scale: 1:60,000

Date Modified: 21/Oct/2019



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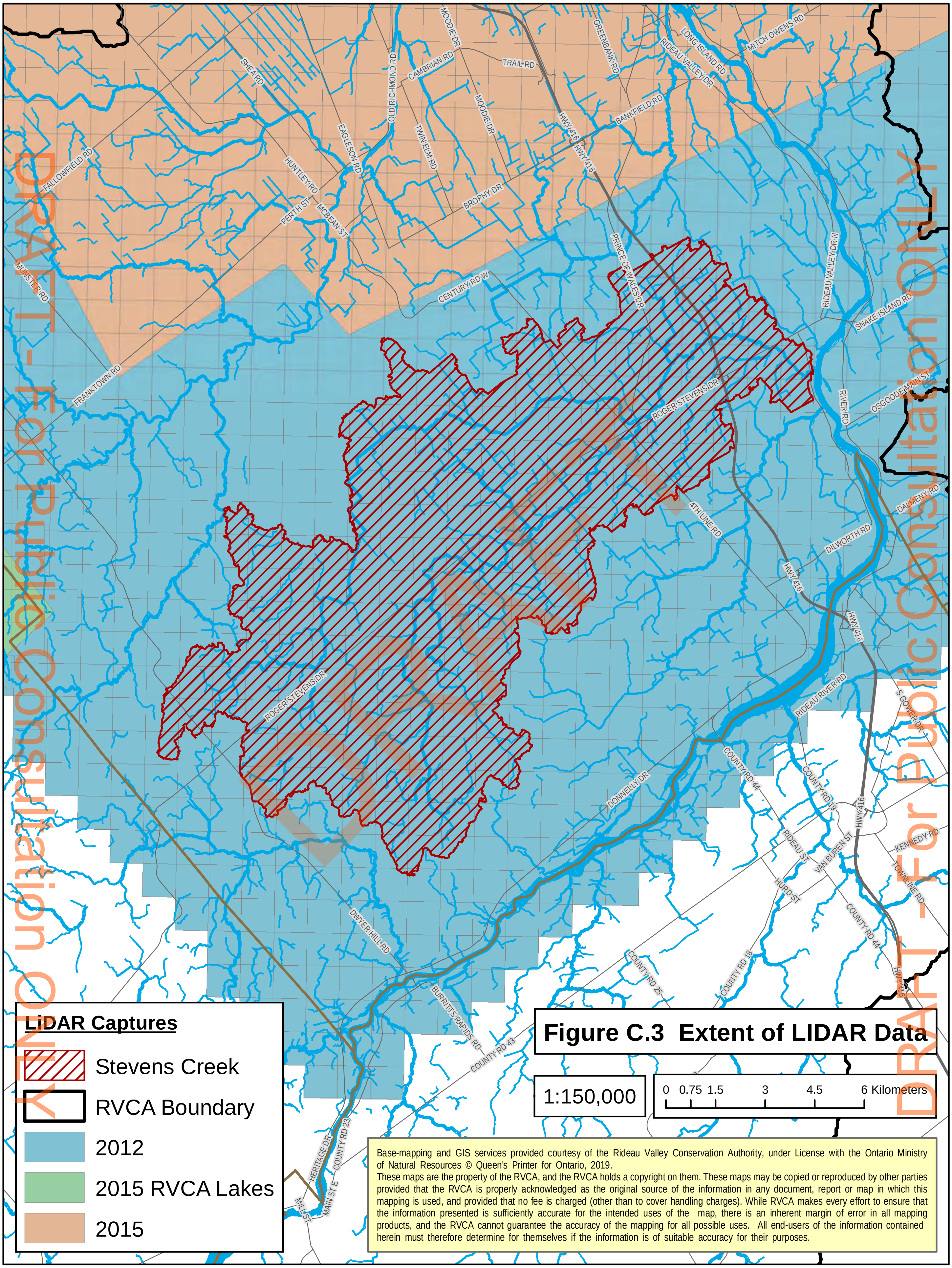

Figure C.3 Extent of LIDAR Data

Table C.1 Field verification of LIDAR data (spot heights)

	RVCA Field Survey (August 3 and 11, 2016)							Nearest Lidar Point	Comparison		
Location ID	X (m)	Y (m)	Z (m)	Horizontal Accuracy (m)	Veritcal Accuracy (m)	Date/Time	Field Observations	Z (m)	△Z (m)	|△Z| (cm)	|△Z| > 0.33m
rollinghill-1	449424.077	5000879.5	88.704	0.01	0.015	3/8/2016 10:50	Road	88.6248	-0.079	7.9	
rollinghill-2	449413.102	5000866.81	88.655	0.01	0.015	3/8/2016 10:51	Road	88.6124	-0.043	4.3	
rollinghill-3	449386.347	5000849.05	88.483	0.013	0.02	3/8/2016 10:52	Road	88.4234	-0.060	6.0	
rollinghill-4	449352.037	5000836.31	88.295	0.013	0.02	3/8/2016 10:53	Road	88.2857	-0.009	0.9	
rollinghill-5	449341.188	5000836.47	88.372	0.013	0.019	3/8/2016 10:53	Road	88.3614	-0.011	1.1	
rollinghill-6	449332.763	5000852.32	88.576	0.013	0.02	3/8/2016 10:54	Road	88.5632	-0.013	1.3	
rollinghill-7	449322.755	5000874.54	89.046	0.013	0.02	3/8/2016 10:54	Road	89.0252	-0.021	2.1	
rollinghill-8	449312.918	5000892.52	89.456	0.014	0.02	3/8/2016 10:55	Road	89.4717	0.016	1.6	
rollinghill-9	449303.516	5000910.16	89.841	0.013	0.02	3/8/2016 10:56	Road	89.7933	-0.048	4.8	
rollinghill-10	449294.17	5000927.44	90.224	0.013	0.02	3/8/2016 10:56	Road	90.2237	0.000	0.0	
rollinghill-11	449099.747	5000628	87.978	0.015	0.02	3/8/2016 11:05	Road	87.9715	-0.007	0.7	
rollinghill-12	449088.244	5000619.49	88.239	0.015	0.02	3/8/2016 11:05	Road	88.1879	-0.051	5.1	
rollinghill-13	449069.445	5000608.76	88.691	0.015	0.018	3/8/2016 11:07	Road	88.6743	-0.017	1.7	
rollinghill-14	449053.803	5000599.83	89.115	0.014	0.019	3/8/2016 11:07	Road	89.0618	-0.053	5.3	
rollinghill-15	449026.116	5000585.41	89.824	0.014	0.019	3/8/2016 11:09	Road	89.8299	0.006	0.6	
rollinghill-16	449007.504	5000577.52	90.268	0.014	0.019	3/8/2016 11:09	Road	90.2652	-0.003	0.3	
rollinghill-17	448994.834	5000585.74	90.36	0.015	0.02	3/8/2016 11:10	Road	90.3195	-0.041	4.1	
rollinghill-18	448983.461	5000605.11	90.161	0.014	0.019	3/8/2016 11:10	Road	90.1278	-0.033	3.3	
rollinghill-19	448975.414	5000619.74	90.013	0.015	0.02	3/8/2016 11:11	Road	89.999	-0.014	1.4	
rollinghill-20	448967.966	5000634.33	89.858	0.013	0.02	3/8/2016 11:13	Road	89.7572	-0.101	10.1	
rollinghill-21	448957.547	5000653.98	89.583	0.014	0.02	3/8/2016 11:14	Road	89.5606	-0.022	2.2	
rollinghill-22	448996.456	5000571.7	90.466	0.014	0.019	3/8/2016 11:17	Road	90.4935	0.027	2.7	
rollinghill-23	449010.538	5000549.81	90.325	0.011	0.015	3/8/2016 11:18	Road	90.3126	-0.012	1.2	
rollinghill-24	449019.323	5000532.03	90.135	0.01	0.018	3/8/2016 11:19	Road	90.1273	-0.008	0.8	
rollinghill-25	449027.144	5000517.4	89.969	0.014	0.019	3/8/2016 11:19	Road	89.9351	-0.034	3.4	
rollinghill-26	449031.959	5000508.26	89.83	0.014	0.02	3/8/2016 11:20	Road	89.801	-0.029	2.9	
rollinghill-27	449039.98	5000499.65	89.595	0.01	0.02	3/8/2016 11:21	Road	89.6082	0.013	1.3	
rollinghill-28	449046.121	5000487.99	89.516	0.01	0.02	3/8/2016 11:23	Road	89.5222	0.006	0.6	
rollinghill-29	449111.82	5000647.37	87.753	0.01	0.02	3/8/2016 11:29	Road	87.7822	0.029	2.9	
rollinghill-30	449114.211	5000668.21	87.54	0.01	0.02	3/8/2016 11:30	Road	87.4949	-0.045	4.5	
westbo-1	449228.53	4999982.22	91.627	0.012	0.019	3/8/2016 11:45	Road	91.6315	0.005	0.5	
westbo-2	449215.01	4999972.22	92.415	0.013	0.02	3/8/2016 11:48	Road	92.3649	-0.050	5.0	
westbo-3	449190.872	4999971.02	92.895	0.011	0.02	3/8/2016 11:50	Road	92.8856	-0.009	0.9	
westbo-4	449178.011	4999968.34	92.635	0.013	0.02	3/8/2016 11:53	Road	92.661	0.026	2.6	
westbo-5	449160.927	4999967.92	92.127	0.013	0.02	3/8/2016 11:55	Road	92.0628	-0.064	6.4	
westbo-6	449155.318	4999995.46	92.996	0.013	0.02	3/8/2016 11:59	Road	92.9678	-0.028	2.8	
westbo-7	449235.321	4999961.65	91.142	0.013	0.02	3/8/2016 12:02	Road	91.1323	-0.010	1.0	
westbo-8	449245.956	4999927.71	90.66	0.013	0.02	3/8/2016 12:06	Road	90.7128	0.053	5.3	

Table C.1 Field verification of LIDAR data (spot heights)

	RVCA Field Survey (August 3 and 11, 2016)							Nearest Lidar Point	Comparison		
Location ID	X (m)	Y (m)	Z (m)	Horizontal Accuracy (m)	Veritcal Accuracy (m)	Date/Time	Field Observations	Z (m)	△Z (m)	|△Z| (cm)	|△Z| > 0.33m
westbo-9	449251.722	4999899.48	90.583	0.012	0.019	3/8/2016 12:06	Road	90.6279	0.045	4.5	
westbo-10	449252.985	4999891.61	90.591	0.013	0.02	3/8/2016 12:08	Road	90.5958	0.005	0.5	
lockhead-1	448950.349	4998558.85	87.099	0.01	0.019	3/8/2016 13:20	Road	87.0822	-0.017	1.7	
lockhead-2	448961.987	4998565.21	87.128	0.01	0.018	3/8/2016 13:21	Road	87.113	-0.015	1.5	
lockhead-3	448978.112	4998573.73	87.167	0.008	0.015	3/8/2016 13:21	Road	87.1446	-0.022	2.2	
lockhead-4	448991.872	4998580.98	87.157	0.009	0.016	3/8/2016 13:22	Road	87.1434	-0.014	1.4	
lockhead-5	448947.132	4998556.83	87.107	0.011	0.019	3/8/2016 13:23	Road	87.0811	-0.026	2.6	
lockhead-6	448124.611	4997942.54	92.781	0.011	0.019	3/8/2016 13:27	Road	92.7316	-0.049	4.9	
lockhead-7	448129.623	4997948.37	92.656	0.011	0.02	3/8/2016 13:27	Road	92.6803	0.024	2.4	
lockhead-8	448139.476	4997951.66	92.677	0.011	0.02	3/8/2016 13:28	Road	92.6445	-0.033	3.3	
lockhead-9	448152.386	4997958.76	92.592	0.011	0.02	3/8/2016 13:29	Road	92.605	0.013	1.3	
lockhead-10	448162.936	4997964.53	92.548	0.011	0.02	3/8/2016 13:29	Road	92.4953	-0.053	5.3	
lockhead-11	448178.268	4997972.82	92.421	0.011	0.02	3/8/2016 13:31	Road	92.3283	-0.093	9.3	
lockhead-12	448119.44	4997939.82	92.834	0.009	0.017	3/8/2016 13:32	Road	92.8027	-0.031	3.1	
lockhead-13	448102.21	4997930.33	92.939	0.01	0.018	3/8/2016 13:33	Road	92.8502	-0.089	8.9	
lockhead-14	448086.525	4997921.03	93.049	0.012	0.02	3/8/2016 13:34	Road	93.0053	-0.044	4.4	
lockhead-15	448072.058	4997912.67	93.229	0.011	0.018	3/8/2016 13:34	Road	93.1032	-0.126	12.6	
lockhead-16	447233.216	4996967	88.435	0.009	0.013	3/8/2016 13:39	Road	88.3803	-0.055	5.5	
lockhead-17	447248.9	4996974.1	88.453	0.011	0.016	3/8/2016 13:40	Road	88.41	-0.043	4.3	
lockhead-18	447258.174	4996979.38	88.574	0.011	0.017	3/8/2016 13:40	Road	88.4716	-0.102	10.2	
lockhead-19	447266.731	4996984.99	88.687	0.014	0.02	3/8/2016 13:41	Road	88.6348	-0.052	5.2	
lockhead-20	447275.191	4996991.23	88.822	0.014	0.02	3/8/2016 13:42	Road	88.7983	-0.024	2.4	
lockhead-21	447290.207	4997006.62	89.199	0.012	0.019	3/8/2016 13:42	Road	89.1323	-0.067	6.7	
lockhead-22	447227.698	4996963.82	88.438	0.01	0.015	3/8/2016 13:44	Road	88.3631	-0.075	7.5	
lockhead-23	447214.463	4996957.43	88.411	0.011	0.016	3/8/2016 13:45	Road	88.3904	-0.021	2.1	
lockhead-24	447199.71	4996949.32	88.394	0.011	0.016	3/8/2016 13:45	Road	88.3436	-0.050	5.0	
lockhead-25	447182.127	4996939.64	88.306	0.01	0.014	3/8/2016 13:46	Road	88.2903	-0.016	1.6	
lockhead-26	446459.607	4997011.5	89.948	0.009	0.014	3/8/2016 13:51	Road	89.8963	-0.052	5.2	
lockhead-27	446468.175	4997015.86	89.957	0.011	0.017	3/8/2016 13:52	Road	89.8441	-0.113	11.3	
lockhead-28	446483.581	4997024.64	89.957	0.012	0.017	3/8/2016 13:52	Road	89.9031	-0.054	5.4	
lockhead-29	446500.178	4997033.9	89.989	0.012	0.017	3/8/2016 13:53	Road	89.9008	-0.088	8.8	
lockhead-30	446515.979	4997042.89	90.051	0.012	0.017	3/8/2016 13:53	Road	89.9409	-0.110	11.0	
lockhead-31	446531.858	4997052.03	90.109	0.011	0.016	3/8/2016 13:54	Road	90.0247	-0.084	8.4	
lockhead-32	446456.257	4997009.16	89.966	0.008	0.012	3/8/2016 13:55	Road	89.905	-0.061	6.1	
lockhead-33	446439.331	4996999.88	89.978	0.011	0.016	3/8/2016 13:56	Road	89.9428	-0.035	3.5	
lockhead-34	446423.649	4996991.12	89.977	0.01	0.017	3/8/2016 13:56	Road	89.902	-0.075	7.5	
lockhead-35	446411.831	4996984.44	89.981	0.011	0.016	3/8/2016 13:57	Road	89.9156	-0.065	6.5	
lockhead-36	445216.496	4996303.6	90.371	0.008	0.012	3/8/2016 14:01	Road	90.289	-0.082	8.2	

Table C.1 Field verification of LIDAR data (spot heights)

	RVCA Field Survey (August 3 and 11, 2016)							Nearest Lidar Point	Comparison		
Location ID	X (m)	Y (m)	Z (m)	Horizontal Accuracy (m)	Veritcal Accuracy (m)	Date/Time	Field Observations	Z (m)	△Z (m)	|△Z| (cm)	|△Z| > 0.33m
lockhead-37	445200.763	4996294.83	90.362	0.01	0.015	3/8/2016 14:02	Road	90.2778	-0.084	8.4	
lockhead-38	445183.236	4996284.73	90.295	0.012	0.018	3/8/2016 14:02	Road	90.2625	-0.033	3.3	
lockhead-39	445166.52	4996275.12	90.232	0.013	0.019	3/8/2016 14:03	Road	90.1635	-0.069	6.9	
lockhead-40	445150.099	4996265.68	90.163	0.013	0.019	3/8/2016 14:03	Road	90.1095	-0.053	5.3	
lockhead-41	445140.433	4996260.31	90.152	0.014	0.02	3/8/2016 14:03	Road	90.1659	0.014	1.4	
lockhead-42	445111.862	4996243.76	90.42	0.013	0.02	3/8/2016 14:04	Road	90.3592	-0.061	6.1	
lockhead-43	445218.401	4996304.21	90.341	0.012	0.019	3/8/2016 14:06	Road	90.241	-0.100	10.0	
lockhead-44	445229.505	4996310.76	90.312	0.012	0.019	3/8/2016 14:08	Road	90.2466	-0.065	6.5	
lockhead-45	445242.15	4996317.85	90.255	0.012	0.019	3/8/2016 14:08	Road	90.2607	0.006	0.6	
lockhead-46	444711.774	4996089.95	89.974	0.009	0.015	3/8/2016 14:12	Road	89.9363	-0.038	3.8	
lockhead-47	444697.343	4996082.57	89.947	0.009	0.015	3/8/2016 14:12	Road	89.936	-0.011	1.1	
lockhead-48	444676.206	4996070.85	90.015	0.011	0.019	3/8/2016 14:13	Road	89.9617	-0.053	5.3	
lockhead-49	444654.837	4996059.49	90.038	0.012	0.02	3/8/2016 14:15	Road	89.9782	-0.060	6.0	
lockhead-50	444643.127	4996052.5	90.062	0.012	0.02	3/8/2016 14:17	Road	90.0015	-0.061	6.1	
lockhead-51	444713.874	4996089.6	89.938	0.012	0.02	3/8/2016 14:19	Road	89.8543	-0.084	8.4	
lockhead-52	444732.993	4996100.79	89.977	0.012	0.02	3/8/2016 14:20	Road	89.8521	-0.125	12.5	
lockhead-53	444747.939	4996109.33	89.977	0.012	0.02	3/8/2016 14:20	Road	89.9506	-0.026	2.6	
lockhead-54	444764.484	4996117.67	90.002	0.011	0.019	3/8/2016 14:21	Road	89.9396	-0.062	6.2	
lockhead-55	444777.747	4996124.91	89.983	0.01	0.017	3/8/2016 14:22	Road	89.8755	-0.108	10.8	
lockhead-56	443296.305	4995305.73	91.072	0.009	0.014	3/8/2016 14:27	Road	90.9669	-0.105	10.5	
lockhead-57	443282.137	4995298.69	91.077	0.008	0.013	3/8/2016 14:27	Road	91.05	-0.027	2.7	
lockhead-58	443266.437	4995290.6	91.069	0.013	0.02	3/8/2016 14:28	Road	91.0035	-0.065	6.5	
lockhead-59	443251.705	4995281.99	91.11	0.011	0.017	3/8/2016 14:28	Road	91.0743	-0.036	3.6	
lockhead-60	443239.112	4995273.78	91.296	0.011	0.017	3/8/2016 14:29	Road	91.2561	-0.040	4.0	
lockhead-61	443231.394	4995269.05	91.591	0.012	0.018	3/8/2016 14:29	Road	91.5333	-0.058	5.8	
lockhead-62	443300.896	4995309	91.049	0.011	0.017	3/8/2016 14:31	Road	90.9702	-0.079	7.9	
lockhead-63	443318.432	4995318.75	91.144	0.011	0.017	3/8/2016 14:31	Road	91.0288	-0.115	11.5	
lockhead-64	443332.533	4995326.61	91.229	0.014	0.019	3/8/2016 14:32	Road	91.1368	-0.092	9.2	
lockhead-65	443346.925	4995333.97	91.289	0.014	0.02	3/8/2016 14:33	Road	91.2267	-0.062	6.2	
malleff-1	439490.452	4994539.65	95.188	0.01	0.016	11/8/2016 14:30	Road	95.0786	-0.109	10.9	
malleff-2	439496.01	4994533.18	95.228	0.015	0.019	11/8/2016 14:32	Road	95.1372	-0.091	9.1	
malleff-3	439501.731	4994526.44	95.248	0.01	0.017	11/8/2016 14:32	Road	95.1376	-0.110	11.0	
malleff-4	439508.982	4994518.08	95.216	0.013	0.019	11/8/2016 14:33	Road	95.1021	-0.114	11.4	
malleff-5	439514.097	4994512.25	95.188	0.014	0.02	11/8/2016 14:33	Road	95.0513	-0.137	13.7	
malleff-6	439527.83	4994496.65	95.089	0.013	0.02	11/8/2016 14:35	Road	95.0215	-0.067	6.7	
malleff-7	439537.914	4994485.08	94.986	0.01	0.017	11/8/2016 14:35	Road	94.9193	-0.067	6.7	
malleff-8	439542.849	4994479.45	94.924	0.01	0.018	11/8/2016 14:36	Road	94.8068	-0.117	11.7	
malleff-9	439550.621	4994470.5	94.872	0.011	0.018	11/8/2016 14:36	Road	94.7633	-0.109	10.9	

Table C.1 Field verification of LIDAR data (spot heights)

	RVCA Field Survey (August 3 and 11, 2016)							Nearest Lidar Point	Comparison		
Location ID	X (m)	Y (m)	Z (m)	Horizontal Accuracy (m)	Veritcal Accuracy (m)	Date/Time	Field Observations	Z (m)	△Z (m)	|△Z| (cm)	|△Z| > 0.33m
malleff-10	439558.631	4994461.37	94.831	0.012	0.019	11/8/2016 14:37	Road	94.8043	-0.027	2.7	
malleff2-1	440021.884	4993931.93	94.739	0.006	0.009	11/8/2016 14:47	Road	94.7112	-0.028	2.8	
malleff2-2	440010.937	4993943.72	94.632	0.007	0.012	11/8/2016 14:48	Road	94.5925	-0.040	4.0	
malleff2-3	440002.181	4993954.02	94.625	0.008	0.012	11/8/2016 14:48	Road	94.5606	-0.064	6.4	
malleff2-4	439992.524	4993965.33	94.588	0.008	0.013	11/8/2016 14:49	Road	94.6202	0.032	3.2	
malleff2-5	439983.052	4993975.88	94.611	0.01	0.015	11/8/2016 14:49	Road	94.5917	-0.019	1.9	
malleff2-6	439972.879	4993987.61	94.564	0.009	0.014	11/8/2016 14:49	Road	94.5365	-0.027	2.7	
malleff2-7	439964.015	4993998.35	94.581	0.011	0.019	11/8/2016 14:50	Road	94.5459	-0.035	3.5	
malleff2-8	439953.097	4994010.72	94.632	0.011	0.017	11/8/2016 14:50	Road	94.5961	-0.036	3.6	
malleff2-9	439942.079	4994023.6	94.758	0.011	0.018	11/8/2016 14:51	Road	94.6878	-0.070	7.0	
malleff2-10	439930.677	4994036.3	94.873	0.013	0.02	11/8/2016 14:52	Road	94.8349	-0.038	3.8	
pierce-1	440862.988	4993776.05	93.281	0.006	0.01	11/8/2016 14:59	Road	93.3717	0.091	9.1	
pierce-2	440872.127	4993784.16	93.25	0.007	0.011	11/8/2016 14:59	Road	93.3484	0.098	9.8	
pierce-3	440879.137	4993790.25	93.219	0.008	0.012	11/8/2016 15:00	Road	93.3171	0.098	9.8	
pierce-4	440889.168	4993799.03	93.155	0.011	0.017	11/8/2016 15:00	Road	93.2581	0.103	10.3	
pierce-5	440901.729	4993809.86	93.062	0.01	0.016	11/8/2016 15:01	Road	93.1352	0.073	7.3	
pierce-6	440913.973	4993820.37	93.005	0.01	0.015	11/8/2016 15:01	Road	93.0823	0.077	7.7	
pierce-7	440926.849	4993832.41	92.961	0.009	0.014	11/8/2016 15:02	Road	93.0117	0.051	5.1	
pierce-8	440936.45	4993840.39	92.945	0.01	0.015	11/8/2016 15:02	Road	93.0578	0.113	11.3	
pierce-9	440948.724	4993851.05	92.92	0.01	0.015	11/8/2016 15:02	Road	92.9892	0.069	6.9	
pierce-10	440958.888	4993857.85	92.853	0.009	0.015	11/8/2016 15:03	Road	92.873	0.020	2.0	
pierce-11	441588.396	4994402.64	93.807	0.008	0.011	11/8/2016 15:08	Road	93.8221	0.015	1.5	
pierce-12	441599.674	4994412.77	93.901	0.008	0.011	11/8/2016 15:08	Road	93.8649	-0.036	3.6	
pierce-13	441611.188	4994422.69	93.945	0.009	0.013	11/8/2016 15:09	Road	93.9475	0.002	0.2	
pierce-14	441623.607	4994433.44	93.983	0.011	0.015	11/8/2016 15:09	Road	94.0124	0.029	2.9	
pierce-15	441630.458	4994439.14	94.043	0.01	0.014	11/8/2016 15:10	Road	94.0254	-0.018	1.8	
pierce-16	441583.921	4994400.01	93.764	0.007	0.009	11/8/2016 15:11	Road	93.8143	0.050	5.0	
pierce-17	441571.143	4994388.16	93.744	0.01	0.014	11/8/2016 15:11	Road	93.7399	-0.004	0.4	
pierce-18	441559.181	4994377.85	93.705	0.011	0.016	11/8/2016 15:12	Road	93.6894	-0.016	1.6	
pierce-19	441549.417	4994369.46	93.658	0.013	0.018	11/8/2016 15:12	Road	93.6579	0.000	0.0	
pierce-20	441539.925	4994361.12	93.613	0.011	0.015	11/8/2016 15:13	Road	93.6244	0.011	1.1	
rogersteven-1	441785.318	4996704.13	91.734	0.009	0.011	08/15/2016 09:31:42	Road	91.729	-0.005	0.5	
rogersteven-2	441800.233	4996717.08	91.679	0.011	0.013	08/15/2016 09:32:37	Road	91.6423	-0.037	3.7	
rogersteven-3	441810.334	4996725.66	91.648	0.012	0.015	08/15/2016 09:33:02	Road	91.6438	-0.004	0.4	
rogersteven-4	441823.898	4996737.37	91.635	0.012	0.015	08/15/2016 09:33:42	Road	91.698	0.063	6.3	
rogersteven-5	441837.264	4996748.66	91.736	0.013	0.016	08/15/2016 09:34:13	Road	91.7322	-0.004	0.4	
rogersteven-6	441772.367	4996693	91.799	0.011	0.014	08/15/2016 09:36:02	Road	91.7553	-0.044	4.4	
rogersteven-7	441756.024	4996679.07	91.833	0.012	0.016	08/15/2016 09:36:48	Road	91.832	-0.001	0.1	

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Table C.1 Field verification of LIDAR data (spot heights)

	RVCA Field Survey (August 3 and 11, 2016)							Nearest Lidar Point	Comparison		
Location ID	X (m)	Y (m)	Z (m)	Horizontal Accuracy (m)	Veritcal Accuracy (m)	Date/Time	Field Observations	Z (m)	△Z (m)	|△Z| (cm)	|△Z| > 0.33m
rogersteven-8	441735.908	4996661.76	91.862	0.012	0.016	08/15/2016 09:38:04	Road	91.8543	-0.008	0.8	
rogersteven-9	441718.417	4996646.65	91.902	0.012	0.016	08/15/2016 09:38:53	Road	91.9567	0.055	5.5	
rogersteven-10	441705.303	4996635.35	91.979	0.012	0.016	08/15/2016 09:39:27	Road	92.0047	0.026	2.6	
rogersteven-11	440145.083	4995298.17	92.291	0.01	0.016	08/15/2016 09:47:33	Road	92.3293	0.038	3.8	
rogersteven-12	440137.376	4995291.83	92.307	0.01	0.014	08/15/2016 09:47:58	Road	92.3557	0.049	4.9	
rogersteven-13	440153.95	4995305.81	92.267	0.011	0.017	08/15/2016 09:48:47	Road	92.3027	0.036	3.6	
rogersteven-14	440153.82	4995305.74	92.275	0.01	0.014	08/15/2016 09:49:52	Road	92.3105	0.036	3.6	
rogersteven-15	440163.056	4995313.7	92.263	0.011	0.016	08/15/2016 09:50:15	Road	92.3104	0.047	4.7	
rogersteven-16	440179.104	4995327.26	92.218	0.011	0.016	08/15/2016 09:50:45	Road	92.2899	0.072	7.2	
rogersteven-17	440195.209	4995341.06	92.146	0.013	0.02	08/15/2016 09:51:35	Road	92.1914	0.045	4.5	
rogersteven-18	440212.783	4995355.92	92.076	0.013	0.02	08/15/2016 09:52:20	Road	92.0895	0.014	1.4	
rogersteven-19	440224.727	4995366.06	92.023	0.013	0.019	08/15/2016 09:54:33	Road	92.0242	0.001	0.1	
rogersteven-20	440245.212	4995383.31	92.021	0.01	0.016	08/15/2016 09:55:23	Road	92.0718	0.051	5.1	
rogersteven-21	440262.561	4995398.13	92.245	0.01	0.016	08/15/2016 09:56:13	Road	92.1952	-0.050	5.0	
rogersteven-22	440277.041	4995410.25	92.457	0.01	0.016	08/15/2016 09:56:45	Road	92.4617	0.005	0.5	
rogersteven-23	440297.637	4995427.84	92.661	0.011	0.017	08/15/2016 09:58:01	Road	92.6689	0.008	0.8	
mnccordacy-1	442647.355	4995927.45	94.684	0.008	0.011	08/15/2016 10:11:37	Road	94.6406	-0.043	4.3	
mnccordacy-2	442669.109	4995904.2	95.386	0.013	0.02	08/15/2016 10:12:36	Road	95.3087	-0.077	7.7	
mnccordacy-3	442692.501	4995877.53	96.324	0.014	0.019	08/15/2016 10:13:26	Road	96.3357	0.012	1.2	
mnccordacy-4	442715.538	4995852.28	96.452	0.013	0.02	08/15/2016 10:15:15	Road	96.4113	-0.041	4.1	
mnccordacy-5	442734.02	4995830.91	96.412	0.014	0.018	08/15/2016 10:17:03	Road	96.3971	-0.015	1.5	
mnccordacy-6	442642.185	4995936.06	94.376	0.013	0.017	08/15/2016 10:19:28	Road	94.3588	-0.017	1.7	
mnccordacy-7	442622.385	4995959.16	93.88	0.015	0.02	08/15/2016 10:20:14	Road	93.8795	-0.001	0.1	
mnccordacy-8	442594.524	4995991.91	92.971	0.012	0.017	08/15/2016 10:21:41	Road	92.9454	-0.026	2.6	
mnccordacy-9	442579.194	4996008.66	92.508	0.014	0.019	08/15/2016 10:22:20	Road	92.5297	0.022	2.2	
mnccordacy-10	442567.049	4996022.74	92.169	0.014	0.02	08/15/2016 10:22:55	Road	92.1295	-0.040	4.0	
mnccordacy-11	442000.853	4996673.09	92.233	0.014	0.02	08/15/2016 10:31:06	Road	92.2341	0.001	0.1	
mnccordacy-12	441980.275	4996699.54	91.966	0.007	0.017	08/15/2016 10:37:09	Road	91.9752	0.009	0.9	
mnccordacy-13	441966.584	4996715.38	91.808	0.013	0.02	08/15/2016 10:41:52	Road	91.7732	-0.035	3.5	
mnccordacy-14	441954.654	4996728.88	91.743	0.012	0.02	08/15/2016 10:45:00	Road	91.7924	0.049	4.9	
mnccordacy-15	441937.413	4996749.02	91.624	0.014	0.019	08/15/2016 10:47:23	Road	91.6605	0.036	3.6	
mnccordacy-16	442008.719	4996666.38	92.235	0.014	0.02	08/15/2016 10:49:16	Road	92.2113	-0.024	2.4	
mnccordacy-17	442022.949	4996650.1	92.473	0.014	0.02	08/15/2016 10:51:35	Road	92.4411	-0.032	3.2	
mnccordacy-18	442036.634	4996634.34	92.579	0.013	0.02	08/15/2016 10:52:48	Road	92.5727	-0.006	0.6	
mnccordacy-19	442052.247	4996616.02	92.917	0.013	0.02	08/15/2016 10:53:37	Road	92.8621	-0.055	5.5	
mnccordacy-20	442064.991	4996601.09	93.269	0.013	0.02	08/15/2016 10:54:11	Road	93.2892	0.020	2.0	
mnccordacy-21	440497.602	4998414.86	92.757	0.009	0.014	08/15/2016 11:11:51	Road	92.7225	-0.034	3.4	
mnccordacy-22	440483.107	4998432.15	92.704	0.009	0.014	08/15/2016 11:12:58	Road	92.6843	-0.020	2.0	

Table C.1 Field verification of LIDAR data (spot heights)

	RVCA Field Survey (August 3 and 11, 2016)							Nearest Lidar Point	Comparison		
Location ID	X (m)	Y (m)	Z (m)	Horizontal Accuracy (m)	Veritcal Accuracy (m)	Date/Time	Field Observations	Z (m)	△Z (m)	|△Z| (cm)	|△Z| > 0.33m
mnccordacy-23	440467.951	4998451.05	92.69	0.009	0.015	08/15/2016 11:13:32	Road	92.6889	-0.001	0.1	
mnccordacy-24	440457.895	4998463.33	92.703	0.01	0.016	08/15/2016 11:13:59	Road	92.6896	-0.013	1.3	
mnccordacy-25	440446.127	4998477.75	92.777	0.01	0.016	08/15/2016 11:14:31	Road	92.8114	0.034	3.4	
mnccordacy-26	440433.057	4998493.37	92.872	0.01	0.016	08/15/2016 11:15:02	Road	92.8033	-0.069	6.9	
mnccordacy-27	440423.976	4998504.35	92.919	0.01	0.016	08/15/2016 11:15:29	Road	92.8715	-0.048	4.8	
mnccordacy-28	440413.696	4998516.77	92.928	0.01	0.016	08/15/2016 11:15:55	Road	92.8593	-0.069	6.9	
mnccordacy-29	440404.025	4998528.46	92.935	0.01	0.016	08/15/2016 11:16:20	Road	92.8556	-0.079	7.9	
mnccordacy-30	440391.912	4998543.6	92.928	0.011	0.017	08/15/2016 11:16:48	Road	92.92	-0.008	0.8	
mnccordacy-31	440379.797	4998558.2	92.91	0.008	0.012	08/15/2016 11:22:27	Road	92.8499	-0.060	6.0	
pollock-1	440766.139	4999760.21	94.771	0.012	0.018	08/15/2016 11:33:33	Road	94.6833	-0.088	8.8	
pollock-2	440787.14	4999772.17	94.769	0.012	0.019	08/15/2016 11:34:28	Road	94.6197	-0.149	14.9	
pollock-3	440811.986	4999785.85	94.786	0.013	0.02	08/15/2016 11:35:12	Road	94.6996	-0.086	8.6	
pollock-4	440832.158	4999796.57	94.81	0.013	0.02	08/15/2016 11:35:58	Road	94.7102	-0.100	10.0	
pollock-5	440853.012	4999808.27	94.901	0.013	0.02	08/15/2016 11:36:34	Road	94.7983	-0.103	10.3	
pollock-6	440873.693	4999819.9	95.038	0.013	0.02	08/15/2016 11:37:17	Road	94.9201	-0.118	11.8	
pollock-7	440902.181	4999835.91	95.165	0.013	0.02	08/15/2016 11:38:18	Road	95.0314	-0.134	13.4	
pollock-8	440917.334	4999847.34	95.37	0.013	0.02	08/15/2016 11:39:03	Road	95.3724	0.002	0.2	
pollock-9	440933.528	4999856.24	95.461	0.013	0.019	08/15/2016 11:40:13	Road	95.44	-0.021	2.1	
pollock-10	440952.591	4999866.77	95.611	0.009	0.013	08/15/2016 11:42:07	Road	95.5115	-0.100	10.0	
shellstar-1	442920.511	4998527.64	93.798	0.013	0.018	08/15/2016 11:54:58	Road	93.6986	-0.099	9.9	
shellstar-2	442907.008	4998521.62	93.478	0.013	0.02	08/15/2016 11:57:16	Road	93.4535	-0.024	2.4	
shellstar-3	442877.165	4998507.9	92.789	0.012	0.02	08/15/2016 12:01:33	Road	92.7521	-0.037	3.7	
shellstar-4	442863.37	4998498.13	92.562	0.012	0.019	08/15/2016 12:04:02	Road	92.4614	-0.101	10.1	
shellstar-5	442848.927	4998490.05	92.324	0.01	0.017	08/15/2016 12:04:36	Road	92.2256	-0.098	9.8	
dr blaire-1	442945.109	4998419.13	93.741	0.009	0.014	08/15/2016 12:10:27	Road	93.7105	-0.030	3.0	
dr blaire-2	442944.148	4998409.11	93.76	0.013	0.016	08/15/2016 12:10:49	Road	93.7386	-0.021	2.1	
dr blaire-3	442943.473	4998395.75	93.784	0.014	0.018	08/15/2016 12:11:14	Road	93.7449	-0.039	3.9	
dr blaire-4	442956.369	4998384.45	93.925	0.015	0.019	08/15/2016 12:11:46	Road	93.8366	-0.088	8.8	
dr blaire-5	442968.666	4998380.32	94.298	0.013	0.02	08/15/2016 12:12:28	Road	94.245	-0.053	5.3	
phelean-6	447600.362	5002467.7	93.473	0.008	0.013	08/15/2016 14:17:53	Gravel Road	93.4353	-0.038	3.8	
phelean-7	447575.88	5002454.22	92.925	0.011	0.017	08/15/2016 14:18:35	Gravel Road	92.8465	-0.079	7.9	
phelean-8	447554.713	5002442.46	92.526	0.012	0.018	08/15/2016 14:19:11	Gravel Road	92.4683	-0.058	5.8	
phelean-9	447533.249	5002430.76	92.223	0.012	0.019	08/15/2016 14:19:45	Gravel Road	92.2138	-0.009	0.9	
phelean-10	447511.09	5002418.37	91.924	0.013	0.02	08/15/2016 14:20:19	Gravel Road	91.8801	-0.044	4.4	
phelean-11	447609.573	5002472.56	93.677	0.012	0.018	08/15/2016 14:22:32	Gravel Road	93.6919	0.015	1.5	
phelean-12	447631.018	5002484.49	94.173	0.012	0.018	08/15/2016 14:23:16	Gravel Road	94.1436	-0.029	2.9	
phelean-13	447645.794	5002492.87	94.473	0.011	0.017	08/15/2016 14:23:46	Gravel Road	94.4447	-0.028	2.8	
phelean-14	447669.944	5002506.59	94.841	0.011	0.017	08/15/2016 14:24:23	Gravel Road	94.8295	-0.011	1.1	

Table C.1 Field verification of LIDAR data (spot heights)

	RVCA Field Survey (August 3 and 11, 2016)							Nearest Lidar Point	Comparison		
Location ID	X (m)	Y (m)	Z (m)	Horizontal Accuracy (m)	Veritcal Accuracy (m)	Date/Time	Field Observations	Z (m)	△Z (m)	|△Z| (cm)	|△Z| > 0.33m
phelean-15	447687.859	5002516.88	94.974	0.012	0.018	08/15/2016 14:24:56	Gravel Road	95.0006	0.027	2.7	
2nd line-1	446259.68	5000966.97	89.308	0.008	0.013	08/15/2016 14:35:25	Gravel Road	89.2421	-0.066	6.6	
2nd line-2	446286.025	5000938.16	89.205	0.012	0.019	08/15/2016 14:36:15	Gravel Road	89.1874	-0.018	1.8	
2nd line-3	446301.237	5000920.16	89.193	0.012	0.02	08/15/2016 14:37:55	Gravel Road	89.1814	-0.012	1.2	
2nd line-4	446326.598	5000889.53	89.196	0.012	0.02	08/15/2016 14:45:56	Gravel Road	89.1858	-0.010	1.0	
2nd line-5	446341.955	5000875.92	89.275	0.009	0.013	08/15/2016 14:46:46	Gravel Road	89.2732	-0.002	0.2	
2nd line-6	446355.274	5000860.21	89.187	0.013	0.019	08/15/2016 14:47:44	Gravel Road	89.1869	0.000	0.0	
2nd line-7	446370.96	5000841.98	89.011	0.011	0.017	08/15/2016 14:48:43	Gravel Road	88.996	-0.015	1.5	
2nd line-8	446382.656	5000828.12	88.915	0.011	0.019	08/15/2016 14:49:18	Gravel Road	88.8702	-0.045	4.5	
2nd line-9	446397.636	5000813.32	88.836	0.012	0.02	08/15/2016 14:50:14	Gravel Road	88.8376	0.002	0.2	
2nd line-10	446415.561	5000792.78	88.68	0.012	0.02	08/15/2016 14:50:58	Gravel Road	88.6924	0.012	1.2	
3rd line-6	444799.926	4999579.37	88.51	0.014	0.017	08/15/2016 15:21:19	Gravel Road	88.379	-0.131	13.1	
3rd line-7	444786.475	4999592.74	88.493	0.013	0.016	08/15/2016 15:21:52	Gravel Road	88.3944	-0.099	9.9	
3rd line-8	444780.289	4999603.49	88.355	0.009	0.011	08/15/2016 15:24:03	Gravel Road	88.3504	-0.005	0.5	
3rd line-9	444772.538	4999609.55	88.422	0.011	0.014	08/15/2016 15:24:22	Gravel Road	88.3693	-0.053	5.3	
3rd line-10	444764.991	4999617.93	88.406	0.015	0.019	08/15/2016 15:24:53	Gravel Road	88.3803	-0.026	2.6	
3rd line-11	444755.794	4999628.81	88.362	0.014	0.018	08/15/2016 15:25:16	Gravel Road	88.3152	-0.047	4.7	
3rd line-12	444744.132	4999643.15	88.356	0.015	0.019	08/15/2016 15:26:11	Gravel Road	88.3069	-0.049	4.9	
3rd line-13	444734.843	4999652.89	88.337	0.015	0.019	08/15/2016 15:26:32	Gravel Road	88.2831	-0.054	5.4	
3rd line-14	444724.758	4999663.88	88.338	0.014	0.018	08/15/2016 15:26:55	Gravel Road	88.2666	-0.071	7.1	
3rd line-15	444717.813	4999671.7	88.359	0.015	0.019	08/15/2016 15:27:14	Gravel Road	88.2806	-0.078	7.8	
old forest-1	445001.946	4998156.94	98.438	0.011	0.016	08/15/2016 15:34:43	Road	98.3789	-0.059	5.9	
old forest-2	445002.752	4998147.7	98.512	0.01	0.014	08/15/2016 15:35:01	Road	98.5368	0.025	2.5	
old forest-3	445003.727	4998135.14	98.63	0.012	0.016	08/15/2016 15:35:21	Road	98.6326	0.003	0.3	
old forest-4	445004.324	4998125.26	98.609	0.012	0.017	08/15/2016 15:35:39	Road	98.5876	-0.021	2.1	
old forest-5	445004.652	4998117.12	98.535	0.013	0.018	08/15/2016 15:35:56	Road	98.5903	0.055	5.5	
old forest-6	445005.403	4998107.74	98.467	0.013	0.017	08/15/2016 15:36:15	Road	98.439	-0.028	2.8	
old forest-7	445005.617	4998101.45	98.396	0.014	0.018	08/15/2016 15:36:29	Road	98.4175	0.021	2.1	
old forest-8	445004.546	4998095.59	98.324	0.015	0.017	08/15/2016 15:37:10	Road	98.3586	0.035	3.5	
old forest-9	445004.128	4998088.24	98.206	0.015	0.017	08/15/2016 15:37:28	Road	98.1883	-0.018	1.8	
old forest-10	445005.217	4998080.21	98.149	0.015	0.018	08/15/2016 15:38:08	Road	98.0957	-0.053	5.3	
perkins-1	443708.673	4997668.51	89.888	0.008	0.012	08/22/2016 11:12:44	Road	89.8285	-0.059	5.9	
perkins-2	443693.332	4997661.07	89.741	0.015	0.016	08/22/2016 11:13:15	Road	89.7074	-0.034	3.4	
perkins-3	443673.936	4997647.91	89.589	0.014	0.022	08/22/2016 11:13:52	Road	89.5456	-0.043	4.3	
church st-1	443675.666	4997521.47	89.821	0.01	0.018	08/22/2016 11:32:43	Road	89.7903	-0.031	3.1	
church st-2	443661.034	4997493.71	89.773	0.008	0.015	08/22/2016 11:33:53	Road	89.6806	-0.092	9.2	
church st-3	443643.426	4997461.91	89.914	0.01	0.016	08/22/2016 11:34:43	Road	89.9049	-0.009	0.9	
church st-4	443628.459	4997435.22	90.019	0.012	0.02	08/22/2016 11:35:35	Road	89.878	-0.141	14.1	

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	RVCA Field Survey (August 3 and 11, 2016)							Nearest Lidar Point	Comparison		
Location ID	X (m)	Y (m)	Z (m)	Horizontal Accuracy (m)	Veritcal Accuracy (m)	Date/Time	Field Observations	Z (m)	△Z (m)	|△Z| (cm)	|△Z| > 0.33m
church st-5	443617.437	4997417.51	90.078	0.012	0.02	08/22/2016 11:37:16	Road	90.0358	-0.042	4.2	
church st-6	443601.558	4997387.13	90.197	0.01	0.017	08/22/2016 11:38:10	Road	90.1762	-0.021	2.1	
church st-7	443589.175	4997365.6	90.348	0.013	0.019	08/22/2016 11:38:49	Road	90.3652	0.017	1.7	
church st-8	443675.669	4997523.61	89.769	0.011	0.018	08/22/2016 11:43:25	Road	89.7012	-0.068	6.8	
church st-9	443687.877	4997543.16	89.9	0.013	0.02	08/22/2016 11:44:39	Road	89.8568	-0.043	4.3	
church st-10	443718.423	4997610.59	89.729	0.011	0.016	08/22/2016 11:46:05	Road	89.7032	-0.026	2.6	
perkins st-1	443720.125	4997670.95	90.261	0.01	0.015	08/22/2016 11:47:48	Road	90.2502	-0.011	1.1	
perkins st-2	443696.704	4997662.7	89.734	0.01	0.016	08/22/2016 11:48:23	Road	89.7021	-0.032	3.2	
perkins st-3	443675.02	4997648.7	89.583	0.011	0.017	08/22/2016 11:49:01	Road	89.5879	0.005	0.5	
perkins st-4	443653.21	4997638.54	89.614	0.011	0.017	08/22/2016 11:49:37	Road	89.6394	0.025	2.5	
perkins st-5	443630.415	4997624.62	89.467	0.014	0.019	08/22/2016 11:50:21	Road	89.4725	0.006	0.6	
perkins st-6	443614.081	4997614.42	89.322	0.013	0.017	08/22/2016 11:51:02	Road	89.3396	0.018	1.8	
perkins st-7	443600.643	4997605.5	89.276	0.012	0.016	08/22/2016 11:51:31	Road	89.2287	-0.047	4.7	
perkins st-8	443582.796	4997595.21	89.175	0.012	0.017	08/22/2016 11:52:08	Road	89.1635	-0.012	1.2	
perkins st-9	443564.839	4997590.11	89.109	0.011	0.018	08/22/2016 11:52:39	Road	89.0771	-0.032	3.2	
perkins st-10	443544.67	4997591.74	89.102	0.012	0.017	08/22/2016 11:53:13	Road	89.094	-0.008	0.8	
james st-1	443756.677	4998097.05	89.482	0.008	0.013	08/22/2016 12:10:59	Road	89.4529	-0.029	2.9	
james st-2	443756.385	4998081.89	89.384	0.011	0.017	08/22/2016 12:11:28	Road	89.3706	-0.013	1.3	
james st-3	443749.236	4997994.96	89.01	0.014	0.018	08/22/2016 12:16:52	Road	88.9077	-0.102	10.2	
ffvarn-1	444043.231	4998643.98	89.926	0.008	0.012	08/22/2016 12:31:53	Road	90.0102	0.084	8.4	
ffvarn-2	444033.392	4998638.72	90.051	0.008	0.014	08/22/2016 12:32:34	Road	90.1021	0.051	5.1	
ffvarn-3	444016.428	4998627.56	90.244	0.01	0.015	08/22/2016 12:33:07	Road	90.2568	0.013	1.3	
ffvarn-4	444004.872	4998621.5	90.44	0.011	0.017	08/22/2016 12:33:35	Road	90.5359	0.096	9.6	
ffvarn-5	443993.248	4998614.76	90.774	0.01	0.015	08/22/2016 12:34:06	Road	90.8135	0.040	4.0	
ffvarn-6	443981.943	4998606.83	91.248	0.011	0.017	08/22/2016 12:34:34	Road	91.2603	0.012	1.2	
ffvarn-7	443973.553	4998600.14	91.607	0.01	0.017	08/22/2016 12:34:59	Road	91.5923	-0.015	1.5	
ffvarn-8	443965.566	4998592.93	91.937	0.012	0.018	08/22/2016 12:35:25	Road	92.0126	0.076	7.6	
ffvarn-9	443952.863	4998581.08	92.402	0.012	0.02	08/22/2016 12:36:00	Road	92.4511	0.049	4.9	
ffvarn-10	443938.694	4998568.75	92.593	0.013	0.02	08/22/2016 12:37:18	Road	92.6535	0.061	6.1	
michlleagelo-1	443917.281	4998443.44	91.29	0.009	0.015	08/22/2016 12:43:55	Road	91.2772	-0.013	1.3	
michlleagelo-2	443913.607	4998465.56	91.698	0.011	0.019	08/22/2016 12:44:43	Road	91.6445	-0.054	5.4	
michlleagelo-3	443911.081	4998480.28	91.929	0.009	0.014	08/22/2016 12:45:19	Road	91.936	0.007	0.7	
michlleagelo-4	443908.405	4998491.26	92.128	0.012	0.019	08/22/2016 12:45:55	Road	92.1	-0.028	2.8	
michlleagelo-5	443906.561	4998512.95	92.593	0.012	0.02	08/22/2016 12:48:49	Road	92.5138	-0.079	7.9	
michlleagelo-6	443916.142	4998445.38	91.317	0.008	0.014	08/22/2016 12:50:17	Road	91.229	-0.088	8.8	
michlleagelo-7	443917.279	4998427.82	91.006	0.012	0.02	08/22/2016 12:52:01	Road	90.9907	-0.015	1.5	
michlleagelo-8	443924.908	4998404.04	90.837	0.014	0.02	08/22/2016 12:55:05	Road	90.7736	-0.063	6.3	
michlleagelo-9	443932.748	4998363.33	90.568	0.012	0.018	08/22/2016 12:57:24	Road	90.5212	-0.047	4.7	

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Table C.1 Field verification of LIDAR data (spot heights)

	RVCA Field Survey (August 3 and 11, 2016)							Nearest Lidar Point	Comparison		
Location ID	**X (m)**	**Y (m)**	**Z (m)**	**Horizontal Accuracy (m)**	**Veritcal Accuracy (m)**	**Date/Time**	**Field Observations**	**Z (m)**	**△Z (m)**	**|△Z| (cm)**	**|△Z| > 0.33m**
michlleagelo-10	443939.851	4998335.68	90.7	0.011	0.018	08/22/2016 12:58:27	Road	90.6425	-0.057	5.7	
michlleagelo-11	443951.055	4998322.34	90.808	0.01	0.016	08/22/2016 12:59:18	Road	90.7985	-0.009	0.9	

Mean △Z :	4.5	0 Yes out of 306
Median△Z :	3.8	
Max △Z :	14.9	
Min △Z :	0.0	

Discarded Points

1st line-1	448411.406	5001558.76	95.78	0.009	0.015	08/15/2016 13:53:49	Road Repaved	95.5317	-0.248	24.8	
1st line-2	448417.895	5001545.66	95.746	0.01	0.017	08/15/2016 13:54:16	Road Repaved	95.4617	-0.284	28.4	
1st line-3	448427.495	5001524.76	95.771	0.011	0.017	08/15/2016 13:54:49	Road Repaved	95.4737	-0.297	29.7	
1st line-4	448435.742	5001506.98	95.743	0.012	0.02	08/15/2016 13:55:20	Road Repaved	95.4017	-0.341	34.1	YES
1st line-5	448447.113	5001482.45	95.667	0.012	0.02	08/15/2016 13:56:25	Road Repaved	95.3911	-0.276	27.6	
1st line-6	448462.274	5001449.71	95.59	0.013	0.02	08/15/2016 13:57:23	Road Repaved	95.3018	-0.288	28.8	
1st line-7	448472.179	5001428.19	95.598	0.012	0.018	08/15/2016 13:58:09	Road Repaved	95.3088	-0.289	28.9	
1st line-8	448485.034	5001400.53	95.474	0.012	0.019	08/15/2016 13:59:05	Road Repaved	95.2704	-0.204	20.4	
1st line-9	448491.682	5001385.92	95.401	0.012	0.019	08/15/2016 13:59:32	Road Repaved	95.1867	-0.214	21.4	
1st line-10	448499.555	5001369.07	95.37	0.012	0.02	08/15/2016 14:00:16	Road Repaved	95.1269	-0.243	24.3	
phelean-1	448135.637	5002858.05	90.118	0.007	0.012	08/15/2016 14:08:40	Gravel Road Regraded	89.9972	-0.121	12.1	
phelean-2	448170.654	5002876.69	89.704	0.009	0.014	08/15/2016 14:09:30	Gravel Road Regraded	89.5679	-0.136	13.6	
phelean-3	448195.2	5002890.12	89.525	0.01	0.016	08/15/2016 14:10:07	Gravel Road Regraded	89.427	-0.098	9.8	
phelean-4	448218.878	5002903	89.426	0.011	0.017	08/15/2016 14:10:43	Gravel Road Regraded	89.2579	-0.168	16.8	
phelean-5	448243.321	5002916.48	89.225	0.011	0.017	08/15/2016 14:11:21	Gravel Road Regraded	89.1104	-0.115	11.5	
3rd line-1	445712.199	4998531.21	89.684	0.009	0.01	08/15/2016 15:06:09	Gravel Road Regraded	89.5104	-0.174	17.4	
3rd line-2	445721.812	4998519.47	89.612	0.011	0.015	08/15/2016 15:06:39	Gravel Road Regraded	89.4153	-0.197	19.7	
3rd line-3	445727.283	4998513.16	89.56	0.015	0.02	08/15/2016 15:07:11	Gravel Road Regraded	89.4586	-0.101	10.1	
3rd line-4	445731.482	4998507.23	89.51	0.014	0.017	08/15/2016 15:07:34	Gravel Road Regraded	89.3784	-0.132	13.2	
3rd line-5	445739.291	4998499.06	89.515	0.015	0.017	08/15/2016 15:07:59	Gravel Road Regraded	89.3372	-0.178	17.8	

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Appendix D

HEC-HMS Model – Selected Screen Shots

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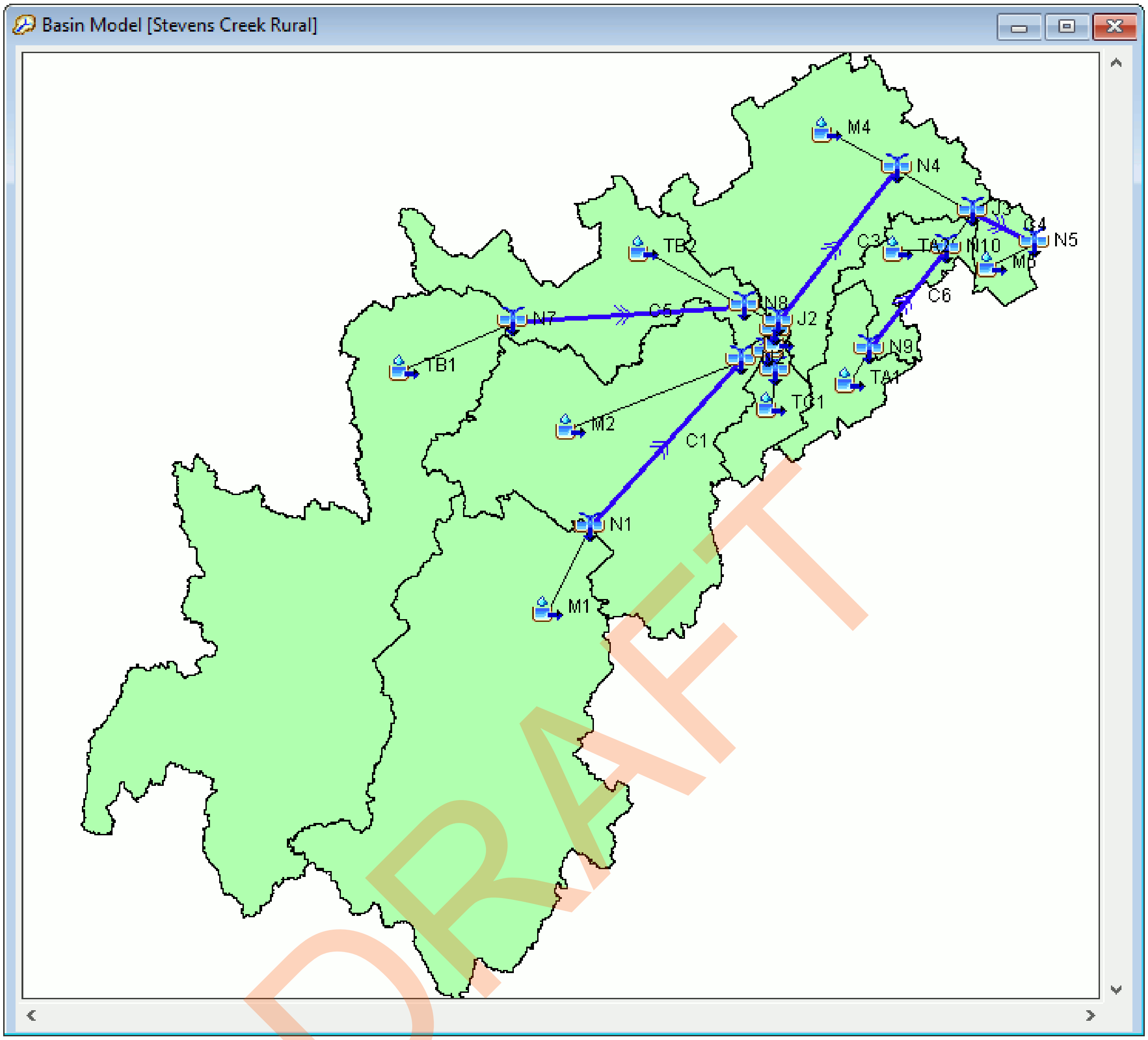
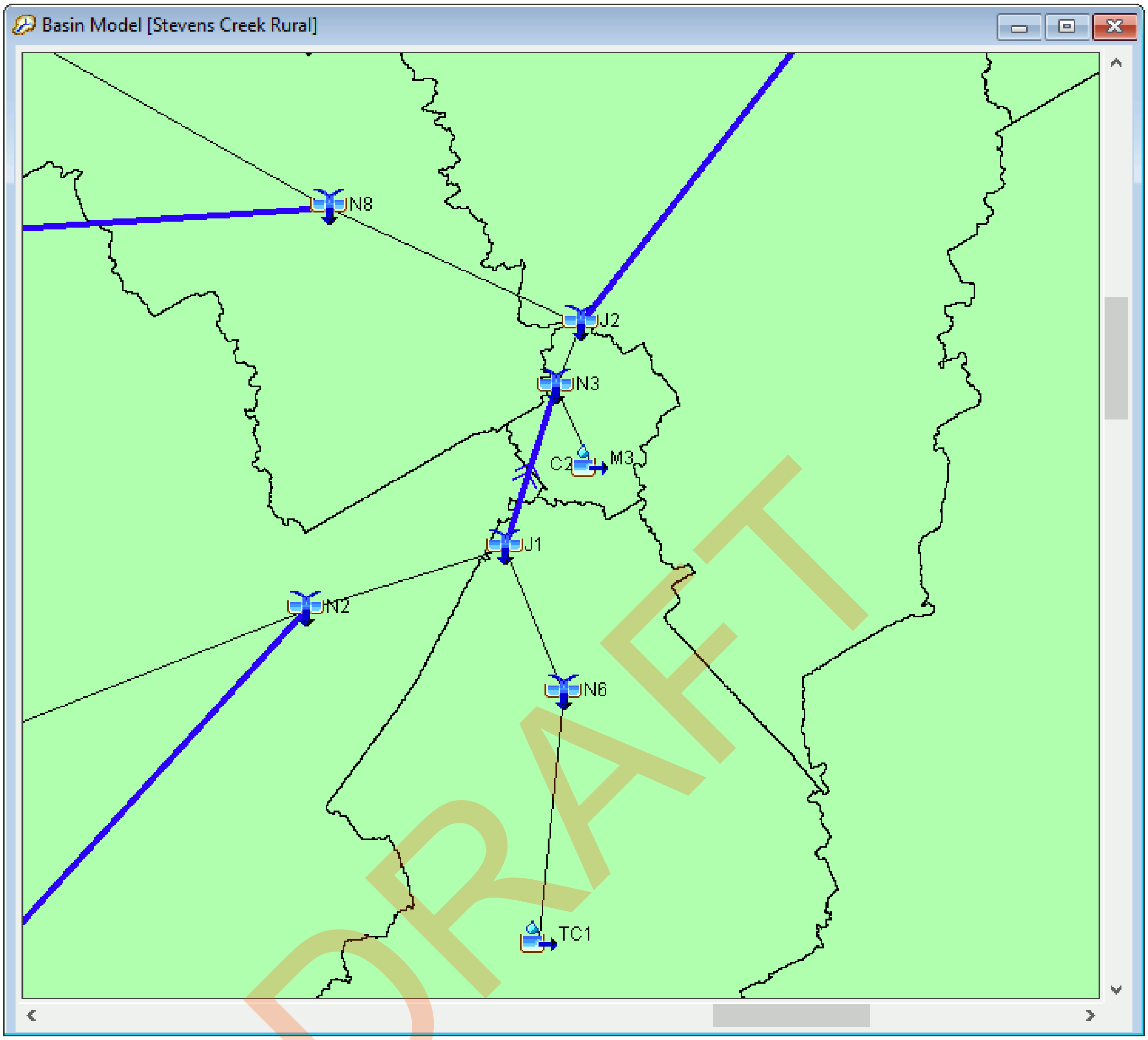
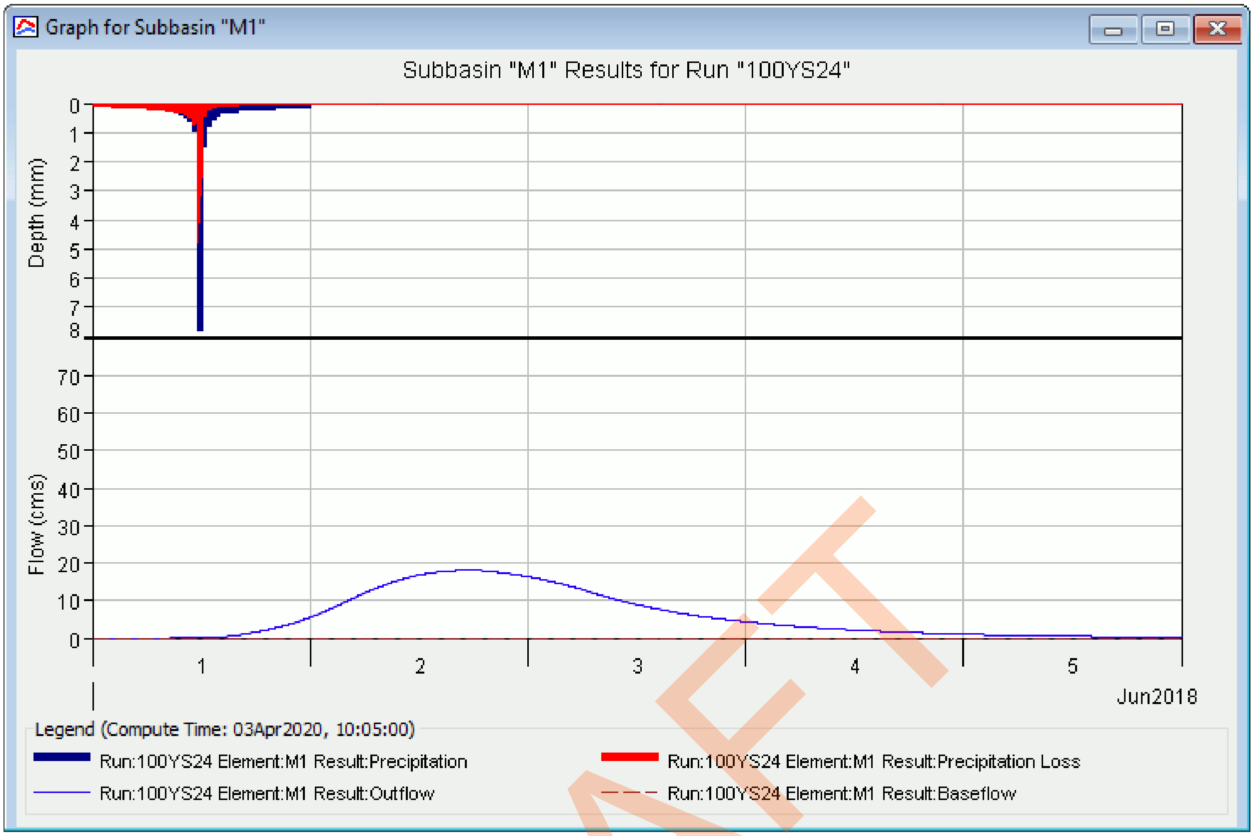
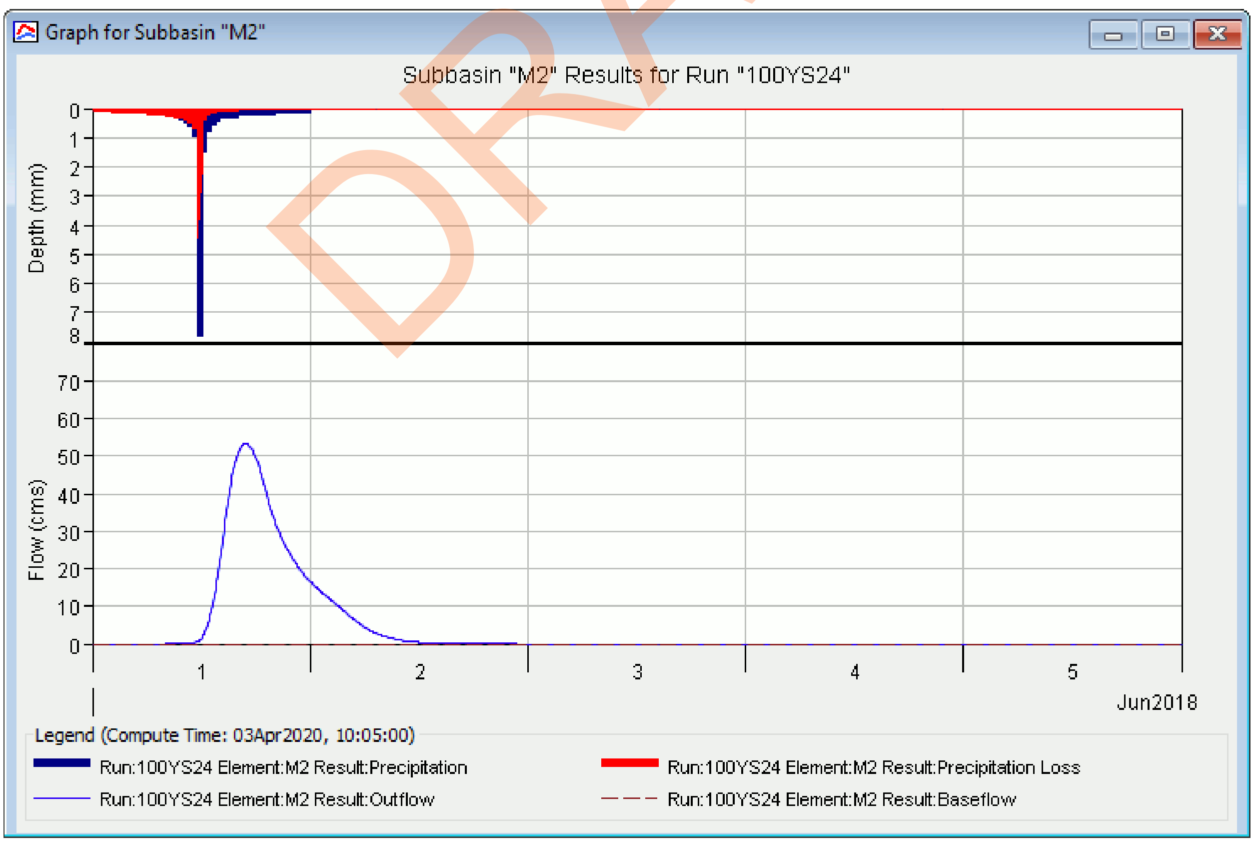

Basin Model [Stevens Creek Rural]
M4
N4
J3
N5
TB2
C3
N10
N8
J2
C6
N7
C5
N9
TB1
TA1
TC1
M2
C1
N1
M1



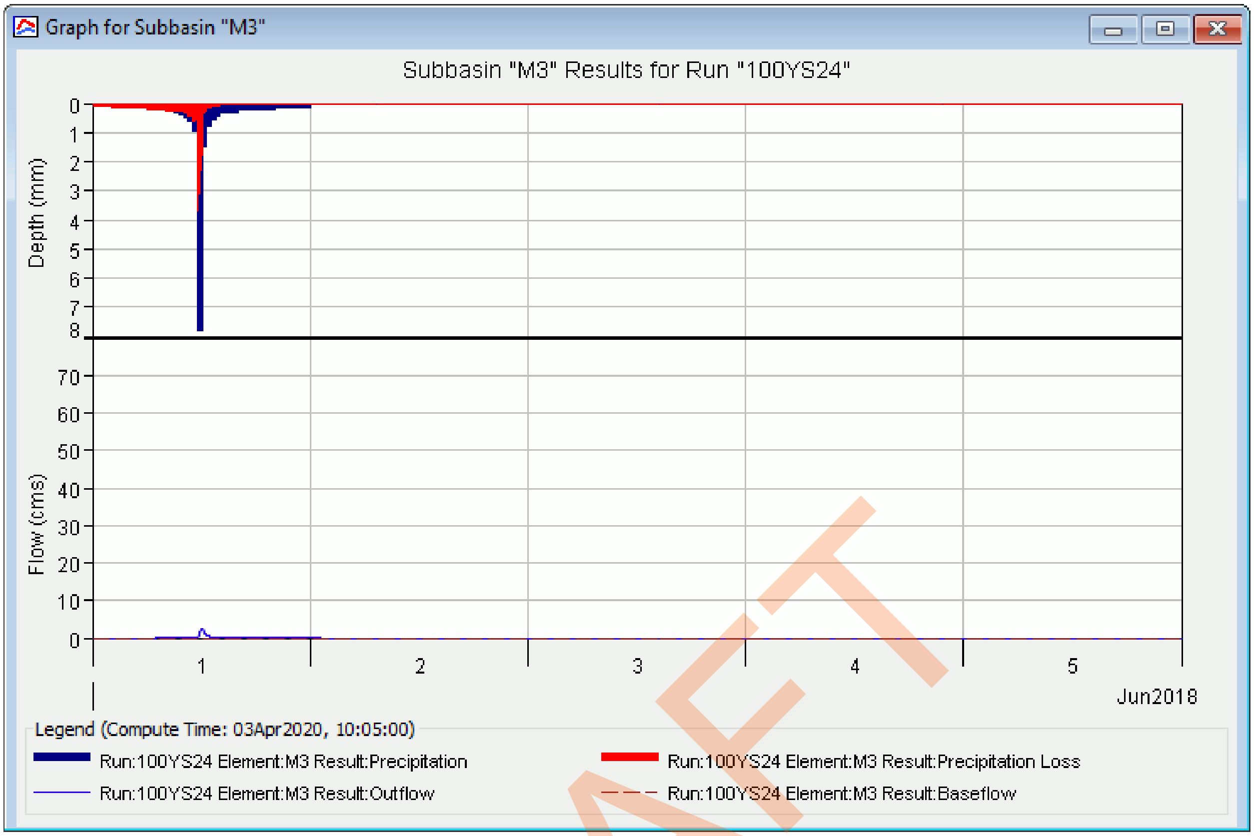
Basin Model [Stevens Creek Rural]
N8
J2
N3
C2
M3
J1
N2
N6
TC1
DRAFT

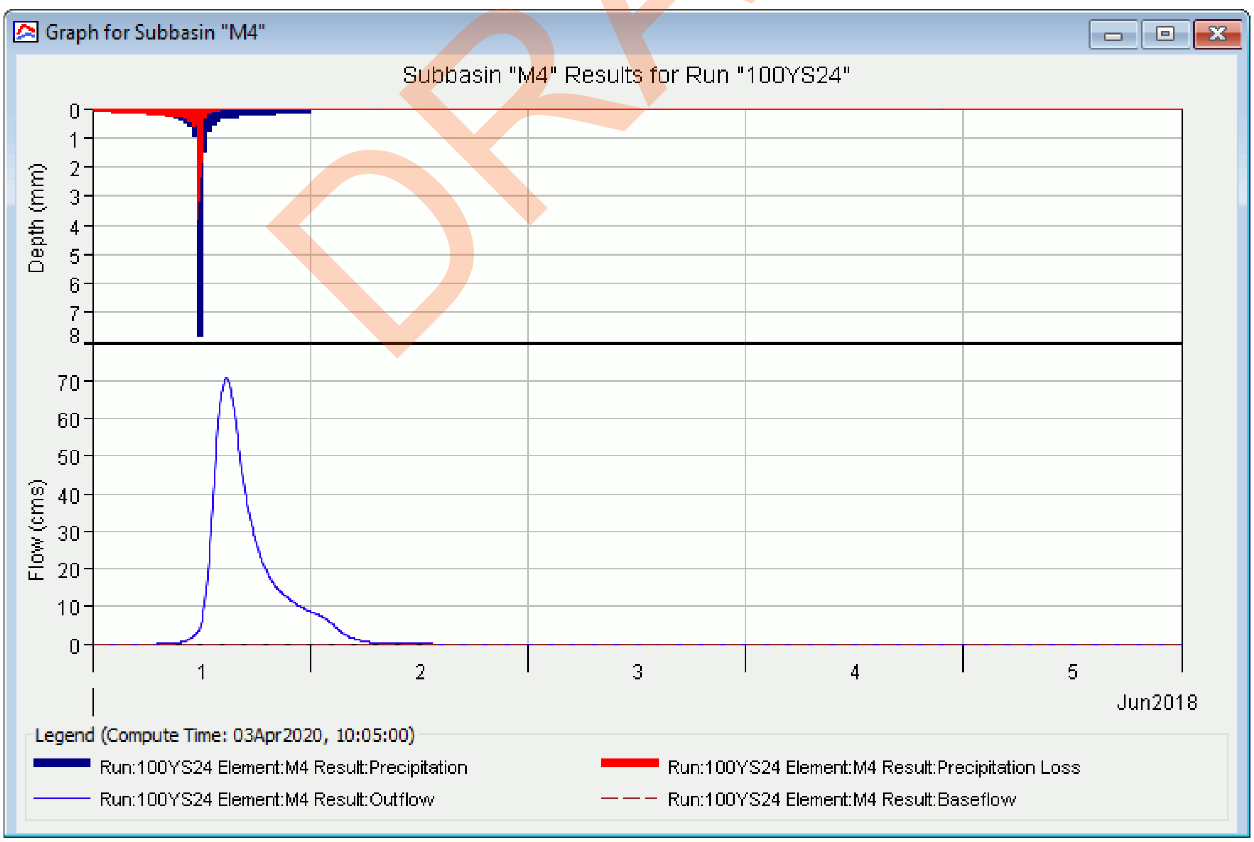


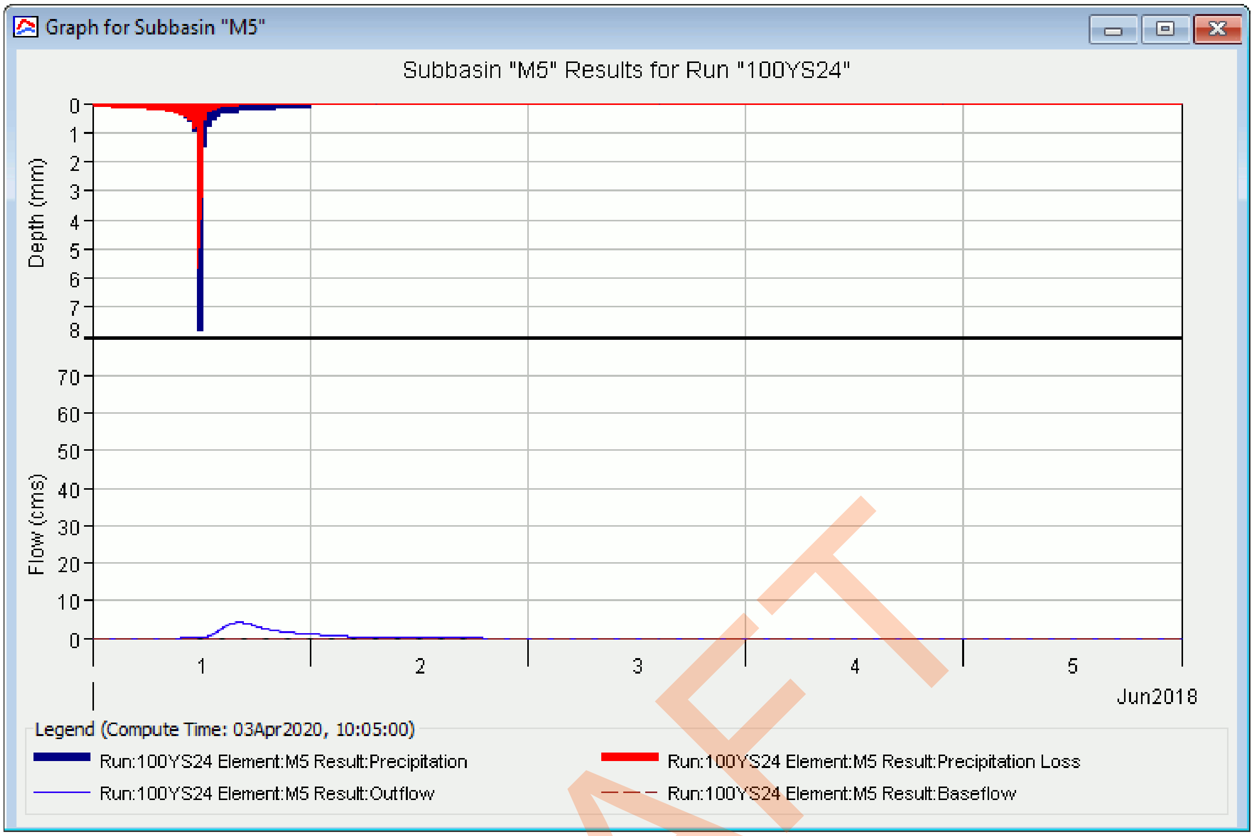
Graph for Subbasin "M1"
Subbasin "M1" Results for Run "100YS24"
Depth (mm)
Flow (cms)
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:M1 Result:Precipitation
Run:100YS24 Element:M1 Result:Precipitation Loss
Run:100YS24 Element:M1 Result:Outflow
Run:100YS24 Element:M1 Result:Baseflow



Graph for Subbasin "M2"
Subbasin "M2" Results for Run "100YS24"
Depth (mm)
Flow (cms)
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:M2 Result:Precipitation
Run:100YS24 Element:M2 Result:Precipitation Loss
Run:100YS24 Element:M2 Result:Outflow
Run:100YS24 Element:M2 Result:Baseflow


Graph for Subbasin "M3"
Subbasin "M3" Results for Run "100YS24"
Depth (mm)
Flow (cms)
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:M3 Result:Precipitation
Run:100YS24 Element:M3 Result:Precipitation Loss
Run:100YS24 Element:M3 Result:Outflow
Run:100YS24 Element:M3 Result:Baseflow


Graph for Subbasin "M4"
Subbasin "M4" Results for Run "100YS24"
Depth (mm)
Flow (cms)
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:M4 Result:Precipitation
Run:100YS24 Element:M4 Result:Precipitation Loss
Run:100YS24 Element:M4 Result:Outflow
Run:100YS24 Element:M4 Result:Baseflow



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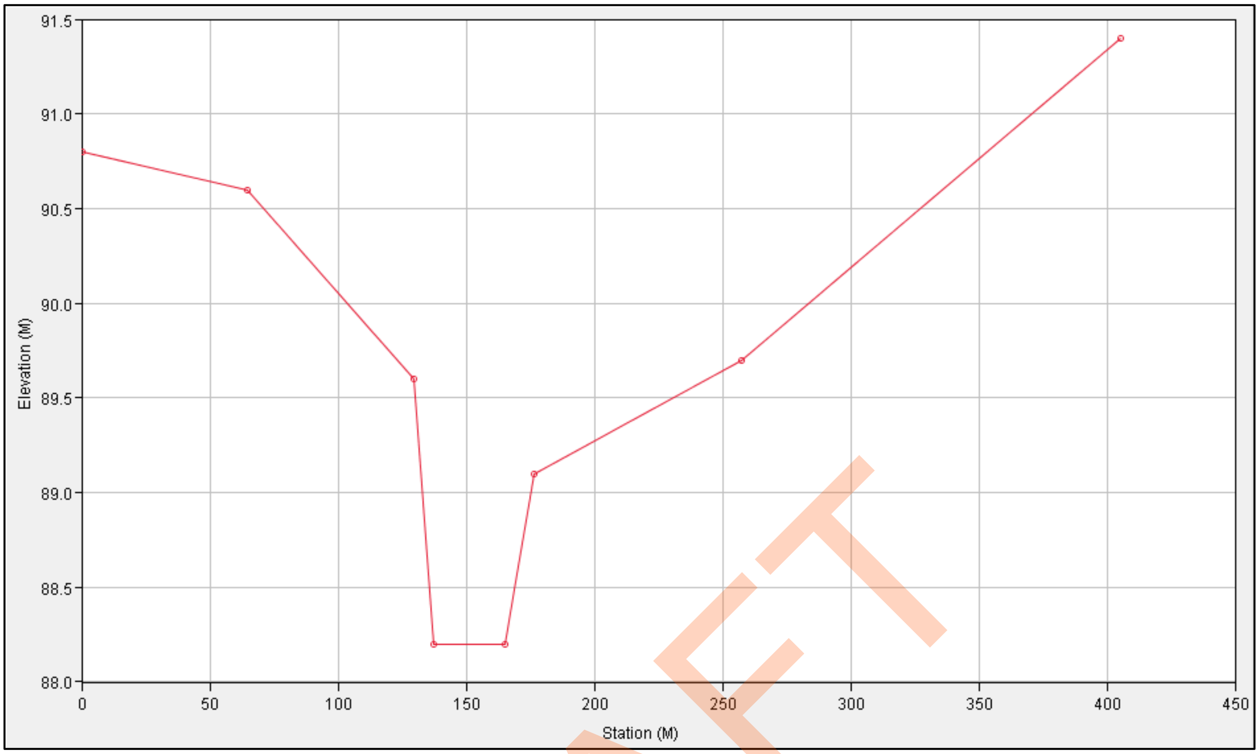
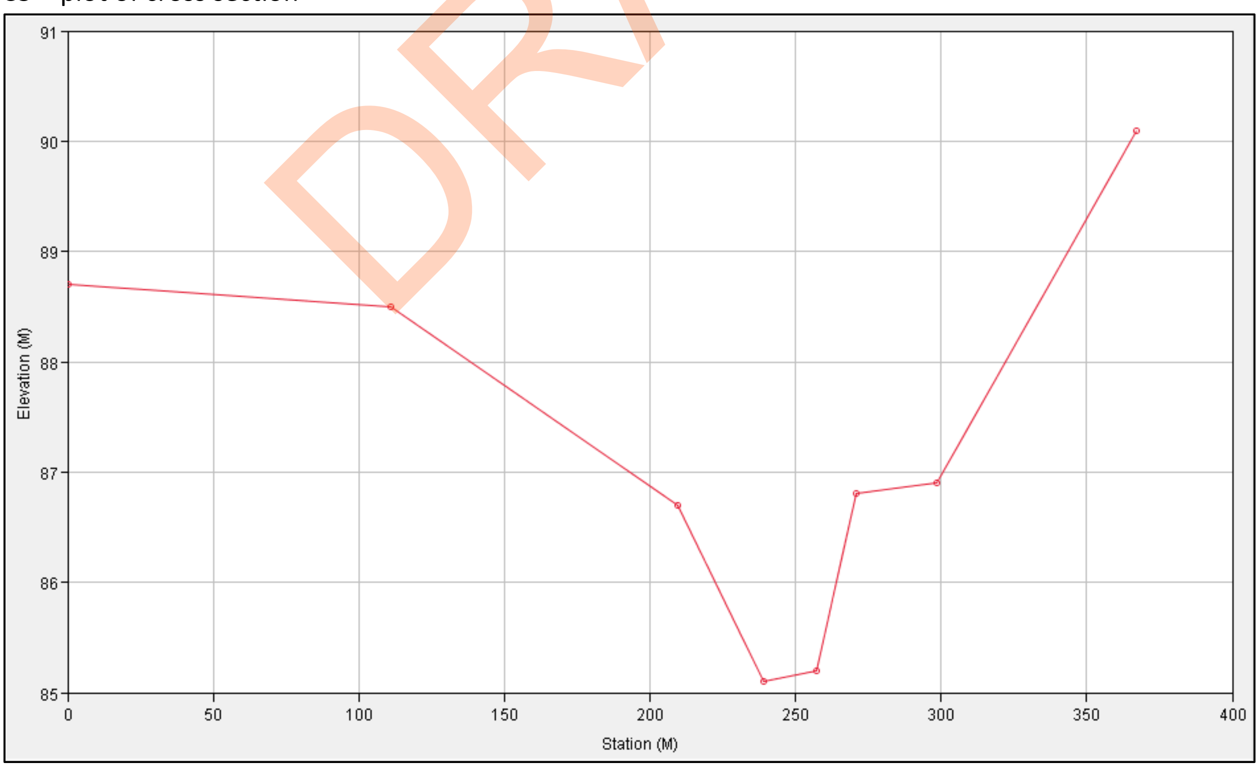
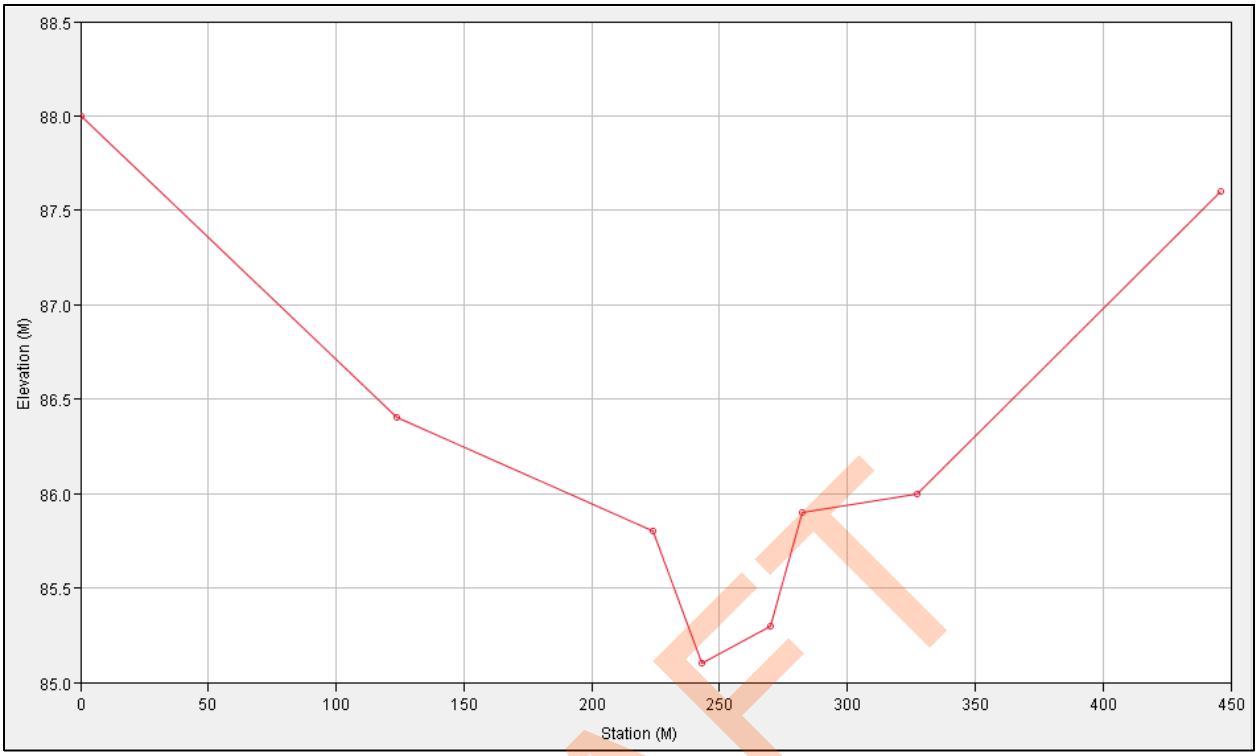
C1 – plot of cross section



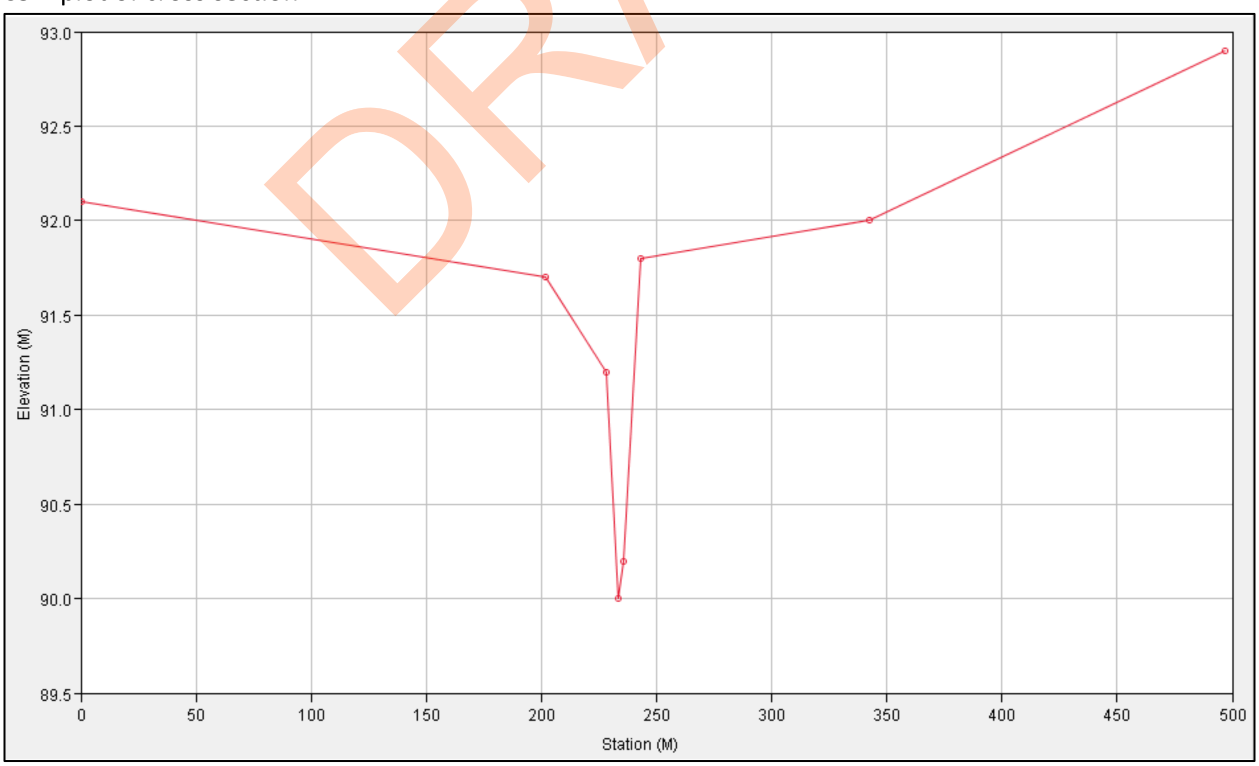
C3 – plot of cross section



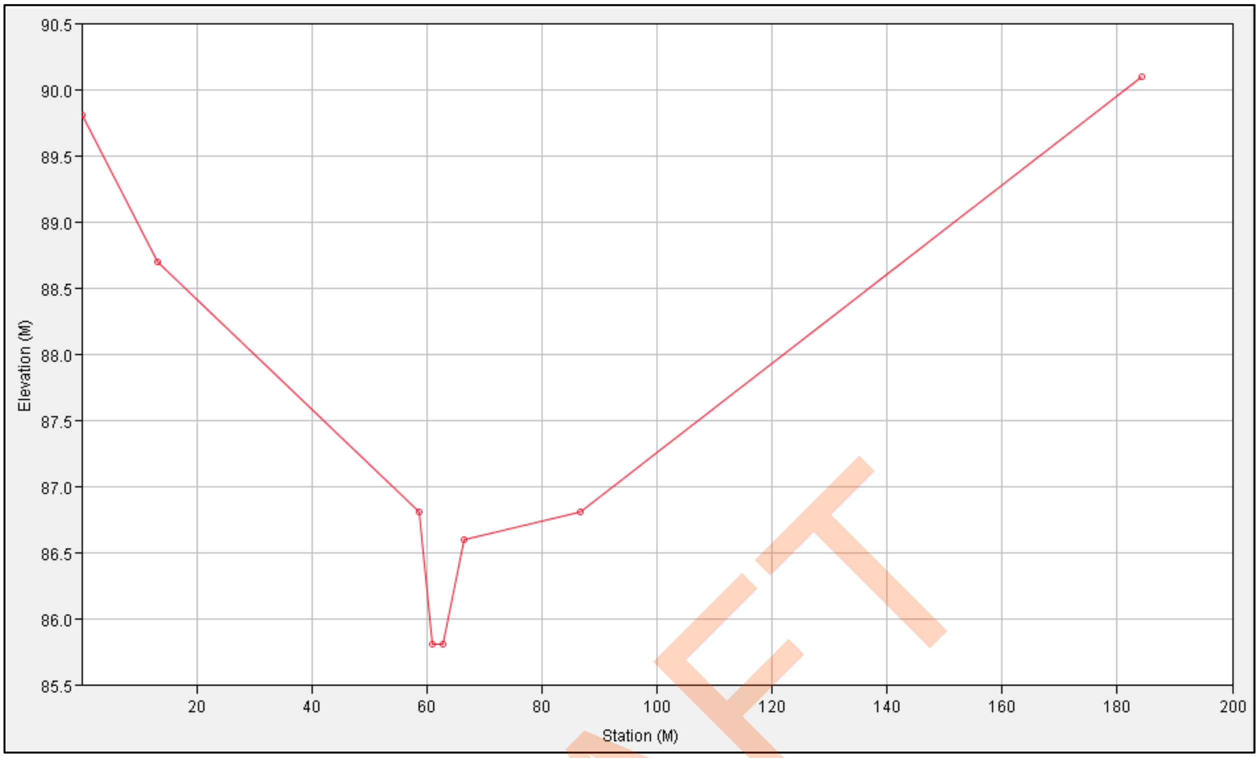
C4 – plot of cross section

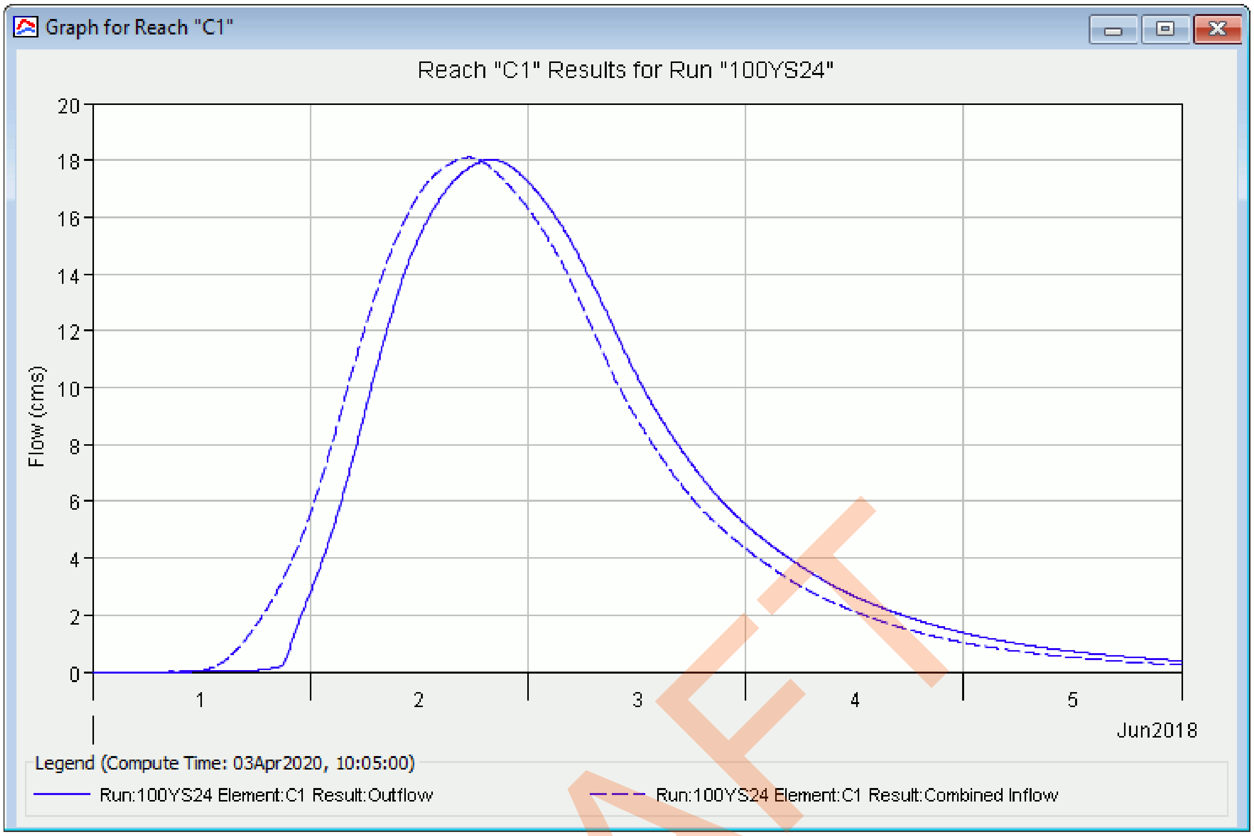


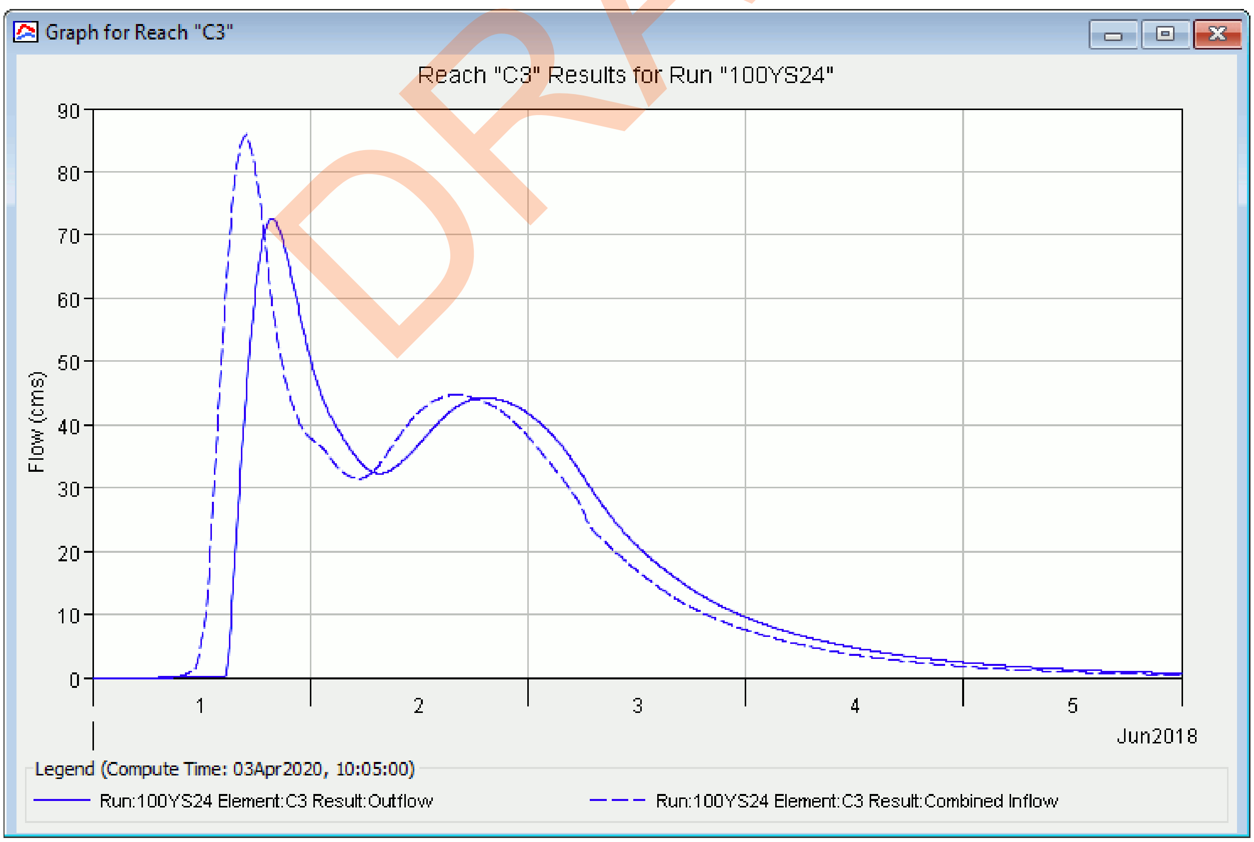
C5 – plot of cross section

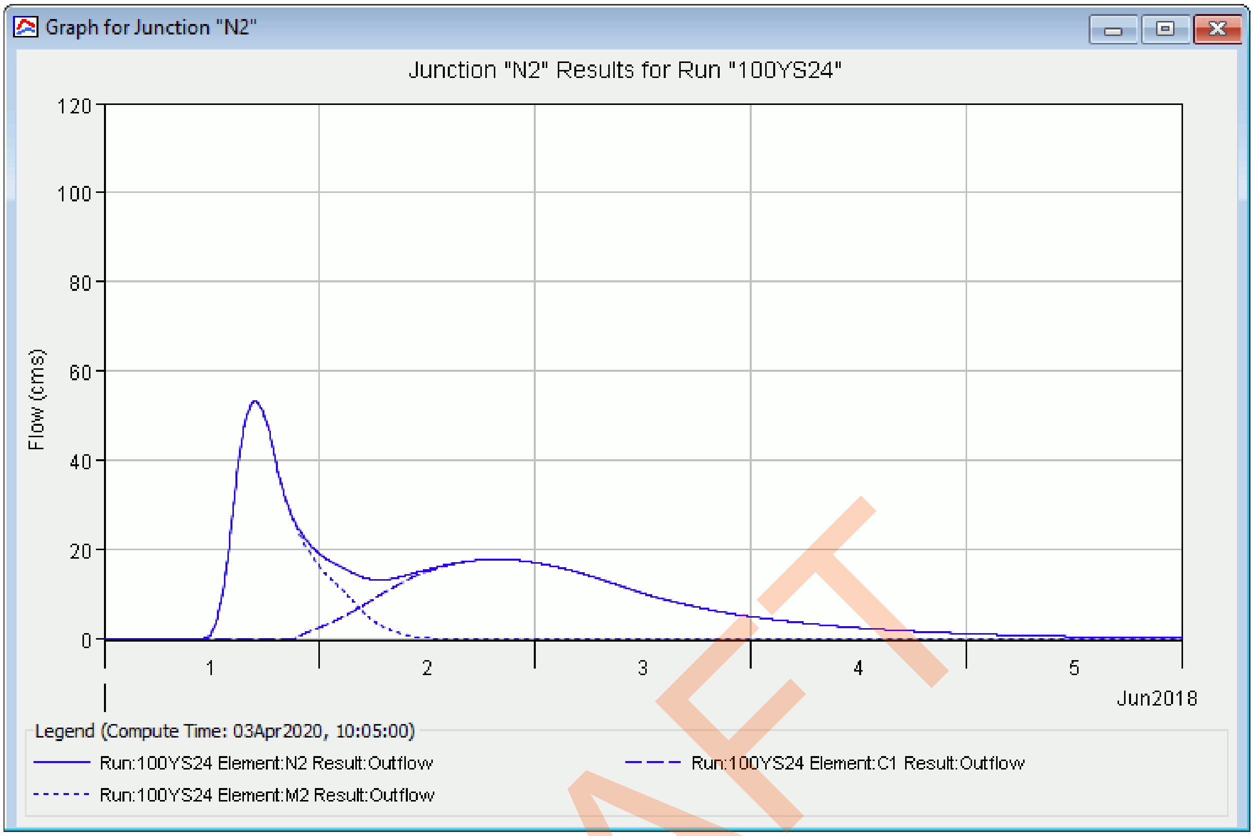


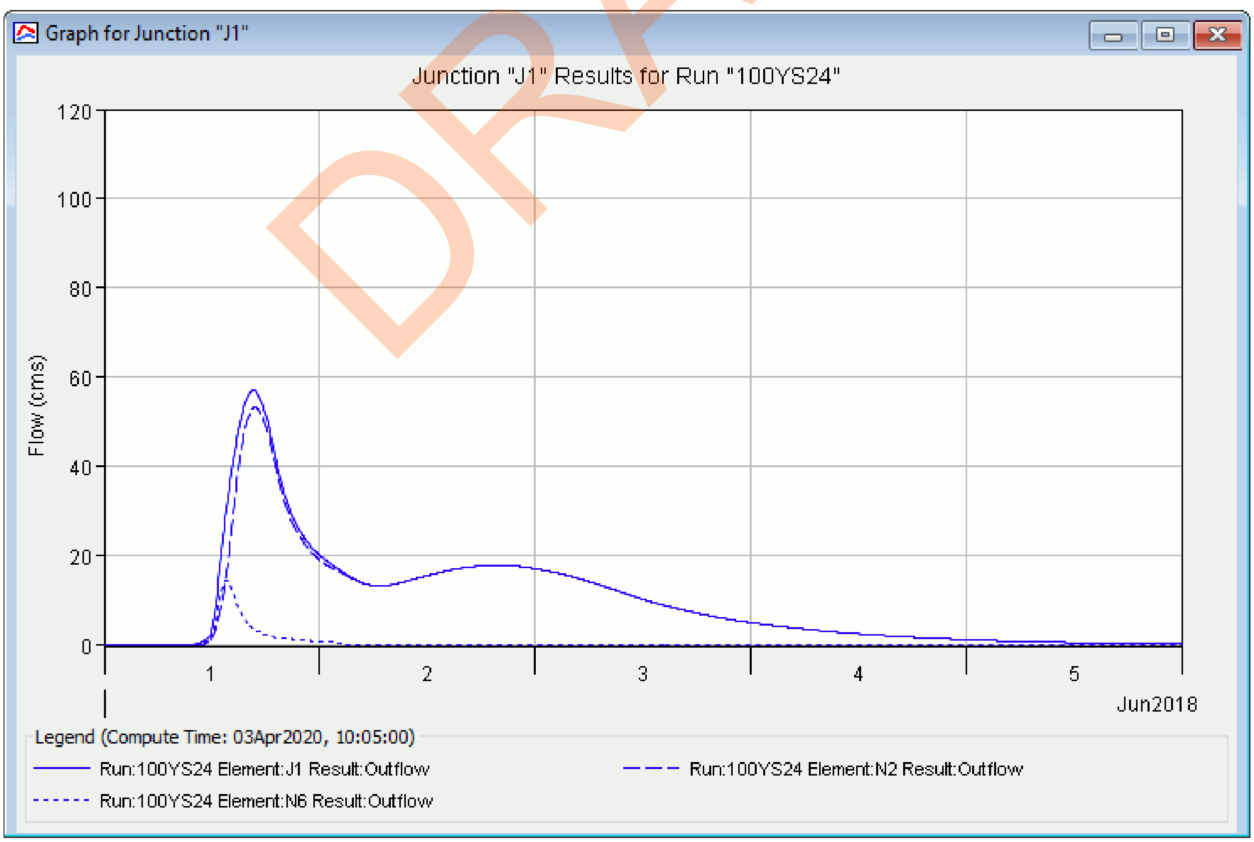
C6 – plot of cross section

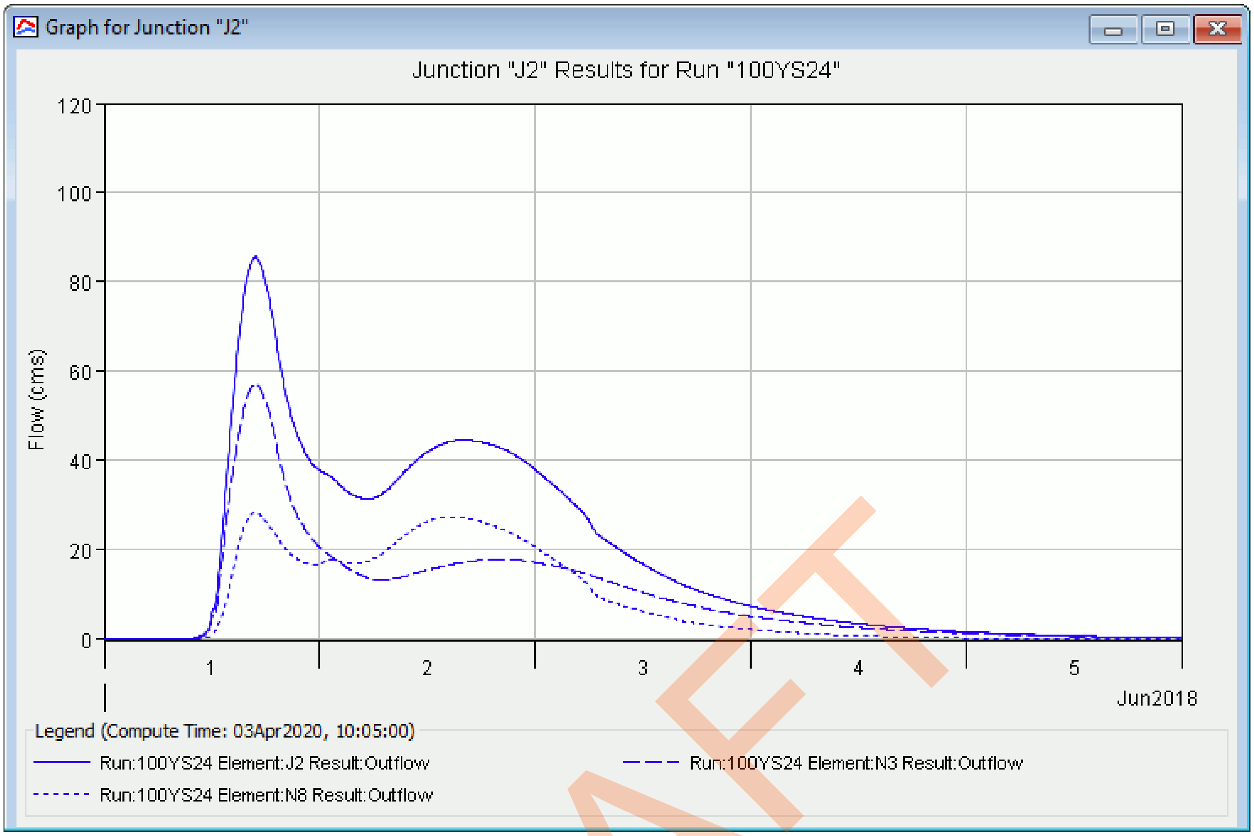


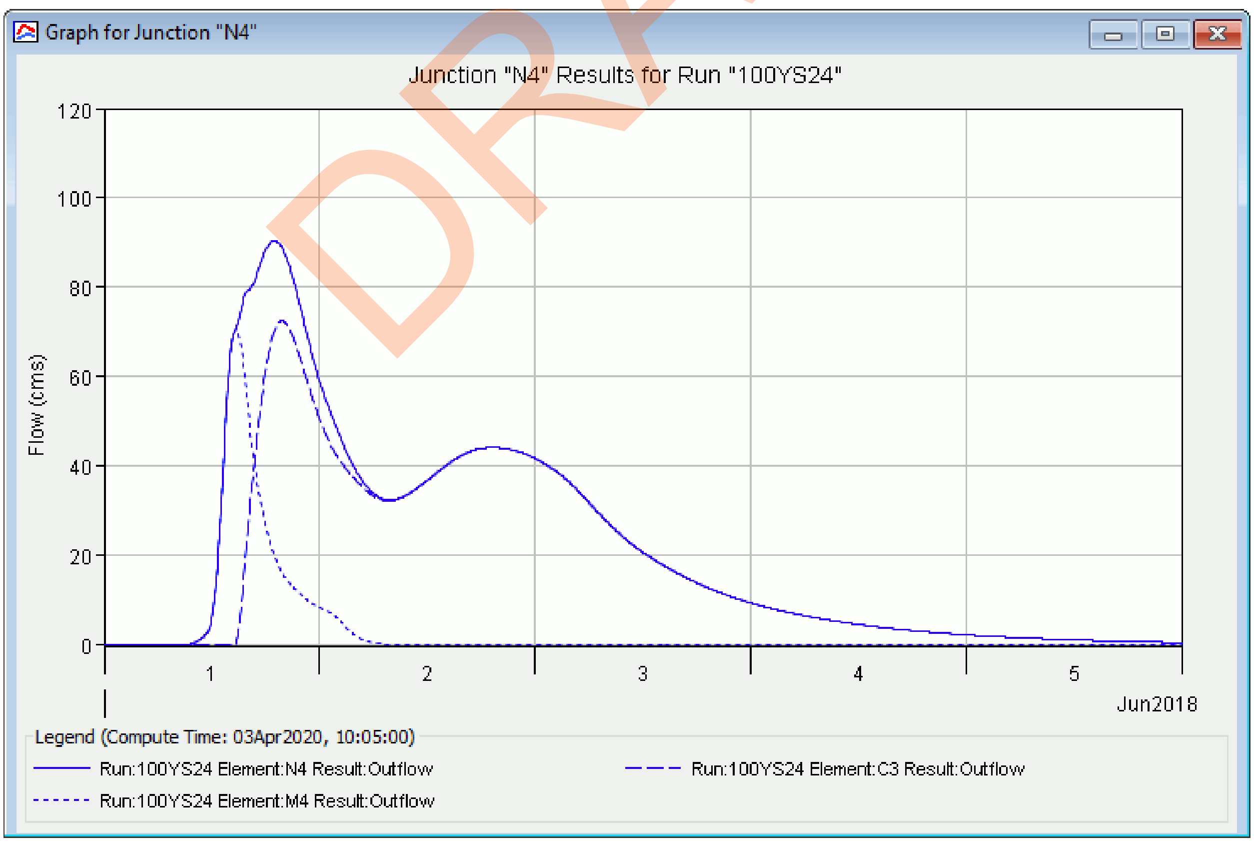

Graph for Reach "C1"
Reach "C1" Results for Run "100YS24"
Flow (cms)
0
2
4
6
8
10
12
14
16
18
20
1
2
3
4
5
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:C1 Result:Outflow
Run:100YS24 Element:C1 Result:Combined Inflow

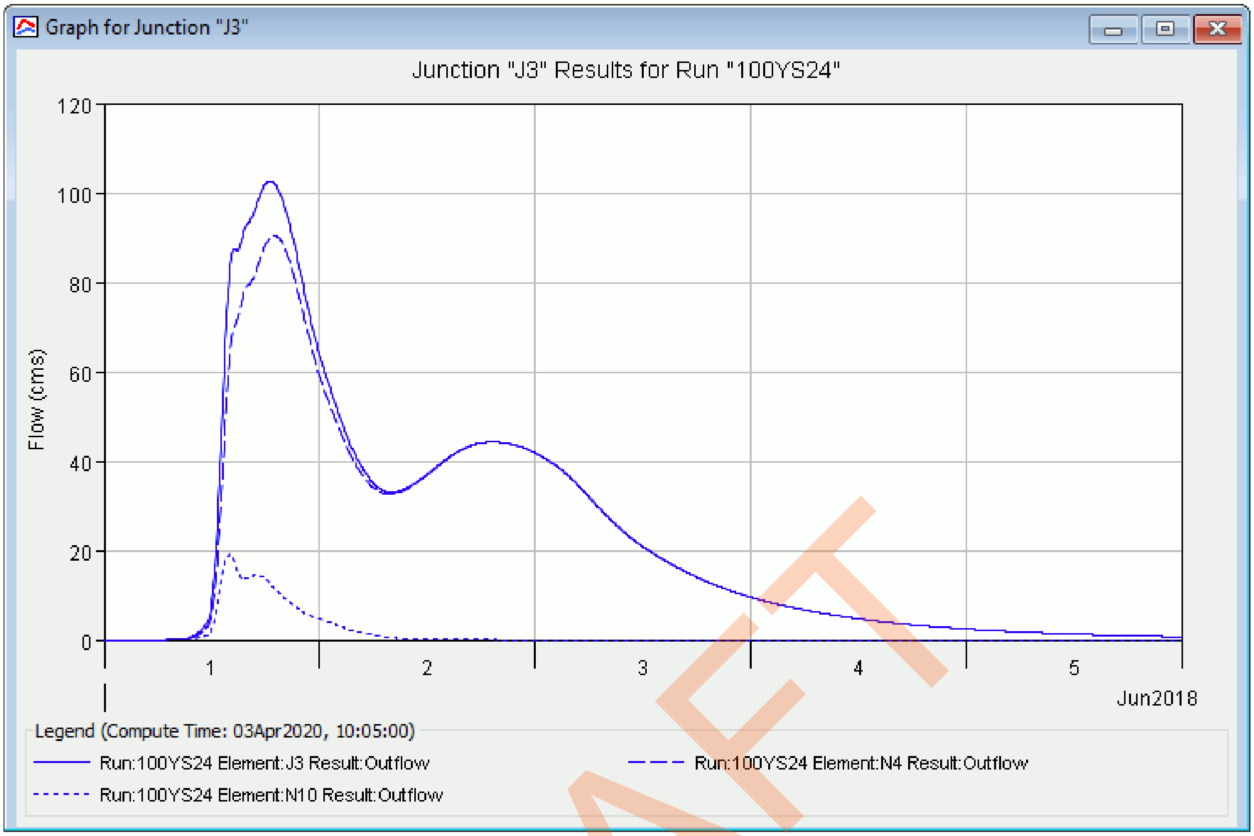

Graph for Reach "C3"
Reach "C3" Results for Run "100YS24"
Flow (cms)
0
10
20
30
40
50
60
70
80
90
1
2
3
4
5
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:C3 Result:Outflow
Run:100YS24 Element:C3 Result:Combined Inflow

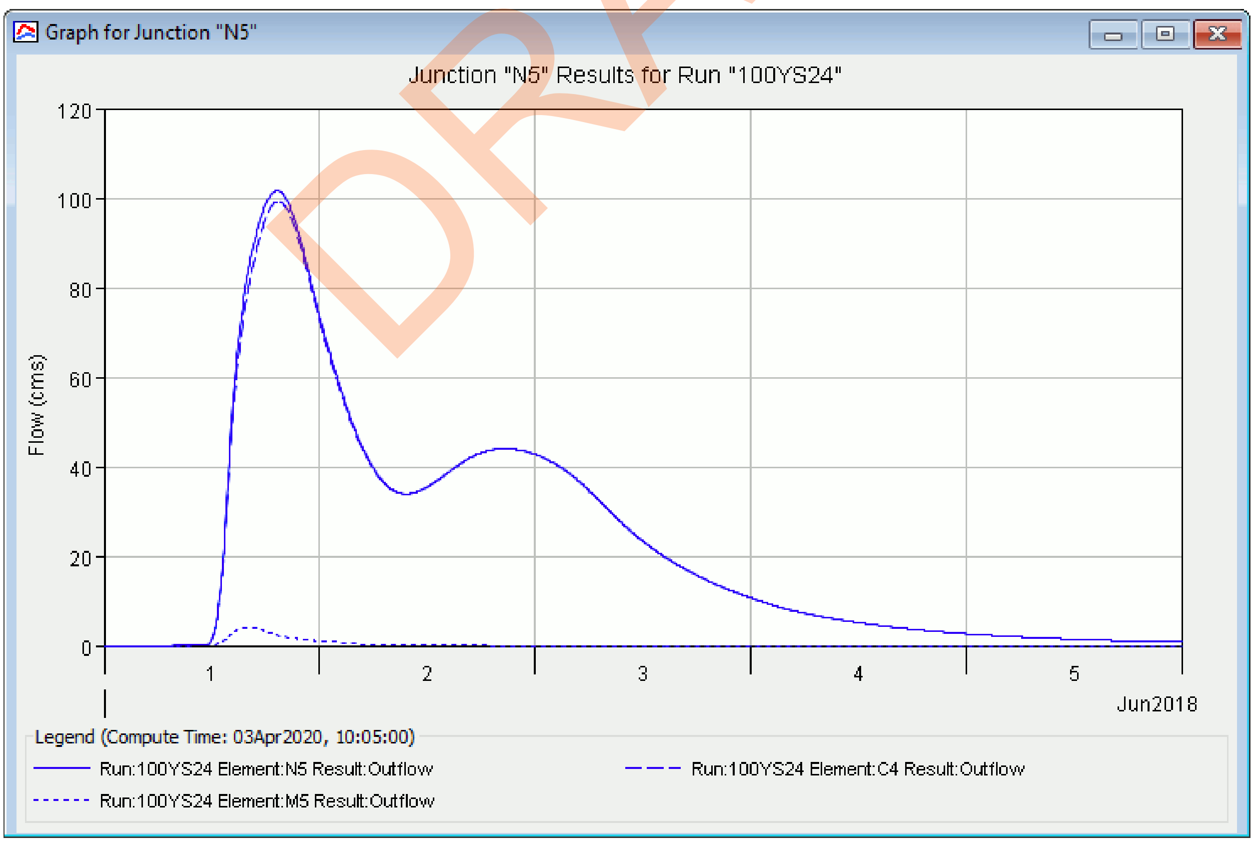

Graph for Junction "N2"
Junction "N2" Results for Run "100YS24"
Flow (cms)
0
20
40
60
80
100
120
1
2
3
4
5
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:N2 Result:Outflow
Run:100YS24 Element:C1 Result:Outflow
Run:100YS24 Element:M2 Result:Outflow


Graph for Junction "J1"
Junction "J1" Results for Run "100YS24"
Flow (cms)
0
20
40
60
80
100
120
1
2
3
4
5
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:J1 Result:Outflow
Run:100YS24 Element:N2 Result:Outflow
Run:100YS24 Element:N6 Result:Outflow


Graph for Junction "J2"
Junction "J2" Results for Run "100YS24"
120
100
80
60
40
20
0
Flow (cms)
1
2
3
4
5
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:J2 Result:Outflow
Run:100YS24 Element:N3 Result:Outflow
Run:100YS24 Element:N8 Result:Outflow


Graph for Junction "N4"
Junction "N4" Results for Run "100YS24"
120
100
80
60
40
20
0
Flow (cms)
1
2
3
4
5
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:N4 Result:Outflow
Run:100YS24 Element:C3 Result:Outflow
Run:100YS24 Element:M4 Result:Outflow


Graph for Junction "J3"
Junction "J3" Results for Run "100YS24"
120
100
80
60
40
20
0
Flow (cms)
1
2
3
4
5
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:J3 Result:Outflow
Run:100YS24 Element:N4 Result:Outflow
Run:100YS24 Element:N10 Result:Outflow


Graph for Junction "N5"
Junction "N5" Results for Run "100YS24"
120
100
80
60
40
20
0
Flow (cms)
1
2
3
4
5
Jun2018
Legend (Compute Time: 03Apr2020, 10:05:00)
Run:100YS24 Element:N5 Result:Outflow
Run:100YS24 Element:C4 Result:Outflow
Run:100YS24 Element:M5 Result:Outflow

Appendix E

Road Crossings - Photographs

Rideau Valley Drive (Upstream)

Rideau Valley Drive (Downstream)

Roger Stevens Drive near Kars (Upstream)

Roger Stevens Drive near Kars (Downstream)

2nd Line Road South (Upstream)

2nd Line Road South (Downstream)

HWY 416 Northbound (Upstream)

HWY 416 Southbound (Downstream)

3rd Line Road South (Upstream)

3rd Line Road South (Downstream)

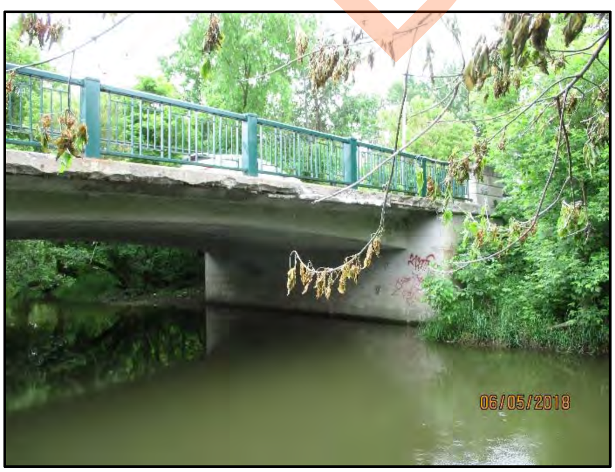
6530 3rd Line Road South (Upstream)

Roger Stevens Drive in North Gower (Upstream)

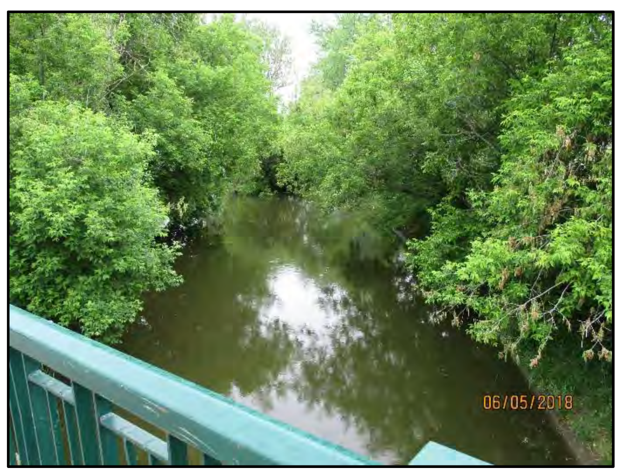
Roger Stevens Drive in North Gower (Downstream)

4th Line Road in North Gower (Upstream)

4th Line Road in North Gower (Downstream)



Church Street (Upstream)



Church Street (Downstream)

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McCordick Road near Church Street (Upstream)

McCordick Road near Church Street (Downstream)


Malakoff Road near Pierce Road (Upstream)


Malakoff Road near Pierce Road (Downstream)

Roger Stevens Drive at 2nd Line Road (Upstream)

Roger Stevens Drive at 2nd Line Road (Downstream)

2nd Line Road South at Roger Stevens (Upstream)

2nd Line Road South at Roger Stevens (Downstream)


HWY 416 (Upstream)


HWY 416 (Downstream)


Roger Stevens Drive and 3rd Line Rd (Upstream)


Roger Stevens Drive and 3rd Line Rd (Downstream)

James Craig Street (Upstream)

James Craig Street (Downstream)

Prince of Wales Drive (Upstream)

Prince of Wales Drive (Downstream)

Edward Kidd Park Ped Bridge (Upstream)

Edward Kidd Park Ped Bridge (Downstream)

4th Line Road near Shellstar Drive (Upstream)

4th Line Road near Shellstar Drive (Downstream)

McCordick Road north of R. Stevens (Upstream)

McCordick Road north of R. Stevens (Downstream)

Malakoff Road near Pollock Road (Upstream)

Malakoff Road near Pollock Road (Downstream)

Appendix F

Bathymetry Report by Water's Edge

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July 3, 2019
WE 19018

Dr. Ferdous Ahmed, Ph.D., P.Eng.
Senior Water Resources Engineer
Rideau Valley Conservation Authority
3889 Rideau valley Drive
Nepean, Ontario
K4M 1A5

Dear Mr. Ahmed:

RE: Stevens Creek Bathymetric Survey - Summary Report
City of Ottawa, Ontario
Rideau Valley Conservation Authority

Water's Edge was authorized by Rideau Valley Conservation Authority (RVCA) to complete an 18km bathymetric survey of Stevens Creek located within the City of Ottawa. The survey starts about 400m upstream of Malakoff Road. The creek flows northeast 18 km before joining the Rideau River in the town of Kars, ON. The survey ends at the confluence of Stevens Creek and Rideau River. The following key points are noted;

Dates of the Survey:
The bathymetric survey was completed the week of May 27, 2019.

Conditions during the Survey:
Stevens Creek flows were at a normal spring level during field work. The lower reach is backwatered by the Rideau River. This creates slow moving water with deeper water. Moving upstream towards the top end of the survey the creek becomes shallow and quicker flowing. The channel substrates also change from deep sedimentation in the lower reaches to gravel and cobble dominated reaches upstream.

Survey Equipment, Methodology and Procedures:
Sub-centimetre, survey-grade Sokkia GRX1 and a Nikon DTM-350 Total Station were used for all survey data collection. The GPS system used is based on RTK on the TOP-NET network.

Cross sections were surveyed at the locations provided by the RVCA. Cross sections were surveyed from edge of water to edge of water at each location. Each change in grade in the cross section was surveyed while keeping the point spacing no greater than 1-2m.

The use of a flat bottom jon boat allowed the survey team to navigate open water areas in the lower reaches of Stevens Creek. The creek remains navigable up to the town of North Gower.

Bathymetry Processing:
The bathymetric survey was processed and a PXYZD formatted excel spreadsheet was created.

Verification and Quality Control Description:
The original survey was completed in NAD83 CSRS 2010, UTM Zone 18N and fixed vertically to CGVD2013. The final product has been submitted to the RVCA in NAD83 CSRS 2010, UTM Zone 18N and CGVD1928 HT2.0.

To ensure accuracy, the attached cosine benchmarks (0011986U012, 0011986U014 AND 00820010097, see Appendix A) were observed.

The GPS units used have accuracy control settings which were set to 0.03 m Vertical and 0.03m Horizontal for the entire survey.

In summary, Water's Edge is pleased to provide Rideau Valley Conservation with this data and Summary Report.

Respectfully submitted,

Ed Gazendam, Ph.D., P.Eng.,
President, Sr. Geomorphologist
Water's Edge

Eric Gazendam
Fluvial Geomorphic Technician
Water's Edge

APPENDIX A:

Benchmarks

Ontario Ministry of Natural Resources and Forestry

COSINE Station Report

Retrieval Date: 2019-Jun-06

Control Survey Information Exchange

Station: 0011986U012

Known Status: Existing
Last Reported Visit:
Monument Type: CAP
Station Type: SPIR

AKA Names: 00186U012, 86U012, CP88211
Number of Ref Sketches: 0
Networks [usage]: 3301V [FIXV], 3301V13 [FIXV]

Location Description:
KARS - BRIDGE ALONG ROGER STEVENS RD (HWY NO 6), 1.5 KM NW FROM UNITED CHURCH. ABUTMENT, 25 CM FROM EAST SIDE.

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: NAD-1983:ORIG	**Horiz Order:** Unclassified	**Ellipsoidal Order:**
Latitude: N45° 9′ 15.3xxxxx″	**Longitude:** W75° 39′ 45.2xxxxx″	**Ellipsoidal elev:**

UTM Zone: 18	**E:** E447920.xxx	**N:** N5000299.xxx	**C. S. F.:** 0.99963334	**Mrdl Convg:** -0° 28′ 11.2″
MTM Zone: 9	**E:** E370645.xxx	**N:** N5001927.xxx	**C. S. F.:** 0.99995329	**Mrdl Convg:** 0° 35′ 37.6″

Vertical (Geoidal) Control Data

Datum: CGVD2013	**Vert Order:** First Order	**Elevation:** 88.245
Meridional defl:	**Prime vert defl:**	**Undulation:**

Datum: CGVD28:78	**Vert Order:** First Order	**Elevation:** 88.552
Meridional defl:	**Prime vert defl:**	**Undulation:**

Maintenance / History

Date	Description
2019-Mar-20	Established by GSC 1986. Inspected 1988. Used in 2011.

Reference Sketches

Reference sketch for 0011986U012 is not available.

Ontario Ministry of Natural Resources and Forestry

COSINE Station Report

Retrieval Date: 2019-Jun-06

Control Survey Information Exchange

Station: 0011986U014

Known Status: Existing

AKA Names: 00186U014, 86U014, CP88211

Number of Ref Sketches: 0

Networks [usage]:

Last Reported Visit:

Monument Type: -

Station Type: SPIR

Location Description:

Township: NORTH GOWER BRIDGE ALONG ROGER STEVENS RD (HWY NO 6), 0.3 KM EAST OF INTER WITH HWY NO 5 (TRAFFIC LIGHTS), TABLET IN NORTH FACE OF NE ABUTMENT, 0.3 M BELOW BRIDGE DECK, 20 CM FROM EAST SIDE.

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: **NAD-1927:SCAL**	Horiz Order: Unclassified	Ellipsoidal Order: Unclassified
Latitude: N45° 7′ 58.0xxxxx″	Longitude: W75° 42′ 43.0xxxxx″	Ellipsoidal elev: 91.xxx

UTM Zone: 18	E: E444015.xxx	N: N4997729.xxx	C. S. F.: 0.99962427	Mrdl Convg: -0° 30′ 16.6″
MTM Zone: 9	E: E366787.xxx	N: N4999285.xxx	C. S. F.: 0.99993296	Mrdl Convg: 0° 33′ 30.8″

Vertical (Geoidal) Control Data

Datum: **CGVD2013**	Vert Order: First Order	Elevation: 89.914
Meridional defl:	Prime vert defl:	Undulation:

Datum: **CGVD28:78**	Vert Order: First Order	Elevation: 90.221
Meridional defl:	Prime vert defl:	Undulation:

Maintenance / History

Date	Description
2019-Mar-20	GSC; last inspected: 1988

Reference Sketches

Reference sketch for 0011986U014 is not available.

Ontario Ministry of Natural Resources and Forestry

Control Survey Information Exchange

COSINE Station Report

Retrieval Date: 2019-Jun-06

Station:

00820010097

AKA Names:

Number of Ref Sketches: 1

Networks [usage]: 3229 [FREE], 3229V [FREE], C2ANDD2 [FREE], CBN31D [FREE]

Known Status: Existing

Last Reported Visit:

Monument Type: CAP

Station Type: GPS

Location Description:

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: **NAD-1983:CSRS:CBNV6-2010.0**	**Horiz Order:** CSRS Class D	**Ellipsoidal Order:** Fourth Order
Latitude: N45° 5′ 34.834692″	**Longitude:** W75° 39′ 12.379658″	**Ellipsoidal elev:** 63.428

UTM Zone: 18	**E:** E448582.420	**N:** N4993490.341	**C. S. F.:** 0.99962256	**Mrdl Convg:** -0° 27′ 46.1″
MTM Zone: 9	**E:** E371433.924	**N:** N4995129.923	**C. S. F.:** 0.99994463	**Mrdl Convg:** 0° 35′ 58.6″

Datum: **NAD-1983:CSRS:CBNv3-1997.0**	**Horiz Order:** CSRS Class D	**Ellipsoidal Order:** Fourth Order
Latitude: N45° 5′ 34.835122″	**Longitude:** W75° 39′ 12.380509″	**Ellipsoidal elev:** 63.412

UTM Zone: 18	**E:** E448582.401	**N:** N4993490.354	**C. S. F.:** 0.99962256	**Mrdl Convg:** -0° 27′ 46.1″
MTM Zone: 9	**E:** E371433.905	**N:** N4995129.936	**C. S. F.:** 0.99994463	**Mrdl Convg:** 0° 35′ 58.6″

Datum: **NAD-1983:ORIG**	**Horiz Order:** Third Order	**Ellipsoidal Order:** Unclassified
Latitude: N45° 5′ 34.841740″	**Longitude:** W75° 39′ 12.378780″	**Ellipsoidal elev:** 63.xxx

UTM Zone: 18	**E:** E448582.441	**N:** N4993490.558	**C. S. F.:** 0.99962256	**Mrdl Convg:** -0° 27′ 46.1″
MTM Zone: 9	**E:** E371433.941	**N:** N4995130.141	**C. S. F.:** 0.99994463	**Mrdl Convg:** 0° 35′ 58.6″

Vertical (Geoidal) Control Data

No vertical data found.

Maintenance / History

No maintenance data found.

Reference Sketches

Ministry of Transportation
Ontario

MONUMENT POSITION SKETCH

DATE: APR 17 · 2001	Job File:	Mon:
	Map Sheet:	
TIES UPDATED	Order:	Elev.:
	MTM - Zone:	C.M.:

TYPE OF MONUMENT: SIB & CAP RELATIONSHIP TO GROUND: - 5cm

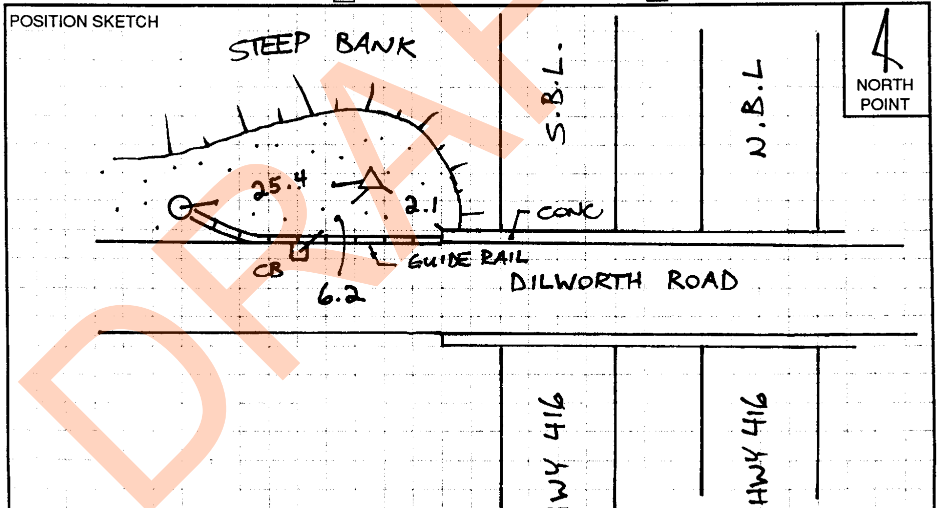
INTERVISIBLE WITH: 00820010096 & 00820010098

LOCATION:

Point is located 2.2 km north of Rideau River Rd. at Dillworth Road on Highway 416 north of Kemptville. The point is set west of the southbound lane on the northwest corner of the Dilworth Road overpass.

PURPOSE: LOCATE POINT [✓] PRECISE REFERENCE [ ]

POSITION SKETCH



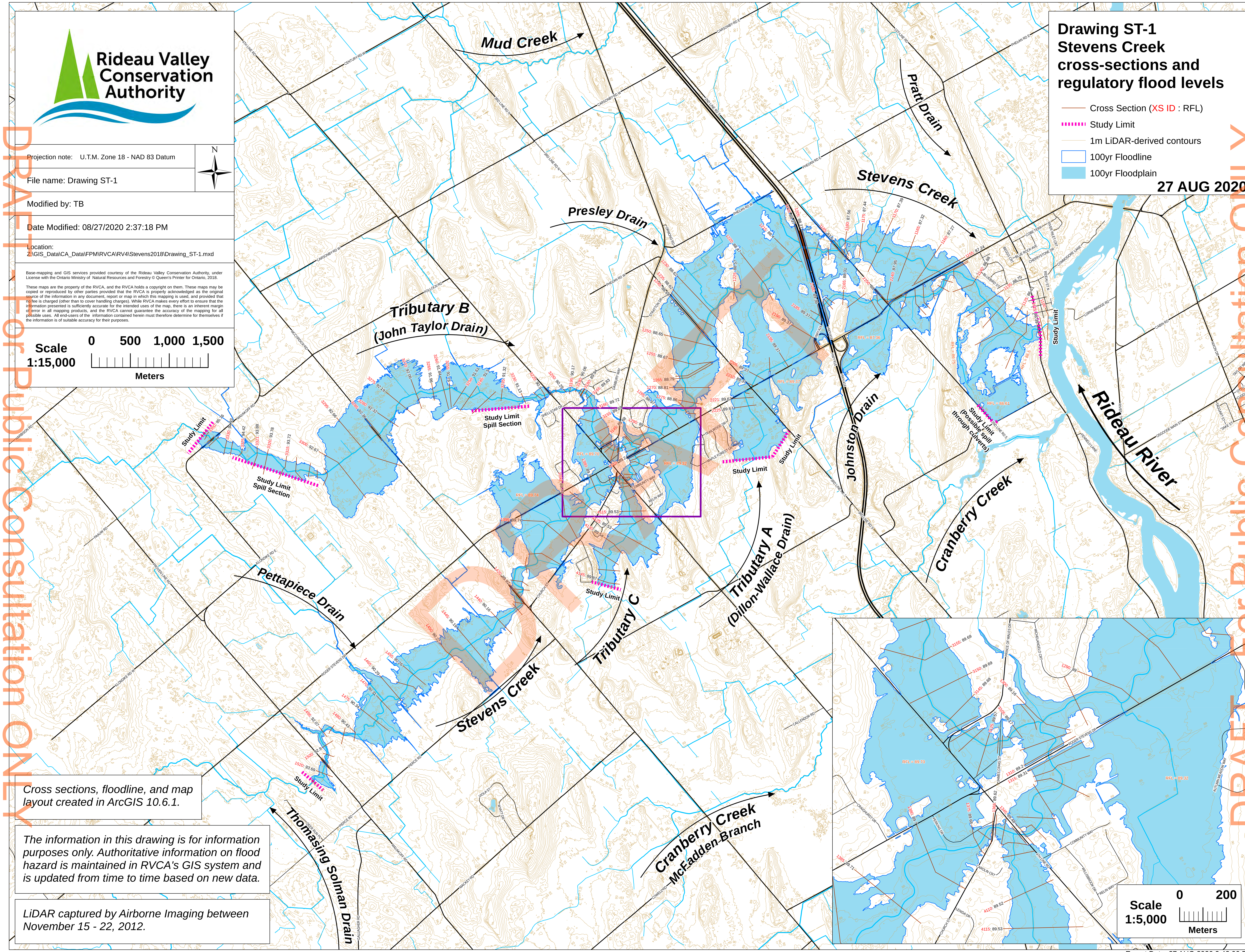
MONUMENT No. 00820010097

PH-D-808 88-08

Appendix G

Full-Size Drawings

(Drawings ST-1 and ST-2)



Rideau Valley Conservation Authority

Projection note: U.T.M. Zone 18 - NAD 83 Datum

File name: Drawing ST-1

Modified by: TB

Date Modified: 08/27/2020 2:37:18 PM

Location:
Z:\GIS_Data\CA_Data\FPM\RVCA\RV4\Stevens2018\Drawing_ST-1.mxd

Scale 1:15,000 — 0, 500, 1,000, 1,500 Meters

Drawing ST-1
Stevens Creek cross-sections and regulatory flood levels

- Cross Section (XS ID : RFL)
- Study Limit
- 1m LiDAR-derived contours
- 100yr Floodline
- 100yr Floodplain

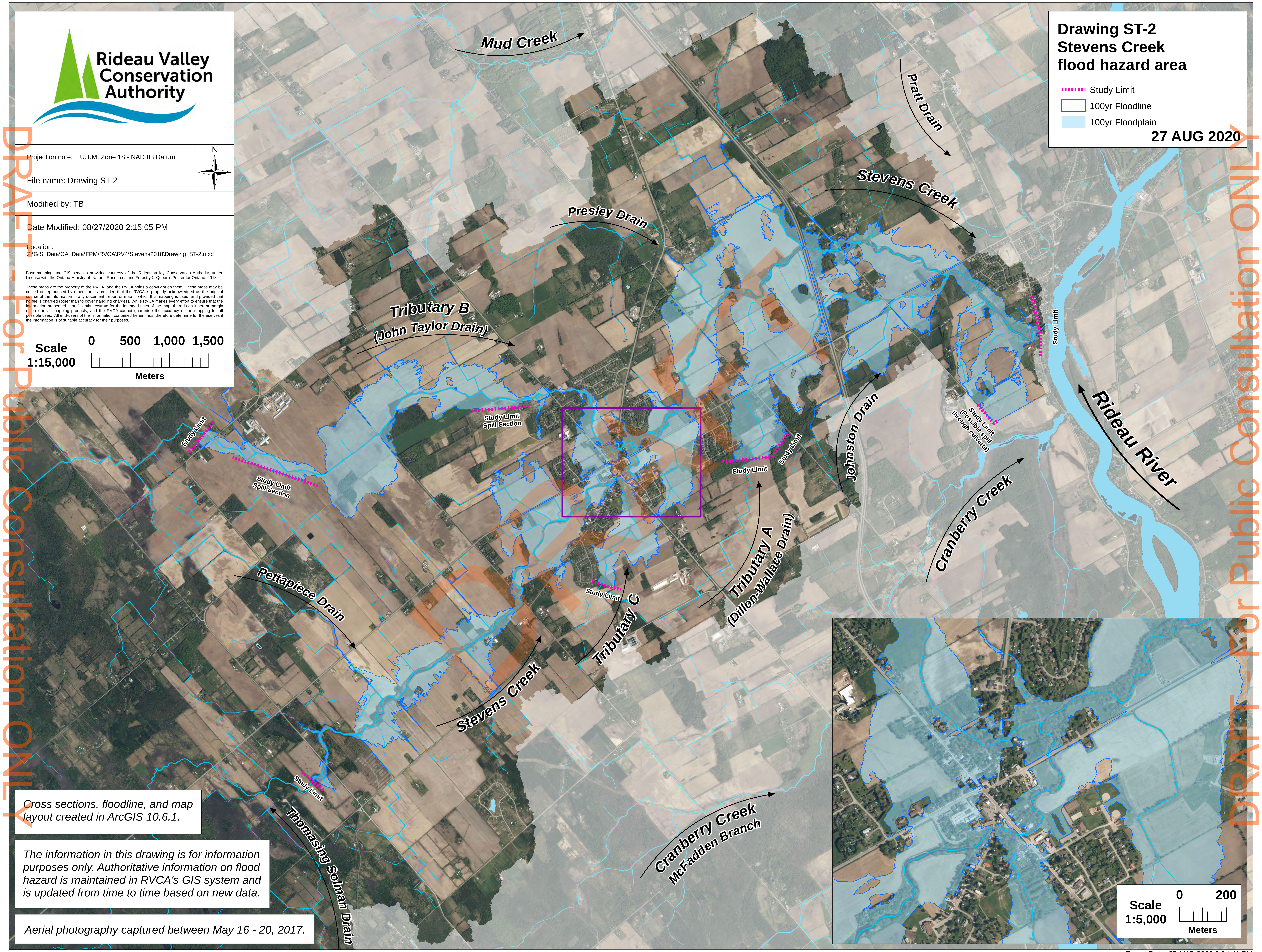
27 AUG 2020

Cross sections, floodline, and map layout created in ArcGIS 10.6.1.

The information in this drawing is for information purposes only. Authoritative information on flood hazard is maintained in RVCA's GIS system and is updated from time to time based on new data.

LiDAR captured by Airborne Imaging between November 15 - 22, 2012.

Export Date: 27 AUG 2020 2:43:00 PM



Export Date: 27 AUG 2020 2:34:41 PM