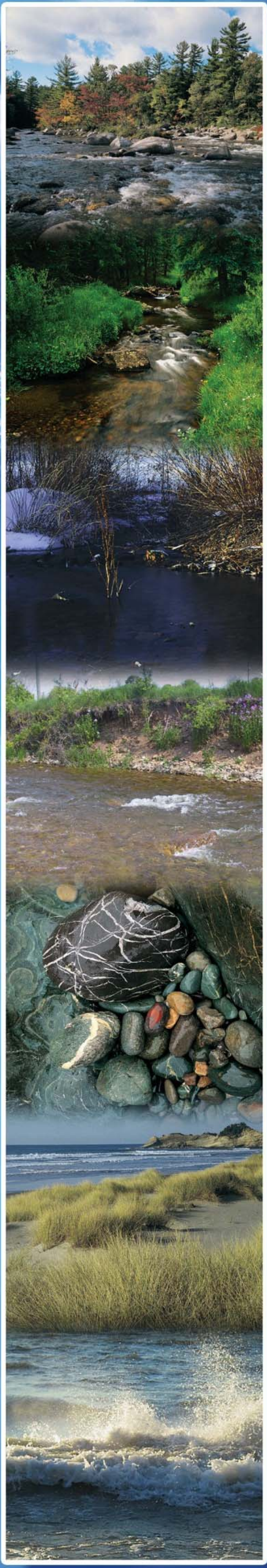


water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

Middle Monora Creek
Orangeville, ON

Fluvial Geomorphological Assessment: Erosion Threshold & Meander Beltwidth Assessments and Floodplain Mapping

October 29, 2013
Revised April 10, 2019

October 29, 2013
Revised April 10, 2019
WE 13016

Ms. Carmen Jandu
Orangeville Highlands Ltd.
2458 Dundas St. W.
Mississauga, Ontario
L5K 1R8

Dear Ms. Jandu:

RE: Orangeville Highlands Phase 2 – Middle Monora Creek
Fluvial Geomorphological Assessment:
Erosion Threshold and Meander Beltwidth Assessments

Water's Edge was authorized by Orangeville Highlands Ltd. to complete a fluvial and floodplain assessment of Middle Monora Creek in the Town of Orangeville, Ontario. This report outlines the following:

- Existing geomorphic stream conditions;
- Erosion threshold conditions;
- Meander beltwidth assessment and,
- Floodplain mapping.

We have completed our assessment of the creek in accordance with the approved project Terms of Reference. Data sources for the analysis include:

- Map of the study area (from © OpenStreetMap contributors and Google Imagery);
- Physiography of Southern Ontario by Chapman & Putnam (digital data from Ministry of Northern Development and Mines (MNDM));
- Topography information from J. D. Barnes Ltd;
- Site Inspections and Geomorphic Surveys; and,
- Discussions with Orangeville Highlands Ltd., Urbantech Consulting and CVC staff.

Site inspections and a geomorphic survey of Middle Monora Creek were completed by Water's Edge staff in June 2013. The site inspection was undertaken after an initial review of the mapping and available literature was completed in order to confirm site and general system characteristics.

The Study Area (see Figures 1 and 2) is located in Middle Monora Creek west of Highway 10 at the downstream end to 200m upstream of the Orangeville Highlands property and between Starrview Crescent Town of Mono and Hansen Boulevard within Orangeville, Ontario at the upstream end. The complete study reach of the creek is approximately 1.25 km long.

1.0 EXISTING CONDITIONS

Geology & Physiography

Reviewing the site area's surficial materials is important to evaluate active channel processes. Stream channel form and sediment supply are controlled by the region's physiography and underlying surficial geology.

Middle Monora Creek is located in two physiographic regions – Hillsburgh Sandhills in the upstream reaches of the site and Guelph Drumlin Field in the downstream reaches. The outstanding characteristics of the Hillsburgh Sandhills are rough topography, sandy materials, and the flat bottomed swampy valley through the Oakville Moraine kame deposits. The upper reaches are located on the kame moraines and as the name suggests, this physiographic region is dominated by fine sands which is atypical of kame moraines. The lower reaches are located in a spillway landform within a drumlinized plain which is characterized by till deposits from ancient meltwater spillways. The land between the drumlins is often swampy. The northern part of this physiographic region which contains the study area has been classified in the Harriston catena. The soil type in this sequence has a silty texture and is yellowish brown in colour. Figure 1 shows the local physiography in the study area.

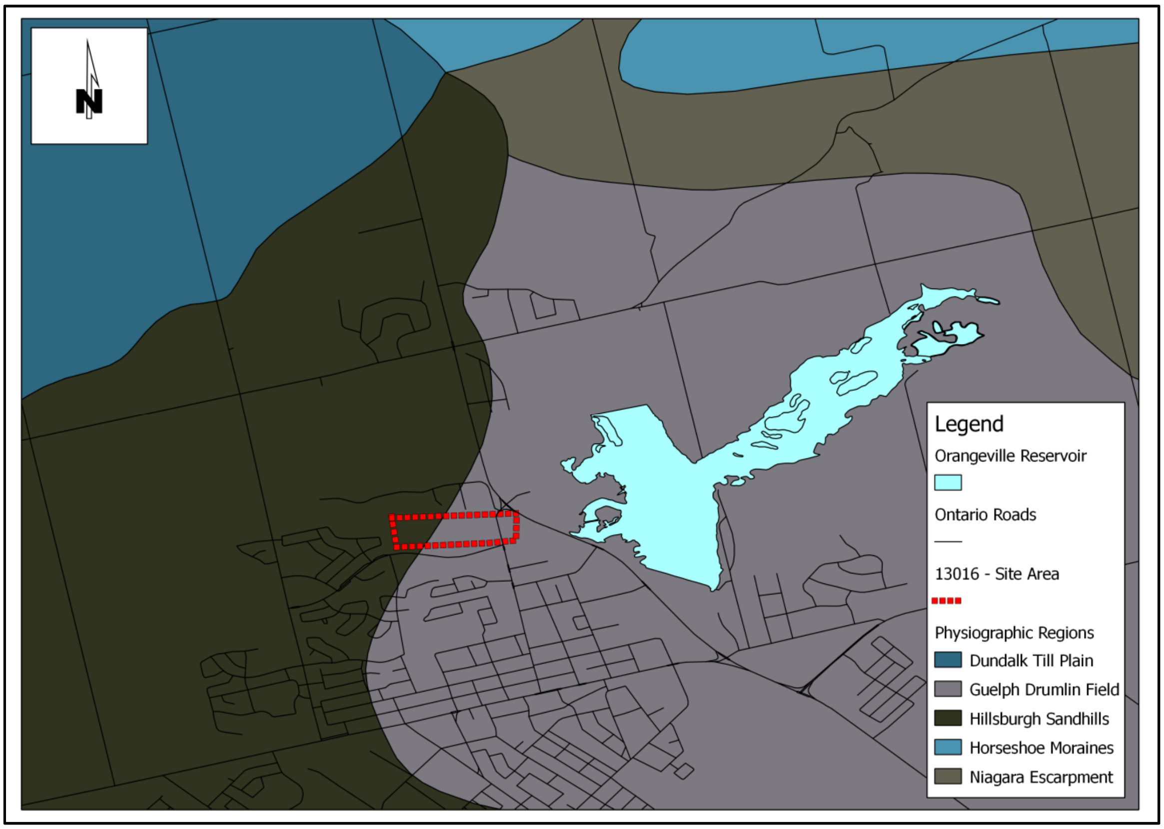


Figure 1: Local Physiography (data from MNDM)

General Watershed Characteristics
Middle Monora Creek is likely a 2nd/3rd order tributary of the Monora Creek. It originates west of Blind Line in Orangeville and drains into the Orangeville Reservoir east of Highway 10.

Channel Characterization
A geomorphic survey was performed on a portion of Middle Monora Creek. The study area began approximately 1.25 km upstream of Highway 10. The downstream boundary was formed by Highway 10. A total of 18 sections were surveyed.

Figure 2 shows the study reach within Middle Monora Creek. In addition to confirming our desktop assessment, field reconnaissance and a geomorphic survey included the determination of various geomorphic parameters. Figures showing the longitudinal profiles and cross sections of Middle Monora Creek are provided in Appendix A. Appendix B shows photographs detailing typical channel conditions within the study area.

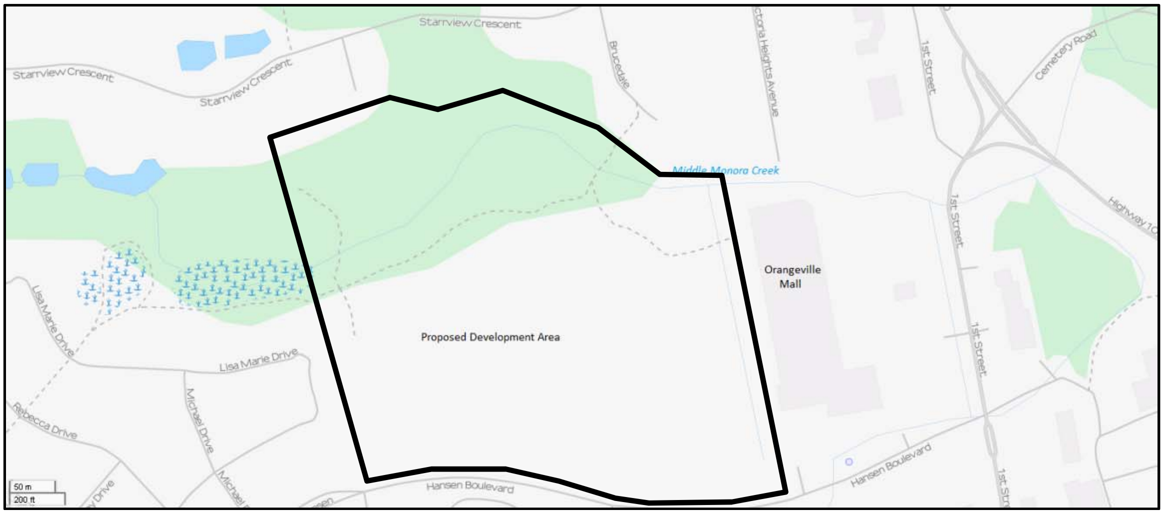


Figure 2: Location of Site (modified map from © OpenStreetMap contributors)

Reach Delineation
Channel morphology and substrate characteristics can change along a watercourse. Hence, it becomes imperative to account for these changes by delineating lengths of a watercourse that exhibit similar planform, sediment substrate, land use, local geology, valley confinement, hydrology and slope. In this study, six different reaches were delineated to account for change landuse, physical constraints (including hydraulic controls), sediment substrates and local geology. Other characteristics remained very comparable along the entire length of the Middle Monora Creek that was studied. Figure 3 shows the planform view of the different reaches. The general reach characteristics are presented in Table 1.

Reach 1
This reach is the downstream most reach and is located between Highway 10 and First Street. The substrate within the reach ranges from silts to gravel. However, large portions of this reach, particularly in the riffles, are dominated by sands. The channel is only slightly entrenched (Entrenchment Ratio > 2.2) and shows low Width/Depth ratios (W/D < 12). The average bankfull slope in the reach is 0.004 m/m. The general bankfull width is approximately 1.7 m (based on our evaluation of bankfull conditions).

Reach 2
The substrate within the reach ranges from silts to gravel. However, large portions of this reach, particularly in the downstream riffles, are dominated by fine gravels. The channel is only slightly entrenched (Entrenchment Ratio > 2.2) and low Width/Depth ratios (W/D < 12). The average bankfull slope in the reach is 0.016 m/m. The general bankfull width is approximately 1.4 (based on our evaluation of bankfull conditions).

Reach 3
The upstream section of this reach is bounded by outlet from an existing pond south of the creek. The substrate within the reach ranges from silts to sands. Generally, the channel is only slightly entrenched (Entrenchment Ratio > 2.2). This reach shows low values for Width/Depth ratio (W/D < 12). The average bankfull slope in the reach is 0.016 m/m. The general bankfull width is approximately 1.4m (based on our evaluation of bankfull conditions).

Reach 4
The upstream section of this creek is bounded by a culvert beneath a walkway that connects to the subdivision north of the study area. The substrate within the reach ranges from silts to gravel. However, large portions of this reach, particularly in the riffles, are dominated by sands and gravel. The channel is only slightly entrenched (Entrenchment Ratio > 2.2) and generally shows a low

width to depth ratio (W/D < 12). The average bankfull slope in the reach is 0.019 m/m. The general bankfull width is approximately 2.1 (based on our evaluation of bankfull conditions).

Reach 5
The upstream boundary of this reach is directly north of the west end of Orangeville Highlands property. The substrate within the reach ranges from silts to cobbles. Generally, the channel is only slightly entrenched (Entrenchment Ratio > 2.2). This reach generally shows low values for Width/Depth ratio (W/D < 12). The average bankfull slope in the reach is 0.019 m/m. The general bankfull width is approximately 2.5m (based on our evaluation of bankfull conditions).

Reach 6
The upstream boundary of this extends the west end of Orangeville Highlands property by 200 m. The substrate within the reach ranges from silts to cobbles. Generally, the channel is only slightly entrenched (Entrenchment Ratio > 2.2). This reach shows high values for Width/Depth ratio (W/D > 12). The average bankfull slope in the reach is 0.019 m/m. The general bankfull width is approximately 1.5m (based on our evaluation of bankfull conditions).

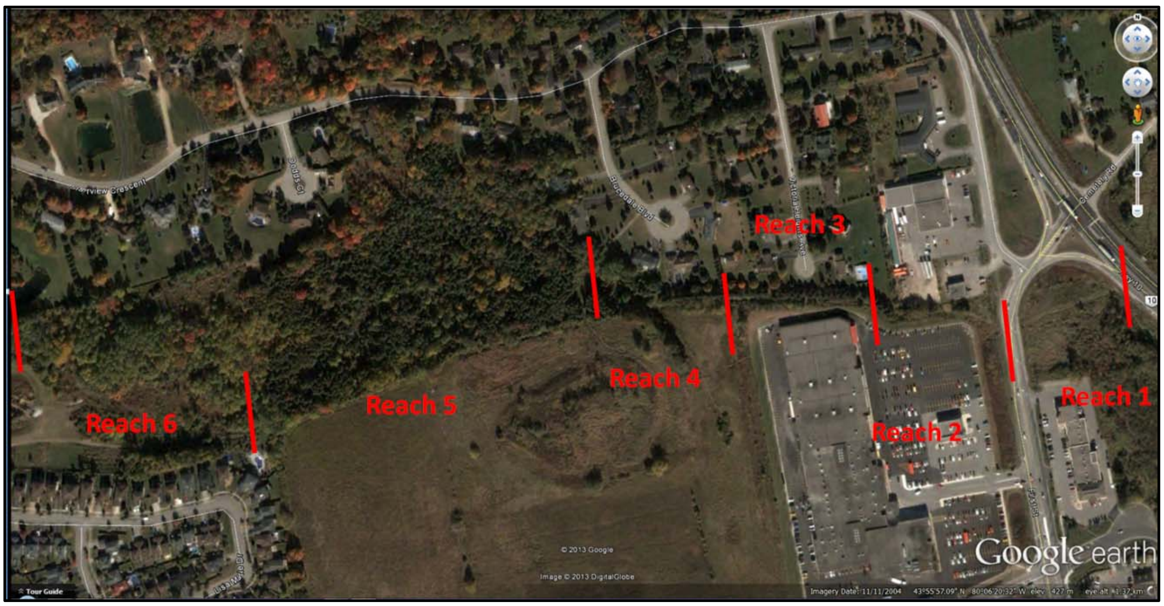


Figure 3: Location of Reaches (image from GoogleEarth)

In summary, the study area of Middle Monora Creek can generally be considered to be a Rosgen E4/5 system showing characteristics of a C4 system in upstream most reach.

The results of the observed and calculated geomorphic parameters are noted in Table 2. Stream classifications are also presented in Table 2. While classification of stream systems into relatively simple categories can be problematic, classification for the purposes of communicating a general idea of stream conditions is simple and helpful. However, the nature of the watershed and the highly altered channel conditions result in a system that may not be in equilibrium with its classification. Classification is not to be considered as a prediction for the ultimate response to existing erosion treatments. As such, this classification should be considered carefully

Table 1: General Reach Characteristics

Reach	Characteristics
1	Artificially straightened channel in grassland area with large floodplain High amounts of large woody debris Highly erodible bank material Good pool/riffle pattern
2	Artificially straightened channel Rip-rap in channel. Natural substrates are fine and erodible Built-up floodplain Poor pool/riffle pattern
3	Artificially straightened channel Built-up floodplain Channel substrate is highly erodible Poor pool/riffle pattern
4	E-type channel with some forested riparian and large floodplain High amounts of large woody debris. Some log jams observed Some sub-angular substrate observed in channel (possibly introduced)
5	Natural channel in forested area with large floodplain High amounts of large woody debris causing jams & changes in channel morphology Good pool/riffle pattern. Banks are not generally stable Dynamic system within the forested area Width/Depth ratio decreases as channel progresses downstream Riparian is forested
6	Natural channel in forested area with large floodplain High amounts of large woody debris Good pool/riffle pattern Riparian is forested

Table 2: Summary of Study Area Geomorphic Parameters

Parameter	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6
Bankfull Width (m)	1.72	1.43	1.39	2.11	2.45	1.54
Bankfull Mean Depth (m)	0.23	0.22	0.20	0.30	0.25	0.11
Bankfull Max Depth (m)	0.45	0.33	0.41	0.51	0.37	0.27
Bankfull Area (m^2)	0.38	0.31	0.27	0.65	0.63	0.19
Wetted Perimeter (m)	2.21	1.74	1.79	2.49	2.71	1.76
Hydraulic Radius (m)	0.17	0.18	0.15	0.25	0.22	0.10
Width-Depth Ratio	8.05	6.51	7.55	7.28	11.22	14.25
Entrenchment Ratio	6.87	4.01	6.58	3.86	4.27	8.55
Bankfull Slope	0.00434	0.01606	0.01552	0.01865	0.01806	0.01806
Channel Substrate D_{50} (mm)	1.27	37.36	0.14	Coarse sands to cobbles	54.90	Silts to fine gravels
Channel Substrate D_{84} (mm)	4.69	53.61	0.31		88.10	
Rosgen Classification	E	E	E	E	E/C	C

2.0 STREAM ASSESSMENT SCORES

In addition to classification of a stream system, various techniques for geomorphic assessments are used to better understand general stream conditions (stability, habitat, erosion/degradation, riparian, etc.). In our assessment of Middle Monora Creek, we used Rapid Geomorphic Assessment and Rapid Stream Assessment Technique. The raw worksheets for these assessments can be found in Appendix C.

Rapid Geomorphic Assessment (RGA)
Creek stability was assessed using a Rapid Geomorphic Assessment (MOE, 2004). The RGA assessment focuses entirely on the geomorphic component of a river system. The RGA method consists of four factors that summarize various components of channel adjustment, specifically: aggradation, degradation, channel widening and plan form adjustment. Each factor is assessed separately and the total score indicates the overall stability of the system. This methodology has been applied to numerous streams and rivers and the following table details the ranking criteria (see Table 3).

The scores for the reaches of Middle Monora Creek were determined to range from 0.18 to 0.46 which can largely be considered to be indicative of a "Transitional" or "Stressed" system. However, the upstream most reach was determined to be "in regime" and the reach immediately downstream of the "in regime" reach was determined to be "in adjustment" since widespread evidence of aggradation, widening and planimetric form adjustments were observed. The remaining reaches scores indicating a transitional nature. The detailed RGA evaluation is presented in Appendix C.

Table 3: Interpretation of RGA Score

Stability Index (SI) Value	Classification	Interpretation
SI ≤ 0.20	In Regime	The channel morphology is within a range of variance for rivers of similar hydrographic characteristics and evidence of instability is isolated or associated with normal river meander processes.
0.21 ≤ SI ≤0.40	**Transitional/Stressed**	**Channel morphology is within a range of variance for rivers of similar hydrographic characteristics but the evidence of instability is frequent.**
SI ≥ 0.40	In Adjustment	Channel morphology is not within the range of variance and evidence of instability is wide spread.

Rapid Stream Assessment Technique (RSAT)
Rapid Stream Assessment Technique was developed by John Galli and other staff of the Metropolitan Washington (DC) Council of Governments (Galli et al, 1996). The RSAT systematically focuses on conditions reflecting aquatic-system response to watershed urbanization. It groups responses into six categories, presumed to adequately evaluate the conditions of the river system at the time of measurement on a reach-by-reach basis. The six categories are:

1. Channel stability;
2. Channel scouring and sediment deposition;
3. Physical in-stream habitat;
4. Water quality;
5. Riparian habitat conditions; and
6. Biological conditions.

River channel stability and cross-sectional characterization is a critical component of RSAT. The entire channel was inspected for signs of instability (such as bank sloughing, recently exposed non-woody tree roots, general absence of vegetation within bottom third of the bank, recent tree falls, etc.) and channel degradation or downcutting (such as high banks in small headwater streams and erosion around man-made structures). Observations were noted and cross-section measurements were made.

A rapid assessment of soil conditions along the river banks is also conducted to determine soil texture and potential erodibility of the watercourse bank. Qualitative water quality measurements were also made (temperature, turbidity, colour and odour) along with an indication of substrate fouling (i.e., the unwanted accumulation of sediment).

RSAT also typically involves a quantitative sampling and evaluation of benthic organisms. As no benthic sampling was undertaken, the score was based on site conditions and general observations of water quality.

Each category was assigned a value which was then summed to provide an overall score and ranking. Table 4 details the range of scores and rankings with a higher score suggesting a healthier system.

Within these broad categories, we evaluated the study area and determined an average RSAT score of 31.5. In general, Middle Monora Creek, within the study area, is a "fair" or a "good" system. A reach by reach breakdown score indicates that the upstream three reaches are in a "good" condition, while the downstream three reaches are in a "fair" condition.

The results of the RSAT evaluation are included in Appendix C.

Table 4: Interpretation of RSAT Score

RSAT Score	Ranking
41-50	Excellent
31-40	**Good**
21-30	**Fair**
11-20	Poor
0-10	Degraded

3.0 CHANNEL FLOWS

Using data from the geomorphic field work, and using a friction factor/relative roughness methodology, bankfull flows in this system were determined. The results of the friction factor approach were very similar to that of Limerinos' method and the Darcy-Weisbach method. Bankfull flows were obtained for all four reaches. However, bankfull indicators are more obvious and reliable within Reach 1 and Reach 6 than in Reaches 4 and 5 given that the middle reaches are fairly dynamic. The average flows in both Reaches 1 and 6 are 0.38m^3/s. The middle reaches show a range of bankfull flows ranging from 0.5 to 1.12 m^3/s. In these middle reaches, the low flow channel is still in the process of development. The channel in Reaches 1 and 6 have been fairly undisturbed in recent times so that the channel is fairly stable with a developed low flow channel. Reaches 4 and 5 have a high supply of woody debris and organic matter which were noted to form channel constrictions in some sections. Thus, the channel through these areas is trying to establish quasi-equilibrium conditions. Additionally, Reaches 2 are also stressed due to the input from the existing pond. The channel in these reaches has not established itself. Therefore, the bankfull indicators here are not reliable. Therefore, to establish bankfull estimates, Reach 1 and 6 are the most reliable.

Independently, and based on our database of stream systems of stream in quasi-equilibrium, we also examined a typical bankfull width and depth for this size of watershed. Based on the resultant area (width x depth, computed using information from our stream database) and a velocity determined with Manning's equation, a range of flows from 0.36 to 1.01m^3/s were calculated. The flows for the downstream reaches are very comparable to our estimates from the previous method. However, the flows in the upstream reaches are not very comparable. A possible reason for this discrepancy is that the stream database does not specifically account for streams within watersheds of varying landuse.

As a result, we also regressed the existing return period flows as provided by CVC. The resultant 1:1.5 and 1:1.01 year return period flow is expected to be 0.38 and 0.30m^3/s, respectively (see Figure 4). Typically, bankfull return periods have been associated with 1:1.5 year return period. This theory holds true in this case. The correlation between calculations based on geomorphic results and flow regression represents a reasonable confirmation of the field results.

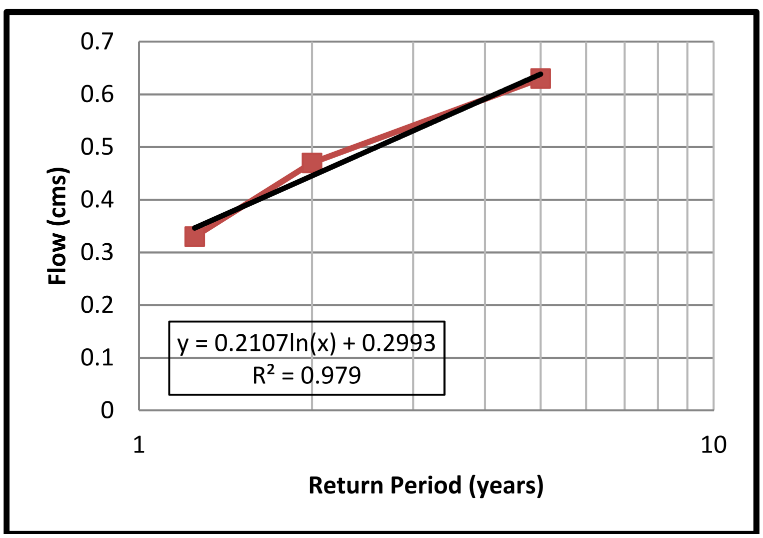


Figure 4: Flow Regression Analysis

As such, bankfull flow is estimated to be approximately 0.4m^3/s (based on Reach 1 and 6 where the bankfull indicators are well defined) within the study reach.

4.0 EROSION THRESHOLD ASSESSMENT

4.1 General

The geomorphic assessments included measurements of channel, bank and bankfull flow characteristics. The survey provided a measure of the local energy gradient. Detailed information was collected in order to determine erosion thresholds, shear stress and critical discharge values. Erosion thresholds indicate the point at which sustained flows will tend to entrain and transport sediment, specifically the D_{50} and D_{84} of the substrate materials.

Calculations of bankfull discharge were based on measurements of channel cross-sectional dimensions, bankfull gradient and stream bed roughness. Additionally, a variety of geomorphic threshold predictors were used in combination with measurements of substrate and bank material to determine the appropriate erosion threshold. Reaches 1, 2 and 3 were assessed to identify the erosion potential criteria.

Given the nature of the substrate and bank composition, the calculations performed to determine the threshold discharge for bed materials were based two types of approaches. The first approach utilizes tractive forces while the other is based on permissible velocities. For the first approach, the Critical Particle Shear Stress is examined against the mean Boundary Shear Stress at the channel. To determine the Critical Particle Shear Stress the formulae presented by Komar (1987) and Fischenich (2001) were used, both of which are based on the original Shields work. Based on the critical shear stress determined by this method, a critical depth is back-calculated and a critical discharge is determined. The permissible velocity approach utilizes Hjulstrom's chart to plot the particle mean velocity and the median particle size to determine if the material represented by the median grain size is likely to erode, deposit or be transported. The mean velocity plotted is the permissible velocity determined from a table presented by Fortier and Scobey (1926) for various materials types. Additionally, a permissible tractive force approach for grassed channels (Temple, 1980) was also used. This approach establishes an effective bed shear stress which is then compared to the permissible shear stress for an existing class of vegetation. A critical flow is calculated for the permissible shear stress for cross sections where the permissible shear stresses exceed effective bed shear stress.

4.2 Erosion Threshold Considerations

Using the data collected during the field investigations, related hydraulic parameters were determined including stream power, unit stream power, bed shear stress/effective bed shear stress and critical shear stress/permissible shear stress were determined at each cross section.

Of the three reaches assessed, the substrate in all cross sections in Reach 3 and one of the cross sections in Reach 2, and two cross sections in Reach 1 are primarily composed of fine particles (silts and sands). These particles contribute to very low critical shear stresses (which is a function of particle size) calculated using the tractive force method using the Komar (1987) and Fischenich (2001) formulae. However, in some cases, factors such as vegetation in addition to channel substrate provide roughness and reduce shear stresses on the channel. Reaches 1, 2 and 3 show vegetation in the channel (refer to Appendix B for photos). This is particularly true of cross sections showing finer particles sizes. In these cases, the permissible shear stresses were used to determine the critical flows and additionally, the bed shear stresses calculated were corrected to account for the vegetation using the Temple (1980) equation. The vegetation in the channels was classified as "Class E". The appropriate parameters for this class of vegetation were used to determine the effective bed shear stress and the permissible shear stress and velocity.

The channel materials chosen at each cross section for the permissible velocity method is presented in Table 5. A critical shear stress is associated with each of the permissible velocity values. This information is used to determine the critical discharge. Tables 6A, 6B and 6C provide the summary of the results from the various methods for Reach 1, 2, and 3, respectively. The highlighted rows in the table indicate the method chosen to determine the critical flows. Additionally, Figures 5 to 7 in show the Hjulstrom Charts for the surveyed reaches.

Table 5: Permissible Velocity Bed Materials Used

Cross Section	Bed Material used
R1XS2	Fine gravel
R1XS3	Alluvial silts, non-colloidal
R1XS4	Fine gravel
R2XS1	Alluvial silts, non-colloidal
R2XS2	Graded silts to cobbles when non-colloidal
R2XS3	Graded silts to cobbles when non-colloidal
R3XS1	Silt loam, non-colloidal
R3XS2	Sandy loam, non-colloidal
R3XS3	Alluvial silts, non-colloidal

NOTE: Descriptions of bed materials are based on Chang (1988)

As shown in Tables 6A, 6B and 6C, the permissible shear stress for vegetated channels was chosen for every cross section except for cross sections 2 and 3 of Reach 2. For these two cross sections, the tractive force method as per the Komar formula was used.

Table 6A: Summary of Geomorphic Analyses – Reach 1

Method	Parameter	R1XS2	R1XS3	R1XS4
SUMMARY PARAMETERS	Relative Roughness (m/m)	186.6	74.0	16.0
	Shear Velocity (m/s)	0.08	0.09	0.08
	Velocity based on FF/RR (m/s)	1.28	1.17	0.79
	Bankfull Q (cms)	0.37	0.35	0.40
	Froude #	0.91	0.73	0.60
	Stream Power (W/m)	15.8	14.9	16.9
	Unit Stream Power (W/m^2)	10.9	13.0	6.1
	BED SHEAR τ_o (N/m^2)	6.7	7.6	6.8
	Effective BED SHEAR τ_o (N/m^2)	0.14	0.17	0.21
KOMAR 1987	CRITICAL τ_{cr} (N/m^2)	0.61	0.33	1.84
	RATIO τ_{cr} / τ_o	0.23	0.51	0.12
FISCHENICH 2001	CRITICAL τ_{cr} (N/m^2)	0.49	0.25	1.60
	RATIO τ_{cr} / τ_o	0.29	0.66	0.13
PERMISSIBLE VELOCITY (COLLOIDAL WATER)	CRITICAL τ_{cr} (N/m^2)	15.33	7.18	15.33
	RATIO τ_{cr} / τ_o	0.01	0.02	0.01
	Permissible Velocity (m/s)	1.52	1.07	1.52
PERMISSIBLE VELOCITY (VEGETATED CHANNEL)	CRITICAL τ_{cr} (N/m^2)	16.8	16.8	16.8
	RATIO τ_{cr} / τ_o	0.01	0.01	0.01
	Permissible Velocity (m/s)	0.8	0.8	0.8

Table 6B: Summary of Geomorphic Analyses – Reach 2

Method	Parameter	R2XS1	R2XS2	R2XS3
SUMMARY PARAMETERS	Relative Roughness (m/m)	2994.8	2.8	3.0
	Shear Velocity (m/s)	0.17	0.16	0.16
	Velocity based on FF/RR (m/s)	3.79	0.83	0.90
	Bankfull Q (cms)	1.30	0.21	0.31
	Froude #	2.47	0.58	0.63
	Stream Power (W/m)	204.8	32.9	49.3
	Unit Stream Power (W/m^2)	143.2	27.6	29.7
	BED SHEAR τ_o (N/m^2)	28.3	24.5	26.4
	Effective BED SHEAR τ_o (N/m^2)	0.6	4.2	5.0
KOMAR 1987	CRITICAL τ_{cr} (N/m^2)	0.04	40.79	40.79
	RATIO τ_{cr} / τ_o	13.53	0.10	0.12
FISCHENICH 2001	CRITICAL τ_{cr} (N/m^2)	0.03	45.64	45.64
	RATIO τ_{cr} / τ_o	17.57	0.09	0.11
PERMISSIBLE VELOCITY (COLLOIDAL WATER)	CRITICAL τ_{cr} (N/m^2)	7.18	38.32	38.32
	RATIO τ_{cr} / τ_o	0.08	0.11	0.13
	Permissible Velocity (m/s)	1.07	1.68	1.68
PERMISSIBLE VELOCITY (VEGETATED CHANNEL)	CRITICAL τ_{cr} (N/m^2)	16.8	16.8	16.8
	RATIO τ_{cr} / τ_o	0.04	0.25	0.30
	Permissible Velocity (m/s)	0.8	0.8	0.8

Table 6C: Summary of Geomorphic Analyses – Reach 3

Method	Parameter	R3XS1	R3XS2	R3XS3
SUMMARY PARAMETERS	Relative Roughness (m/m)	3000.0	1078.0	681.8
	Shear Velocity (m/s)	0.15	0.13	0.17
	Velocity based on FF/RR (m/s)	3.40	2.69	3.16
	Bankfull Q (cms)	0.75	0.58	1.20
	Froude #	2.37	2.29	2.06
	Stream Power (W/m)	114.2	88.8	182.4
	Unit Stream Power (W/m^2)	108.8	57.3	115.4
	BED SHEAR τ_o (N/m^2)	22.8	18.1	28.0
	Effective BED SHEAR τ_o (N/m^2)	0.36	0.26	1.0
KOMAR 1987	CRITICAL τ_{cr} (N/m^2)	0.04	0.08	0.20
	RATIO τ_{cr} / τ_o	9.76	3.20	4.97
FISCHENICH 2001	CRITICAL τ_{cr} (N/m^2)	0.03	0.06	0.15
	RATIO τ_{cr} / τ_o	12.68	4.15	6.46
PERMISSIBLE VELOCITY (COLLOIDAL WATER)	CRITICAL τ_{cr} (N/m^2)	5.27	3.59	7.18
	RATIO τ_{cr} / τ_o	0.07	0.07	0.14
	Permissible Velocity (m/s)	0.91	0.76	1.07
PERMISSIBLE VELOCITY (VEGETATED CHANNEL)	CRITICAL τ_{cr} (N/m^2)	16.8	16.8	16.8
	RATIO τ_{cr} / τ_o	0.02	0.02	0.06
	Permissible Velocity (m/s)	0.8	0.8	0.8

Based on the various erosion threshold parameters, critical flows of the cross sections were determined. Of these flows, the critical flow for a given reach was determined based on the limiting cross section which is defined as the cross section with the lowest value for critical flow within a reach. These flows are presented in Table 7.

Table 7: Summary of Critical Flows

Reach	Limiting XS	Critical Flow (cms)
1	R1XS3	0.274
2	R2XS1	0.069
3	R3XS1	0.036

The lowest flow value (0.036 m^3/s at Reach 3) can be considered to be the critical flow for the subject reach.

The Hjulstrom diagrams shown below are based on the permissible velocities for colloidal water scenarios and the median grain size at each cross section. Additionally, the velocity for Class E vegetated channels is plotted using the average of all median grain sizes in the reach.

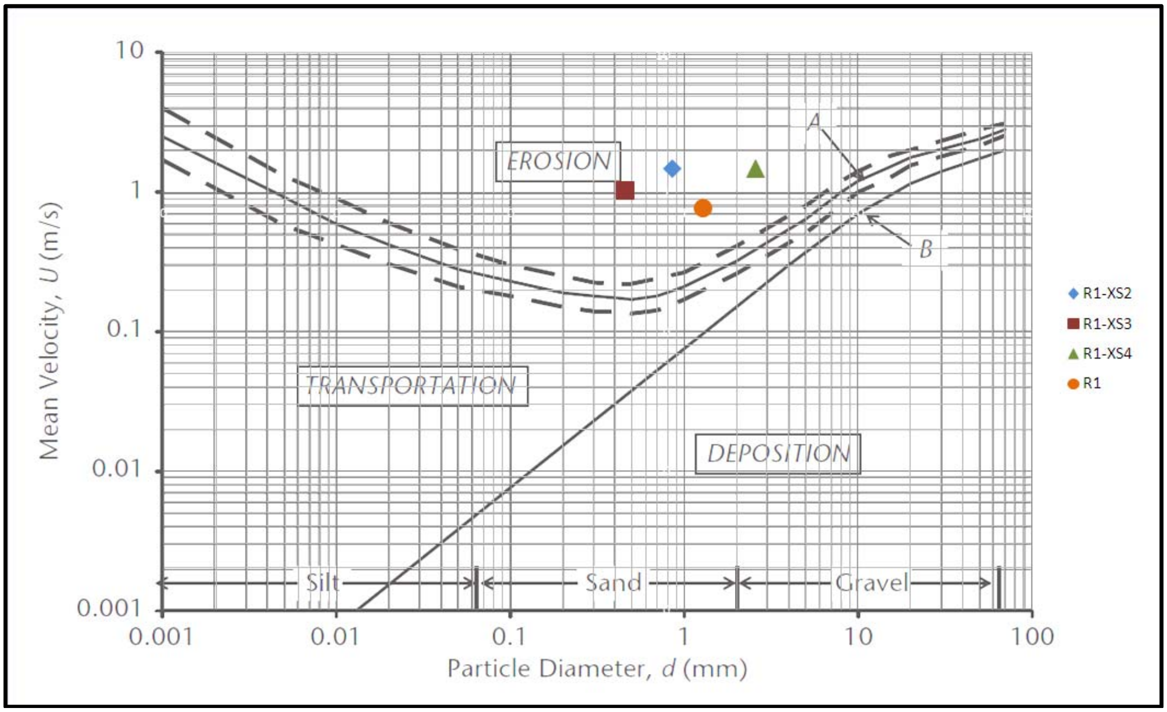


Figure 5: Hjulstrom's Chart for Reach 1 (modified from Dingman, 2009)

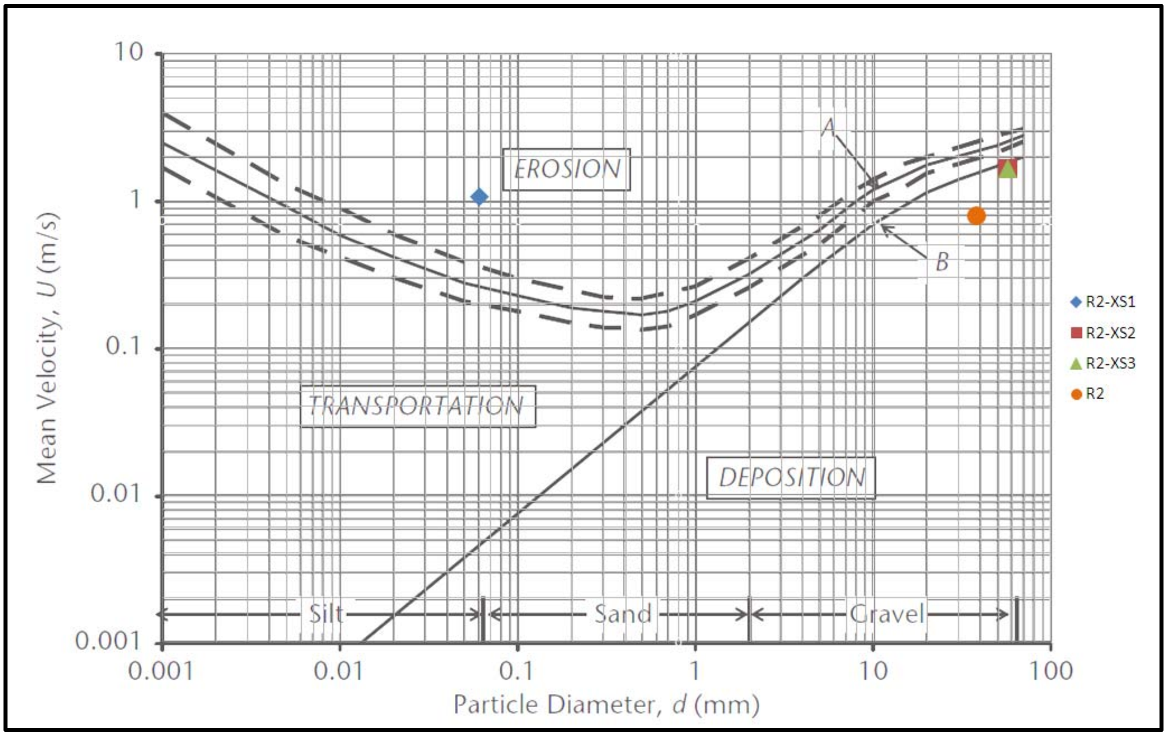


Figure 6: Hjulstrom's Chart for Reach 2 (modified from Dingman, 2009)

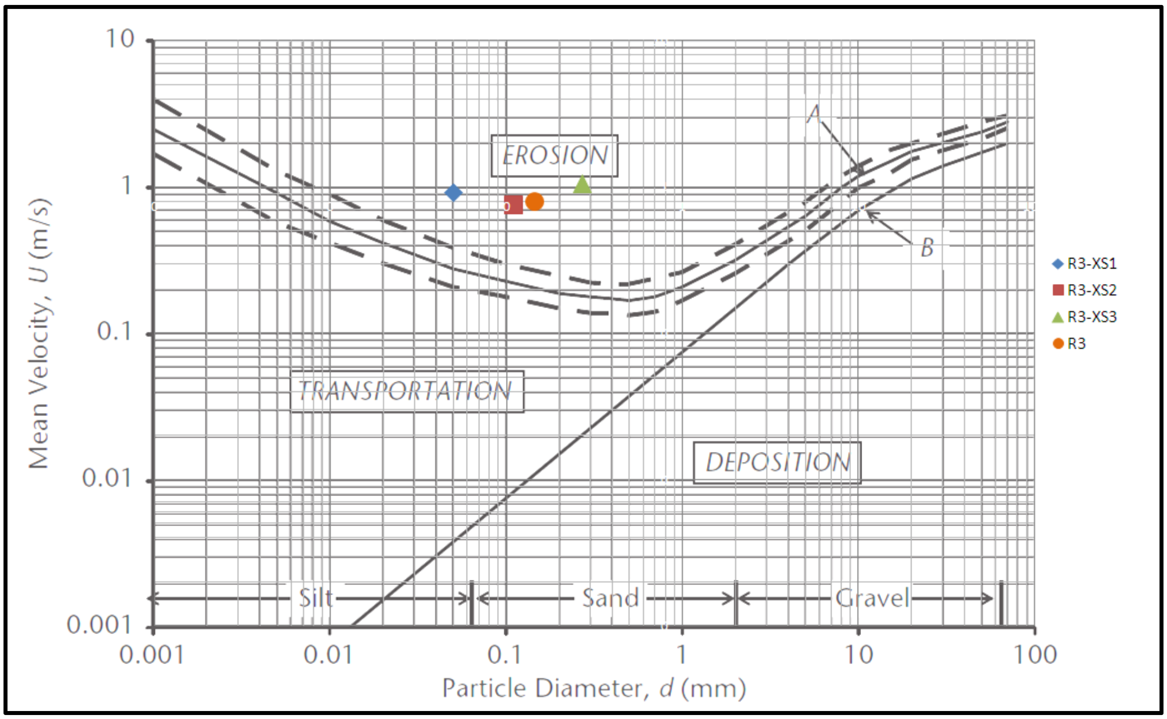


Figure 7: Hjulstrom's Chart for Reach 3 (modified from Dingman, 2009)

4.3 Discussion

The tractive force approach formulae used (Komar and Fischenich) provide converging values for critical shear stresses with Fischenich approach usually being the most conservative approach. As discussed previously, the Temple approach had to be used to accurately represent the channel and calculate the erosion threshold parameters as channel vegetation had to be taken into account. The channel vegetation provides additional roughness and ability to handle shear stresses from channel flows and hence reduces the potential for erosion. This approach required a correction factor to be used for the boundary shear stress. The resulting shear stress, termed the effective boundary (or bed) shear stress ranged from 0.14 Pa to 5 Pa. The maximum critical shear stress in the channel was determined to be 40.8 Pa. For the noted type of vegetation class, the permissible shear stress was determined to be 16.8 Pa.

The permissible velocities approach is based on general channel substrate material without taking other channel conditions into account. It is a less conservative approach but may be used to confirm the upper bound critical stress values obtained through other approaches. In our Hjulstrom diagrams, we have used the permissible velocities based on "colloidal water". This approach assumes that there will be suspended solids in the stream at flows at which critical stresses occur on the bed. Permissible velocities based on "clear water" provide lower critical shear stress values and may be used as worst-case scenarios. However, since we do not anticipate clear water conditions in cases of bankfull flows, the analyses based on this approach is not included in this report.

From Figure 5, it is evident that within Reach 1, median grain sizes are fine enough that they lie in the erosion side of the curves. However, in Reach 2, only cross section shows fine grain size that is likely to erode. Reach 3 is similar to Reach 1. However, it must be noted that although the diagrams act as predictors of the possibility of sediment transport and erosion, they do not take external factors such as vegetation into account. Therefore, the permissible velocities cannot be considered in isolation.

Based on the limiting cross sections (as determined by the cross sections showing the least critical flow value) as discussed in the previous section, the corresponding critical flow values was determined for the entire subject reach (Table 7). The tractive force method was used in conjunction of the permissible shear stress approach. Based on the results shown in tables 6 and 7, it is evident that 0.036 m^3/s is the critical flow through Reach 3.

4.4 Flow Duration Analysis

Existing and proposed conditions SWMHYMO models for the contributing watershed were developed. The watershed areas were based on discussions with CVC staff and the Functional Servicing Report provided by Urbantech (2010). The total area of the watershed up to the confluence of Middle Monora Creek with the channel proceeding from the proposed stormwater management (SWM) pond is 59.15 ha while the contributing area of the proposed development is 12.15 ha.

The models were run in continuous mode. As the model is not calibrated, typical parameter values representing the local watersheds were selected while basic development modelling parameters were acquired from the stormwater management modelling (Urbantech, 2010). It is noted that the proposed conditions modelling includes the proposed SWM facilities proposed as part of the Orangeville Highlands Phase 2 development.

The continuous rainfall data represents historical data for the 1986 to 1991 period, with this period being representative of a dry year, a wet year and the remainder being typical years. However, the SWMHYMO model does not have the ability to model winter conditions. As such, the model was used to simulate frost-free conditions only by modelling from April 1 to October 31, of each individual year. The antecedent moisture conditions were assumed to be saturated on April 1, which accounts for the spring freshet period of each year. Other model parameters are based on accepted values. In particular, the SK value was set at 0.25 which is appropriate for these soil conditions and is reasonably conservative.

The erosion assessment essentially consists of an erosion index approach where a post-development hydrograph is compared to pre-development hydrograph to determine the duration that the hydrograph exceeds a certain threshold.

The fluvial assessment component of this study concluded that the substrate and banks were not susceptible to increases in erosive forces due to the proposed development. Based on our fluvial assessment and from our threshold analysis, the critical discharge at this location is summarized in Table 7. The smallest, and therefore most conservative, discharge (i.e. a flow of 0.036 m^3/s in Reach 3) was utilized in the continuous SWMHYMO model to confirm the volume and duration of the erosion detention required for site control. This was specifically done by a pre vs. post development erosion exceedance analysis.

The model was run for existing and proposed conditions in order to determine the number of hours that the critical discharge (i.e. 0.036 m^3/s) was exceeded (see Table 7). The resultant erosive hours for existing and proposed conditions that the threshold is exceeded are summarized in Table 8. It is noted that the total time period for the continuous modelling is approximately 5200 hours.

From Table 8, it can be seen that with stormwater management, post-development releases are generally similar to that of existing conditions. Any positive change (i.e., increase in number of erosive hours), are less than 5% and can be considered to be statistically insignificant. The results indicate that three out of six years have no change while only one out of six years have a slight increase in flow exceedance where the proposed flows exceed existing conditions flows by 0.4 hours. The results also show a reduction of number of erosive flow hours for two of the six years.

Typically, the stormwater management facility design parameters would be adjusted to determine the required extended detention storage and draindown times. In this particular case, we can confirm that the proposed storage and draindown times are satisfactory.

Table 8: Resultant Hours above the Erosion Threshold Discharge

Time	1986	1987	1988	1989	1990	1991
Existing	0	0	2.4	0	4.5	9.6
Proposed	0	0	2.1	0	4.3	10
Change (%)	0	0	-12.5	0	-4.4	4.2

5.0 MEANDER BELTWIDTH ASSESSMENT

Beltwidth/Erosion Hazard Delineation Procedure
Assessment of the meander beltwidth was undertaken in accordance with commonly accepted meander beltwidth delineation procedures and follows the CVC's beltwidth delineating procedures outlined in the CVC Fluvial Geomorphic Guidelines.

It was determined by way of contour data and site observations that the channel is for the most part confined within the valley, which is a key component in determining the final beltwidth or hazard limits. There are some exceptions to the confinement however, where the valley is wide enough that the channel does not come within 15 metres of the valley toe of slope. In these cases, the channel can be described as partially confined or misfit. The channel here is not eroding the toe of the slope and does not show any signs of having done so in the past. The beltwidth/hazard delineation analysis will therefore be limited to erosion rates, analysis of the slope, and addition of the development setback.

The CVC's Fluvial Geomorphic Guidelines state that for a confined valley system three things are required; quantification of rates of erosion at the toe of slope, determination of geotechnically stable top of slope, and determination of development setback.

Erosion Rates and Historical Analysis
Erosion rates are determined by comparing the outside bends of a stream channel with the use of historical air photos. We have acquired and examined 1963, 1977, 1989, 1993, and 2002. Reaches 1 to 4 show a drastic change between years 1977 and 1989. These reaches were realigned perhaps for the construction of the Orangeville Mall directly south of Reaches 2 and 3, Therefore, for the determination of erosion rates and beltwidths, we used photos from 1989 to 2002 in addition to our 2013 survey. Air photo analysis shows that Middle Monora Creek generally has a straightened and a generally stable channel in the first seven beltwidth sections. However, due to heavy tree cover no historical comparisons could be made for the remaining sections. Vegetation for the study area in these sections is typically coniferous trees, shrubs and tall grasses which mask the channel.

Alternatively, the erosion rates will be approximated using Ontario's Natural Hazards Training Manual. The manual makes note of minimum toe erosion allowance for rivers within 15m of slope toe. In much of the study area the channel is within 15m of the slope toe, so the erosion allowance applies to this channel. For soft/firm cohesive soil with evidence of active erosion the erosion allowance would be between 8-15m. In this case because of the small bankfull width of Middle Monora the lowest of this range, 8m, would be applied. This 8 metre erosion allowance is applied to the edge of the bankfull channel with the stable slope being calculated up from this buffer. **Map 1** accounts for the toe of slope and an 8m channel erosion allowance.

Stable Slope
The CVC guideline states that the stable slope should be assessed through geotechnical analysis, however it is our opinion that the slopes adjacent to the proposed development are stable based on their existing gradient. This is supported by the Natural Hazards Training Manual which states that stable slope can be assessed by adding 3.0 times the height of the slope to the erosion allowance. Measurements of the slope indicate a gradient of approximately 4.5H:1V at the steepest location, with the majority of the slope being greater than 7H:1V. In addition, the slope is well vegetated, and no active erosion of the slope is occurring on or at the toe of the slope. **Map 1** accounts for a 3H:1V stable slope line.

Beltwidth Determination
The final beltwidth is based on the channel erosion allowance, the stable slope analysis, and an arbitrary development setback. Firstly, the erosion setback was taken from the Natural Hazards Training Manual and an 8m buffer has been applied to the bankfull channel. Secondly, the stable slope allowance is calculated from either the 8m erosion allowance buffer or the existing toe of

slope, whichever is greater. As the height of the slope varies throughout the study area, the setback from the erosion allowance/toe of slope varies as well and therefore required multiple points of measurements for the varying slopes. The 3:1 slope is calculated by multiplying the height of the slope by a factor of 3.0. For instance, a bank height of 4m has a 12m offset from the toe of slope. This offset is then applied to the toe of slope or erosion allowance, whichever is greater.

Finally, once the top of stable slope line is identified, the 10m erosion access allowance buffer is applied, and the final hazard line can be delineated. **Map 1** shows the toe of slope, 8m channel erosion allowance, the 3H:1V stable slope line, and the 10m erosion access allowance.

6.0 FLOODLINE MAPPING

Objective and Scope
For the purpose of creating floodline mapping of the study area, HEC-RAS, a one-dimensional hydraulic model developed by US-Army Corps of Engineers was used. The CVC provided a model for the Middle Monora Creek and this model was updated with the site survey data. The limits of the study extend from 100m upstream of Orangeville Highlands (OH) property to Middle Monora Creek at Highway 10. Although the model includes the reach of the creek downstream of the subject property, the focus of the modelling was on the creek adjacent to the subject property. Determining floodlines downstream of the subject property is beyond the scope of this study.

Hydraulic modeling was carried out to develop floodlines and hence create flood mapping for a Regional Flood of 5.48 m^3/s. The Regional Flood flow was obtained from the latest hydrologic modelling by CVC. Previous studies use other regional flow values. In this study, we use the CVC's most recently updated regional flood of 5.48 m^3/s which supersedes previous regional flood values. In addition to the hydrology provided by the CVC, the post-development increase from an on-site SWM facility was added to the downstream end of the property in the model. The increase in flow only applied to the Regional event and was an increase of 0.507 m^3/s for a total of 5.987 m^3/s.

Model Input Parameters
A HEC-RAS model needs geometric, flows, and boundary conditions as inputs. The cross sections surveyed and used for geomorphic assessments were used as model inputs.

Additionally, surveyed cross sections located immediately upstream and downstream of hydraulic structures were also included in the model. Details relating to the structures (a total of three culverts with the entire study area) were also included. The cross sections were extracted from geomorphic survey (by Water's Edge) and a topographic survey (by J. D. Barnes).

Based on sediment analysis (pebble counts and grain size analysis), channel roughness was input for each cross section. Modified Cowan approach was used to determine floodplain roughness.

The modelling approach taken was a conservative one to examine if the floodlines crossed the subject property. Therefore, levees were included in some of the cross sections downstream of the subject property to keep the flow within the channel and avoiding spillage into the parking lot of the Orangeville Mall. The levees create a backwatering effect and increase the flood elevations through creek adjacent to the subject property.

Results
The results of the model are shown alongside the provided CVC model results in Table 10. The flow area (FA) and top width (TW) at each cross section are also shown. Under a Regional Storm event of 5.48 m^3/s, the floodlines of Middle Monora Creek can be expected to remain north of the subject property. A floodline map (Map 2) based on these results is attached.

Currently, there exists a potential drainage feature at the northeast portion of subject property. This feature is referred to as Drainage Feature A and it falls between river stations 1.106 and 1.039.

The removal of Drainage Feature A will not affect the floodlines as the floodlines do not extend to this feature. However, appropriate ecological assessments will be required to confirm that the removal of this feature will not have adverse impacts on the system.

As shown in Map 2, the culvert crossing between river stations 1.151 and 1.13 can be expected to be inundated in a Regional Flood. It is recommended that the culvert capacity be increased to prevent loss of infrastructure.

Results of the post development flow modelling are shown in **Table 10**. The flows are only calculated for the Regional Flow as the 2 – 100-year events are controlled by the SWM facility to existing release rates. The Regional Flow was increased by 0.507 m^3/s after station 1.039 and the resultant changes ranged from 0.01m to 0.06m in the downstream cross sections.

Table 10: Profile Output Summary

Reach Location River Station			CVC Original Model			Updated Model			Updated Model Incl. Post Dev. Flows DS		
			W.S. Elev	Flow Area	Top Width	W.S. Elev	Flow Area	Top Width	W.S. Elev	Flow Area	Top Width
Upstream of OH property	Original	1.790	438.20	6.40	72.11	438.20	6.4	72.11	438.2	6.4	72.11
	Original	1.68	432.23	2.36	9.66	432.23	2.36	9.66	432.23	2.36	9.66
	Original	1.51	430.35	5.90	21.25	430.55	10.57	26.76	430.55	10.57	26.76
Adjacent to OH property		1.465				428.68	3.92	12.17	428.68	3.92	12.17
		1.45				428.30	2.6	8.34	428.3	2.6	8.34
	Original	1.350	427.54	6.31	20.83						
		1.341				426.07	5.26	19.65	426.07	5.26	19.65
		1.294				425.13	3.6	14.51	425.13	3.6	14.51
	Original	1.250	426.87	19.42	60.70						
		1.232				424.63	30.44	66.04	424.63	30.44	66.04
	Original	1.200	426.48	6.59	25.77						
		1.173				424.62	64.41	63.53	424.62	64.41	63.53
		1.151				424.62	58.57	55.25	424.62	58.57	55.25
	Original	1.120	422.37	2.53	9.32						
		Culvert									
		1.13				422.18	4.75	14.03	422.18	4.75	14.03
		1.106				421.71	4.02	15.3	421.71	4.02	15.3
		1.039				420.51	2.76	5.26	420.51	2.76	5.26
	Original	1.030	421.01	2.83	5.54						
Downstream of OH Property		0.976				419.43	3.02	7.12	419.43	3.02	7.12
	Original	0.93	419.66	7.23	21.62	419.09	4.71	11.74	419.15	4.71	11.74
	Original	0.85	418.47	3.93	11.16	418.45	3.89	11.11	418.46	3.89	11.11
	Original	0.74	417.72	5.71	18.06	417.72	5.8	18.32	417.76	5.8	18.32
	Original	1st St.	Bridge								

The electronic version of the model can be made available upon request.

7.0 SUMMARY

Middle Monora Creek is likely a 3rd order stream that flows through the Hillsburgh Sandhills and Guelph Drumlin Field physiographic regions. The study area is located city of Orangeville, Ontario.

In order to carry out a fluvial assessment, a geomorphic survey of approximately 1.25 km of the stream in the area of interest was carried out. The sediment substrate in the study area was dominated by sand and silts in the downstream end and by sands and gravels at the upstream end. As such, the study area was determined to predominantly show characteristics of a Rosgen E4/5 and those of a C4/5 channel at the upstream most reach. Two assessment tools, namely, RSAT and RGA, were used to assess stream condition. RSAT scores show that the stream is generally in a good or a fair state. Therefore, the habitat conditions and the stream's response to urbanization are "Good". RGA score indicates that the stream, like most urban streams is in a transitional state, i.e., the stream is trying to achieve the state of quasi-equilibrium.

An erosion threshold assessment was performed for Reaches 1, 2 and 3 to determine the critical erosion threshold criteria. The critical flow of 0.036 m^3/s occurs at Reach 3. This value was used to create a continuous hydrologic model. The results of this model show that generally the number of hours during which erosive flow is expected to occur in the proposed conditions is similar to that or the existing conditions.

In order to identify development constraints within the Orangeville Highlands property, meander beltwidth assessments and floodline mapping for a regional storm event were performed. The floodline mapping performed for two different boundary conditions show that the regional floodlines do not affect the subject property. Similarly, the meander beltwidths/slope assessment also show that the limit of meandering of the creek adjacent to the subject property is typically limited to the forested area north of the property. The maps (**Map 1 and Map 2**) showing these constraints are attached.

Respectfully submitted,

Ed Gazendam, Ph.D.., P.Eng.,
President, Sr. Geomorphologist

Water's Edge Environmental Solutions Team Ltd.

Attachments:

Map 1: Meander Beltwidth Map
Map 2: Floodline Mapping

Appendix A: Profile and Cross Sections (for Geomorphic Analyses)
Appendix B: Photographs
Appendix C: Stream Assessment Worksheets
Appendix D: SWMHYMO Model Output
Appendix E: HEC-RAS Output Cross Sections

REFERENCES

Chang, H.H. (1988). Fluvial Processes in River Engineering, John Wiley and Sons, New York and other cities, citing Fortier, S., and Scobey, F.C. (1926). "Permissible canal velocities," Transactions of the ASCE, 89:940-984.

Dingman, S. L. (2009). Fluvial Hydraulics, Oxford University Press, Inc., New York.

Fischenich. 2001. Stability Thresholds for Stream Restoration Materials. EMRRP Technical Notes Collection (ERDC TN-EMRRP-SR-29), U.S. Army Engineer Research and Development Center, Vicksburg, M.S. www.wes.army.mil/e/emrrp

Galli, J. 1996, *Rapid Stream Assessment Technique (RSAT) field methods*. 36 pp. Metropolitan Washington Council of Governments, Department of Environmental Programs, Washington, DC.

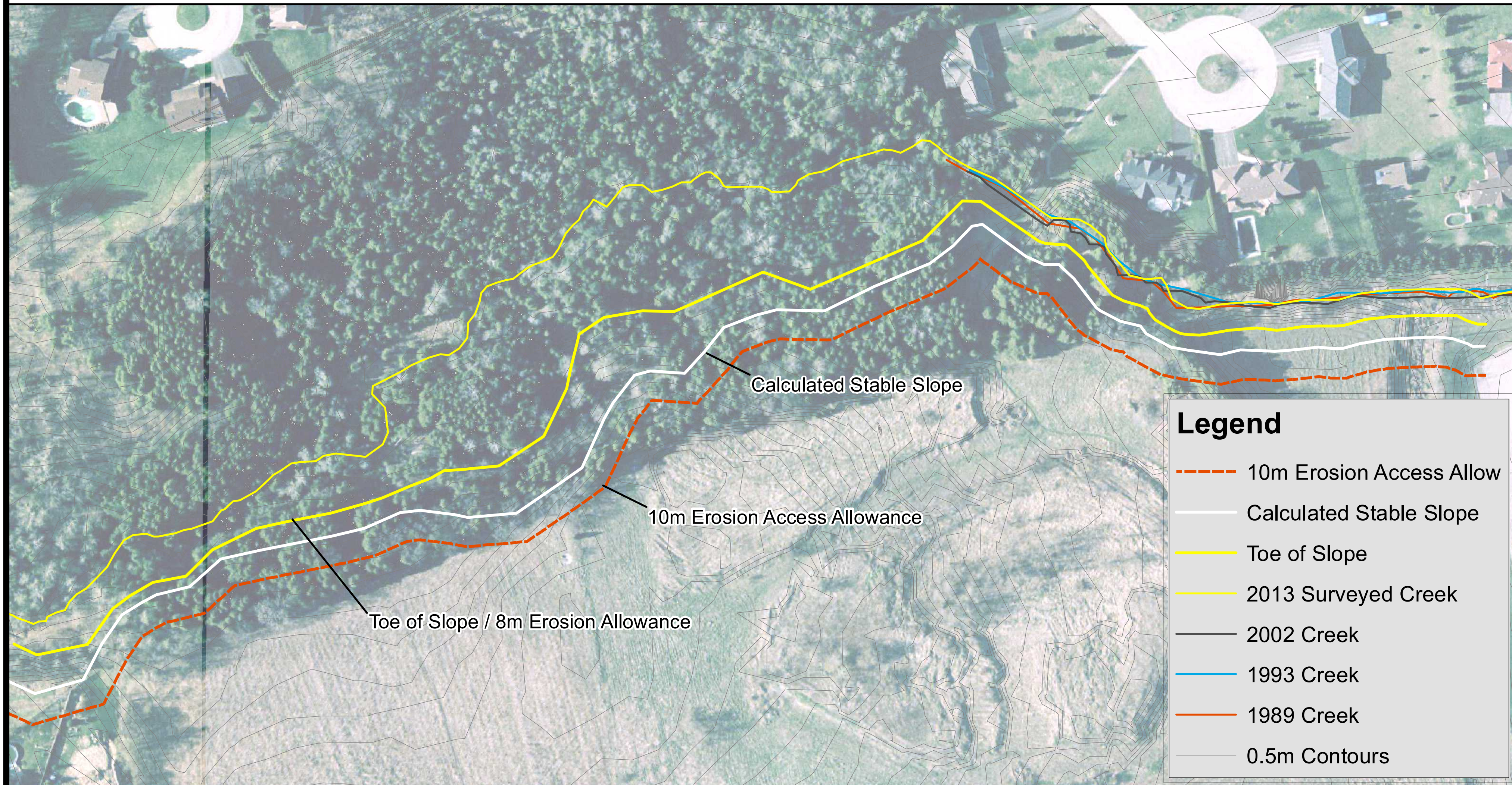
Komar, Paul D. 1987. Selective grain entrainment and the empirical evaluation of flow competence. Sedimentology, 34: 1165-1176.

Ontario Ministry of Environment. March 2003. Stormwater Management Planning and Design Manual. Chapter 3.

Platts, W.S., W.F. Megahan, and G.W. Minshall. 1983. *Methods for evaluating stream, riparian, and biotic conditions*. U.S. Department of Agriculture, Forest Service, General Technical Report INT-138.

Temple, D. M. 1980. *Tractive Force Design of Vegetated Channels*. Transactions, American Society of Agricultural Engineers. 23(4): 884-890.

Urbantech Consulting. 2010. *Functional Servicing Report. Orangeville Highlands Phase II*. Project#: 06-233-PH2



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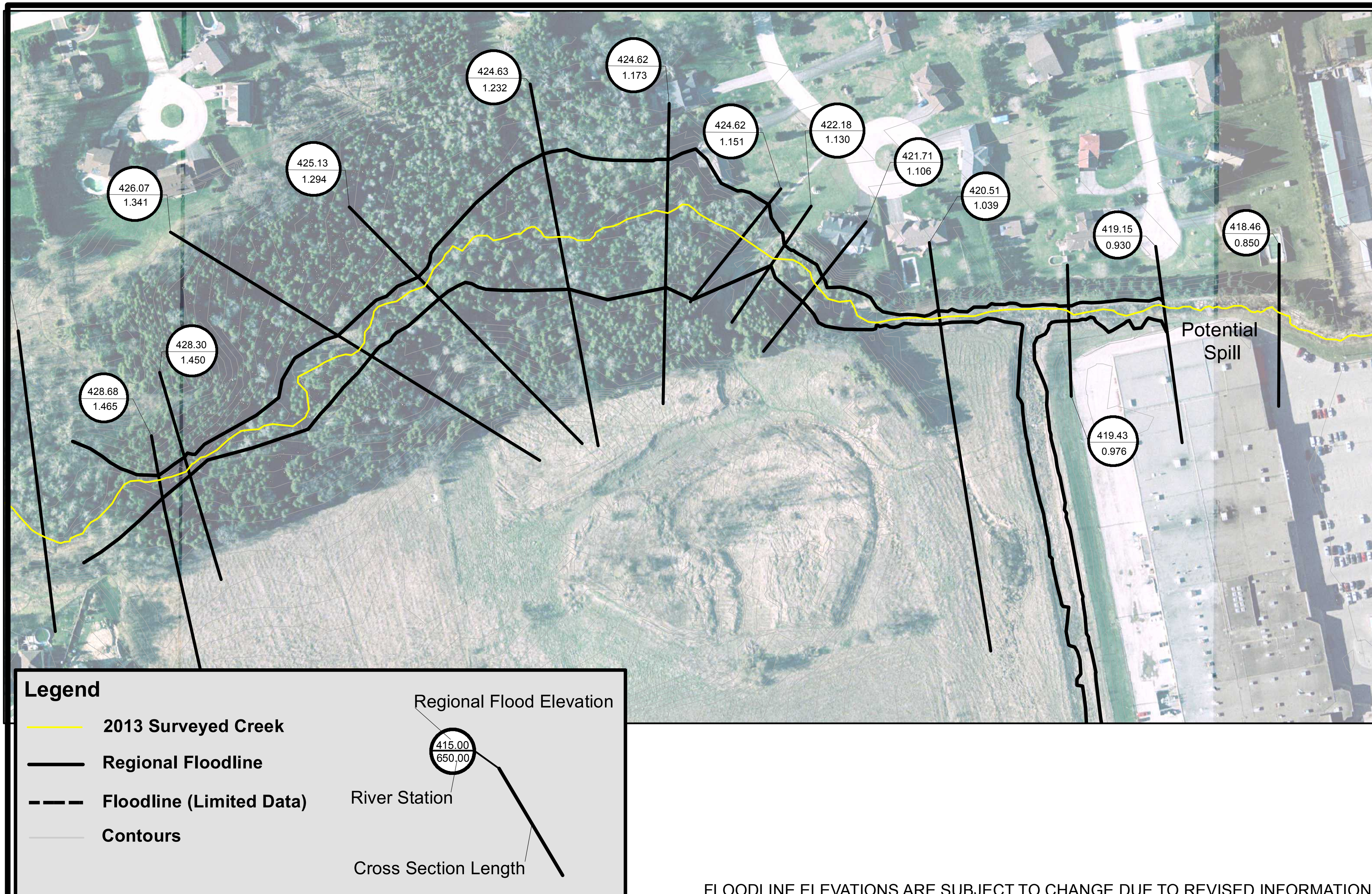
N W E S

0 12.5 25 50 75

Meters

Contour Interval: 0.25m

Meander Beltwidth Delineation	Map No.: 1	Date: Apr. 09, 2019
Orangeville Highlands Phase 2 Middle Monora Creek	Checked By: EG	Drawn By: NG



FLOODLINE ELEVATIONS ARE SUBJECT TO CHANGE DUE TO REVISED INFORMATION

water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

N W E S

0 15 30 60 90
Meters

Contour Interval: 0.25m

Floodline Mapping	Map No.: 2	Date: Apr. 09, 2019
Orangeville Highlands Phase 2 Middle Monora Creek	Checked By: EG	Drawn By: NG

APPENDIX A:

Profile and Cross Sections

Middle Monora Creek Orangeville, Ontario

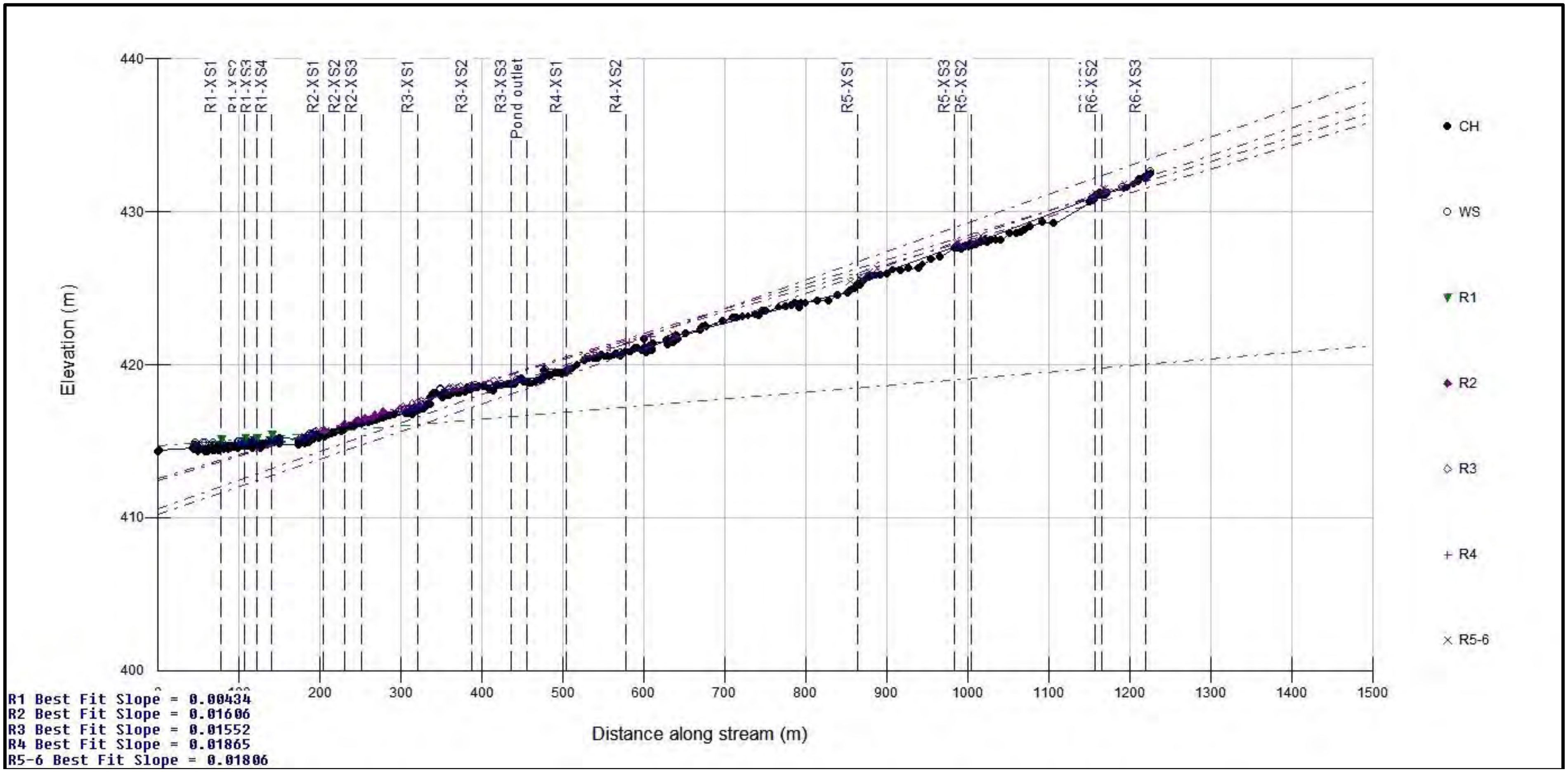


Figure 1: Middle Monora Creek - Existing Profile

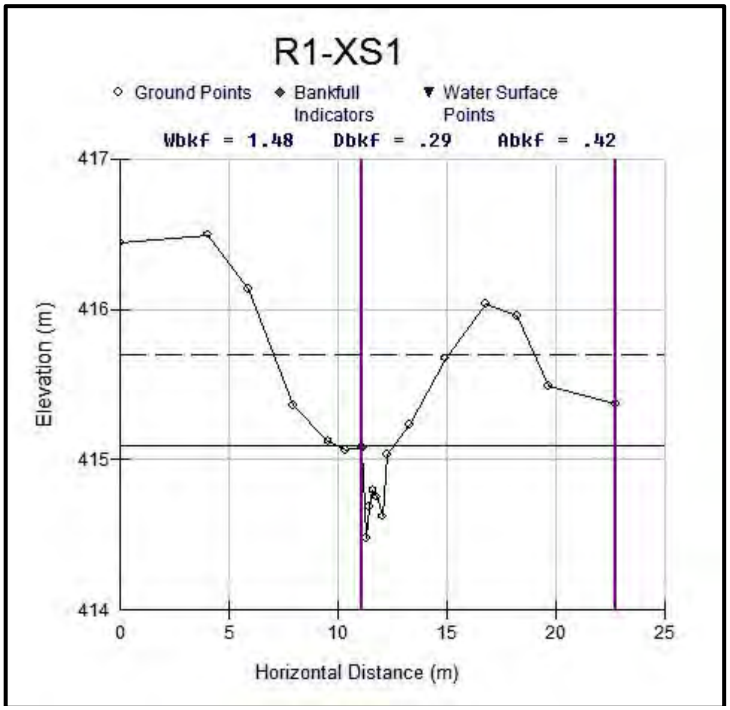


Figure 2: Cross Section R1XS1

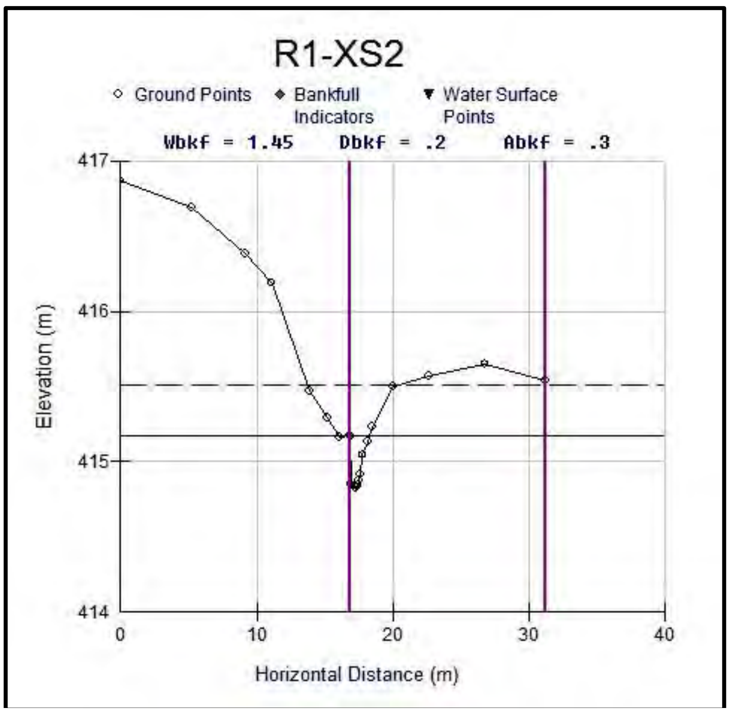


Figure 3: Cross Section R1XS2

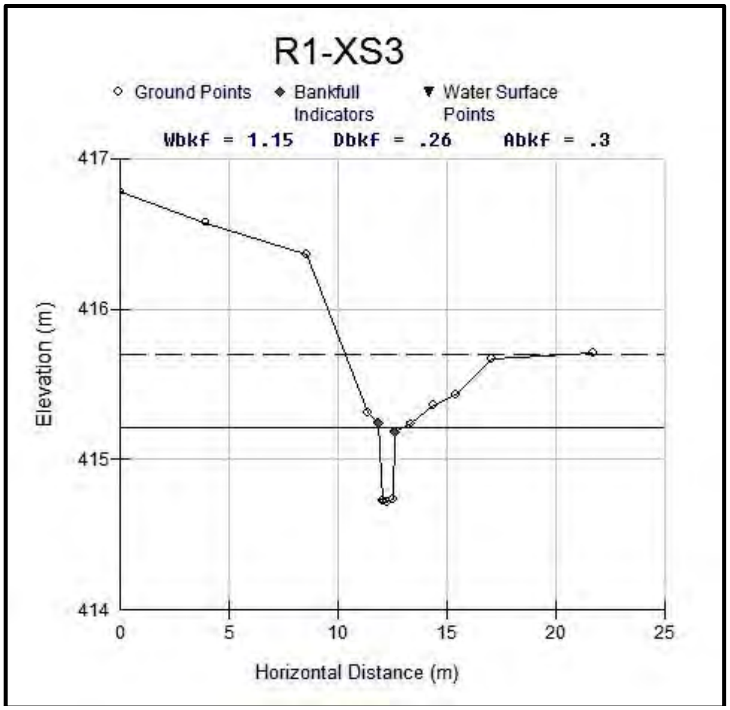


Figure 4: **Cross Section R1XS3**

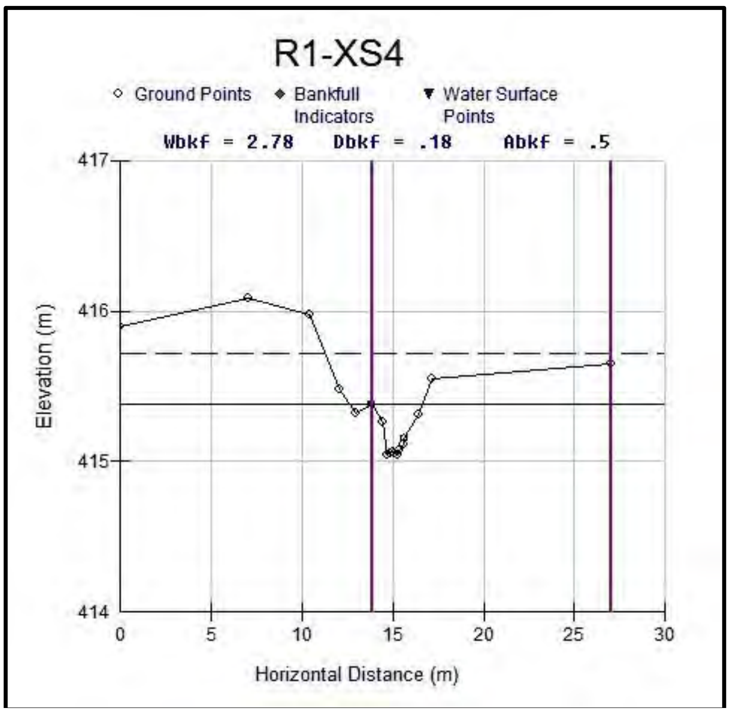


Figure 5: **Cross Section R1XS4**

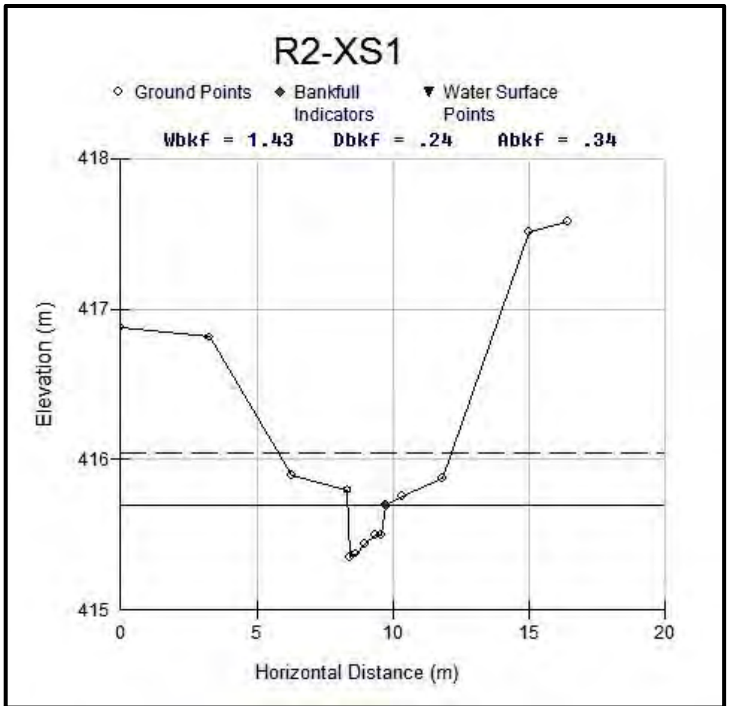


Figure 6: Cross Section R2XS1

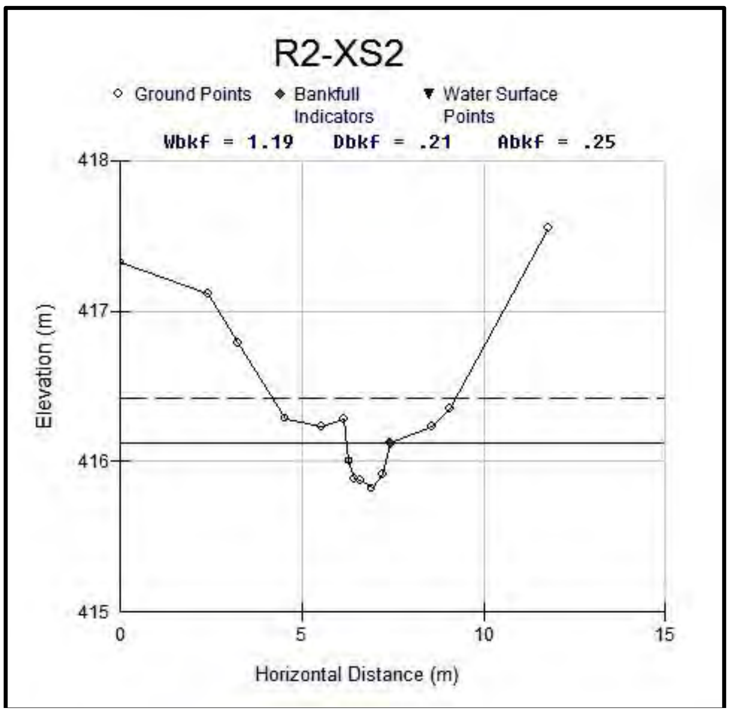


Figure 7: Cross Section R2XS2

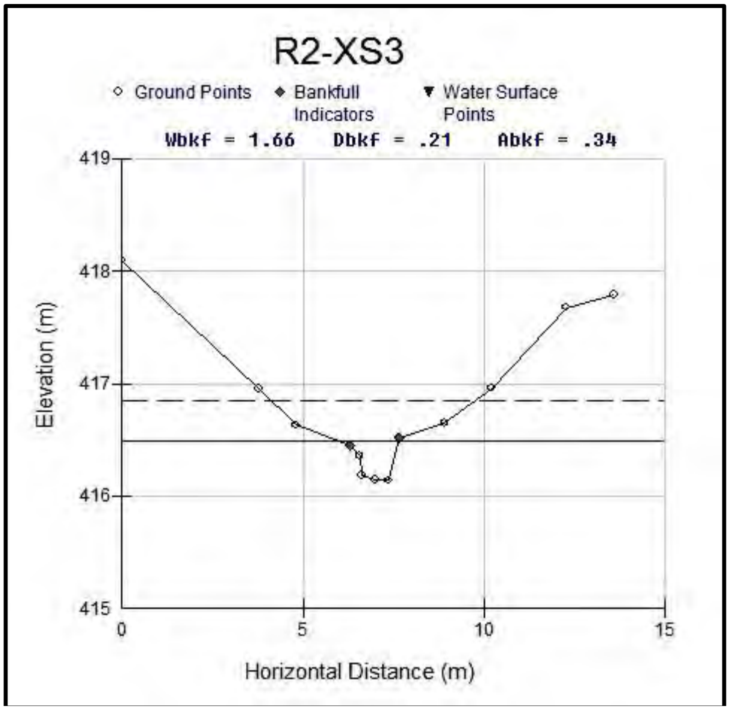


Figure 8: Cross Section R2XS3

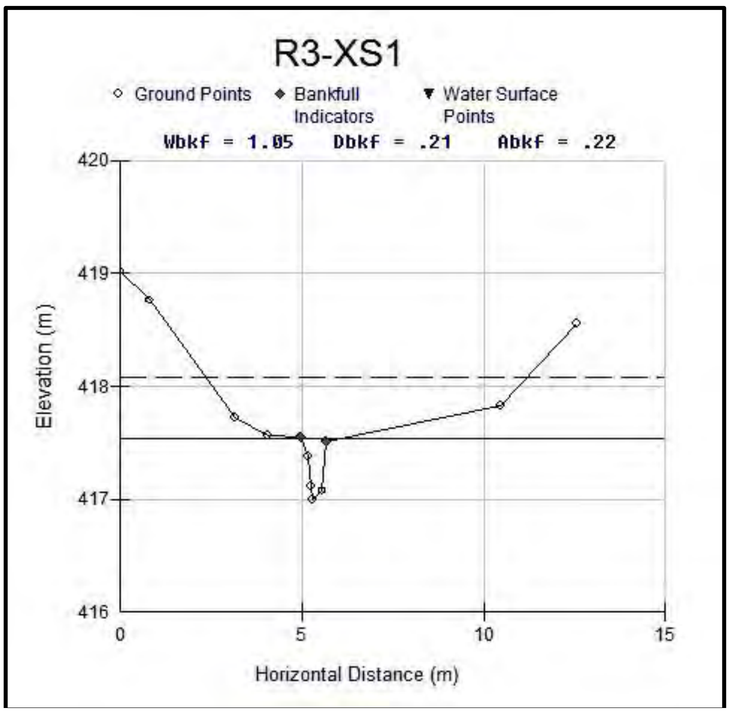


Figure 9: Cross Section R3XS1

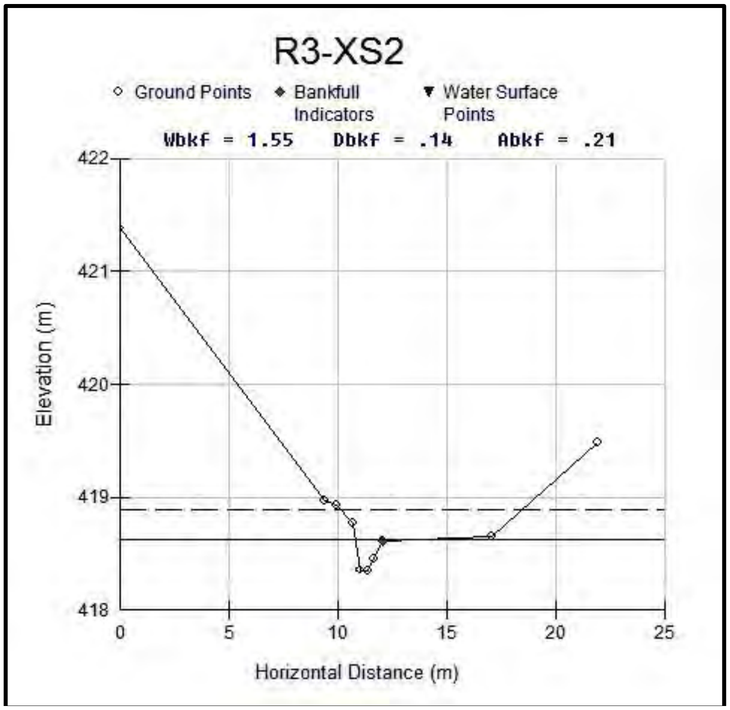


Figure 10: Cross Section R3XS2

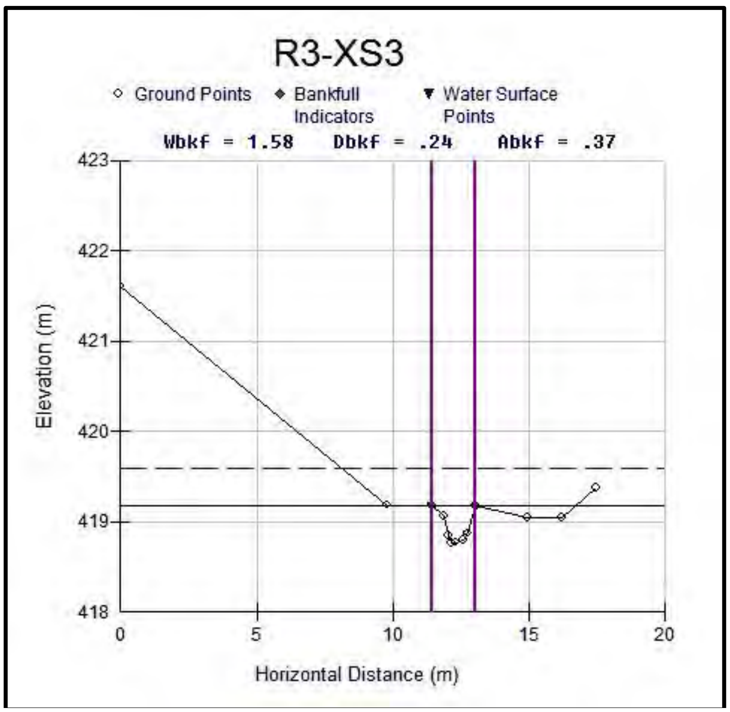


Figure 11: Cross Section R3XS3

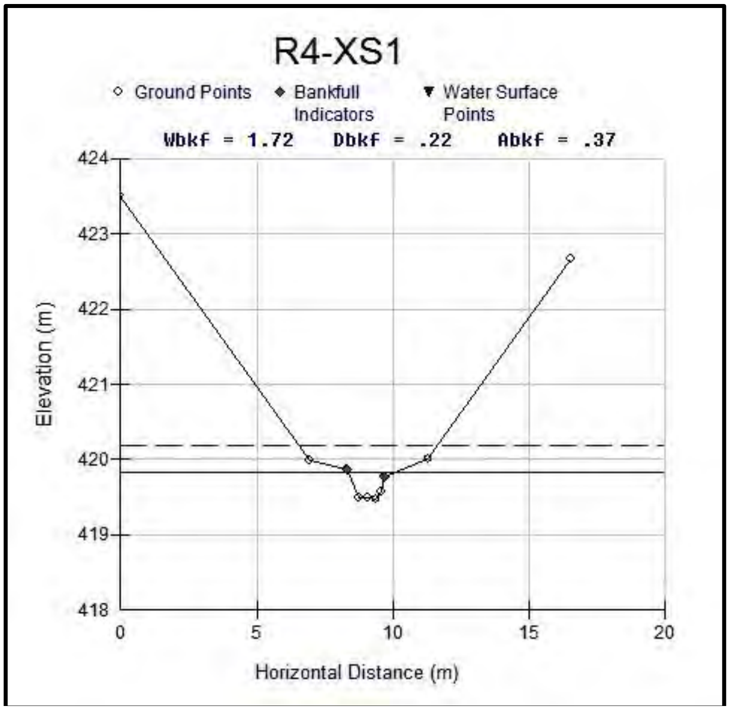


Figure 12: Cross Section R4XS1

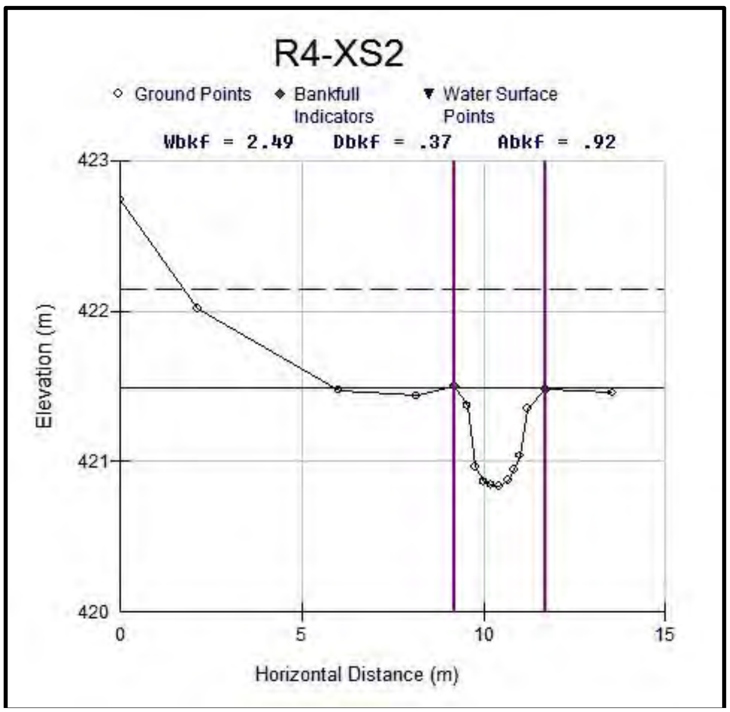


Figure 13: Cross Section R4XS2

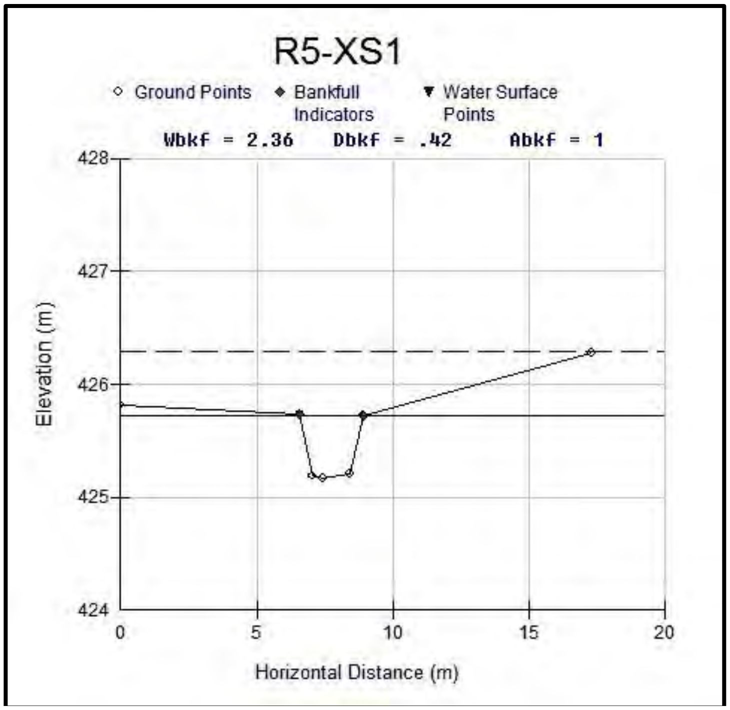


Figure 14: Cross Section R5XS1

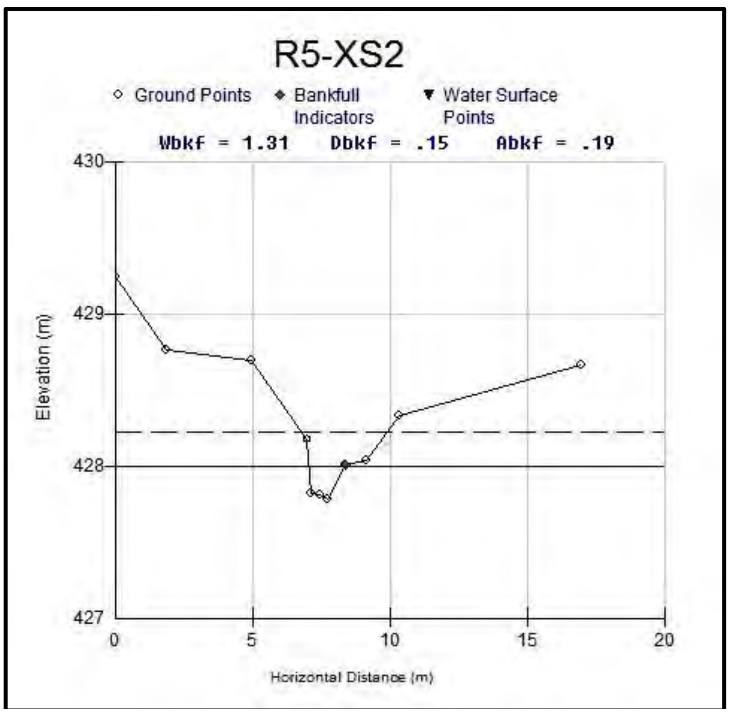


Figure 15: Cross Section R5XS2

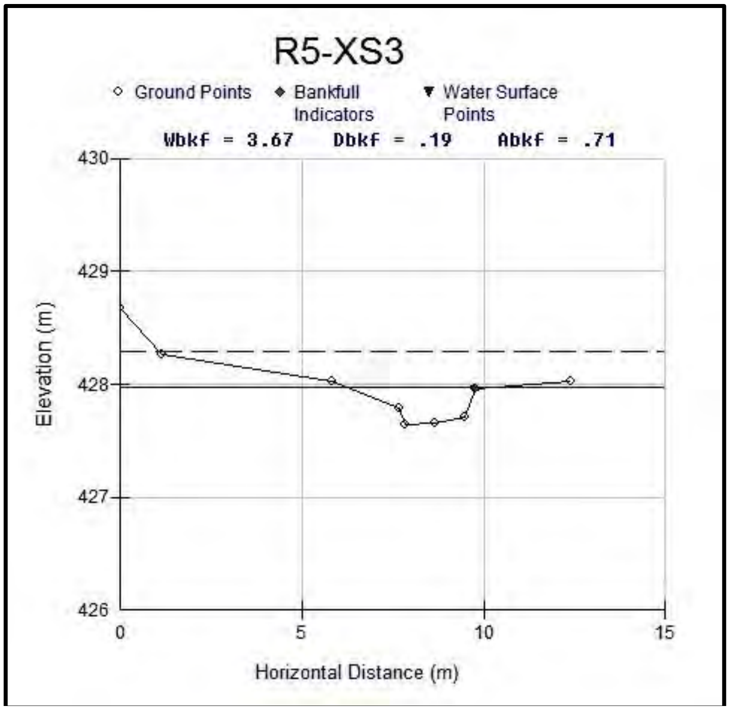


Figure 16: **Cross Section R5XS3**

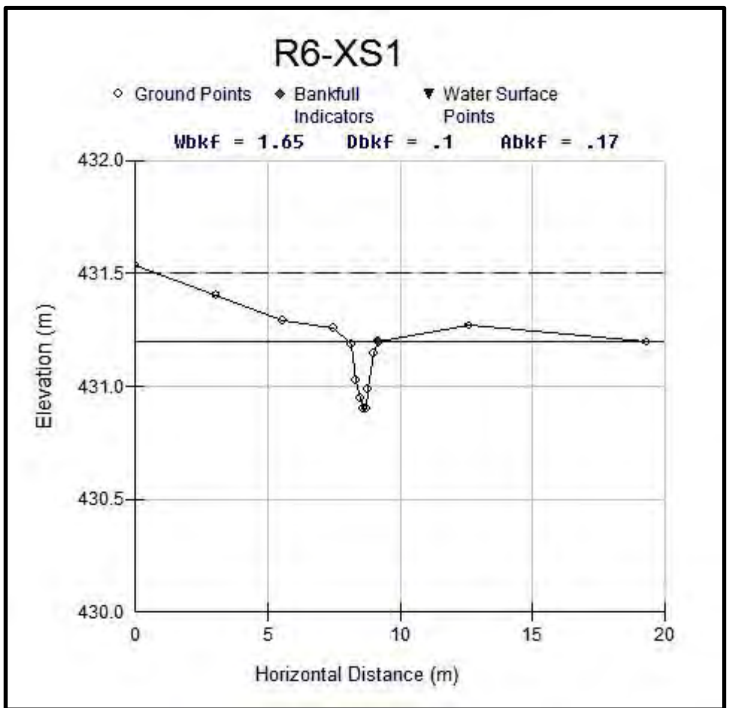


Figure 17: **Cross Section R6XS1**

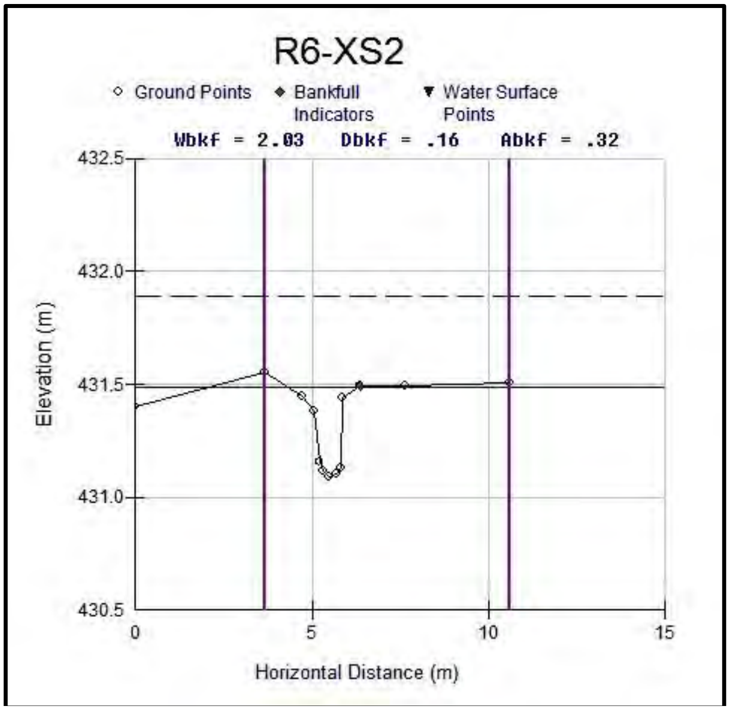


Figure 18: Cross Section R6XS2

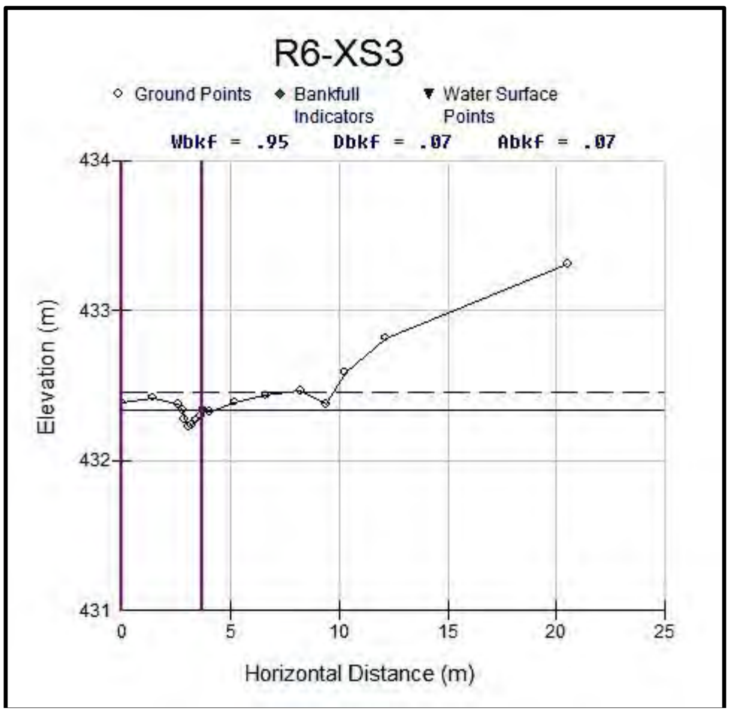
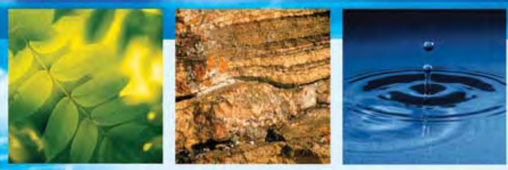


Figure 19: Cross Section R6XS3



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APPENDIX B:

Photographs

Middle Monora Creek Orangeville, Ontario

PHOTOGRAPH NO.: 1
FROM: Cross Section R1-XS1
LOOKING: At Right Bank
COMMENT: Reach 1

PHOTOGRAPH NO.: 2
FROM: Cross Section R1-XS1
LOOKING: At Left Bank
COMMENT: Reach 1

PHOTOGRAPH NO.: 3
FROM: Cross Section R1-XS1
LOOKING: Upstream
COMMENT: Reach 1

PHOTOGRAPH NO.: 4
FROM: Cross Section R1-XS1
LOOKING: Downstream
COMMENT: Reach 1

File #:13016

PHOTOGRAPH NO.: 5
FROM: Cross Section R1-XS2
LOOKING: At Right Bank
COMMENT: Reach 1

PHOTOGRAPH NO.: 6
FROM: Cross Section R1-XS2
LOOKING: At Left Bank
COMMENT: Reach 1

File #:13016

PHOTOGRAPH NO.: 7
FROM: Cross Section R1-XS2
LOOKING: Upstream
COMMENT: Reach 1

PHOTOGRAPH NO.: 8
FROM: Cross Section R1-XS2
LOOKING: Downstream
COMMENT: Reach 1

PHOTOGRAPH NO.: 9
FROM: Cross Section R1-XS3
LOOKING: At Right Bank
COMMENT: Reach 1

PHOTOGRAPH NO.: 10
FROM: Cross Section R1-XS3
LOOKING: At Left Bank
COMMENT: Reach 1

PHOTOGRAPH NO.: 11
FROM: Cross Section R1-XS3
LOOKING: Upstream
COMMENT: Reach 1

PHOTOGRAPH NO.: 12
FROM: Cross Section R1-XS3
LOOKING: Downstream
COMMENT: Reach 1

File #:13016

PHOTOGRAPH NO.: 13
FROM: Cross Section R1-XS4
LOOKING: At Right Bank
COMMENT: Reach 1

PHOTOGRAPH NO.: 14
FROM: Cross Section R1-XS4
LOOKING: At Left Bank
COMMENT: Reach 1

Middle Monora Creek, Orangeville

water's edge
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File #:13016

PHOTOGRAPH NO.: 15
FROM: Cross Section R1-XS4
LOOKING: Downstream
COMMENT: Reach 1

PHOTOGRAPH NO.: 16
FROM: Cross Section R1-XS4
LOOKING: Upstream
COMMENT: Reach 1

PHOTOGRAPH NO.: 17
FROM: Channel in Reach 1
LOOKING: Upstream end of culvert at Highway 10
COMMENT: Reach 1

PHOTOGRAPH NO.: 18
FROM: Channel in Reach 1
LOOKING: Downstream end of culvert at Highway 10
COMMENT: Reach 1

PHOTOGRAPH NO.: 19
FROM: Channel in Reach 1
LOOKING: Downstream end of culvert at First Street
COMMENT: Reach 1

PHOTOGRAPH NO.: 20
FROM: Channel in Reach 1
LOOKING: At the substrate in culvert
COMMENT: Note the coarse substrate in the culvert

File #:13016

PHOTOGRAPH NO.: 21
FROM: Cross Section R2-XS1
LOOKING: Right Bank
COMMENT: Reach 2

PHOTOGRAPH NO.: 22
FROM: Cross Section R2-XS1
LOOKING: Left Bank
COMMENT: Reach 2

PHOTOGRAPH NO.: 23
FROM: Cross Section R2-XS1
LOOKING: Downstream
COMMENT: Reach 2

PHOTOGRAPH NO.: 24
FROM: Cross Section R2-XS1
LOOKING: Upstream
COMMENT: Reach 2

PHOTOGRAPH NO.: 25
FROM: Cross Section R2-XS3
LOOKING: Right Bank
COMMENT: Reach 2

PHOTOGRAPH NO.: 26
FROM: Cross Section R2-XS3
LOOKING: Left Bank
COMMENT: Reach 2

PHOTOGRAPH NO.: 27
FROM: Cross Section R2-XS3
LOOKING: Downstream
COMMENT: Reach 2

PHOTOGRAPH NO.: 28
FROM: Cross Section R2-XS3
LOOKING: Upstream
COMMENT: Reach 2

PHOTOGRAPH NO.: 29
FROM: Cross Section R2-XS2
LOOKING: Right Bank
COMMENT: Reach 2

PHOTOGRAPH NO.: 30
FROM: Cross Section R2-XS2
LOOKING: Left Bank
COMMENT: Reach 2

PHOTOGRAPH NO.: 31
FROM: Cross Section R2-XS2
LOOKING: Downstream
COMMENT: Reach 2

PHOTOGRAPH NO.: 32
FROM: Cross Section R2-XS2
LOOKING: Upstream
COMMENT: Reach 2

PHOTOGRAPH NO.: 33
FROM: Channel in Reach 2 at the upstream end
LOOKING: Upstream end of Reach 2
COMMENT: Note the angular (introduced) substrate

PHOTOGRAPH NO.: 34
FROM: Floodplain on right bank
LOOKING: At floodplain
COMMENT: Reach 2

PHOTOGRAPH NO.: 35
FROM: Cross Section R3-XS1
LOOKING: Downstream
COMMENT: Reach 3

PHOTOGRAPH NO.: 36
FROM: Cross Section R3-XS1
LOOKING: Upstream
COMMENT: Reach 3

File #:13016

PHOTOGRAPH NO.: 37
FROM: Cross Section R3-XS1
LOOKING: Right Bank
COMMENT: Reach 3

PHOTOGRAPH NO.: 38
FROM: Cross Section R3-XS1
LOOKING: Left Bank
COMMENT: Reach 3

PHOTOGRAPH NO.: 39
FROM: Cross Section R3-XS2
LOOKING: Downstream
COMMENT: Reach 3

PHOTOGRAPH NO.: 40
FROM: Cross Section R3-XS2
LOOKING: Upstream
COMMENT: Reach 3 – Note the gabions

PHOTOGRAPH NO.: 41
FROM: Cross Section R3-XS2
LOOKING: Right Bank
COMMENT: Reach 3 – Note the walkway. This section is disturbed.

PHOTOGRAPH NO.: 42
FROM: Cross Section R3-XS2
LOOKING: Left Bank
COMMENT: Reach 3

PHOTOGRAPH NO.: 43
FROM: Cross Section R3-XS3
LOOKING: Downstream
COMMENT: Reach 3

PHOTOGRAPH NO.: 44
FROM: Cross Section R3-XS3
LOOKING: Upstream
COMMENT: Reach 3

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PHOTOGRAPH NO.: 45
FROM: Cross Section R3-XS3
LOOKING: Right Bank
COMMENT: Reach 3

PHOTOGRAPH NO.: 46
FROM: Cross Section R3-XS3
LOOKING: Left Bank
COMMENT: Reach 3

PHOTOGRAPH NO.: 47
FROM: Channel in Reach 3
LOOKING: At the existing pond – south of the creek
COMMENT: Reach 3

PHOTOGRAPH NO.: 48
FROM: Channel in Reach 3
LOOKING: At the outlet from the existing pond
COMMENT: Reach 3

File #:13016

PHOTOGRAPH NO.: 49
FROM: Cross Section R4-XS1
LOOKING: Right Bank
COMMENT: Reach 4

PHOTOGRAPH NO.: 50
FROM: Cross Section R4-XS1
LOOKING: Left Bank
COMMENT: Reach 4

PHOTOGRAPH NO.: 51
FROM: Cross Section R4-XS1
LOOKING: Downstream
COMMENT: Reach 4

PHOTOGRAPH NO.: 52
FROM: Cross Section R4-XS1
LOOKING: Upstream
COMMENT: Reach 4

PHOTOGRAPH NO.: 53
FROM: Cross Section R4-XS2
LOOKING: Right Bank
COMMENT: Reach 4

PHOTOGRAPH NO.: 54
FROM: Cross Section R4-XS2
LOOKING: Left Bank
COMMENT: Reach 4

File #:13016

PHOTOGRAPH NO.: 55
FROM: Cross Section R4-XS2
LOOKING: Downstream
COMMENT: Reach 4

PHOTOGRAPH NO.: 56
FROM: Cross Section R4-XS2
LOOKING: Upstream
COMMENT: Reach 4

PHOTOGRAPH NO.: 57
FROM: Channel
LOOKING: At debris jam. Note the 0.6m drop in channel bed
COMMENT: Reach 4

PHOTOGRAPH NO.: 58
FROM: Cross Section 15
LOOKING: At channel substrate. Note the sub-angular riverstone
COMMENT: Reach 4

PHOTOGRAPH NO.: 59
FROM: Channel in R4
LOOKING: At a riffle upstream of R4XS2
COMMENT: Reach 4

PHOTOGRAPH NO.: 60
FROM: Channel
LOOKING: At meander bend downstream of the culvert at pedestrian walkway
COMMENT: Reach 4. Note the point bar with eroding banks

PHOTOGRAPH NO.: 61
FROM: Channel
LOOKING: At the downcutting bed, overhanging bank.
COMMENT: Reach 4. Note the clay till, sands and gravels that form the substrate here.

PHOTOGRAPH NO.: 62
FROM: Channel
LOOKING: At the perched pipe arch CSP culvert under pedestrian walkway
COMMENT: Reach 4

PHOTOGRAPH NO.: 63
FROM: Cross Section R5-XS1
LOOKING: Downstream
COMMENT: Reach 5

PHOTOGRAPH NO.: 64
FROM: Cross Section R5-XS1
LOOKING: Upstream
COMMENT: Reach 5

File #:13016

PHOTOGRAPH NO.: 65
FROM: Cross Section R5-XS1
LOOKING: Right Bank
COMMENT: Reach 5

PHOTOGRAPH NO.: 66
FROM: Cross Section R5-XS1
LOOKING: Left Bank
COMMENT: Reach 5

PHOTOGRAPH NO.: 67
FROM: Cross Section R5-XS2
LOOKING: Downstream
COMMENT: Reach 5

PHOTOGRAPH NO.: 68
FROM: Cross Section R5-XS2
LOOKING: Upstream
COMMENT: Reach 5

PHOTOGRAPH NO.: 69
FROM: Cross Section R5-XS2
LOOKING: Right Bank
COMMENT: Reach 5

PHOTOGRAPH NO.: 70
FROM: Cross Section R5-XS2
LOOKING: Left Bank
COMMENT: Reach 5

PHOTOGRAPH NO.: 71
FROM: Cross Section R5-XS3
LOOKING: Downstream
COMMENT: Reach 5

PHOTOGRAPH NO.: 72
FROM: Cross Section R5-XS3
LOOKING: Upstream
COMMENT: Reach 5

PHOTOGRAPH NO.: 73
FROM: Cross Section R5-XS3
LOOKING: Right Bank
COMMENT: Reach 5

PHOTOGRAPH NO.: 73
FROM: Cross Section R5-XS3
LOOKING: Left Bank
COMMENT: Reach 5

PHOTOGRAPH NO.: 75
FROM: Cross Section R5-XS3
LOOKING: At Channel
COMMENT: Reach 5

PHOTOGRAPH NO.: 76
FROM: Channel
LOOKING: At culvert under pedestrian walkway at upstream end
COMMENT: Reach 5

File #:13016

PHOTOGRAPH NO.: 77
FROM: Cross Section R6-XS1
LOOKING: Right Bank
COMMENT: Reach 6

PHOTOGRAPH NO.: 78
FROM: Cross Section R6-XS1
LOOKING: Left Bank
COMMENT: Reach 6

File #:13016

PHOTOGRAPH NO.: 79
FROM: Cross Section R6-XS1
LOOKING: Downstream
COMMENT: Reach 6

PHOTOGRAPH NO.: 80
FROM: Cross Section R6-XS1
LOOKING: Upstream
COMMENT: Reach 6

PHOTOGRAPH NO.: 81
FROM: Cross Section R6-XS2
LOOKING: Right Bank
COMMENT: Reach 6

PHOTOGRAPH NO.: 82
FROM: Cross Section R6-XS2
LOOKING: Left Bank
COMMENT: Reach 6

PHOTOGRAPH NO.: 83
FROM: Cross Section R6-XS2
LOOKING: Downstream
COMMENT: Reach 6

PHOTOGRAPH NO.: 84
FROM: Cross Section R6-XS2
LOOKING: Upstream
COMMENT: Reach 6

PHOTOGRAPH NO.: 85
FROM: Cross Section R6-XS3
LOOKING: Right Bank
COMMENT: Reach 6

PHOTOGRAPH NO.: 86
FROM: Cross Section R6-XS3
LOOKING: Left Bank
COMMENT: Reach 6

File #:13016

PHOTOGRAPH NO.: 87
FROM: Cross Section R6-XS3
LOOKING: Downstream
COMMENT: Reach 6

PHOTOGRAPH NO.: 88
FROM: Cross Section R6-XS3
LOOKING: Upstream
COMMENT: Reach 6

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Fluvial Geomorphology

Natural Channel Design

Stream Restoration

Monitoring

Erosion Assessment

Sediment Transport

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APPENDIX C:

Rapid Field Assessment Worksheets

Middle Monora Creek Orangeville, Ontario

Rapid Geomorphic Assessment

Date: June 4/5, 2013
Evaluator: CB
Stream: Middle Monora Creek
Conditions: Sunny/Overcast

	Geomorphic Indicator		Reach Number:					
Form / Process	**No**	**Description**	**1**	**2**	**3**	**4**	**5**	**6**
Evidence of Aggradation (AI)	1	Lobate bar	0	1	0	1	1	0
	2	Coarse material in riffles embedded	1	1	1	1	1	1
	3	Siltation in pools	1	1	1	1	1	1
	4	Medial bars	1	1	1	0	0	0
	5	Accretion on point bars	0	1	0	0	1	0
	6	Poor longitudinal sorting of bed materials	0	1	0	0	0	0
	7	Deposition in the overbank zone	0	0	1	0	0	0
		Sum of Indices	0.43	0.86	0.57	0.43	0.57	0.29
Evidence of Degradation (DI)	1	Exposed bridge footing(s)	0	0	0	0	0	0
	2	Exposed sanitary/storm sewer/pipeline/etc.	0	0	0	0	0	0
	3	Elevated storm sewer outfall(s)	0	0	0	1	0	0
	4	Undermined gabion baskets/concrete aprons/etc.	0	0	0	0	0	0
	5	Scour pools d/s of culverts/storm sewer outlets	0	0	0	1	0	0
	6	Cut face on bar forms	0	0	0	0	1	0
	7	Head cutting due to knick point migration	0	0	0	1	0	1
	8	Terrace cut through older bar material	0	0	0	0	0	0
	9	Suspended armour layer visible in bank	0	0	0	1	0	0
	10	Channel worn into undisturbed overburden/bedrock	0	0	0	0	0	0
		Sum of Indices	0.00	0.00	0.00	0.40	0.10	0.10
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.	0	0	0	1	1	1
	2	Occurrence of large organic debris	1	1	1	1	1	1
	3	Exposed tree roots	0	1	1	1	1	0
	4	Basal scour on inside meander bends	1	1	1	1	1	0
	5	Basal scour on both sides of channel through riffle	0	0	0	1	1	0
	6	Gabion baskets/concrete walls/etc. out flanked	0	0	0	0	0	0
	7	Length of basal scour >50% through subject reach	0	0	0	1	1	0
	8	Exposed length of previously buried pipe/cable/etc.	0	0	0	0	0	0
	9	Fracture lines along top of bank	0	0	0	0	0	0
	10	Exposed building foundation	0	0	0	0	0	0
		Sum of Indices	0.20	0.30	0.30	0.60	0.60	0.20
Evidence of Planimetric Form Adjustment (PI)	1	Formation of cut (s)	1	1	1	0	1	0
	2	Single thread channel to multiple channel	1	0	0	0	0	1
	3	Evolution of pool-riffle form to low bed relief form	0	0	0	0	0	0
	4	Cutoff channel(s)	0	0	1	0	1	0
	5	Formation of island(s)	0	0	1	0	1	0
	6	Thalweg alignment out of phase meander form	0	0	0	0	0	0
	7	Bar forms poorly formed/reworked/removed	1	1	1	1	1	0
		Sum of Indices	0.43	0.29	0.57	0.14	0.57	0.14
Stability Index (SI) = (AI + DI+ WI+ PI) /m			0.26	0.36	0.36	0.39	0.46	0.18

General Comments:

RAPID STREAM ASSESSMENT TECHNIQUE

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Creek Name: Middle Monora
Date: June 4/5, 2013
Assessor: CB

RSAT Evaluation Category	General Verbal Rating Categories and Associated Point Range				
	Excellent	Good	Fair	Poor	Points
1. Channel Stability	9-11	6-8	3-5	0-2	7
2. Channel Scouring/Deposition	7-8	5-6	3-4	0-2	4
3. Physical Instream Habitat	7-8	5-6	3-4	0-2	6
4. Water Quality	7-8	5-6	3-4	0-2	6
5. Riparian Habitat Conditions	6-7	4-5	2-3	0-2	5
6. Biological Indicators	7-8	5-6	3-4	0-2	8

RSAT Score	Ranking
41-50	Excellent
31-40	Good
21-30	Fair
11-20	Poor
0-10	Degraded

Evaluation Category	R1	R2	R3	R4	R5	R6
1 Channel Stability	6	6	7	6	5	8
2 Channel Scour and Sediment Deposition	5	5	5	6	4	6
3 Physical In-stream Habitat	4	5	5	6	6	5
4 Water Quality	4	4	4	6	7	5
5 Riparian Habitat Conditions	3	3	4	5	7	6
6 Biological Indicators	4.5	4.5	5	6	6	5
Total Score:	**26.5**	**27.5**	**30**	**35**	**35**	**35**
Verbal Ranking:	**Fair**	**Fair**	**Fair**	**Good**	**Good**	**Good**

APPENDIX D:

SWMHYMO Model Output

Middle Monora Creek Orangeville, Ontario

```
==============================================================================

 SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999  =========
 S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
 SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9 Ver. 4.02
     S   W W   M   M  H   H    Y    M   M  O   O       9999   9999 July 1999
 SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9 =========
                                                      9   9  9   9 # 2010664
      StormWater Management HYdrologic Model           999    999  =========

 ***************************************************************************
 *************************** SWMHYMO-99 Ver/4.02 ***************************
 *******  A single event and continuous hydrologic simulation model  *******
 *******     based on the principles of HYMO and its successors      *******
 *******                 OTTHYMO-83 and OTTHYMO-89.                  *******
 ***************************************************************************
 ******* Distributed by:  J.F. Sabourin and Associates Inc.           *******
 *******                  Ottawa,  Ontario: (613) 727-5199            *******
 *******                  Gatineau, Quebec: (819) 243-6858            *******
 *******                  E-Mail: swmhymo@jfsa.Com                    *******
 ***************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++ Licensed user: Water's Edge                                +++++++
 +++++++               Cambridge             SERIAL#:2010664        +++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ***************************************************************************
 *******           ++++++ PROGRAM ARRAY DIMENSIONS ++++++             *******
 *******           Maximum value for ID numbers  :     10             *******
 *******           Max. number of rainfall points:  15000             *******
 *******           Max. number of flow points    :  15000             *******
 ***************************************************************************


 ********************  D E T A I L E D   O U T P U T  ********************
 ***************************************************************************
 *       DATE: 2013-10-29     TIME: 15:14:51     RUN COUNTER: 000072       *
 ***************************************************************************
 * Input   filename: Z:\3SWMHY~1\13016\13016E.dat                          *
 * Output  filename: Z:\3SWMHY~1\13016\13016E.out                          *
 * Summary filename: Z:\3SWMHY~1\13016\13016E.sum                          *
 * User comments:                                                          *
 * 1:______________________________________________________________________*
 * 2:______________________________________________________________________*
 * 3:______________________________________________________________________*
 ***************************************************************************

--------------------------------------------------------------------------------
001:0001------------------------------------------------------------------------
*#*************************************************************************
*# HYDROLOGIC MODEL (COAST ROAD DEVELOPMENT)                              *
*# EXISTING CONDITIONS - CONTINUOUS MODEL                                 *
*#                                                                        *
*# CREDIT VALLEY CONSERVATION AUTHORITY                                   *
*#------------------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                           *
*# MODEL: SWMHYMO                                                         *
*#                                                                        *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                                   *
*#                                                                        *
*# DATA FILE: 13016E.DAT                                                  *
*# DESIGN STORM EVENTS (EXISTING CONDITIONS 1986-91 RAINFALL)             *
*#*************************************************************************
*
  ** END OF RUN :  85

*******************************************************************************
```

```
--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19860401
    METOUT=   2 (output = METRIC)
    NRUN  = 086
    NSTORM=   0
--------------------------------------------------------------------------------
086:0002------------------------------------------------------------------------
*#*****************************************************************
*# HYDROLOGIC MODEL (COAST ROAD DEVELOPMENT)                      *
*# EXISTING CONDITIONS - CONTINUOUS MODEL                         *
*#                                                                *
*# CREDIT VALLEY CONSERVATION AUTHORITY                           *
*#---------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                   *
*# MODEL: SWMHYMO                                                 *
*#                                                                *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                           *
*#                                                                *
*# DATA FILE: 13016E.DAT                                          *
*# DESIGN STORM EVENTS (EXISTING CONDITIONS 1986-91 RAINFALL)     *
*#*****************************************************************
*
--------------------------------------------------------------------------------
086:0002------------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1986.0401
                       End date     = 1986.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19860401 @  0hrs to the end of 19861101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    723.1 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        23.8     16.7     16.0     11.5      6.0      3.0    mm/hr
      19860815 19860826 19860718 19860827 19860827 19860827  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         125       96       85       70       60       48
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         125       79       53       19        1        0

--------------------------------------------------------------------------------
086:0003------------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =   15.46 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =     .74 mm
               Average  API value =   23.17 mm
               Total precipitation=  723.10 mm
--------------------------------------------------------------------------------
086:0004------------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
*
----------------------
```

```
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 723.10   (mm).  Now is  11.90   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.72, S*min= 64.50, S*avg= 64.60,  CNavg= 79.72

     Unit Hyd Qpeak  (cms)=    4.941

     PEAK FLOW       (cms)=     .008 (i)
     TIME TO PEAK    (hrs)=  116.267
                     or on  1986.0405_20:16
     RUNOFF VOLUME    (mm)=     .066
     TOTAL RAINFALL   (mm)=   11.900
     RUNOFF COEFFICIENT   =     .006

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
086:0005------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS (OH)
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   12.15   Curve Number   (CN)=61.00
| 02:001001 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.72, S*min= 64.50, S*avg= 64.60,  CNavg= 79.72

     Unit Hyd Qpeak  (cms)=    1.015

     PEAK FLOW       (cms)=     .002 (i)
     TIME TO PEAK    (hrs)=  116.267
                     or on  1986.0405_20:16
     RUNOFF VOLUME    (mm)=     .066
     TOTAL RAINFALL   (mm)=   11.900
     RUNOFF COEFFICIENT   =     .006

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
086:0006------------------------------------------------------------------------
*
--------------------
| ADD HYD (002000) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------               (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 01:001000    59.15      .008  116.27    .07    .000
               +ID2 02:001001    12.15      .002  116.27    .07    .000
                =======================================================
                SUM 06:002000    71.30      .009  116.27    .07    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
```

```
--------------------------------------------------------------------------------
086:0007------------------------------------------------------------------------
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002000     .009     .000        4|22:16         .0        .0
--------------------------------------------------------------------------------
086:0008------------------------------------------------------------------------
*
  ** END OF RUN :  86

********************************************************************************




--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19870401
    METOUT=   2 (output = METRIC)
    NRUN  = 087
    NSTORM=   0
--------------------------------------------------------------------------------
087:0002------------------------------------------------------------------------
*#******************************************************************
*# HYDROLOGIC MODEL (COAST ROAD DEVELOPMENT)                        *
*# EXISTING CONDITIONS - CONTINUOUS MODEL                           *
*#                                                                  *
*# CREDIT VALLEY CONSERVATION AUTHORITY                             *
*#-----------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                     *
*# MODEL: SWMHYMO                                                   *
*#                                                                  *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                             *
*#                                                                  *
*# DATA FILE: 13016E.DAT                                            *
*# DESIGN STORM EVENTS (EXISTING CONDITIONS 1986-91 RAINFALL)      *
*#******************************************************************
*
--------------------------------------------------------------------------------
087:0002------------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1987.0401
                       End date     = 1987.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19870401 @  0hrs to the end of 19871101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    450.2 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        35.8     17.9     11.9      6.2      3.1      1.6    mm/hr
      19870913 19870913 19870913 19870720 19870720 19870913  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         126      102       91       81       67       53
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         125       63       41       10        1        0
```

```
--------------------------------------------------------------------------------
087:0003------------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =    7.39 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =    1.06 mm
               Average  API value =   15.57 mm
               Total precipitation=  450.20 mm
--------------------------------------------------------------------------------
087:0004------------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 450.20   (mm).  Now is  21.80   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 64.88, S*min= 64.50, S*avg= 64.53,  CNavg= 79.74

     Unit Hyd Qpeak  (cms)=    4.941

     PEAK FLOW       (cms)=     .020 (i)
     TIME TO PEAK    (hrs)=  141.250
                     or on  1987.0406_21:15
     RUNOFF VOLUME    (mm)=     .479
     TOTAL RAINFALL   (mm)=   21.800
     RUNOFF COEFFICIENT   =     .022

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
087:0005------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS (OH)
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   12.15   Curve Number   (CN)=61.00
| 02:001001 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 64.88, S*min= 64.50, S*avg= 64.53,  CNavg= 79.74

     Unit Hyd Qpeak  (cms)=    1.015
```

```
     PEAK FLOW       (cms)=     .004 (i)
     TIME TO PEAK    (hrs)=  141.250
                     or on  1987.0406_21:15
     RUNOFF VOLUME    (mm)=     .478
     TOTAL RAINFALL   (mm)=   21.800
     RUNOFF COEFFICIENT   =     .022

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
087:0006------------------------------------------------------------------------
*
--------------------
| ADD HYD (002000) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:001000    59.15     .020  141.25    .48    .000
                +ID2 02:001001    12.15     .004  141.25    .48    .000
                 ==================================================
                 SUM 06:002000    71.30     .024  141.25    .48    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
087:0007------------------------------------------------------------------------
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002000     .024     .001        6|02:11         .0        .0
--------------------------------------------------------------------------------
087:0008------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
087:0002------------------------------------------------------------------------
*
  ** END OF RUN :  87

********************************************************************************




--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19880401
    METOUT=   2 (output = METRIC)
    NRUN  = 088
    NSTORM=   0
--------------------------------------------------------------------------------
088:0002------------------------------------------------------------------------
*#*******************************************************************
*# HYDROLOGIC MODEL (COAST ROAD DEVELOPMENT)                         *
*# EXISTING CONDITIONS - CONTINUOUS MODEL                            *
*#                                                                   *
*# CREDIT VALLEY CONSERVATION AUTHORITY                              *
*#------------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                      *
*# MODEL: SWMHYMO                                                    *
*#                                                                   *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                              *
*#                                                                   *
*# DATA FILE: 13016E.DAT                                             *
*# DESIGN STORM EVENTS (EXISTING CONDITIONS 1986-91 RAINFALL)      *
*#*******************************************************************
*
```

```
-------------------------------------------------------------------------------
088:0002-----------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1988.0401
                       End date     = 1988.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19880401 @  0hrs to the end of 19881101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    400.0 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        29.4     14.7     10.0      5.1      2.6      1.4    mm/hr
      19880724 19880724 19880724 19880724 19880724 19880904  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         114       93       88       80       66       49
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         113       66       34        7        1        0

-------------------------------------------------------------------------------
088:0003-----------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =    5.53 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =     .51 mm
               Average  API value =   14.18 mm
               Total precipitation=  400.00 mm
-------------------------------------------------------------------------------
088:0004-----------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 400.00   (mm).  Now is  19.60   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.35, S*min= 64.50, S*avg= 64.57,  CNavg= 79.73

     Unit Hyd Qpeak  (cms)=    4.941

     PEAK FLOW       (cms)=     .106 (i)
     TIME TO PEAK    (hrs)=   71.367
                     or on  1988.0403_23:22
     RUNOFF VOLUME    (mm)=    1.414
     TOTAL RAINFALL   (mm)=   19.600
```

```
     RUNOFF COEFFICIENT   =     .072

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
088:0005-----------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS (OH)
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   12.15   Curve Number   (CN)=61.00
| 02:001001 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.35, S*min= 64.50, S*avg= 64.57,  CNavg= 79.73

     Unit Hyd Qpeak  (cms)=    1.015

     PEAK FLOW       (cms)=     .022 (i)
     TIME TO PEAK    (hrs)=   71.367
                     or on  1988.0403_23:22
     RUNOFF VOLUME    (mm)=    1.414
     TOTAL RAINFALL   (mm)=   19.600
     RUNOFF COEFFICIENT   =     .072

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
088:0006-----------------------------------------------------------------------
*
--------------------
| ADD HYD (002000) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 01:001000    59.15      .106   71.37   1.41    .000
               +ID2 02:001001    12.15      .022   71.37   1.41    .000
                ==================================================
                SUM 06:002000    71.30      .128   71.37   1.41    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
088:0007-----------------------------------------------------------------------
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002000     .128     .004        3|01:23        2.4       3.3
-------------------------------------------------------------------------------
088:0008-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
088:0002-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
088:0002-----------------------------------------------------------------------
*
  ** END OF RUN :  88

*******************************************************************************
```

```
--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19890401
    METOUT=   2 (output = METRIC)
    NRUN  = 089
    NSTORM=   0
--------------------------------------------------------------------------------
089:0002------------------------------------------------------------------------
*#*****************************************************************
*# HYDROLOGIC MODEL (COAST ROAD DEVELOPMENT)                      *
*# EXISTING CONDITIONS - CONTINUOUS MODEL                         *
*#                                                                *
*# CREDIT VALLEY CONSERVATION AUTHORITY                           *
*#---------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                   *
*# MODEL: SWMHYMO                                                 *
*#                                                                *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                           *
*#                                                                *
*# DATA FILE: 13016E.DAT                                          *
*# DESIGN STORM EVENTS (EXISTING CONDITIONS 1986-91 RAINFALL)      *
*#*****************************************************************
*
--------------------------------------------------------------------------------
089:0002------------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1989.0401
                       End date     = 1989.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19890401 @  0hrs to the end of 19891101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    417.0 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        21.6     10.9      7.3      4.5      2.3      1.8    mm/hr
      19890725 19890725 19890725 19890602 19890602 19890726  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
          98       75       71       64       59       43
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
          97       57       34       15        5        0

--------------------------------------------------------------------------------
089:0003------------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =   13.89 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =     .56 mm
               Average  API value =   14.43 mm
               Total precipitation=  417.00 mm
--------------------------------------------------------------------------------
089:0004------------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
```

```
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 417.00   (mm).  Now is  18.60   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.34, S*min= 64.50, S*avg= 64.57,  CNavg= 79.73

     Unit Hyd Qpeak  (cms)=    4.941

     PEAK FLOW       (cms)=     .021 (i)
     TIME TO PEAK    (hrs)=   58.283
                     or on  1989.0403_10:17
     RUNOFF VOLUME    (mm)=     .360
     TOTAL RAINFALL   (mm)=   18.600
     RUNOFF COEFFICIENT   =     .019

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
089:0005------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS (OH)
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   12.15   Curve Number   (CN)=61.00
| 02:001001 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.34, S*min= 64.50, S*avg= 64.57,  CNavg= 79.73

     Unit Hyd Qpeak  (cms)=    1.015

     PEAK FLOW       (cms)=     .004 (i)
     TIME TO PEAK    (hrs)=   58.283
                     or on  1989.0403_10:17
     RUNOFF VOLUME    (mm)=     .360
     TOTAL RAINFALL   (mm)=   18.600
     RUNOFF COEFFICIENT   =     .019

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
089:0006------------------------------------------------------------------------
*
--------------------
| ADD HYD (002000) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:001000    59.15     .021   58.28    .36    .000
                +ID2 02:001001    12.15     .004   58.28    .36    .000
                 ==================================================
                 SUM 06:002000    71.30     .026   58.28    .36    .000
```

```
   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
089:0007------------------------------------------------------------------------
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002000     .026     .001        3|11:13         .0        .0
--------------------------------------------------------------------------------
089:0008------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
089:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
089:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
089:0002------------------------------------------------------------------------
*
  ** END OF RUN :  89

********************************************************************************




--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19900401
    METOUT=   2 (output = METRIC)
    NRUN  = 090
    NSTORM=   0
--------------------------------------------------------------------------------
090:0002------------------------------------------------------------------------
*#*****************************************************************
*# HYDROLOGIC MODEL (COAST ROAD DEVELOPMENT)                       *
*# EXISTING CONDITIONS - CONTINUOUS MODEL                          *
*#                                                                 *
*# CREDIT VALLEY CONSERVATION AUTHORITY                            *
*#----------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                    *
*# MODEL: SWMHYMO                                                  *
*#                                                                 *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                            *
*#                                                                 *
*# DATA FILE: 13016E.DAT                                           *
*# DESIGN STORM EVENTS (EXISTING CONDITIONS 1986-91 RAINFALL)      *
*#*****************************************************************
*
--------------------------------------------------------------------------------
090:0002------------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1990.0401
                       End date     = 1990.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19900401 @  0hrs to the end of 19901101
      Number of rainfall increments read=   5160 (  215.0 days)
```

```
      Total precipitation read=    515.7 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        19.2     12.8      8.5      4.3      2.4      1.8    mm/hr
      19900812 19900812 19900812 19900812 19900813 19900813  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         115       92       84       67       59       48
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         114       75       53       21        5        0

--------------------------------------------------------------------------------
090:0003------------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =    3.85 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =    1.91 mm
               Average  API value =   17.55 mm
               Total precipitation=  515.70 mm
--------------------------------------------------------------------------------
090:0004------------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 515.70   (mm).  Now is  26.20   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.13, S*min= 64.50, S*avg= 64.57,  CNavg= 79.73

     Unit Hyd Qpeak  (cms)=    4.941

     PEAK FLOW       (cms)=     .082 (i)
     TIME TO PEAK    (hrs)=  234.400
                     or on  1990.0410_18:24
     RUNOFF VOLUME    (mm)=    1.721
     TOTAL RAINFALL   (mm)=   26.200
     RUNOFF COEFFICIENT   =     .066

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
090:0005------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS (OH)
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   12.15   Curve Number   (CN)=61.00
| 02:001001 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660
```

```
                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.13, S*min= 64.50, S*avg= 64.57,  CNavg= 79.73

     Unit Hyd Qpeak  (cms)=    1.015

     PEAK FLOW       (cms)=     .017 (i)
     TIME TO PEAK    (hrs)=  234.400
                     or on  1990.0410_18:24
     RUNOFF VOLUME    (mm)=    1.721
     TOTAL RAINFALL   (mm)=   26.200
     RUNOFF COEFFICIENT   =     .066

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
090:0006-----------------------------------------------------------------------
*
--------------------
| ADD HYD (002000) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 01:001000    59.15     .082  234.40   1.72    .000
               +ID2 02:001001    12.15     .017  234.40   1.72    .000
                ==================================================
                SUM 06:002000    71.30     .099  234.40   1.72    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
090:0007-----------------------------------------------------------------------
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002000     .099     .001        9|23:21        4.5       1.9
-------------------------------------------------------------------------------
090:0008-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
090:0002-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
090:0002-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
090:0002-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
090:0002-----------------------------------------------------------------------
*
  ** END OF RUN :  90

*******************************************************************************




--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19910401
    METOUT=   2 (output = METRIC)
```

```
    NRUN  = 091
    NSTORM=   0
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*#*****************************************************************
*# HYDROLOGIC MODEL (COAST ROAD DEVELOPMENT)                      *
*# EXISTING CONDITIONS - CONTINUOUS MODEL                         *
*#                                                                *
*# CREDIT VALLEY CONSERVATION AUTHORITY                           *
*#---------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                   *
*# MODEL: SWMHYMO                                                 *
*#                                                                *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                           *
*#                                                                *
*# DATA FILE: 13016E.DAT                                          *
*# DESIGN STORM EVENTS (EXISTING CONDITIONS 1986-91 RAINFALL)     *
*#*****************************************************************
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1991.0401
                       End date     = 1991.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19910401 @  0hrs to the end of 19911101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    504.6 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        16.5     11.8     10.4      6.9      3.7      1.8    mm/hr
      19910529 19910803 19910803 19910803 19910803 19910803  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         109       89       82       68       58       41
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         108       60       29       10        1        0

--------------------------------------------------------------------------------
091:0003------------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =    8.85 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =    1.73 mm
               Average  API value =   17.09 mm
               Total precipitation=  504.60 mm
--------------------------------------------------------------------------------
091:0004------------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
```

```
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 504.60   (mm).  Now is  54.00   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 64.64, S*min= 64.50, S*avg= 64.51,  CNavg= 79.75

     Unit Hyd Qpeak  (cms)=    4.941

     PEAK FLOW       (cms)=     .756 (i)
     TIME TO PEAK    (hrs)=  209.400
                     or on  1991.0409_17:24
     RUNOFF VOLUME    (mm)=   14.350
     TOTAL RAINFALL   (mm)=   54.000
     RUNOFF COEFFICIENT   =     .266

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
091:0005------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS (OH)
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   12.15   Curve Number   (CN)=61.00
| 02:001001 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .660

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 64.64, S*min= 64.50, S*avg= 64.51,  CNavg= 79.75

     Unit Hyd Qpeak  (cms)=    1.015

     PEAK FLOW       (cms)=     .155 (i)
     TIME TO PEAK    (hrs)=  209.400
                     or on  1991.0409_17:24
     RUNOFF VOLUME    (mm)=   14.350
     TOTAL RAINFALL   (mm)=   54.000
     RUNOFF COEFFICIENT   =     .266

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
091:0006------------------------------------------------------------------------
*
--------------------
| ADD HYD (002000) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:001000    59.15     .756  209.40  14.35    .000
                +ID2 02:001001    12.15     .155  209.40  14.35    .000
                 ===================================================
                 SUM 06:002000    71.30     .911  209.40  14.35    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
091:0007------------------------------------------------------------------------
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
```

```
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002000     .911     .013        9|00:23       9.6       4.5
--------------------------------------------------------------------------------
091:0008------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
      FINISH
--------------------------------------------------------------------------------
********************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
 086:0004 CONTINUOUS NASHYD
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
   Simulation ended on 2013-10-29     at 15:14:55
================================================================================
```

```
=============================================================================

 SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999  =========
 S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
 SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9 Ver. 4.02
     S   W W   M   M  H   H    Y    M   M  O   O       9999   9999 July 1999
 SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9 =========
                                                      9   9  9   9 # 2010664
      StormWater Management HYdrologic Model           999    999  =========

 **************************************************************************
 *************************** SWMHYMO-99 Ver/4.02 **************************
 *******  A single event and continuous hydrologic simulation model  *******
 *******     based on the principles of HYMO and its successors      *******
 *******                 OTTHYMO-83 and OTTHYMO-89.                  *******
 **************************************************************************
 ******* Distributed by:  J.F. Sabourin and Associates Inc.           *******
 *******                 Ottawa,  Ontario: (613) 727-5199            *******
 *******                 Gatineau, Quebec: (819) 243-6858            *******
 *******                 E-Mail: swmhymo@jfsa.Com                    *******
 **************************************************************************

 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++ Licensed user: Water's Edge                                +++++++
 +++++++               Cambridge             SERIAL#:2010664        +++++++
 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 **************************************************************************
 *******           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            *******
 *******           Maximum value for ID numbers  :     10            *******
 *******           Max. number of rainfall points:  15000            *******
 *******           Max. number of flow points    :  15000            *******
 **************************************************************************


 ********************   D E T A I L E D   O U T P U T   *******************
 **************************************************************************
 *       DATE: 2013-10-29     TIME: 15:15:19     RUN COUNTER: 000073       *
 **************************************************************************
 * Input   filename: Z:\3SWMHY~1\13016\13016P.dat                         *
 * Output  filename: Z:\3SWMHY~1\13016\13016P.out                         *
 * Summary filename: Z:\3SWMHY~1\13016\13016P.sum                         *
 * User comments:                                                         *
 * 1:_____________________________________________________________________*
 * 2:_____________________________________________________________________*
 * 3:_____________________________________________________________________*
 **************************************************************************

-------------------------------------------------------------------------------
001:0001-----------------------------------------------------------------------
*
*
*
*
*#*****************************************************************
*# HYDROLOGIC MODEL (ORANGEVILLE HIGHLANDS - PHASE 2)              *
*# PROPOSED CONDITIONS - CONTINUOUS MODEL                          *
*#                                                                 *
*# CREDIT VALLEY CONSERVATION AUTHORITY                            *
*#----------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                    *
*# MODEL: SWMHYMO                                                  *
*#                                                                 *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                            *
*#                                                                 *
*# DATA FILE: 13016P.DAT                                           *
*# DESIGN STORM EVENTS (PROPOSED CONDITIONS 1986-91 RAINFALL)      *
*#*****************************************************************
*
  ** END OF RUN :  85

*******************************************************************************
```

```
--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19860401
    METOUT=   2 (output = METRIC)
    NRUN  = 086
    NSTORM=   0
--------------------------------------------------------------------------------
086:0002------------------------------------------------------------------------
*
*
*
*
*#*******************************************************************
*# HYDROLOGIC MODEL (ORANGEVILLE HIGHLANDS - PHASE 2)                *
*# PROPOSED CONDITIONS - CONTINUOUS MODEL                            *
*#                                                                   *
*# CREDIT VALLEY CONSERVATION AUTHORITY                              *
*#------------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                      *
*# MODEL: SWMHYMO                                                    *
*#                                                                   *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                              *
*#                                                                   *
*# DATA FILE: 13016P.DAT                                             *
*# DESIGN STORM EVENTS (PROPOSED CONDITIONS 1986-91 RAINFALL)        *
*#*******************************************************************
*
--------------------------------------------------------------------------------
086:0002------------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1986.0401
                       End date     = 1986.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19860401 @  0hrs to the end of 19861101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    723.1 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        23.8     16.7     16.0     11.5      6.0      3.0    mm/hr
      19860815 19860826 19860718 19860827 19860827 19860827  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         125       96       85       70       60       48
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         125       79       53       19        1        0

--------------------------------------------------------------------------------
086:0003------------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =   15.46 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =     .74 mm
               Average  API value =   23.17 mm
```

```
               Total precipitation=  723.10 mm
--------------------------------------------------------------------------------
086:0004------------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                  Total area = 59.15 ha
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .690

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 723.10   (mm).  Now is  11.90   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.72, S*min= 64.50, S*avg= 64.60,  CNavg= 79.72

     Unit Hyd Qpeak  (cms)=    4.727

     PEAK FLOW       (cms)=     .008 (i)
     TIME TO PEAK    (hrs)=  116.283
                     or on  1986.0405_20:17
     RUNOFF VOLUME    (mm)=     .066
     TOTAL RAINFALL   (mm)=   11.900
     RUNOFF COEFFICIENT   =     .006

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
086:0005------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                     PROPOSED DEVELOPMENT (Controlled)
*
----------------------
| CONTINUOUS STANDHYD|   Area    (ha)=   11.60
| 02:001001 DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.12         3.48
     Dep. Storage     (mm)=       8.00         5.00
     Average Slope     (%)=        .50         1.00
     Length            (m)=      15.00        35.00
     Mannings n           =       .013         .250

               CONTINUOUS SIMULATION INPUT PARAMETERS:
               IaRECimp (hrs)=  2.00, IaRECper (hrs)= 12.00,
               SMIN      (mm)= 31.15, SMAX      (mm)=207.66, SK= .250
               InterEventTime  (hrs)= 24.00

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 31.74, S*min= 31.15, S*avg= 31.20,  CNavg= 89.06

     Max.eff.Inten.(mm/hr)=        .00          .14
                over (min)        1.00       112.00
     Storage Coeff.  (min)=        .00 (ii)  112.03 (ii)
     Unit Hyd. Tpeak (min)=        .00       112.00
     Unit Hyd. peak  (cms)=        .00          .01
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .00          .00           .000 (iii)
     TIME TO PEAK    (hrs)=        .00       117.30        117.300
                                                    or on 1986.0405_21:18
     RUNOFF VOLUME    (mm)=        .00          .13           .040
```

```
     TOTAL RAINFALL   (mm)=      11.90        11.90         11.900
     RUNOFF COEFFICIENT   =        .00          .01           .003
      *** NOTE: The impervious area has no runoff.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  77.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
086:0006------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                    PROPOSED DEVELOPMENT (Uncontrolled)
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=     .58   Curve Number   (CN)=69.00
| 03:001002 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .050

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 44.82,  SMAX   (mm)=298.82,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 45.67, S*min= 44.82, S*avg= 44.90,  CNavg= 84.98

     Unit Hyd Qpeak  (cms)=     .640

     PEAK FLOW       (cms)=     .000 (i)
     TIME TO PEAK    (hrs)=  115.017
                     or on  1986.0405_19:01
     RUNOFF VOLUME    (mm)=     .094
     TOTAL RAINFALL   (mm)=   11.900
     RUNOFF COEFFICIENT   =     .008

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
086:0007------------------------------------------------------------------------
*
--------------------
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 01:001000    59.15      .008  116.28    .07    .000
               +ID2 03:001002      .58      .000  115.02    .09    .000
                ===================================================
                SUM 04:002001    59.73      .008  116.28    .07    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
086:0008------------------------------------------------------------------------
*
* ROUTE PROPOSED DEVELOPMENT THROUGH SUPER-PIPE FACILITY
*
---------------------
| ROUTE RESERVOIR   |    Requested routing time step = 20.0 min.
|  IN>02:(001001)   |
| OUT<05:(003001)   |    =========  OUTFLOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |    1.030  .4500E+00
                            .021  .2200E+00   |    1.334  .4900E+00
                            .159  .2800E+00   |    1.527  .5125E+00
                            .417  .3475E+00   |    1.544  .5200E+00
                            .676  .3975E+00   |     .000  .0000E+00
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.
```

```
     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (001001)      11.60      .000   117.300       .040
     OUTFLOW<05: (003001)      11.60      .000   121.983       .039
    OVERFLOW<07: (003002)        .00      .000      .000       .000

                  TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                  CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                  PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=    9.620
                  TIME SHIFT OF PEAK FLOW         (min)=   281.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.3809E-03

--------------------------------------------------------------------------------
086:0009------------------------------------------------------------------------
*
* ADD ROUTED AND OVERFLOW HYDROGRAPHS
*
--------------------
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 04:002001    59.73     .008  116.28    .07    .000
                +ID2 05:003001    11.60     .000  121.98    .04    .000
                 ==================================================
                 SUM 06:002001    71.33     .008  116.28    .06    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
086:0010------------------------------------------------------------------------
*
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002001     .008     .000       10|10:00        .0        .0
--------------------------------------------------------------------------------
086:0011------------------------------------------------------------------------
*
  ** END OF RUN :  86

********************************************************************************




--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19870401
    METOUT=   2 (output = METRIC)
    NRUN  = 087
    NSTORM=   0
--------------------------------------------------------------------------------
087:0002------------------------------------------------------------------------
*
*
*
*
*#******************************************************************
*# HYDROLOGIC MODEL (ORANGEVILLE HIGHLANDS - PHASE 2)               *
*# PROPOSED CONDITIONS - CONTINUOUS MODEL                           *
*#                                                                  *
*# CREDIT VALLEY CONSERVATION AUTHORITY                             *
```

```
*#-------------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                      *
*# MODEL: SWMHYMO                                                    *
*#                                                                   *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                              *
*#                                                                   *
*# DATA FILE: 13016P.DAT                                             *
*# DESIGN STORM EVENTS (PROPOSED CONDITIONS 1986-91 RAINFALL)        *
*#*******************************************************************
*
--------------------------------------------------------------------------------
087:0002------------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1987.0401
                       End date     = 1987.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19870401 @  0hrs to the end of 19871101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    450.2 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        35.8     17.9     11.9      6.2      3.1      1.6    mm/hr
      19870913 19870913 19870913 19870720 19870720 19870913  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         126      102       91       81       67       53
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         125       63       41       10        1        0

--------------------------------------------------------------------------------
087:0003------------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =    7.39 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =    1.06 mm
               Average  API value =   15.57 mm
               Total precipitation=  450.20 mm
--------------------------------------------------------------------------------
087:0004------------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .690

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 450.20   (mm).  Now is  21.80   (mm).
```

```
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 64.88, S*min= 64.50, S*avg= 64.53,  CNavg= 79.74

     Unit Hyd Qpeak  (cms)=    4.727

     PEAK FLOW       (cms)=     .020 (i)
     TIME TO PEAK    (hrs)=  141.250
                     or on  1987.0406_21:15
     RUNOFF VOLUME    (mm)=     .479
     TOTAL RAINFALL   (mm)=   21.800
     RUNOFF COEFFICIENT   =     .022

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
087:0005------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                    PROPOSED DEVELOPMENT (Controlled)
*
----------------------
| CONTINUOUS STANDHYD|   Area    (ha)=   11.60
| 02:001001 DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.12         3.48
     Dep. Storage     (mm)=       8.00         5.00
     Average Slope     (%)=        .50         1.00
     Length            (m)=      15.00        35.00
     Mannings n           =       .013         .250

               CONTINUOUS SIMULATION INPUT PARAMETERS:
               IaRECimp (hrs)=  2.00, IaRECper (hrs)= 12.00,
               SMIN      (mm)= 31.15, SMAX      (mm)=207.66, SK= .250
               InterEventTime  (hrs)= 24.00

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 31.33, S*min= 31.15, S*avg= 31.16,  CNavg= 89.07

     Max.eff.Inten.(mm/hr)=       1.00          .22
                over (min)        6.00        99.00
     Storage Coeff.  (min)=       6.36 (ii)   98.75 (ii)
     Unit Hyd. Tpeak (min)=       6.00        99.00
     Unit Hyd. peak  (cms)=        .18          .01
                                                             *TOTALS*
     PEAK FLOW       (cms)=        .02          .00           .024 (iii)
     TIME TO PEAK    (hrs)=     140.65       141.97        141.000
                                                   or on 1987.0406_21:00
     RUNOFF VOLUME    (mm)=       2.60          .91          2.093
     TOTAL RAINFALL   (mm)=      21.80        21.80         21.800
     RUNOFF COEFFICIENT   =        .12          .04           .096

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  77.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
087:0006------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                    PROPOSED DEVELOPMENT (Uncontrolled)
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=     .58   Curve Number   (CN)=69.00
| 03:001002 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .050

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 44.82,  SMAX   (mm)=298.82,  SK = .250
```

```
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 45.09, S*min= 44.82, S*avg= 44.85,  CNavg= 84.99

     Unit Hyd Qpeak  (cms)=     .640

     PEAK FLOW       (cms)=     .000 (i)
     TIME TO PEAK    (hrs)=  139.000
                     or on  1987.0406_19:00
     RUNOFF VOLUME    (mm)=     .664
     TOTAL RAINFALL   (mm)=   21.800
     RUNOFF COEFFICIENT   =     .030

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
087:0007-----------------------------------------------------------------------
*
--------------------
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:001000    59.15     .020  141.25    .48    .000
                +ID2 03:001002      .58     .000  139.00    .66    .000
                 ======================================================
                 SUM 04:002001    59.73     .020  141.25    .48    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
087:0008-----------------------------------------------------------------------
*
* ROUTE PROPOSED DEVELOPMENT THROUGH SUPER-PIPE FACILITY
*
---------------------
| ROUTE RESERVOIR   |    Requested routing time step = 20.0 min.
|  IN>02:(001001)   |
| OUT<05:(003001)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |    1.030  .4500E+00
                            .021  .2200E+00   |    1.334  .4900E+00
                            .159  .2800E+00   |    1.527  .5125E+00
                            .417  .3475E+00   |    1.544  .5200E+00
                            .676  .3975E+00   |     .000  .0000E+00
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.

     ROUTING RESULTS           AREA     QPEAK     TPEAK       R.V.
     --------------------      (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (001001)      11.60      .024   141.000      2.093
     OUTFLOW<05: (003001)      11.60      .002   144.200      2.043
    OVERFLOW<07: (003002)        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    8.370
                   TIME SHIFT OF PEAK FLOW         (min)=   192.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2108E-01

-------------------------------------------------------------------------------
087:0009-----------------------------------------------------------------------
*
* ADD ROUTED AND OVERFLOW HYDROGRAPHS
*
--------------------
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
```

```
                ID1 04:002001    59.73     .020  141.25    .48    .000
               +ID2 05:003001    11.60     .002  144.20   2.04    .000
                ======================================================
                SUM 06:002001    71.33     .022  141.27    .73    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
087:0010-----------------------------------------------------------------------
*
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002001     .022     .001       10|10:00         .0        .0
-------------------------------------------------------------------------------
087:0011-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
087:0002-----------------------------------------------------------------------
*
  ** END OF RUN :  87

*******************************************************************************




--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19880401
    METOUT=   2 (output = METRIC)
    NRUN  = 088
    NSTORM=   0
-------------------------------------------------------------------------------
088:0002-----------------------------------------------------------------------
*
*
*
*
*#*******************************************************************
*# HYDROLOGIC MODEL (ORANGEVILLE HIGHLANDS - PHASE 2)                *
*# PROPOSED CONDITIONS - CONTINUOUS MODEL                            *
*#                                                                   *
*# CREDIT VALLEY CONSERVATION AUTHORITY                              *
*#------------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                      *
*# MODEL: SWMHYMO                                                    *
*#                                                                   *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                              *
*#                                                                   *
*# DATA FILE: 13016P.DAT                                             *
*# DESIGN STORM EVENTS (PROPOSED CONDITIONS 1986-91 RAINFALL)        *
*#*******************************************************************
*
-------------------------------------------------------------------------------
088:0002-----------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1988.0401
                       End date     = 1988.1101
                       Time span    =  214 days
                       Station ID   = 1234567
```

```
      RAINFALL RECORD STATISTICS:
      Data read from 19880401 @  0hrs to the end of 19881101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    400.0 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        29.4     14.7     10.0      5.1      2.6      1.4    mm/hr
      19880724 19880724 19880724 19880724 19880724 19880904  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         114       93       88       80       66       49
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         113       66       34        7        1        0

--------------------------------------------------------------------------------
088:0003------------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =    5.53 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =     .51 mm
               Average  API value =   14.18 mm
               Total precipitation=  400.00 mm
--------------------------------------------------------------------------------
088:0004------------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .690

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 400.00   (mm).  Now is  19.60   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.35, S*min= 64.50, S*avg= 64.57,  CNavg= 79.73

     Unit Hyd Qpeak  (cms)=    4.727

     PEAK FLOW       (cms)=     .103 (i)
     TIME TO PEAK    (hrs)=   71.400
                    or on  1988.0403_23:24
     RUNOFF VOLUME    (mm)=    1.414
     TOTAL RAINFALL   (mm)=   19.600
     RUNOFF COEFFICIENT   =     .072

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
088:0005------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                    PROPOSED DEVELOPMENT (Controlled)
*
```

```
 ----------------------
 | CONTINUOUS STANDHYD|   Area    (ha)=   11.60
 | 02:001001 DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
 ----------------------
                              IMPERVIOUS    PERVIOUS (i)
      Surface Area     (ha)=       8.12         3.48
      Dep. Storage     (mm)=       8.00         5.00
      Average Slope     (%)=        .50         1.00
      Length            (m)=      15.00        35.00
      Mannings n          =       .013         .250

                CONTINUOUS SIMULATION INPUT PARAMETERS:
                IaRECimp (hrs)=  2.00, IaRECper (hrs)= 12.00,
                SMIN      (mm)= 31.15, SMAX      (mm)=207.66, SK= .250
                InterEventTime  (hrs)= 24.00

                STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
                S*max= 31.56, S*min= 31.15, S*avg= 31.18,  CNavg= 89.07

      Max.eff.Inten.(mm/hr)=       1.70         1.37
                 over (min)        5.00        50.00
      Storage Coeff.  (min)=       5.14 (ii)   49.73 (ii)
      Unit Hyd. Tpeak (min)=       5.00        50.00
      Unit Hyd. peak  (cms)=        .22          .02
                                                             *TOTALS*
      PEAK FLOW       (cms)=        .04          .01           .042 (iii)
      TIME TO PEAK    (hrs)=      63.00        71.52         63.000
                                                    or on 1988.0403_15:00
      RUNOFF VOLUME    (mm)=       2.60         2.55          2.586
      TOTAL RAINFALL   (mm)=      19.60        19.60         19.600
      RUNOFF COEFFICIENT   =        .13          .13           .132

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  77.0    Ia = Dep. Storage  (Above)
       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 -----------------------------------------------------------------------------
 088:0006---------------------------------------------------------------------
 *
 * SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
 *                    PROPOSED DEVELOPMENT (Uncontrolled)
 *
 ----------------------
 | CONTINUOUS NASHYD  |   Area    (ha)=     .58   Curve Number   (CN)=69.00
 | 03:001002 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
 ----------------------   U.H. Tp(hrs)=    .050

                          CONTINUOUS SIMULATION INPUT PARAMETERS:
                          IaREC (hrs)= 12.00,
                          SMIN   (mm)= 44.82,  SMAX   (mm)=298.82,  SK = .250
                          InterEventTime (hrs)= 24.00

                          BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
                STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
                S*max= 45.41, S*min= 44.82, S*avg= 44.87,  CNavg= 84.99

      Unit Hyd Qpeak  (cms)=     .640

      PEAK FLOW       (cms)=     .002 (i)
      TIME TO PEAK    (hrs)=   71.000
                      or on  1988.0403_23:00
      RUNOFF VOLUME    (mm)=    1.919
      TOTAL RAINFALL   (mm)=   19.600
      RUNOFF COEFFICIENT   =     .098

      (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 -----------------------------------------------------------------------------
 088:0007---------------------------------------------------------------------
 *
 --------------------
```

```
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 01:001000    59.15      .103   71.40   1.41    .000
               +ID2 03:001002      .58      .002   71.00   1.92    .000
                =======================================================
                SUM 04:002001    59.73      .103   71.40   1.42    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
088:0008------------------------------------------------------------------------
*
* ROUTE PROPOSED DEVELOPMENT THROUGH SUPER-PIPE FACILITY
*
---------------------
| ROUTE RESERVOIR   |    Requested routing time step = 20.0 min.
|  IN>02:(001001)   |
| OUT<05:(003001)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                          (cms)    (ha.m.)    |   (cms)    (ha.m.)
                           .000  .0000E+00    |    1.030  .4500E+00
                           .021  .2200E+00    |    1.334  .4900E+00
                           .159  .2800E+00    |    1.527  .5125E+00
                           .417  .3475E+00    |    1.544  .5200E+00
                           .676  .3975E+00    |     .000  .0000E+00
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (001001)      11.60      .042    63.000      2.586
     OUTFLOW<05: (003001)      11.60      .002    64.567      2.581
    OVERFLOW<07: (003002)        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    5.446
                   TIME SHIFT OF PEAK FLOW         (min)=    94.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.2376E-01

--------------------------------------------------------------------------------
088:0009------------------------------------------------------------------------
*
* ADD ROUTED AND OVERFLOW HYDROGRAPHS
*
--------------------
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 04:002001    59.73      .103   71.40   1.42    .000
               +ID2 05:003001    11.60      .002   64.57   2.58    .000
                =======================================================
                SUM 06:002001    71.33      .105   71.40   1.61    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
088:0010------------------------------------------------------------------------
*
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002001     .105     .001       10|10:00       2.1        .8
--------------------------------------------------------------------------------
```

```
088:0011--------------------------------------------------------------------
*
----------------------------------------------------------------------------
088:0002--------------------------------------------------------------------
*
----------------------------------------------------------------------------
088:0002--------------------------------------------------------------------
*
  ** END OF RUN :  88

****************************************************************************




--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19890401
    METOUT=   2 (output = METRIC)
    NRUN  = 089
    NSTORM=   0
----------------------------------------------------------------------------
089:0002--------------------------------------------------------------------
*
*
*
*
*#*****************************************************************
*# HYDROLOGIC MODEL (ORANGEVILLE HIGHLANDS - PHASE 2)              *
*# PROPOSED CONDITIONS - CONTINUOUS MODEL                          *
*#                                                                 *
*# CREDIT VALLEY CONSERVATION AUTHORITY                            *
*#----------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                    *
*# MODEL: SWMHYMO                                                  *
*#                                                                 *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                            *
*#                                                                 *
*# DATA FILE: 13016P.DAT                                           *
*# DESIGN STORM EVENTS (PROPOSED CONDITIONS 1986-91 RAINFALL)      *
*#*****************************************************************
*
----------------------------------------------------------------------------
089:0002--------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1989.0401
                       End date     = 1989.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19890401 @  0hrs to the end of 19891101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    417.0 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        21.6     10.9      7.3      4.5      2.3      1.8    mm/hr
      19890725 19890725 19890725 19890602 19890602 19890726  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
          98       75       71       64       59       43
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
          97       57       34       15        5        0

----------------------------------------------------------------------------
089:0003--------------------------------------------------------------------
```

```
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =   13.89 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =     .56 mm
               Average  API value =   14.43 mm
               Total precipitation=  417.00 mm
--------------------------------------------------------------------------------
089:0004------------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .690

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 417.00   (mm).  Now is  18.60   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.34, S*min= 64.50, S*avg= 64.57,  CNavg= 79.73

     Unit Hyd Qpeak  (cms)=    4.727

     PEAK FLOW       (cms)=     .021 (i)
     TIME TO PEAK    (hrs)=   58.300
                    or on  1989.0403_10:18
     RUNOFF VOLUME    (mm)=     .360
     TOTAL RAINFALL   (mm)=   18.600
     RUNOFF COEFFICIENT   =     .019

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
089:0005------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                    PROPOSED DEVELOPMENT (Controlled)
*
----------------------
| CONTINUOUS STANDHYD|   Area    (ha)=   11.60
| 02:001001 DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.12         3.48
     Dep. Storage     (mm)=       8.00         5.00
     Average Slope     (%)=        .50         1.00
     Length            (m)=      15.00        35.00
     Mannings n           =       .013         .250

               CONTINUOUS SIMULATION INPUT PARAMETERS:
               IaRECimp (hrs)=  2.00, IaRECper (hrs)= 12.00,
               SMIN      (mm)= 31.15, SMAX      (mm)=207.66, SK= .250
               InterEventTime  (hrs)= 24.00

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 31.55, S*min= 31.15, S*avg= 31.18,  CNavg= 89.07
```

```
     Max.eff.Inten.(mm/hr)=       1.30          .25
                over (min)        6.00        94.00
     Storage Coeff.  (min)=       5.72 (ii)   94.38 (ii)
     Unit Hyd. Tpeak (min)=       6.00        94.00
     Unit Hyd. peak  (cms)=        .19          .01
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .03          .00           .030 (iii)
     TIME TO PEAK    (hrs)=      58.00        59.20         58.000
                                                   or on 1989.0403_10:00
     RUNOFF VOLUME    (mm)=       1.80          .69          1.467
     TOTAL RAINFALL   (mm)=      18.60        18.60         18.600
     RUNOFF COEFFICIENT   =        .10          .04           .079

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  77.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
089:0006------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                    PROPOSED DEVELOPMENT (Uncontrolled)
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=     .58   Curve Number   (CN)=69.00
| 03:001002 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .050

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 44.82,  SMAX   (mm)=298.82,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 45.41, S*min= 44.82, S*avg= 44.87,  CNavg= 84.99

     Unit Hyd Qpeak  (cms)=     .640

     PEAK FLOW       (cms)=     .000 (i)
     TIME TO PEAK    (hrs)=   58.000
                     or on  1989.0403_10:00
     RUNOFF VOLUME    (mm)=     .502
     TOTAL RAINFALL   (mm)=   18.600
     RUNOFF COEFFICIENT   =     .027

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
089:0007------------------------------------------------------------------------
*
--------------------
| ADD HYD (002001) | ID: NHYD      AREA     QPEAK   TPEAK   R.V.     DWF
--------------------               (ha)     (cms)   (hrs)   (mm)   (cms)
                ID1 01:001000    59.15      .021   58.30    .36    .000
               +ID2 03:001002      .58      .000   58.00    .50    .000
                ==================================================
                SUM 04:002001    59.73      .021   58.30    .36    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
089:0008------------------------------------------------------------------------
*
* ROUTE PROPOSED DEVELOPMENT THROUGH SUPER-PIPE FACILITY
*
---------------------
| ROUTE RESERVOIR   |    Requested routing time step = 20.0 min.
|  IN>02:(001001)   |
| OUT<05:(003001)   |    =========  OUTLFOW STORAGE TABLE  =========
```

```
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |    1.030  .4500E+00
                            .021  .2200E+00   |    1.334  .4900E+00
                            .159  .2800E+00   |    1.527  .5125E+00
                            .417  .3475E+00   |    1.544  .5200E+00
                            .676  .3975E+00   |     .000  .0000E+00
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (001001)      11.60      .030    58.000      1.467
     OUTFLOW<05: (003001)      11.60      .001    59.867      1.465
    OVERFLOW<07: (003002)        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    4.698
                   TIME SHIFT OF PEAK FLOW         (min)=   112.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.1498E-01

--------------------------------------------------------------------------------
089:0009------------------------------------------------------------------------
*
* ADD ROUTED AND OVERFLOW HYDROGRAPHS
*
--------------------
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 04:002001    59.73     .021   58.30    .36    .000
                +ID2 05:003001    11.60     .001   59.87   1.47    .000
                 ==================================================
                 SUM 06:002001    71.33     .022   58.32    .54    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
089:0010------------------------------------------------------------------------
*
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002001     .022     .000       10|10:00        .0        .0
--------------------------------------------------------------------------------
089:0011------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
089:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
089:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
089:0002------------------------------------------------------------------------
*
  ** END OF RUN :  89

********************************************************************************
```

```
--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19900401
    METOUT=   2 (output = METRIC)
    NRUN  = 090
    NSTORM=   0
-------------------------------------------------------------------------------
090:0002-----------------------------------------------------------------------
*
*
*
*
*#*****************************************************************
*# HYDROLOGIC MODEL (ORANGEVILLE HIGHLANDS - PHASE 2)              *
*# PROPOSED CONDITIONS - CONTINUOUS MODEL                          *
*#                                                                 *
*# CREDIT VALLEY CONSERVATION AUTHORITY                            *
*#----------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                    *
*# MODEL: SWMHYMO                                                  *
*#                                                                 *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                            *
*#                                                                 *
*# DATA FILE: 13016P.DAT                                           *
*# DESIGN STORM EVENTS (PROPOSED CONDITIONS 1986-91 RAINFALL)      *
*#*****************************************************************
*
-------------------------------------------------------------------------------
090:0002-----------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1990.0401
                       End date     = 1990.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19900401 @  0hrs to the end of 19901101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    515.7 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        19.2     12.8      8.5      4.3      2.4      1.8    mm/hr
      19900812 19900812 19900812 19900812 19900813 19900813  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         115       92       84       67       59       48
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         114       75       53       21        5        0

-------------------------------------------------------------------------------
090:0003-----------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =    3.85 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =    1.91 mm
               Average  API value =   17.55 mm
               Total precipitation=  515.70 mm
-------------------------------------------------------------------------------
090:0004-----------------------------------------------------------------------
*
```

```
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .690

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 515.70   (mm).  Now is  26.20   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 65.13, S*min= 64.50, S*avg= 64.57,  CNavg= 79.73

     Unit Hyd Qpeak  (cms)=    4.727

     PEAK FLOW       (cms)=     .081 (i)
     TIME TO PEAK    (hrs)=  234.433
                     or on  1990.0410_18:26
     RUNOFF VOLUME    (mm)=    1.721
     TOTAL RAINFALL   (mm)=   26.200
     RUNOFF COEFFICIENT   =     .066

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
090:0005-----------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                    PROPOSED DEVELOPMENT (Controlled)
*
----------------------
| CONTINUOUS STANDHYD|   Area    (ha)=   11.60
| 02:001001 DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.12         3.48
     Dep. Storage     (mm)=       8.00         5.00
     Average Slope     (%)=        .50         1.00
     Length            (m)=      15.00        35.00
     Mannings n           =       .013         .250

               CONTINUOUS SIMULATION INPUT PARAMETERS:
               IaRECimp (hrs)=  2.00, IaRECper (hrs)= 12.00,
               SMIN      (mm)= 31.15, SMAX      (mm)=207.66, SK= .250
               InterEventTime  (hrs)= 24.00

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 31.45, S*min= 31.15, S*avg= 31.19,  CNavg= 89.06

     Max.eff.Inten.(mm/hr)=       3.00          .95
                over (min)        4.00        56.00
     Storage Coeff.  (min)=       4.10 (ii)   55.65 (ii)
     Unit Hyd. Tpeak (min)=       4.00        56.00
     Unit Hyd. peak  (cms)=        .28          .02
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .07          .01           .073 (iii)
     TIME TO PEAK    (hrs)=     233.98       234.77        234.000
                                                    or on 1990.0410_18:00
     RUNOFF VOLUME    (mm)=       8.40         3.07          6.802
     TOTAL RAINFALL   (mm)=      26.20        26.20         26.200
     RUNOFF COEFFICIENT   =        .32          .12           .260

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
```

```
          CN* =  77.0    Ia = Dep. Storage  (Above)
     (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
          THAN THE STORAGE COEFFICIENT.
    (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
090:0006-----------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                    PROPOSED DEVELOPMENT (Uncontrolled)
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=     .58   Curve Number   (CN)=69.00
| 03:001002 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .050

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 44.82,  SMAX   (mm)=298.82,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 45.26, S*min= 44.82, S*avg= 44.87,  CNavg= 84.99

     Unit Hyd Qpeak  (cms)=     .640

     PEAK FLOW       (cms)=     .001 (i)
     TIME TO PEAK    (hrs)=  234.000
                     or on  1990.0410_18:00
     RUNOFF VOLUME    (mm)=    2.325
     TOTAL RAINFALL   (mm)=   26.200
     RUNOFF COEFFICIENT   =     .089

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
090:0007-----------------------------------------------------------------------
*
--------------------
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:001000    59.15     .081  234.43   1.72    .000
                +ID2 03:001002      .58     .001  234.00   2.32    .000
                 ==================================================
                 SUM 04:002001    59.73     .082  234.43   1.73    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
090:0008-----------------------------------------------------------------------
*
* ROUTE PROPOSED DEVELOPMENT THROUGH SUPER-PIPE FACILITY
*
---------------------
| ROUTE RESERVOIR   |    Requested routing time step = 20.0 min.
|  IN>02:(001001)   |
| OUT<05:(003001)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |    1.030  .4500E+00
                            .021  .2200E+00   |    1.334  .4900E+00
                            .159  .2800E+00   |    1.527  .5125E+00
                            .417  .3475E+00   |    1.544  .5200E+00
                            .676  .3975E+00   |     .000  .0000E+00
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (001001)      11.60      .073   234.000      6.802
     OUTFLOW<05: (003001)      11.60      .007   237.167      2.841
```

```
    OVERFLOW<07: (003002)        .00      .000      .000       .000

                   TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                   CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                   PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=    9.084
                   TIME SHIFT OF PEAK FLOW         (min)=   190.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=.6942E-01

      *** WARNING: Outflow volume is less than inflow volume.
-------------------------------------------------------------------------------
090:0009-----------------------------------------------------------------------
*
* ADD ROUTED AND OVERFLOW HYDROGRAPHS
*
--------------------
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 04:002001    59.73     .082  234.43   1.73    .000
                +ID2 05:003001    11.60     .007  237.17   2.84    .000
                 ==================================================
                 SUM 06:002001    71.33     .086  234.43   1.91    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
090:0010-----------------------------------------------------------------------
*
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002001     .086     .002       10|10:00        4.3       1.7
-------------------------------------------------------------------------------
090:0011-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
090:0002-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
090:0002-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
090:0002-----------------------------------------------------------------------
*
-------------------------------------------------------------------------------
090:0002-----------------------------------------------------------------------
*
  ** END OF RUN :  90

*******************************************************************************




--------------------
| START            |  Project  dir.: Z:\3SWMHY~1\13016\
--------------------  Rainfall dir.: Z:\3SWMHY~1\13016\
    TZERO =   .00 hrs on 19910401
    METOUT=   2 (output = METRIC)
    NRUN  = 091
    NSTORM=   0
-------------------------------------------------------------------------------
091:0002-----------------------------------------------------------------------
*
```

```
*
*
*
*#****************************************************************
*# HYDROLOGIC MODEL (ORANGEVILLE HIGHLANDS - PHASE 2)              *
*# PROPOSED CONDITIONS - CONTINUOUS MODEL                          *
*#                                                                *
*# CREDIT VALLEY CONSERVATION AUTHORITY                            *
*#---------------------------------------------------------------*
*# MODEL SETUP BY: WATER'S EDGE                                    *
*# MODEL: SWMHYMO                                                  *
*#                                                                *
*# MODEL CREATED: OCTOBER 21, 2013            PROJECT NO: 13016 *
*# MODEL CREATED BY: CB                                            *
*#                                                                *
*# DATA FILE: 13016P.DAT                                           *
*# DESIGN STORM EVENTS (PROPOSED CONDITIONS 1986-91 RAINFALL)      *
*#****************************************************************
*
-------------------------------------------------------------------------------
091:0002-----------------------------------------------------------------------
*
--------------------
| READ AES DATA    |   AES filename = Z:\3SWMHY~1\13016\TORON6YR.123
--------------------   Data type    = 123 (hourly rainfall)
                       Start date   = 1991.0401
                       End date     = 1991.1101
                       Time span    =  214 days
                       Station ID   = 1234567

      RAINFALL RECORD STATISTICS:
      Data read from 19910401 @  0hrs to the end of 19911101
      Number of rainfall increments read=   5160 (  215.0 days)
      Total precipitation read=    504.6 mm
      Maximum average rainfall intensities over
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
        16.5     11.8     10.4      6.9      3.7      1.8    mm/hr
      19910529 19910803 19910803 19910803 19910803 19910803  date
      Number of rainfall events per following interevent time
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         109       89       82       68       58       41
      Number of events with at least the following durations
        1 hr    2 hrs    3 hrs    6 hrs   12 hrs   24 hrs
         108       60       29       10        1        0

-------------------------------------------------------------------------------
091:0003-----------------------------------------------------------------------
*
--------------------
| COMPUTE API      |   Initial API  = 100.00 mm
--------------------   APIk factor  =    .85 /day

          ANTECEDENT PRECIPITATION INDEX (API) STATISTICS:
               Initial  API value =  100.00 mm
               End date API value =    8.85 mm
               Maximum  API value =  100.00 mm
               Minimum  API value =    1.73 mm
               Average  API value =   17.09 mm
               Total precipitation=  504.60 mm
-------------------------------------------------------------------------------
091:0004-----------------------------------------------------------------------
*
* EXTERNAL AREA - Mid Monora Watershed upto u/s of proposed pond minus OH
*                 Total area = 59.15 ha
*
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=   59.15   Curve Number   (CN)=61.00
| 01:001000 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .690

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 64.50,  SMAX   (mm)=430.01,  SK = .250
```

```
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
      *** WARNING: Duration of storm was reduced.
                   Length of storm had to be cut from ***** points to 15000 .

      *** WARNING: Total rainfall volume has changed.
                   Volume was 504.60   (mm).  Now is  54.00   (mm).

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 64.64, S*min= 64.50, S*avg= 64.51,  CNavg= 79.75

     Unit Hyd Qpeak  (cms)=    4.727

     PEAK FLOW       (cms)=     .731 (i)
     TIME TO PEAK    (hrs)=  209.433
                     or on  1991.0409_17:26
     RUNOFF VOLUME    (mm)=   14.350
     TOTAL RAINFALL   (mm)=   54.000
     RUNOFF COEFFICIENT   =     .266

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
091:0005------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                    PROPOSED DEVELOPMENT (Controlled)
*
----------------------
| CONTINUOUS STANDHYD|   Area    (ha)=   11.60
| 02:001001 DT= 1.00 |   Total Imp(%)=   70.00   Dir. Conn.(%)=   70.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.12         3.48
     Dep. Storage     (mm)=       8.00         5.00
     Average Slope     (%)=        .50         1.00
     Length            (m)=      15.00        35.00
     Mannings n          =       .013         .250

               CONTINUOUS SIMULATION INPUT PARAMETERS:
               IaRECimp (hrs)=  2.00, IaRECper (hrs)= 12.00,
               SMIN      (mm)= 31.15, SMAX      (mm)=207.66, SK= .250
               InterEventTime  (hrs)= 24.00

               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 31.21, S*min= 31.15, S*avg= 31.16,  CNavg= 89.07

     Max.eff.Inten.(mm/hr)=      12.80         9.98
                over (min)        2.00        22.00
     Storage Coeff.  (min)=       2.29 (ii)   22.45 (ii)
     Unit Hyd. Tpeak (min)=       2.00        22.00
     Unit Hyd. peak  (cms)=        .51          .05
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .29          .07           .351 (iii)
     TIME TO PEAK    (hrs)=     209.00       209.13        209.000
                                                    or on 1991.0409_17:00
     RUNOFF VOLUME    (mm)=      17.10        21.23         18.339
     TOTAL RAINFALL   (mm)=      54.00        54.00         54.000
     RUNOFF COEFFICIENT   =        .32          .39           .340

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  77.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
091:0006------------------------------------------------------------------------
*
* SUBJECT PROPERTY - ORANGEVILLE HIGHLANDS - PHASE 2
*                    PROPOSED DEVELOPMENT (Uncontrolled)
*
```

```
----------------------
| CONTINUOUS NASHYD  |   Area    (ha)=     .58   Curve Number   (CN)=69.00
| 03:001002 DT= 1.00 |   Ia      (mm)=   5.000   # of Linear Res.(N)= 5.00
----------------------   U.H. Tp(hrs)=    .050

                         CONTINUOUS SIMULATION INPUT PARAMETERS:
                         IaREC (hrs)= 12.00,
                         SMIN   (mm)= 44.82,  SMAX   (mm)=298.82,  SK = .250
                         InterEventTime (hrs)= 24.00

                         BASEFLOW SIMULATION INPUT PARAMETERS: [Option=-1.]
               STATISTICS OF CONTINUOUSLY COMPUTED S-VALUE:
               S*max= 44.92, S*min= 44.82, S*avg= 44.84,  CNavg= 85.00

     Unit Hyd Qpeak  (cms)=     .640

     PEAK FLOW       (cms)=     .014 (i)
     TIME TO PEAK    (hrs)=  209.000
                     or on  1991.0409_17:00
     RUNOFF VOLUME    (mm)=   17.742
     TOTAL RAINFALL   (mm)=   54.000
     RUNOFF COEFFICIENT   =     .329

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
091:0007------------------------------------------------------------------------
*
--------------------
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 01:001000    59.15      .731  209.43  14.35    .000
                +ID2 03:001002      .58      .014  209.00  17.74    .000
                 ==================================================
                 SUM 04:002001    59.73      .731  209.43  14.38    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
091:0008------------------------------------------------------------------------
*
* ROUTE PROPOSED DEVELOPMENT THROUGH SUPER-PIPE FACILITY
*
---------------------
| ROUTE RESERVOIR   |    Requested routing time step = 20.0 min.
|  IN>02:(001001)   |
| OUT<05:(003001)   |    =========  OUTLFOW STORAGE TABLE  =========
---------------------    OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
                           (cms)    (ha.m.)   |    (cms)    (ha.m.)
                            .000  .0000E+00   |    1.030  .4500E+00
                            .021  .2200E+00   |    1.334  .4900E+00
                            .159  .2800E+00   |    1.527  .5125E+00
                            .417  .3475E+00   |    1.544  .5200E+00
                            .676  .3975E+00   |     .000  .0000E+00
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.

     ROUTING RESULTS            AREA     QPEAK     TPEAK       R.V.
     --------------------       (ha)     (cms)     (hrs)       (mm)
     INFLOW >02: (001001)      11.60      .351   209.000     18.339
     OUTFLOW<05: (003001)      11.60      .013   209.883     15.329
    OVERFLOW<07: (003002)        .00      .000      .000       .000

                  TOTAL NUMBER OF SIMULATED OVERFLOWS  =        0
                  CUMULATIVE TIME OF OVERFLOWS  (hours)=      .00
                  PERCENTAGE OF TIME OVERFLOWING    (%)=      .00


                  PEAK   FLOW   REDUCTION [Qout/Qin](%)=    3.648
                  TIME SHIFT OF PEAK FLOW         (min)=    53.00
                  MAXIMUM  STORAGE   USED       (ha.m.)=.1341E+00
```

```
      *** WARNING: Outflow volume is less than inflow volume.
--------------------------------------------------------------------------------
091:0009------------------------------------------------------------------------
*
* ADD ROUTED AND OVERFLOW HYDROGRAPHS
*
--------------------
| ADD HYD (002001) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)   (cms)
                 ID1 04:002001    59.73     .731  209.43  14.38    .000
                +ID2 05:003001    11.60     .013  209.88  15.33    .000
                 =====================================================
                 SUM 06:002001    71.33     .743  209.43  14.54    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
091:0010------------------------------------------------------------------------
*
*
* DETERMINE EROSION INDEX FOR CRITICAL REACH
*
--------------------
| EROSION INDEX    |  User selected INDEX Method    = 1 (Erosive hours)
--------------------  Critical Flow for Erosion, Qce=    .036

            ID NHYD      Qpeak     Qavg   Flow Duration   Erosive  Exceedance
                         (cms)    (cms)    (dddd|hh:mm)    Hours       (%)
            06:002001     .743     .012       10|10:00       10.0       4.0
--------------------------------------------------------------------------------
091:0011------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
--------------------------------------------------------------------------------
091:0002------------------------------------------------------------------------
*
      FINISH
--------------------------------------------------------------------------------
********************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
 086:0004 CONTINUOUS NASHYD
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
 086:0005 CONTINUOUS STANDHYD
      *** NOTE: The impervious area has no runoff.
 086:0008 ROUTE RESERVOIR
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.
 087:0004 CONTINUOUS NASHYD
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
 087:0008 ROUTE RESERVOIR
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.
 088:0004 CONTINUOUS NASHYD
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
 088:0008 ROUTE RESERVOIR
      **** ERROR: Routing time step must be less than inflow
```

```
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.
 089:0004 CONTINUOUS NASHYD
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
 089:0008 ROUTE RESERVOIR
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.
 090:0004 CONTINUOUS NASHYD
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
 090:0008 ROUTE RESERVOIR
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.
      *** WARNING: Outflow volume is less than inflow volume.
 091:0004 CONTINUOUS NASHYD
      *** WARNING: Duration of storm was reduced.
      *** WARNING: Total rainfall volume has changed.
 091:0008 ROUTE RESERVOIR
      **** ERROR: Routing time step must be less than inflow
                  hydrograph DT.
                  RDT was set equal to inflow hydrograph DT.
      *** WARNING: Outflow volume is less than inflow volume.
   Simulation ended on 2013-10-29     at 15:15:29
================================================================================
```

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APPENDIX E:

HEC-RAS Output Cross Sections

Middle Monora Creek Orangeville, Ontario

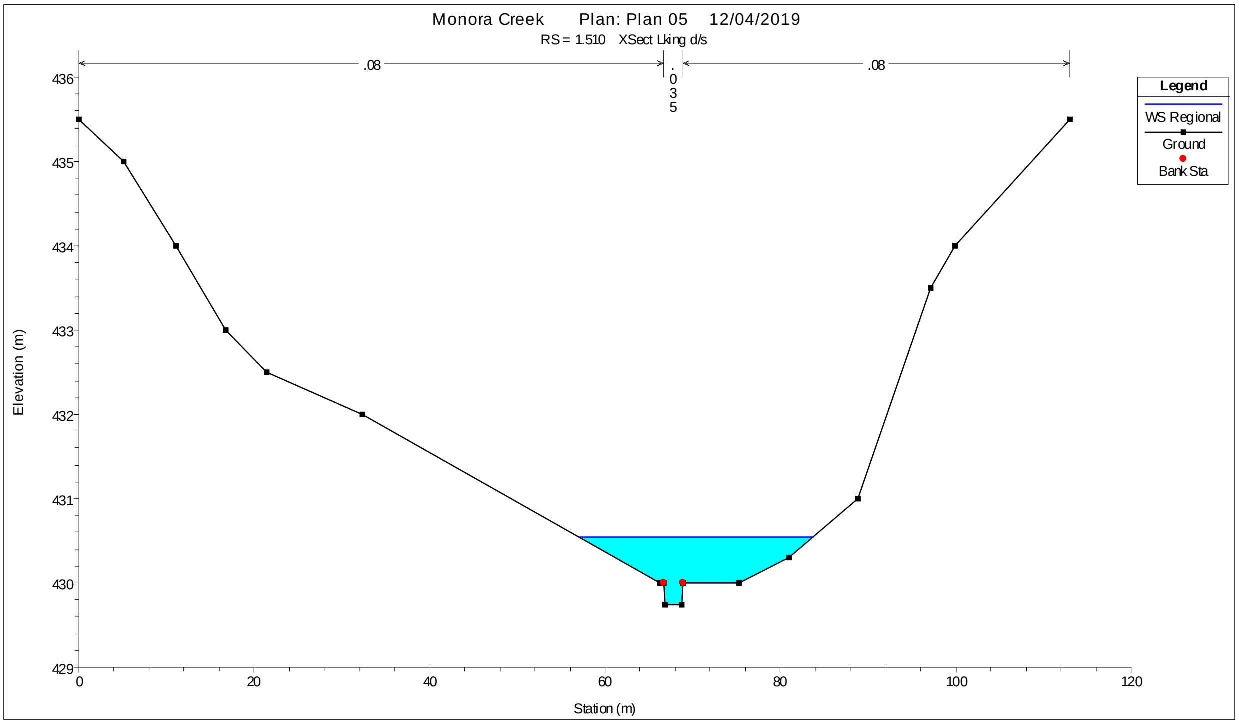

Figure 1: Cross Section at RS 1.510

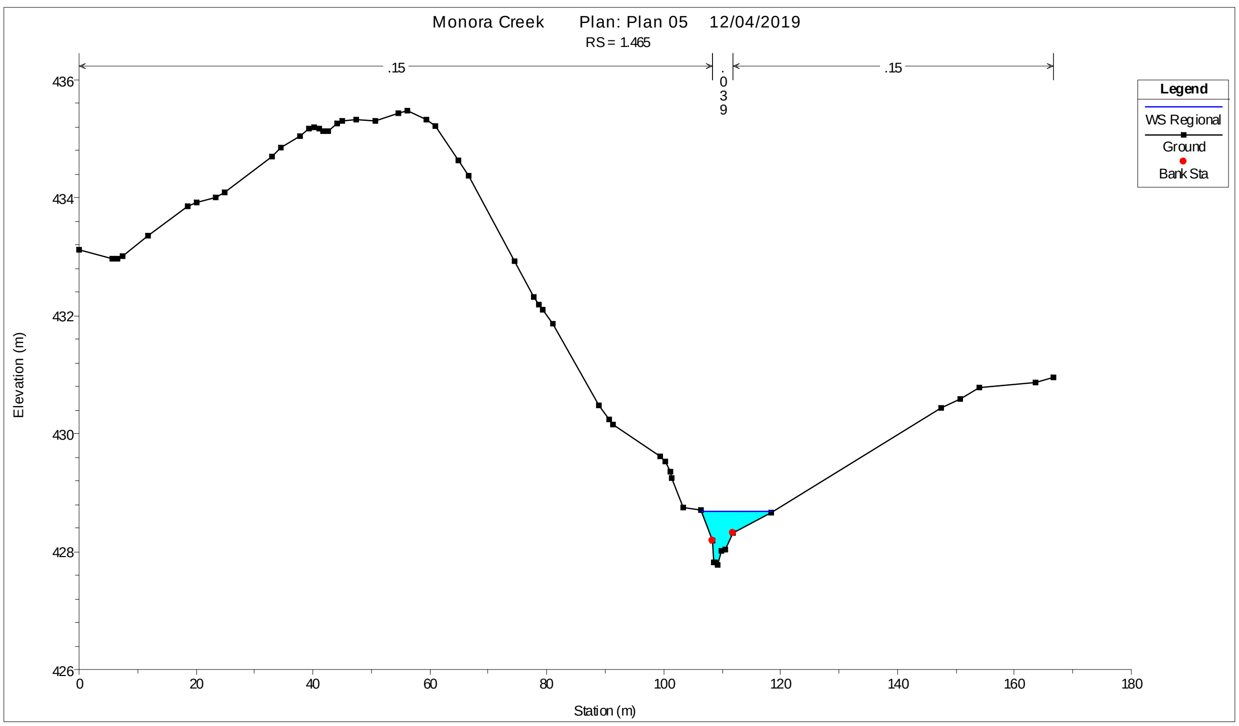

Figure 2: Cross Section at RS 1.465

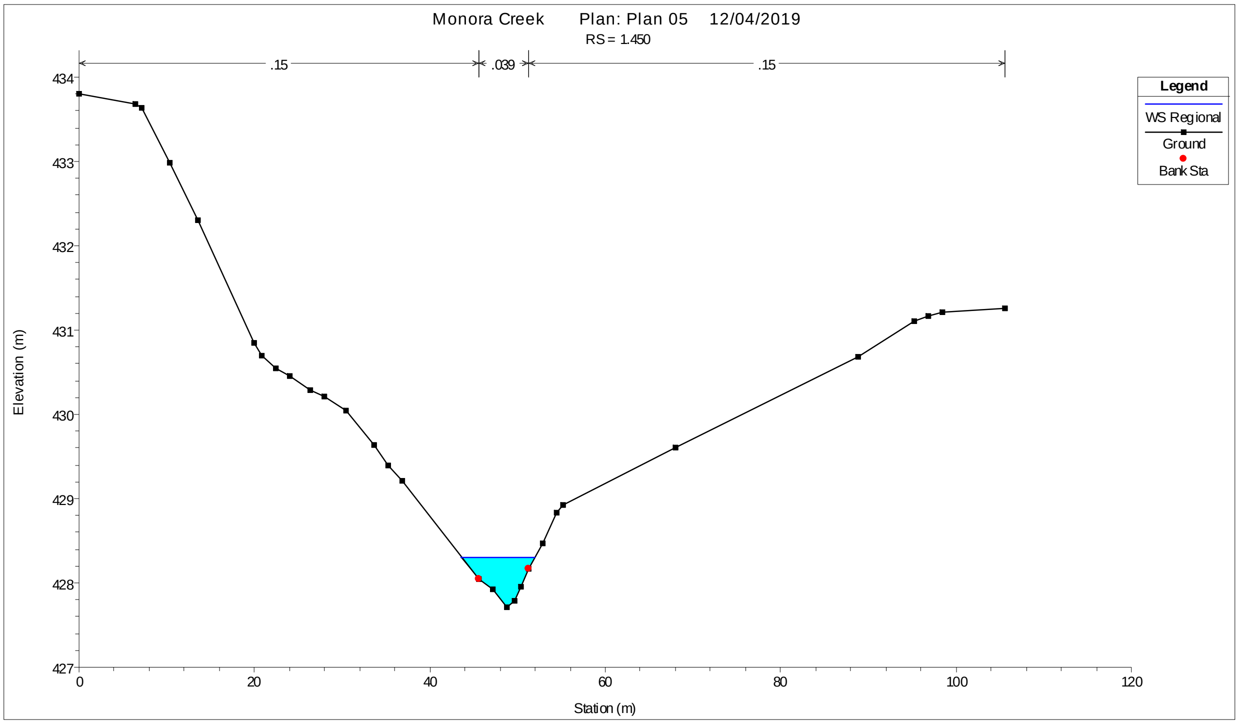

Figure 3: Cross Section at RS 1.450

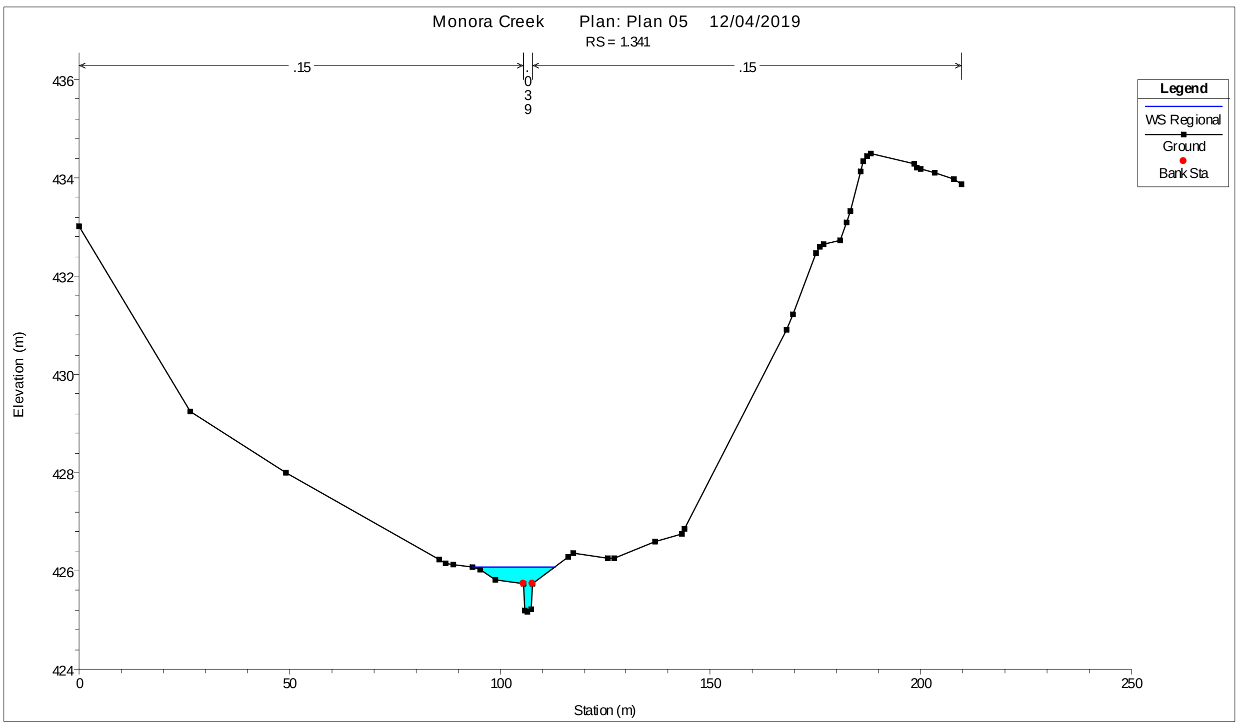

Figure 4: Cross Section at RS 1.341

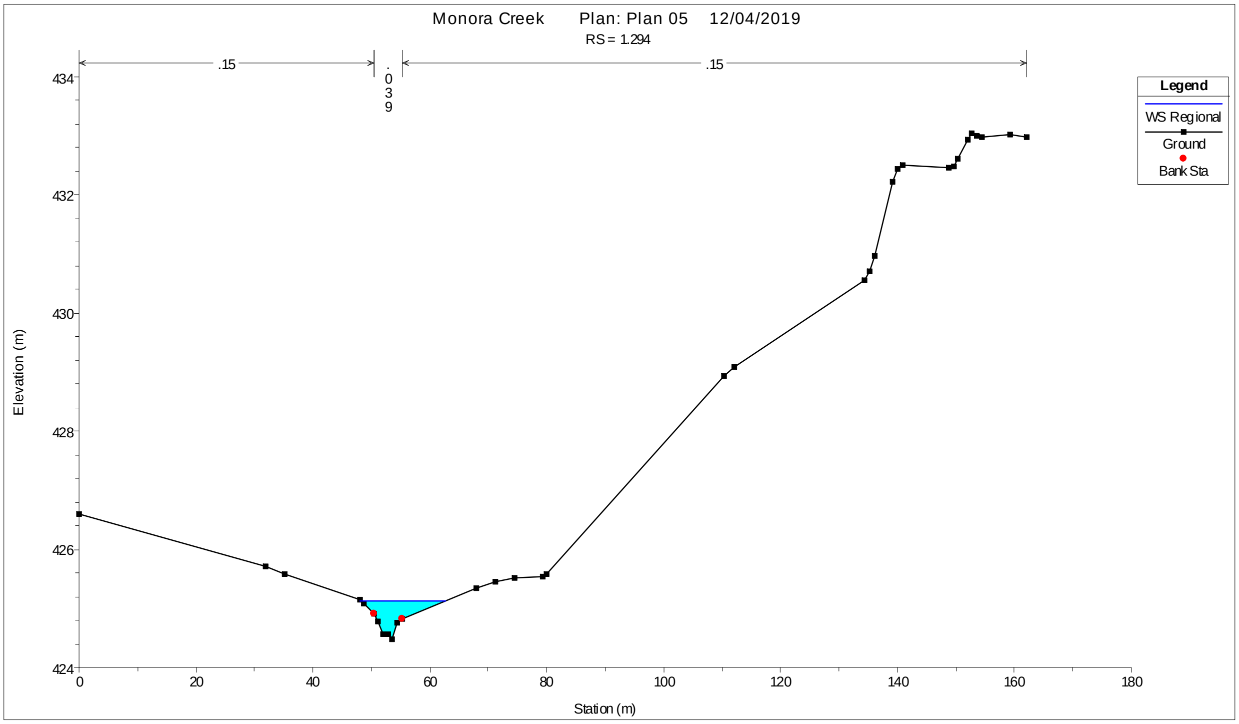

Figure 5: Cross Section at RS 1.294

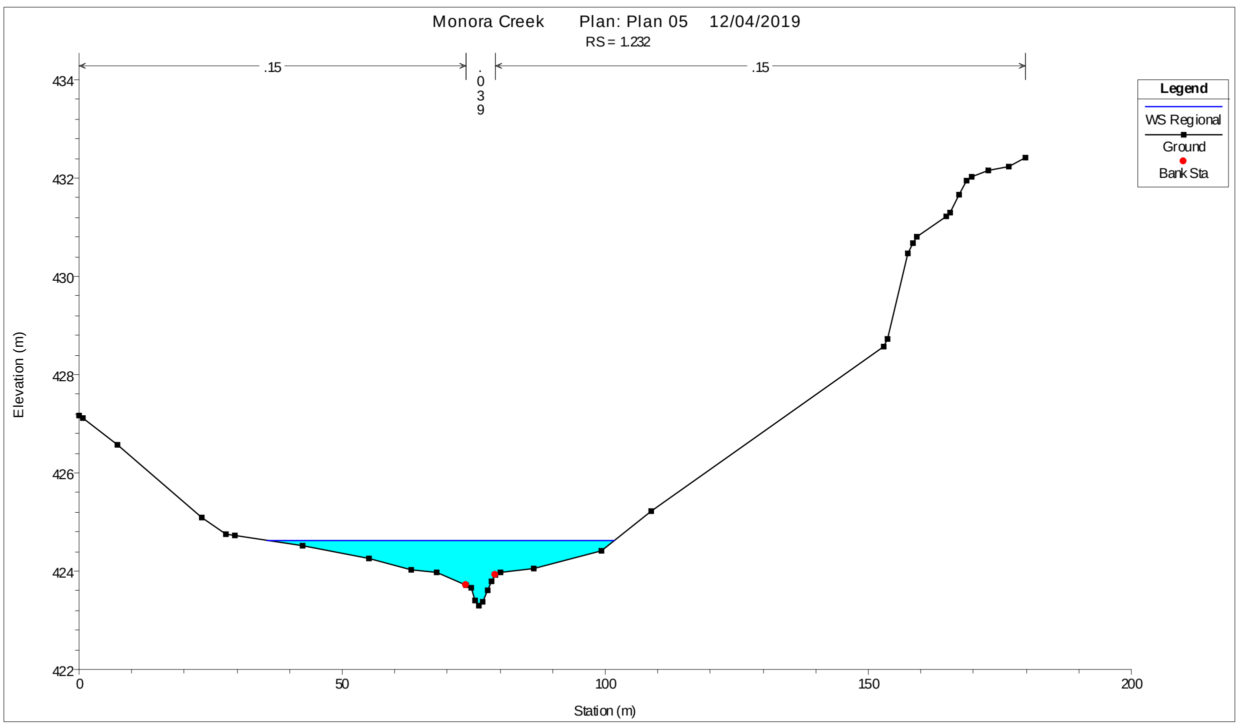

Figure 6: Cross Section at RS 1.232

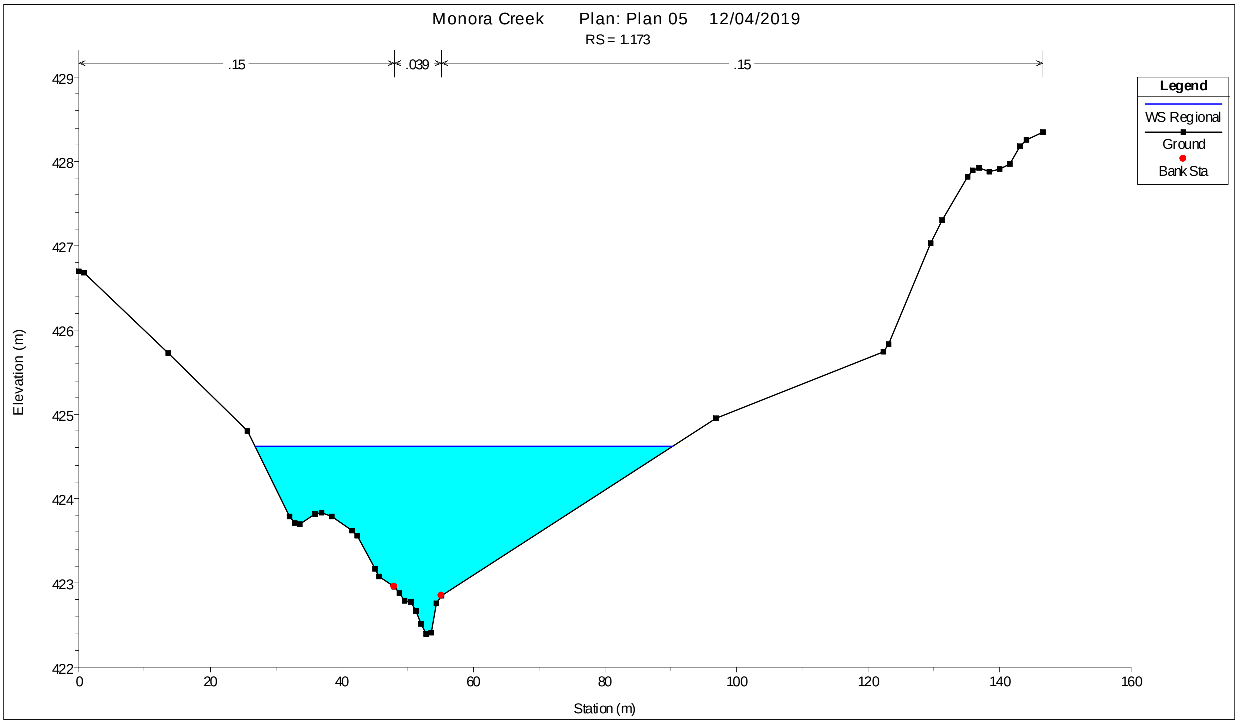

Figure 7: Cross Section at RS 1.173

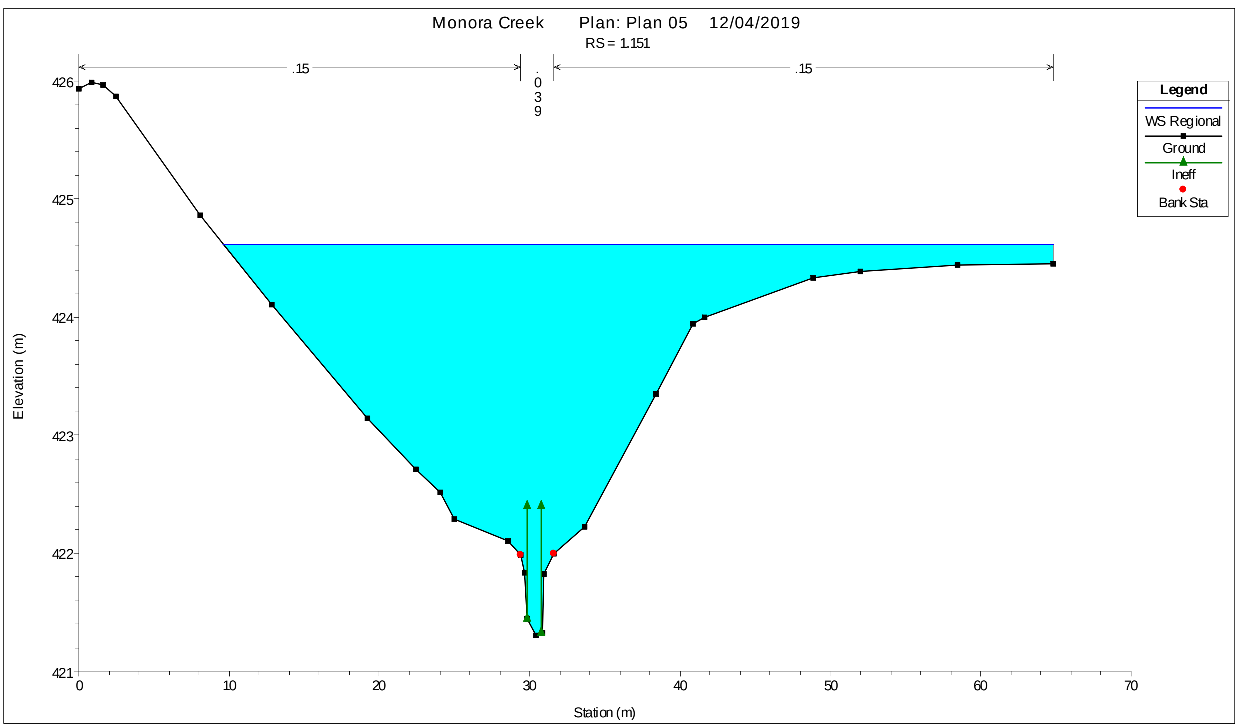

Figure 8: Cross Section at RS 1.151

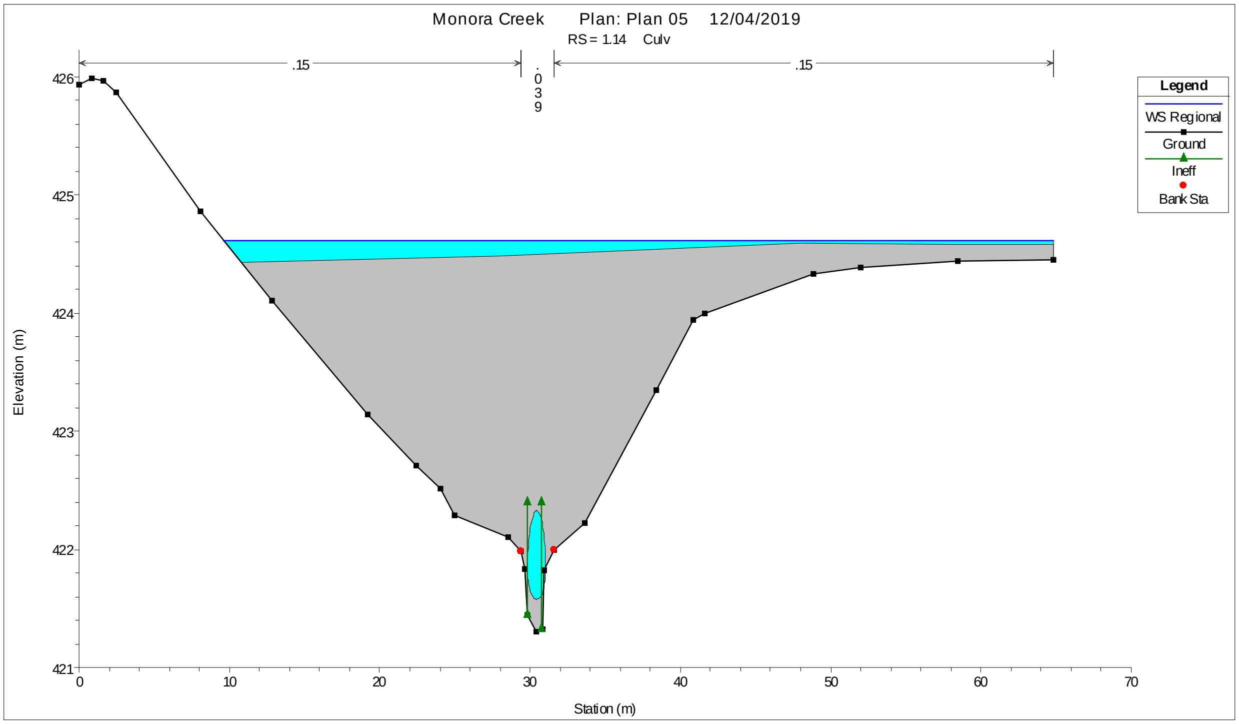

Figure 9: Cross Section at RS 1.140

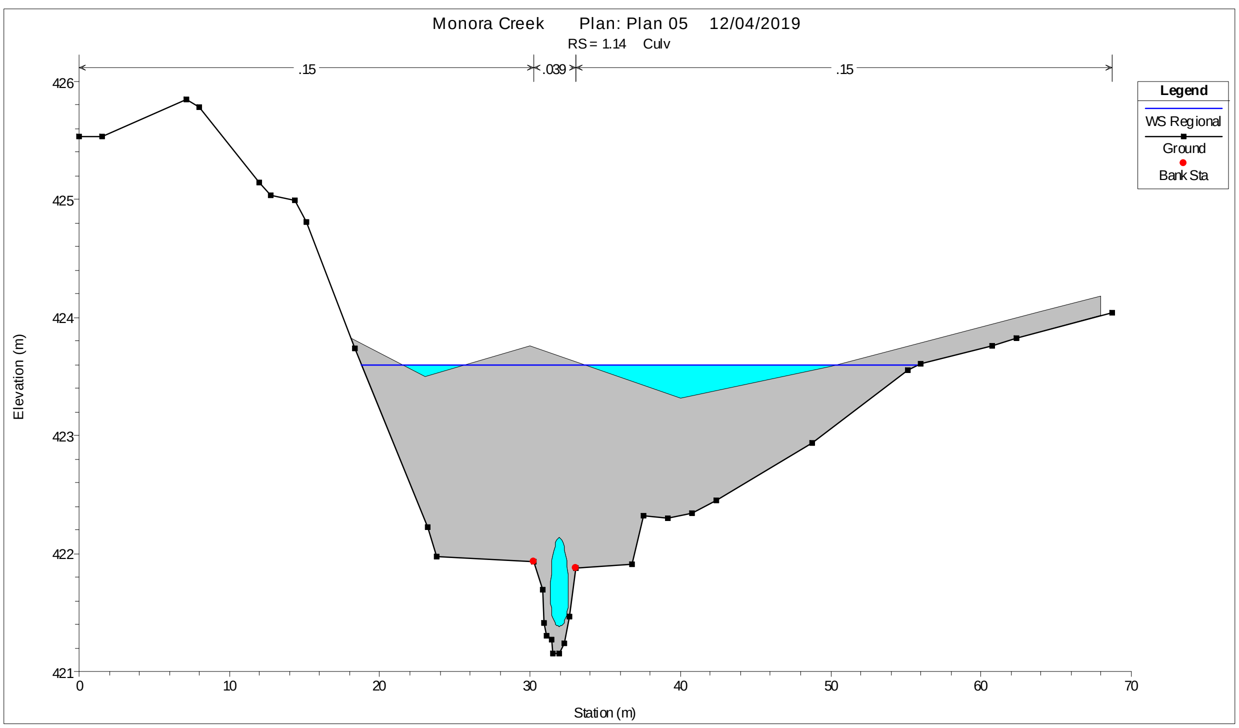

Figure 10: Cross Section at RS 1.14

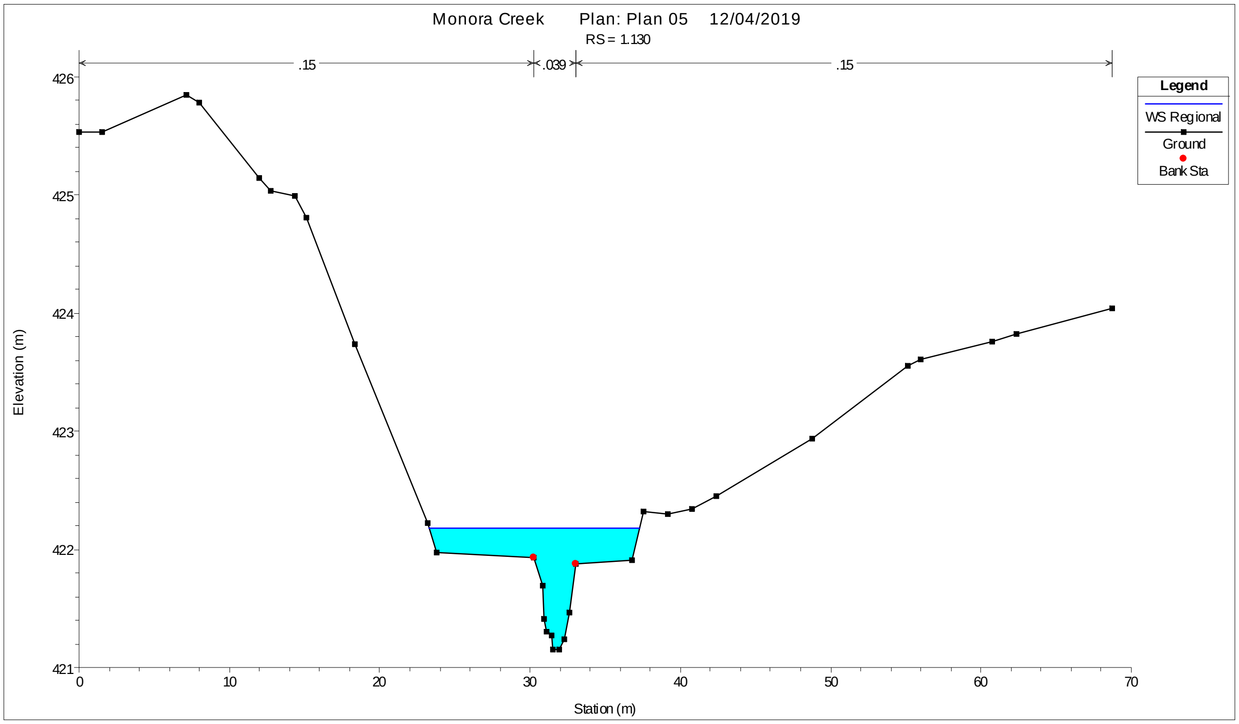

Figure 11: Cross Section at RS 1.130

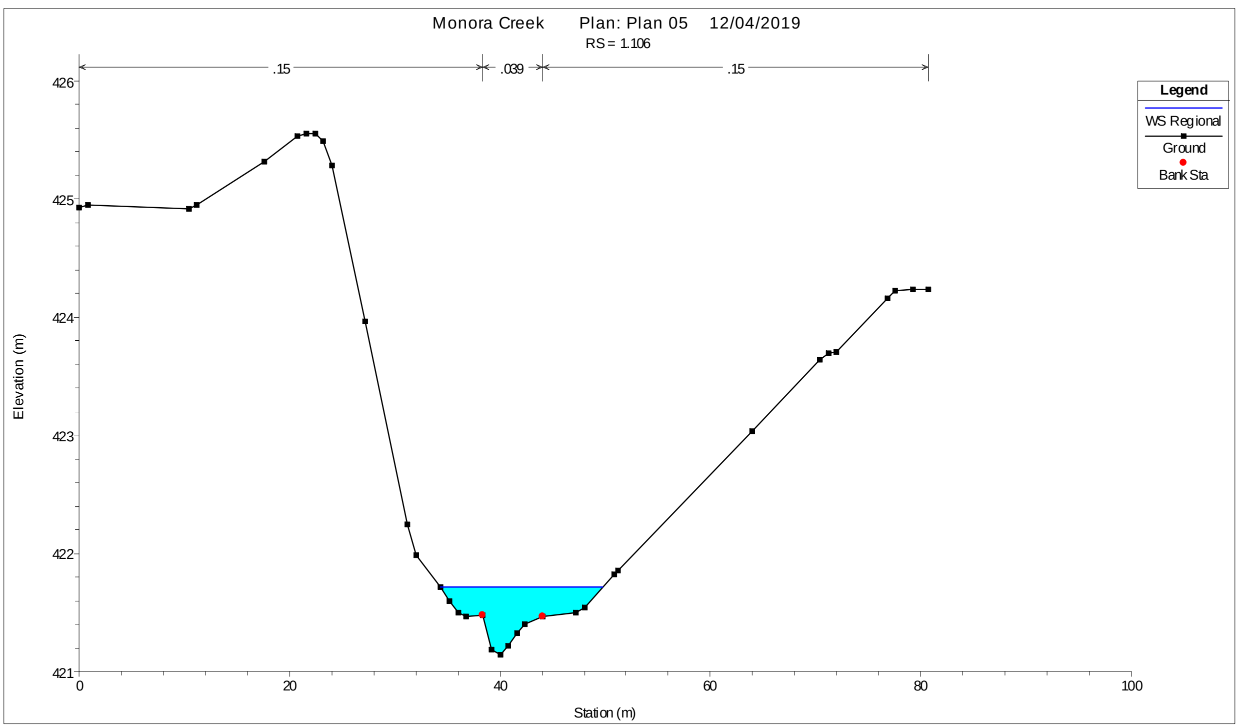

Figure 12: Cross Section at RS 1.039

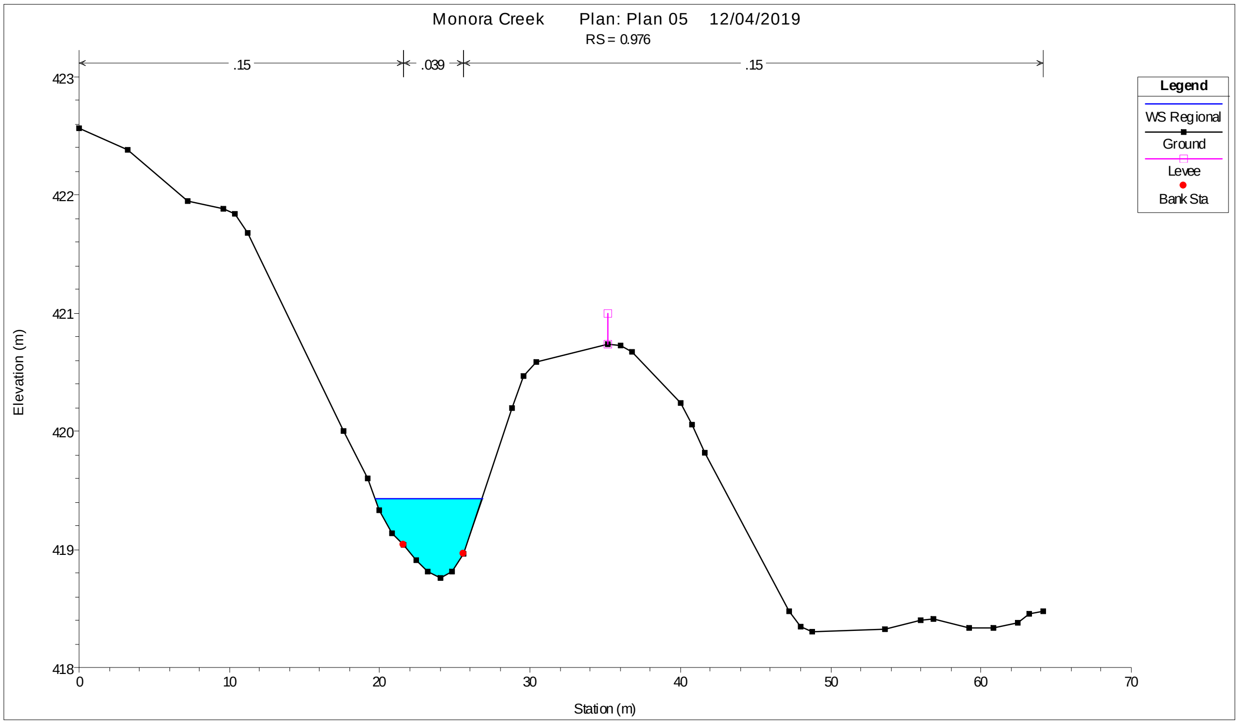

Figure 12: Cross Section at RS 0.976

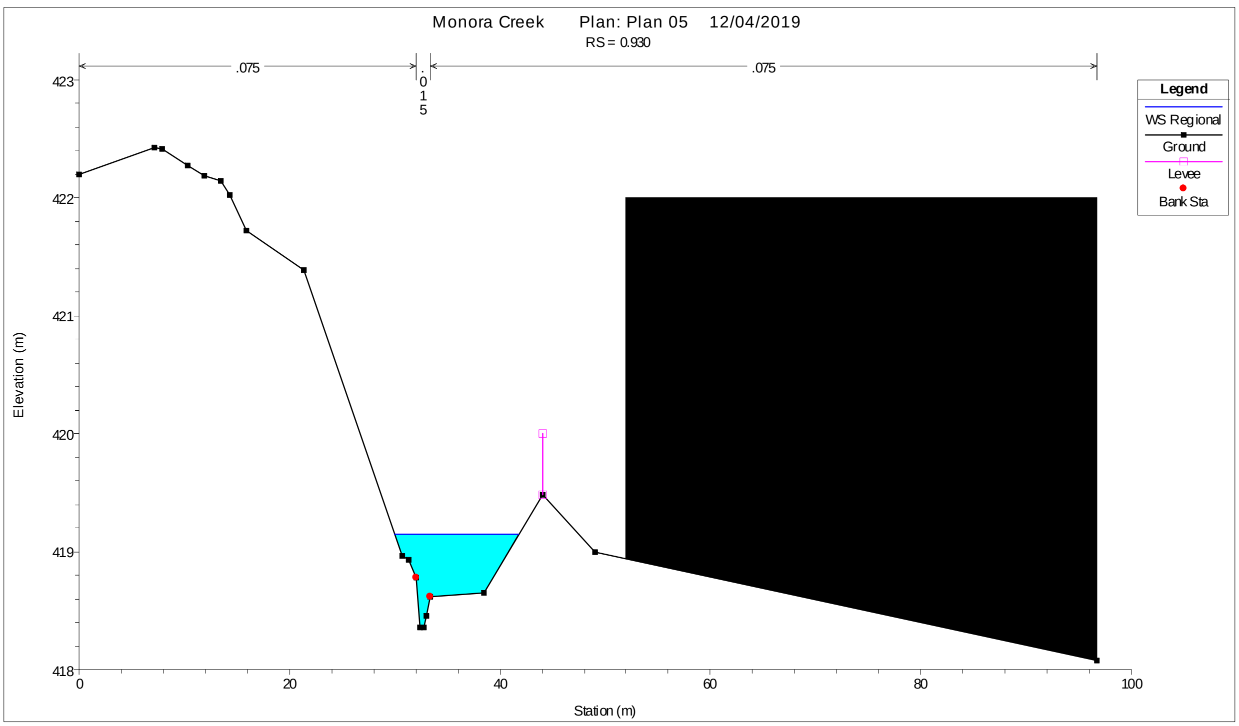

Figure 12: Cross Section at RS 0.930

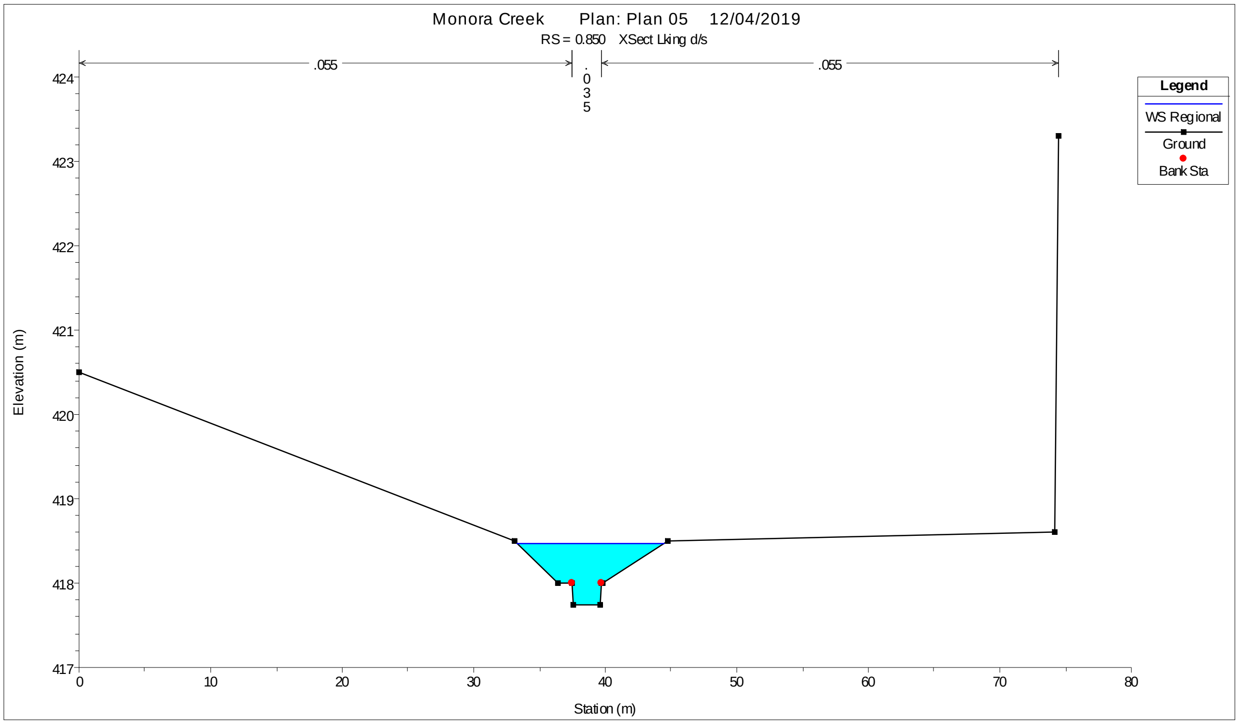

Figure 12: Cross Section at RS 0.850

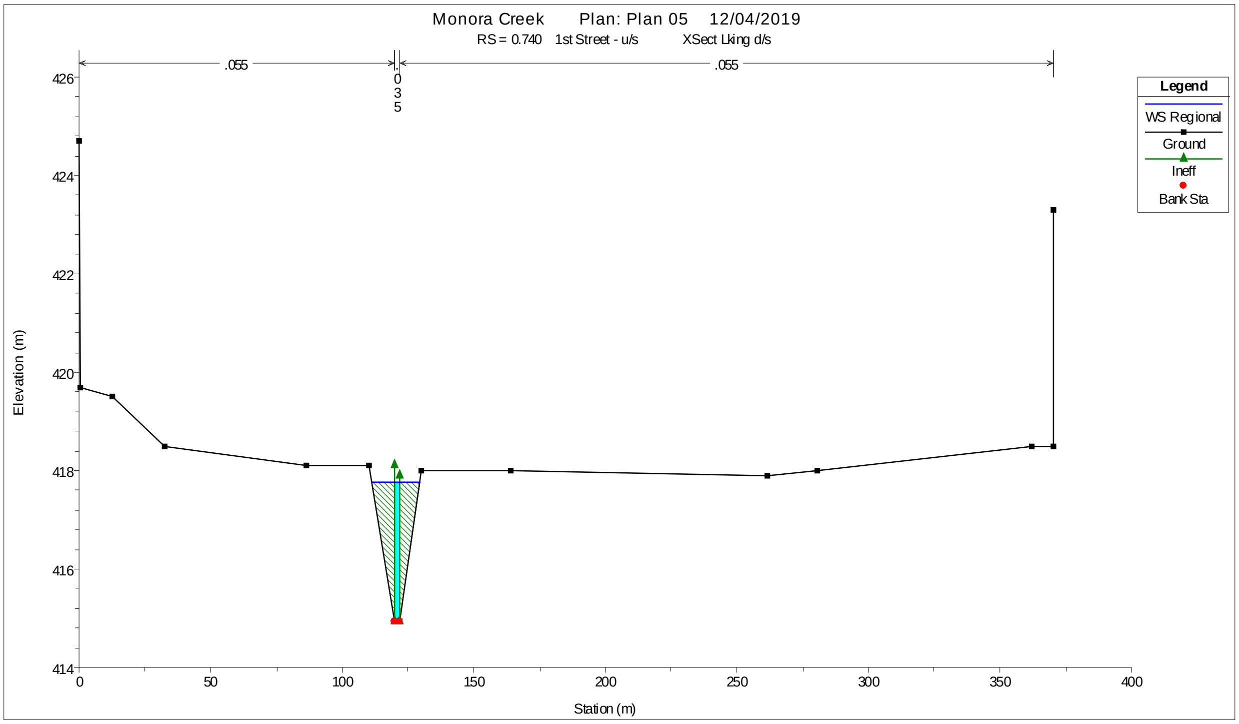

Figure 12: Cross Section at RS 0.740

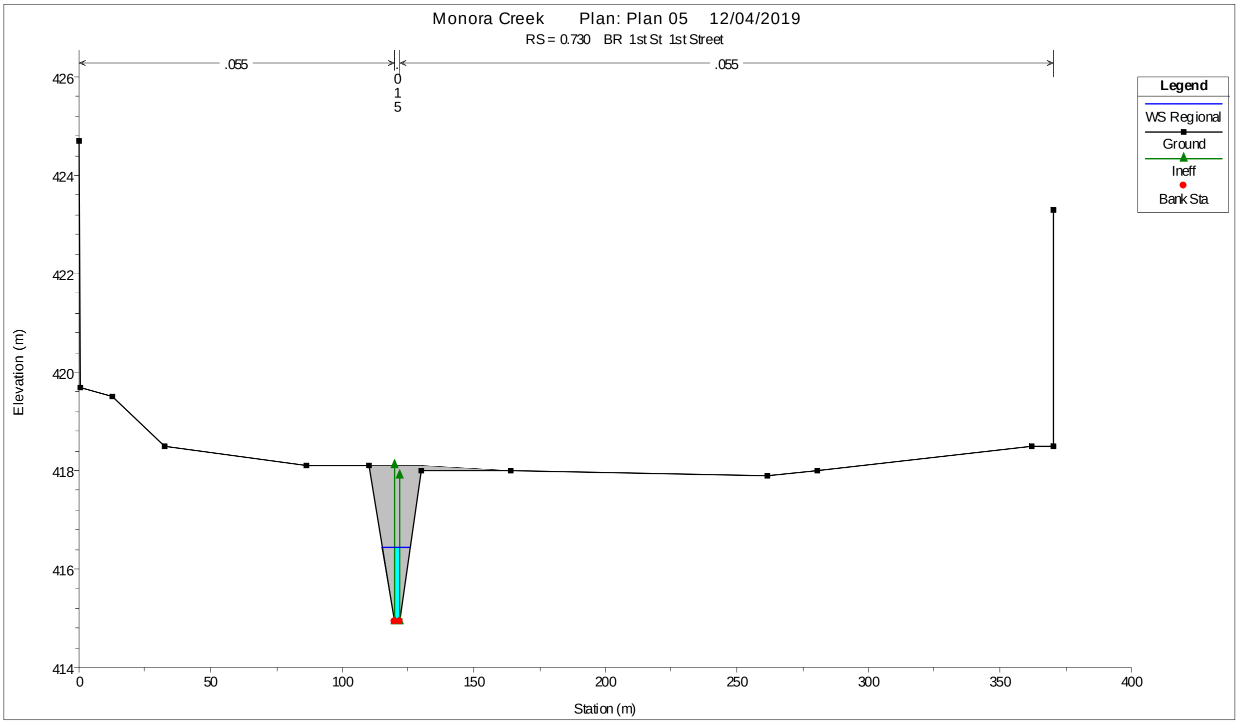

Figure 12: Cross Section at RS 0.740

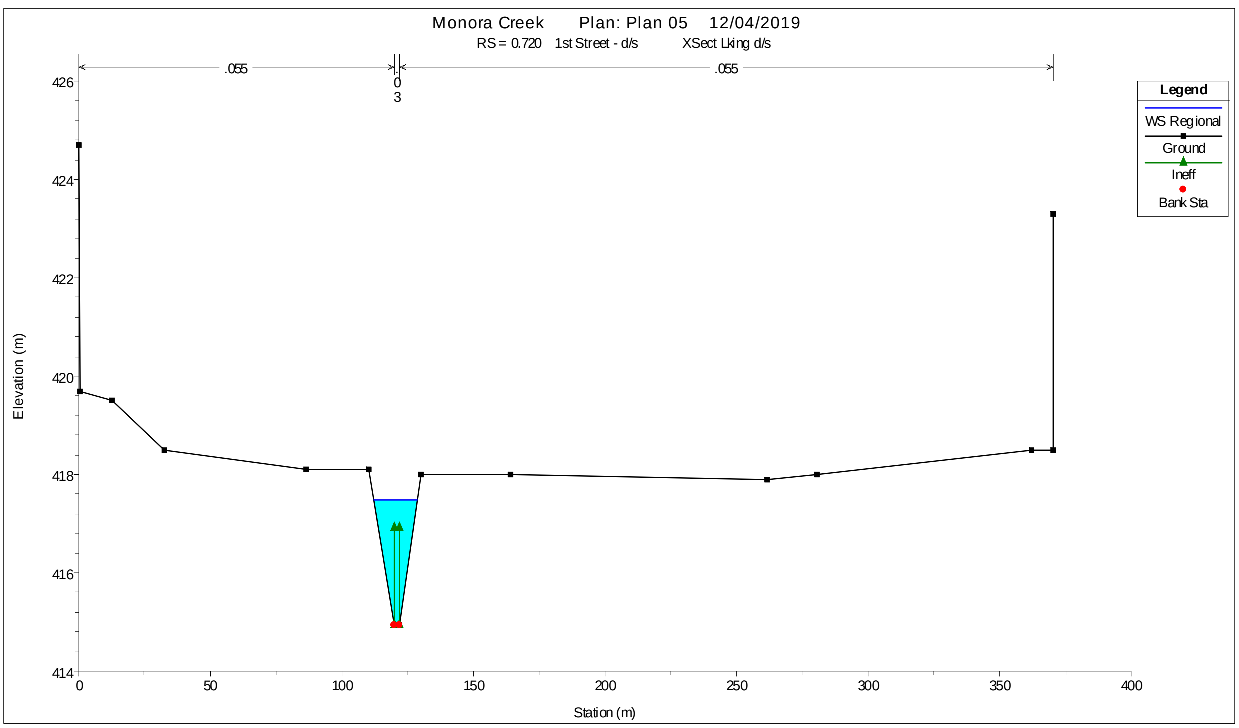

Figure 12: Cross Section at RS 0.720