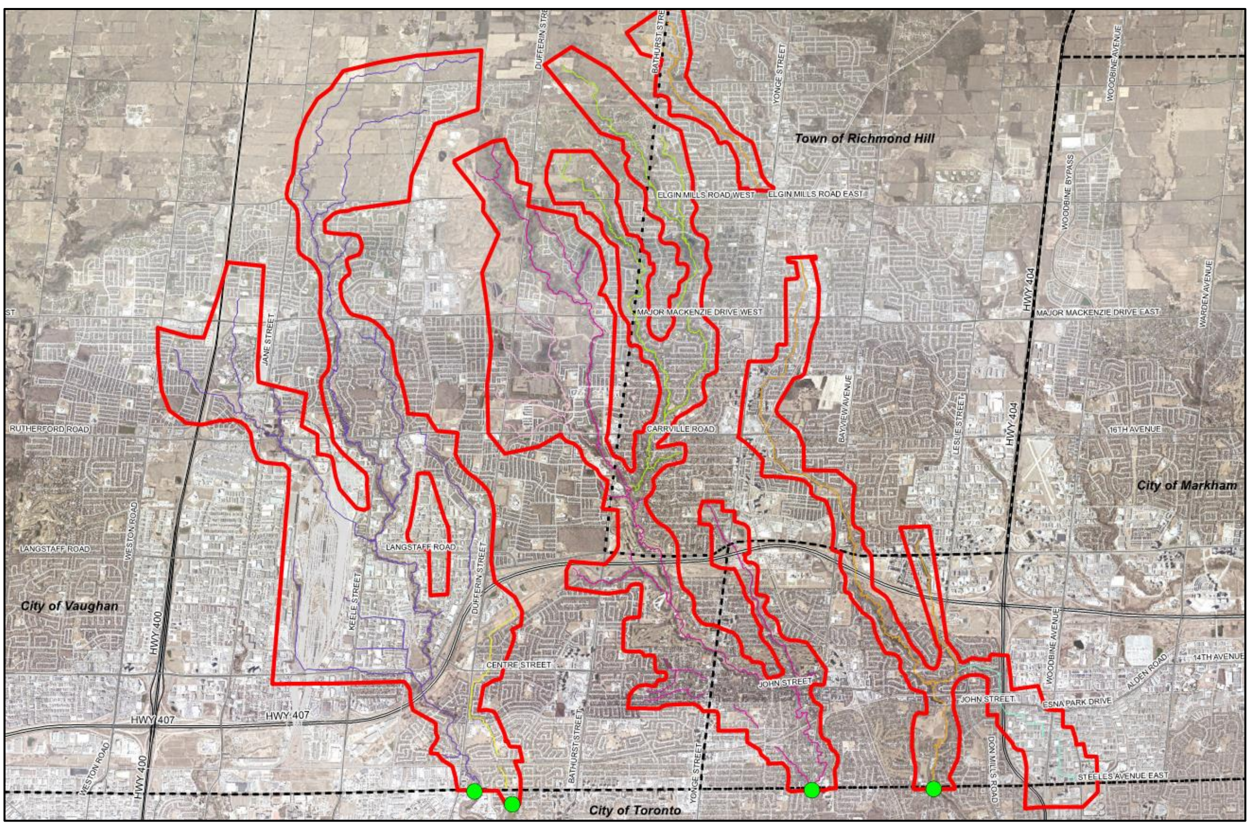
Toronto and Region Conservation Authority
Report Number: Contract #10020950

Don River Floodplain Mapping Phase II

August 11, 2020

Final



wsp

Don River Floodplain Mapping Phase II

Toronto and Region Conservation Authority

Final

Project No.: 19M-00961-00
Client Ref: Contract #10020950
Date: August 11, 2020

WSP
100 Commerce Valley Drive West
Thornhill, ON
Canada L3T 0A1

T: +1 905 882-1100
F: +1 905 882-0055
wsp.com

August 11, 2020

Toronto and Region Conservation Authority
101 Exchange Avenue
Vaughan, ON L4K 5R6

Attention: Qiao Ying, M.Sc., P.Eng.
Senior Engineer, Capital Projects Engineering Service
Development and Engineering Services Division

Dear Ms. Qiao:

Subject: Don River Floodplain Mapping Report (Client ref.: Contract #10020950)

We are pleased to submit our FINAL report develop and produce the updated floodplain maps for the Don River and its tributaries north of Steeles Avenue (Phase II) within TRCA's area of jurisdiction.

The Final Report has been prepared in accordance with the tasks identified in the Terms of Reference (TOR), and address all comments received from the TRCA during the study period.

We trust the submission of this document meets your requirements. We wish to thank the TRCA staff for your invaluable assistance in acquiring the necessary information required to complete the study.

Should you have any comments we look forward to your response.

Yours sincerely,

2020-08-12

Albert Zhuge, M.A.Sc., P.Eng., PMP
Senior Project Manager
Water Resources

AZ/mjnAZ/mjn

WSP ref.: 19M-00961-00

100 Commerce Valley Drive West
Thornhill, ON
Canada L3T 0A1

T: +1 905 882-1100
F: +1 905 882-0055
wsp.com

Revision History

FIRST ISSUE

25 Jun 2020	DRAFT – for client review / comment	
Prepared by	Reviewed by	Approved By
Xiaoxu (Iris) Qu, P.Eng., Senior Project Engineer	Albert Zhuge, M.A.Sc, P.Eng., PMP Senior Project Manager	Albert Zhuge, M.A.Sc, P.Eng., PMP Senior Project Manager
REVISION 1		
07 July 2020	FINAL DRAFT	
Prepared by	Reviewed by	Approved By
Xiaoxu (Iris) Qu, P.Eng., Senior Project Engineer; Jenny Chui, M.Sc. Senior Hydraulic Modeller	Albert Zhuge, M.A.Sc, P.Eng., PMP Senior Project Manager	Albert Zhuge, M.A.Sc, P.Eng., PMP Senior Project Manager
FINAL		
11 August 2020	FINAL	
Prepared by	Reviewed by	Approved By
Xiaoxu (Iris) Qu, P.Eng., Senior Project Engineer; Jenny Chui, M.Sc. Senior Hydraulic Modeller	Albert Zhuge, M.A.Sc, P.Eng., PMP Senior Project Manager	Albert Zhuge, M.A.Sc, P.Eng., PMP Senior Project Manager

Signatures

Prepared by

11 August 2020
Date

Xiaoxu (Iris) Qu, P.Eng.
Senior Project Engineer

11 August 2020
Date

Jenny Chui, M.Sc.
Senior Hydraulic Modeller

Approved[1] by (must be reviewed for technical accuracy prior to approval)

11 August 2020
Date

Albert Zhuge, M.A.Sc., P.Eng., PMP
Senior Project Manager

WSP prepared this report solely for the use of the intended recipient, Toronto and Region Conservation Authority, in accordance with the professional services agreement. The intended recipient is solely responsible for the disclosure of any information contained in this report. The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance or decisions. WSP does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report. This limitations statement is considered an integral part of this report.

The original of this digital file will be conserved by WSP for a period of not less than 10 years. As the digital file transmitted to the intended recipient is no longer under the control of WSP, its integrity cannot be assured. As such, WSP does not guarantee any modifications made to this digital file subsequent to its transmission to the intended recipient.

[1] Approval of this document is an administrative function indicating readiness for release and does not impart legal liability on to the Approver for any technical content contained herein. Technical accuracy and fit-for-purpose of this content is obtained through the review process. The Approver shall ensure the applicable review process has occurred prior to signing the document.

Contributors

Client

Senior Engineer, Capital Projects	Qiao Ying, M.Sc., P.Eng.
Project Engineer, Capital Projects	Melody Brown, P.Eng.
Project Manager, Capital Projects	Wilfred Ho
GIS Technologist, Information Technology Management	Michael Todd
Senior Manager, Capital Projects	Nick Lorrain, C.E.T

WSP

Senior Project Engineer	Xiaoxu (Iris) Qu, P.Eng.
Senior Hydraulic Modeller	Jenny Chui, M.Sc.
Senior Project Manager	Albert Zhuge, M.A.Sc., P.Eng., PMP
Proof (non-technical) / Format	Melinda Nowak

Subconsultants

N/A

Executive Summary

WSP was retained by the Toronto and Region Conservation Authority (TRCA) to complete the Don River Floodplain Mapping Update – Phase II study (Contract # 10020950). The subject study includes the Don River and its tributaries north of Steeles Avenue. The Don River Phase I study (south of Steeles Avenue) was completed by TRCA in January 2020.

The Don River watershed is one of the most urbanized in Canada. The TRCA is responsible for managing the river and its surrounding watershed. This study focused on the Don River north of Steels Avenue including the East branch and its tributaries and West branch and its tributaries, which has a watershed area of approximately 150 km^2.

The project was completed in accordance with the tasks identified in the Terms of Reference (TOR), which are provided below:

- Collected and reviewed the background data and as-built drawings from City of Markham, City of Toronto and City of Vaughan in August 2019, and performed database management to identify any data gaps and completed the standard procedures to fill these gaps (**TASK 1**).
- Determined the boundary conditions and prepared the peak flow table including the 2- to 100-year, 350-year and Regional event with total of 402 flow changing locations provided by the TRCA (**TASK 3 & 4**).
- Identified total of 346 watercourse crossings located at highway / roadway / driveway were hydraulic significant and required for the field reconnaissance; the detailed information of 326 watercourse crossings were gathered by WSP (302) and TRCA (24) between August and October 2019. The detailed information included the structure dimensions, water depth, photographs, and other information such as structure sketches, structure type, end-treatment, flow obstruction by debris, railing height, etc. and the field information was summarized in the field inventory sheets. Remaining 20 watercourse crossings were not visited due to not being accessible or were located on private lands with no permit to access granted; prepared a master structure comparison table including three sources of data: as-built drawings, existing HEC-RAS models and field measurements (**TASK 5, 6 &7**).
- Created the low flow channels in 3 branches including approximately 7.6 km long in East Don, approximately 7.4 km long in West Don and approximately 13.1 km long in German Mills Creek. These low flow channels were based on TRCA channel

surveys and field measured water depths at the crossings, and were combined with the original LiDAR to generate the revised DEM for the study area (**TASK 8 & 2**).

— Confirmed 4 piped areas and developed the PCSWMM models for these areas; the results from the PCSWMM models were used as the HEC-RAS model internal boundaries in these areas (**TASK 9**).
— Developed a HEC-RAS hydraulic model using the latest version of 5.0.7 for the study area. The model components include approximately 150.7 km river reaches, 3399 cross sections and total of 304 structures (bridges, culverts and inline structures) (**TASK 10**).
— Performed the steady simulations using the 2- to 100-year, 350-year and Regional peak flows provided by the TRCA; conducted the sensitivity analysis on boundary conditions (±0.3 m), roughness coefficients (±15%) and flow inputs (±10%), the results show the model is stable under a range of variations in these parameters (**TASK 11**).
— Generated the Regulatory floodlines; prepared a Structure Overtopping Table under the 2- to 100-year, 350 year and Regional event; identified 32 potential spill areas within the project limits, and the flow paths were estimated for these potential spills (**TASK 12**).
— Prepared the deliverables in compliance with the TRCA NDMP floodplain mapping requirements (**TASK 13**):
    - **Appendix A** – Structure Data Sheet: compiled the field inventory sheets from the field reconnaissance in 2019;
    - **Appendix B** – TRCA Standard Manning's Roughness: provided by the TRCA as part of the background data;
    - **Appendix C** – PCSWMM Modelling Memo: prepared a technical memo for the identified piping areas using PCSWMM modelling;
    - **Appendix D** – HEC-RAS Output: prepared a standard HEC-RAS output table for all reaches for all storm events;
    - **Appendix E** – Flow nodes used for the development of HEC-RAS model flow table provided by the TRCA;
    - **Appendix F** – Modelling Approach by Crossing Structure: extracted the source information of structure geometry used in the model from the master structure comparison table;
    - **Appendix G** – Regulatory Floodplain Mapping of the Don River Phase II.
— Prepare a technical report to document the methodology of the hydraulic analysis and summarize the results (**TASK 14**).

TABLE OF CONTENTS

Tables

Figures

Appendices

1 INTRODUCTION

1.1 Overview of the Don River Watershed

WSP was retained by the Toronto and Region Conservation Authority (TRCA) to complete Don River Floodplain Mapping Update – Phase II (Contract # 10020950) including the Don River and its tributaries north of Steeles Avenue (**Figure 1-1**). The Don River Phase I study (south of Steeles Avenue) was completed by TRCA in January 2020.

The Don River drains an area of approximately 350 km^2. It flows south from its headwaters on the Oak Ridges Moraine to the Keating Channel at the northeast corner of the Toronto Harbour, where it empties into Lake Ontario. The Don River is formed from two rivers, the East and West Branches, that meet about 7 km north of Lake Ontario. The east branch of the Don River rises at the south edge of the Oak Ridges Moraine just to the west of Yonge Street, flowing south-eastward through ravine forests in Richmond Hill, Thornhill, east of Willowdale and Don Mills. A second branch of the eastern Don River, known as German Mills Creek, parallels the main eastern branch and joins it at Steeles Avenue, the northern boundary of Toronto. The western branch starts near Maple, Ontario, flowing south-east through the suburban industrial belt of Concord (Vaughan), and the G. Ross Lord Reservoir. It crosses Yonge Street as it flows through Hoggs Hollow, past York University's Glendon ("valley of the Don") campus, and then flows on to Leaside before joining the eastern half.

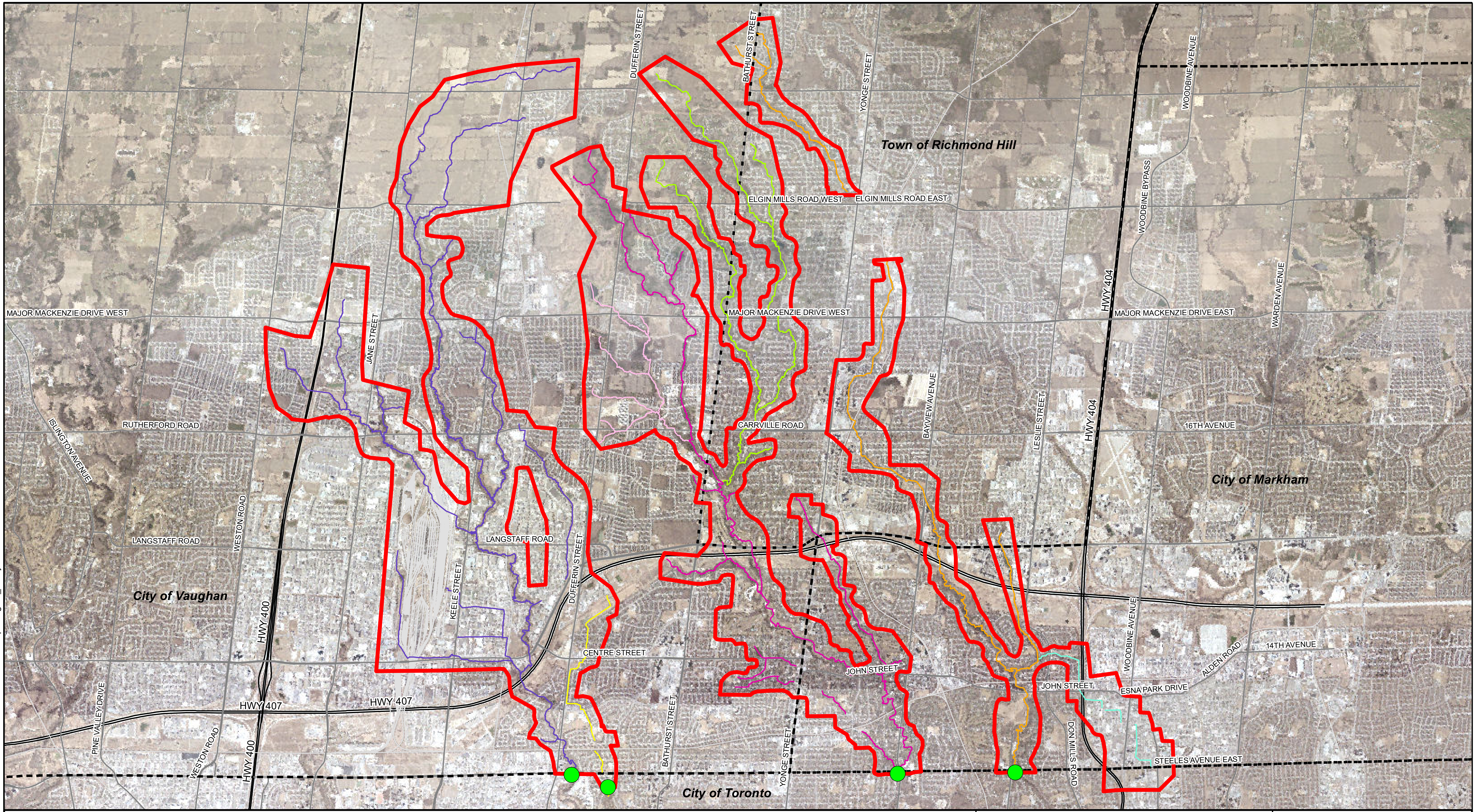
The Don River watershed is one of the most urbanized in Canada. The TRCA is responsible for managing the river and its surrounding watershed. This study focused on the Don River north of Steels Avenue including the East branch and its tributaries and West branch and its tributaries, which has a watershed area of approximately 150 km^2.

1.2 Report Structure and Work Scope

The structure of the report for the subject floodplain mapping study followed the task sequence defined in the scope of the work, which is described as follows:

- Collect and review the background data and as-built drawings from local and regional municipalities, and perform database management to identify any data gaps and complete the standard procedures to fill these gaps (TASK 1).

- Determine the boundary conditions and prepare the flow table for the hydraulic model (TASK 3 & 4).
- Identify the watercourse crossings that required the field survey in the study area; conduct field reconnaissance to collect the structure information including opening size, length, structure type, material, photos, etc.; prepare a master structure comparison table including three sources of data: as-built drawings, existing HEC-RAS models and field measurements (TASK 5, 6 &7).
- Create low flow channel based on TRCA channel surveys and field measured water depths at the crossings, and generate revised DEM (TASK 8 & 2).
- Confirm the piped areas and develop PCSWMM models for these areas; the results from PCSWMM models were used as the HEC-RAS model boundaries in these areas (TASK 9).
- Develop a HEC-RAS hydraulic model for the study area (TASK 10).
- Perform simulations using the flows provided by TRCA and conduct the sensitivity analysis (TASK 11).
- Generate the Regulatory floodlines; identify potential spill areas; deliver output for flood risk screening and characterization (TASK 12 & 13).
- Prepare a report to document the methodology of the hydraulic analysis and summarize the results (TASK 14).



Legend

- STUDY AREAS
- DOWNSTREAM BOUNDARY IN PHASE II HEC-RAS MODEL (PROVIDED BY PHASE I HEC-RAS MODEL)
- ROADS
- RAILWAY
- HIGHWAY
- MUNICIPAL BOUNDARY
- CARRVILLE CREEK
- CUMMER CREEK
- EAST DON RIVER
- FISHERVILLE CREEK
- GERMAN MILLS CREEK
- PATTERSON CREEK
- WEST DON RIVER

CLIENT	TORONTO AND REGION CONSERVATION AUTHORITY
TITLE	DON RIVER FLOODPLAIN MAPPING UPDATE - PHASE II
	STUDY AREAS

wsp

Checked: I.Q	Drawn: J.C
Date: July 2020	Proj. No.: 19M-00961-00
Scale	Figure No.: 1-1

Document Path: X:\DIV38\2019\19M-00961-00 Don River FPM PH2\GIS\ReportFigure_StudyAreas.mxd

2 BACKGROUND REVIEW AND AS-BUILT INFORMATION COLLECTION (TASK 1)

2.1 Background Data Review

The following background data was provided by the TRCA in July and October 2019:

- GIS datasets including all required shapefiles including study area; watercourses; road and railway; building footprints; flagged area for land change since 2015; watercourse crossings; storm sewer mapping; land use; current Regional floodline, etc.
- LiDAR collected in Spring 2015
- Orthographic images from 2015 (50 cm) and 2018 (30 cm)
- Previous HEC-RAS hydraulic models and studies
- As-built drawings from 407 ETR, MTO, CN Rail, York Region, etc.
- TRCA Standard Manning's Roughness, presented in **Appendix B**
- TRCA landuse and landcover ALL classes FINAL

2.2 Collection of Information for Identified Piped Areas

2.2.1 Identified Piped Areas

Six areas (Area 1 has two separate sub-areas) including four in East Don River and two in West Don River were originally identified to be the piped flow areas within the subject study area, as illustrated in **Figure 2-1**. The locations of these piped areas are presented below:

- Area 1 including two separate sub-areas: Fishersville Creek between Charlton Avenue and Conley Park (Storm sewer north); Fishersville Creek between Steeles Avenue and Fishersville Road (Storm sewer south)
- Area 2: West Don River between Bradwick Drive and Rivermede Road
- Area 3: East Don River between Clark Avenue and Proctor Avenue
- Area 4: East Don River between Yonge Street and Elgin Street

- Area 5: East Don River Cummer Creek Crossing Woodbine Avenue and south of Denison Street
- Area 6: East Don River Cummer Creek between Steelcase Road and Denison Street

2.2.2 Collected Information

The required storm sewer information in Area 2 was provided by The TRCA as part of the background data in July 2019. The information included engineering drawings, models and a geodatabase that contained the sewer network system with the parameters of pipes, manholes, catchbasins, and ditch inlets. The information for the remaining piped areas was collected from the City of Markham, City of Toronto and City of Vaughan in August 2019. The received information is listed below:

City of Markham for Areas 3 - 6

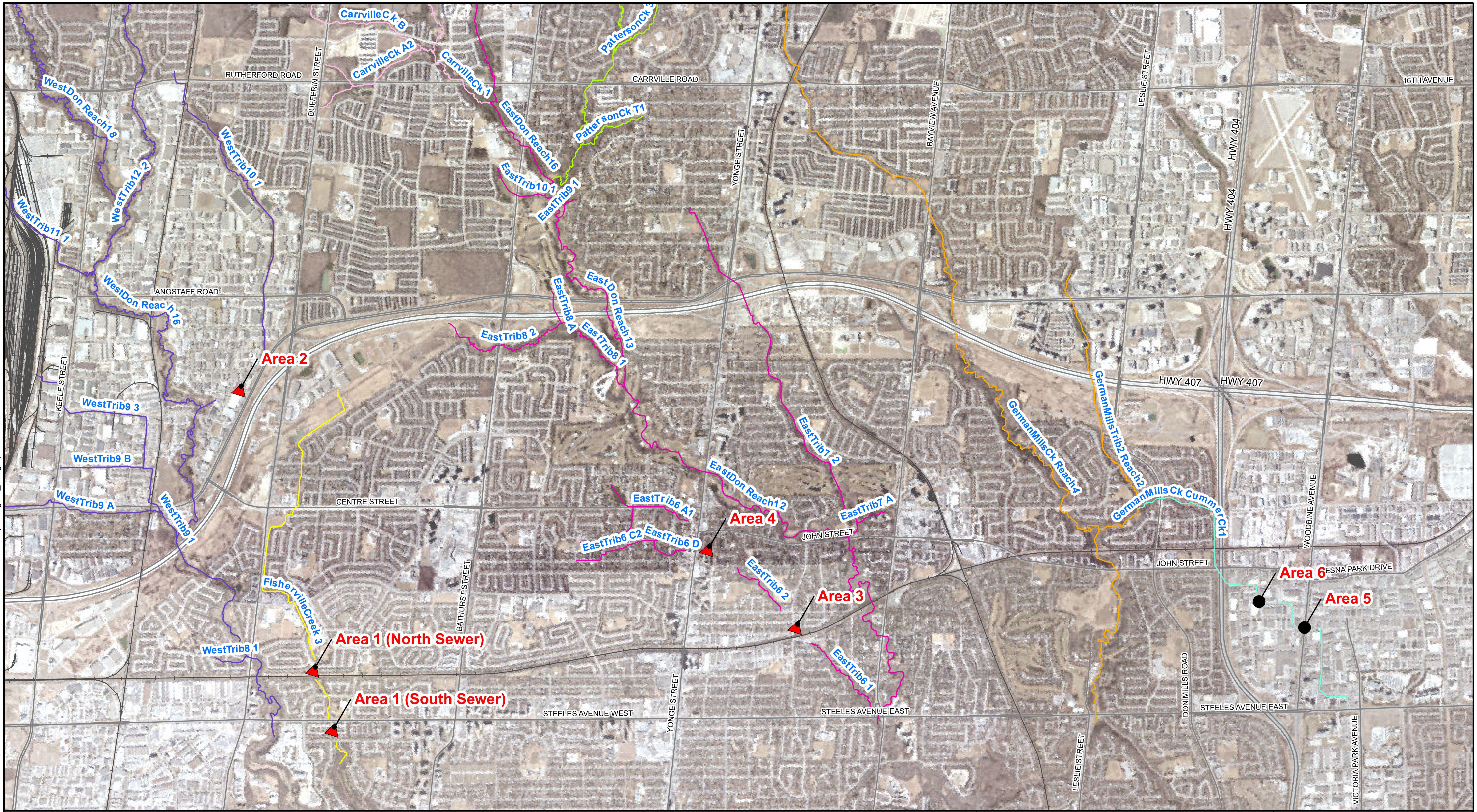
- Geodatabase and design or as-built drawings
- PCSWMM models for Areas 5 and 6; InfoWorks models for Areas 3 and 4

City of Toronto for Sub Area (Storm Sewer South) in Area 1

- Engineering drawings in CAD and TIFF format

City of Toronto for Sub Area (Storm Sewer North) in Area 1

- Geodatabase package; however, some invert elevations were missing in the package



Legend

- ▲ PIPED FLOW AREA LOCATIONS
- ● PIPED FLOW AREA REMOVED, REPLACED BY CULVERTS
- ROADS
- RAILWAY
- HIGHWAY
- CARRVILLE CREEK
- CUMMER CREEK
- EAST DON RIVER
- FISHERVILLE CREEK
- GERMAN MILLS CREEK
- PATTERSON CREEK
- WEST DON RIVER

CLIENT	TORONTO AND REGION CONSERVATION AUTHORITY
TITLE	DON RIVER FLOODPLAIN MAPPING UPDATE - PHASE II
	PIPED FLOW AREA LOCATIONS

wsp

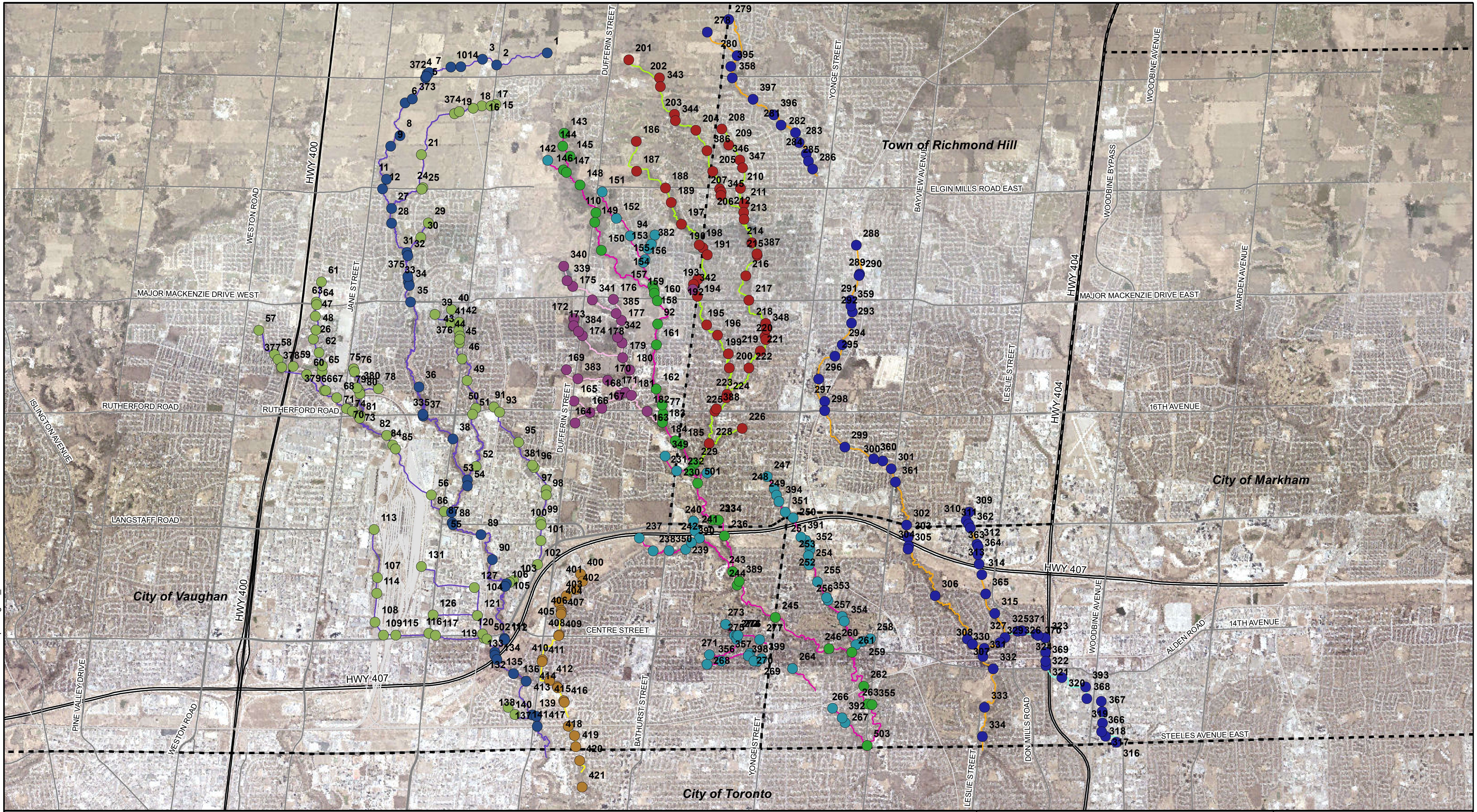
Checked: I.Q	Drawn: J.C
Date: April 2020	Proj. No.: 19M-00961-00
Scale: 1:34,500	Figure No.: **2-1**

3 DEVELOPMENT OF A HEC-RAS STEADY-STATE FLOW TABLE (TASK 3)

The latest peak flows including the 2- to 100-year, 350-year and Regional event were provided by the TRCA in January 2020, along with a GIS shapefile showing a total of 402 flow changing locations within the study area, as illustrated in **Figure 3-1**. Below **Table 3-1** provides the numbers of the flow input locations in the rivers / branches. The river chainage of each flow changing location was determined and the steady flow data was prepared for the simulation of the HEC-RAS model. The flow table is provided in **Appendix E.**

Table 3-1: Summary of Flow Input Numbers

River	Branch / Tributary	Number of Flow Inputs
East Don River	Main Branch	37
	Carrville Creek	27
	German Mills Creek	73
	Patterson Creek	51
	Tributaries	58
West Don River	Main Branch	46
	Fisherville Creek	22
	Tributaries	88
	East Don River	246
	West Don River	156
	Total Flow Input Locations	402



Document Path: X:\DIV38\2019\19M-00961-00 Don River FPM PH2\GIS\ReportFigure_FlowNode.mxd

Legend

Flow Nodes (402)

- East Don Main Branch (37)
- Carrville Creek (27)
- German Mills Creek (73)
- Patterson Creek (51)
- East Don Tributaries (58)
- West Don Main Branch (46)
- FishervilleCreek (22)
- West Don Tributaries (88)

- CARRVILLE CREEK
- CUMMER CREEK
- EAST DON RIVER
- FISHERVILLE CREEK
- GERMAN MILLS CREEK
- PATTERSON CREEK
- WEST DON RIVER
- MUNICIPAL BOUNDARY
- ROADS
- RAILWAY
- HIGHWAY

CLIENT	TORONTO AND REGION CONSERVATION AUTHORITY
TITLE	DON RIVER FLOODPLAIN MAPPING UPDATE - PHASE II
	LOCATION OF FLOW NODES

wsp

Checked: I.Q	Drawn: J.C
Date: July 2020	Proj. No.: 19M-00961-00
Scale	Figure No.: **3-1**

4 DEVELOPMENT OF HEC-RAS MODEL BOUNDARY CONDITIONS (TASK 4)

4.1 Flow Input Boundary

Generally, the flow boundary was defined at the branch upstream end. As stated above, the peak flows for the 2- to 100-year, 350-year and Regional event were received from the TRCA. These flows were entered into the model as the flow input boundary.

4.2 Model Downstream Boundary

As indicated above, the study area for the Phase II HEC-RAS model was north of Steeles Avenue. In order to tie in the completed Phase I HEC-RAS model, the East Don main branch and its tributary German Mills Creek and the West Don main branch and its tributary Fisherville Creek were extended to just south of Steeles Avenue in the Phase II HEC-RAS model, as shown in **Figure 1-1**. The water levels of the 2- to 100-year, 350-year and Regional event were supplied by the TRCA at the two downstream end cross-sections for these four branches. These water levels were applied to define the downstream boundary of the Phase II HEC-RAS model. The received water levels and corresponding river stations in the Don River Phase II HEC-RAS model are presented in **Table 4-1**.

Table 4-1: Downstream Boundary – Received Water Levels

River	Reach	River station (Phase II Model)	2-yr		5-yr		10-yr		25-yr		50-yr		100-yr		350-yr		Regional	
			Peak Flow (m^3/s)	Water Level (m)	Peak Flow (m^3/s)	Water Level (m)	Peak Flow (m^3/s)	Water Level (m)	Peak Flow (m^3/s)	Water Level (m)	Peak Flow (m^3/s)	Water Level (m)	Peak Flow (m^3/s)	Water Level (m)	Peak Flow (m^3/s)	Water Level (m)	Peak Flow (m^3/s)	Water Level (m)
East Don	Reach 10	45.52	15.44	145.20	32.31	145.82	43.87	146.12	58.78	146.77	74.76	147.23	89.62	147.44	168.56	147.98	536.53	149.17
		2	15.44	145.09	32.31	145.76	43.87	146.10	58.78	146.79	74.76	147.25	89.62	147.45	168.56	147.99	536.53	149.14
	German Mills 3	44.68	17.48	147.98	23.60	148.17	27.60	148.28	32.93	148.39	36.44	148.46	41.27	148.55	55.03	148.78	186.52	150.00
		27.42	17.48	147.90	23.60	148.07	27.60	148.18	32.93	148.26	36.44	148.32	41.27	148.39	55.03	148.55	186.52	149.75
West Don	Reach 13	146.37	21.91	180.07	28.61	180.24	33.34	180.33	40.32	180.45	46.14	180.54	54.81	180.66	113.40	181.30	294.71	182.53
		105.24	21.91	179.90	28.61	180.04	33.34	180.14	40.32	180.26	46.14	180.36	54.81	180.49	113.40	181.16	294.71	182.31
	Fisherville Creek 1	281.62	2.72	182.33	3.76	182.48	5.97	182.72	9.26	182.96	12.34	183.11	14.89	183.22	23.26	183.50	68.34	184.25
		275.64	2.72	182.32	3.76	182.47	5.97	182.71	9.26	182.95	12.34	183.10	14.89	183.21	23.26	183.49	68.34	184.25

4.3 Boundary for Piped Area

As stated in **Section 2**, 6 areas were identified to be the piped flow areas within the subject study area. The downstream boundaries of the piped areas were determined from the computed water levels at the corresponding cross-sections in the Don River Phase II HEC-RAS model. Then the upstream water levels of the piped areas were produced using the PCSWMM models, which were used as the internal boundaries in the HEC-RAS model for the identified piped areas. The procedure is described in detail in **Section 7**.

5 IDENTIFICATION OF WATERCOURSE CROSSINGS AND FIELD RECONNAISSANCE (TASK 5, 6 & 7)

5.1 Watercourse Crossings Identification

The purpose of identifying the watercourse crossings was to determine the number of the structures which are hydraulic significant and required for field reconnaissance. The locations of all watercourse crossings within the study area were provided by the TRCA in the GIS shape file as part of the background information. 400 crossings with basic information including the stream name, street name and municipality were contained in the shape file. The TRCA also supplied the shape file that included the structures from the existing georeferenced HEC-RAS models. These crossings were reviewed by WSP using the high resolution orthophotos and a total of 346 watercourse crossings located at highway / roadway / driveway were determined to require the detail site reconnaissance.

5.2 Field Reconnaissance

Upon the completion of the watercourse crossing identification for the study area, the field reconnaissance was carried out to collect the detailed information at the identified crossings by WSP from early August to mid September, 2019. A total of 322 watercourse crossings were visited by WSP and the detailed information at 302 watercourse crossings were gathered, of which 20 watercourse crossings were not measured due to not being accessible or were located on private lands with no permit to access granted. The remaining 24 watercourse crossings were visited and measured by the TRCA in October 2019.

At each culvert / bridge site, the structure dimensions were measured, and other information including structure length, structure sketches, structure type, water depth, end-treatment, flow obstruction by debris, railing height, photographs and other general condition comments were collected and summarized in the field inventory sheets.

Field inventory sheets for the identified 346 watercourse crossings were compiled in pdf format and delivered to the TRCA as part of the project, as enclosed in **Appendix A**.

5.3 Structure Comparison Table

The master structure comparison table was created to summarize the available information from three data sources: 1) As-built; 2) current HEC-RAS model and 3) field inventory for a total of 346 watercourse crossings. The table was divided by seven sections, which are presented below:

- Section 1: Basic information and identification including structure number; Yes or No in current hydraulic models; rational of crossing identification from both WSP and TRCA
- Section 2 & 3: Structure with As-built information or in current HEC-RAS model including inverts; obverts; structure type; material; opening size; length; obvert to road height, etc.
- Section 4: Field inventory including structure type; material; opening size; length; obvert to road height; water depth, etc.
- Section 5: Discrepancies / Notes including whether there are significant discrepancies comparing three data set (Y / N); number of data source; notes to describe the discrepancy
- Section 6: Recommendation by WSP whether the crossing be included in the model and which data source be used in the model
- Section 7: TRCA review and recommendation

After reviewed by the TRCA, a total of 304 structures were confirmed to be coded in the Don River Phase II HEC-RAS model. Forty-two crossings were either small crossings without any data or crossings with some available information but believed to be inaccurate based on the aerial image / Google Earth and yet difficult to access for confirmation (such as the Railway Yard at Keele Street \ Highway 7 within West Don River), these crossings were not included in the Don River Phase II HEC-RAS model. The master structure comparison table is provided in **Appendix F**.

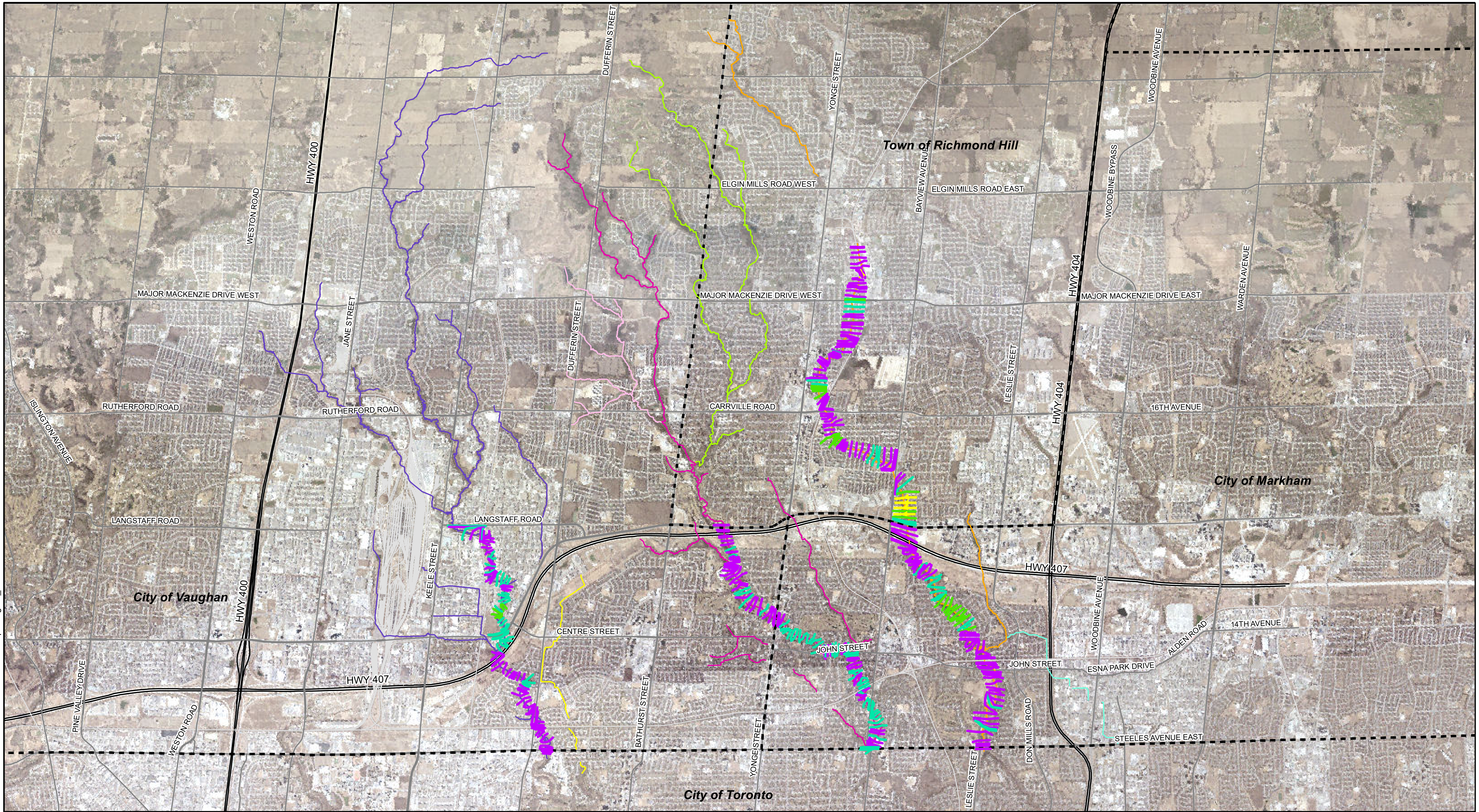
6 LOW FLOW CHANNEL AND DEM (TASK 8 & TASK 2)

6.1 Low Flow Channel Locations

Due to LiDAR did not pick up the underneath of water surface, the channel bottom in the Lidar data still represents the water surface during time when LiDAR flew and the water depths vary from 10 cm on headwater reaches to over 0.5 m – 1 m on lower reaches. Based on the TRCA available survey data and measured water depths at crossings during the site reconnaissance, the TRCA identified the low flow channel be created in the lower reaches of the East and West Don River and the lower reach of German Mills Creek, a tributary of East Don River. The river stations and lengths of these channels are shown below:

— East Don River, starting from Old Langstaff Road at Reach 13 RS 1020.74 to Steeles Avenue East at Reach 10 RS 2, with a total length of approximately 7.6 km
— West Don River, starting from Langstaff Road at Reach 16 RS 2612.415 to Steeles Avenue West at Reach 13 RS 105.24, with a total length of approximately 7.4 km
— German Mills Creek, starting from Crosby Avenue at Reach 4 RS 10639.96 to Steeles Avenue East at Reach 3 RS 27.42, with a total length of approximately 13.1 km

The low flow channel locations and approximately depth adjustments are illustrated in **Figure 6-1.**



Document Path: X:\DIV38\2019\19M-00961-00 Don River FPM PH2\GIS\ReportFigure_LowFlowChannel.mxd

Legend

LOCATION OF LOW FLOW CHANNEL

Depth Adjustments (m)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- >2

CARRVILLE CREEK
CUMMER CREEK
EAST DON RIVER
FISHERVILLE CREEK
GERMAN MILLS CREEK
PATTERSON CREEK
WEST DON RIVER
MUNICIPAL BOUNDARY
ROADS
RAILWAY
HIGHWAY

CLIENT: TORONTO AND REGION CONSERVATION AUTHORITY

TITLE: DON RIVER FLOODPLAIN MAPPING UPDATE - PHASE II

LOCATION OF LOW FLOW CHANNEL AND APPROX. DEPTH ADJUSTMENTS

wsp

Checked: I.Q	Drawn: J.C
Date: July 2020	Proj. No.: 19M-00961-00
Scale:	Figure No.: 6-1

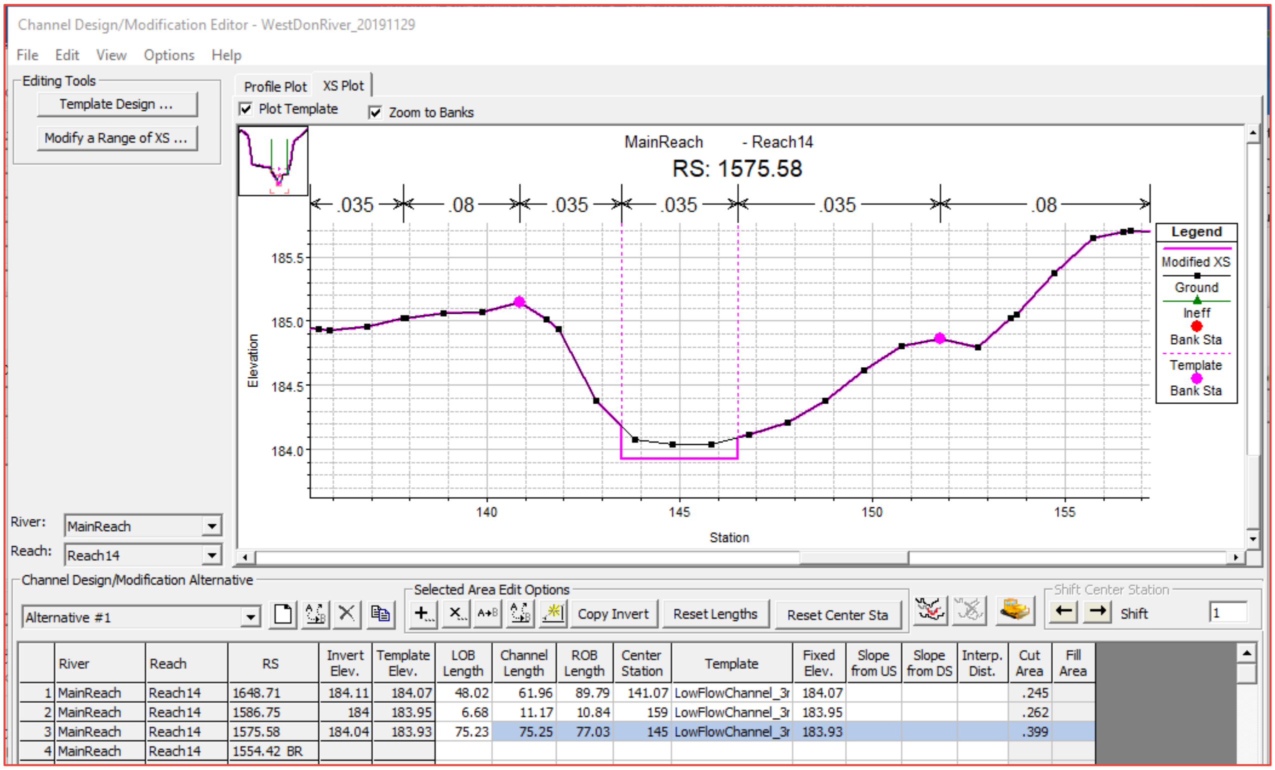
6.2 Methodology of Generating Low Flow Channel

Upon discussion with the TRCA, a 3 m wide rectangle section was applied as the low flow channel for the above reaches. The water depths were collected for the majority of the identified watercourse crossings during the field reconnaissance in 2019. These water depths were used to calculate the bed elevations of the low flow channels at the crossings. Below describes the steps to generate the low flow channels:

1 The bed elevations of each crossing were extracted from the LiDAR provided by the TRCA in 2019 and summarized in the excel table. The field collected water depths were used to adjust the LiDAR generated bed elevations at the crossings, then a linear interpolation was applied between the watercourse crossings to generate the revised stream bed elevations of the low flow channel at each cross section.

2 Under the Channel Design / Modification Editor in HEC-RAS, a cross-section template design was created using a rectangle section with 3 m wide and a Manning's roughness of 0.035. An example of Channel Design / Modification Editor is shown in **Figure 6-2**.

3 The low flow channel was created using the calculated low flow channel inverts and cross-section template along the identified reaches in the East and West Don River as well as German Mills Creek. An example of the comparison of the stream bed profiles (original vs. with low flow channel) is illustrated in **Figure 6-3**.



	River	Reach	RS	Invert Elev.	Template Elev.	LOB Length	Channel Length	ROB Length	Center Station	Template	Fixed Elev.	Slope from US	Slope from DS	Interp. Dist.	Cut Area	Fill Area
1	MainReach	Reach14	1648.71	184.11	184.07	48.02	61.96	89.79	141.07	LowFlowChannel_3r	184.07				.245	
2	MainReach	Reach14	1586.75	184	183.95	6.68	11.17	10.84	159	LowFlowChannel_3r	183.95				.262	
3	MainReach	Reach14	1575.58	184.04	183.93	75.23	75.25	77.03	145	LowFlowChannel_3r	183.93				.399	
4	MainReach	Reach14	1554.42 BR													

Figure 6-2: HEC-RAS Channel Design / Modification Editor to Add Low Flow Channel Section

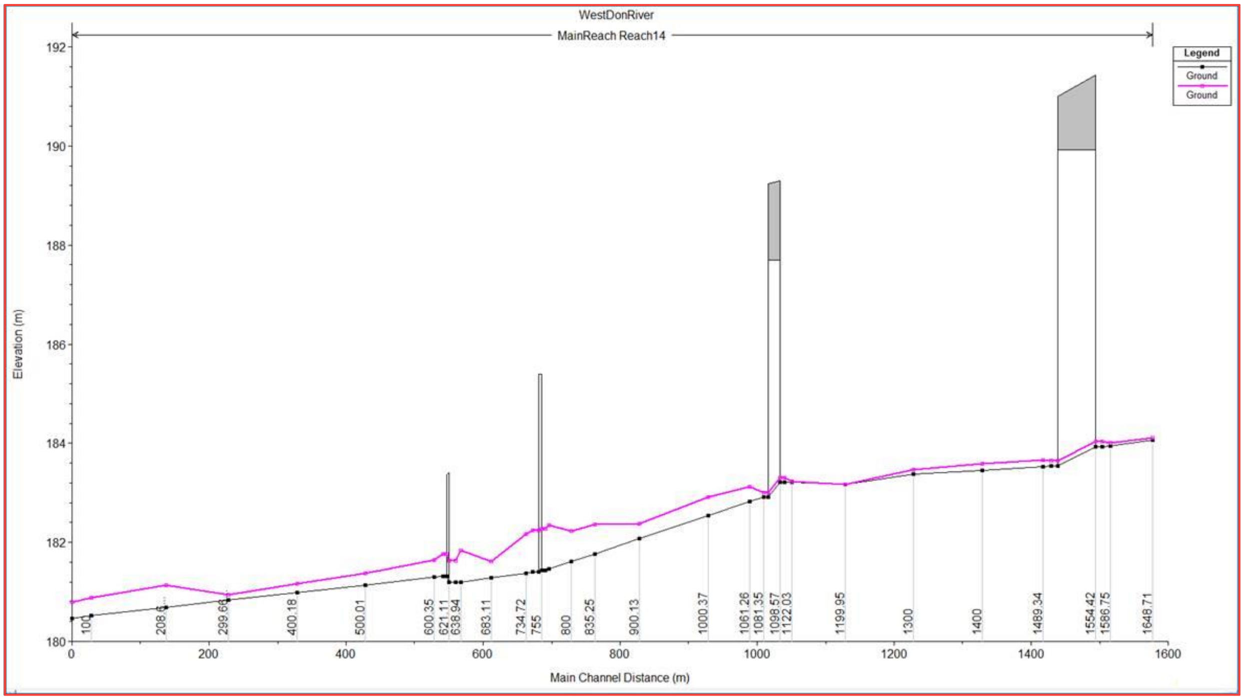


Figure 6-3: Comparison of Stream Bed Profile – Original (Pink) vs with Low Flow Channels (Black)

6.3 Revised DEM

After generating the low flow channel at required reaches in East Don, West Don and German Mills Creek, the original LiDAR was revised by adding these low flow channels to create a new DEM raster file. The DEM was submitted to the TRCA for review in January 2020.

In addition, 31 locations were identified to be the grading changing areas including construction, development and demolition within the study area. The new gradings of these areas were integrated into the revised DEM (with the low flow channels) and generated the final DEM by the TRCA. The final DEM, supplied by the TRCA in February 2020, was then loaded to the RAS Mapper in HEC-RAS to form the terrain, which was used in the HEC-RAS model simulations for the Don River Floodplain Mapping Phase II study.

7 DEVELOPMENT OF PCSWMM MODEL FOR IDENTIFIED PIPED FLOW AREAS (TASK 9)

As illustrated in **Figure 2-1** in **Section 2**, six areas (Area 1 has two sub-areas) including four in the East Don River and two in the West Don River were originally identified as the piped flow areas within the subject study area. Later, instead of modelling in PCSWMM, two piped areas in Cummer Creek (Area 5 and 6) in the East Don River were entered as culverts in the Don River Phase II HEC-RAS model. As such, four areas were modelled using the PCSWMM software. Then the modelled head water levels from the PCSWMM models were applied as the internal boundaries to upstream ends in the Don River Phase II HEC-RAS model.

7.1 PCSWMM Software

PCSWMM 2017 version was selected to model the identified buried piped flow areas for this study. PCSWMM, a PC version of EPA's Stormwater Management Model (SWMM), is a dynamic model which is capable to model pipes with different dimensions, slopes, bends and inverts. The model is widely used for planning, analysis and design related to drainage systems in urban areas in Ontario.

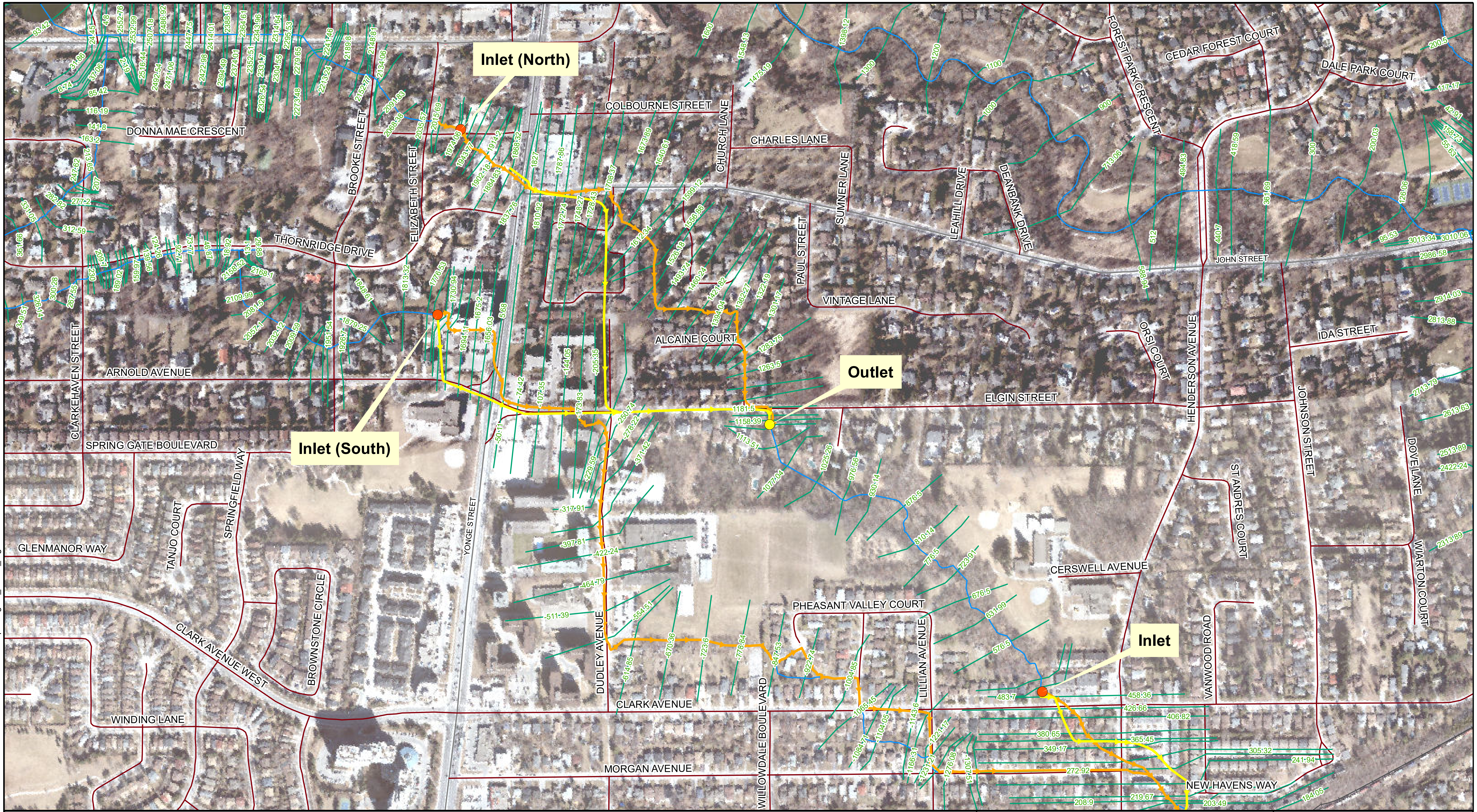
7.2 PCSWMM Model Construction

Four PCSWMM models (Area 1 includes two sub-areas) were constructed for this study. The pipe lengths, sizes, inlet and outlet inverts were collected from a previous TRCA technical memo, the City of Vaughan and City of Markham. Locations and basic pipe information of four piped flow areas are summarized in **Table 7-1**. An example of the PCSWMM model components (Pipe Area 4) is presented in **Figure 7-1**. Additional information is provided in **Appendix C**.

These pipes were coded in the PCSWMM models which were simulated to determine the capacity of the pipes and headwater level at the inlet. In addition, the overland flow paths were coded in the PCSWMM models to capture the flows exceeding from the buried pipes. The alignments and cross-sections of these overland flow paths were generated from the DEM. The layouts of pipes and overland paths are illustrated in **Appendix C**.

Table 7-1: Piped Flow Area Locations and Pipe Basic Information

Area #	River	Location	Pipe Basic Information					
			Height (m)	Width (m)	Length (m)	Barrels	Shape	Material
Area 1	Fishersville Creek	between Charlton Avenue and Conley Park (Storm Sewer North)	1.8	3	112.01	2	Box	Concrete
			3	3	22.1	2	Box	Concrete
			2.7	3.3	36.564	1	Ellipse	CWP
		between Steeles Ave and Fisherville Road (Storm Sewer South)	1.5	5.2	29.4	1	Box	Concrete
			1.8	3.6	198	1	Box	Concrete
			2.3	4.91	20	1	Box	Concrete
Area 2	West Don River	between Bradwick Drive and Rivermede Road	2.44	3.66	796.88	1	Box	Concrete
Area 3	East Don River	between Clark Avenue and Proctor Avenue	1.83	2.59	48	1	Box	Concrete
			2	3.4	97	1	Box	Concrete
			ø2.58		30.6	1	Circle	Concrete
			ø2.45		191.26	1	Circle	Concrete
			ø2.75		124.477	2	Circle	Concrete
			2.4	1.8	18.481	2	Box	Concrete
Area 4	East Don River	between Yonge Street and Elgin Street	ø1.8		586.023	1	Circle	Concrete
			ø1.2		101.18	1	Circle	Concrete
			ø1.5		281.06	1	Circle	Concrete
			ø2.1		248.7	1	Circle	Concrete



Legend

- STORM SEWER INLET
- STORM SEWER OUTLET

PCSWMM MODEL

- STORM SEWER PIPES
- OVERLAND FLOW PATHS
- Don River
- HecRAS Model Cross-Sections
- ROADS
- RAILWAY
- HIGHWAY

CLIENT	TORONTO AND REGION CONSERVATION AUTHORITY
TITLE	DON RIVER FLOODPLAIN MAPPING UPDATE - PHASE II
	PCSWMM MODEL PIPED FLOW AREA 4

wsp

Checked: I.Q	Drawn: J.C
Date: July 2020	Proj. No.: 19M-00961-00
Scale: 1:5,447	Figure No.: **7-1**

Document Path: X:\DIV38\2019\19M-00961-00 Don River FPM PH2\GIS\Report\Figure_Area4_Fig7-1.mxd

7.3 PCSWMM Model Simulation and Results

The static conditions were utilized in these models where the constant flows obtained from the TRCA were coded at the upstream end and fixed tailwater elevations extracted from the Don River Phase II HEC-RAS model were entered at the outfalls located at the downstream limits of the PCSWMM models. The 2- to 100-year and 350-year flow events as well as Regional flood event were simulated in the PCSWMM models. Details of the model inputs and results for each area are presented in **Appendix C**.

8 DEVELOPMENT OF HEC-RAS MODEL (TASK 10)

8.1 HEC-RAS Software

HEC-RAS is a computer program that models the hydraulics of water flow through natural rivers and other channels. The program is developed by the United States Army Corps of Engineers and is widely applied in Ontario to manage the open channels, floodplain management and other public works. HEC-RAS is equipped to model a network of channels, a dendritic system or a single river reach. It is capable of modelling subcritical, supercritical, and mixed flow regime flow along with the effects of bridges, culverts, weirs, and structures.

The basic computational procedure of HEC-RAS for steady flow is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction and contraction / expansion. The momentum equation may be used in situations where the water surface profile is rapidly varied. These situations include hydraulic jumps, hydraulics of bridges, and evaluating profiles at river confluences.

The latest Version 5.0.7 was used in this study.

8.2 HEC-RAS Model Development

8.2.1 HEC-GeoRAS

HEC-GeoRAS is a set of procedures, tools, and utilities for processing geospatial data in ArcGIS using a graphical user interface (GUI). The interface allows the preparation of geometric data for import into HEC-RAS and processes the simulation results including water surface profile, velocity and water depth exported from HEC-RAS for floodplain study and floodplain mapping.

The themes including the stream centerline, cross-section cut lines, main channel banks, overbank flow paths, blocked obstructions, land use and structure's deck / roadway were created in HEC-GeoRAS and later imported into the HEC-RAS to model the subject area.

8.2.2 Don River Network

A GIS watercourse shapefile defining the Don River network to be included in the Phase II hydraulic model was supplied by the TRCA in July 2019 as part of the background information. The extents of the drainage network for modelling is illustrated in **Figure** 1-1 in **Section 1**.

The watercourse alignments received from the TRCA were reviewed and adjusted by WSP to follow the actual watercourse centrelines based on the high resolution orthographic images and LiDAR. The network in the model contains approximately 150.7 km of stream channel with approximately 92.6 km of the East Don River and its tributaries and approximately 58.1 km of the West Don River and its tributaries. The modelled drainage length for the main branches and major tributaries are presented in **Table 8-1**.

Table 8-1: Modelled Drainage Length in Don River Phase II HEC-RAS Model

River	Branch / Tributary	Modelled Drainage Length (km)
East Don River	Main Branch	18.5
	Carrville Creek	9.6
	German Mills Creek	27.1
	Patterson Creek	21.1
	Tributaries	16.2
West Don River	Main Branch	22.4
	Fishersville Creek	4.2
	Tributaries	31.5

East Don River	92.6
West Don River	58.1
Total Modelled Drainage Length (km)	**150.7**

8.2.3 Cross-Sections

A total of 3399 cross-sections were generated from the revised DEM which incorporated low flow channels and grading updates discussed in **Section 6.3** to define the bathymetric and floodplain of the Don River in the study area. The cross-section was cut from left to right bank (looking downstream) and perpendicular to the stream centrelines and contours. A general space of 100 m was applied along the channel alignments. However, in the river geometry rapid change or meander locations, the cross-section space was reduced to a minimum of 25 m. The widths of the cross-sections were varied from 50 m to 500 m to ensure the modelled highest water surface would be contained within the cross-sections.

Downstream Reach Lengths and Bank Stations

As stated above, the centerlines of the streams, left and right overbank flow paths and bank lines were created in HEC-GeoRAS and imported to the HEC-RAS to define the downstream reach lengths for the channel and overbanks as well as the main channel bank stations. Modifications of the main channel bank stations were later made to properly reflect the main flow conveyance area by either top to top for the well-defined channels or 2 m for undefined channels.

Manning's N

Horizontal variation in Manning's roughness was used for all cross-sections. Generally, a Manning's n of 0.035 was applied for the main channels, and a Manning's n of 0.05 to 0.08 was used for the overbank portions based on the land use and Standard Manning's n values provided by TRCA.

Ineffective Flow Areas

Ineffective flow areas were defined at the upstream and downstream cross-sections for every bridge and culvert crossing using "Normal" ineffective mode. Two pairs of stations and elevations were entered to establish the left and right side of ineffective areas. The stations were set to be 1:1 of the upstream distance. The elevation was set to be the top of the deck / roadway at the upstream cross-section and the mid of the deck / roadway top to the bridge low chord / culvert obvert at the downstream cross-section and ineffective areas were also defined at the off-line ponds and off-line floodplain storage.

Levees

Left and/or right levees with stationing and elevations were placed for any cross-section with the high ground to ensure the water would not flow to the left of the left levee station or to the right of the right levee station until either of the levee elevations was exceeded.

Obstructions

A GIS shapefile of building footprints was supplied by the TRCA. The shapefile was reviewed and updated for the latest development using the latest high resolution images provided by the TRCA. For the model purpose, the building height was assumed to be 5 m. The blocked obstruction layer was generated in HEC-GeoRAS and imported into the HEC-RAS model. Blocked obstruction was not only defined when cross-section intersects with buildings but also buildings are in-between cross-section.

Contraction / Expansion Coefficient

The contraction / expansion coefficient of 0.1 / 0.3 was applied for the general cross-sections, while the contraction / expansion coefficient of 0.3 / 0.5 was utilized in the cross-sections at the upstream and downstream of the structures.

8.2.4 Hydraulic Structures

The model contains a total of 304 structures (bridges, culverts and inline structures) including 187 structures in the East Don River and 117 structures in the West Don River. **Table 8-2** summarizes the number of the structures coded in the main branches and major tributaries.

As instructed by the HEC-RAS application, four user defined cross-sections were utilized in every bridge and culvert to compute the energy losses due to the structure. These cross-sections, two (cross-section 3 & 4) were at the upstream of the structure and two (cross-section 1 & 2) were at the downstream of the structure, were properly placed to comply with the requirements of HEC-RAS.

Geometry of Structures

Dimensions of the structures including opening sizes and length were obtained from the field measurements, existing hydraulic models or as-built drawings.

For the culverts, upstream / downstream inverts were extracted from the LiDAR and then proper adjustments made using the measured water depths during the 2019 field reconnaissance. The entrance loss coefficient and Manning's n were defined based on the material of the culverts.

Table 8-2: Modelled Number of Structures in Don River Phase II HEC-RAS Model

River	Branch / Tributary	Number of Modelled Structures
East Don River	Main Branch	24
	Carrville Creek	10
	German Mills Creek	51
	Patterson Creek	38
	Other Tributaries	64
West Don River	Main Branch	28
	Fisherville Creek	6
	Other Tributaries	83

East Don River	187
West Don River	117
Total Modelled Structures	304

Bridge Modelling Approach

The bridge modelling approach was defined in the HEC-RAS "Bridge Modelling Approach Editor" including low flow and high flow methods. For the low flow method, "Energy (Standard Step)" method was selected for the clear span bridges; while "Momentum" and "Yarnell (Class A only)" were applied to model the bridges with piers, the modelled water profiles were governed by the higher elevations. For the high flow method, "Energy Only (Standard Step)" was used for the bridges with the modelled highest water levels lower than the soffit elevations; while "Pressure and/or Weir" method was applied when the calculated water levels are above the soffit elevations.

9 HEC-RAS MODEL SIMULATIONS (TASK 11)

9.1 Model Simulations

The 2-, 5-, 10-, 25-, 50-, 100-, 350-year and Regional events were simulated using the HEC-RAS model developed by WSP for the Don River Phase II study. Flow inputs and boundary conditions are described in **Section 3** and **4** in this report. The modelled water levels for various flow events were summarized in the table and examined between two consecutive cross-sections to ensure a maximum water surface elevation difference of 1.0 m was achieved, and whether the model defaults to the critical depths at the cross-sections was also checked. Additional cross-sections were added at the locations where the water surface elevation difference was above 1 m and the model defaults to the critical depth.

9.2 Sensitivity Analysis

Sensitivity analysis on boundary conditions (±0.3 m), roughness coefficients (±15%) and flow inputs (±10%) were conducted as part of the study. The results are summarized below.

9.2.1 Boundary Conditions

The water levels at 4 downstream boundaries were obtained from the Don River Phase I hydraulic model, as presented in **Table 4-1**. These water levels were adjusted to plus / minus 0.3 m for the boundary condition sensitivity analysis.

The average changes, maximum increase and maximum decrease of the computed water surface elevations for the 2- to 350-year and Regional events are summarized in **Table 9-1**. The number of computational cross-sections in the HEC-RAS model where critical depth is the resultant computed water surface elevation for three simulations are also provided in **Table 9-2**.

Table 9-1: Computed Water Surface Elevation Changes – Boundary Condition Sensitivity Analysis

Event	Starting Water Surface Elevation +0.3 m				Starting Water Surface Elevation -0.3 m			
	Average change in CWSE[1] (m)	Maximum Increase in CWSE (m)	Maximum Decrease in CWSE (m)	Maximum Upstream Propagation (m) Cross -Section[23]	Average change in CWSE[1] (m)	Maximum Increase in CWSE (m)	Maximum Decrease in CWSE (m)	Maximum Upstream Propagation (m) Cross -Section[23]
2- year	0.003	0.31	-0.13	GermanMills Ck Reach3 XS507.48 (509.6m); EastDon Reach11 XS163.21 (249.0m), EastTrib6 Reach1 XS65.13 (150.9m); FishervilleCreek Reach 2 XS796.97 (237m); WestDon Reach13 XS781.22 (676.0m)	0.00	0.01	-0.32	GermanMills Ck Reach3 XS507.48 (509.6m); EastDon Reach11 XS163.21 (249.0m), EastTrib6 Reach1 XS65.13 (150.9m); FishervilleCreek Reach 2 XS796.97 (237m); WestDon Reach13 XS781.22 (676.0m)
5- year	0.003	0.31	-0.05	GermanMills Ck Reach3 XS507.48 (509.6m); EastDon Reach11 XS281.06 (366.8m), EastTrib6 Reach1 XS320.32 (406.1m); FishervilleCreek Reach 2 XS796.97 (237m); FishervilleCreek Reach 1 XS281.62 (281.62m); WestDon Reach13 XS781.22 (676.0m)	0.00	0.02	-0.33	GermanMills Ck Reach3 XS507.48 (509.6m); EastDon Reach11 XS360.77 (446.5m), EastTrib6 Reach1 XS320.32 (408.07m); FishervilleCreek Reach 2 XS796.97 (237m); FishervilleCreek Reach 1 XS281.62 (281.62m); WestDon Reach13 XS681.29 (576.1m)
10-year	0.003	0.32	-0.07	GermanMills Ck Reach3 XS507.48 (509.6m); EastDon Reach11 XS523.75 (609.5m), EastTrib6 Reach1 XS320.32 (406.1m); FishervilleCreek Reach 2 XS796.97 (237m); WestDon Reach13 XS681.29 (576.1m)	0.00	0.06	-0.33	GermanMills Ck Reach3 XS507.48 (509.6m); EastDon Reach11 XS163.21 (249.0m), EastTrib6 Reach1 XS320.32 (406.1m); FishervilleCreek Reach 2 XS796.97 (237m); WestDon Reach13 XS681.29 (576.1m)
25-year	0.003	0.32	-0.01	GermanMills Ck Reach3 XS507.48 (509.6m); EastDon Reach11 XS714.25 (800.3m), EastTrib6 Reach1 XS400 (485.7m); FishervilleCreek Reach 2 XS796.97 (237m); WestDon Reach13 XS881.6 (776.4m)	0.00	0.19	-0.35	GermanMills Ck Reach3 XS507.48 (509.6m); EastDon Reach11 XS714.25 (802.27m), EastTrib6 Reach1 XS600 (685.7m); FishervilleCreek Reach 2 XS796.97 (237m); WestDon Reach13 XS681.29 (576.1m)
50-year	0.003	0.44	-0.01	GermanMills Ck Reach3 XS507.48 (509.6m); EastDon Reach11 XS714.25 (800.3m), EastTrib6 Reach1 XS320.32 (406.1m); FishervilleCreek Reach 2 XS796.97 (237m); WestDon Reach13 XS994.66 (610.6m)	0.00	0.02	-0.36	GermanMills Ck Reach3 XS106.4 (172.5m); EastDon Reach11 XS714.25 (802.27m), EastTrib6 Reach1 XS500 (585.7m); FishervilleCreek Reach 2 XS700.24 (140m); WestDon Reach13 XS781.22 (676.0m)
100-year	0.003	0.34	-0.22	GermanMills Ck Reach3 XS106.4 (172.5m); EastDon Reach11 XS806.47 (892.2m), EastTrib6 Reach1 XS320.32 (406.1m); FishervilleCreek Reach 2 XS796.97 (237m); WestDon Reach13 XS183.42 (78.2m)	0.00	0.01	-0.45	GermanMills Ck Reach3 XS100.22 (135.5m); EastDon Reach11 XS714.25 (802.27m), EastTrib6 Reach1 XS400 (485.7m); FishervilleCreek Reach 2 XS700.24 (140m); WestDon Reach13 XS950.13 (844.9m)
350-year	0.002	0.36	-0.07	GermanMills Ck Reach3 XS100.22 (135.5m); EastDon Reach11 XS806.47 (892.2m), EastTrib6 Reach1 XS320.32 (406.1m); FishervilleCreek Reach 2 XS796.97 (237m); WestDon Reach13 XS950.13 (844.9m)	0.00	0.01	-0.35	GermanMills Ck Reach3 XS402.11 (404.3m); EastDon Reach11 XS1201.45 (1287.2m), EastTrib6 Reach1 XS320.32 (406.1m); FishervilleCreek Reach 2 XS700.24 (140m); WestDon Reach13 XS950.13 (844.9m)
Regional	0.002	0.34	0.00	GermanMills Ck Reach3 XS44.68 (80m); East Don Reach 11 XS 22.97 (108.7m), EastTrib6 Reach1 XS320.32 (406.1m); FishervilleCreek Reach 3 XS1735.99 (~1200m); WestDon Reach13 XS950.13 (844.9m)	0.00	0.01	-0.31	GermanMills Ck Reach3 XS44.68 (80m); East Don Reach 11 XS 22.97 (108.7m); FishervilleCreek Reach 2 XS971.49 (411m); WestDon Reach13 XS926.14 (820.9m)

Note: 1. CWSE = Computed Water Surface Elevation;
2. The cross-section number is indicative of the zone of influence of the change in boundary conditions;
3. The number in the bracket indicates the the maximum propagation distance from the location of changed boundary condition.

Table 9-2: Summary of Critical Depth Occurrence – Boundary Condition Sensitivity Analysis

Scenario	Critical Depth Occurrence by Event							
	2-year	5-year	10-year	25-year	50-year	100-year	350-year	Regional
Starting Water Surface Elevation +0.3 m	2329	2341	2347	2358	2359	2359	2338	2303
Base Model	2329	2341	2347	2358	2359	2359	2338	2303
Starting Water Surface Elevation -0.3 m	2329	2341	2347	2358	2359	2359	2338	2303

Note: The values presented in this table are the number of computational cross-sections in the HEC-RAS model where critical depth is the resultant computed water surface elevation.

9.2.2 Roughness Coefficients

Roughness coefficients of each cross-section in the model were adjusted by ±15% to perform the sensitivity analysis. The average changes, maximum increase and maximum decrease of the computed water surface elevations for the 2- to 350-year and Regional events are summarized in **Table 9-3**. The number of computational cross-sections in the HEC-RAS model where critical depth is the resultant computed water surface elevation for three simulations are also provided in **Table 9-4**.

Table 9-3: Computed Water Surface Elevation Changes – Roughness Coefficient Sensitivity Analysis

Event	Manning's n + 15%			Manning's n - 15%		
	Average Change in CWSE[1] (m)	Maximum Increase in CWSE (m)	Maximum Decrease in CWSE (m)	Average Change in CWSE[1] (m)	Maximum Increase in CWSE (m)	Maximum Decrease in CWSE (m)
2- year	0.02	0.28	-0.26	-0.03	0.14	-0.36
5- year	0.03	0.21	-0.27	-0.03	0.19	-0.27
10-year	0.03	0.37	-0.27	-0.03	0.59	-0.37
25-year	0.03	0.50	-0.51	-0.03	0.21	-0.60
50-year	0.03	0.29	-0.12	-0.03	0.20	-0.56
100-year	0.03	0.62	-0.16	-0.03	0.58	-0.51
350-year	0.04	0.51	-0.18	-0.03	0.18	-0.78
Regional	0.04	0.54	-1.51	-0.04	0.79	-0.53

Note: [1]CWSE – Computed Water Surface Elevation

Table 9-4: Summary of Critical Depth Occurrence – Roughness Coefficient Sensitivity Analysis

Scenario	Critical Depth Occurrence by Event							
	2-year	5-year	10-year	25-year	50-year	100-year	350-year	Regional
Manning's n +15%	2294	2302	2304	2305	2306	2305	2305	2264
Base Model	2329	2341	2347	2358	2359	2359	2338	2303
Manning's n -15%	2383	2399	2400	2418	2416	2410	2384	2343

Note: The values presented in this table are the number of computational cross-sections in the HEC-RAS model where critical depth is the resultant computed water surface elevation.

9.2.3 Flow Inputs

Each flow input in the model was adjusted by ±10% to perform the sensitivity analysis. The average changes, maximum increase and maximum decrease of the computed water surface elevations for the 2- to 350-year and Regional events are summarized in **Table 9-5**. The number of computational cross-sections in the HEC-RAS model where critical depth is the resultant computed water surface elevation for three simulations are also provided in **Table 9-6**.

Table 9-5: Computed Water Surface Elevation Changes – Flow Input Sensitivity Analysis

Event	Peak Flow +10%			Peak Flow -10%		
	Average Change in CWSE[1] (m)	Maximum Increase in CWSE (m)	Maximum Decrease in CWSE (m)	Average Change in CWSE[1] (m)	Maximum Increase in CWSE (m)	Maximum Decrease in CWSE (m)
2- year	0.03	0.31	-0.24	-0.03	0.42	-0.30
5- year	0.03	0.37	-0.57	-0.04	0.17	-0.53
10-year	0.04	0.23	-0.26	-0.04	0.26	-0.71
25-year	0.05	0.58	-0.52	-0.05	0.34	-0.50
50-year	0.05	0.42	-0.20	-0.05	0.34	-0.56
100-year	0.05	0.90	-0.22	-0.06	0.22	-0.82
350-year	0.08	0.99	-0.63	-0.08	0.39	-1.85
Regional	0.09	1.39	-1.42	-0.12	0.99	-2.11

Note: [1]CWSE = Computed Water Surface Elevation

Table 9-6: Summary of Critical Depth Occurrence – Flow Input Sensitivity Analysis

Scenario	Critical Depth Occurrence by Event							
	2-year	5-year	10-year	25-year	50-year	100-year	350-year	Regional
Peak Flow +10%	2334	2344	2352	2358	2359	2360	2344	2298
Base Model	2329	2341	2347	2358	2359	2359	2338	2303
Peak Flow -10%	2330	2339	2342	2349	2364	2360	2345	2312

Note: The values presented in this table are the number of computational cross-sections in the HEC-RAS model where critical depth is the resultant computed water surface elevation.

9.2.4 Conclusion of Sensitivity Analysis

The sensitivity analysis shows that the model is stable under a range of variations in Manning's n roughness, peak flows and starting boundary conditions. The increases and decreases in water levels and critical occurrences align well with that would be expected from a robust model.

10 FLOOD CHARACTERIZATION AND SCREENING (TASK 12)

10.1 Flood Mapping Generation

Upon receipt of TRCA approval for the new hydraulic model, preparation of the floodplain delineations for the required suite of flow scenarios required for this assignment (ref. Task 1D) was completed in collaboration with TRCA. The flow scenarios were the Regional Storm and the 2-, 5-,10-, 25-, 50-, 100-, and 350-year design storms.

The delineation of the Regulatory flood line has been completed in compliance with Ministry of Natural Resources and Forestry (MNRF) procedures, whereby the greater of the 100-year or Hurricane Hazel inundation limits has been used to establish the Regulatory flood line. The 100-year and Hurricane Hazel inundation limits have been subjected to a greater level of scrutiny for accuracy commensurate with an engineering flood delineation approach.

Flood inundation limits for the other flow scenarios have not been subjected to the same “clean-up” effort as the engineered flood delineations as the 2-, 5-,10-, 25-, 50-, 100-, and 350-year design storm flood zones are to be used for flood risk screening and characterization only.

The Regulatory floodplain maps were generated for the study area, as provided in **Appendix G**.

10.2 Structure Overtopping

Structure overtopping for each storm event was identified and summarized in **Table 10-1** with no overtopping highlighted in green and overtopping highlighted in red.

Table 10-1: Structure Overtopping Summary

Structure#	Structure Type	HEC-RAS Watercourse Designation	Top of Road/When Weir Flow Begins (m)	HEC-RAS Section Upstream of Structure	Difference between Computed Water Surface Elevation and Top of Road Elevation (m)							
					2- year	5- year	10-year	25-year	50-year	100-year	350-year	Regional
Don_300	Bridge	GermanMillsCk/Reach3	155.57	100.22	-7.52	-7.33	-7.21	-7.13	-6.98	-6.75	-6.37	-4.68
Don_301	Culvert	GermanMillsCk/Reach3	149.92	522.41	0.72	0.76	0.74	0.07	0.92	0.98	1.25	2.36
Don_303	Culvert	GermanMillsCk/Reach3	169.44	2051.56	-12.63	-12.46	-12.35	-12.22	-12.13	-11.99	-11.43	-7.6
Don_304	Culvert	GermanMillsCk/Reach3	177.86	2330.3	-17.52	-17.19	-17.01	-17.57	-17.25	-16.35	-15.73	-8.66
Don_305	Bridge	GermanMillsCk/Reach4	171.95	723.29	-5.36	-5.21	-5.12	-5.01	-4.9	-4.81	-4.39	-2.75
Don_306	Culvert	GermanMillsCk/Reach4	189.77	3475.44	-0.62	-0.4	-0.25	-0.06	0.03	0.09	0.26	0.84
Don_307	Bridge	GermanMillsCk/Reach4	196.76	3665.89	-6.85	-6.72	-6.63	-6.51	-6.43	-6.36	-6.13	-5.01
Don_308	Culvert	GermanMillsCk/Reach4	201.6	3971.57	-9.61	-9.36	-9.21	-9.01	-8.82	-8.66	-8.06	-4.61
Don_309&310	Culvert	GermanMillsCk/Reach4	202.17	5157.87	-3.6	-3.47	-3.38	-3.28	-3.17	-3.08	-2.74	-1.01
Don_311	Bridge	GermanMillsCk/Reach4	202.61	6218.7	-2.35	-2.23	-2.15	-2.04	-1.95	-1.88	-1.64	-0.11
Don_312	Culvert	GermanMillsCk/Reach4	208.71	7096.04	-4.88	-4.79	-4.72	-4.63	-4.56	-4.49	-4.29	-2.84
Don_313	Culvert	GermanMillsCk/Reach4	207.35	7266.07	-2.45	-2.27	-2.16	-2.04	-1.94	-1.86	-1.57	0.45
Don_315	Culvert	GermanMillsCk/Reach4	208.03	7737	-1.64	-1.48	-1.38	-1.26	-1.17	-1.1	-0.84	0.8
Don_316	Bridge	GermanMillsCk/Reach4	209.79	8051	-2.18	-2.05	-1.96	-1.86	-1.78	-1.71	-1.46	0.25
Don_317	Culvert	GermanMillsCk/Reach4	209.64	8348.71	-1.33	-1.2	-1.11	-1	-0.92	-0.85	-0.6	0.96
Don_318	Culvert	GermanMillsCk/Reach4	210.06	8412.99	-1.58	-1.42	-1.32	-1.22	-1.13	-1.06	-0.7	1.1
Don_319	Culvert	GermanMillsCk/Reach4	210.62	8641.28	-1.54	-1.38	-1.29	-1.18	-1.1	-1.02	-0.74	0.92
Don_320	Bridge	GermanMillsCk/Reach4	211.32	8826.84	-0.93	-0.78	-0.68	-0.57	-0.47	-0.4	-0.08	1.25
Don_321	Culvert	GermanMillsCk/Reach4	214.5	9092.57	-2.37	-2.14	-2.02	-1.88	-1.76	-1.66	-1.3	0.59
Don_322	Culvert	GermanMillsCk/Reach4	218.25	9527.2	-2.15	-2.02	-1.94	-1.88	-1.84	-1.73	-1.34	0.72
Don_324	Culvert	GermanMillsCk/Reach4	223.99	10015.83	-2.44	-2.29	-2.2	-2.09	-2.02	-1.95	-1.64	0.4
Don_325	Culvert	GermanMillsCk/Reach4	225.64	10082.64	-3.98	-3.83	-3.73	-3.62	-3.54	-3.46	-3.1	0.37
Don_326	Culvert	GermanMillsCk/Reach4	229.25	10639.96	-2.6	-2.5	-2.43	-2.36	-2.29	-2.24	-1.95	0.39
Don_327	Inline Structure	GermanMillsCk/Reach5	240.89	12578.14	2.3	2.46	2.53	2.61	2.66	2.71	3.04	4.04
Don_328	Culvert	GermanMillsCk/Reach5	246.55	12886.43	-2.15	-2.11	-2.09	-2.06	-2.05	-2.03	-1.96	-1.37
Don_329	Culvert	GermanMillsCk/Reach5	249.58	13015.47	-1.04	-0.91	-0.83	-0.74	-0.68	-0.61	-0.2	-0.01
Don_331	Culvert	GermanMillsCk/Reach5	252.54	13302.95	-0.63	-0.46	-0.35	-0.23	-0.16	-0.07	-0.05	-0.07
Don_332	Culvert	GermanMillsCk/Reach5	252.98	13379.43	-0.7	-0.51	-0.41	-0.27	-0.17	-0.04	0.04	0.08
Don_333	Culvert	GermanMillsCk/Reach5	255.05	13498.78	-1.59	-1.5	-1.45	-1.39	-1.36	-1.31	-1.14	-0.01
Don_334	Culvert	GermanMillsCk/Reach5	262.65	14008.91	-3.88	-3.83	-3.79	-3.75	-3.72	-3.69	-3.61	-1.51
Don_335	Culvert	GermanMillsCk/Reach5	279.53	15408.53	-0.94	-0.89	-0.86	-0.83	-0.8	-0.77	-0.72	0.16
Don_336	Culvert	GermanMillsCk/Reach5	281.74	15491.63	-1.96	-1.94	-1.92	-1.9	-1.88	-1.87	-1.84	-0.02
Don_337	Culvert	GermanMillsCk/Reach6	296.58	106.21	-1.24	-1.15	-1.09	-1.02	-0.94	-0.87	-0.66	0.4
Don_338	Culvert	GermanMillsCk/Reach6	302.06	526.68	-2.39	-2.3	-2.25	-2.19	-2.12	-2.06	-1.9	0.25
Don_339	Culvert	GermanMillsTrib2/Reach1	168.03	378.87	-4.85	-4.65	-4.52	-4.39	-4.24	-4.13	-3.6	1.24
Don_340	Culvert	GermanMillsTrib2/Reach2	175.97	487.1	-5	-4.93	-4.88	-4.86	-4.83	-4.78	-4.58	-4.2
Don_341	Culvert	GermanMillsTrib2/Reach2	183.83	1627.36	-1.71	-1.65	-1.62	-1.59	-1.56	-1.52	-1.28	-0.7
Don_342	Culvert	GermanMillsTrib2/Reach2	187.7	1954.16	-0.86	-0.79	-0.75	-0.71	-0.68	-0.61	-0.24	0.35
Don_343	Culvert	GermanMillsTrib2/Reach2	196.78	2419.41	-4.36	-4.32	-4.3	-4.27	-4.24	-4.22	-4.17	-2.45
Don_344	Bridge	GermanMillsCk/CummerCk1	174.02	280.54	-6.72	-6.55	-6.45	-6.35	-6.22	-6.1	-5.83	-4.23
Don_345	Inline Structure	GermanMillsCk/CummerCk1	167.56	319.58	1.96	2.26	2.45	2.65	2.84	2.91	3.05	3.61
Don_346	Bridge	GermanMillsCk/CummerCk1	168.77	576.72	0.78	1.09	1.28	1.48	1.67	1.75	1.92	2.73
Don_347	Culvert	GermanMillsCk/CummerCk1	178.75	1225.04	-8.09	-7.83	-7.69	-7.53	-7.38	-7.25	-6.98	-5.39
Don_348	Culvert	GermanMillsCk/CummerCk1	173.31	1560.75	-2.25	-2.01	-1.86	-1.68	-1.5	-1.34	-0.9	1.73
Don_349	Culvert	GermanMillsCk/CummerCk1	173.73	1741.59	-2.11	-1.85	-1.68	-1.51	-1.36	-1.22	-0.85	1.33
Don_350	Culvert	GermanMillsCk/CummerCk1	173.61	2092.16	-1.4	-1.16	-0.97	-0.75	-0.56	-0.38	0.07	1.45
Don_351	Culvert	GermanMillsCk/CummerCk1	175.17	2505.2	-1.48	-1.2	-0.96	-0.66	-0.29	0.05	0.2	0.62
Don_352	Culvert	GermanMillsCk/CummerCk1	175.89	2843.92	-1.87	-1.55	-1.28	-0.93	-0.51	-0.08	0.06	0.47
Don_353	Culvert	GermanMillsCk/CummerCk1	176.36	3036.96	-2.1	-1.79	-1.56	-1.24	-0.83	-0.4	-0.2	0.48
Don_354	Culvert	GermanMillsCk/CummerCk1	176.86	3543.33	-1.75	-1.58	-1.46	-1.3	-1.05	-0.74	-0.56	0.28
Don_355	Culvert	GermanMillsCk/CummerCk1	176.39	3739.8	-0.88	-0.75	-0.66	-0.54	-0.37	-0.11	0.1	0.85
Don_356	Culvert	GermanMillsCk/CummerCk1	177.21	3827.77	-1.33	-1.28	-1.24	-1.21	-1.18	-0.9	-0.66	0.4
Don_357	Culvert	GermanMillsTrib3/Reach1	302.73	325.82	-1.47	-1.46	-1.45	-1.44	-1.41	-1.26	-1.22	-0.96
Don_358	Bridge	EastDon/Reach10	148.92	78.99	-3.65	-3	-2.65	-2.04	-1.49	-1.31	-0.19	1.24
Don_359	Culvert	EastDon/Reach11	149.16	73.61	-3.69	-2.96	-2.55	-1.97	-1.41	-1.15	0.66	2.04
Don_360	Bridge	EastDon/Reach11	152.17	1201.45	-3.26	-2.66	-2.33	-2.06	-1.82	-1.62	0.32	2.08
Don_361	Bridge	EastDon/Reach11	169.85	1745.32	-18.81	-18.27	-18	-17.73	-17.51	-17.35	-16.49	-14.16
Don_362	Bridge	EastDon/Reach11	155.23	3010.06	-1.85	-1.35	-1.16	-0.56	-0.22	0.13	0.65	1.9
Don_363	Culvert	EastDon/Reach12	161.54	494.83	-7.02	-6.47	-6.22	-5.89	-5.57	-5.27	-3.52	1.53
Don_364	Bridge	EastDon/Reach12	159.84	1697.16	-2.29	-1.81	-1.53	-1.21	-0.92	-0.68	0.42	3.42
Don_365	Culvert	EastDon/Reach12	165.69	2041	-7.09	-6.9	-6.62	-6.28	-5.97	-5.73	-4.34	0.84
Don_366	Bridge	EastDon/Reach13	166.5	154.44	-2.58	-2.25	-2.08	-1.83	-1.58	-1.43	0.5	1.48
Don_367	Culvert	EastDon/Reach13	165.77	336.48	-1.21	-0.83	-0.64	-0.33	0.03	0.23	1.76	3.96
Don_368	Bridge	EastDon/Reach13	184.7	887.97	-17.54	-17.21	-17.05	-16.83	-16.6	-16.41	-15.02	-12.46
Don_369	Culvert	EastDon/Reach13	179.99	1001.51	-12.71	-12.34	-12.15	-11.92	-11.69	-11.5	-10.11	-5.83
Don_370	Bridge	EastDon/Reach13	170.26	1020.74	-2.86	-2.48	-2.28	-2.01	-1.73	-1.48	0.62	4.9
Don_371	Culvert	EastDon/Reach16	186.87	520.57	-6.46	-6.25	-6.15	-6	-5.9	-5.7	0.17	1.02
Don_372	Culvert	EastDon/Reach16	183.89	792.38	-2.81	-2.5	-2.32	-2.06	-1.79	-1.52	3.16	4.03
Don_373	Culvert	EastDon/Reach16	182.42	817.52	-1	-0.7	-0.5	-0.17	0.18	0.36	4.64	5.5
Don_374	Culvert	EastDon/Reach17	194.74	282.77	-8.13	-8.07	-8.03	-7.97	-7.92	-7.86	-6.83	-1.72
Don_375	Bridge	EastDon/Reach17	200.73	838.89	-5.15	-5.05	-4.99	-4.91	-4.83	-4.74	-3.55	-1.89
Don_376	Culvert	EastDon/Reach17	205.9	1251.56	-4.71	-4.64	-4.6	-4.55	-4.49	-4.42	-3.87	-2.84
Don_377	Bridge	EastDon/Reach17	217	2254.27	-7.48	-7.4	-7.35	-7.3	-7.23	-7.16	-6.42	-4.79
Don_378	Culvert	EastDon/Reach17	221.89	3023.05	-6.53	-6.48	-6.45	-6.41	-6.37	-6.32	-4.87	0.51
Don_379	Culvert	EastDon/Reach18	235.8	1907.73	-1.08	-1.04	-1.01	-0.98	-0.93	-0.85	0.12	0.92
Don_380	Culvert	EastDon/Reach18	235.98	1995.13	-0.26	-0.24	-0.23	-0.22	-0.19	-0.12	0.3	0.97

Structure#	Structure Type	HEC-RAS Watercourse Designation	Top of Road/When Weir Flow Begins (m)	HEC-RAS Section Upstream of Structure	Difference between Computed Water Surface Elevation and Top of Road Elevation (m)							
					2- year	5- year	10-year	25-year	50-year	100-year	350-year	Regional
Don_381	Culvert	EastDon/Reach18	249.78	2680.01	-7.24	-7.23	-7.22	-7.21	-7.19	-7.17	-6.86	-3.97
Don_382	Culvert	EastTrib6/1	147.72	64.17	-2.13	-1.37	-0.91	-0.06	0.61	0.8	1.43	2.9
Don_387	Culvert	EastTrib6/A1	173.42	2030.34	-0.56	0.06	0.19	0.27	0.3	0.4	1.4	1.65
Don_388	Culvert	EastTrib6/A1	174.34	2148.81	-0.88	-0.44	-0.19	0.09	0.14	0.19	0.52	0.87
Don_389	Bridge	EastTrib6/A1	174.27	2223.58	-0.27	0.07	0.31	0.34	0.32	0.48	0.93	1.46
Don_390	Culvert	EastTrib6/A1	175.71	2273.48	-1.56	-1.19	-1.05	-0.99	-0.93	-0.85	-0.47	0.07
Don_391	Culvert	EastTrib6/A1	175.36	2289.02	-0.9	-0.35	0.01	0.22	0.28	0.4	0.42	0.63
Don_392	Culvert	EastTrib6/A1	175.45	2326.54	-0.82	-0.27	0.14	0.28	0.34	0.41	0.46	0.62
Don_393	Culvert	EastTrib6/A1	175.22	2343.96	-0.55	0.12	0.41	0.54	0.59	0.65	0.7	0.87
Don_394	Culvert	EastTrib6/A1	175.54	2388.15	-0.65	0.01	0.21	0.28	0.33	0.38	0.49	0.76
Don_395	Culvert	EastTrib6/A1	175.59	2441.07	-0.43	0.18	0.27	0.32	0.36	0.41	0.56	0.86
Don_396	Culvert	EastTrib6/A1	175.79	2486.92	-0.46	0.13	0.22	0.26	0.25	0.19	0.53	0.72
Don_397	Culvert	EastTrib6/A1	175.89	2532.99	-0.35	0.23	0.3	0.37	0.42	0.49	0.61	0.87
Don_398	Culvert	EastTrib6/A2	176.41	25.56	-0.28	0.29	0.23	0.18	0.31	0.34	0.44	0.65
Don_399	Culvert	EastTrib6/A2	178.93	242.79	-1.16	-1.03	-0.89	-0.69	-0.54	-0.35	0.07	0.26
Don_400	Culvert	EastTrib6/A2	179.73	277.2	-1.15	-1.01	-0.85	-0.61	-0.42	-0.2	0.02	0.17
Don_401	Culvert	EastTrib6/A2	180.95	424.11	-0.98	-0.92	-0.78	-0.58	-0.42	-0.24	0.34	0.47
Don_402	Culvert	EastTrib6/A2	182.48	556.17	-0.75	-0.67	-0.61	-0.38	-0.22	0.07	0.18	0.31
Don_403	Culvert	EastTrib6/B	176.44	24.45	-0.17	0.07	0.09	0.1	0.12	0.19	0.35	0.6
Don_405	Culvert	EastTrib6/D	174.34	1951.54	-0.27	-0.08	0.12	0.12	0.17	0.2	0.25	0.5
Don_406	Culvert	EastTrib7/1	156.53	103.76	-2.93	-2.39	-2.14	-1.61	-1.22	-0.79	0.25	1.06
Don_407	Culvert	EastTrib7/1	156.4	184.76	-2.46	-2.03	-1.45	-0.48	0.27	0.46	0.8	1.3
Don_408	Culvert	EastTrib7/A	164.23	43.53	-9.29	-9.21	-9.12	-8.25	-7.53	-7.33	-6.94	-6.38
Don_409	Culvert	EastTrib7/A	161.01	137.76	-0.53	-0.5	-0.49	-0.47	-0.45	-0.43	-0.38	-0.26
Don_410	Culvert	EastTrib7/2	168.35	1064.88	-4.18	-3.91	-3.77	-3.64	-3.54	-3.44	-2.93	-0.85
Don_411	Bridge	EastTrib7/2	172.4	1461.29	-3.42	-3.14	-2.99	-2.85	-2.72	-2.59	-1.99	-1.27
Don_412	Culvert	EastTrib7/2	177.06	1871.95	-3.93	-3.68	-3.56	-3.42	-3.3	-3.18	-2.62	-0.36
Don_413	Culvert	EastTrib7/2	178.43	2032.5	-1.46	-1.2	-0.9	-0.56	-0.2	0.22	0.62	1.02
Don_414	Culvert	EastTrib7/2	179.72	2145.59	-1.37	-0.98	-0.72	-0.45	-0.14	0.18	0.38	1.84
Don_415	Culvert	EastTrib7/2	180.74	2258.32	-1.48	-1.26	-1.16	-1.03	-0.92	-0.32	0.53	0.99
Don_416	Culvert	EastTrib7/2	185.99	2566.93	-2.41	-2.23	-1.91	-1.01	-0.33	-0.33	-0.33	0.22
Don_417	Culvert	EastTrib7/2	187.28	2603.33	-3.45	-3.05	-2.77	-1.64	-0.61	-0.2	-0.01	-0.02
Don_418	Culvert	EastTrib7/2	200.51	2828.2	-15.9	-15.72	-15.64	-14.88	-13.83	-13.4	-13.12	-12.51
Don_419	Culvert	EastTrib7/2	190.98	3036.19	-4.69	-4.54	-4.46	-4.26	-4.06	-3.74	-3.09	-1.71
Don_420	Culvert	EastTrib7/2	191.29	3450.6	-1.09	-0.95	-0.88	-0.61	-0.31	0.05	0.68	0.76
Don_421	Culvert	EastTrib8/A	184.88	171	-7.3	-7.17	-7.01	-6.86	-6.76	-6.68	-6.39	-5.51
Don_422	Culvert	EastTrib8/A	185.2	289.62	-5	-4.9	-4.78	-4.68	-4.56	-4.38	-3.99	-2.82
Don_423	Culvert	EastTrib8/2	197.57	883.66	-7.06	-7.04	-7.01	-6.97	-6.94	-6.92	-6.67	-5.77
Don_424	Culvert	EastTrib10/1	181.89	147.57	-4.22	-3.95	-3.81	-3.43	-3.15	-2.79	-0.34	0.47
Don_425	Culvert	EastTrib10/1	186.31	342.9	-4.41	-4.37	-4.28	-3.85	-3.44	-1.65	0.37	0.54
Don_426	Culvert	PattersonCk/2	190.21	816.32	-3.12	-2.95	-2.86	-2.72	-2.58	-2.45	-1.25	0.81
Don_427	Culvert	PattersonCk/2	196.13	1182.7	-4.57	-4.43	-4.35	-4.26	-4.15	-4.05	-2.67	0.98
Don_428	Culvert	PattersonCk/3	197.53	328.43	-0.36	-0.17	-0.08	0.04	0.1	0.14	0.56	1.65
Don_429	Culvert	PattersonCk/3	205.13	812.74	-3.11	-2.96	-2.89	-2.8	-2.73	-2.65	-1.56	0.81
Don_430	Culvert	PattersonCk/3	208.45	1240.92	-1.7	-1.54	-1.47	-1.38	-1.32	-1.25	0.27	0.2
Don_431	Culvert	PattersonCk/3	211.25	1570.83	-1.53	-1.33	-1.19	-1.01	-0.88	-0.72	0.34	1.18
Don_432	Culvert	PattersonCk/3	216.93	1930.67	-4.15	-4.08	-4.06	-3.84	-3.85	-3.56	-2.56	0.45
Don_433	Culvert	PattersonCk/3	225.57	2692.27	-6.02	-5.88	-5.82	-5.77	-5.62	-5.4	-3.88	0.54
Don_434	Culvert	PattersonCk/3	222.87	2770.5	-1.13	-0.89	-0.81	-0.75	-0.5	-0.22	0.53	3.26
Don_435	Culvert	PattersonCk/3	224.29	2951.69	-1.68	-1.61	-1.6	-1.53	-1.45	-1.33	0.24	1.85
Don_436	Culvert	PattersonCk/3	227.13	3345.44	-1.15	-1.03	-0.97	-0.88	-0.8	-0.7	0.29	0.99
Don_437	Culvert	PattersonCk/3	228.68	3528.92	-1.37	-1.26	-1.2	-1.12	-1.04	-0.84	-0.13	1.57
Don_438	Culvert	PattersonCk/3	233.8	3794.64	-1.79	-1.52	-1.37	-1.17	-0.96	-0.71	0.2	0.71
Don_439	Culvert	PattersonCk/3	239.89	4709.84	-4.17	-4.04	-3.99	-3.9	-3.81	-3.71	-3.25	0.44
Don_440	Culvert	PattersonCk/4	240.59	167.86	-2.04	-1.79	-1.57	-1.3	-1.09	-0.13	0.18	0.82
Don_442	Culvert	PattersonCk/4	248.46	777.72	-4.72	-4.69	-4.66	-4.63	-4.43	-4.28	-3.6	0.42
Don_443	Culvert	PattersonCk/4	252.79	1230.42	-3.19	-3.13	-3.1	-3.02	-2.81	-2.66	-1.91	0.55
Don_444	Culvert	PattersonCk/4	262.37	2034.85	-4.21	-4.15	-4.1	-4.05	-3.9	-3.8	-2.46	0.73
Don_445	Culvert	PattersonCk/4	266.01	2608.87	-1.92	-1.88	-1.87	-1.84	-1.82	-1.8	0.15	0.65
Don_447	Bridge	PattersonCk/T2	199	360.04	-1.54	-1.43	-1.36	-1.28	-1.18	-1.07	-0.82	0.55
Don_448	Culvert	PattersonCk/T2	203.06	800.69	-1.66	-1.55	-1.47	-1.38	-1.26	-1.16	-0.82	0.65
Don_449	Culvert	PattersonCk/T2	207.7	1187.83	-1.64	-1.5	-1.38	-1.22	-1.09	-0.97	-0.69	0.68
Don_450	Culvert	PattersonCk/T2	208.18	1248.17	-1.56	-1.42	-1.35	-1.25	-1.14	-1.04	-0.59	0.79
Don_451	Inline Structure	PattersonCk/T2	213.12	1671.73	-0.21	0.12	0.2	0.3	0.39	0.47	0.72	1.51
Don_452	Culvert	PattersonCk/T2	220.23	2088.06	-5.16	-4.91	-4.76	-4.56	-4.35	-4.11	-2.79	0.77
Don_453	Culvert	PattersonCk/T2	225.84	2774.1	-5.2	-5.07	-5	-4.92	-4.85	-4.79	-4.61	0.36
Don_454	Culvert	PattersonCk/T2	226.53	2862.59	-4.84	-4.7	-4.61	-4.51	-4.41	-4.33	-4.05	0.61
Don_455	Culvert	PattersonCk/T2	229.54	3282.44	-4.6	-4.45	-4.34	-4.15	-4.01	-3.89	-2.66	0.41
Don_456	Culvert	PattersonCk/T2	234.28	4004.54	-2.95	-2.82	-2.75	-2.67	-2.6	-2.55	-1.97	0.35
Don_458	Culvert	PattersonCk/T2	238.7	4185.26	-3.88	-3.62	-3.47	-3.33	-3.21	-2.95	-2.01	0.27
Don_459	Culvert	PattersonCk/T2	253.68	5840.04	-2.45	-2.44	-2.43	-2.41	-2.38	-2.34	-2.08	-0.72
Don_460	Culvert	PattersonCk/T2	263.71	6837.71	-1.86	-1.81	-1.78	-1.73	-1.69	-1.64	0.13	0.45
Don_461	Culvert	PattersonCk/T2	267.21	7019.02	-1.3	-1.25	-1.21	-1.17	-1.14	-1.11	0.08	0.38
Don_462	Culvert	PattersonCk/T3	240.56	159.55	-1.07	-1.01	-0.99	-0.94	-0.87	-0.87	-0.02	0.64
Don_463	Culvert	PattersonCk/T3	247.61	505.93	-1.61	-1.55	-1.48	-1.27	-1.17	-1.09	-0.23	0.3
Don_464	Culvert	PattersonCk/T3	250.34	658.11	-0.35	-0.25	-0.03	0.06	0.1	0.12	0.32	0.57
Don_465	Culvert	PattersonCk/T3	258.33	987.42	-3	-2.97	-2.95	-2.89	-2.85	-2.81	-2.18	-0.26
Don_466	Culvert	PattersonCk/T3	263.82	1707.74	-0.99	-0.92	-0.89	-0.68	-0.51	-0.39	-0.04	-0.02

Structure#	Structure Type	HEC-RAS Watercourse Designation	Top of Road/When Weir Flow Begins (m)	HEC-RAS Section Upstream of Structure	Difference between Computed Water Surface Elevation and Top of Road Elevation (m)							
					2- year	5- year	10-year	25-year	50-year	100-year	350-year	Regional
Don_467	Culvert	CarrvilleCk/1	192.7	422.52	-5.65	-5.47	-5.35	-5.21	-5.1	-5.02	-4.21	-0.02
Don_468	Bridge	CarrvilleCk/1	201.6	902.13	-10.74	-10.62	-10.53	-10.43	-10.36	-10.29	-9.22	-7.36
Don_469	Bridge	CarrvilleCk/2	201.4	150.57	-7	-6.86	-6.77	-6.68	-6.62	-6.55	-6.08	-5.32
Don_471	Culvert	CarrvilleCk/3	217.31	1080.26	-5.6	-5.53	-5.49	-5.46	-5.42	-5.39	-5.18	-4.67
Don_472	Culvert	CarrvilleCk/4	232.82	826.65	-5.43	-5.14	-5.02	-4.8	-4.61	-4.45	0.3	0.3
Don_473	Culvert	CarrvilleCk/4	233.86	1017.12	-3.51	-3.22	-3.07	-2.7	-2.21	-1.73	0.17	0.34
Don_474	Culvert	CarrvilleCk/A2	208.84	663.19	-2.77	-2.73	-2.71	-2.65	-2.63	-2.61	-2	-1.4
Don_477	Culvert	CarrvilleCk/B	205.61	333.28	-3.1	-3.08	-3.05	-3.02	-3.01	-2.99	-2.86	-2.7
Don_478	Culvert	CarrvilleCk/B	229.2	1104.15	-5.85	-5.8	-5.77	-5.5	-5.48	-5.45	-4.5	0.23
Don_479	Culvert	CarrvilleCk/D	222.34	1111.14	-2.28	-2.15	-2.08	-1.98	-1.91	-1.83	-0.41	0.39
Don_480	Culvert	EastTrib11/2	246.57	369.28	-8.24	-8.23	-8.23	-8.21	-8.2	-8.2	-7.92	-7.51
Don_481	Culvert	EastTrib11/2	253.31	848.93	-6.04	-6.03	-6.03	-5.99	-5.98	-5.98	-5.72	-5.4
Don_483	Culvert	FishvilleCreek/3	186.9	796.97	-1.7	-1.53	-1.16	-0.75	-0.33	0.16	0.35	0.77
Don_486	Culvert	FishvilleCreek/3	188.37	1491.21	-1.68	-1.58	-1.41	-1.24	-1.09	-0.98	-0.37	0.55
Don_487	Culvert	FishvilleCreek/3	189.81	1778.92	-1.76	-1.62	-1.43	-1.23	-1.06	-0.94	-0.5	0.48
Don_488	Culvert	FishvilleCreek/3	190	2543.1	-0.83	-0.75	-0.57	-0.31	-0.12	0.09	0.58	1.28
Don_489	Culvert	FishvilleCreek/3	193.76	3174.02	-1.4	-1.33	-1.19	-0.97	-0.79	-0.65	-0.16	0.66
Don_490	Culvert	FishvilleCreek/3	195.05	3612.66	-2.05	-2.01	-1.99	-1.83	-1.68	-1.55	-0.92	0.31
Don_491	Bridge	WestDon/Reach13	181.21	183.42	-1.12	-0.93	-0.82	-0.67	-0.53	0.01	0.68	1.65
Don_493	Bridge	WestDon/Reach13	191	994.66	-9.26	-9.13	-9.05	-8.93	-8.82	-8.69	-7.72	-5.23
Don_494	Bridge	WestDon/Reach13	184.3	1268.67	-2.32	-2.16	-2.06	-1.93	-1.82	-1.69	-0.81	1.76
Don_496	Bridge	WestDon/Reach14	183.4	631.97	-0.05	0.05	0.08	0.08	0.17	0.2	0.6	2.84
Don_497	Bridge	WestDon/Reach14	185.4	761.85	-1.84	-1.69	-1.6	-1.48	-1.34	-1.19	0.18	1.08
Don_498	Bridge	WestDon/Reach14	189.3	1111.2	-4.44	-4.24	-4.12	-4.02	-3.95	-3.88	-3.23	-0.88
Don_499	Bridge	WestDon/Reach14	191.44	1575.58	-5.85	-5.66	-5.53	-5.38	-5.25	-5.13	-4.36	-1.87
Don_500	Bridge	WestDon/Reach15	191.27	546.41	-4.06	-3.87	-3.77	-3.68	-3.59	-3.49	-2.74	-0.41
Don_501	Bridge	WestDon/Reach15	194.39	1832.51	-3.61	-3.48	-3.41	-3.34	-3.26	-3.19	-2.54	0.74
Don_502	Bridge	WestDon/Reach16	192.44	897.4	0.08	0.19	0.23	0.27	0.31	0.33	0.91	3.04
Don_503	Bridge	WestDon/Reach16	202.41	1858.23	-7.59	-7.4	-7.3	-7.21	-7.14	-7.08	-6.34	-2.16
Don_504	Bridge	WestDon/Reach16	199.66	2612.42	-3.25	-3	-2.89	-2.76	-2.65	-2.54	-1.19	1.32
Don_506	Culvert	WestDon/Reach18	212.03	1128.5	-6.48	-6.4	-6.35	-6.31	-6.27	-6.22	-5.28	0.09
Don_507	Culvert	WestDon/Reach18	215.57	2202.38	-2.35	-2.23	-2.15	-2.1	-2.03	-1.9	0.22	1
Don_508	Culvert	WestDon/Reach18	220.12	3283.3	-3.6	-3.33	-3.13	-2.95	-2.69	-1.52	0.49	1.18
Don_509	Inline Structure	WestDon/Reach18	218.8	3299.21	0.54	-1.54	-1.26	-0.97	-0.56	0.61	1.83	2.53
Don_510	Bridge	WestDon/Reach18	219.7	3460.48	-0.36	-1.89	-1.85	-1.83	-1.45	-0.28	0.93	1.65
Don_511	Inline Structure	WestDon/Reach18	218.5	3476.23	0.84	0.59	0.6	0.61	0.62	0.93	2.14	2.88
Don_512	Culvert	WestDon/Reach18	233.25	5570.64	-6.67	-6.58	-6.53	-6.49	-6.39	-6.25	-5.49	-2.5
Don_513	Culvert	WestDon/Reach18	234.6	5941.89	-4.88	-4.8	-4.74	-4.67	-4.54	-4.41	-3.29	0.27
Don_514	Culvert	WestDon/Reach18	231.96	5986.95	-1.28	-1.01	-0.87	-0.68	-0.22	0.26	0.77	2.91
Don_515	Culvert	WestDon/Reach18	238.38	6865.51	-2.06	-1.95	-1.88	-1.78	-1.64	-1.4	0.06	1.19
Don_516	Inline Structure	WestDon/Reach18	237.1	6875.1	0.32	-0.33	-0.06	0.16	0.36	0.66	1.47	2.48
Don_517	Culvert	WestDon/Reach19	243.87	798.7	-3.51	-3.44	-3.39	-3.3	-3.19	-3.01	-2.24	0.47
Don_519	Culvert	WestDon/Reach20	248.3	525.59	-2.15	-2.12	-2.1	-2.07	-1.97	-1.84	-1	0.4
Don_520	Culvert	WestDon/Reach20	272.41	3322.69	-0.59	-0.51	-0.46	-0.39	-0.33	-0.28	0.2	0.41
Don_522	Culvert	WestDon/Reach20	297.19	4880.67	-2.31	-2.26	-2.22	-2.18	-2.15	-2.12	-2.18	0.2
Don_523	Culvert	WestTrib8/1	184.17	70.38	-2.06	-1.87	-1.76	-1.61	-1.47	-1.31	-0.03	1.91
Don_524	Culvert	WestTrib8/1	188.45	243.05	-3.55	-3.52	-3.5	-3.46	-3.29	-3.15	-2.4	0.21
Don_526	Culvert	WestTrib9/1	186.36	126.27	0.2	0.33	0.41	0.51	0.61	0.7	1.1	3.49
Don_527	Culvert	WestTrib9/2	188.05	94.25	-1.43	-1.27	-1.17	-1.04	-0.89	-0.75	0.07	1.9
Don_528	Culvert	WestTrib9/2	192.65	158.71	-5.22	-5.18	-5.15	-5.12	-4.99	-4.82	-3.18	-2.69
Don_529	Culvert	WestTrib9/2	190.91	324.59	-0.6	-0.36	-0.21	0.12	0.28	0.4	0.65	0.92
Don_530	Culvert	WestTrib9/3	194.4	208.28	-1.81	-1.65	-1.56	-1.37	-1.2	-1.05	-0.72	0.55
Don_531	Culvert	WestTrib9/3	194.74	475.57	-1.12	-1.02	-0.93	-0.63	-0.39	-0.15	0.15	1.06
Don_532	Culvert	WestTrib9/3	194.81	522.35	-0.79	-0.62	-0.51	-0.28	-0.03	0.17	0.33	0.99
Don_533	Culvert	WestTrib9/3	194.58	631.71	-0.43	-0.18	-0.02	0.15	0.27	0.45	0.6	1.26
Don_534	Culvert	WestTrib9/3	195.31	747.75	-0.89	-0.68	-0.53	-0.3	-0.12	-0.03	0.11	0.66
Don_535	Culvert	WestTrib9/3	195.3	829.32	-0.74	-0.55	-0.39	-0.1	0.12	0.18	0.25	0.77
Don_536	Culvert	WestTrib9/3	195.87	902.97	-1.11	-0.92	-0.78	-0.47	-0.2	-0.04	-0.03	0.59
Don_537	Culvert	WestTrib9/3	195.91	1000.13	-1.06	-0.88	-0.67	-0.25	0.1	0.23	0.33	0.85
Don_538	Culvert	WestTrib9/3	196.64	1082.25	-0.96	-0.77	-0.65	-0.41	-0.2	-0.12	0	0.6
Don_539	Culvert	WestTrib9/3	196.75	1166.8	-0.76	-0.53	-0.39	-0.05	0.13	0.19	0.29	0.8
Don_540	Culvert	WestTrib9/3	197.29	1240.93	-1.07	-0.66	-0.56	-0.26	-0.03	0.06	0.2	0.44
Don_541	Culvert	WestTrib9/3	198.03	1365.49	-1.01	-0.83	-0.7	-0.33	0.1	0.17	0.24	0.51
Don_542	Culvert	WestTrib9/3	198.61	1490.64	-1.31	-1.17	-1.07	-0.79	-0.41	-0.33	-0.2	0.4
Don_544	Culvert	WestTrib9/A	188.05	63.34	-1.41	-1.24	-1.13	-0.97	-0.8	-0.65	0.65	1.91
Don_545	Culvert	WestTrib9/A	192.65	124.82	-5.2	-5.14	-5.11	-5.06	-5.01	-4.96	-3.87	-2.54
Don_546	Culvert	WestTrib9/A	190.61	203.22	-1.53	-1.3	-1.14	-0.93	-0.65	-0.3	0.15	0.38
Don_547	Culvert	WestTrib9/A	193.21	315.7	-2.48	-2.37	-2.28	-2.01	-1.57	-1.25	0.37	0.89
Don_548	Culvert	WestTrib9/A	200.7	992.65	-2.9	-2.78	-2.69	-2.58	-2.36	-2.11	-0.07	0.7
Don_549	Culvert	WestTrib9/A	200.93	1111.01	-1.91	-1.67	-1.5	-1.25	-0.67	0.01	0.02	0.51
Don_555	Culvert	WestTrib9/B	192.6	161.83	-0.87	-0.8	-0.74	-0.64	-0.52	-0.4	-0.24	0.71
Don_556	Culvert	WestTrib9/B	198	541.29	0.04	0.08	0.1	0.13	0.15	0.19	0.25	0.38
Don_559	Culvert	WestTrib10/1C	202.32	1518.75	-2.84	-2.81	-2.79	-2.76	-2.65	-2.57	-1.25	0.74
Don_560	Culvert	WestTrib10/1C	204.61	1828.51	-4.17	-4.09	-4.04	-3.97	-3.86	-3.77	-2.33	0.35
Don_562	Culvert	WestTrib10/1C	207.53	2347.42	-0.72	-0.34	-0.12	0.07	0.16	0.22	0.81	1.5
Don_563	Culvert	WestTrib10/1C	209.94	2453.12	-3.11	-2.74	-2.52	-2.33	-2.24	-2.17	-1.45	0.35
Don_564	Inline Structure	WestTrib10/1C	208.75	2719.95	0.52	0.64	0.72	0.74	0.74	0.73	0.67	1.58
Don_565	Culvert	WestTrib10/1C	215.9	3660.6	-1.33	-1.29	-1.27	-1.24	-1.22	-1.18	-0.85	0.01

Structure#	Structure Type	HEC-RAS Watercourse Designation	Top of Road/When Weir Flow Begins (m)	HEC-RAS Section Upstream of Structure	Difference between Computed Water Surface Elevation and Top of Road Elevation (m)							
					2- year	5- year	10-year	25-year	50-year	100-year	350-year	Regional
Don_567	Culvert	WestTrib10/1	218.47	4211.82	-1.26	-1.2	-1.15	-1.11	-1.07	-0.96	-0.75	-0.06
Don_568	Culvert	WestTrib10/1	218.9	4267.58	-1.64	-1.56	-1.51	-1.45	-1.39	-1.25	-0.98	0.02
Don_569	Culvert	WestTrib10/1	218.97	4329.13	-1.71	-1.61	-1.55	-1.48	-1.42	-1.26	-0.96	0.33
Don_570	Culvert	WestTrib10/1	219.72	4422.13	-1.44	-1.34	-1.28	-1.21	-1.15	-0.99	-0.67	0.23
Don_571	Culvert	WestTrib10/1	221.02	4546.89	-2.61	-2.5	-2.43	-2.35	-2.27	-2.07	-1.56	0.13
Don_572	Culvert	WestTrib11/1	201.59	290.84	-3.66	-3.44	-3.31	-3.15	-3	-2.85	-2.19	0.64
Don_573	Culvert	WestTrib11/1	208.69	1389.75	-4.75	-4.54	-4.43	-4.31	-4.15	-3.96	0.11	0.43
Don_574	Culvert	WestTrib11/1	207.11	1545.41	-2.6	-2.32	-2.15	-1.95	-1.66	-1.19	1.69	2.02
Don_575	Culvert	WestTrib11/1	209.87	1904.21	-4.81	-4.6	-4.47	-4.3	-4.06	-3.65	0.21	1.13
Don_576	Bridge	WestTrib11/1	211.59	2302.37	-5.22	-5.09	-5.02	-4.92	-4.77	-4.66	-1.49	-0.28
Don_577	Culvert	WestTrib11/2	211.77	102	-3.74	-3.59	-3.51	-3.44	-3.35	-3.25	-1.49	0.66
Don_578	Culvert	WestTrib11/2	211.47	494.26	-2.04	-2	-1.96	-1.92	-1.8	-1.67	-0.88	1.41
Don_579	Culvert	WestTrib11/2	214.41	571.23	-4.31	-4.24	-4.2	-4.15	-3.98	-3.72	-1.64	0.86
Don_580	Culvert	WestTrib11/2	217.16	1159.66	-4.55	-4.5	-4.48	-4.39	-4.25	-4.13	-3.41	-1.62
Don_581	Culvert	WestTrib11/3	215.06	60.7	-1.68	-1.62	-1.58	-0.56	0.18	0.32	0.8	1.46
Don_583	Culvert	WestTrib11/3	221.9	999.23	-6.49	-6.45	-6.44	-6.41	-6.33	-6.12	-5.14	-0.39
Don_584	Culvert	WestTrib11/3	220.6	1422.96	-3.69	-3.67	-3.66	-3.64	-3.63	-3.6	-3.33	0.95
Don_587	Culvert	WestTrib11/A1	211.77	61	-3.71	-3.65	-3.61	-3.57	-3.52	-3.45	-1.78	0.67
Don_588	Culvert	WestTrib11/A1	215.2	560.03	-1.46	-1.36	-1.3	-1.22	-0.91	-0.77	0.3	0.58
Don_589	Culvert	WestTrib11/A2	221.97	522.11	-4.14	-4.03	-3.97	-3.89	-3.79	-3.67	-3.36	-1.79
Don_590	Culvert	WestTrib11/B	218.01	97.85	-3.42	-3.28	-3.2	-3.1	-3	-2.84	-1.75	0.73
Don_591	Culvert	WestTrib11/B	219.17	368.65	0.11	0.13	0.14	0.16	0.17	0.19	0.24	0.41
Don_592	Culvert	WestTrib11/C	220.57	418.32	-2.57	-2.56	-2.55	-2.55	-2.54	-2.53	-2.22	-0.58
Don_593	Inline Structure	WestTrib11/C	219.03	427.25	-0.64	-0.56	-0.5	-0.44	-0.37	-0.27	0.22	1.04
Don_594	Bridge	WestTrib11/C	220.09	782.11	-1.61	-1.52	-1.45	-1.37	-1.29	-1.18	-0.61	0.78
Don_595	Bridge	WestTrib11/C	221.45	1059.83	-1.28	-1.25	-1.23	-1.21	-1.18	-1.14	-0.21	0.5
Don_596	Bridge	WestTrib11/C	222.6	1135.24	-1.57	-1.54	-1.52	-1.5	-1.48	-1.45	-0.57	0.26
Don_597	Bridge	WestTrib11/C	223.08	1180.51	-0.63	-0.6	-0.58	-0.56	-0.54	-0.52	0.23	0.87
Don_598	Inline Structure	WestTrib11/C	223.58	1227.37	-1.12	-1.1	-1.08	-1.07	-1.05	-1.03	-0.01	0.89
Don_599	Culvert	WestTrib11/C	223.01	1307.39	-0.3	-0.22	-0.17	-0.1	-0.02	0.06	1.11	2.92
Don_600	Bridge	WestTrib11/C	224.91	1515.24	-1.53	-1.5	-1.47	-1.44	-1.41	-1.37	-0.35	1.08
Don_601	Culvert	WestTrib11/C	224.65	1535.14	-1.13	-1.11	-1.1	-1.08	-1.06	-1.04	-0.07	1.35
Don_602	Culvert	WestTrib11/C	230.18	1772.74	-5.21	-5.17	-5.14	-5.11	-5.08	-5.04	-4.04	-3.06
Don_603	Culvert	WestTrib11/C	228.08	1893.86	-2.01	-1.97	-1.96	-1.93	-1.91	-1.88	-1.17	-0.58
Don_604	Culvert	WestTrib11/C	230.4	2157.2	-2.65	-2.63	-2.61	-2.6	-2.58	-2.56	-2.03	-0.74
Don_605	Culvert	WestTrib12/2	206.65	491.99	-3.49	-3.36	-3.27	-3.15	-2.92	-2.68	-1.92	0.68
Don_607	Culvert	WestTrib12/2	218.23	1981.46	-2.31	-2.18	-2.12	-2.04	-1.87	-1.69	-1.29	0.66
Don_608	Culvert	WestTrib12/2	219	2091.75	-2.08	-1.86	-1.73	-1.47	-1.17	-0.74	0.18	0.75
Don_610	Culvert	WestTrib12/2	222.6	2707.62	-2.38	-2.3	-2.24	-2.18	-2.27	-2.18	-1.7	0.54
Don_611	Culvert	WestTrib12/2	225.65	3242.36	-2.23	-2.06	-1.95	-1.84	-1.57	-1.05	0.13	0.66
Don_612	Culvert	WestTrib12/2	227.55	3701.37	-1.87	-1.76	-1.69	-1.61	-1.44	-1.28	-0.6	0.67
Don_614	Culvert	WestTrib12/2	229.77	4043.48	-0.27	0	0.11	0.16	0.2	0.25	0.36	0.65
Don_616	Culvert	WestTrib12/3	230.35	93.11	-0.71	-0.4	-0.28	-0.17	-0.05	0.1	0.2	0.34
Don_617	Culvert	WestTrib12/3	230.88	207.96	-0.53	-0.45	-0.4	-0.35	-0.29	-0.15	0.12	0.17
Don_618	Culvert	WestTrib13/1	243.13	483.82	-3.44	-3.42	-3.4	-3.39	-3.37	-3.33	-2.89	-2.05
Don_619	Culvert	WestTrib14/1	248.29	516.73	-2.71	-2.69	-2.66	-2.61	-2.52	-2.44	-1.92	0.12
Don_620	Culvert	WestTrib14/1	251.47	946.95	-2.75	-2.71	-2.67	-2.59	-2.48	-2.29	-2.07	-0.4
Don_621	Culvert	WestTrib14/1	284.2	3197.43	-5.67	-5.58	-5.55	-5.52	-5.46	-5.4	0.22	0.58
Don_622	Culvert	WestTrib14/1	289.93	3646.3	-4.29	-4.24	-4.2	-4.16	-4.12	-4.05	-1.84	0.18
Don_624	Culvert	EastTrib6/C1	176.21	27.01	-0.25	-0.17	-0.1	0.03	0.03	0.05	0.07	0.18
Don_625	Culvert	EastTrib6/C2	176.39	29.27	-0.14	0.07	0.11	0.15	0.16	0.19	0.21	0.34
Don_626	Culvert	EastTrib6/C2	176.59	46.87	-0.16	0.13	0.17	0.2	0.23	0.25	0.28	0.41
Don_627	Culvert	EastTrib6/C2	177.04	92.71	-0.26	0.06	0.13	0.18	0.21	0.23	0.28	0.42
Don_628	Culvert	EastTrib6/C2	177.8	124.26	-0.46	-0.13	0.09	0.14	0.17	0.21	0.27	0.44
Don_629	Culvert	EastTrib6/C2	177.71	135.57	-0.23	0.11	0.2	0.24	0.27	0.31	0.37	0.53
Don_630	Culvert	EastTrib6/C2	178.15	172.55	-0.23	0.03	0.1	0.15	0.18	0.2	0.22	0.33
Don_631	Culvert	EastTrib6/C2	178.87	200.05	-0.52	-0.26	-0.02	0.17	0.26	0.29	0.35	0.47
Don_632	Culvert	EastTrib6/C2	179.29	217.67	-0.57	-0.3	0.06	0.2	0.28	0.33	0.4	0.56
Don_633	Culvert	EastTrib6/C2	180.25	256.91	-0.75	-0.48	-0.27	0.04	0.1	0.14	0.18	0.29
Don_634	Culvert	EastTrib6/C2	183.91	570.3	-1.45	-1.25	-1.1	-0.92	-0.76	-0.69	-0.62	-0.4
Don_635	Culvert	EastTrib6/C2	183.64	594.46	-1	-0.81	-0.64	-0.43	-0.21	-0.05	0.05	0.25
Don_636	Culvert	EastTrib6/C2	183.8	646.1	-0.5	-0.26	-0.05	0.11	0.13	0.17	0.22	0.35
Don_637	Culvert	EastTrib6/C2	184.63	664.49	-1.19	-0.87	-0.45	0.06	0.15	0.19	0.24	0.38
Don_638	Culvert	EastTrib6/C2	183.61	674.48	-0.09	0.17	0.57	1.08	1.17	1.21	1.26	1.41
Don_639	Culvert	EastTrib6/C2	183.47	704.13	0.15	0.31	0.72	1.22	1.31	1.35	1.41	1.56
Don_640	Culvert	EastTrib6/C2	183.72	722.8	0.13	0.18	0.47	0.97	1.07	1.1	1.16	1.31
Don_641	Culvert	EastTrib6/C2	183.90	736.88	0.06	0.11	0.30	0.79	0.89	0.93	0.98	1.13
Don_642	Culvert	EastTrib6/C2	183.98	753.09	0.13	0.16	0.23	0.71	0.81	0.85	0.9	1.05
Don_643	Culvert	EastTrib6/C2	184.05	766.29	0.14	0.19	0.24	0.64	0.74	0.78	0.83	0.99
Don_644	Culvert	EastTrib6/C2	184.38	785.13	0.04	0.06	0.12	0.32	0.41	0.45	0.5	0.66
Don_645	Culvert	EastTrib6/C2	184.75	796.45	0.11	0.14	0.19	0.22	0.25	0.28	0.3	0.45
Don_646	Culvert	EastTrib6/C2	185.31	838.52	0.1	0.14	0.16	0.19	0.23	0.23	0.26	0.38

10.3 Identification of Spills and Spill Paths

The Technical Guide, River & Stream Systems: Flooding Hazard Limit (MNR 2002; refer to Section 4.13 of the guidelines) defines a spill as occurring when flood levels overtop the banks of a watercourse and spill overland away from the watercourse channel. Frequently, this spill will move into another watershed or join the originating watercourse at a distance downstream. Further, the guidelines describe that:

The effect of spills moving into another watershed should be assessed to determine the potential flood risks. Alternative measures should be investigated to prevent the spill moving into the adjacent watershed. If the amount of spill is relatively small, less than 10% of the peak flow, the flood plain mapping for the watercourse should be based on the original flow, without any deduction for the spill. For larger spills, allowance for the reduced flow should only be made where the review of alternatives proves that the spill cannot be prevented, either because there are no feasible alternatives or the costs,

when compared to the potential benefits, are too high. Where the spill re-joins the watercourse further downstream, the route of the spill should be examined to determine the potential harmful effects of overland flow. No reduction should be made for the spill in the downstream flood plain computations.

Upon completion of the model simulation and flood mapping generation, 32 spill areas were identified under the Regional event within the project study limits. The potential spill path for each spill was estimated based on the available topographic information. Below describes each spill area in detail.

10.3.1.1 Spill Area #1 - Kersey Crescent at Structure DON_430

Spill Area #1 is located on the south side of Kersey Crescent near crossings DON_430 (Kersey Crescent) on watercourse Patterson Creek Reach 3 in Richmond Hill. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1240.92 and 1216.68 (**Figure 10-1**).

Spill waters from the area would be expected to flow south along Kersey Crescent. The available topographic information also suggests the possibility that spill waters may flow into the residential area south of the intersection of Kersey Crescent and Yongehurst Road (**Figure 10-2**).

Figure 10-1: Spill Area #1 – Kersey Crescent: Local Context

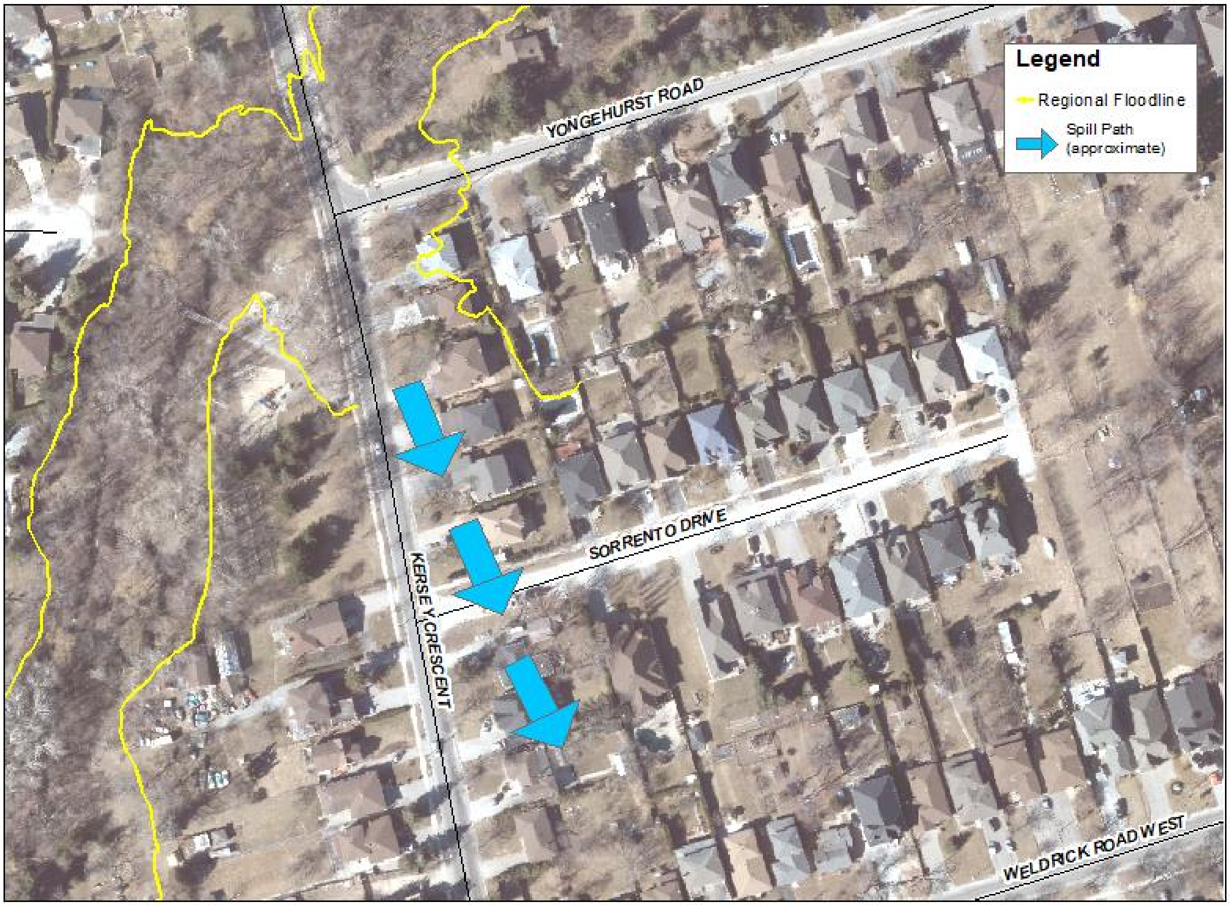


Figure 10-2: Spill Area #1 – Kersey Crescent: Possible Spill Pathways

The following metrics are available:

- The grades along Kersey Crescent generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill is 207.7 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 207.93 m and 208.65 m, respectively, a difference of 0.72 m (about 2.36 feet)
- The width of the spill zone, as depicted, is less than 50 m for the Regulatory Flood
- The grades along the Kersey Crescent spill path are approximately 0.95%
- The Regulatory Flood flow at this location is 105.84 m^3/s.

10.3.1.2 Spill Area #2 – May Avenue at Structure DON_431

Spill Area #2 is located on the east side of May Avenue near crossings DON_431 (May Avenue) on watercourse Patterson Creek Reach 3 in Richmond Hill. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1570.83 and 1545.87 (**Figure 10-3**).

Spill waters from the area would be expected to flow east along May Avenue. The available topographic information also suggests the possibility that spill waters may flow into the residential area along May Avenue (**Figure 10-4**).

Figure 10-3: Spill Area #2 – May Avenue: Local Context

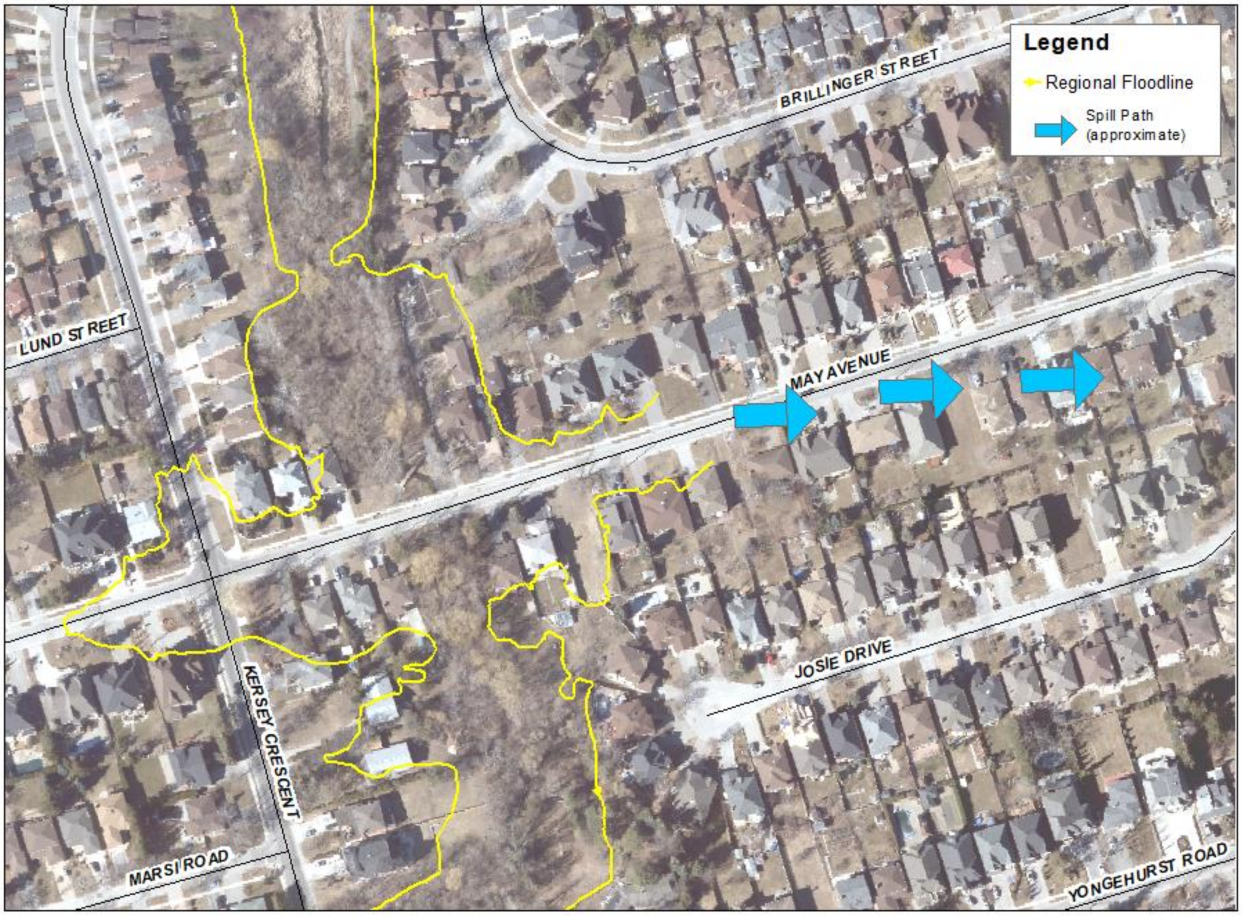


Figure 10-4: Spill Area #2 – May Avenue: Possible Spill Pathways

The following metrics are available:

- The grades along May Avenue generally fall to the east. The ground elevations associated with these features, generally in the area of potential spill, is 211.7 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 212.12 m and 212.39 m, respectively, a difference of 0.27 m (about 0.89 feet)
- The width of the spill zone, as depicted, is less than 25 m for the Regulatory Flood
- The grades along the May Avenue spill path are approximately 0.97%
- The Regulatory Flood flow at this location is 105.19 m^3/s

10.3.1.3 Spill Area #3 – Residential Area North of Structure DON_399

Spill Area #3 is located on the north side of Calvin Chambers Road near crossings DON_399 (Calvin Chambers Road) on watercourse East Tributary 6 Reach A2 in Richmond Hill. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 277.2 and 262.18 (**Figure 10-5**).

Spill waters from the area would be expected to flow east to the Residential Areas. The available topographic information also suggests the possibility that spill waters may flow along residential areas about 125 m and discharge into the East Tributary 6, Reach C2 near HEC-RAS cross-section 109.59. (**Figure 10-6**). The available topographic information also suggests the possibility that spill waters may flow into the residential area east of Clarkehaven Street.

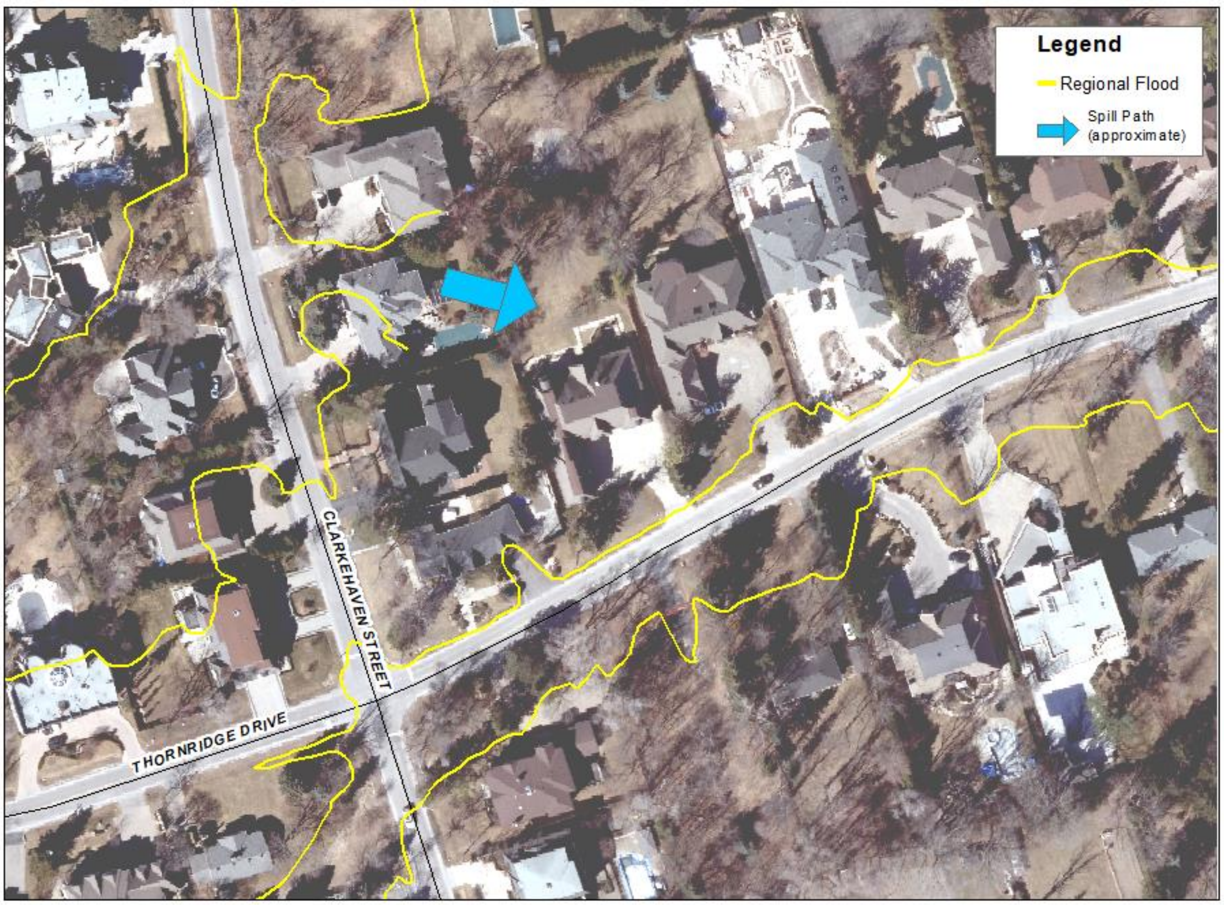


Figure 10-5: Spill Area #3 – Residential Area: Local Context

Figure 10-6: Spill Area #3 – Residential Areas: Possible Spill Pathways

The following metrics are available:

- The grades along Residential Areas generally fall to the east. The ground elevations associated with these features, generally in the area of potential spill is 179.90 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 272.20 m and 262.18 m, respectively, a difference of 0.7 m (about 2.3 feet)
- The width of the spill zone, as depicted, is less than 33 m in the east side for the Regulatory Flood
- The grades along the Residential Areas on east side spill path are approximately 2.3%
- The Regulatory Flood flow at this location is 8.27 m^3/s

10.3.1.4 Spill Area #4 – Bathurst Street at Structure DON_458

Spill Area #4 is located on the south side of Bathurst Street near crossings DON_458 (Bathurst Street) on watercourse Patterson Creek Reach T2 in Richmond Hill. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 4185.26 and 4133.19 (**Figure 10-7**).

Spill waters from the area would be expected to flow south along Bathurst Street. The available topographic information also suggests the possibility that spill waters may flow into the residential area south of the intersection of Bathurst Street and Mill Street (**Figure 10-8**).

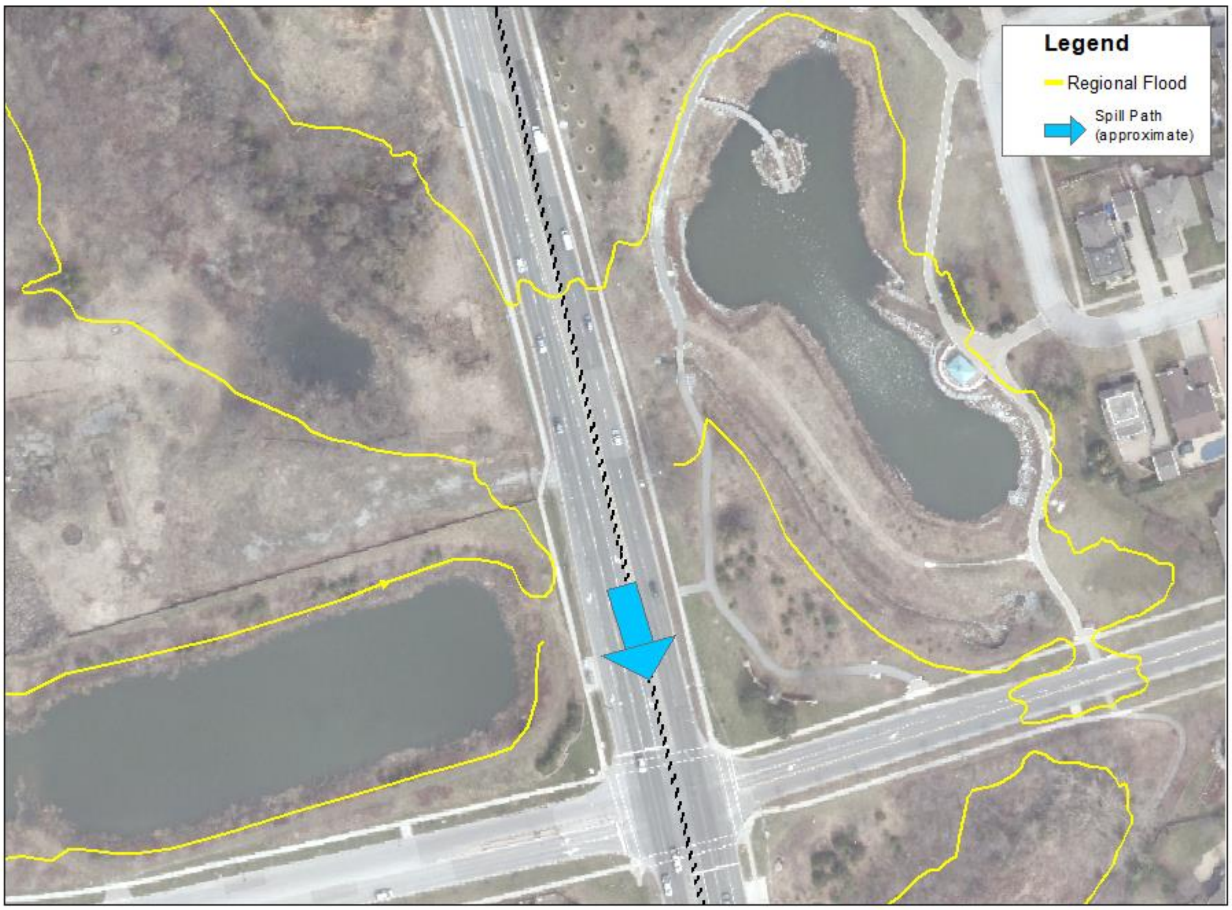


Figure 10-7: Spill Area #4 – Bathurst Street: Local Context

Figure 10-8: Spill Area #4 – Bathurst Street: Possible Spill Pathways

The following metrics are available:

- The grades along Bathurst Street generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 238.20 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 239.28 m and 235.99 m, respectively, a difference of 3.29 m (about 10.8 feet)
- The width of the spill zone, as depicted, is less than 20 m in both the east side and west side for the Regulatory Flood
- The grades along the Bathurst Street spill path are approximately 1.89%
- The Regulatory Flood flow at this location is 33.27 m^3/s

10.3.1.5 Spill Area #5 – Draper Boulevard at Structure DON_488

Spill Area #5 is located on the west side of Draper Boulevard at crossings DON_488 (Draper Boulevard) on watercourse Fishersville Creek Reach 3 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 2543.1 and 2482.96 (**Figure 10-9**).

Spill waters from the area would be expected to flow west along Glen Shields Avenue. The available topographic information also suggests the possibility that spill waters may flow into the residential area west of the intersection of Dufferin Street and Glen Shields Avenue (**Figure 10-10**).

Figure 10-9: Spill Area #5 – Draper Boulevard: Local Context

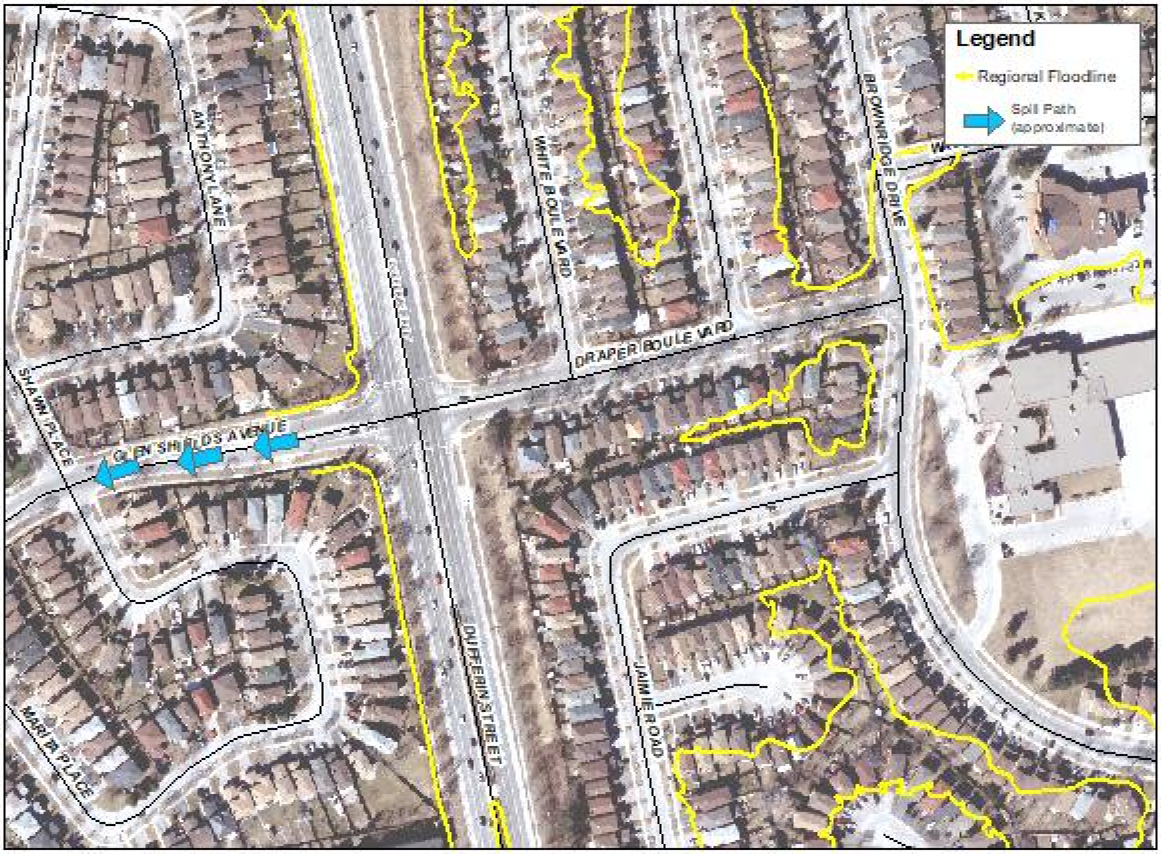


Figure 10-10: Spill Area #5 – Draper Boulevard: Possible Spill Pathways

The following metrics are available:

- The grades along Glen Shields Ave. generally fall to the west. The ground elevations associated with these features, generally in the area of potential spill, is 190.57 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 191.22 m and 191.17 m, respectively, a difference of 0.05 m (about 0.16 feet)
- The width of the spill zone, as depicted, is less than 35 m for the Regulatory Flood
- The grades along the Draper Boulevard spill path on the west are approximately 0.16%
- The Regulatory Flood flow at this location is 34.96 m^3/s.

10.3.1.6 Spill Area #6 – Centre Street at Structure DON_498

Spill Area #6 is located on the west side of Centre Street at crossings DON_489 (Centre Street) on watercourse Fisherville Creek Reach 3 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 3174.02 and 314.49 (**Figure 10-11**).

Spill waters from the area would be expected to flow west along Centre Street. The available topographic information also suggests the possibility that spill waters may flow into the residential area west of the intersection of Dufferin Street and Draper Boulevard, and the commercial area east of the intersection of Dufferin Street and Centre Street (**Figure 10-12**).

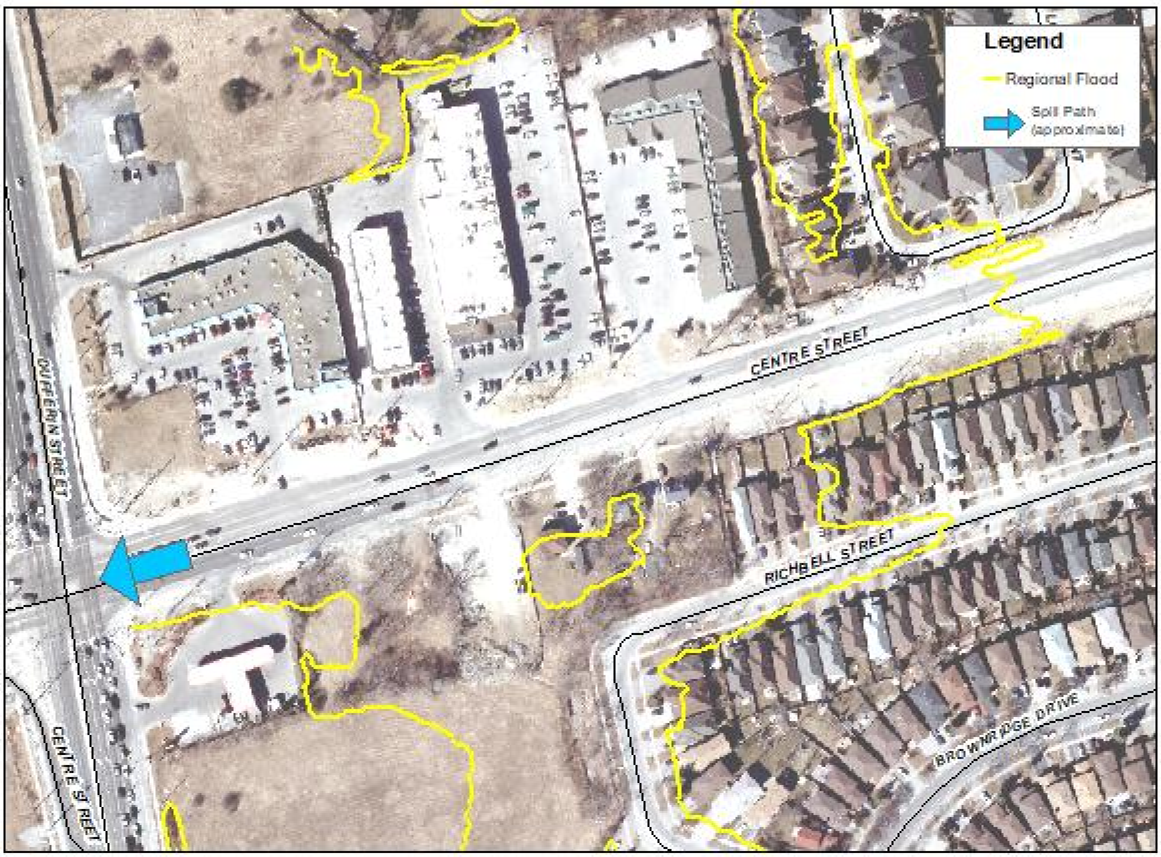


Figure 10-11: Spill Area #6 – Centre Street: Local Context

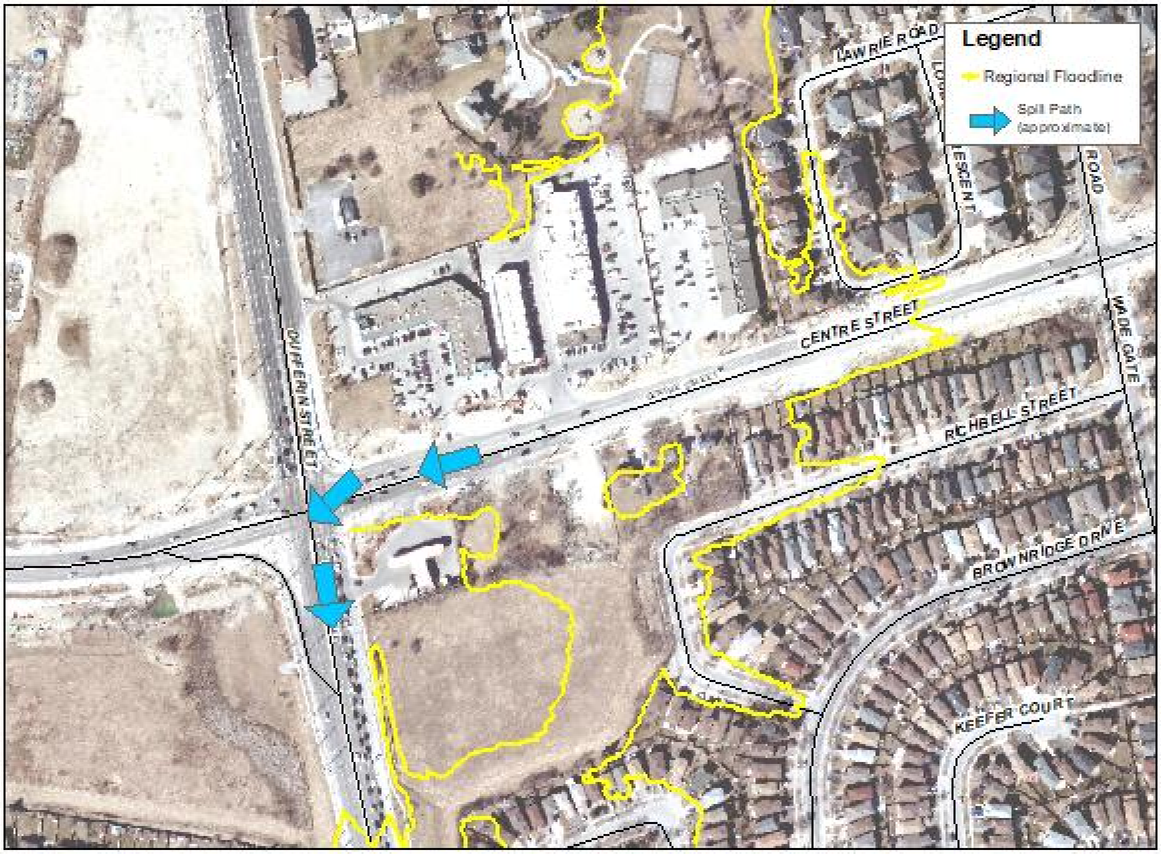


Figure 10-12: Spill Area #6 – Centre Street: Possible Spill Pathways

The following metrics are available:

- The grades along Centre Street generally fall to the east. The ground elevations associated with these features, generally in the area of potential spill, is 193.40 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 194.35 m and 194.38 m, respectively, a difference of 0.03 m (about 0.1 feet)
- The width of the spill zone, as depicted, is less than 111 m on the west side and 30 m on east side for the Regulatory Flood
- The grades along the Centre Street spill path are approximately 0.48%
- The Regulatory Flood flow at this location is 33.98 m^3/s

10.3.1.7 Spill Area #7 – Railway (Metrolinx) at Structure DON_567

Spill Area #7 is located on the west side of the Railway (Metrolinx) at crossings DON_567 (Railway) on watercourse West Don River Tributary 10 Reach 1 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 4211.82 and 4188.81 (**Figure 10-13**).

Spill waters from the area would be expected to flow west of the Railway (Metrolinx). The available topographic information also suggests the possibility that spill waters may flow into the commercial area west of the Railway (Metrolinx) (**Figure 10-14**).

Figure 10-13: Spill Area #7 – Railway (Metrolinx): Local Context

Figure 10-14: Spill Area #7 – Railway (Metrolinx): Possible Spill Pathways

The following metrics are available:

- The grades near the Railway (Metrolinx) generally fall to the west. The ground elevations associated with these features, generally in the area of potential spill, is 217.75 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 219.03 m and 218.14 m, respectively, a difference of 0.89 m (about 2.9 feet)
- The width of the spill zone, as depicted, is less than 67 m for the Regulatory Flood
- The grades along the Railway spill path are approximately 0.80%
- The Regulatory Flood flow at this location is 33.53 m^3/s

10.3.1.8 Spill Area #8 – Rutherford Go Station at Structure DON_569 and DON_570

Spill Area #8 is located on the west side of the Local Driveways at crossings DON_568 (Driveway) and DON_570 (Driveway) on watercourse West Don River Tributary 10 Reach 1 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 4427.56 and 4406.63 (**Figure 10-15**).

Spill waters from the area would be expected to flow west of the Local Driveways. The available topographic information also suggests the possibility that spill waters may flow into the commercial area southwest of the Local Driveways (**Figure 10-16**).

Figure 10-15: Spill Area #8 – Rutherford Go Station: Local Context

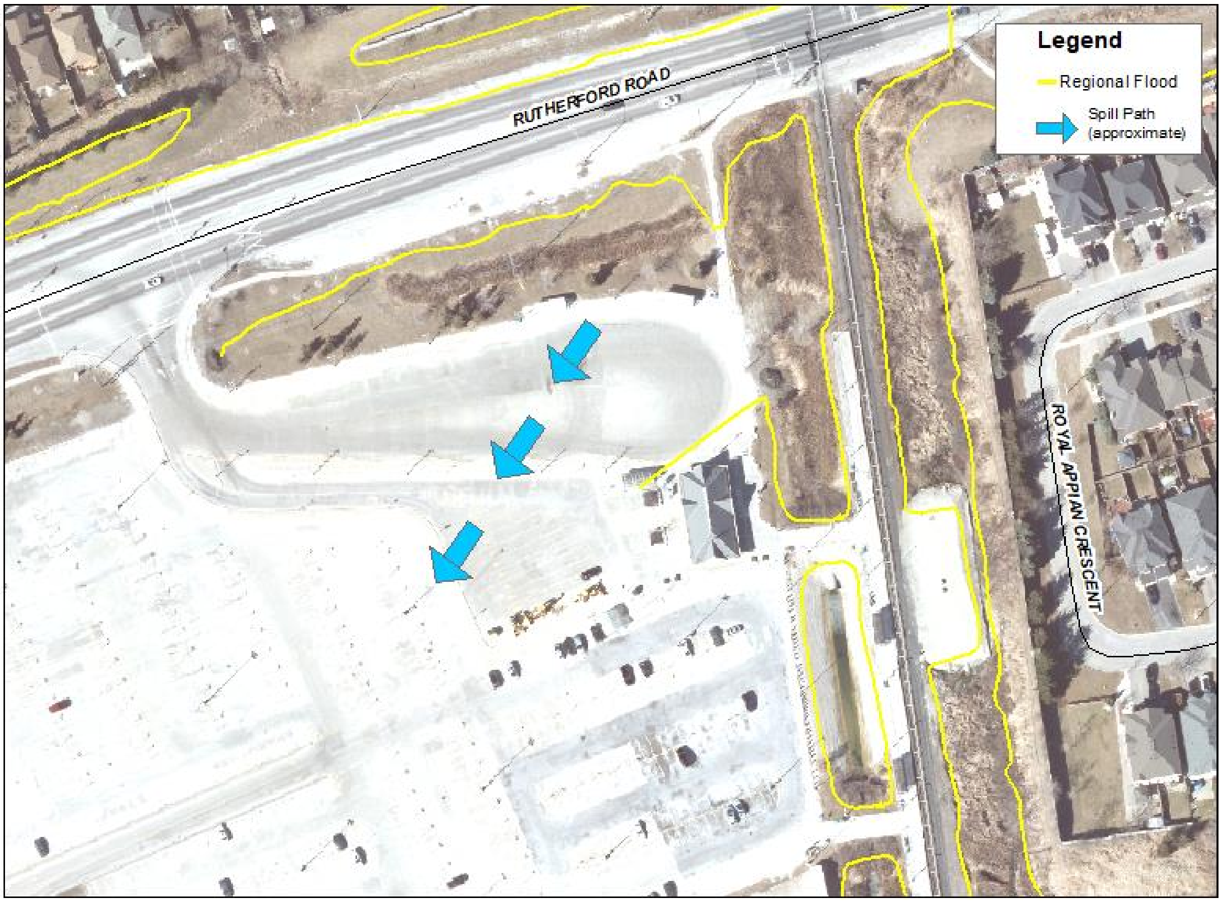


Figure 10-16: Spill Area #8 – Rutherford Go Station: Possible Spill Pathways

The following metrics are available:

- The grades near the Local Driveways generally fall to the west. The ground elevations associated with these features, generally in the area of potential spill, is 219.50 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 220.10 m and 219.97 m, respectively, a difference of 0.13 m (about 0.43 feet)
- The width of the spill zone, as depicted, is less than 100 m for the Regulatory Flood
- The grades along the west side of the Local Driveways spill path are approximately 0.34%
- The Regulatory Flood flow at this location is 6.12 m^3/s

10.3.1.9 Spill Area #9 – Railways at Structure DON_573 and DON_574

Spill Area #9 is located on the west side of Railways at crossings DON_573 (Railway) and DON_574 (Railway) on watercourse West Don River Tributary 11 Reach 1 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1545.41 and 1389.75 (**Figure 10-17**).

Spill waters from the area would be expected to flow west of the Railways. The available topographic information also suggests the possibility that spill waters may flow into the commercial area west of the Railways (**Figure 10-18**).

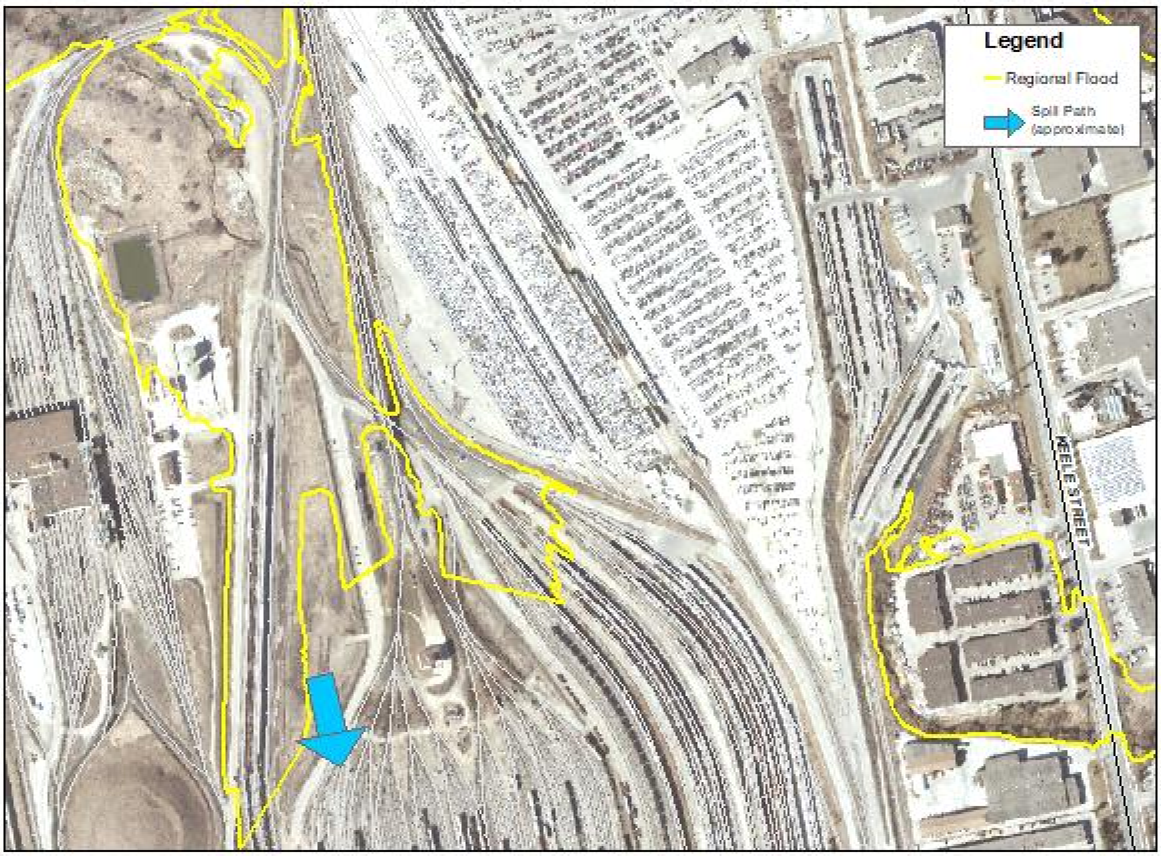


Figure 10-17: Spill Area #9 – Railways: Local Context

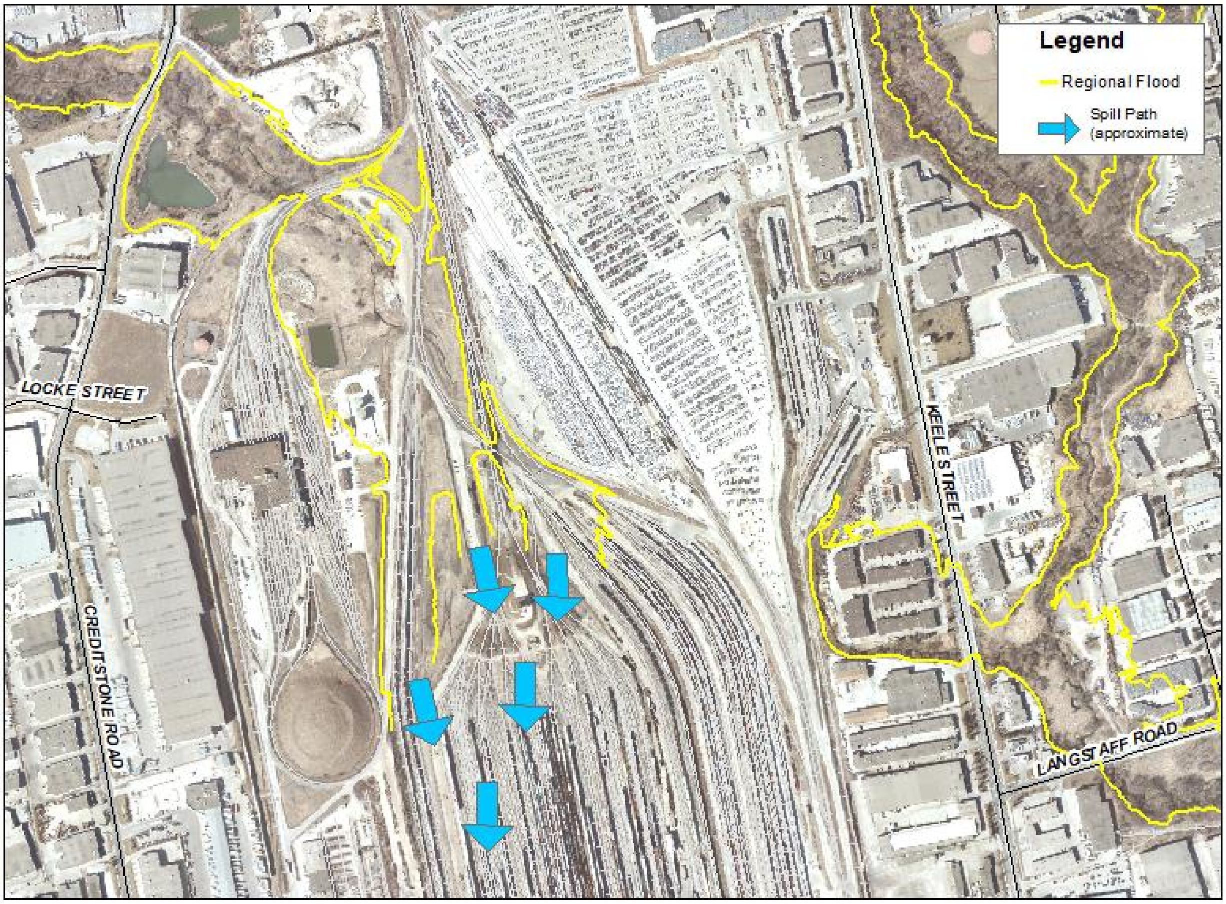


Figure 10-18: Spill Area #9 – Railways: Possible Spill Pathways

The following metrics are available:

- The grades along the Railways generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 207.10 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 209.25 m and 208.19 m, respectively, a difference of 1.06 m (about 3.5 feet)
- The width of the spill zone, as depicted, is less than 264 m for the Regulatory Flood
- The grades along the Railways spill path is approximately 0.3%
- The Regulatory Flood flow at this location is 131.95 m^3/s

10.3.1.10 Spill Area #10 – Charles Street at Structure DON_634

Spill Area #10 is located on the north side of Charles Street at crossing DON_634 (Charles Street) on watercourse East Don River Tributary 6 Reach C2 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 570.3 and 544.99 (**Figure 10-19**).

Spill waters from the area would be expected to flow north of Charles Street. The available topographic information also suggests the possibility that spill waters may flow along Charles Street about 82 m and discharge to East Tributary 6 Reach A2 near HEC-RAS section 538.47 (**Figure 10-20**). The available topographic information also suggests the possibility that spill waters may flow into the residential area north of Charles Street.

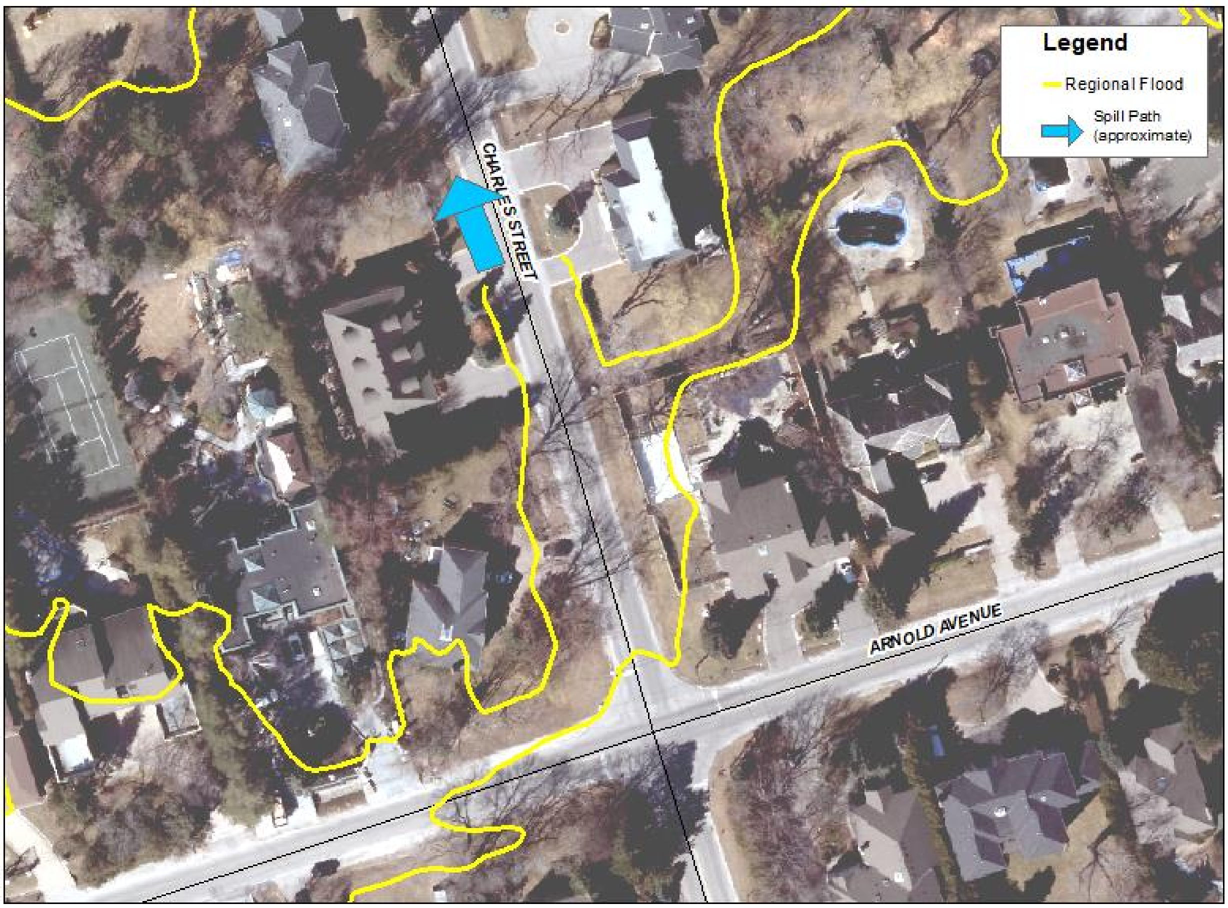


Figure 10-19: Spill Area #10 – Charles Street: Local Context

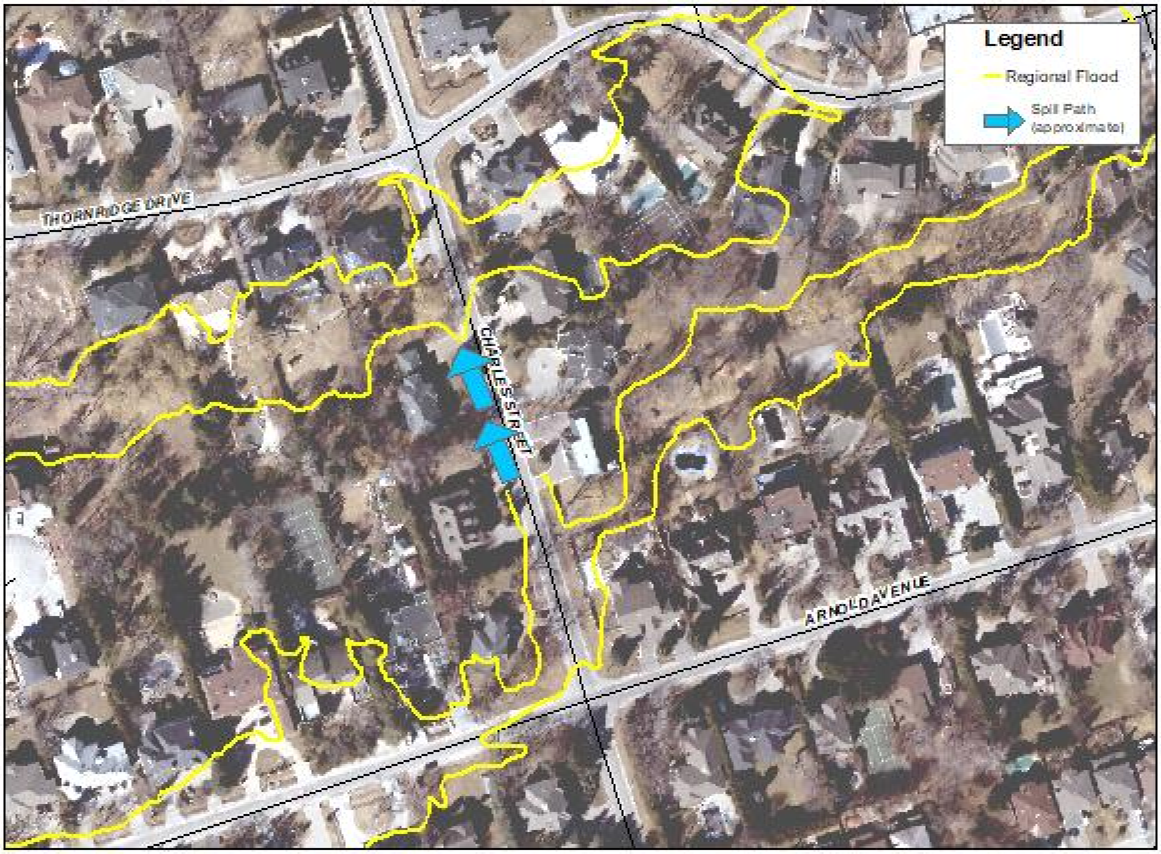


Figure 10-20: Spill Area #10 – Charles Street: Possible Spill Pathways

The following metrics are available:

- The grades along Charles Street generally fall to the north. The ground elevations associated with these features, generally in the area of potential spill, is 182.7 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 184.02 m and 183.17 m, respectively, a difference of 0.85 m (about 2.8 feet)
- The width of the spill zone, as depicted, is less than 16 m for the Regulatory Flood
- The grades along the Charles Street spill path are approximately 0.69%
- The Regulatory Flood flow at this location is 6.65 m^3/s

10.3.1.11 Spill Area #11 – Major Mackenzie Drive West at Structure DON_472

Spill Area #11 is located on the north side of Major Mackenzie Drive West at crossing DON_472 (Major Mackenzie Drive West) on watercourse Carrville Creek Reach 4 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 826.65 and 758.41 (**Figure 10-21**).

Spill waters from the area would be expected to flow east toward Sir Benson Drive. The available topographic information also suggests the possibility that spill waters may flow along Major Mackenzie Drive West about 140 m and discharge to same tributary near HEC-RAS section 603.61 (**Figure 10-22**). The available topographic information also suggests the possibility that spill waters may flow into the commercial area north of Major Mackenzie Drive West.

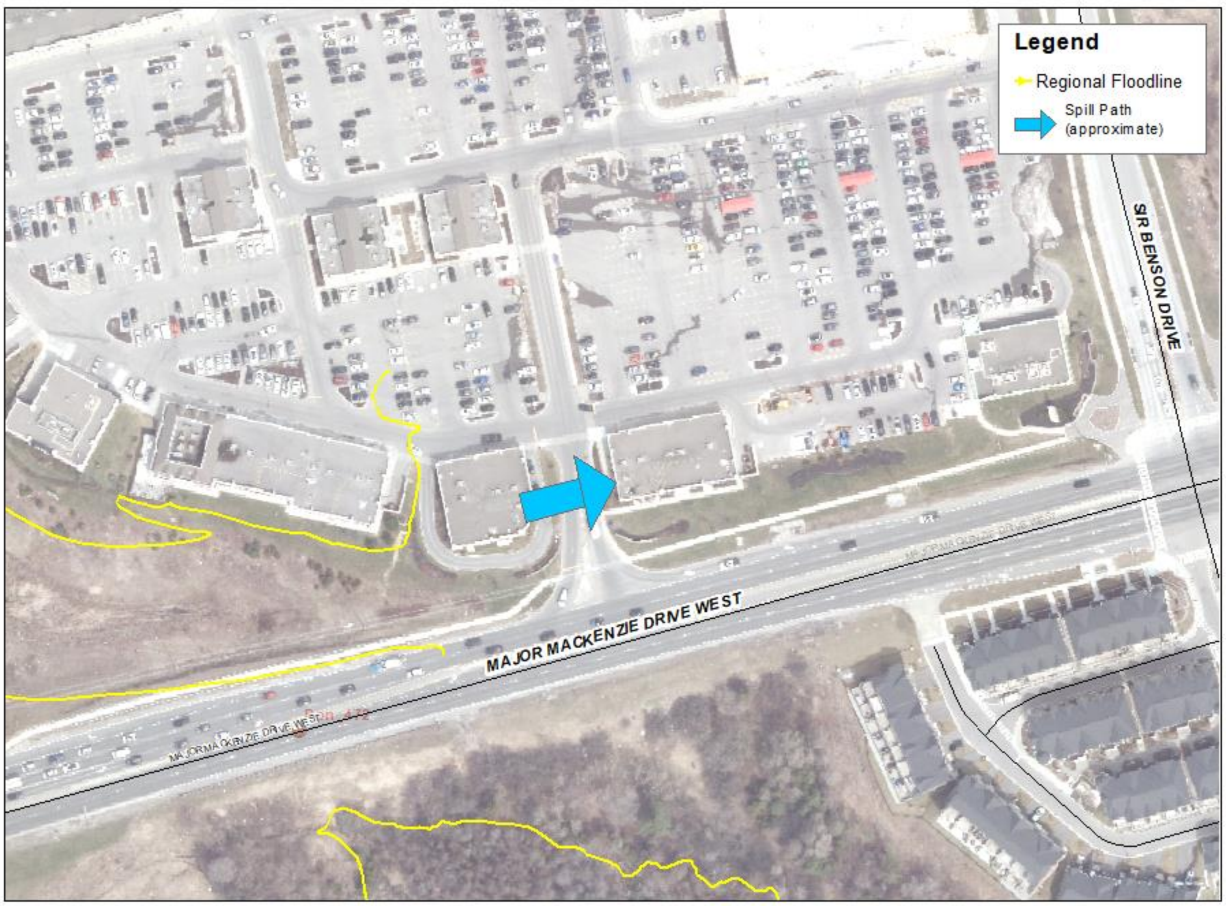


Figure 10-21: Spill Area #11 – Major Mackenzie Drive West: Local Context

Figure 10-22: Spill Area #11 – Major Mackenzie Drive West: Possible Spill Pathways

The following metrics are available:

- The grades along Major Mackenzie Drive West generally fall to the east. The ground elevations associated with these features, generally in the area of potential spill, is 232.9 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 233.12 m and 226.01 m, respectively, a difference of 7.11 m (about 23.3 feet)
- The width of the spill zone, as depicted, is less than 68 m for the Regulatory Flood
- The grades along the Major Mackenzie Drive West spill path is approximately 7.6%
- The Regulatory Flood flow at this location is 19.93 m^3/s

10.3.1.12 Spill Area #12 – Dufferin Street near Structure DON_488

Spill Area #12 is located on the west side of Dufferin Street near crossing DON_488 (Dufferin Street) on watercourse Fisherville Creek Reach 3 in Markham. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 2781.9 and 2699.56 (**Figure 10-23**).

Spill waters from the area would be expected to flow west along Anthony Lane. The available topographic information also suggests the possibility that spill waters may flow into the residential area east of Dufferin Street (**Figure 10-24**).

Figure 10-23: Spill Area #12 – Dufferin Street: Local Context

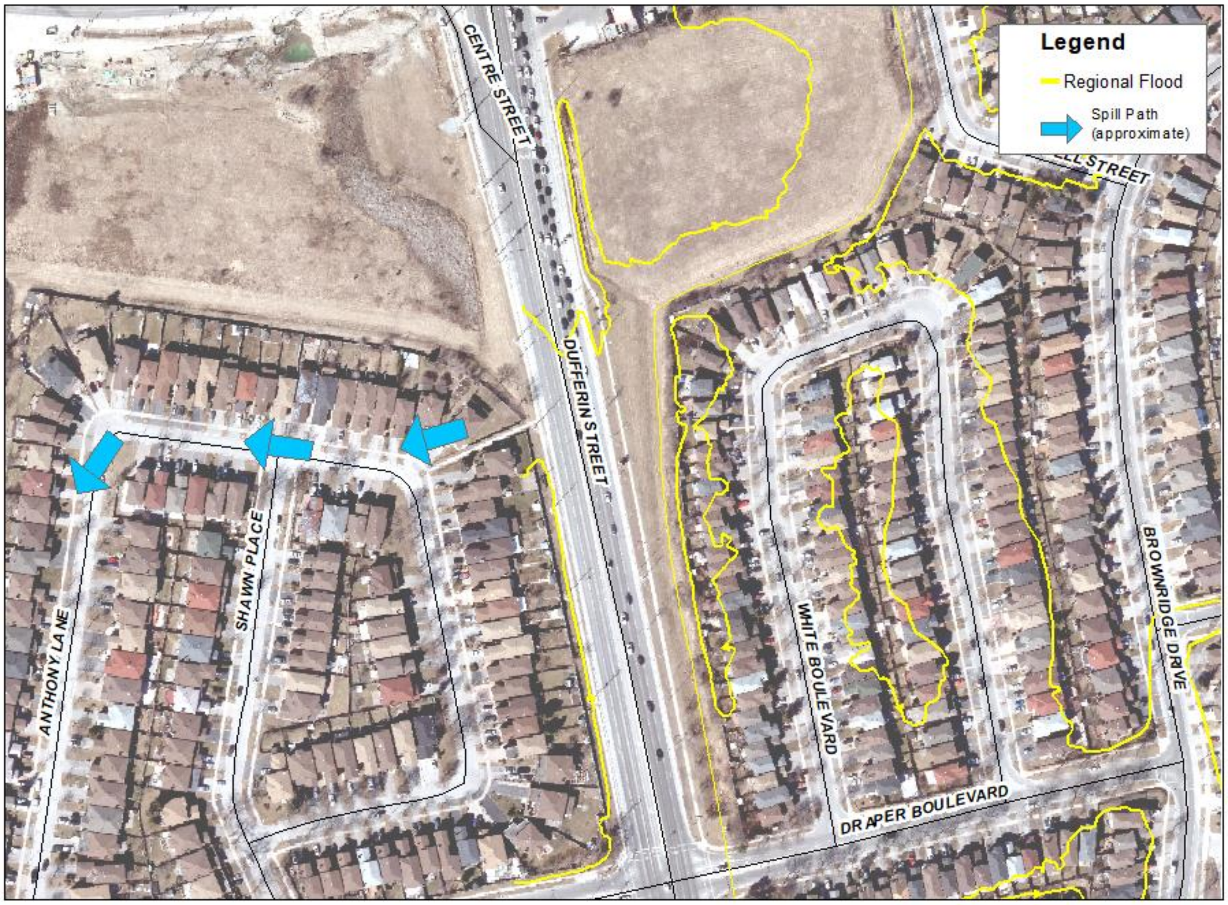


Figure 10-24: Spill Area #12 – Dufferin Street: Possible Spill Pathways

The following metrics are available:

- The grades along Anthony Lane generally fall to the west. The ground elevations associated with these features, generally in the area of potential spill, is 191.8 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 192.01 m and 191.69 m, respectively, a difference of 0.32 m (about 1.0 feet)
- The width of the spill zone, as depicted, is less than 77 m for the Regulatory Flood
- The grades along the Dufferin Street spill path are approximately 1.3%
- The Regulatory Flood flow at this location is 33.98 m^3/s

10.3.1.13 Spill Area #13 – Keele Street near Structure DON_542

Spill Area #13 is located on the west side of Keele Street near crossing DON_542 on watercourse West Tributary 9 Reach 3 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1812.37 and 1700.12 (**Figure 10-25**).

Spill waters from the area would be expected to flow west along the parking lots in the industrial areas. The available topographic information also suggests the possibility that spill waters will flow into the industrial area west of Keele Street (**Figure 10-26**).

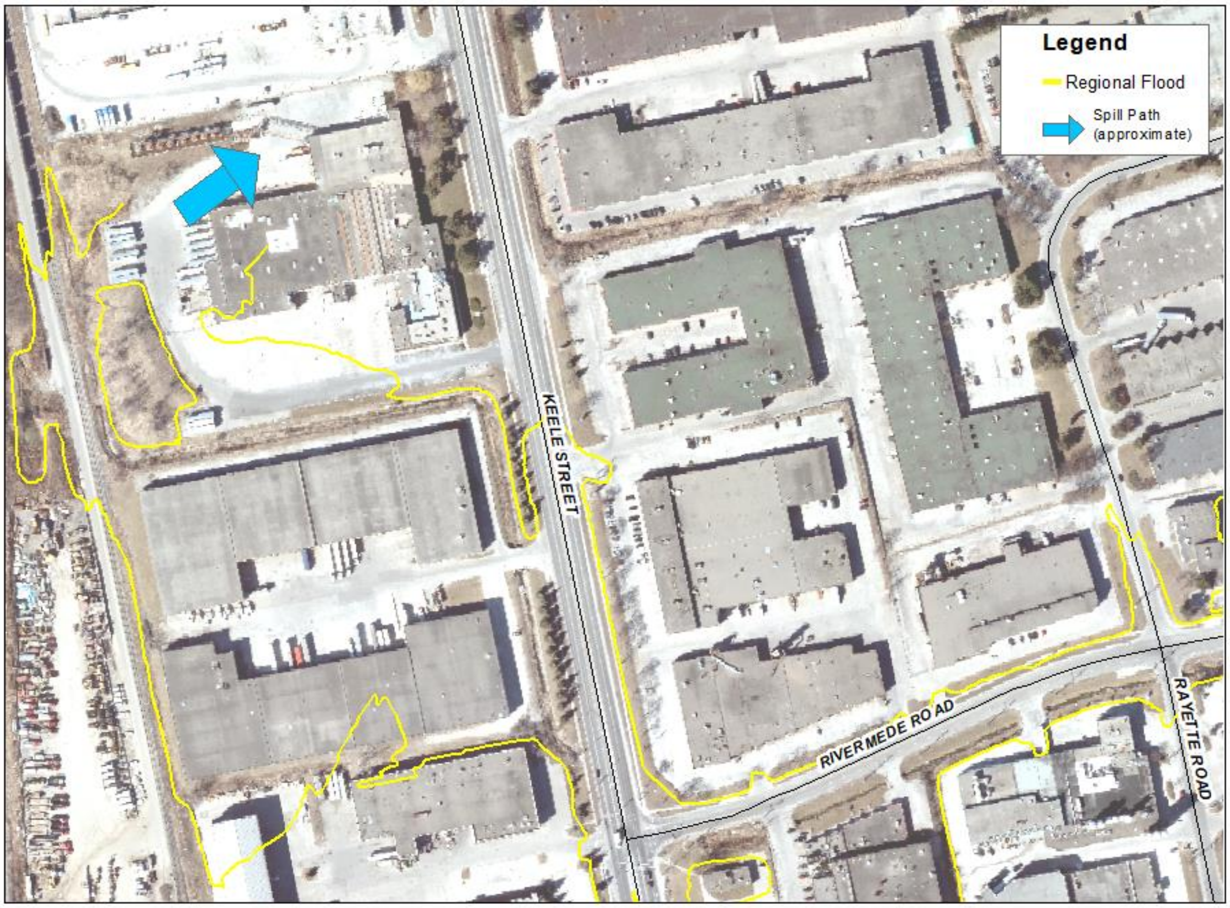


Figure 10-25: Spill Area #13 – Keele Street: Local Context

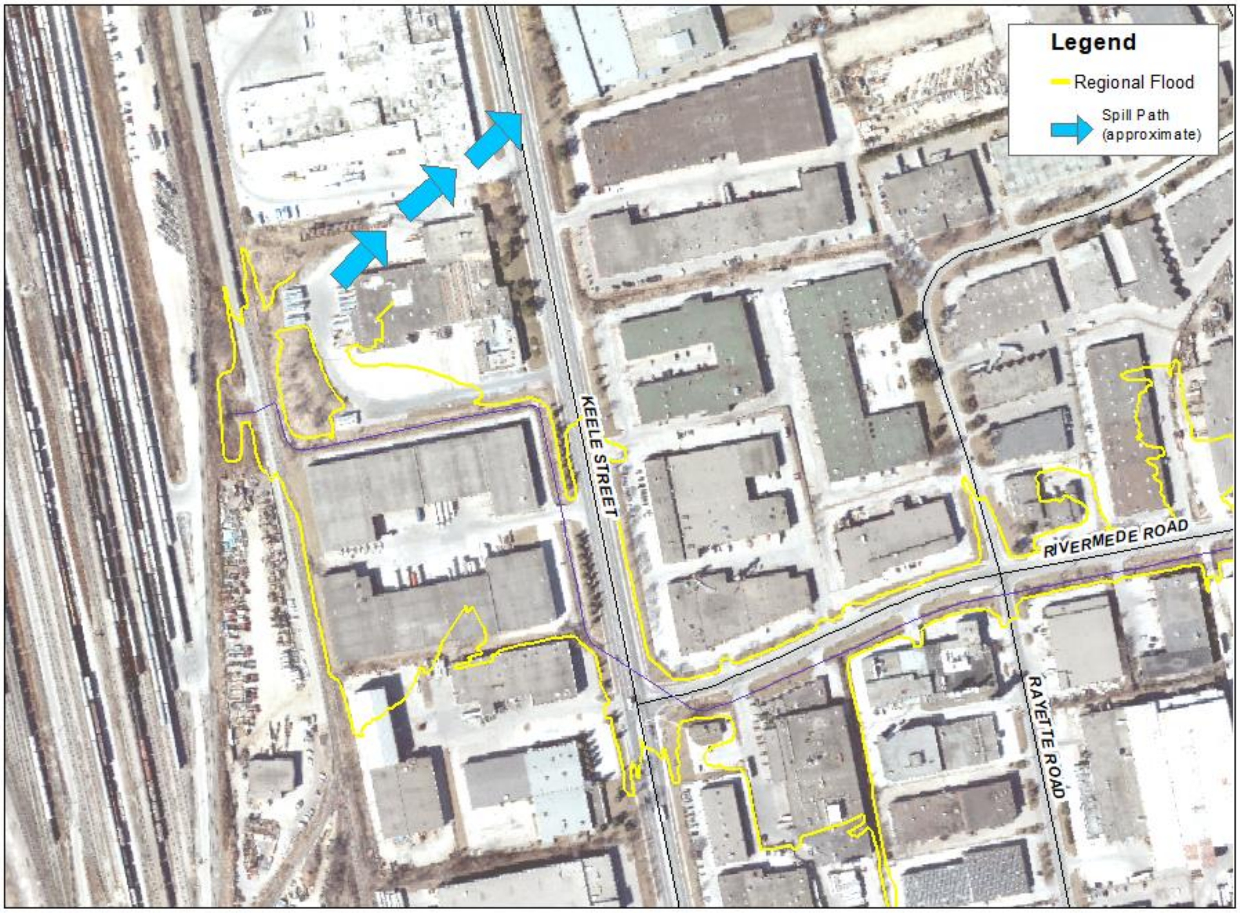


Figure 10-26: Spill Area #13 – Keele Street: Possible Spill Pathways

The following metrics are available:

- The grades along the parking lots generally fall to the east. The ground elevations associated with these features, generally in the area of potential spill, is 200.0 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 200.34 m and 200.31 m, respectively, a difference of 0.03 m (about 0.1 feet)
- The width of the spill zone, as depicted, is less than 86 m for the Regulatory Flood
- The grades along the Keele Street spill path are approximately 0.6%
- The Regulatory Flood flow at this location is 43.32 m^3/s

10.3.1.14 Spill Area #14 – Keele Street at Structure DON_549

Spill Area #14 is located on the south side of Highway 7 at crossing DON_549 (Keele Street) on watercourse West Tributary 9 Reach A in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1111.01 and 1041.24 (**Figure 10-27**).

Spill waters from the area would be expected to flow south along Keele Street. The available topographic information also suggests the possibility that spill waters will flow into the industrial area south of Highway 7 (**Figure 10-28**).

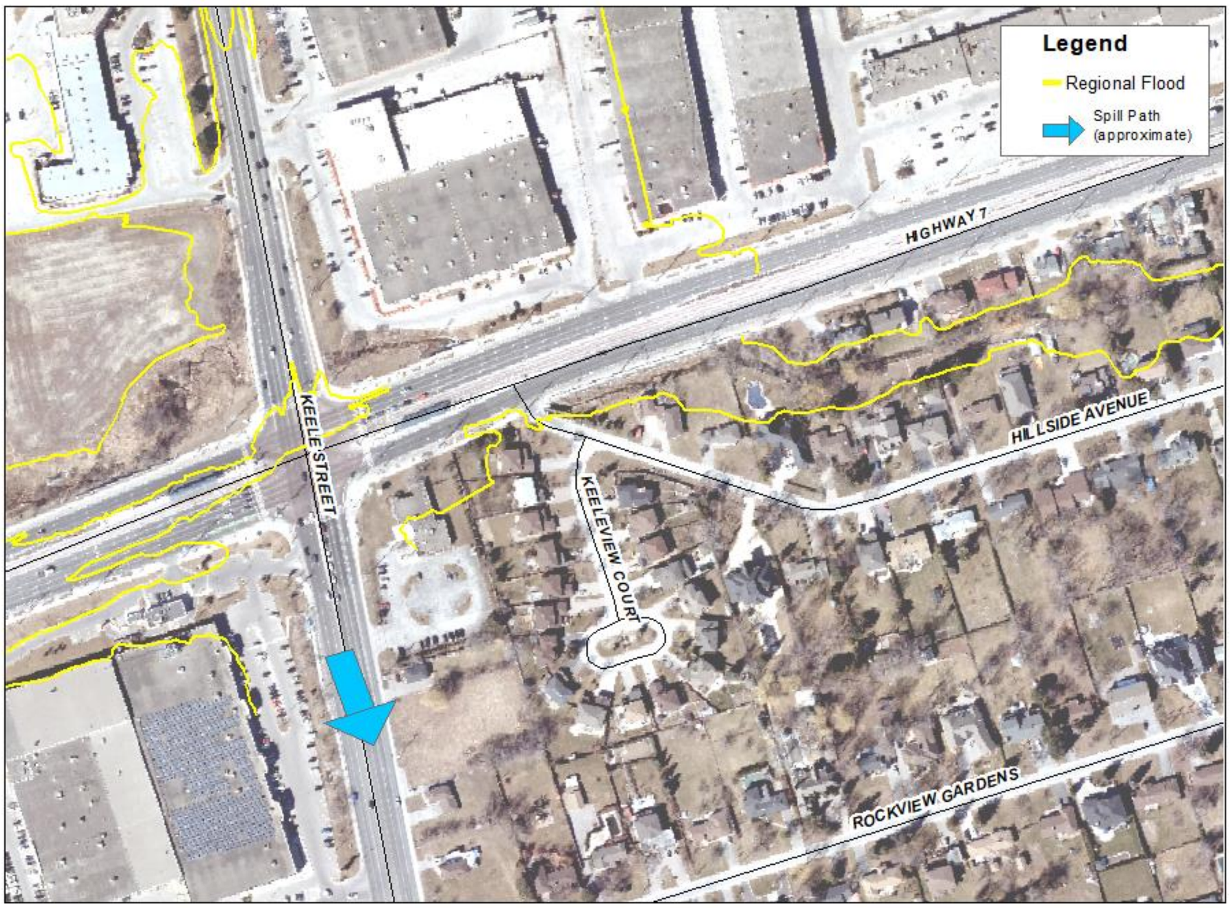


Figure 10-27: Spill Area #14 – Keele Street: Local Context

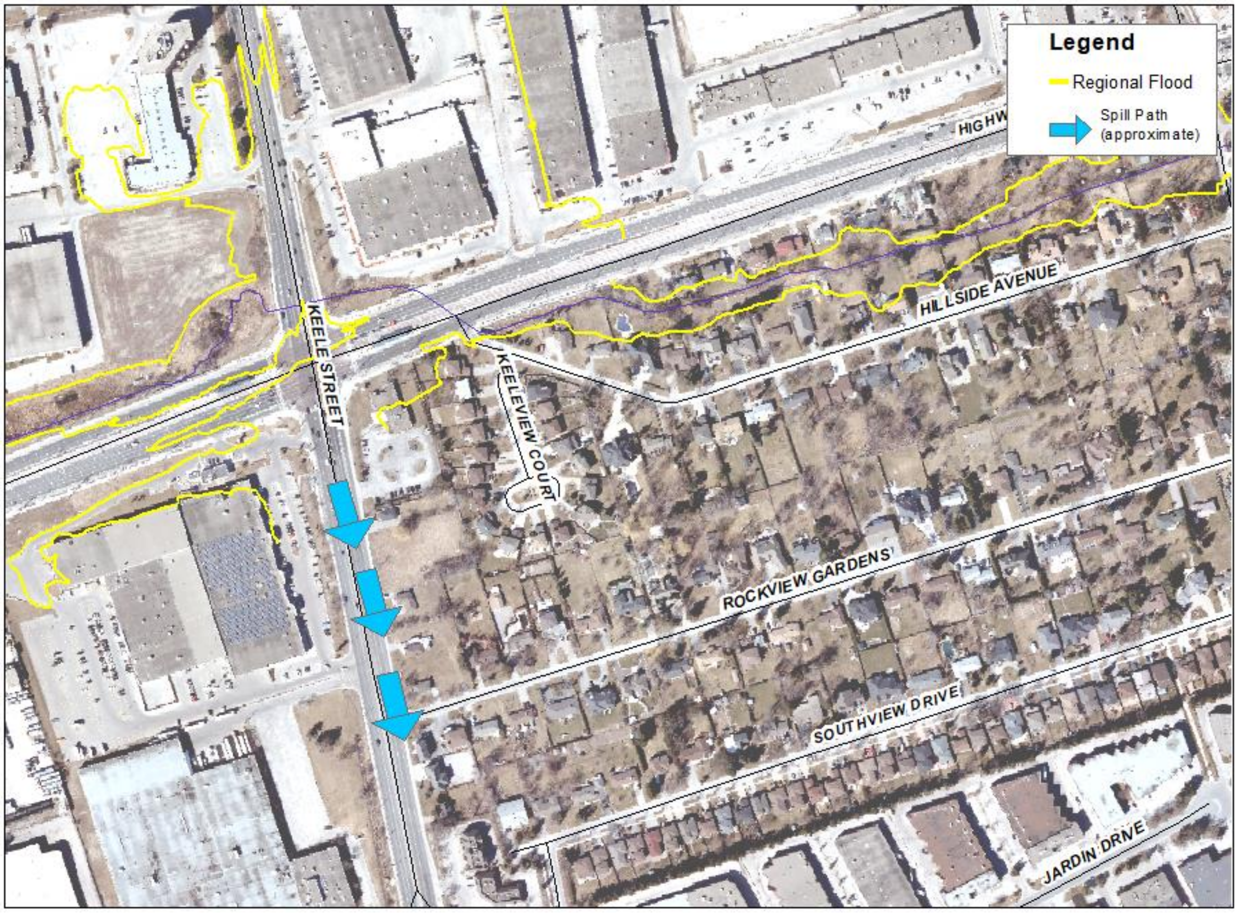


Figure 10-28: Spill Area #14 – Keele Street: Possible Spill Pathways

The following metrics are available:

- The grades along Keele Street generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 200.9 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 201.44 m and 201.43 m, respectively, a difference of 0.01 m (about 0.03 feet)
- The width of the spill zone, as depicted, is less than 139 m for the Regulatory Flood
- The grades along the Keele Street spill path are approximately 0.37%
- The Regulatory Flood flow at this location is 68.88 m^3/s

10.3.1.15 Spill Area #15 – Highway 7 at Structure DON_548

Spill Area #15 is located on the north side of Highway 7 at crossing DON_548 (Hwy. 7) on watercourse West Tributary 9 Reach A in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 923.04 and 914.09 (**Figure 10-29**).

Spill waters from the area would be expected to flow east along Highway 7. The available topographic information also suggests the possibility that spill waters will flow into the industrial and residential areas on both north and south of the Hwy. 7 (**Figure 10-30**).

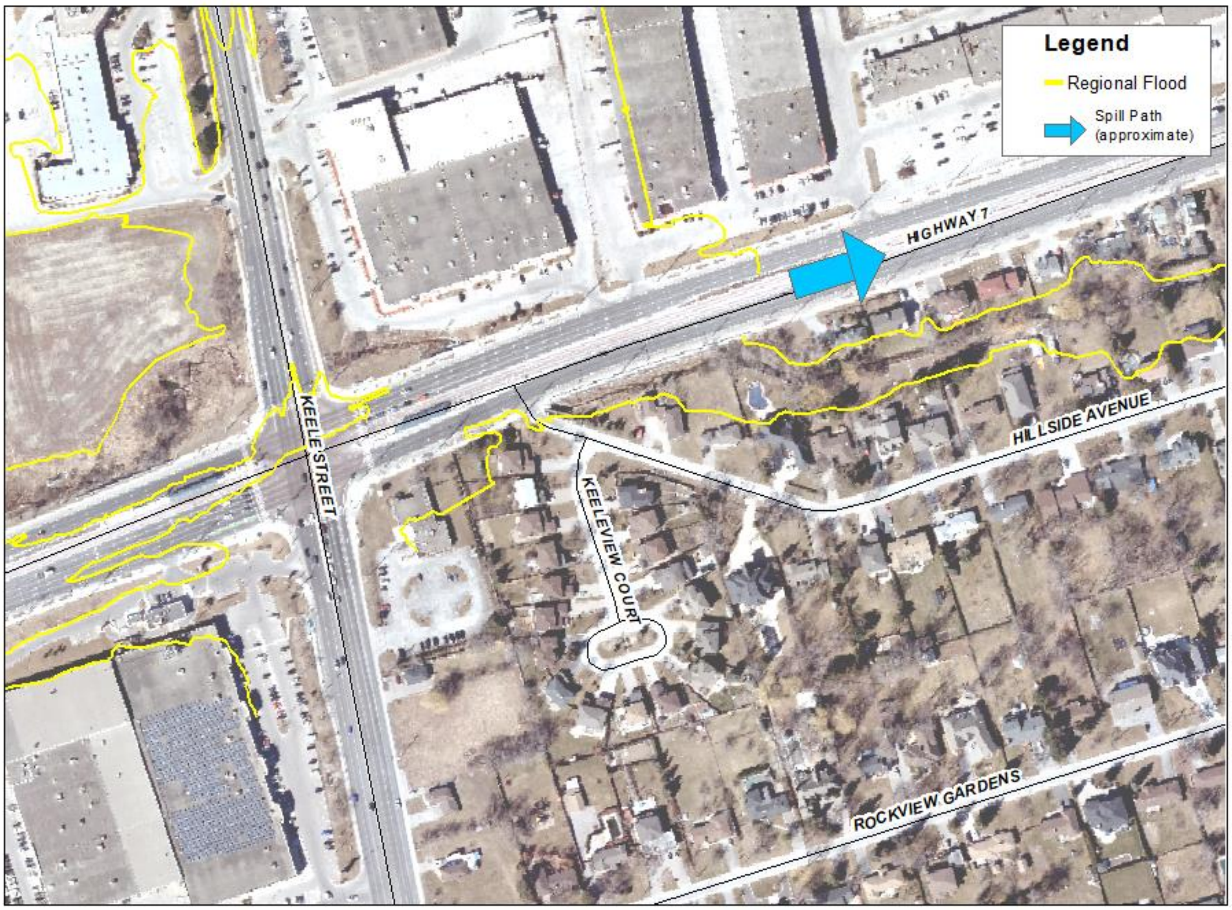


Figure 10-29: Spill Area #15 – Highway 7: Local Context

Figure 10-30: Spill Area #15 – Highway 7: Possible Spill Pathways

The following metrics are available:

- The grades along Hwy. 7 generally fall to the east. The ground elevations associated with these features, generally in the area of potential spill, is 199.5 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 201.4 m and 200.39 m, respectively, a difference of 1.01 m (about 3.31 feet)
- The width of the spill zone, as depicted, is less than 37 m for the Regulatory Flood
- The grades along the Hwy. 7 spill path are approximately 0.20%
- The Regulatory Flood flow at this location is 71.36 m^3/s

10.3.1.16 Spill Area #16 – Highway 7 near Railway

Spill Area #16 is located on the north side of Highway 7 near Railway on watercourse West Tributary 9 Reach A in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1608.87 and 1567.55 (**Figure** 10-31).

Spill waters from the area would be expected to flow north along the ditch and get into the parking lots located in the industrial area. The available topographic information also suggests the possibility that spill waters will flow into the industrial area north of Hwy. 7 (**Figure 10-32**).

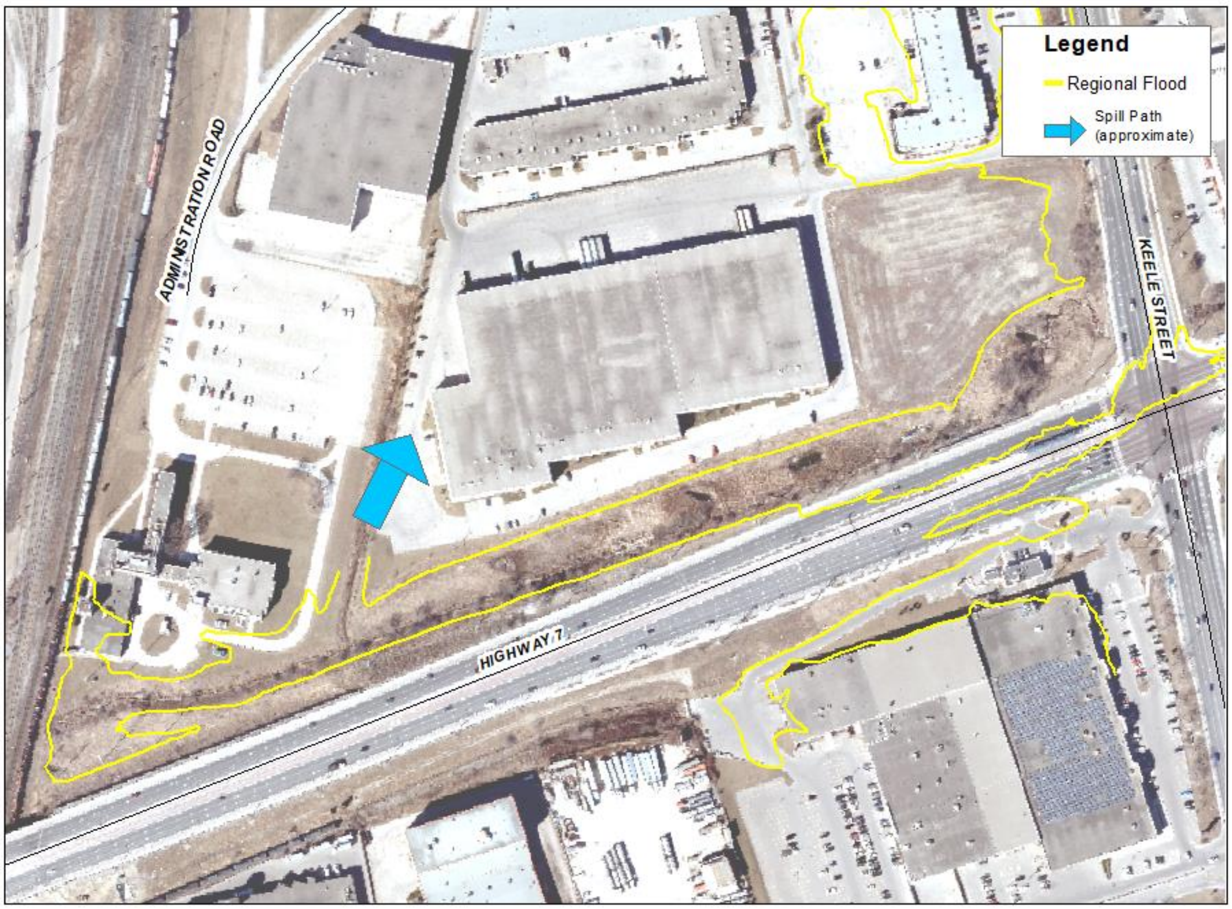


Figure 10-31: Spill Area #16 – Highway 7: Local Context

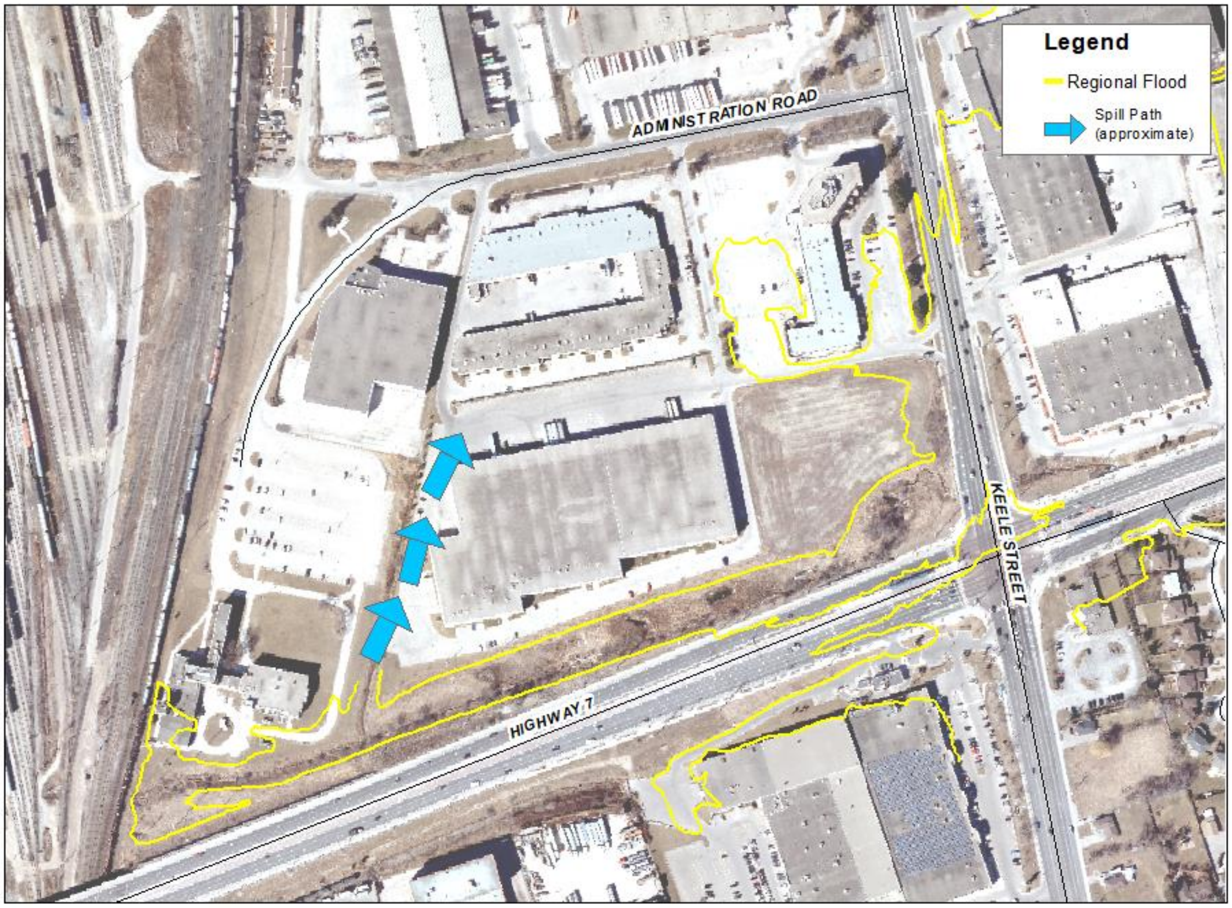


Figure 10-32: Spill Area #16 – Highway 7: Possible Spill Pathways

The following metrics are available:

- The grades along the parking lots generally fall to the north. The ground elevations associated with these features, generally in the area of potential spill, is 202.5 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 203.16 m and 202.18 m, respectively, a difference of 0.98 m (about 3.2 feet)
- The width of the spill zone, as depicted, is less than 19 m for the Regulatory Flood
- The grades along the parking lots spill path is approximately 1.4%
- The Regulatory Flood flow at this location is 70.21 m^3/s

10.3.1.17 Spill Area #17 – Rutherford Road near Railway

Spill Area #17 is located on the north side of Rutherford Road near Railway on watercourse West Tributary 10 Reach 1B in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 824.4 and 796.95 (**Figure** 10-33).

Spill waters from the area would be expected to flow south into the residential area. The available topographic information also suggests the possibility that spill waters will flow into the residential area south of Rutherford Road (**Figure 10-34**).

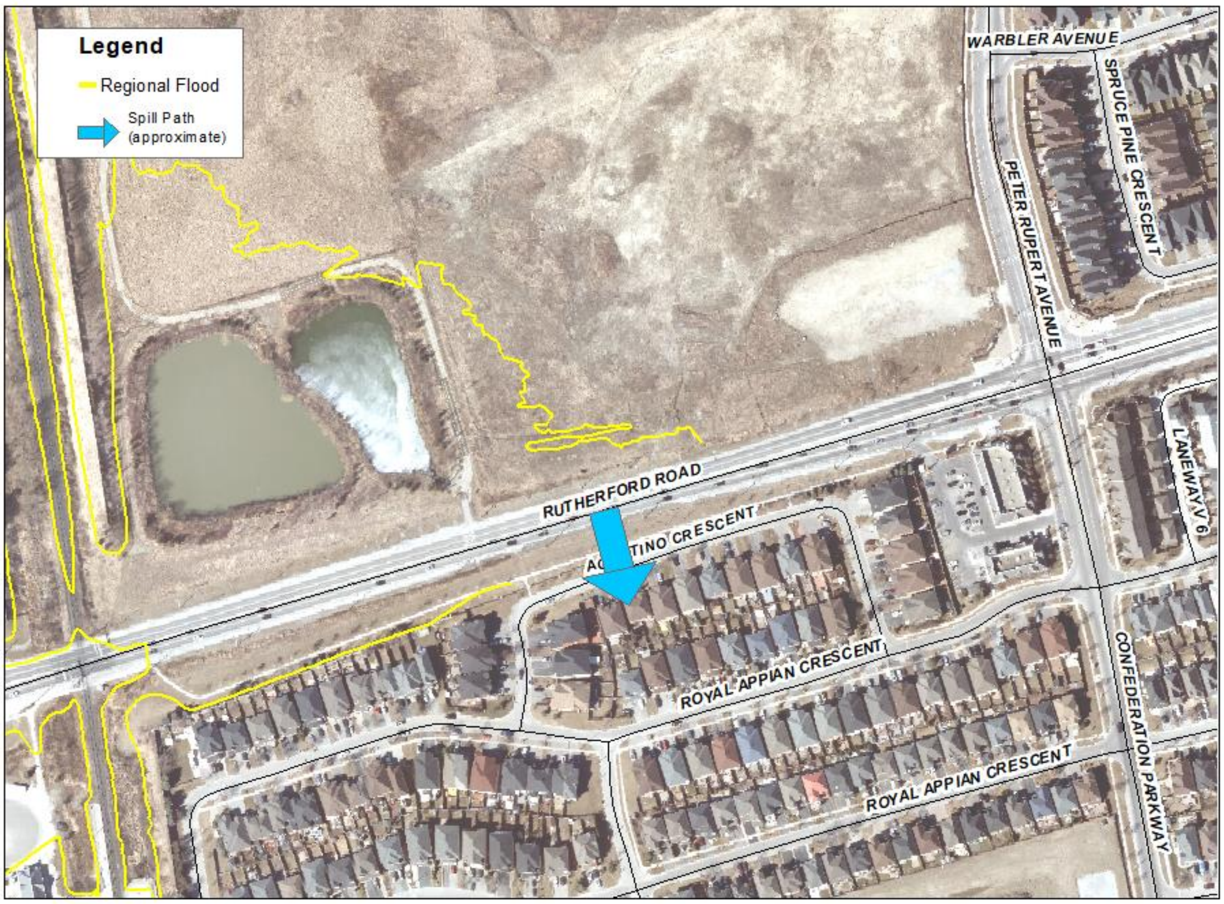


Figure 10-33: Spill Area #17 – Rutherford Road: Local Context

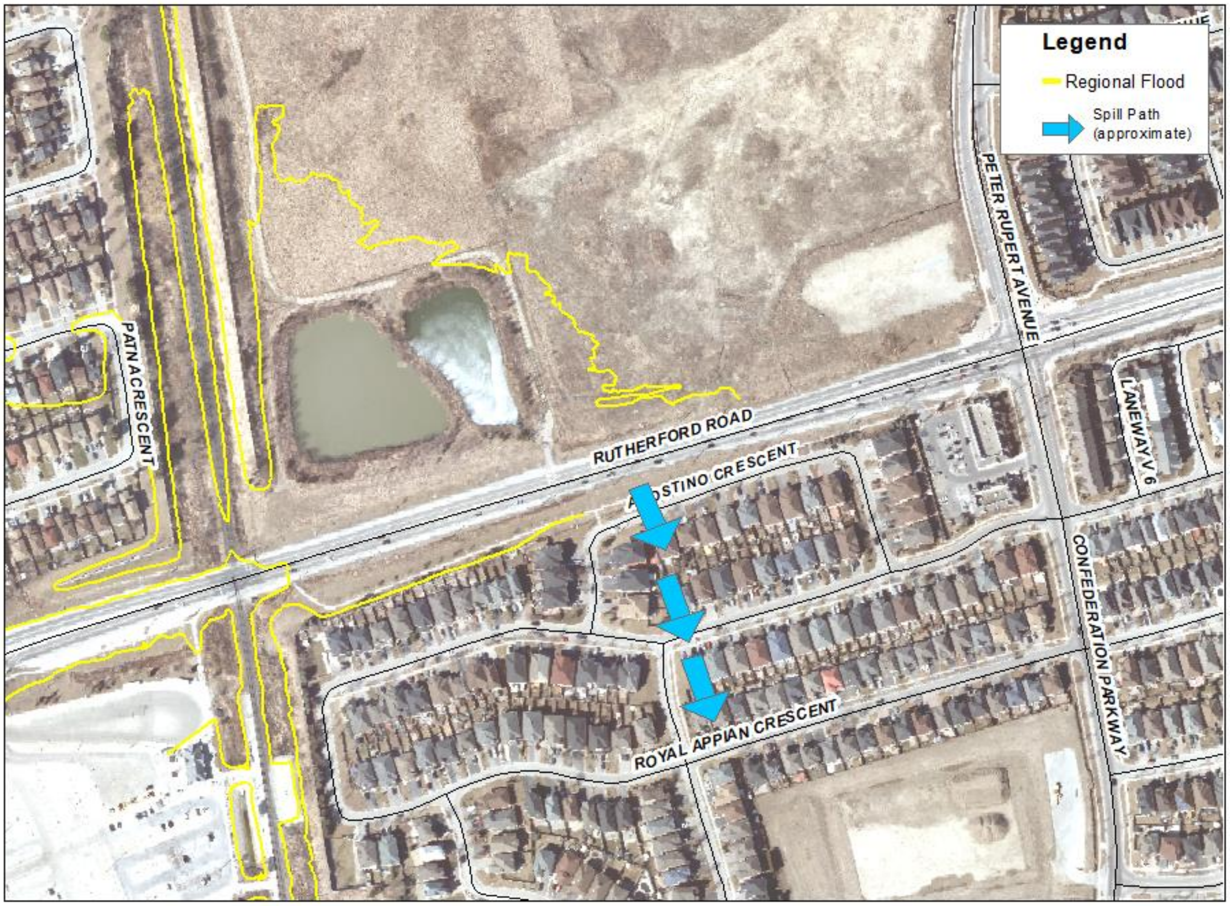


Figure 10-34: Spill Area #17 – Rutherford Road: Possible Spill Pathways

The following metrics are available:

- The grades along the residential areas generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 220.3 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 221.18 m and 221.15 m, respectively, a difference of 0.03 m (about 0.1 feet)
- The width of the spill zone, as depicted, is less than 122 m for the Regulatory Flood
- The grades along the residential areas spill path are approximately 1.0%
- The Regulatory Flood flow at this location is 20.78 m^3/s

10.3.1.18 Spill Area #18 – Local Road within Canada's Wonderland

Spill Area #18 is located on the east side of the local road near Canada's Wonderland on watercourse West Tributary 11 Reach C in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1307.39 and 1283.38 (**Figure 10-35**).

Spill waters from the area would be expected to flow south along the local road. The available topographic information also suggests the possibility that spill waters will flow into the open area east of the local road (**Figure 10-36**).

Figure 10-35: Spill Area #18 – Local Road: Local Context

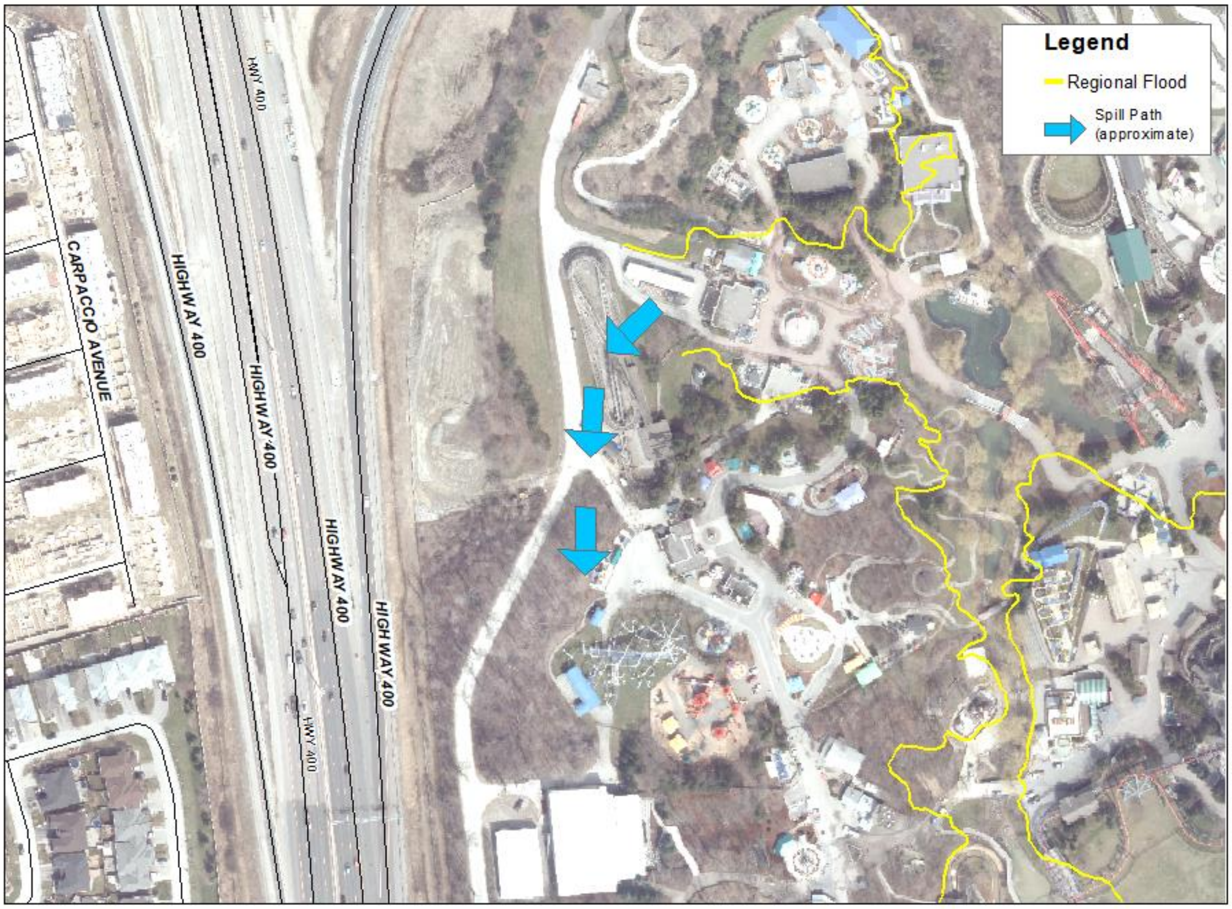


Figure 10-36: Spill Area #18 – Local Road: Possible Spill Pathways

The following metrics are available:

- The grades along the local road generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 225.0 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 225.93 m and 225.92 m, respectively, a difference of 0.01 m (about 0.03 feet)
- The width of the spill zone, as depicted, is less than 55 m for the Regulatory Flood
- The grades along the local road spill path are approximately 1.1%
- The Regulatory Flood flow at this location is 29.51 m^3/s

10.3.1.19 Spill Area #19 – Entry Areas at Canada`s Wonderland

Spill Area #19 is located on the west side of the entry areas at Canada`s Wonderland on watercourse West Tributary 11 Reach C in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1259.77 and 1227.37 (**Figure 10-37**).

Spill waters from the area would be expected to flow south along the entry areas. The available topographic information also suggests the possibility that spill waters will flow into the parking lot at the east of the entry areas (**Figure 10-38**).

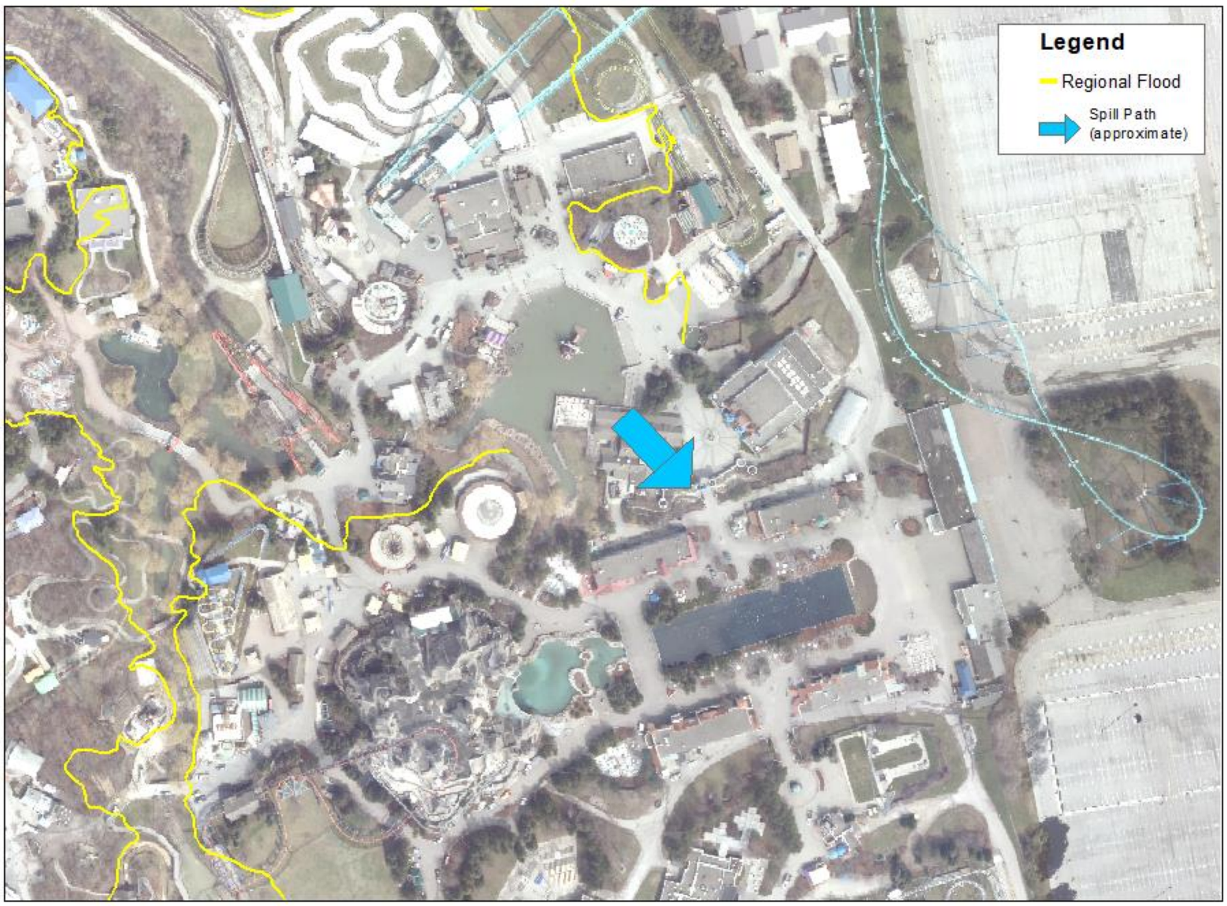


Figure 10-37: Spill Area #19 – Entry Areas: Local Context

Figure 10-38: Spill Area #19 – Entry Areas: Possible Spill Pathways

The following metrics are available:

- The grades at the entry areas generally fall to the east. The ground elevations associated with these features, generally in the area of potential spill, is 225.2 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 225.92 m and 224.47 m, respectively, a difference of 0.01 m (about 0.03 feet)
- The width of the spill zone, as depicted, is less than 99 m for the Regulatory Flood
- The grades along the entry areas spill path are approximately 0.4%
- The Regulatory Flood flow at this location is 29.51 m^3/s

10.3.1.20 Spill Area #20 – Ashton Drive at Structure 619

Spill Area #20 is located on the east side of Cooper Creek Court at Structure 619 (Ashton Drive) on watercourse West Tributary 14 Reach 1 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 516.73 and 474.78 (**Figure 10-39**).

Spill waters from the area would be expected to flow west along Ashton Drive. The available topographic information also suggests the possibility that spill waters may flow along the Ashton Drive corridor about 200 m and discharge to the same tributary near HEC-RAS section 200 (**Figure 10-40**). The available topographic information also suggests the possibility that spill waters will flow into the residential areas at the west side of Cooper Creek Court.

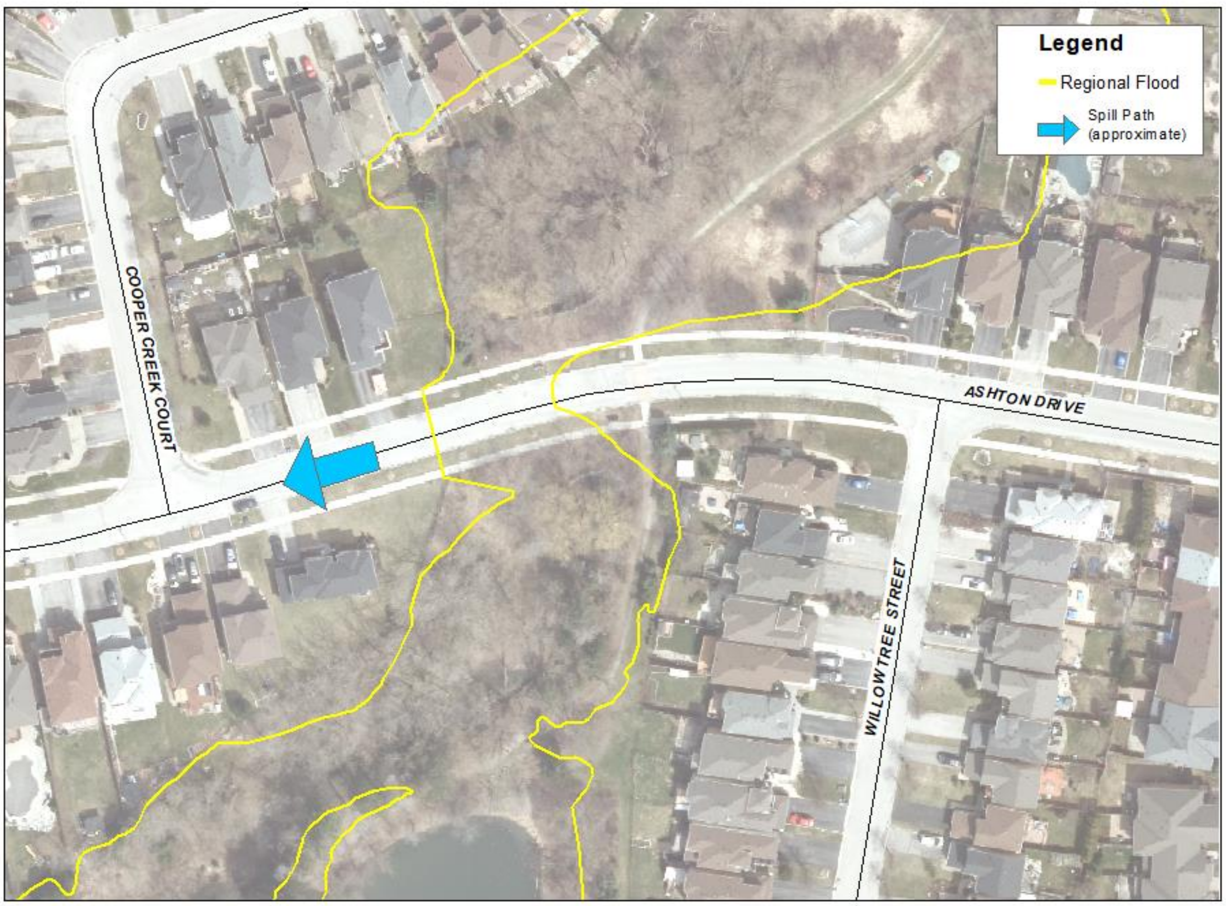


Figure 10-39: Spill Area #20 – Ashton Drive: Local Context

Figure 10-40: Spill Area #20 – Ashton Drive: Possible Spill Pathways

The following metrics are available:

- The grades along Ashton Drive generally fall to the west. The ground elevations associated with these features, generally in the area of potential spill, is 248.1 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 248.41 m and 246.99 m, respectively, a difference of 1.42 m (about 4.7 feet)
- The width of the spill zone, as depicted, is less than 34 m for the Regulatory Flood
- The grades along the Ashton Drive spill path are approximately 0.78%
- The Regulatory Flood flow at this location is 35.53 m^3/s

10.3.1.21 Spill Area #21 – Railway at Structure 621

Spill Area #21 is located on the south side of the Railway at Structure 621 (Railway) on watercourse West Tributary 14 Reach 1 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 3197.43 and 3161.25 (**Figure 10-41**).

Spill waters from the area would be expected to flow south along the Railway. The available topographic information also suggests the possibility that spill waters will flow into the agricultural areas at the west side of the Railway (**Figure 10-42**).

Figure 10-41: Spill Area #21 – Railway: Local Context

Figure 10-42: Spill Area #21 – Railway: Possible Spill Pathways

The following metrics are available:

- The grades along the Railway generally fall to the west. The ground elevations associated with these features, generally in the area of potential spill, is 284.3 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 284.78 m and 278.71 m, respectively, a difference of 6.07 m (about 20 feet)
- The width of the spill zone, as depicted, is less than 14 m for the Regulatory Flood
- The grades along the Railway spill path are approximately 1.15%
- The Regulatory Flood flow at this location is 14.16 m^3/s

10.3.1.22 Spill Area #22 – Railway near Structure 531

Spill Area #22 is located on the south side of the Railway near Structure 531 on watercourse West Tributary 9 Reach 3 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 493.66 and 439.66 (**Figure 10-43**).

Spill waters from the area would be expected to flow south along the Railway. The available topographic information also suggests the possibility that spill waters may flow along the Railway corridor about 200 m and discharge to the West Don River Reach 15 near HEC-RAS section 88.94 (**Figure 10-44**). The available topographic information also suggests the possibility that spill waters will flow into the open space areas at the east side of the Railway.

Figure 10-43: Spill Area #22 – Railway: Local Context

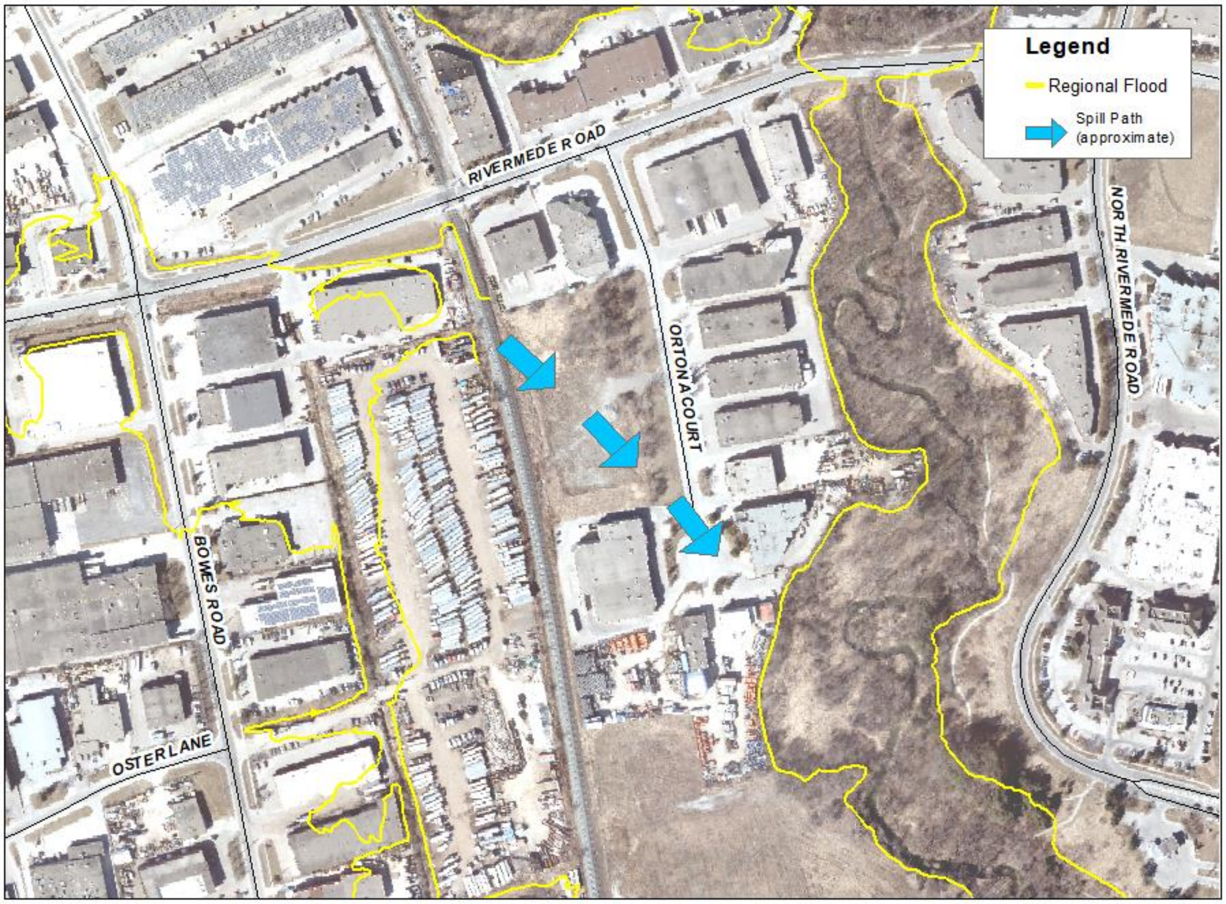


Figure 10-44: Spill Area #22 – Railway: Possible Spill Pathways

The following metrics are available:

- The grades along the Railway generally fall to the west. The ground elevations associated with these features, generally in the area of potential spill, is 195.67 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 195.80 m and 195.78 m, respectively, a difference of 0.02 m (about 0.1 feet)
- The width of the spill zone, as depicted, is less than 51 m for the Regulatory Flood
- The grades along the Railway spill path is are approximately 1.1%
- The Regulatory Flood flow at this location is 44.30 m^3/s

10.3.1.23 Spill Area #23 – Westburne Drive near Structure 571

Spill Area #23 is located on the south side of Westburne Drive near Structure 571 (Rutherford Road) on watercourse West Tributary 10 Reach 1 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 4600.28 and 4496.1 (**Figure 10-45**).

Spill waters from the area would be expected to flow south along Westburne Drive. The available topographic information also suggests the possibility that spill waters will flow into the industrial area at the east side of Westburne Drive (**Figure 10-46**).

Figure 10-45: Spill Area #23 – Westburne Drive: Local Context

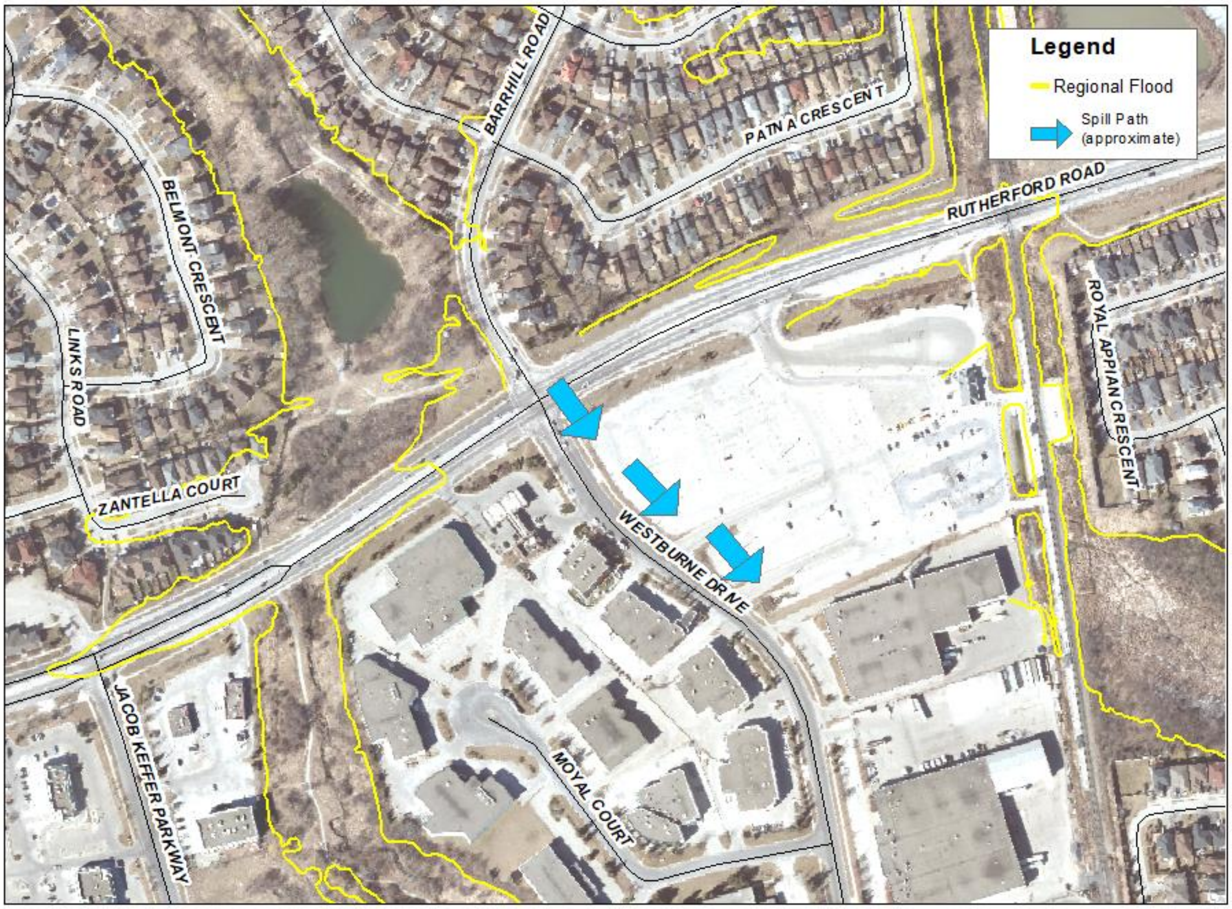


Figure 10-46: Spill Area #23 – Westburne Drive: Possible Spill Pathways

The following metrics are available:

- The grades along Westburne Drive generally fall to the west. The ground elevations associated with these features, generally in the area of potential spill, is 220.52 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 221.15 m and 219.94 m, respectively, a difference of 1.21 m (about 4.0 feet)
- The width of the spill zone, as depicted, is less than 63 m for the Regulatory Flood
- The grades along the Westburne Drive spill path is approximately 0.69%
- The Regulatory Flood flow at this location is 6.12 m^3/s

10.3.1.24 Spill Area #24 – Railway at Structure 521

Spill Area #24 is located on the south side of the Railway near Structure 521 (Railway) on watercourse West Don River Reach 20 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 4562.51 and 4530.87 (**Figure 10-47**).

Spill waters from the area would be expected to flow south along the Railway. The available topographic information also suggests the possibility that spill waters may flow along the Railway corridor about 135 m and discharge to the same tributary near HEC-RAS section 4382.29 (**Figure 10-48**). The available topographic information also suggests the possibility that spill waters will flow into the open space area at the west side of the Railway.

Figure 10-47: Spill Area #24 – Railway: Local Context

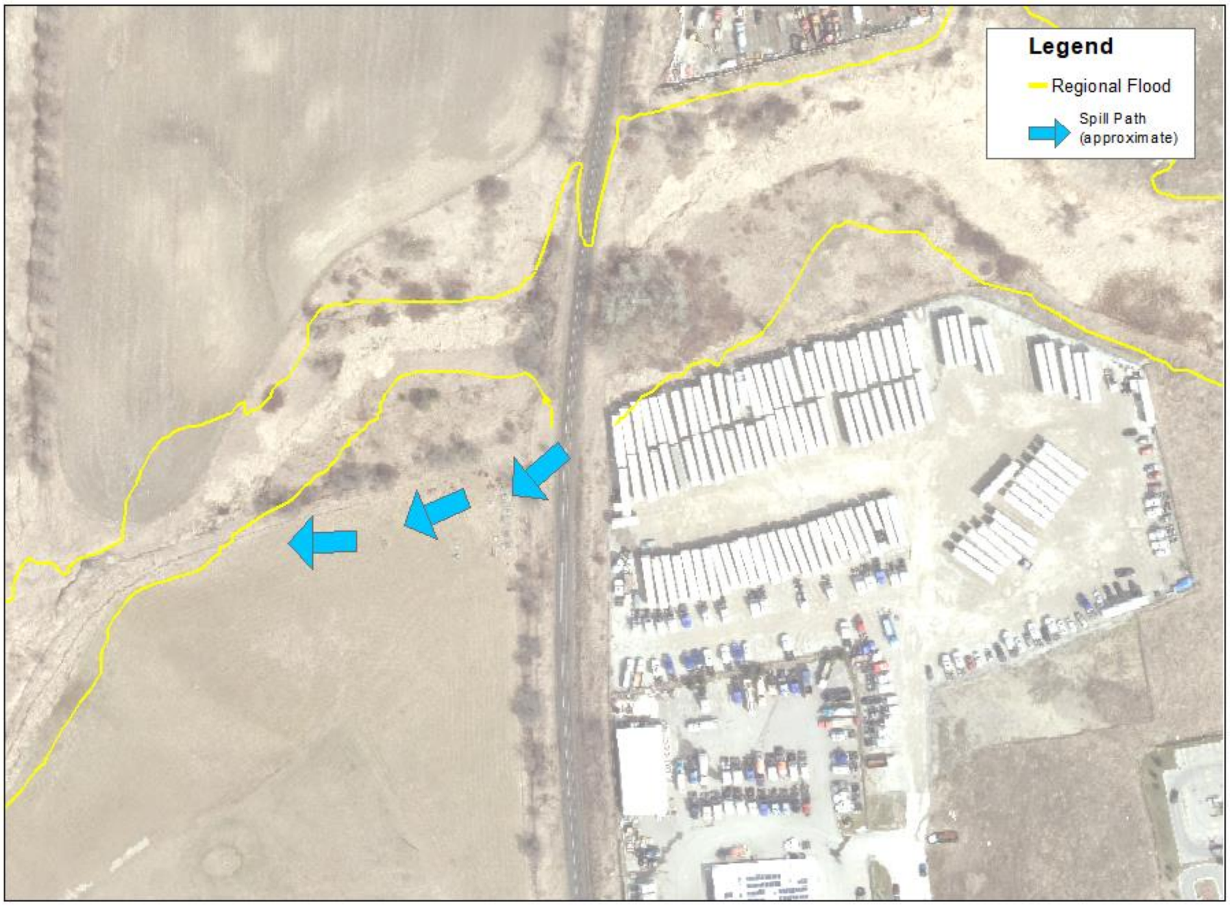


Figure 10-48: Spill Area #24 – Railway: Possible Spill Pathways

The following metrics are available:

- The grades along the Railway generally fall to the west. The ground elevations associated with these features, generally in the area of potential spill, is 295.45 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 295.82 m and 290.83 m, respectively, a difference of 5.0 m (about 16.4 feet)
- The width of the spill zone, as depicted, is less than 20 m for the Regulatory Flood
- The grades along the Railway spill path are approximately 6.1%
- The Regulatory Flood flow at this location is 13.46 m^3/s

10.3.1.25 Spill Area #25 – Railway at Structure 325

Spill Area #25 is located on the south side of the Railway near Structure 325 (Railway) on watercourse German Mills Creek Reach 4 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 10082.64 and 10051.04 (**Figure 10-49**).

Spill waters from the area would be expected to flow south along the Railway. The available topographic information also suggests the possibility that spill waters may flow along the Railway corridor about 222 m and discharge to the same tributary near HEC-RAS section 979.675 (**Figure 10-50**). The available topographic information also suggests the possibility that spill waters will flow into the open space area at the west side of the Railway.

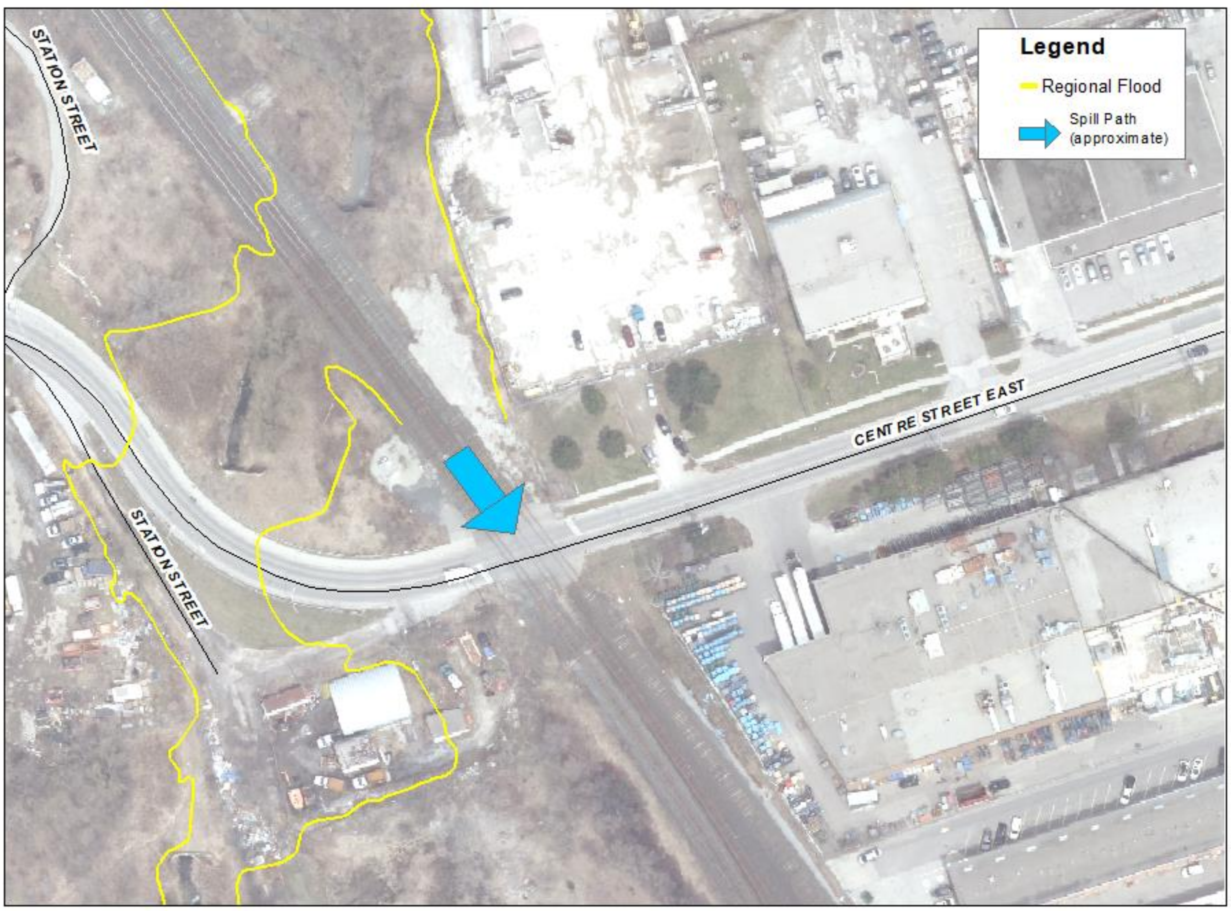


Figure 10-49: Spill Area #25 – Railway: Local Context

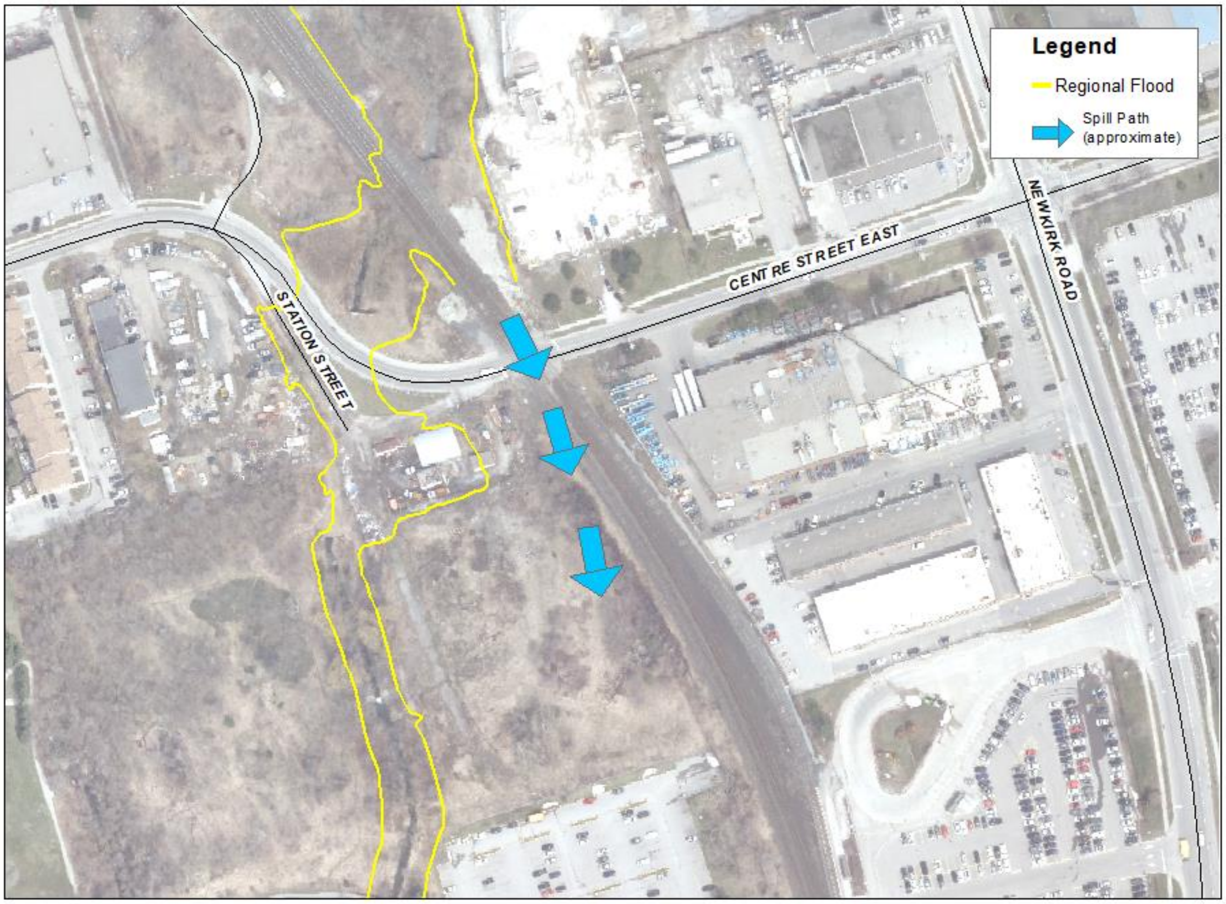


Figure 10-50: Spill Area #25 – Railway: Possible Spill Pathways

The following metrics are available:

- The grades along the Railway generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 225.7 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 226.01 m and 224.37 m, respectively, a difference of 1.6 m (about 5.2 feet)
- The width of the spill zone, as depicted, is less than 23 m for the Regulatory Flood
- The grades along the Railway spill path are approximately 1.3%
- The Regulatory Flood flow at this location is 41.04 m^3/s

10.3.1.26 Spill Area #26 – Bathurst Street at Structure 357

Spill Area #26 is located on the west side of Bathurst Street at Structure 357 (Bathurst Street) on watercourse German Mills Tributary 3 Reach 1 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 544.72.64 and 273.78 (**Figure 10-51**).

Spill waters from the two areas would be expected to flow south along Bathurst Street or to southeast crossing Bathurst Street to the residential area. The available topographic information also suggests the possibility that spill waters will flow into the open space area at the west side of Bathurst Street (**Figure 10-52**).

Figure 10-51: Spill Area #26 – Bathurst Street: Local Context

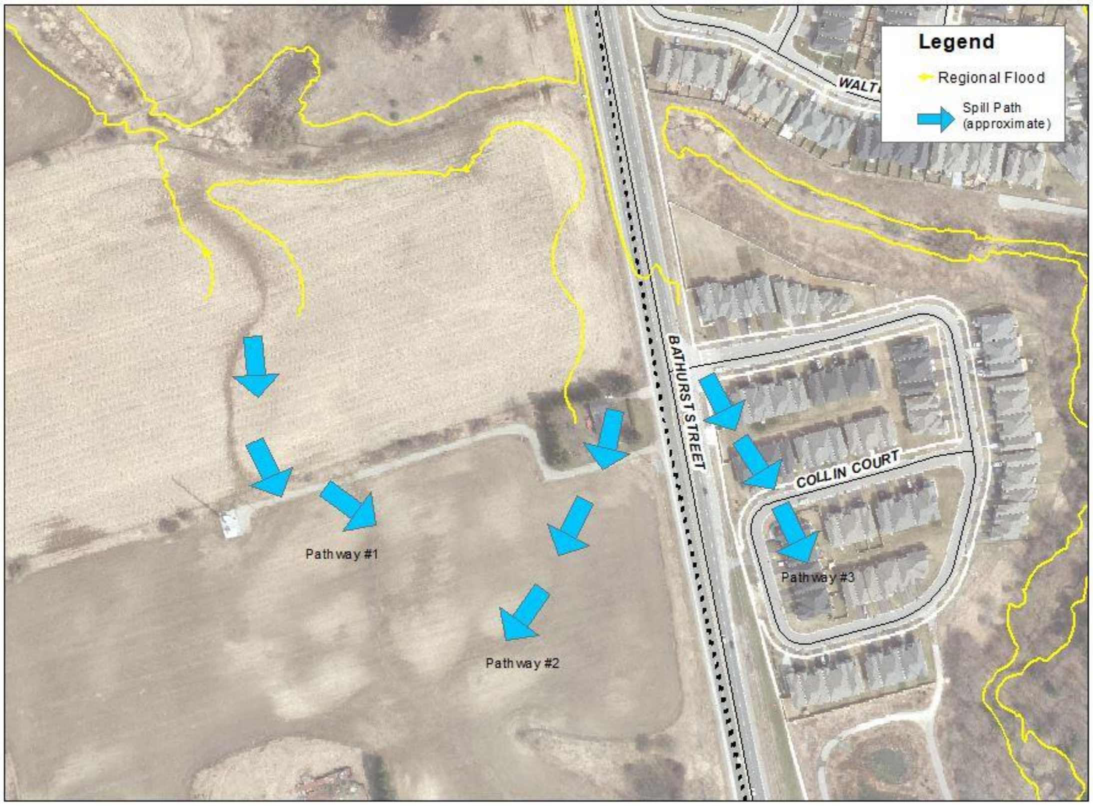


Figure 10-52: Spill Area #26 – Bathurst Street: Possible Spill Pathways

The following metrics are available:

- The grades along Bathurst Street generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 301.18 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 303.07 m and 300.71 m, respectively, a difference of 2.4 m (about 7.9 feet)
- The width of the spill zone (Pathway #1), as depicted, is less than 52 m for the Regulatory Flood
- The width of the spill zone (Pathway #2), as depicted, is less than 64 m for the Regulatory Flood
- The width of the spill zone (Pathway #3), as depicted, is less than 20 m for the Regulatory Flood
- The grade of spill path (Pathway #1) is approximately 1.6%
- The grade of spill path (Pathway #2) is approximately 1.4%
- The grade of spill path (Pathway #3) is approximately 1.7%
- The Regulatory Flood flow at this location is 2.82 m^3/s

10.3.1.27 Spill Area #27 – Long Pipe Flow Area 1 Fishersville Creek at Railway

Spill Area #27 is located on the west side of the Railway at long pipe flow area on watercourse Fishersville Creek Reach 3 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1062.77 and 971.49 (**Figure 10-53**).

Spill waters from the area would be expected to flow west of the Railway. The available topographic information also suggests the possibility that spill waters may flow along the railway corridor about 606 m and discharge to the West Don River Reach 13 near HEC-RAS section 905.13 (**Figure 10-54**). The available topographic information also suggests the possibility that spill waters may flow into the ditch area east of the Railway.

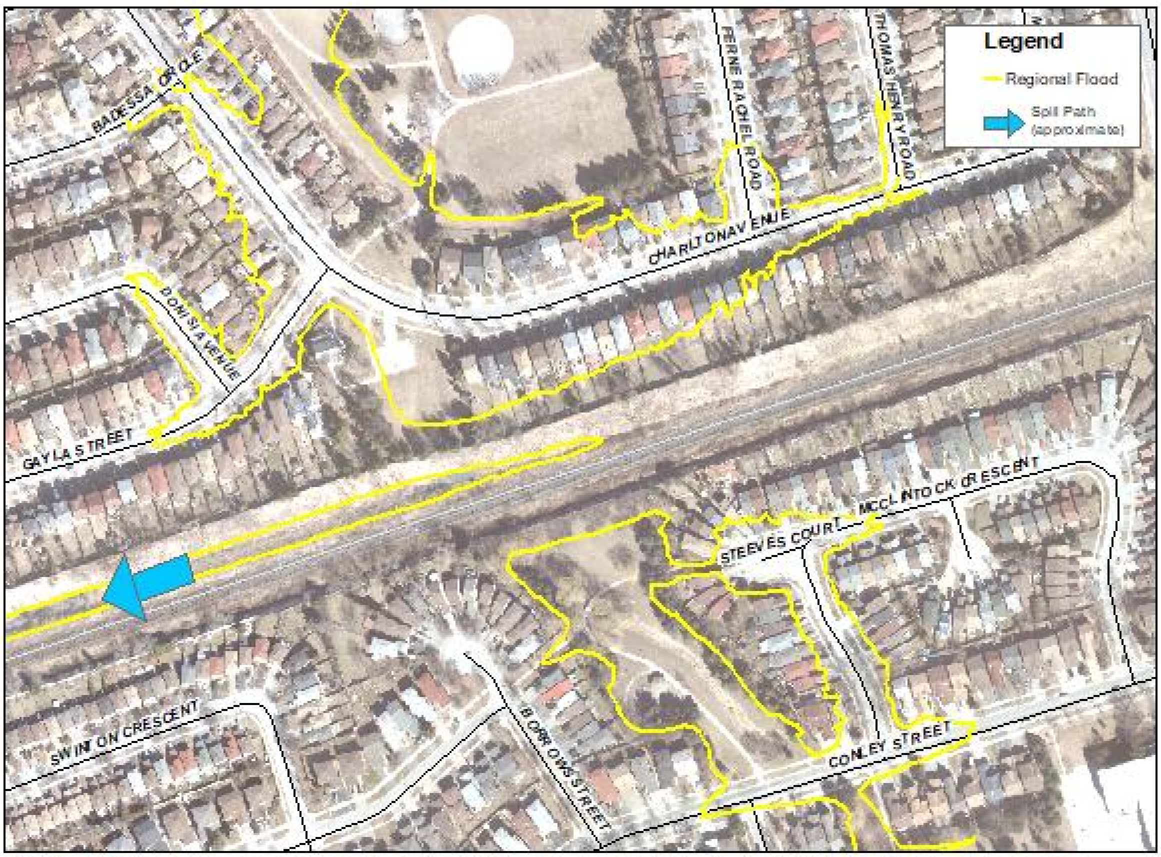


Figure 10-53: Spill Area #27 – Railway: Local Context

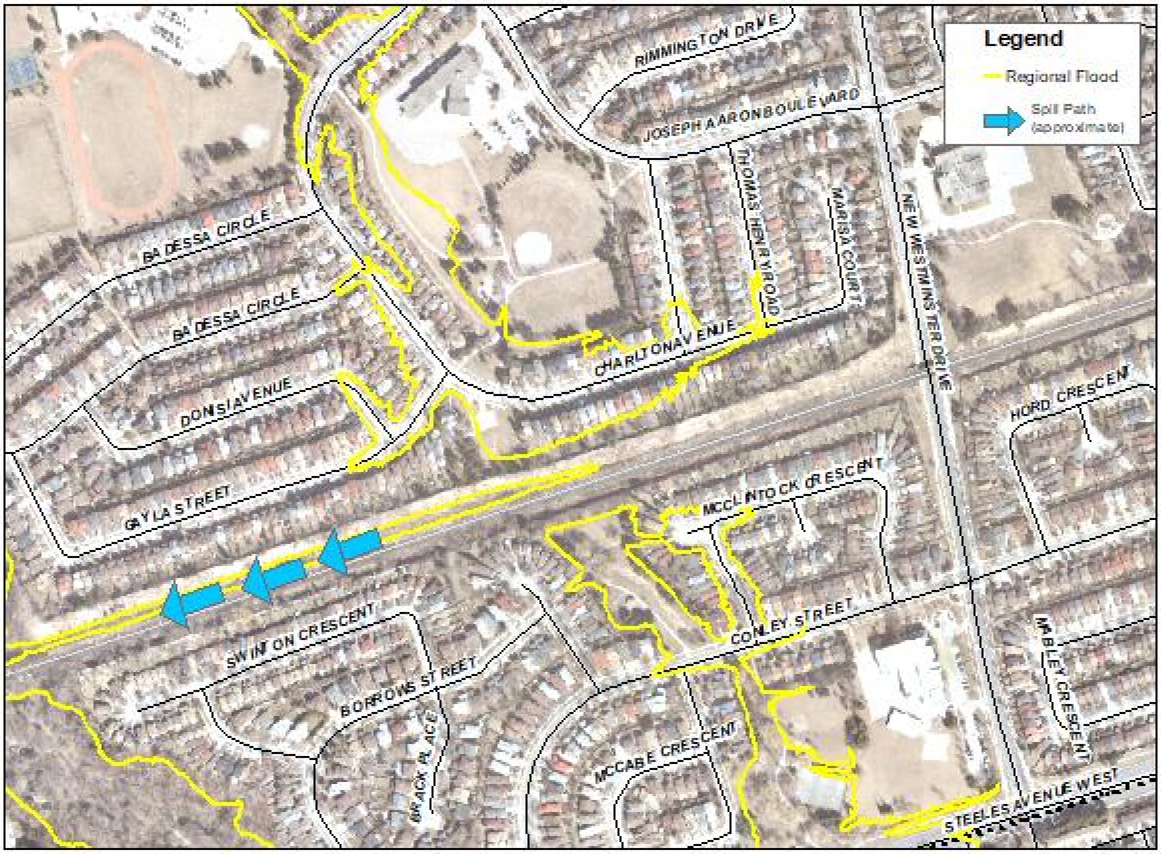


Figure 10-54: Spill Area #27 – Railway: Possible Spill Pathways

The following metrics are available:

- The grades along the Railway generally fall to the west. The ground elevations associated with these features, generally in the area of potential spill, is 187.95 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 188.34 m and 187.78 m, respectively, a difference of 0.56 m (about 1.8 feet)
- The width of the spill zone, as depicted, is less than 15 m for the Regulatory Flood
- The grades along the Railway spill path is approximately 0.40%
- The Regulatory Flood flow at this location is 53.92 m^3/s

10.3.1.28 Spill Area #28 – Long Pipe Flow Area 1 Fishersville Creek at Steeles Avenue West

Spill Area #28 is located on the south side of Steeles Ave. West at long pipe flow area on watercourse Fishersville Creek Reach 3 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 538.17 and 281.62 (**Figure 10-55**).

Spill waters from the area would be expected to flow south of Steeles Ave. West. The available topographic information also suggests the possibility that spill waters may flow along the easement about 250 m and discharge to the same tributary near HEC-RAS section 362.13 (**Figure 10-56**). The available topographic information also suggests the possibility that spill waters may flow into the residential area south of Steeles Ave. West.

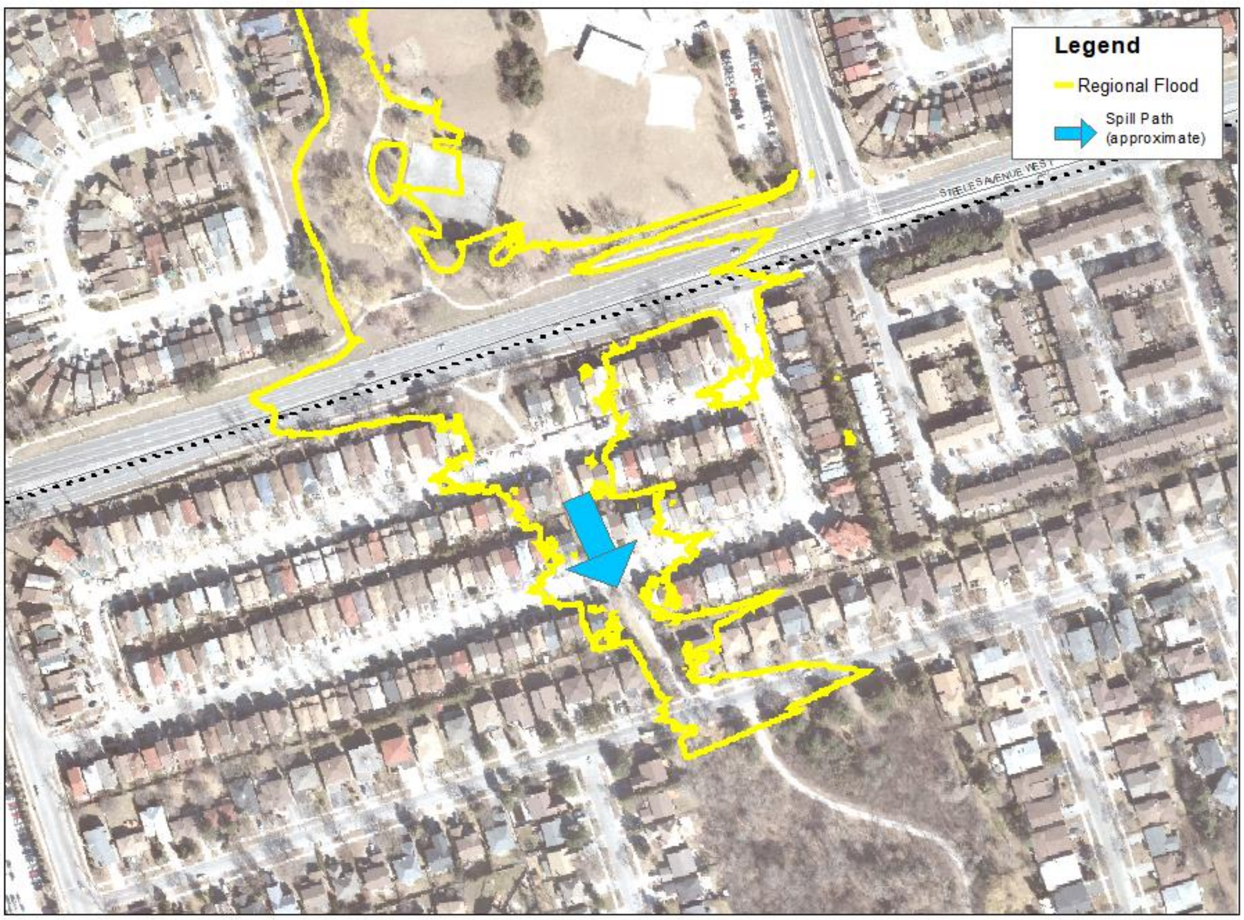


Figure 10-55: Spill Area #28 – Steeles Ave. West: Local Context

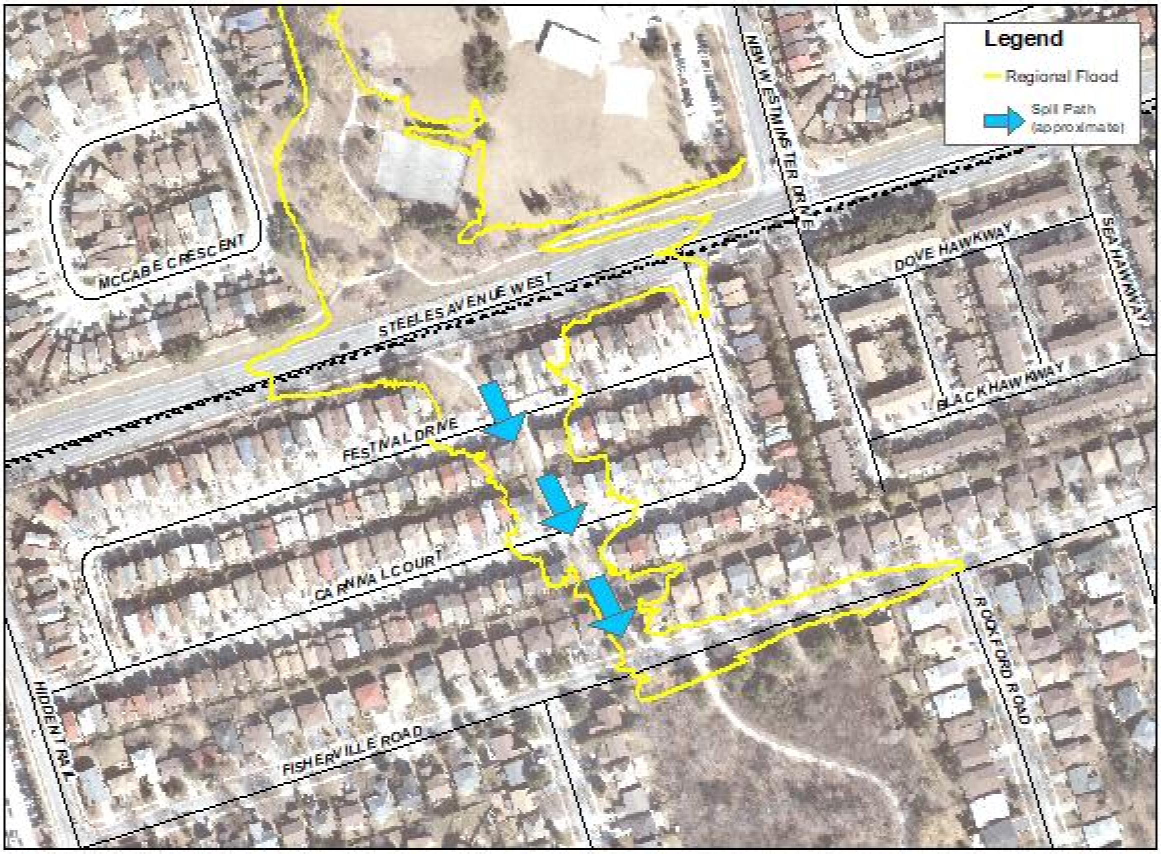


Figure 10-56: Spill Area #28 – Steeles Ave. West: Possible Spill Pathways

The following metrics are available:

- The grades near Steeles Ave. West generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 184.7 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 185.99 m and 184.21 m, respectively, a difference of 1.78 m (about 5.8 feet)
- The width of the spill zone, as depicted, is less than 250 m for the Regulatory Flood
- The grades along the Steeles Ave. West spill path is approximately 1.45%
- The Regulatory Flood flow at this location is 10.0 m^3/s

10.3.1.29 Spill Area #29 – Long Pipe Area 2 West Don River at Bradwick Drive

Spill Area #29 is located on the south side of Bradwick Drive at long pipe flow area on watercourse West Don River Tributary 10 Reach 1 and Reach 2 in Vaughan. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1172.02 (Reach 1) and 123.36 (Reach 2) (**Figure 10-57**).

Spill waters from the area would be expected to flow south of Bradwick Drive. The available topographic information also suggests the possibility that spill waters may flow along Highway 7 and Rivermede Road about 1105 m and discharge to the West Don River Reach 15 near HEC-RAS section 112.54 (**Figure 10-58**). The available topographic information also suggests the possibility that spill waters may flow onto Highway 7 south of Bradwick Drive.

Figure 10-57: Spill Area #29 – Bradwick Drive: Local Context

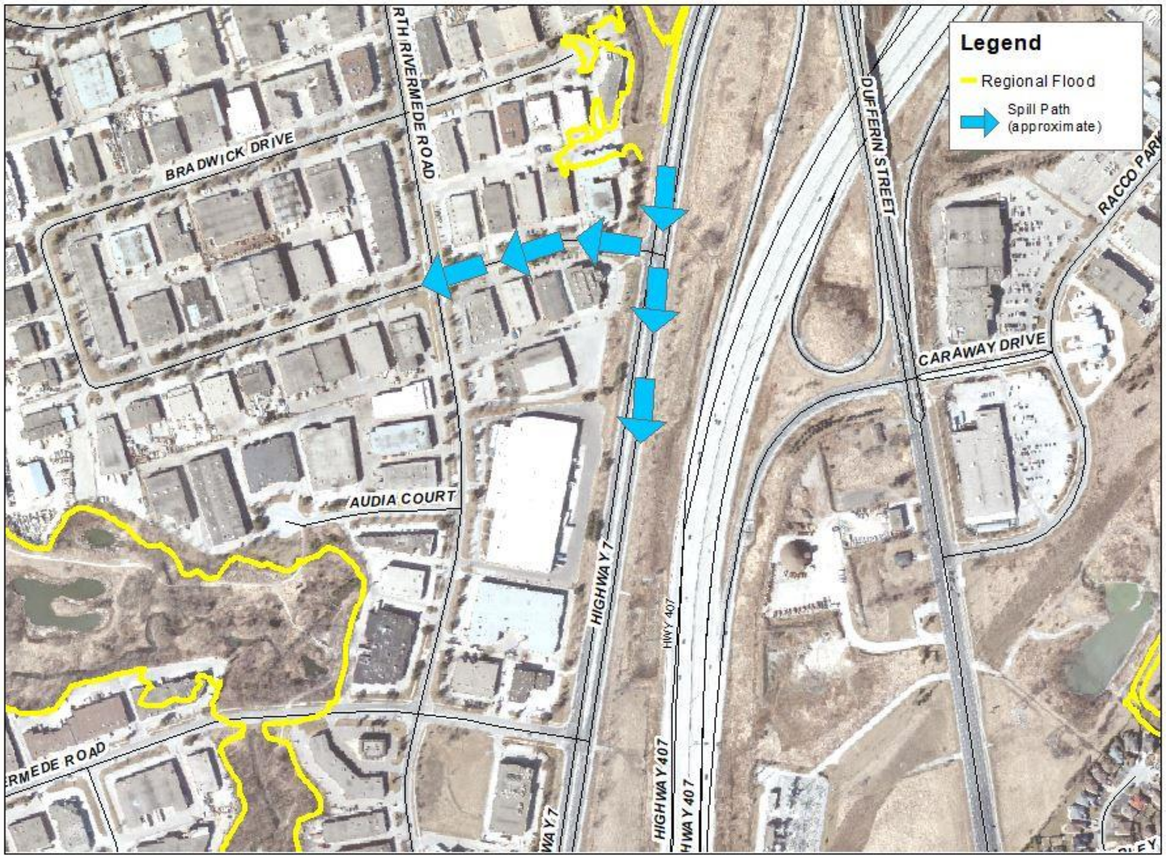


Figure 10-58: Spill Area #29 – Bradwick Drive: Possible Spill Pathways

The following metrics are available:

— The grades near Bradwick Drive generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 199.6 m
— The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 201.76 m and 196.05 m, respectively, a difference of 5.71 m (about 18.7 feet)
— The width of the spill zone, as depicted, is less than 58 m for the Regulatory Flood
— The grades along the Bradwick Drive spill path is approximately 1.04%
— The Regulatory Flood flow at this location is 20.93 m^3/s

10.3.1.30 Spill Area #30 – Long Pipe Flow Area 3 East Don River at Clark Avenue

Spill Area #30 is located on the south side of Clark Drive at long pipe flow area on watercourse East Don River Tributary 6 Reach A1, A1A, A11 and A12 in Markham. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 483.7 (Reach A1) and 816.19 (Reach 1) (**Figure 10-59**).

Spill waters from the area would be expected to flow south of Clark Ave. through two locations. First is through the culverts under the Railway. When the water level backups from the culverts under the railway, the spill waters will flow to Doncaster Ave. that underpass the Railway. The available topographic information also suggests the possibility that spill waters may flow along Doncaster Ave. about 615 m and discharge to the same tributary near HEC-RAS section 112.54 (**Figure 10-60**). The available topographic information also suggests the possibility that spill waters may flow into residential areas south of Clark Drive and south of the Railway.

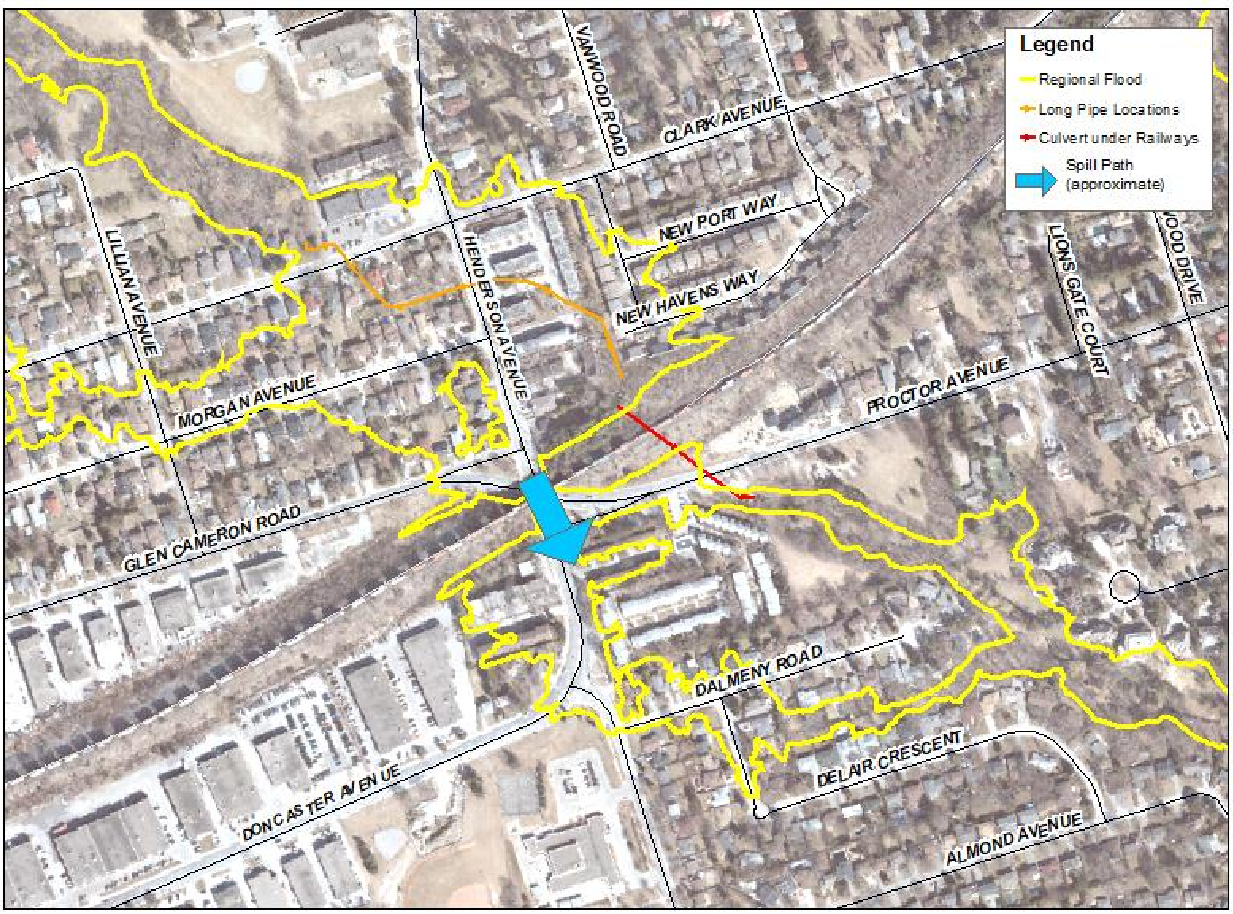


Figure 10-59 Spill Area #30 – Doncaster Ave: Local Context

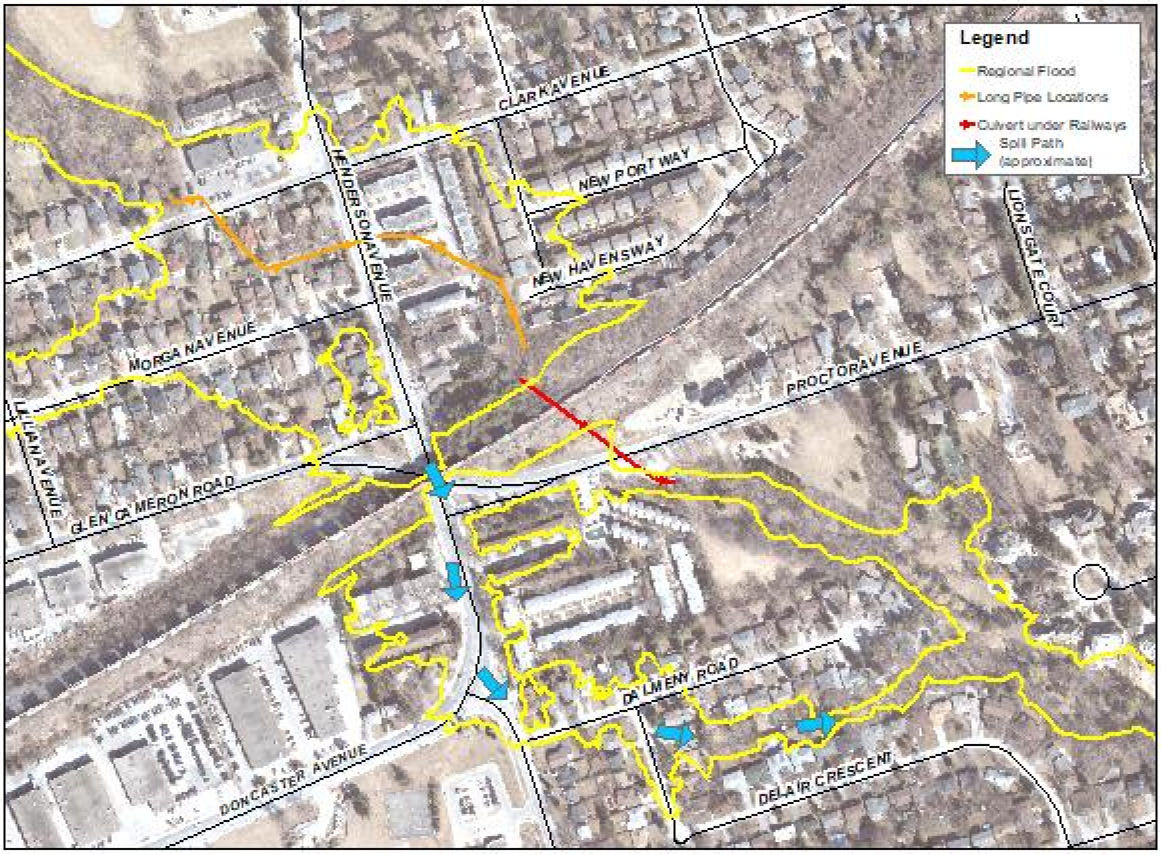


Figure 10-60: Spill Area #30 – Doncaster Ave: Possible Spill Pathways

The following metrics are available:

- The grades along Doncaster Ave generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 155.41 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 162.76 m and 154.06 m, respectively, a difference of 8.7 m (about 28.5 feet)
- The width of the spill zone, as depicted, is less than 311 m for the Regulatory Flood
- The grades along the Doncaster Ave spill path are approximately 0.26%
- The Regulatory Flood flow at this location is 11.79 m^3/s

10.3.1.31 Spill Area #31 – Long Pipe Flow Area 4 East Don River Tributary Piped from Yonge Street to Elgin Street (North)

Spill Area #31 is located on the east side of Yonge Street at long pipe flow area on watercourse East Don River Tributary 6 Reach A1 in Markham. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 18884.83 (Reach A1) and 1113.51 (Reach 1) (**Figure 10-61**).

Spill waters from the area would be expected to flow south of John Street. The available topographic information also suggests the possibility that spill waters may flow along Marie Court and Alcaine Court about 435 m and discharge to the same tributary near HEC-RAS section 1077.04 (**Figure 10-62**). The available topographic information also suggests the possibility that spill waters may flow into the residential area south of the intersection of Yonge Street and John Street.

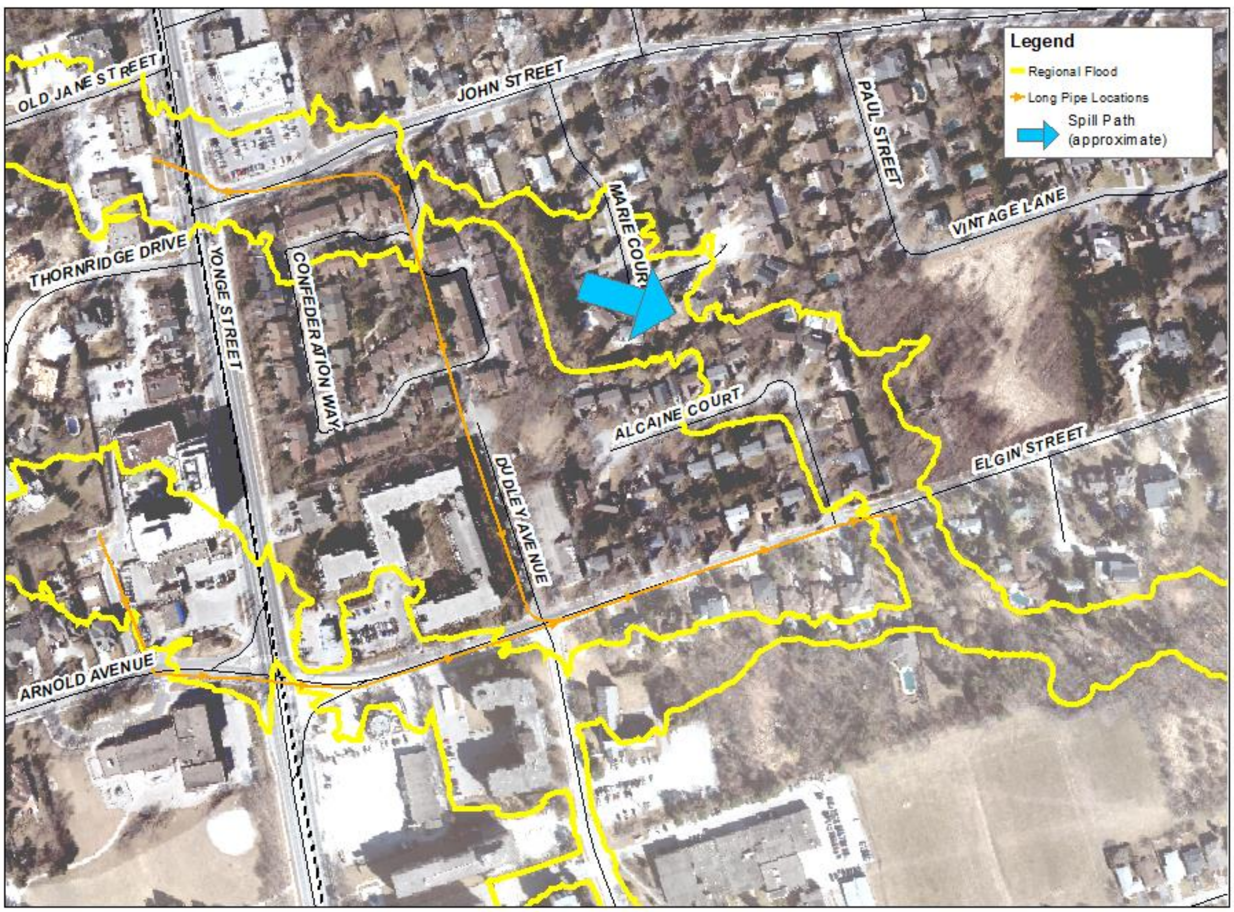


Figure 10-61: Spill Area #31 – Yonge Street: Local Context

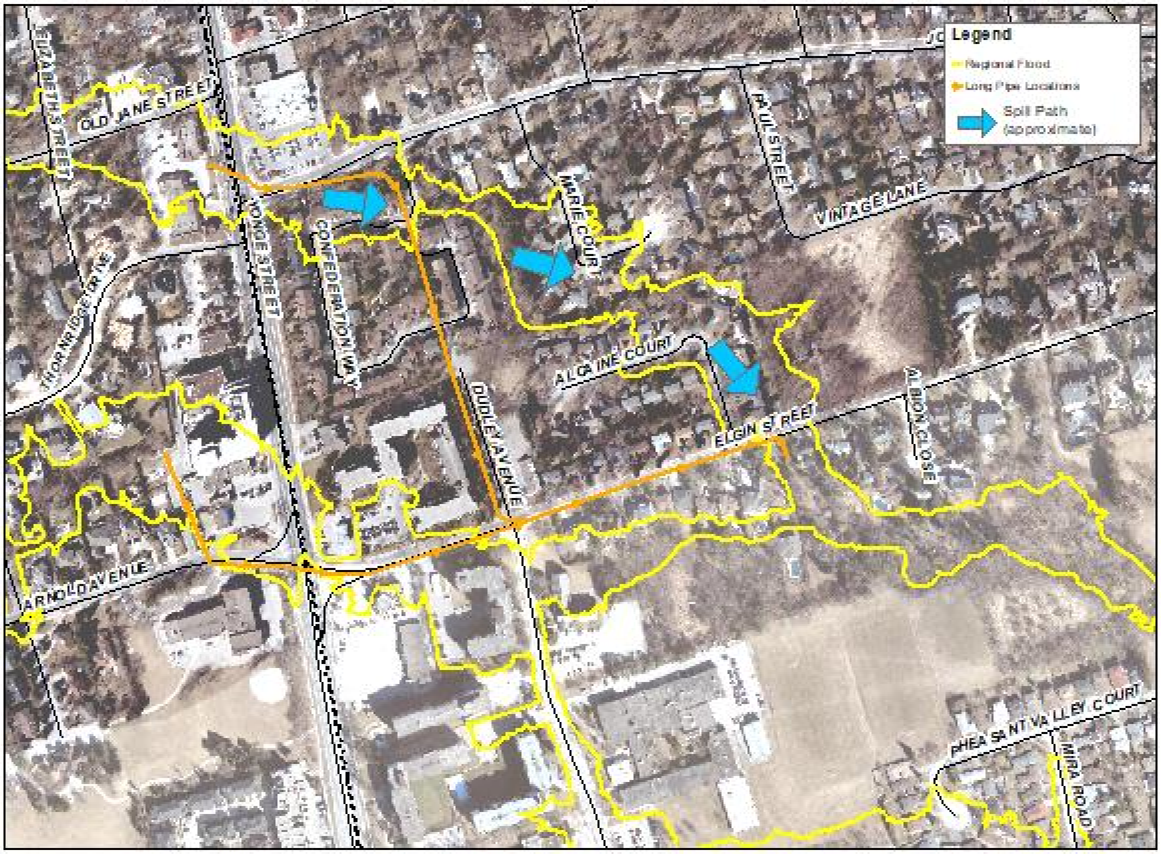


Figure 10-62: Spill Area #31 – Yonge Street: Possible Spill Pathways

The following metrics are available:

- The grades along the residential areas south of Yonge Street and John Street generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 174.40 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 174.82 m and 165.31 m, respectively, a difference of 9.51 m (about 31.2 feet)
- The width of the spill zone, as depicted, is less than 118 m for the Regulatory Flood
- The grades along the Yonge Street spill path is approximately 1.41%
- The Regulatory Flood flow at this location is 23.95 m^3/s

10.3.1.32 Spill Area #32 – Long Pipe Flow Area 4 East Don River Tributary Piped from Yonge Street to Elgin Street (South)

Spill Area #32 is located on the east side of Yonge Street at long pipe flow area on watercourse East Don River Tributary 6 Reach D1 in Markham. The Regulatory Flood inundation limits are unconfined in this area between HEC-RAS sections 1766.41 (Reach D) and -1307.51 (Reach D) (**Figure 10-63**).

Spill waters from the area would be expected to flow south of Elgin Street. The available topographic information also suggests the possibility that spill waters may flow along Dudley Ave. and Clarkaven Line about 435 m and discharge to the East Tributary 6, Reach A1a, near HEC-RAS section 241.94 (**Figure 10-64**). The available topographic information also suggests the possibility that spill waters may flow into the residential area south of the intersection of Yonge Street and Elgin Street.

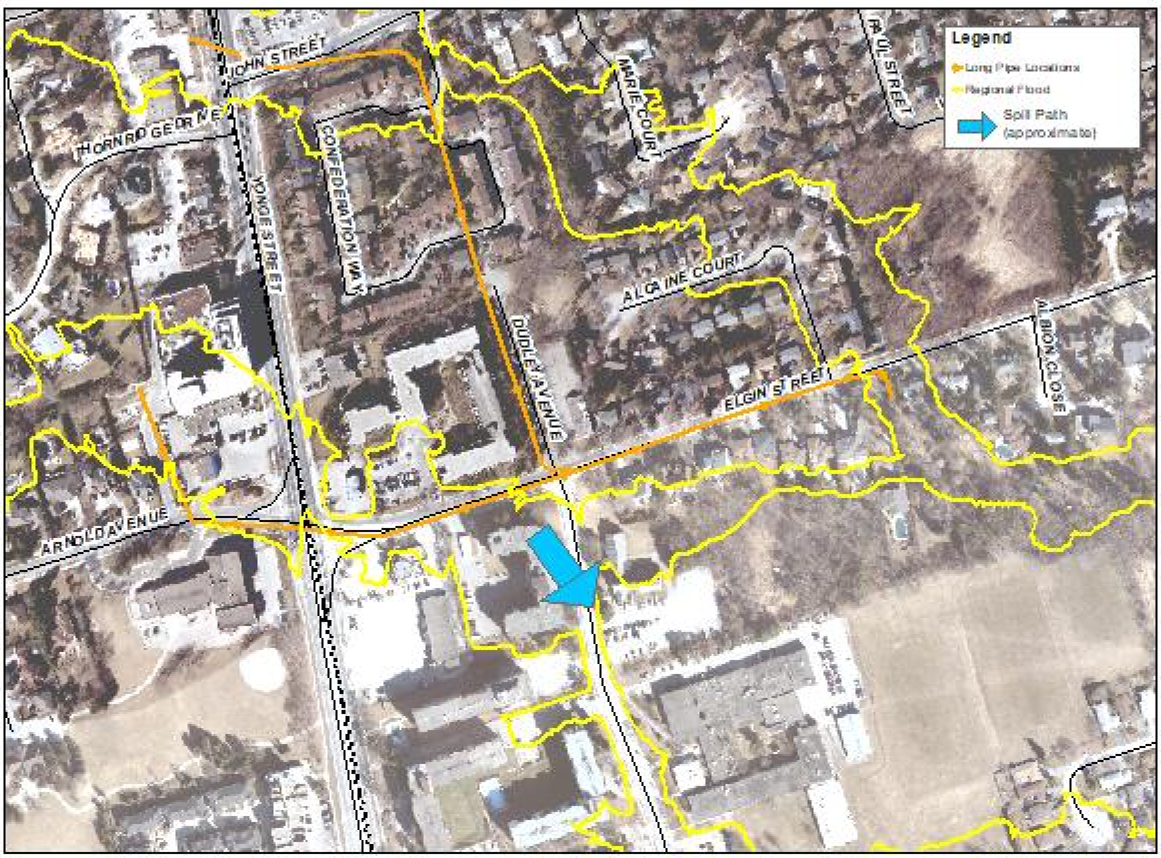


Figure 10-63: Spill Area #32 – Yonge Street – Local Context

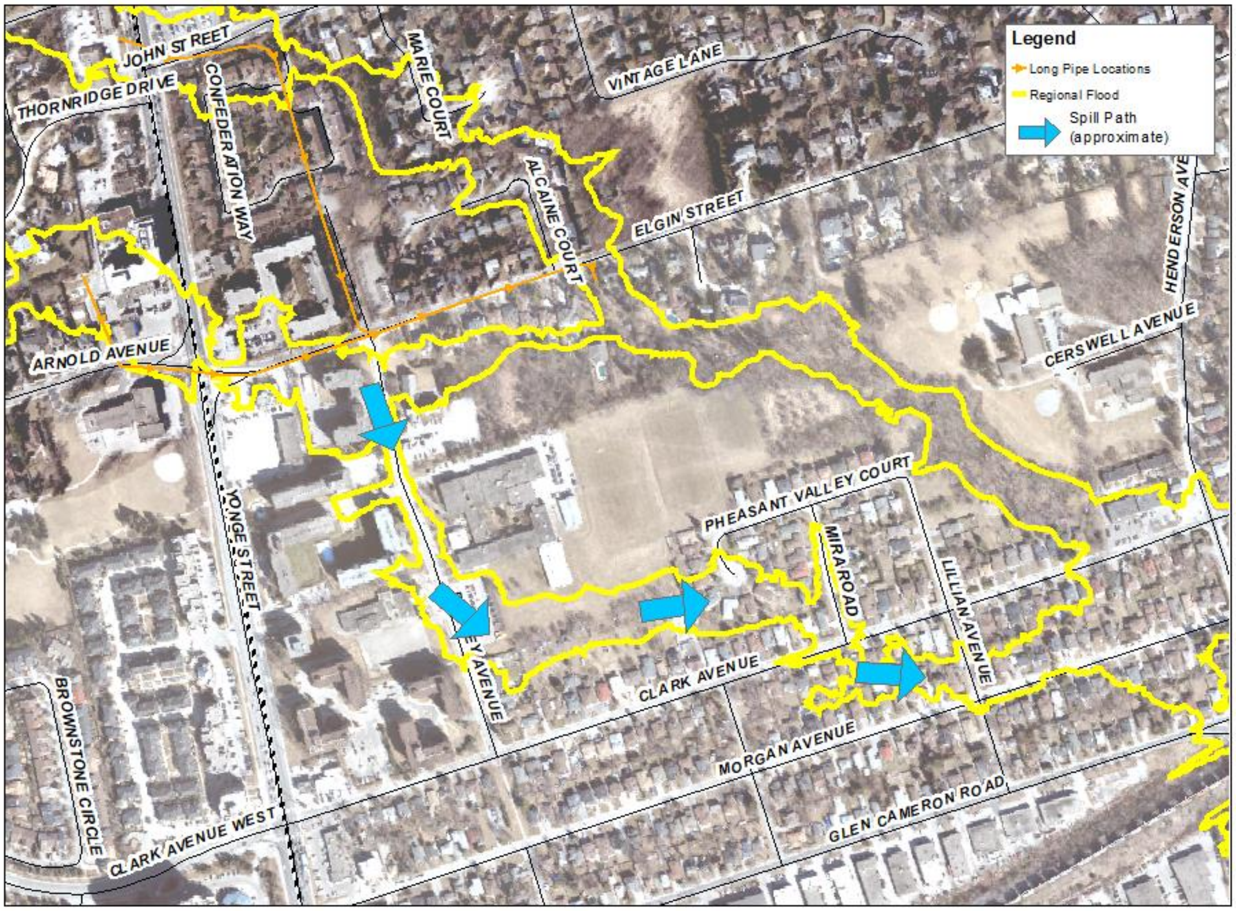


Figure 10-64: Spill Area #32 – Yonge Street: Possible Spill Pathways

The following metrics are available:

- The grades along the residential areas south of Yonge Street and Elgin Street generally fall to the south. The ground elevations associated with these features, generally in the area of potential spill, is 173.27 m
- The Regulatory Flood computed water surface elevations associated with the spill zone bounding HEC-RAS sections are 173.88 m and 163.67 m, respectively, a difference of 10.21 m (about 33.5 feet)
- The width of the spill zone, as depicted, is less than 114 m for the Regulatory Flood
- The grades along the Yonge Street spill path is approximately 1.0%
- The Regulatory Flood flow at this location is 5.34 m^3/s

10.4 Development of Graphical Representations of Model Data

As part of the project, WSP prepared the below deliverables for the TRCA:

- Structure Data Sheet: compiled the field inventory sheets from the field reconnaissance in 2019
- TRCA Standard Manning's Roughness: provided by the TRCA as part of the background data
- PCSWMM Modelling Memo: prepared a technical memo for the identified piping areas using PCSWMM modelling
- HEC-RAS Output: prepared a standard HEC-RAS output table for all reaches for all storm events
- Flow Nodes Used for the Development of HEC-RAS Model Flow Table: provided by the TRCA
- Modelling Approach by Crossing Structure: extracted source information of structure geometry used in the model from the master structure comparison table
- Regulatory Floodplain Mapping of the Don River Phase II

11 SUMMARY

WSP was contracted by the TRCA to perform the Don River Floodplain Mapping Update – Phase II (Contract # 10020950). The study limits included the Don River East and West branches and their tributaries north of Steeles Avenue, which has a watershed area of approximately 150 km^2.

These tasks were completed for the project:

— Collected and reviewed the background data for the study area

— Conducted field reconnaissance to collect the detail information for a total of 346 crossings; prepared a master structure comparison table including three sources of data: as-built drawings, existing HEC-RAS models and field survey

— Developed the low flow channels for the lower reach of the East and West Don River and the lower reach of the German Mills Creek with a total of 28.1 km in length; incorporated the low flow channel and 31 grading changing areas to the LiDAR to create a revised DEM for the hydraulic model

— Developed the PCSWMM models for 4 identified piped areas; the computed water levels from the PCSWMM models were used as the HEC-RAS model internal boundaries in these areas

— Developed a HEC-RAS (version 5.0.7) hydraulic model that included approximately 150.7 km of stream network and a total of 304 structures (bridges, culverts and inline structures) within the study limits

— Performed steady simulations for 2- to 100-year, 350-year and Regional events using the peak flows received from the TRCA; conducted the sensitivity analysis on boundary conditions (±0.3 m), roughness coefficients (±15%) and flow inputs (±10%), the sensitivity analysis results show the model is stable under a range of variations in these parameters.

— Generated the Regulatory floodlines; identified 32 potential spill areas under the Regulatory event and estimated the flow path for each spill

— Prepared a technical report to document the methodology of the hydraulic analysis; prepared seven deliverables to meet the requirements of the TRCA

APPENDIX

A

Structure Data Sheets

APPENDIX

B

TRCA Standard Manning's Roughness

APPENDIX

C

TRCA Modelling Memo

APPENDIX

D

HEC-RAS Output

APPENDIX

E

Flow Nodes Used for the Development of HEC-RAS Steady Flow Table

APPENDIX

F

Modelling Approach by Crossing Structure

APPENDIX

G

Updated Regulatory Floodplain Mapping of Don River Phase II