April 30, 20225

Our File: 2024-5504

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Attention: Engineering Services | Development and Engineering Services

Re: Flood Spill Analysis for Development at 375-421 Kingston RD

1. Introduction

Schaeffer and Associates Ltd. (SCE) has been retained to provide floodplain modeling and Spill analysis for the development of the properties at 421 Kingston RD the City of Pickering ("the subject site") as shown in Figure 1. This Flood Spill Analysis has been prepared for the Regulatory Flood event in support of Site Plan Application (SPA) for a high-rise site plan development by 375 Kingston Road Corporation and 401 Kingston Road Corporation. It has been conducted to address and characterize the spill conditions also according to Toronto and Region Conservation Authority (TRCA) floodplain mapping data (1D HEC-RAS results) showing that there is a floodplain spill at the intersection of Rougemount Drive and Dalewood Drive (**Figure 2**).

To assess the potential spillover in the designated area, SCE has performed an initial analysis using the TRCA-approved 1D HEC-RAS model alongside Lidar data of the surrounding region. This preliminary floodplain analysis indicated that there is a possibility of flooding along Kingston Rd due to backwatering caused by the undersized infrastructure. In response, SCE proposes to further analyze the floodplain by integrating 1D modeling with 2D techniques through the MIKE Flood model. The model was created to understand the extent and impacts of the overland spill after it leaves Petticoat Creek – Reach Tributary B1. The purpose of the current Project is to address the hazard and access/egress concerns effecting the subject site. This approach will improve the characterization of potential spill conditions and confirm whether safe access/egress issues are adequately addressed. This study will ensure compliance with the Ontario Ministry of Natural

Resources and Forestry (MNRF) guidelines as well (River & Stream Systems: Flooding Hazard Limit guidelines, 2002).

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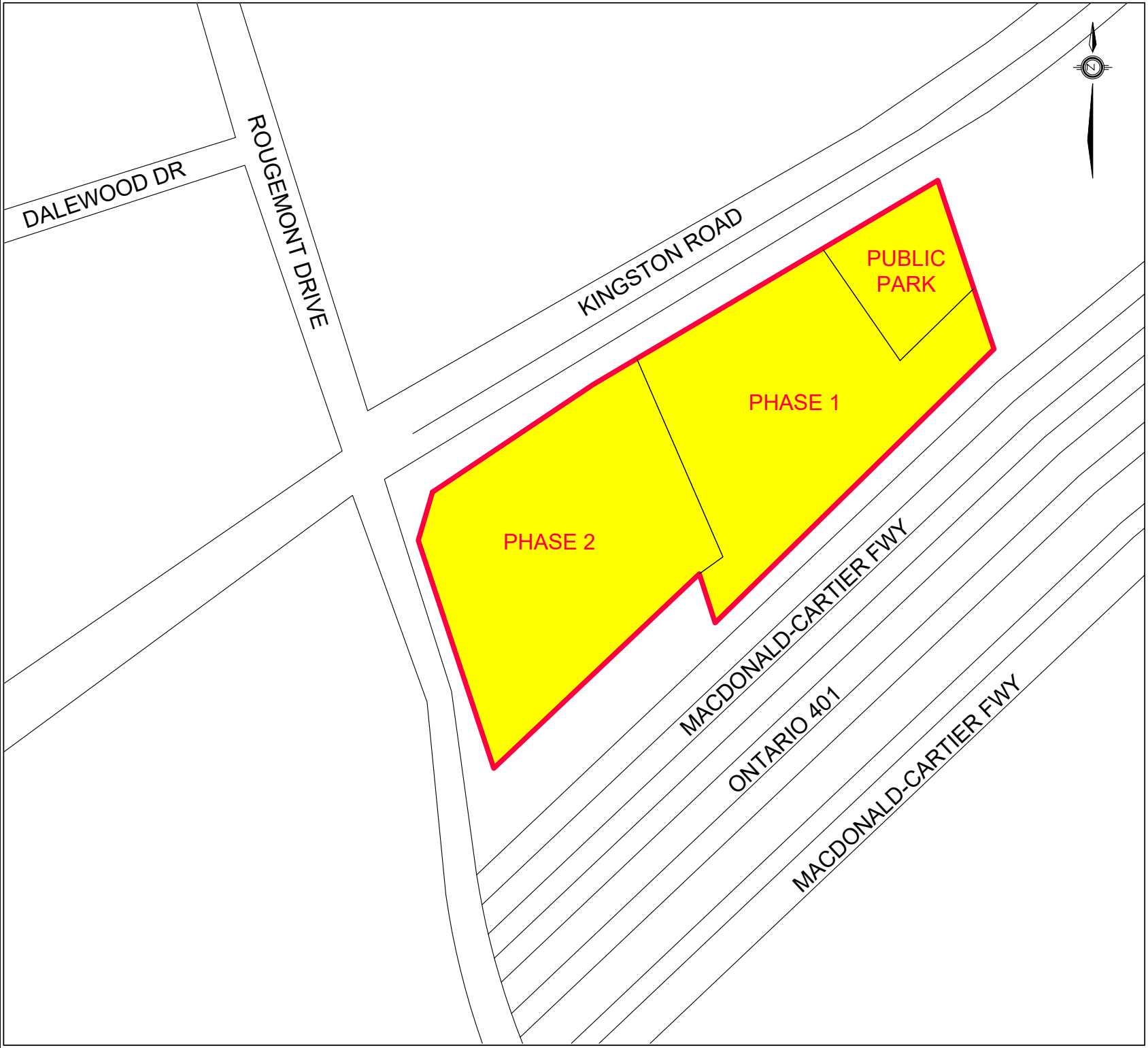
Phil Gotfried



PROPOSED MIXED USED DEVELOPMENT
375 - 421 KINGSTON ROAD
CITY OF PICKERING

LEGEND

SUBJECT AREA

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FIGURE 1
LOCATION PLAN

2024-5504	APRIL 2025	SCALE: N.T.S.

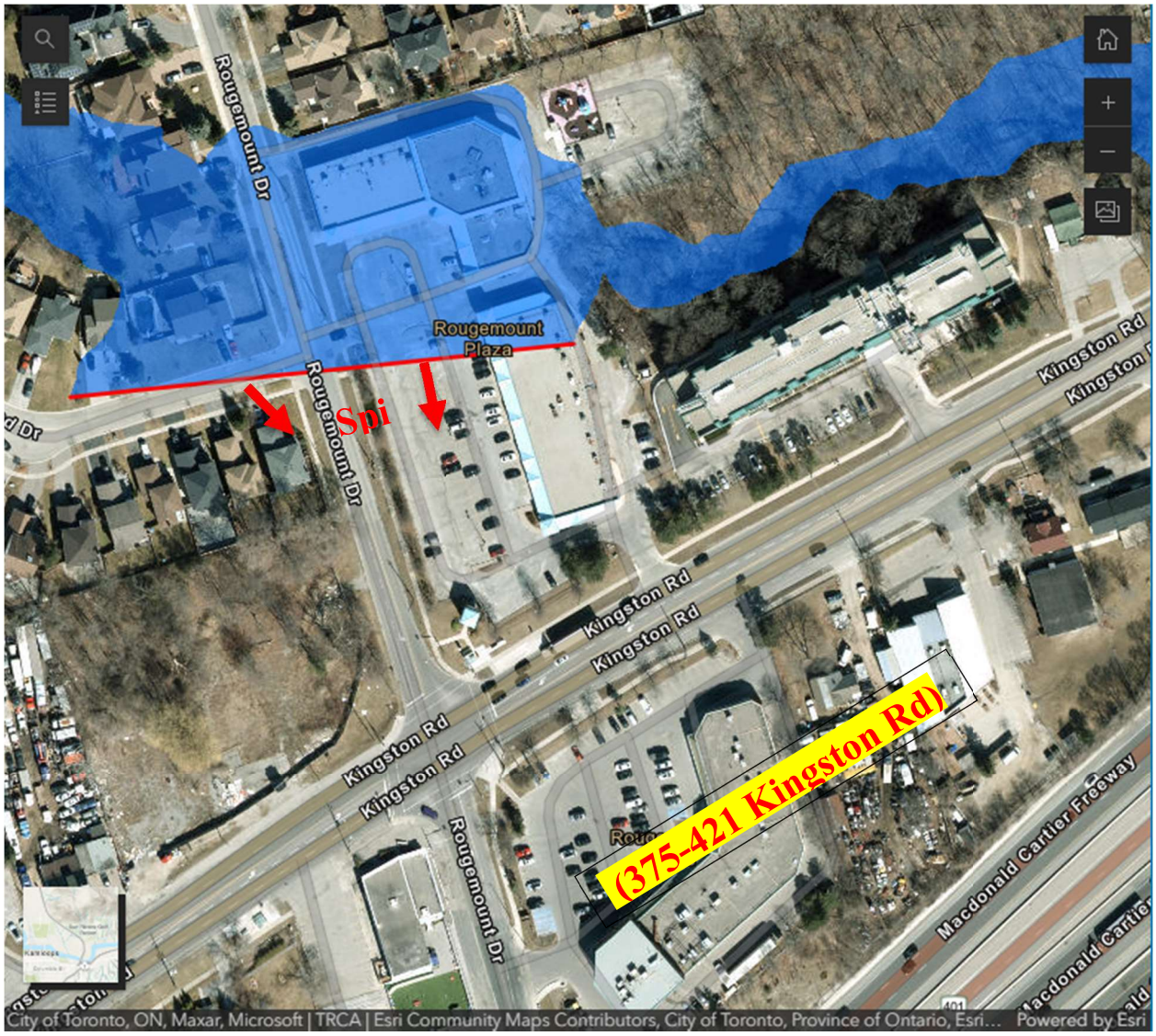

Figure 2: Possible Spill Location at Study Area (TRCA Floodplain Map)

2. Background and Study Area Description

The subject site is located the jurisdiction of TRCA. As shown in **Figure 1**, it is located at the southeast corner of Kingston RD and Rougemount Drive. This analysis examines the spill conditions identified by TRCA with respect to the tributaries in the subject area (Petticoat Creek).

The following resources were reviewed in preparation for this report. Relevant excerpts from the references below are provided in the enclosures to establish context and provide background:

- TRCA Approved Petticoat Creek HEC-RAS Model, dated 2023, and received from TRCA in November 2024.
- TRCA approved Floodplain Map and Topography mapping, dated May 2023, and received from TRCA in August 2024.
- Petticoat Creek Hydrology Update Report, dated December 21, 2020, by WSP, and received from TRCA in 2024.
- TRCA approved Hydrology Model (VO Model), Petticoat Creek Watershed, dated 2020, and received from TRCA in 2024.
- TRCA prepared a preliminary MIKE Flood 2D Model, dated 2023, and received from TRCA in 2024.

As depicted on the Location Map (Figure 1), the subject site is situated at the southeast corner of Kingston RD and Rougemount Drive in the City of Pickering. The Petticoat Creek crosses Rougemount Drive through an existing culvert situated approximately 80 meters northwest of the Rougemount Drive and Kingston RD intersection. Currently the original path of the creek is at the eastside of Rougemount Drive was altered by a midrise development which pipes the flow through its site plan. As a result of this condition, it is anticipated that undersized piping solution as well as overland flow blockages caused by those buildings contribute to the possible spill.

The possible spill would be occurring at this location south side of the existing culvert. After passing under Rougemount Drive and the residential development, the Petticoat Creek continues across Kingston RD via another culvert located about 300 m east of Rougemount Drive and Kingston RD. Following through the Kingston crossing, the creek flows south along the south side of Kingston RD and crosses Highway 401 again through a culvert located roughly 150 m south of the Kingston RD crossing.

3. Topographic Data

SCE utilized topographic LiDAR data acquired from First Base Solutions and integrated it with TRCA's existing conditions mapping to expand the coverage area. The LiDAR-derived topography was incorporated into the contour map used in the TRCA-approved floodplain mapping. This combined and detailed topographic dataset was then used to develop a high-

resolution Triangulated Irregular Network (TIN) for generating digital terrain layers. All analyses for the Project were conducted using the NAD 83 Zone 17 coordinate system and the Canadian Vertical Geodetic Datum of 1928, adjusted in 1978 (CVGD28:78).

A 2D flexible mesh has been developed in the study area limits to reflect the terrain elevations at the creek channel and the floodplain areas. This 2m * 2m mesh would be used as input data into the MIKE 21 and will be linked to the channel by a lateral weir structure.

4. Spill Location

In the existing conditions, under 1D modeling, Petticoat Creek experiences spill conditions at the Rougemount Drive crossing, located northwest of its intersection with Kingston Road. This potential spill area is identified on the TRCA Floodplain Map, as shown in **Figure 2**. It's important to emphasize that these spill conditions are associated with a Regulatory Flood event. The existing culvert at the Rougemount Drive crossing is a 1.5 m diameter, 85 m long pipe culvert. This culvert plays a significant role in creating backwater conditions upstream, which can elevate water levels to the point of overtopping the roadway. **Figure 3** shows a cross-section of this existing crossing at Rougemount Drive (according to the TRCA-approved 1D HEC-RAS Model information).

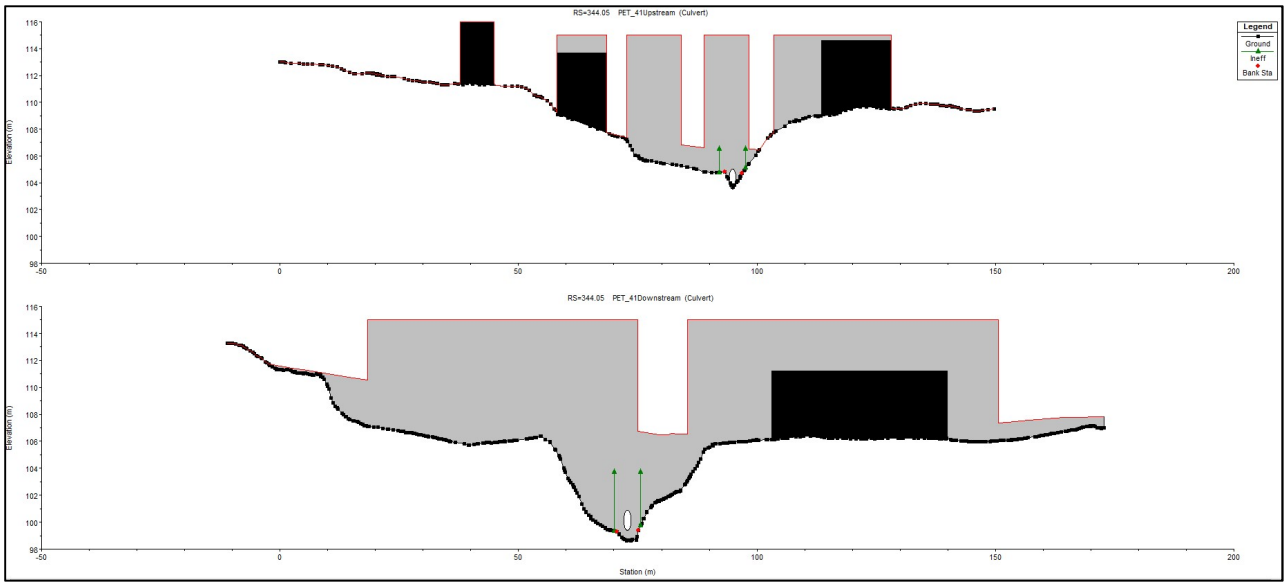

Figure 3: U/S and D/S of the Crossing at Rougemount Drive (Source: TRCA Approved HEC-RAS 1D Model)

To determine the location of the spill, a primarily analysis of the creek's spill conditions was conducted using the HEC-RAS model. The Toronto and Region Conservation Authority (TRCA) provided an approved HEC-RAS model titled “PetticoatCreek_June2022”, which was used for this assessment. SCE reviewed the floodplain using this latest TRCA-approved model and

prepared a detailed spill analysis to illustrate the extent of overflow in the surrounding areas. Subsequently, TRCA's initial, unapproved MIKE Flood 2D model was used to gain a more comprehensive understanding of the situation, particularly identifying a spill over the existing culvert at Rougemount Drive. This report primarily focuses on the methodology for integrating 1D and 2D modeling using MIKE Flood, based on supplementary information provided by TRCA.

5. Methodology of MIKE Flood Modeling

The Floodplain Mapping in Petticoat Creek will produce a 1D-2D integrated MIKE FLOOD hydraulic model. This model was used to define Regional flood maps in support of the site plan application. A 1D-2D model was required to capture the complex nature of the overland flow patterns within the study area, which could not otherwise be adequately delineated using traditional 1D hydraulic modelling techniques (e.g., HEC-RAS).

The Floodplain Mapping was conducted through a MIKE FLOOD (program supplied by DHI) model based on the latest TRCA-approved hydraulic model for the site. The spill flow hydraulics have been analyzed by incorporating two lateral weir structures into the MIKE 11 model, along the two sides of the Petticoat Creek and at the spill location. To enhance the interpolation of spill flow along the floodplain, a 2D mesh has been created and incorporated into the MIKE Flood Model. A detailed description of floodplain mapping and spill analysis will be explained in the following sections.

5.1 Hydrology

WSP developed and completed the hydrology update for Petticoat Creek in 2020 for TRCA. The watershed has a drainage area of approximately 25.8 km^2 and is surrounded by the Rouge River, Duffins Creek, and the Frenchman’s Bay watersheds.

A Visual Otthymo model was developed by WSP (2020) for the Petticoat Creek watershed. The hydrologic model development included: computing catchment parameters, identifying suitable rainfall events, and calibrating and validating the model. A total of 99 subcatchments are included in the hydrologic model. The drainage area upstream of the Trib B1 is 26.1 ha. The 2-year through 100-year design storms were simulated using the 12-hour AES distribution. Consistent with hydrologic modelling principles that align with provincial policy, the Regional storm (Hurricane

Hazel) was simulated using a 12-hour storm period with antecedent moisture conditions represented by an AMC III condition. SCE would be using the flow rates from the Tributary B1 of the Petticoat Creek for hydraulic analysis. The watershed, Flow Node and location of Tributary B1 are shown in **Figure 4**.

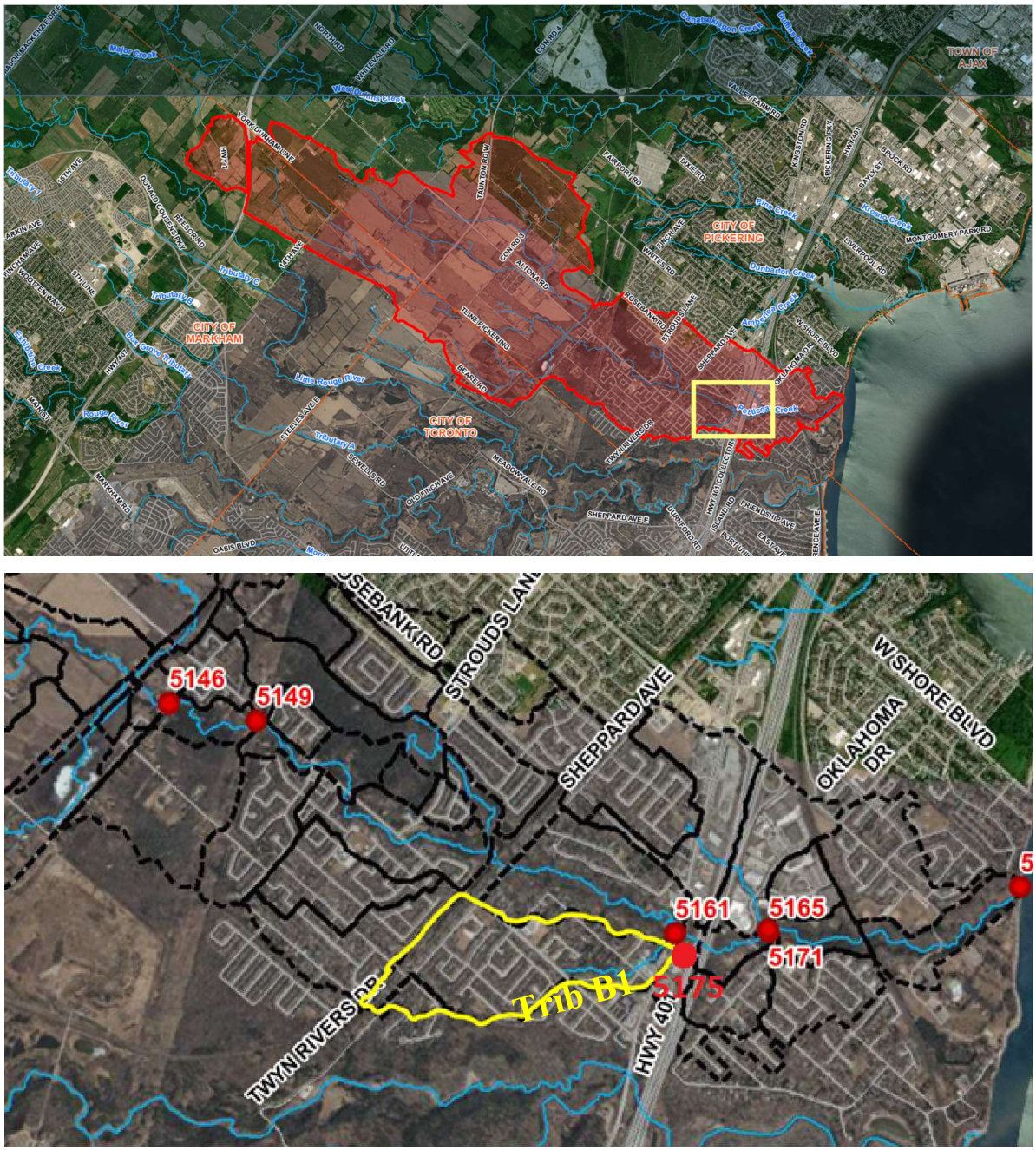

Figure 4: Petticoat Creek Watershed, Node #5175 and Study Area (Source: WSP 2020)

Flows for the design storms and Regional storm within the study area at Node 5175 are presented in **Table 1**.

Table 1 Summary of Peak Flows for Petticoat Creek at Node #5161

Flow Location		Peak Flow Rate (m3/s)						
Petticoat CK Reach	Node	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	Regional (Hazel)
Tributary B1	5175	5.19	7.63	10.42	13.86	15.39	18.35	25.44

The flows from the 2020 Petticoat Creek Hydrology Report (WSP 2020) have been used to support the hydraulic modelling and mapping updates in the subsequent studies described in the following sections.

5.2 Hydraulic Features and Road Crossings

The current approved HEC-RAS 1D modeling incorporates two (2) existing culverts along the Petticoat Reach Trib1 with in the subject area, specifically the first one at the Rougemount Drive crossing and the second one towards the downstream is located beneath a private property at the intersection with Kingston Drive. Data regarding these culverts was sourced from the approved TRCA hydraulic 1D model. **Table 2** provides a summary of the details of these existing culverts. It is important to note that the culvert at Rougemount Drive crossing does influence the spill conditions and backwater effects on the major drainage channel. It helps convey a portion of the major Petticoat Creek flows toward the natural open space on the downstream side of Rougemount Drive and returns the water to the natural watercourse downstream.

Table 2: Summary of Existing Road Crossing Data

Crossing ID	Street Name	HEC-RAS ID	MIKE 11 Node ID	Culvert Type	Culvert Dimension (m)		Invert Elevation (m)		Road Top Elev.(m)
					Diameter (m)	Length	U/S	D/S	
Crossing #1	Rougemount Drive	344.05	462.95	Pipe	1.5	85	103.52	99.39	113.01
Crossing #2	Driveway of 430 Kingston RD	37.62	749.02	Pipe	1.8	24.52	93.02	91.89	97.48

Figure 5 shows the hydraulic features in the 1D model (MIKE 11). As can be seen in the figure, there are two major branches (watercourses) joining at a junction upstream of the Kingston Drive.

5.3 Mike Flood Modelling

In order to the Flood Modelling in the study reaches of Petticoat Creek and its floodplain areas, SCE concurred with TRCA and the City of Pickering that MIKE FLOOD is an appropriate model for assessing alternative solutions due to the hydraulically complex study areas resulting from the Petticoat Creek spills. The MIKE FLOOD model is able to accommodate and process the complex interaction between the Creek and the urban area by combining a MIKE 11 1D riverine model and a MIKE 21 2D overland flood model.

The MIKE 21 2D model used in this study is based on the topography mappings as discussed in Section 3.0. A review of the local topography and development was completed for the Project to ensure the continued appropriateness of using the model. No hydraulically significant changes have occurred within the study area since 2020. Accordingly, the 2020 LiDAR data is sufficient for use in the Project.

The 1D riverine model has been created based on the approved TRCA HEC-RAS 1D model and is encompassed of channel cross-sections that are coupled to a 2D model surface at the Top of the banks by using the two links of bank lines. On the other hand, the 2D portion allows for a detailed representation of spill locations along the channel and spill flow paths throughout the study area as it provides a detailed representation of the bank profile, overland flow paths, and obstructions. **Figure 6** illustrates the MIKE FLOOD model set-up containing 2D model domain and 1D cross-sections.

The boundary condition for the 1D riverine portion of the MIKE FLOOD model is consistent with the approved HEC-RAS model (TRCA 2023) for Petticoat Creek, which includes the study area. The model has cross-sections spaced on average every 50 m with cross-sections situated from left to right looking downstream. The existing MIKE 11 model extends from approximately 50 m east of Altona Rd at the upstream end, to the confluence with the main branch of Petticoat Creek at the downstream end.

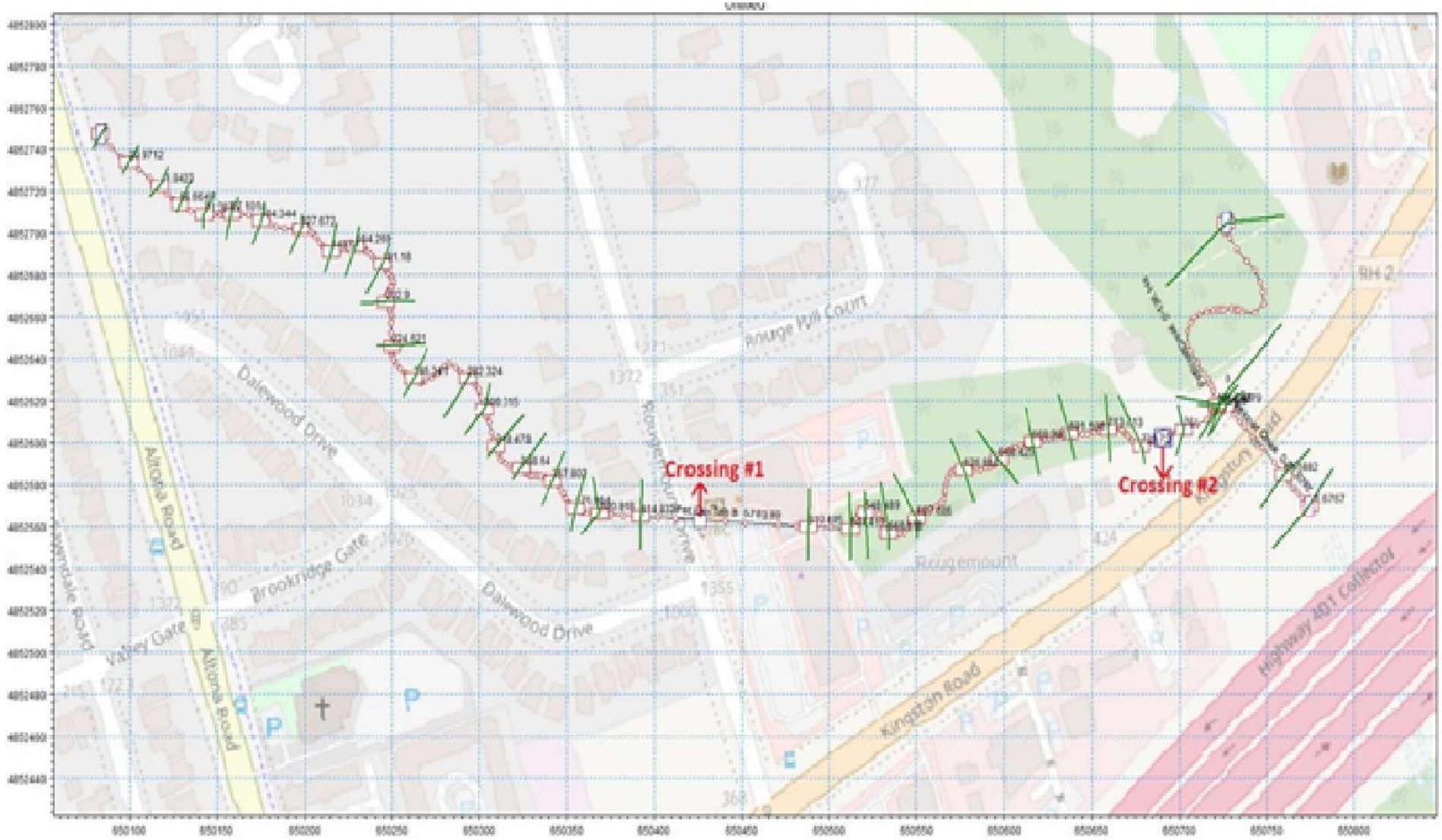

Figure 5: 1D Hydraulic Features and Road Crossings Location in MIKE Flood Environment

The MIKE 11 model extent is sufficient to represent the spill from Petticoat Creek at culvert #1. The flow from flow node 462.95 at The Rougemount Drive (refer to **Table 2**) is applied at the upstream extent of the study area to provide a conservative peak flow. The model was run to represent a steady state flow in accordance with MNRF policy.

The MIKE 21 uses a 2 m × 2 m grid to represent the surface topography and incorporates building footprints as blocked obstructions to ensure water cannot flow through the buildings. Boundary conditions are assigned to the 2D model at the southeast edge of the model domain along Kingston Road. 1D boundary conditions are also assigned along the channel beyond the extent of the 1D channel along the main branch of Petticoat Creek upstream and downstream of the confluence with the main creek.

Flood Spill Analysis for Development at 375-421 Kingston Rd

Legend

- Watercourse
- Cross Section

Excluded Areas

- Building
- River Bed
- Roadway Crossings
- 2D Mesh Area

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Figure 5	MIKE Flood Model Setup		
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90 45 0 90
Meters

As mentioned in Section 3, SCE has updated the surface topography in the TRCA 1D model terrain with an updated LiDAR data from First Base Solutions to represent the latest topo for the study area. Interpolated cross-sections downstream of Culvert #1 were recut from terrain in the floodplain to improve mapping using 1D.

After running the coupled model, the spill occurs at the Petticoat Creek once a Regulatory flood of 25.44 m^3/s is conveyed in the Creek channel towards culvert #1. This flow would result in increased flood levels at the creek and will overtop the crossing and overflow to the floodplain including an overtopping of the existing Rougemount Drive crossing. This culvert with a diameter of 1.5 m does not have adequate capacity to convey the Regulatory event (Regional flow). **Figure 7** shows the Regional Event water level profiles through Petticoat Creek and the study area.

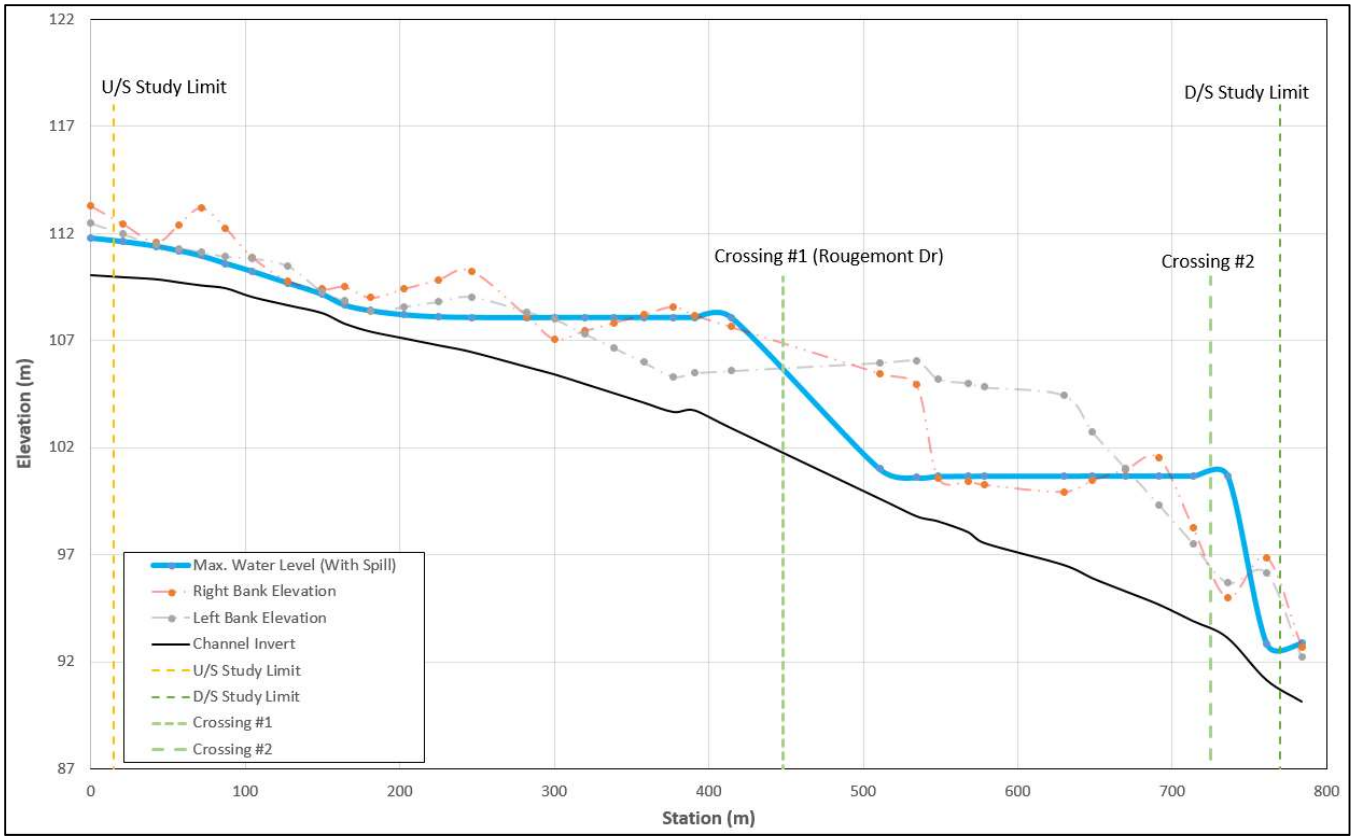

Figure 6: Regional Water Level Profiles within the Study Area and Along the Petticoat Creek Tributary B1

5.4 FLOOD RISK ASSESSMENT

As part of the Petticoat Creek flood evaluation study, a risk assessment is conducted to illustrate the overland flooding resulting from the spill. An extent of flood inundation during the Regulatory flood has been prepared to characterize the flood lines during the event. Flood hazard and risk mapping for the extended area are presented in **Attachment A.**

Considering the flood depth, velocity, and depth-velocity products as three risk factors for the Petticoat Creek and study area, SCE has prepared the floodplain mapping based on these risk criteria and MNRF practices (**Table 3**).

Table 3 Flood Risk Criteria (Source: MNRF Flooding Hazard Limit Guideline)

Risk Level	Low	Medium	High
Depth	≤ 0.3 m	> 0.3 m and ≤ 0.8 m	> 0.8 m
Velocity	≤ 1.7 m/s	≤ 1.7 m/s	> 1.7 m/s
Depth-Velocity	≤ 0.37 m^2/s	≤ 0.37 m^2/s	> 0.37 m^2/s

- **Low risk** flooding includes areas that are inundated but where vehicular and pedestrian ingress and egress are still feasible.
- **Medium risk** areas do not permit vehicular ingress and egress, but pedestrian ingress and egress is possible.
- **High risk** areas do not facilitate safe land access of any kind.

These flood risk criteria were used to develop the flood risk mapping presented in **Attachment A**.

The inundation mapping shows that the floodplain would be affected by the Regulatory Flood upstream of both sides of the Crossing #1, downstream of the Crossing #2, and extending southeastward along the creek crossing with Kingston Road. Four (4) cross sections at U/S and D/S of the existing crossings (crossing #1 and #2), have been used to show the calculated hydraulic parameters at Rougemount Drive overtopping within the spill area to the southeast of the road. **Table 4** provides a summary of the results from the MIKE 1D/2D modeling.

Table 4 TRCA 1D/2D Coupled Regional Event Modeling Results at the Spill Area

Location	Maximum Depth (m)	Maximum Overland Flow Rate (m^3/s)	Maximum Water Surface Elevation (m)
U/S Crossing #1	5.18	24.36	108.08
D/S Crossing #1	1.39	9.14	101.04
U/S Crossing #2	7.56	20.59	100.68
D/S Crossing #2	1.71	19.93	92.86

After reviewing the results, SCE recognized that the proposed site plan of 375-421 Kingston Road is outside of the floodplain and risky areas and the construction of the building would be above the floodplain elevation and would allow for safe access and egress of the subject site via Kingston Road during the Regional Storm event. In this project, SCE has provided the 1D/2D MIKE FLOOD model to TRCA and instructed that this model should be used as the basis for this analysis.

6. Conclusion

The Floodplain Mapping was conducted through a MIKE FLOOD (supplied by DHI) model as developed for the Floodplain analysis and mapping. The model was created to reflect the impacts of the flooding around the subject site. To create the model, the mesh was built such that to reflect the terrain elevations at the subject site and surrounding areas. In this way, the remainder of the model would be effectively unchanged and derived from existing LiDAR data.

The MIKE Flood model was run during the Regional storm event (Regulatory Flood) to assess the impact of the storm on floodplain flow depth, flow velocity, and flood elevation. Flood Depth, Flood Velocity, and a Depth-Velocity product were established throughout the floodplain. **Attachment A** presents the maximum flood depth, maximum flood velocity, and maximum depth-velocity product within the floodplain and vicinity of the developable site.

The intersection of Kingston Rd and Rougemont Drive is not impacted by floodplain and therefore the subject site has safe access/egress. As discussed, the subject site will not be impacted by the Regional Event as the grade of the building is above the Regional flood elevation.

As such, SCE doesn't anticipate any increased risk to life or existing structures within the floodplain as a result of development at 375-421 Kingston Rd.

If you have any questions, please do not hesitate to contact the undersigned.

Yours truly,
SCHAEFFER & ASSOCIATES LTD.

Ramin Jalalirad, M.Sc.
Water Resources Analyst

Debebe Yilak, M.Sc., P.Eng.,
Water Resources Engineer

Enclosed:

Attachment A: Relevant Floodplain Mapping Figures

Attachment A

Relevant Floodplain Mapping

Flood Spill Analysis for Development at 375-421 Kingston Rd

Legend

- Watercourse
- Cross Section

Max Depth

Meter

- 0.0018 - 0.733
- 0.734 - 1
- 1.001 - 1.5
- 1.501 - 2
- 2.001 - 3.5
- 3.501 - 5
- 5.001 - 6
- 6.001 - 7.44

Excluded Riverbed-Edited

- Building
- River Bed

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Figure 1-1	Regulatory Flood Depth (Meter)		
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80 40 0 80 Meters

Flood Spill Analysis for Development at 375-421 Kingston Rd

Legend

- Watercourse
- Cross Section

Excluded Areas

- Building
- River Bed

Max Velocity

m/s

- -2.285 - 0.256
- 0.257 - 1.201
- 1.202 - 2.62
- 2.621 - 4.393
- 4.394 - 6.522
- 6.523 - 8.709
- 8.71 - 10.719
- 10.72 - 12.788

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Figure 2-1	Regulatory Flood Velocity (m/s)		
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70 35 0 70
Meters