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Flood Characterization and Preliminary Remediation Investigations Pickering / Ajax SPA's

Toronto and Region Conservation Authority
City of Toronto

March 2018 (FINAL)

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Prepared For:

The Toronto and Region Conservation Authority

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Executive Summary

As part of the overall Pickering/Ajax Special Policy Area (SPA) 2D Hydraulic Model and Dykes Assessment Study, Valdor Engineering Inc. was retained by the TRCA to characterize the flooding within the Study Area, identify the flood mechanisms and flood risk and investigate preliminary flood remediation options. The Pickering and Ajax dykes were constructed in the 1980's to provide flood protection for the Pickering SPA and the Ajax SPA located within the Duffins Creek watershed.

The results of the MIKE Flood model prepared for the *MIKE Flood 1D-2D Model Development and Regulatory Floodplain Mapping* report (Valdor, March 2018) were used to characterize flooding and to assess the risk of flooding within the Pickering (Village East) SPA (Pickering SPA) and the Notion Road / Pickering Village SPA (Ajax SPA). Under existing conditions, the Pickering SPA experiences flooding commencing with the 350-yr design storm. It was identified that the Pickering Dyke overtops during the 350-yr storm but not during the 100-yr storm. Under existing conditions, the west portion of the Ajax SPA experiences localized flooding east of Notion Road adjacent Duffins Creek commencing with the 2-yr through 100-yr design storms. Under existing conditions, the Ajax Dyke overtops during the 100-yr storm but not during the 50-yr storm. Flooding within the Pickering and Ajax SPA's becomes extensive during the 350-yr and 500-yr design storms and Hurricane Hazel.

During the 500-yr storm in the Pickering SPA, approximately 15 residential type buildings and 2 industrial/commercial buildings are within the zone of high risk flooding. Over 400 residential type buildings and 12 industrial/commercial buildings are within the zone of high risk flooding in the Pickering SPA during the Regional storm. During the 500-yr storm in the Ajax SPA, approximately 13 residential type buildings and 3 industrial/commercial buildings are within the zone of high risk flooding. Approximately 23 residential type buildings and 25 industrial/commercial buildings are within the zone of high risk flooding in the Ajax SPA during the Regional storm.

Additional flooding mechanisms were identified that contribute to flooding during the 500-yr storm within the Pickering SPA. In addition to flow overtopping the existing Pickering Dyke, the identified flood mechanisms include flow spilling across low areas along the west side of Duffins Creek between Kingston Road and Highway 401.

Hydraulic constraints were identified that contribute to flooding during the Regional storm within the Pickering SPA, including: (1) bridge conveyance limitations associated with CN Rail, Go Transit, eastbound and westbound Highway 401, Church Street, Kingston Road and Brock Road; (2) channel conveyance constrictions primarily associated with the noted bridge crossings; (3) low points along the existing flood dyke between Brock Road and Kingston Road; (4) low areas along the north side of Finch Avenue west of Brock Road; (5) a low area along Brock Road north of Finch Avenue; (6) low areas along the west side of Duffins Creek between Kingston Road and Highway 401; and, (7) low areas along Kingston Road west of Duffins Creek.

Additional flooding mechanisms were identified that contribute to flooding during the 500-yr storm within the Ajax SPA. In addition to flow overtopping the existing Ajax Dyke, the identified flood mechanisms include flow spilling across: (1) a low area along Church Street south of Mill Street; and, (2) low areas south of Mill Street and east of Church Street.

Hydraulic constraints were identified that contribute to flooding during the Regional storm within the Ajax SPA, including: (1) bridge conveyance limitations associated with CN Rail, Go Transit, eastbound and westbound Highway 401, and Church Street; (2) channel conveyance constrictions primarily associated

with the noted bridge crossings; (3) low points along the existing flood dyke west of Church Street; (4) a low area along Church Street south of Mill Street; and, (5) low areas south of Mill Street and east of Church Street.

Preliminary flood remediation options were investigated to better understand the extent of remedial works required to achieve a range of flood mitigation scenarios. The options investigated included: (1) full flood remediation for the 500-yr storm; (2) partial flood remediation for the Regional storm; and, (3) full flood remediation for the Regional storm. The results for Option 1 and Option 3 include flood protection for virtually the entire Pickering and Ajax SPA's during the 500-yr and Regional storms, respectively. The most notable improvement in flooding due to the partial flood remediation scenario (Option 2) is the removal of over 250 residential dwellings from the floodplain within the Pickering SPA and the removal of approximately 15 residential dwellings and an apartment building from the floodplain within the Ajax SPA.

It is noted that while flood dykes provide a "real" level of flood protection, the implementation of dykes is not recognized by the MNRF to achieve an official "flood free" designation and lands behind dykes are still considered to reside within the floodplain. In order to meet the MNRF criteria to achieve official "flood free" status, flood remediation works such as flood protection landforms (FPL's) or conveyance improvements are required. Unfortunately, due to the very large footprint required to implement FPL's, this measure is not considered viable within the study area due to the extensive existing development that would be impacted.

The requirements to achieve the 500-yr level of flood remediation are extensive and costly and require further consideration and analysis beyond the scope of this study to confirm the impacts and viability of such an undertaking. The extent and costs associated with the partial and full flood remediation for the Regional storm would appear to be prohibitive but should also be considered for further study and assessed in greater detail.

As the required construction works to achieve dyke rehabilitation and the 500-yr and/or the Regional level of flood remediation for the Pickering and Ajax SPA's are much more extensive than those typically undertaken under the category of "dyke maintenance works" and, given the potential environmental, economic and other impacts associated with the required construction activities, it is recommended that further study be undertaken in accordance with the *Conservation Authority Class EA for Remedial Flood and Erosion Control Projects* (Conservation Ontario, 2002).

Prior to the completion of the Class EA study to review in further detail, evaluate and select the preferred solution to achieve dyke rehabilitation and flood remediation for the 500-yr and/or Regional storms, the identified list of proposed dyke rehabilitation items (*e.g.* flap gate repairs and general maintenance items) included in the *Dyke Level of Service and Rehabilitation Report, Pickering / Ajax SPA's* (Valdor, March 2018) should be implemented as soon as possible.

1.0 INTRODUCTION

As part of the overall Pickering/Ajax Special Policy Area (SPA) Two-dimensional (2D) Hydraulic Model and Dykes Assessment Study, Valdor Engineering Inc. was retained by the TRCA to complete a series of tasks, including: (1) develop a coupled 1D-2D hydraulic model using MIKE Flood for the Study Area and complete regulatory floodplain mapping; (2) complete geotechnical field investigations and assess the stability of the Pickering and Ajax Dykes under a number of loading conditions/failure modes in order to identify dyke rehabilitation requirements; and, (3) characterize the flooding within the study area, identify the mechanisms of flooding and investigate preliminary flood remediation options. The components of the overall study were completed and presented in the following three reports for the Pickering/Ajax SPA's:

- *MIKE Flood 1D-2D Model Development and Regulatory Floodplain Mapping* (Valdor, 2018);
- *Dyke Level of Service and Rehabilitation Report* (Valdor, 2018); and,
- *Flood Characterization and Preliminary Remediation Investigations* (Valdor, 2018).

This report is the *Flood Characterization and Preliminary Remediation Investigations* report and provides the characterization of flooding within the Study Area, identifies the flood mechanisms and flood risk and investigates preliminary flood remediation options.

1.1 Study Area

The study area consists of the entire Pickering (Village East) SPA (referred to in this report as the Pickering SPA) and the Notion Road/Pickering Village SPA (referred to in this report as the Ajax SPA) and includes areas extending upstream and downstream of the SPA's. The Study Area is approximately situated between Valley Farm Road at the upstream end to near Bayly Street West at the downstream end. The general location of the study area and the SPA's, including the approximate location of the Pickering and Ajax Dykes is illustrated in **Figure 1.1**.

1.2 Project Background

The Pickering and Ajax dykes were constructed in the 1980's to provide flood protection for the Pickering SPA and the Ajax SPA located within the Duffins Creek watershed. The flood control works were designed to alleviate flooding within the identified Flood Damage Centre and consisted of two flood protection dykes, one in each municipality. The Pickering Dyke constructed in 1985 extends for approximately 1,150 m north of Kingston Road West near Notion Road and west to Brock Road. It is noted that a portion of the Pickering Dyke near the intersection of Notion Road and Kingston Road West is, in fact, located within the Town of Ajax. The Ajax Dyke constructed in 1984 extends for approximately 325 m west of Church Street South near Mill Street and north to an apartment building located on the west side of Church Street South in the vicinity of Christena Crescent (see **Figure 1.1**). The design of the flood control infrastructure was completed by Simcoe Engineering Group and was intended to provide flood protection up to and including the 500-yr storm flow.

In June 2009, Geomorphic Solutions was retained by the TRCA to complete the *Interim Report – Duffins Creek Flood Protection Dyke Erosion Risk, Level of Service Assessment and Maintenance and Improvement Study*, an interim report to determine the level of flood protection the dykes provide, summarize the fluvial geomorphic assessment and assess the structural condition of the dykes. The Geomorphic Solutions report concluded that the majority of the Pickering dyke provides 500-year flood protection, however, the Ajax dyke only provides the 100-year flood protection. It is noted that these conclusions were based on hydrologic modeling from the early 2000's and one-dimensional (1D) hydraulic modeling using less detailed topographic information. While appropriate at the time, these tools were not as sophisticated as those currently employed. In addition, it is noted that one of the recommendations from the *Interim Report* was to complete a higher level geotechnical assessment including the installation of

boreholes to better understand the structural conditions of the dykes. The *Interim Report* also documented detailed deficiencies and concerns observed that were utilized to facilitate Valdor's field assessment.

Subsequent to the *Hydrologic Model Study Humber, Don and Rouge Rivers, Highland, Duffin, Petticoat and Carruther's Creeks* completed by James F. MacLaren in 1979 using a hydrologic model based on HYMO, a number of hydrology updates for the Duffins Creek Watershed have been completed. Hydrology updates were completed by Aquafor Beech Ltd. in 1991 using the INTERHYMO/OTTHYMO model and in 2002 using the Visual OTTHYMO model. The most recent update is contained in the *2012 Duffins Creek Hydrology Update* using Visual OTTHYMO (Aquafor, 2013).

1.3 Purpose of Report

The purpose of the report is to characterize the existing flooding, identify hydraulic constraints and investigate preliminary flood remediation options for the 500-yr and Regional storms within the Pickering and Ajax SPA's along with a supporting technical report. The 500-yr and Regional Flood Depth Maps prepared in conjunction with the *MIKE Flood 1D-2D Model Development and Regulatory Floodplain Mapping, Pickering / Ajax SPA's* report (Valdor, March 2018) are provided in **Figures 1.2** and **1.3**, respectively.

1.4 Report Scope and Approach

The scope and the key steps of this report are as follows:

- Review available background information and documents.
- Using the 1D-2D MIKE Flood hydraulic model developed in conjunction with the *MIKE Flood 1D-2D Model Development and Regulatory Floodplain Mapping, Pickering / Ajax SPA's* report (Valdor, March 2018), complete the characterization and risk assessment of the existing floodplain within the Pickering and Ajax SPA's.
- Identify the hydraulic constraints that contribute to flooding within the Pickering and Ajax SPA's.
- Investigate preliminary flood remediation options to achieve flood protection for the 500-yr and Regional storms.
- Provide any recommendations for further study, if warranted.

1.5 Previously Completed Available Studies and Information

A review of the following studies and key design drawings provided by the TRCA was completed in preparing the *Flood Characterization and Preliminary Remediation Investigations, Pickering / Ajax SPA's* report:

- Aquafor Beech Limited, *2012 Duffins Creek Hydrology Update*, 11 February 2013.
- Geomorphic Solutions, *Interim Report – Duffins Creek Flood Protection Dyke Erosion Risk, Level of Service Assessment and Maintenance and Improvement Study*, June 2009.
- Greck and Associates, *Flood Plain Map Sheets*, Duf-04 (TRCA, 2004), Duf-05 (TRCA, 2004), Duf-06 (TRCA, 2004).
- James F. Maclaren, *Hydrologic Model Study Humber, Don and Rouge Rivers, Highland, Duffin, Petticoat and Carruther's Creeks*, 1979.
- MMM, *Flood Plain Map Sheets*, Duf-01 (TRCA, 2004), Duf-02 (TRCA, 2004), Duf-03 (TRCA, 2004), Duf-07 (TRCA, 2004), Duf-10 (TRCA, 2004).
- Simcoe Engineering, *Preliminary Engineering Report for Flood Protection on the Duffin Creek in*

the Pickering Ajax Area, 1982.

- Simcoe Engineering, *Ajax Flood Protection Dyke Plan*, August 1984.
- Simcoe Engineering, *Pickering Flood Protection Dyke Plan*, July 1985.
- Valdor Engineering, *Dyke Level of Service and Rehabilitation Report, Pickering / Ajax SPA's*, March 2018.
- Valdor Engineering, *MIKE Flood 1D-2D Model Development and Regulatory Floodplain Mapping, Pickering / Ajax SPA's report*, March 2018.

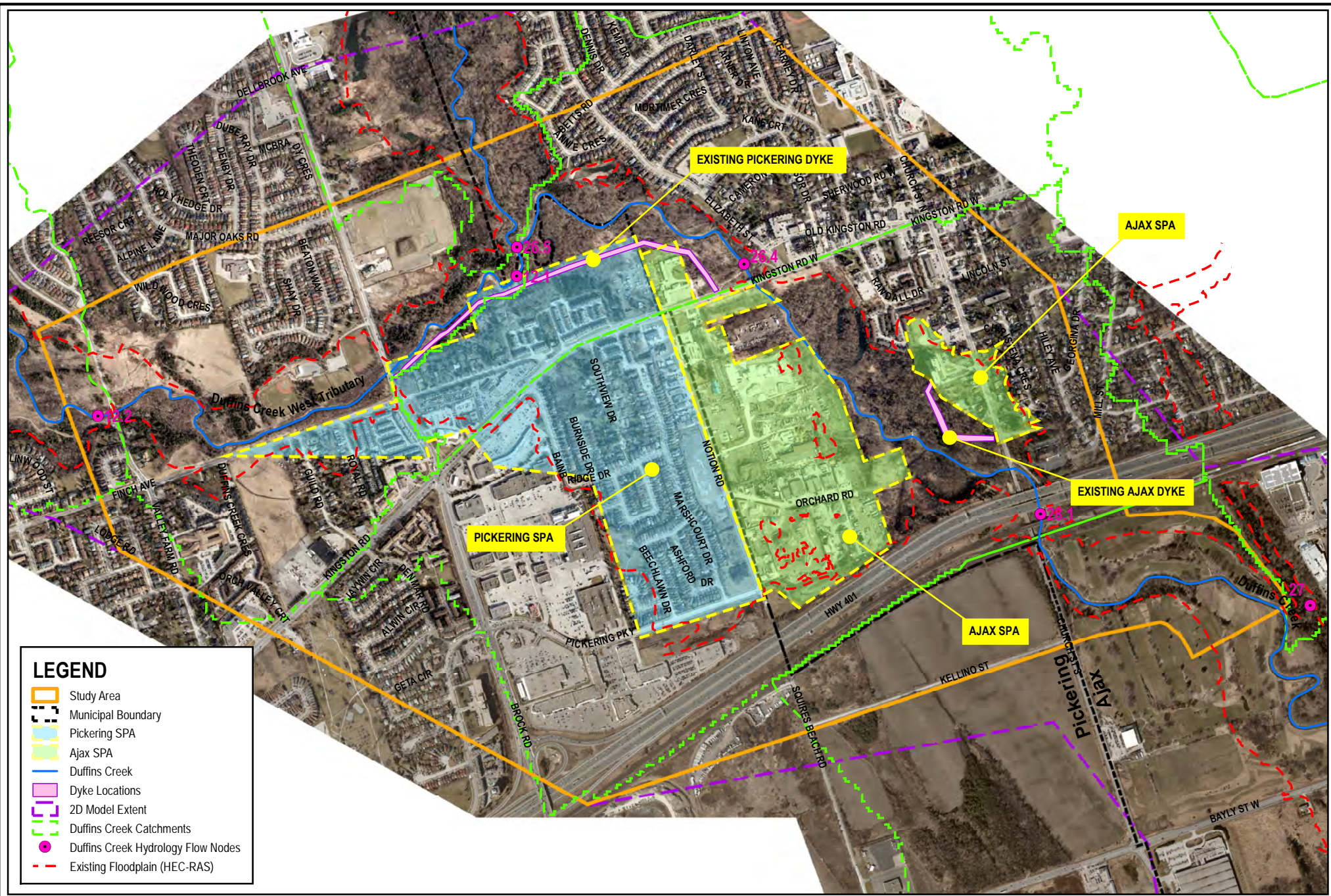


Figure 1.1
STUDY AREA

400 200 0 400 Meters

10 April 2018



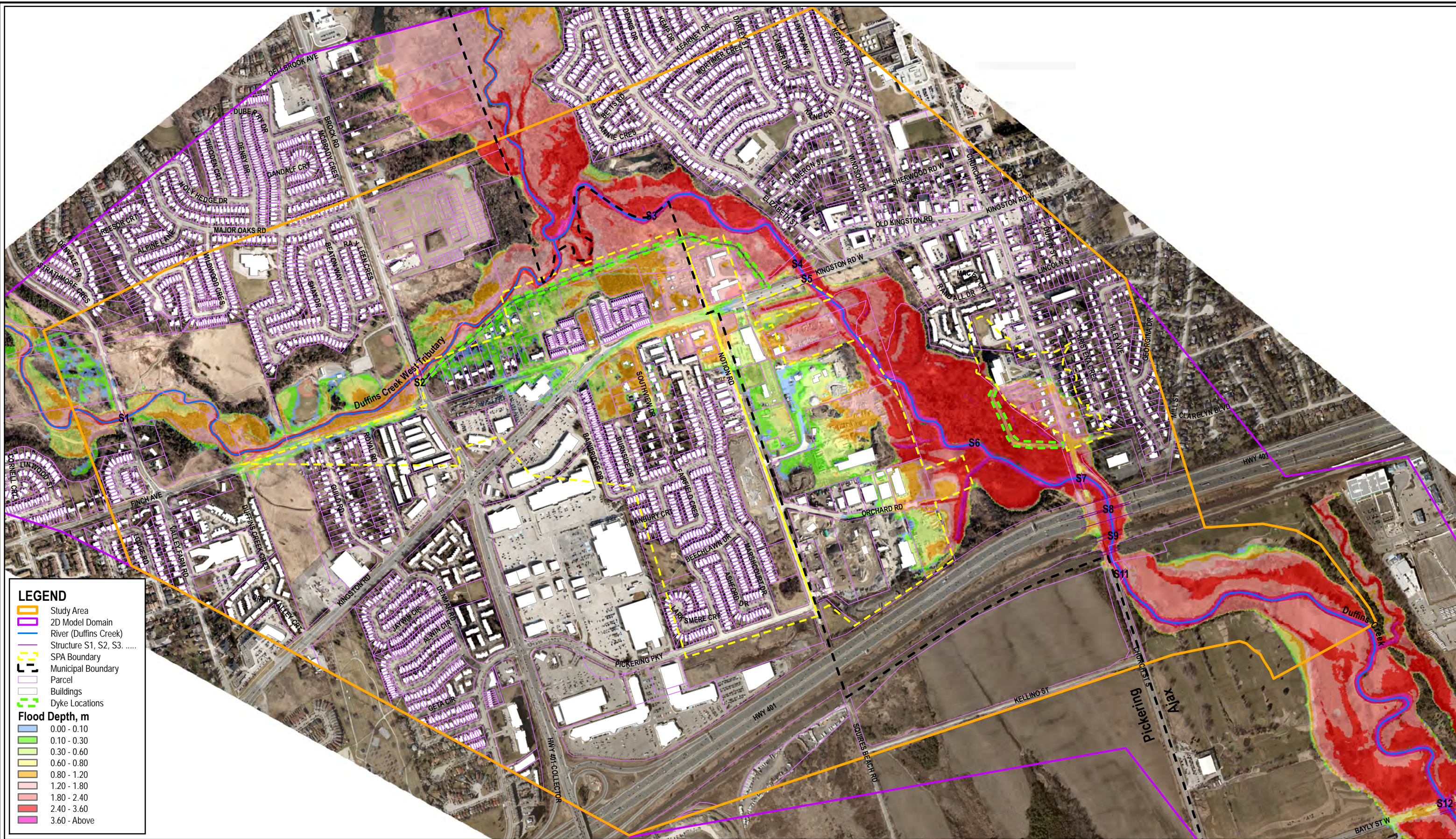


FIGURE 1.2

**500-YR FLOOD DEPTH MAP
(EXISTING CONDITION)**

STEADY INFLOW HYDROGRAPH (500-YR STORM)

250 125 0 250 Meters

01 December 2017



Note:

Flood Depth Mapping based on 2015 LiDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

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PICKERING-AJAX DYKE ASSESSMENT AND FLOOD REMEDIATION STUDY**





FIGURE 1.3
REGIONAL FLOOD DEPTH MAP
 (EXISTING CONDITION)

STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL)

250 125 0 250 Meters

01 December 2017



Note:

Flood Depth Mapping based on 2015 LiDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

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2.0 CHARACTERIZATION AND RISK ASSESSMENT OF THE FLOODPLAIN

The results of the Mike Flood model were used to characterize flooding and to assess the risk of flooding within the Pickering SPA and the Ajax SPA. The following sections provide a general description of the flooding within the SPA's and define the criteria used for flood risk assessment so as to identify areas of high risk flooding for the 500-yr design storm and the Regional storm (Hurricane Hazel).

2.1 General Characteristics of the Floodplain

2.1.1 Pickering SPA

Under existing conditions, the Pickering SPA experiences flooding commencing with the 350-yr design storm (see the flood extent mapping illustrated in **Figure 2.1** for the entire study area and also the SPA-specific extent mapping for the Pickering SPA illustrated in **Figure A.11**). The Pickering Dyke overtops during the 350-yr storm but not during the 100-yr storm. Flooding within the Pickering SPA becomes more extensive during the 500-yr design storm and Hurricane Hazel. The extent of flooding during the 350-yr and 500-yr storms within the Pickering SPA extends south of the Pickering Dyke to south of Kingston Road in the vicinity of Southview Drive and Notion Road. The extent of flooding for the Regional Storm extends west of Notion Road to approximately Brock Road north of Kingston Road and approximately Bainbridge Drive south of Kingston Road and south to approximately Highway 401. The maximum depth and velocity of flow observed for the 500-yr storm flooding limits is approximately 2.4 m and 0.60 m/s, respectively. The majority of flooding for the 500-yr storm was observed to have a depth of between 0.6 m and 1.20 m and a velocity of 0.30 m/s. The maximum depth and velocity of flow observed for the Regional storm flooding limits is approximately 3.6 m and 2.0 m/s, respectively. Additional mapping regarding flood depth, flood velocity and flow direction mapping is provided in the *MIKE Flood 1D-2D Model Development and Regulatory Floodplain Mapping, Pickering / Ajax SPA* report (Valdor, March 2018).

2.1.2 Ajax SPA

Under existing conditions, the Ajax Dyke overtops during the 100-yr storm but not during the 50-yr storm. Under existing conditions, the west portion of the Ajax SPA experiences localized flooding east of Notion Road adjacent Duffins Creek commencing with the 2-yr through 100-yr design storms. Flooding within the east and west portions of the Ajax SPA becomes extensive during the 350-yr and 500-yr design storms and Hurricane Hazel. The extent of flooding during the 350-yr and 500-yr storms within the east portion of the Ajax SPA extends east of the Ajax Dyke to just east of Church Street and from approximately south of Mill Street north to the north limit of the Ajax Dyke (see the flood extent mapping illustrated in **Figure 2.1** for the entire study area and also the SPA-specific extent mapping for the Ajax SPA illustrated in **Figure A.12**). The flooding also extends west of Duffins Creek to Notion Road within the west portion of the Ajax SPA. The extent of flooding for the Regional Storm extends east of the Ajax Dyke to east of Church Street and from approximately south of Mill Street north to approximately Randall Drive and west of Duffins Creek to beyond Notion Road. The maximum depth and velocity of flow observed east of the Ajax Dyke within the east portion of the Ajax SPA for the 500-yr storm flooding limits is approximately 2.4 m and 0.60 m/s, respectively. The majority of flooding for the 500-yr storm was observed to have a depth of between 1.2 m and 1.80 m and a velocity of 0.30 m/s. The maximum depth and velocity of flow observed for the Regional storm flooding limits is approximately 3.6 m and 0.60 m/s, respectively. West of Duffins Creek within the west portion of the Ajax SPA, the maximum depth and velocity of flow observed for the 500-yr storm flooding limits is approximately 3.6 m and 0.90 m/s, respectively. The majority of flooding for the 500-yr storm within the Ajax SPA just east of Notion Road was observed to have a depth of between 0.3 m and 1.20 m and a velocity of 0.30 m/s. The maximum depth and velocity of flow observed for the Regional storm flooding limits is approximately 3.6 m and 0.60 m/s, respectively. Additional mapping regarding flood depth, flood velocity and flow direction mapping is provided in the *MIKE Flood 1D-2D*

Model Development and Regulatory Floodplain Mapping, Pickering / Ajax SPA report (Valdor, March 2018).

2.2 Defining Flood Risk

Criteria provided in the *Technical Guide River and Stream Systems: Flooding Hazard Limit* prepared by the Ontario Ministry of Natural Resources (MNR) in 2002 along with the frequency of flooding are typically used in defining and assessing flood risk. Another consideration in assessing flood risk is the vulnerability of critical services and infrastructure that may exist within identified flood zones.

2.2.1 Flood Risk Criteria

The following criterion was used in defining the upper limits of safe ingress/egress:

- Maximum Depth = 0.8 m;
- Maximum velocity = 1.7 m/s; and,
- Maximum depth-velocity product = 0.37 m²/s

Based on work completed recently in other SPA's, the MNR has revised the flood risk categories and how they are calculated. The revised flood risk categories are divided into low, moderate and high risk and are defined as follows:

- **Low Risk** – Vehicular and pedestrian ingress/egress is available (depth < 0.30 m).
- **Moderate Risk** – Pedestrian ingress/egress ONLY available (depth-velocity product ≤ 0.37 m²/s with a maximum depth of 0.80 m and maximum velocity of 1.70 m/s); and,
- **High Risk** – Depth-velocity product > 0.37 m²/s OR depth > 0.80 m OR velocity > 1.70 m/s.

2.3 Flood Risk Mapping within the Pickering and Ajax SPA's

Using the flood risk criteria identified above, areas of low, moderate and high flood risk were identified within the Pickering and Ajax SPA's. The 500-yr and Regional storm flood risk maps for the entire study area are provided in **Figure 2.2** and **Figure 2.3**, respectively. The 500-yr and Regional storm SPA-specific flood risk mapping for the Pickering SPA is illustrated in **Figures A.13** and **A.15**, respectively. The 500-yr and Regional storm SPA-specific flood risk mapping for the Ajax SPA is illustrated in **Figures A.14** and **A.16**, respectively.

A summary of the key areas impacted and the total areas of low, moderate and high risk flooding within the Pickering and Ajax SPA's is provided in **Tables 2.1** and **2.2** for the 500-yr storm and the Regional storm.

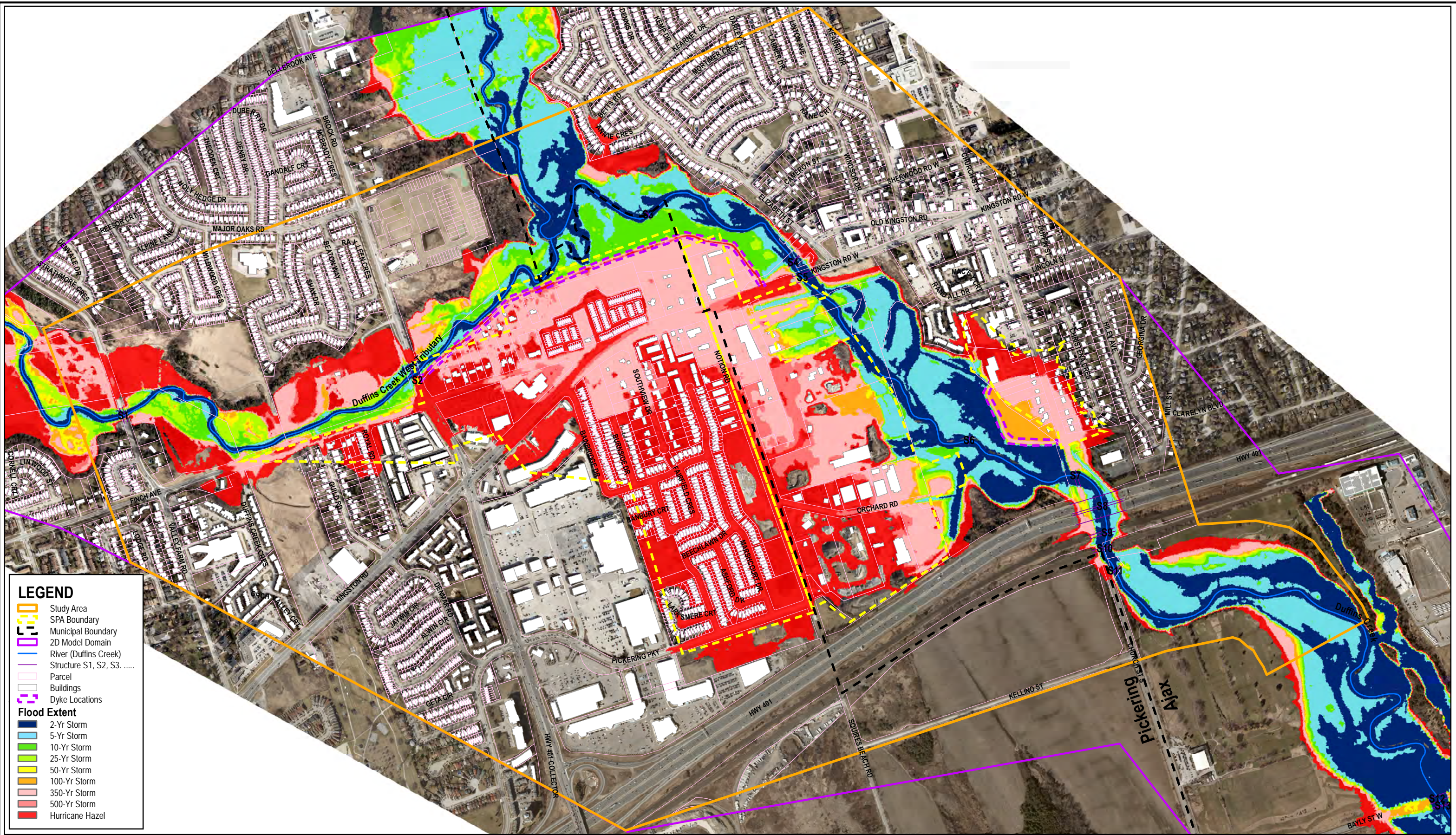
Table 2.1: Extent of Low, Moderate and High Risk Flooding Within the Pickering SPA

Return Period	Key Areas Impacted by Flooding within the SPA (Pickering SPA Area = 68.39 ha)	Extent of Flood Free Area within the Pickering SPA	Extent of Low Risk Flooding within the Pickering SPA	Extent of Moderate Risk Flooding within the Pickering SPA	Extent of High Risk Flooding within the Pickering SPA
500-yr	Residential, commercial, industrial areas, local and arterial roads	46.35 ha (67.78% of SPA)	8.91 ha (13.03% of SPA)	4.57 ha (6.68% of SPA)	8.56 ha (12.51% of SPA)
Regional Storm (Hazel)	Residential, commercial, industrial areas, local and arterial roads	4.07 ha (5.95% of SPA)	5.54 ha (8.10% of SPA)	8.90 ha (13.02% of SPA)	49.88 ha (72.93% of SPA)

Table 2.2: Extent of Low, Moderate and High Risk Flooding Within the Ajax SPA

Return Period	Key Areas Impacted by Flooding within the SPA (Ajax SPA Area = 43.31 ha)	Extent of Flood Free Area within the Ajax SPA	Extent of Low Risk Flooding within the Ajax SPA	Extent of Moderate Risk Flooding within the Ajax SPA	Extent of High Risk Flooding within the Ajax SPA
500-yr	Residential areas, local and arterial roads	14.19 ha (32.75% of SPA)	9.28 ha (21.44% of SPA)	8.44 ha (19.49% of SPA)	11.40 ha (26.32% of SPA)
Regional Storm (Hazel)	Residential areas, local and arterial roads	1.06 ha (2.45% of SPA)	0.99 ha (2.29% of SPA)	0.65 ha (1.49% of SPA)	40.61 ha (93.77% of SPA)

During the 500-yr storm in the Pickering SPA, approximately 15 residential type buildings and 2 industrial/commercial buildings are within the zone of high risk flooding. Over 400 residential type buildings and 12 industrial/commercial buildings are within the zone of high risk flooding in the Pickering SPA during the Regional storm. During the 500-yr storm in the Ajax SPA, approximately 13 residential type buildings and 3 industrial/commercial buildings are within the zone of high risk flooding. Approximately 23 residential type buildings and 25 industrial/commercial buildings are within the zone of high risk flooding in the Ajax SPA during the Regional storm.



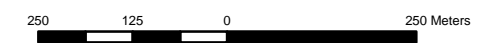
LEGEND

- Study Area
- SPA Boundary
- Municipal Boundary
- 2D Model Domain
- River (Duffins Creek)
- Structure S1, S2, S3,
- Parcel
- Buildings
- Dyke Locations

Flood Extent

- 2-Yr Storm
- 5-Yr Storm
- 10-Yr Storm
- 25-Yr Storm
- 50-Yr Storm
- 100-Yr Storm
- 350-Yr Storm
- 500-Yr Storm
- Hurricane Hazel

FIGURE 2.1
FLOOD EXTENT CORRESPONDING TO VARIOUS STORMS
EXISTING CONDITION - STEADY INFLOW HYDROGRAPH
 (Hurricane Hazel, 500-yr, 350-yr, 100-yr, 50-yr, 25-yr,
 10-yr, 5-yr and 2-yr Storms)



01 December 2017



Note:
Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party

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PICKERING-AJAX DYKE ASSESSMENT AND FLOOD REMEDIATION STUDY

Est. 1992
 for The Living City

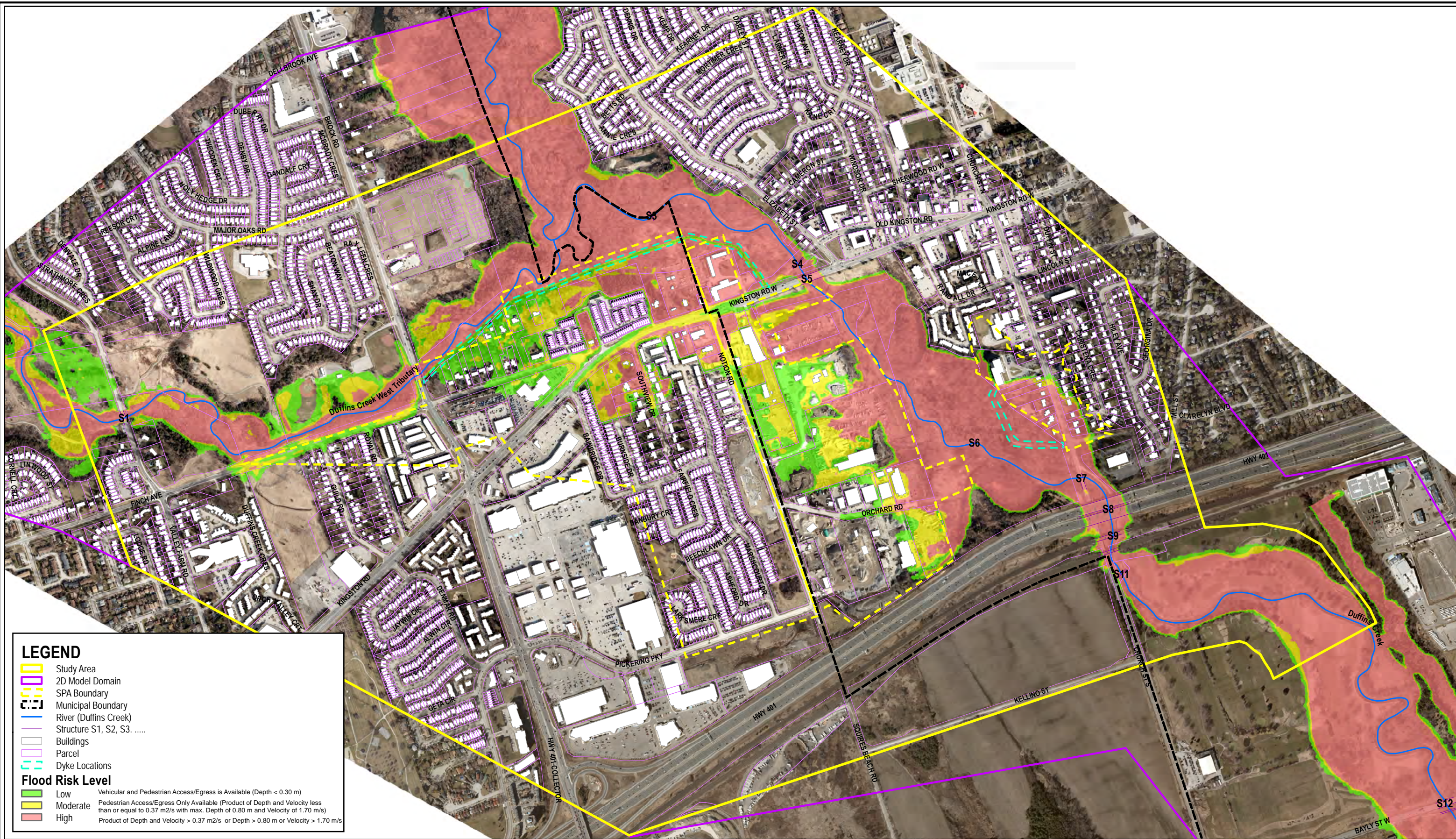


Figure 2.2
500-YR FLOOD RISK MAP
 (EXISTING CONDITION)

STEADY INFLOW HYDROGRAPH (500-YR STORM)

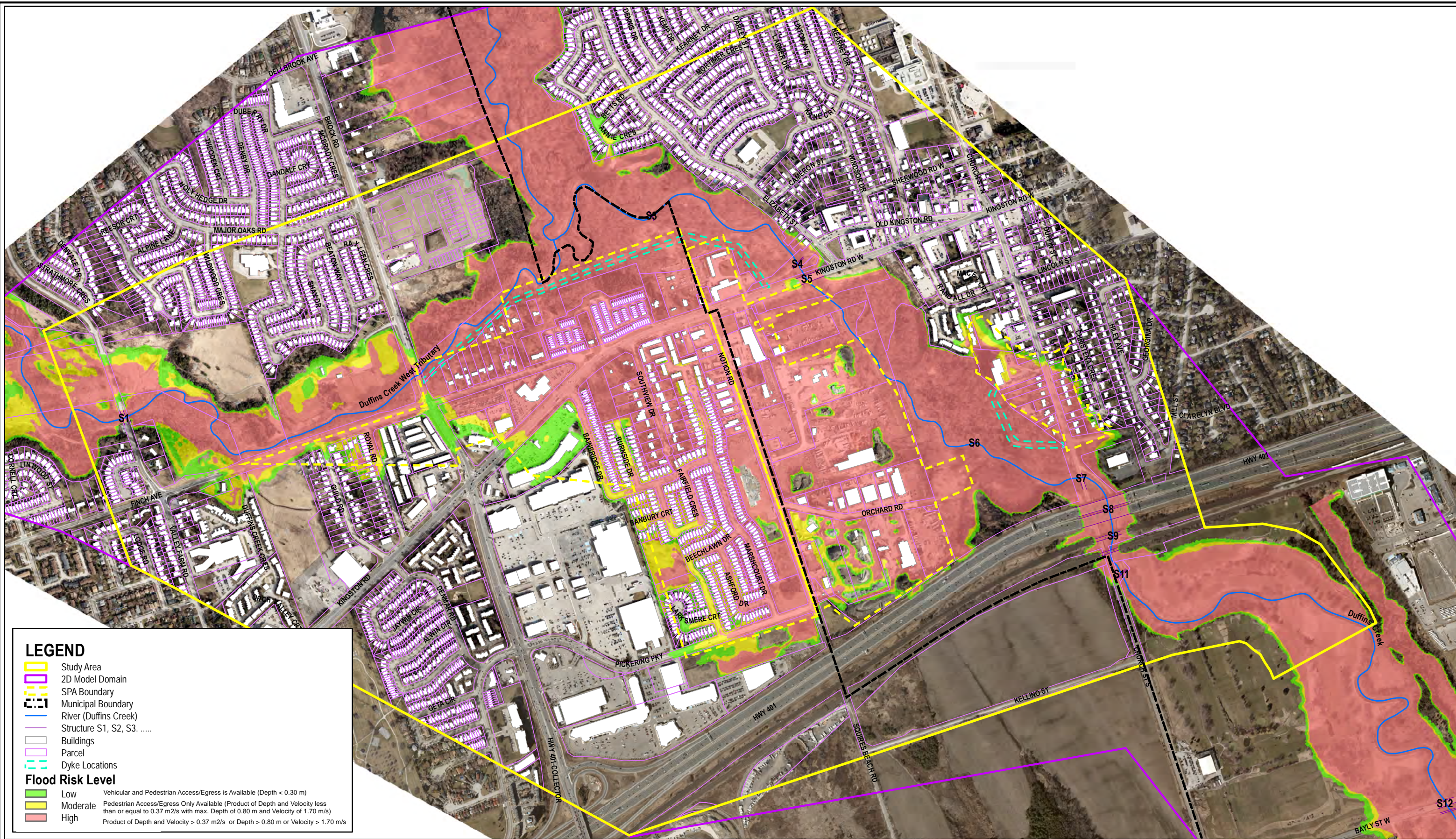


01 December 2017



Note:

Flood Depth Mapping based on 2015 LiDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.



LEGEND

- Study Area
- 2D Model Domain
- SPA Boundary
- Municipal Boundary
- River (Duffins Creek)
- Structure S1, S2, S3,
- Buildings
- Parcel
- Dyke Locations

Flood Risk Level

- Low Vehicular and Pedestrian Access/Egress is Available (Depth < 0.30 m)
- Moderate Pedestrian Access/Egress Only Available (Product of Depth and Velocity less than or equal to 0.37 m²/s with max. Depth of 0.80 m and Velocity of 1.70 m/s)
- High Product of Depth and Velocity > 0.37 m²/s or Depth > 0.80 m or Velocity > 1.70 m/s

Figure 2.3
REGIONAL FLOOD RISK MAP
 (EXISTING CONDITION)
STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL)

250 125 0 250 Meters

01 December 2017

Note:
Flood Depth Mapping based on 2015 LiDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

TORONTO AND REGION CONSERVATION
PICKERING-AJAX DYKE ASSESSMENT AND FLOOD REMEDIATION STUDY

for The Living City

3.0 IDENTIFICATION OF HYDRAULIC CONSTRAINTS WITHIN THE PICKERING AND AJAX SPA'S

There are a number of hydraulic constraints that contribute to flooding within the Pickering and Ajax SPA's. In the sections that follow, these hydraulic constraints are identified, the key causes of flooding within the SPA's are investigated and possible mitigation options are recommended for further detailed study.

3.1 Identifying Hydraulic Constraints

The hydraulic constraints encountered within the Pickering and Ajax SPA's that have been identified as contributing to flooding are described as follows and are illustrated on **Figure 3.1**:

- Undersized hydraulic structures (*e.g.* culverts, bridges with poor conveyance capacity);
- Undersized channels (*e.g.* watercourse with poor conveyance capacity); and
- Constraints due to topography (*e.g.* spill points, low lying or flat, poorly drained topography).

In order to identify possible mitigation options for flooded areas, it is important to have a good understanding of the specific constraints that contribute to the flooding. As such, areas within the SPA's were analyzed using flow direction mapping prepared over a series of time intervals and MIKE Flood animations to understand the flooding process within each SPA. The 500-yr and Regional storm flood flow and flooding process results are provided in **Figures 3.2** and **3.3**, respectively.

3.2 Key Causes of Flooding within the Pickering and Ajax SPA's

Based on an analysis of the flood flow and flooding process results described above, the key causes of flooding within each SPA were identified. A description of the hydraulic constraints identified as contributing to flooding within the SPA's is provided below.

3.2.1 Pickering SPA

The Pickering SPA is located in a flood vulnerable area approximately bound by Notion Road to the east, the Pickering Dyke to the north, Highway 401 and Pickering Parkway to the south and the area extending west of Bainbridge Drive to west of Guild Road along Finch Avenue. Based on an analysis of the flood process mapping provided in **Figure 3.2** and MIKE Flood animations for the 500-yr storm under existing conditions, the key causes of flooding within the Pickering SPA during the 500-yr storm include: (1) low points along the existing flood dyke between Brock Road and Kingston Road; and, (2) low areas along the west side of Duffins Creek between Kingston Road and Highway 401.

Based on an analysis of the flood process mapping provided in **Figure 3.3** and MIKE Flood animations for the Regional storm under existing conditions, the key causes of flooding within the Pickering SPA during the Regional storm include: (1) bridge conveyance limitations associated with the CN Rail crossing, Go Transit crossing, eastbound and westbound Highway 401 crossings, Church Street crossing, Kingston Road crossing and the Brock Road crossing; (2) channel conveyance constrictions primarily associated with the noted bridge crossings; (3) low points along the existing flood dyke between Brock Road and Kingston Road; (4) low areas along the north side of Finch Avenue west of Brock Road; (5) a low area along Brock Road north of Finch Avenue; (6) low areas along the west side of Duffins Creek between Kingston Road and Highway 401; and, (7) low areas along Kingston Road west of Duffins Creek.

3.2.2 Ajax SPA

Ajax SPA – East Portion

The east portion of the Ajax SPA is located in a flood vulnerable area approximately bound by Christena Crescent to the east, Randall Drive to the north, Mill Street to the south and just east of the Ajax Dyke to the west. Based on an analysis of the flood process mapping provided in **Figure 3.2** and MIKE Flood animations for the 500-yr storm under existing conditions, the key causes of flooding within the east portion of the Ajax SPA during the 500-yr storm include: (1) low points along the existing flood dyke west of Church Street; (2) a low area along Church Street south of Mill Street; and, (3) low areas south of Mill Street and east of Church Street.

Based on an analysis of the flood process mapping provided in **Figure 3.3** and MIKE Flood animations for the Regional storm under existing conditions, the key causes of flooding within the east portion of the Ajax SPA during the Regional storm include: (1) bridge conveyance limitations associated with the CN Rail crossing, Go Transit crossing, eastbound and westbound Highway 401 crossings, and the Church Street crossing; (2) channel conveyance constrictions primarily associated with the noted bridge crossings; (3) low points along the existing flood dyke west of Church Street; (4) a low area along Church Street south of Mill Street; and, (5) low areas south of Mill Street and east of Church Street.

Ajax SPA – West Portion

The west portion of the Ajax SPA is located in a flood vulnerable area approximately bound by Duffins Creek to the east, the Pickering Dyke to the north, Highway 401 to the south and Notion Road to the west. Based on an analysis of the flood process mapping provided in **Figure 3.2** and MIKE Flood animations for the 500-yr storm under existing conditions, the key causes of flooding within the west portion of the Ajax SPA during the 500-yr storm include: (1) low points along the existing flood dyke between Brock Road and Kingston Road; and, (2) low areas along the west side of Duffins Creek between Kingston Road and Highway 401.

Based on an analysis of the flood process mapping provided in **Figure 3.3** and MIKE Flood animations for the Regional storm under existing conditions, the key causes of flooding within the west portion of the Ajax SPA during the Regional storm include: (1) bridge conveyance limitations associated with the CN Rail crossing, Go Transit crossing, eastbound and westbound Highway 401 crossings, Church Street crossing, Kingston Road crossing and the Brock Road crossing; (2) channel conveyance constrictions primarily associated with the noted bridge crossings; (3) low points along the existing flood dyke between Brock Road and Kingston Road; (4) a low area along Brock Road north of Finch Avenue; (5) low areas along the west side of Duffins Creek between Kingston Road and Highway 401; and, (6) low areas along Kingston Road west of Duffins Creek.

3.3 Summary and Identification of Possible Mitigation Options for Further Study

Based on an analysis of the completed hydraulic modelling using MIKE Flood, a number of hydraulic constraints were identified that contribute to flooding in the Pickering and Ajax SPA's. Through the preliminary analysis of the flooding process, possible mitigation options for further consideration and detailed hydraulic modelling were identified. Possible mitigation options included the following:

- Bridge conveyance capacity improvements;
- Channel conveyance capacity improvements; and,
- Spill containment / grade adjustments.

A summary of the investigations of hydraulic constraints for the Pickering and Ajax SPA's and possible mitigation options for further consideration and detailed analysis is provided for the 500-yr design storm and the Regional storm in **Tables 3.1** and **3.2**, respectively.

Table 3.1: Summary of Identified Hydraulic Constraints and Possible Mitigation Options – 500-yr Storm

SPA	Identified Hydraulic Constraint (s)	Possible Mitigation Options for Further Detailed Analysis
Pickering SPA	<ul style="list-style-type: none"> • Low points along the existing flood dyke between Brock Road and Kingston Road. • Low areas along the west side of Duffins Creek between Kingston Road and Highway 401. 	<ul style="list-style-type: none"> • Spill containment / grade adjustments.
Ajax SPA (East Portion)	<ul style="list-style-type: none"> • Low points along the existing flood dyke west of Church Street. • Low area along Church Street south of Mill Street. • Low areas south of Mill Street and east of Church Street. 	<ul style="list-style-type: none"> • Spill containment / grade adjustments.
Ajax SPA (West Portion)	<ul style="list-style-type: none"> • Low points along the existing flood dyke between Brock Road and Kingston Road. • Low areas along the west side of Duffins Creek between Kingston Road and Highway 401. 	<ul style="list-style-type: none"> • Spill containment / grade adjustments.

Table 3.2: Summary of Identified Hydraulic Constraints and Possible Mitigation Options – Regional Storm

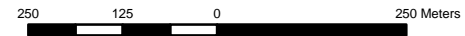
SPA	Identified Hydraulic Constraint (s)	Possible Mitigation Options for Further Detailed Analysis
Pickering SPA	<ul style="list-style-type: none"> • Bridge conveyance limitations associated with CN Rail, Go Transit, eastbound and westbound Highway 401, Church Street, Kingston Road and Brock Road. • Channel conveyance constrictions primarily associated with the noted bridge crossings. • The existing flood dyke between Brock Road and Kingston Road is not high enough since the original design was not intended to provide flood protection for the Regional storm. • Low areas along the north side of Finch Avenue west of Brock Road. • Low area along Brock Road north of Finch Avenue. • Low areas along the west side of Duffins Creek between Kingston Road and Highway 401. • Low area along Kingston Road west of Duffins Creek. 	<ul style="list-style-type: none"> • Spill containment / grade adjustments. • Channel conveyance capacity improvements. • Bridge conveyance capacity improvements.
Ajax SPA (East Portion)	<ul style="list-style-type: none"> • Bridge conveyance limitations associated with the CN Rail crossing, Go Transit crossing, eastbound and westbound Highway 401 crossings, and the Church Street crossing. • Channel conveyance constrictions primarily associated with the noted bridge crossings. • The existing flood dyke west of Church Street is not high enough since the original design was not intended to provide flood protection for the Regional storm. • Low area along Church Street south of Mill Street. • Low areas south of Mill Street and east of Church Street. 	<ul style="list-style-type: none"> • Spill containment / grade adjustments. • Channel conveyance capacity improvements. • Bridge conveyance capacity improvements.
Ajax SPA (West Portion)	<ul style="list-style-type: none"> • Bridge conveyance limitations associated with CN Rail, Go Transit, eastbound and westbound Highway 401, Church Street, Kingston Road and Brock Road. • Channel conveyance constrictions primarily associated with the noted bridge crossings. • The existing flood dyke between Brock Road and Kingston Road is not high enough since the original design was not intended to provide flood protection for the Regional storm. • Low area along Brock Road north of Finch Avenue. • Low areas along the west side of Duffins Creek between Kingston Road and Highway 401. • Low area along Kingston Road west of Duffins Creek. 	<ul style="list-style-type: none"> • Spill containment / grade adjustments. • Channel conveyance capacity improvements. • Bridge conveyance capacity improvements.



LEGEND

- Study Area
- 2D Model Domain
- River (Duffins Creek)
- Bridge Locations
- Existing Dykes
- SPA Boundary
- Municipal Boundary
- Buildings
- Parcel

FIGURE 3.1
KEY HYDRAULIC CONSTRAINTS
LOCATION PLAN



01 December 2017



Note:
Flood Depth Mapping based on 2015 LiDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

TORONTO AND REGION CONSERVATION
PICKERING-AJAX DYKE ASSESSMENT AND FLOOD REMEDIATION STUDY

for The Living City

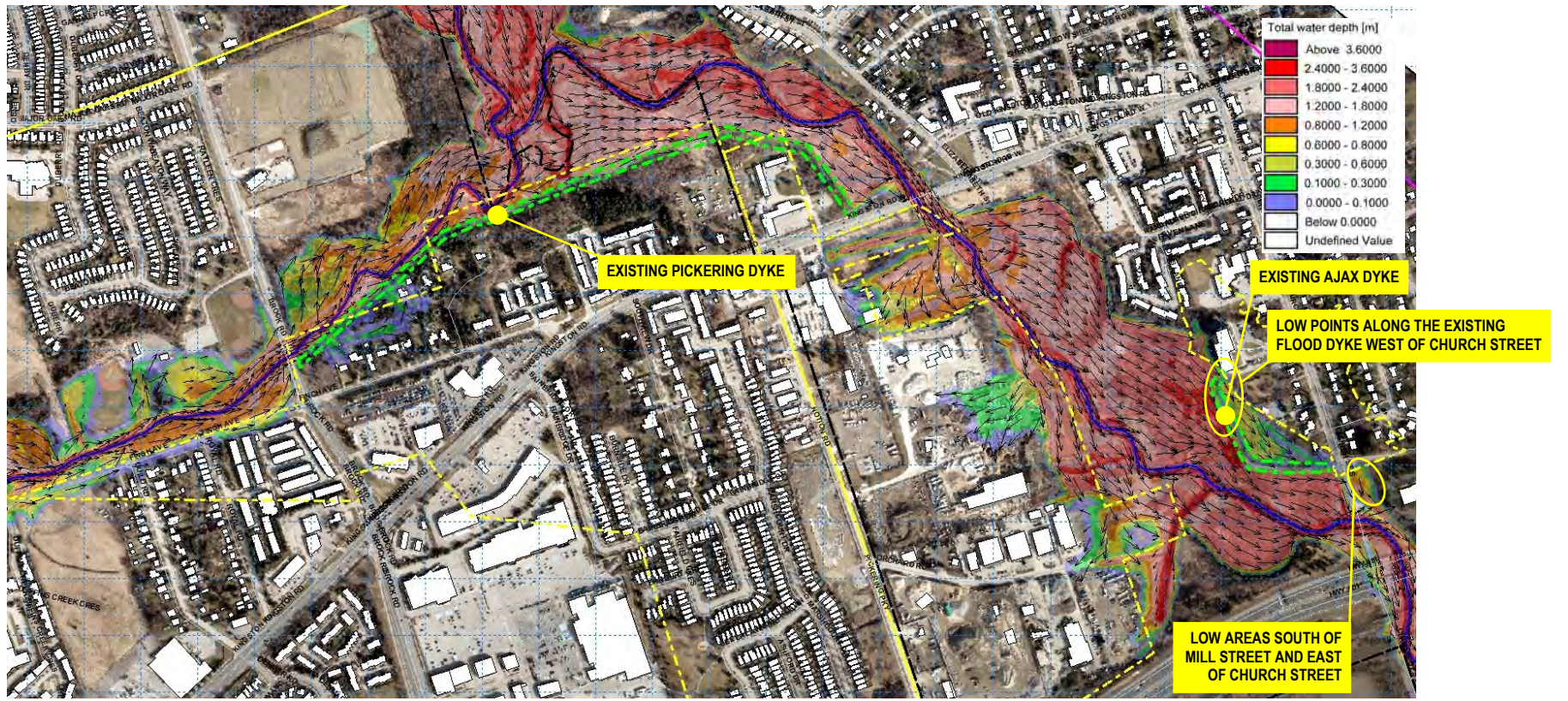


Fig 3.2a Existing Condition (500 -yr)

Flooding at 2:50 hrs

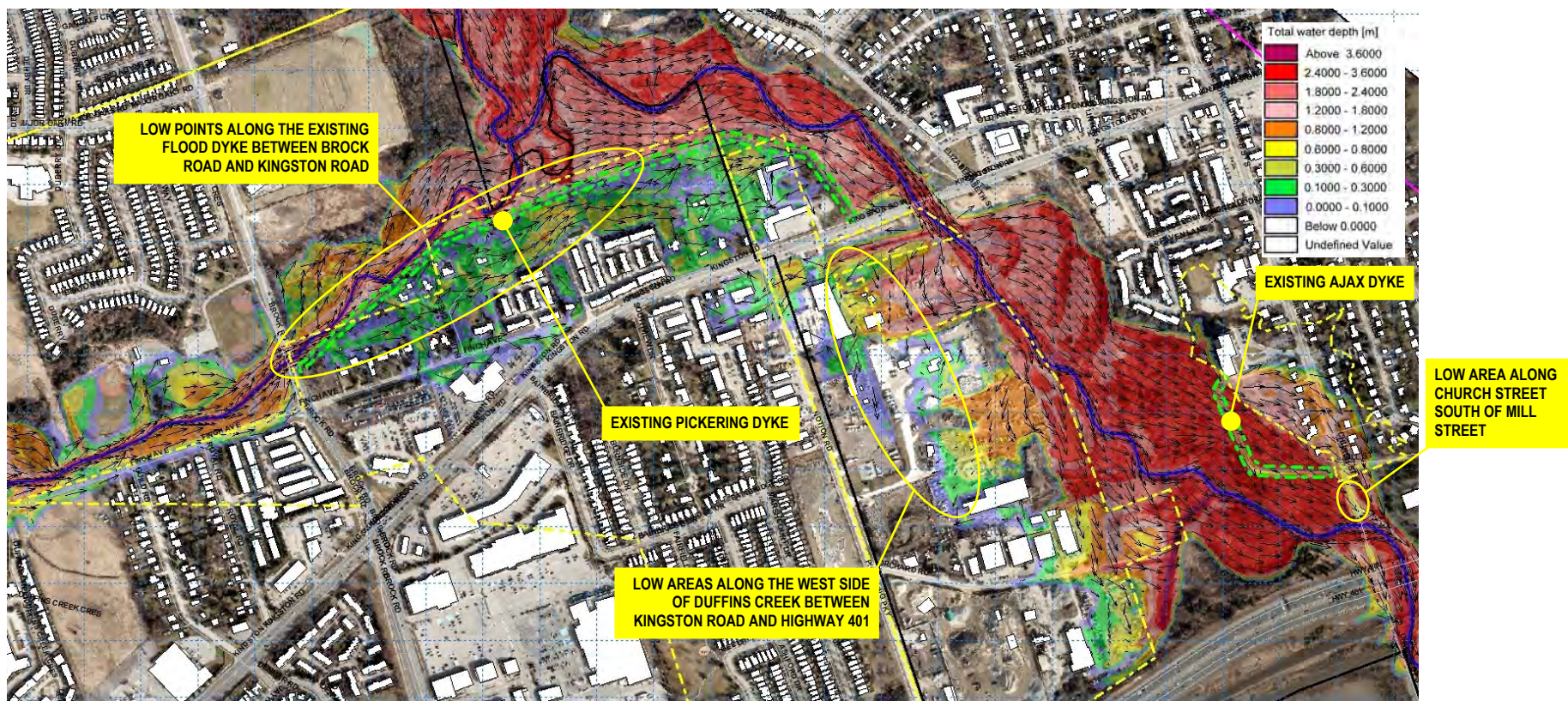


Fig 3.2b Existing Condition (500 -yr)

Flooding at 4:40 hrs

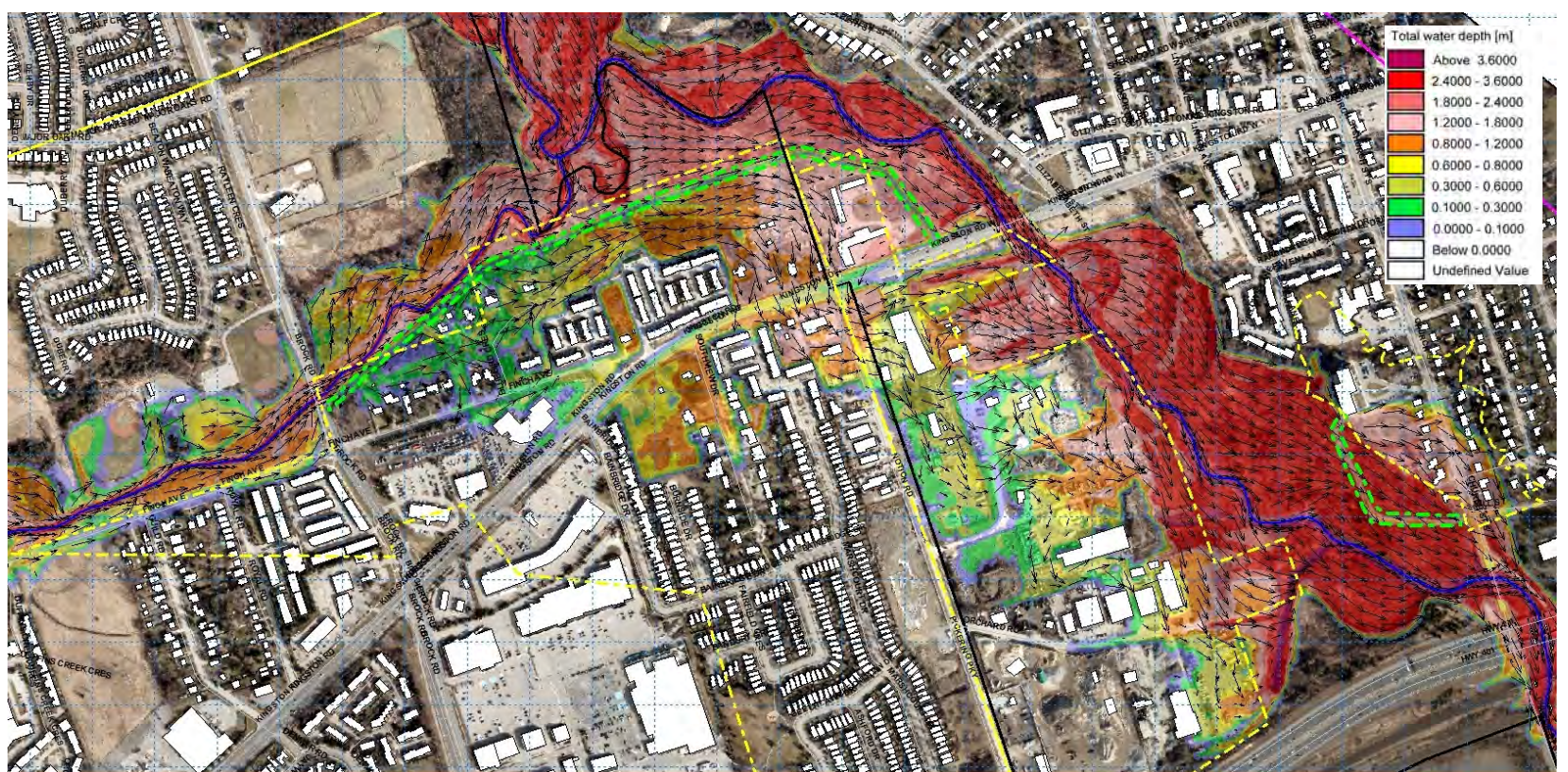


Fig 3.2c Existing Condition (500 -yr)

Flooding at 15:00 hrs

FIGURE 3.2
500-YR FLOOD PROCESS MAP - EXISTING CONDITIONS

STEADY INFLOW HYDROGRAPH (500-YR STORM)



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TORONTO AND REGION CONSERVATION
PICKERING-AJAX DYKE ASSESSMENT AND FLOOD REMEDIATION STUDY



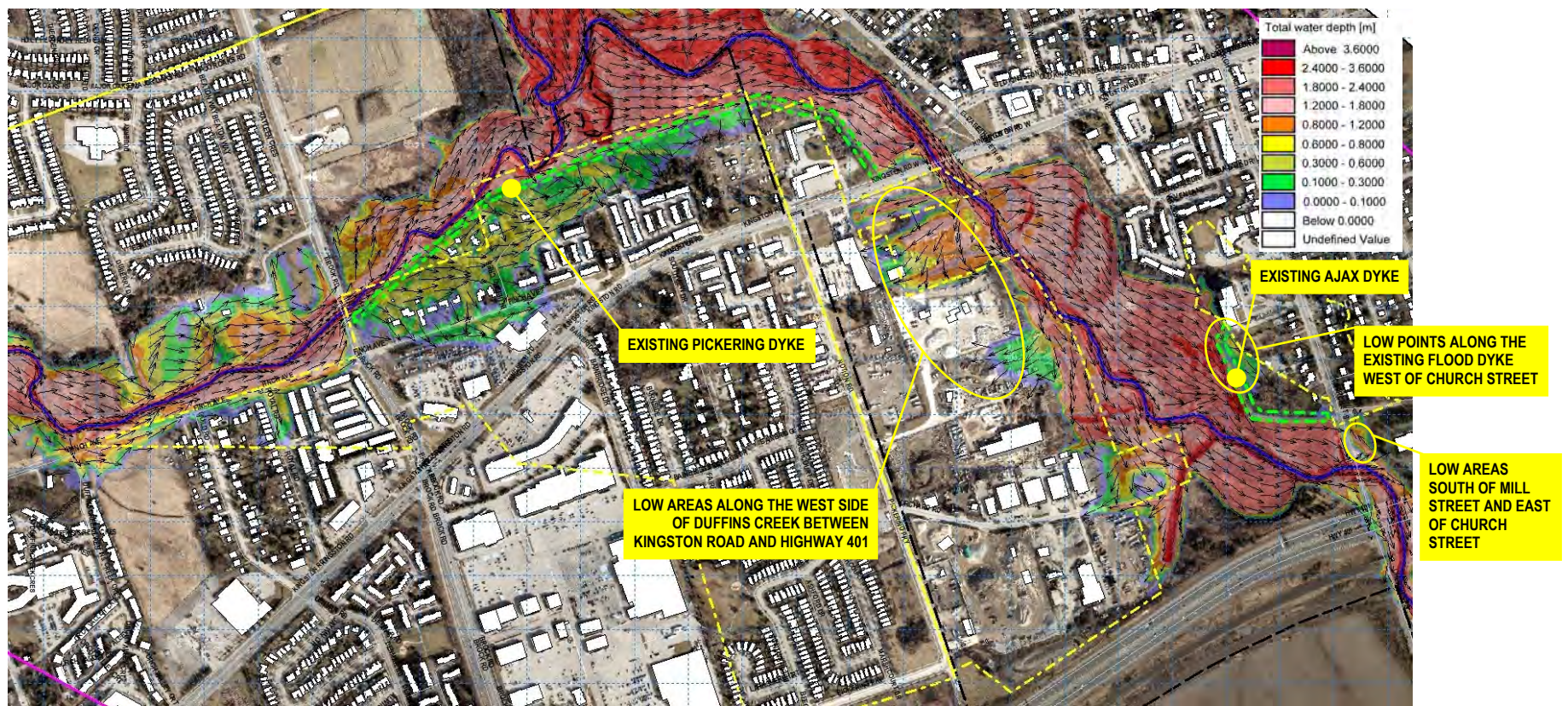


Fig 3.3a Existing Condition (Regional)

Flooding at 1:50 hrs

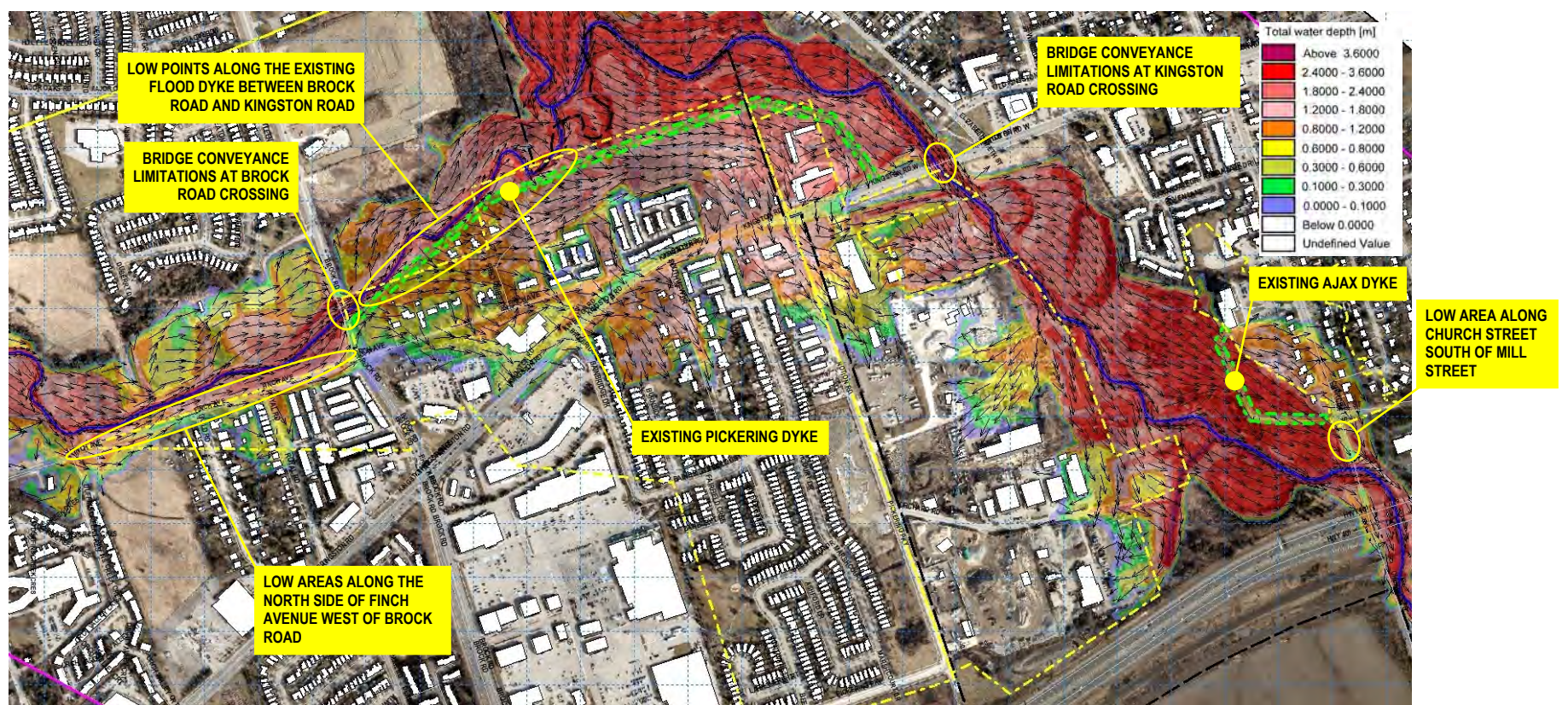


Fig 3.3b Existing Condition (Regional)

Flooding at 2:20 hrs

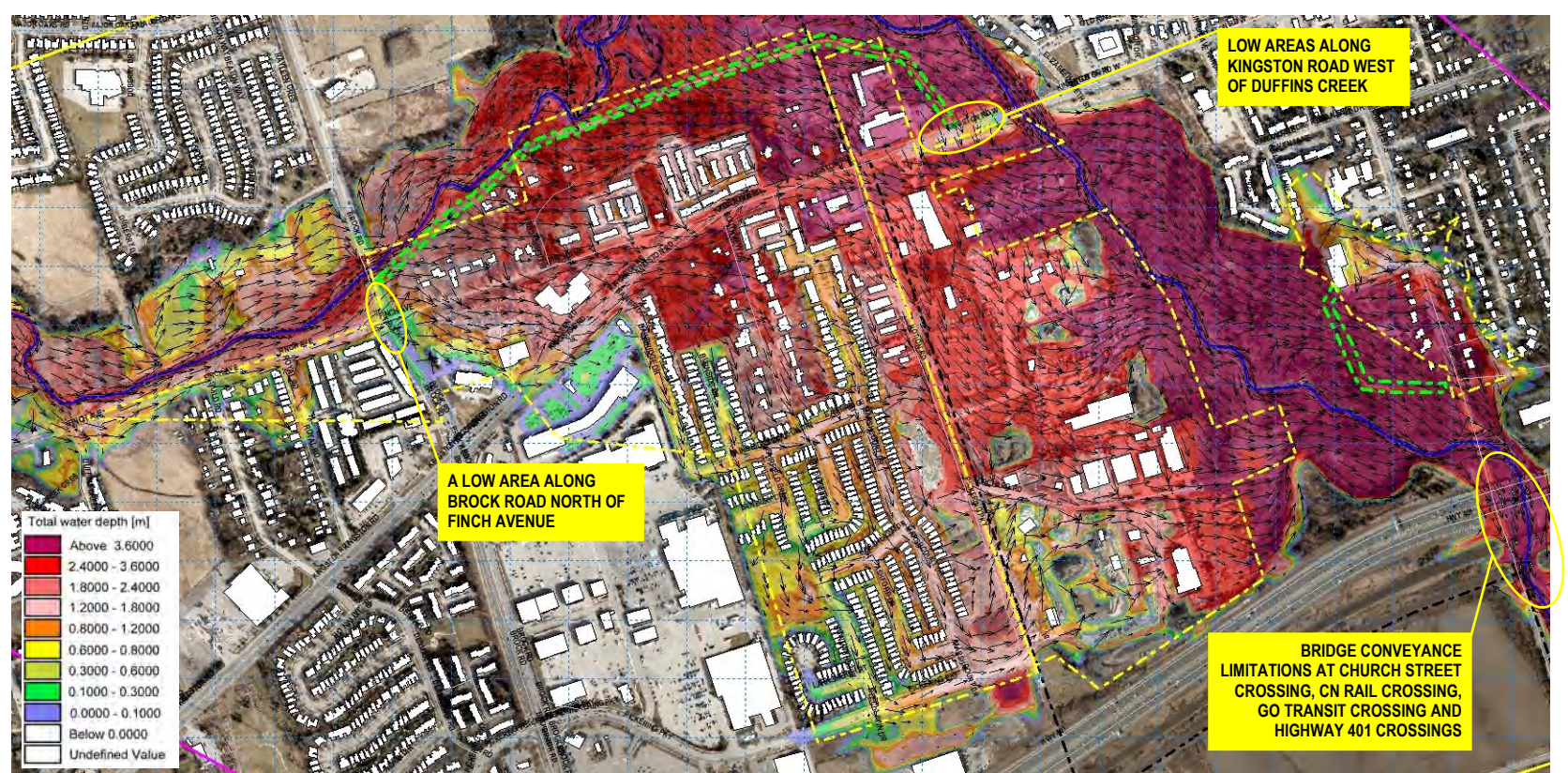


Fig 3.3c Existing Condition (Regional)

Flooding at 15:00 hrs

FIGURE 3.3
REGIONAL FLOOD PROCESS MAP - EXISTING CONDITIONS

STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL STORM)



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TORONTO AND REGION CONSERVATION
PICKERING-AJAX DYKE ASSESSMENT AND FLOOD REMEDIATION STUDY



4.0 PRELIMINARY FLOOD REMEDIATION INVESTIGATIONS

Based on the identified hydraulic constraints and possible flood mitigation options provided in Section 3.0, several preliminary flood remediation options were investigated in order to better understand the extent of remedial works required to achieve a range of flood mitigation scenarios. The options investigated included: (1) full flood remediation for the 500-yr storm; (2) partial flood remediation for the Regional storm; and, (3) full flood remediation for the Regional storm. It is noted that while flood dykes provide a “real” level of flood protection, the implementation of dykes is not recognized by the MNR to achieve an official “flood free” designation and lands behind dykes are still considered to reside within the floodplain. In order to meet the MNR criteria to achieve official “flood free” status, flood remediation works such as flood protection landforms (FPL’s) or conveyance improvements are required. Unfortunately, due to the very large footprint required to implement FPL’s, this measure is not considered viable within the study area due to the extensive existing development that would be impacted. The following sections present the development steps undertaken to achieve each of the flood remediation scenarios investigated.

4.1 Option 1: Full Flood Remediation (500-yr)

An initial scenario was investigated whereby full flood remediation is achieved within the Pickering and Ajax SPA’s for the 500-yr storm. As illustrated in the 500-yr Flood Process Map for Existing Conditions (**Figure 3.2**), flooding during the 500-yr storm occurs within the Pickering and Ajax SPA’s due to flow overtopping the Pickering and Ajax Dykes, flow spilling across low areas along the west side of Duffins Creek between Kingston Road and Highway 401, flow spilling across low areas south of Mill Street and east of Church Street, and flow spilling across the low area along Church Street south of Mill Street. As such, sequential flood remediation steps were implemented and modeled using MIKE Flood to confirm the minimum ultimate flood remediation requirements to achieve full flood remediation for the 500-yr storm.

The initial flood remediation step consisted of raising the Pickering and Ajax Dyke elevations to prevent spilling across the dykes. Based on the preliminary results, it is estimated that the Pickering Dyke would need to be raised by approximately 0.10 to 0.45 m (excl. freeboard) and the Ajax Dyke would need to be raised by approximately 1.05 to 1.40 m (excl. freeboard). As shown in **Figure 4.1**, flooding within the SPA’s is not completely remediated by raising the dykes alone. Although flow does not spill over the dykes, flow continues to spill across the low areas along the west side of Duffins Creek between Kingston Road and Highway 401, across the low areas south of Mill Street and east of Church Street, and across the low area along Church Street south of Mill Street. As such, additional flood remediation elements were added to the modeled scenario including: (1) a new dyke along the west side of Duffins Creek between Kingston Road and the high point north of Highway 401; (2) an extension of the existing Ajax Dyke at the south end to Church Street; (3) the raising of Church Street south of Mill Street; and, (4) a new dyke extending from Church Street to Mill Street. As shown in **Figure 4.2**, the implementation of the noted set of flood remediation elements provides flood protection for virtually the entire Pickering and Ajax SPA’s during the 500-yr storm. In addition, it was determined that the impacts of the proposed flood remediation elements would not raise upstream water levels significantly and would not flood additional buildings not currently residing within the floodplain.

4.2 Option 2: Partial Flood Remediation (Regional)

A second scenario was investigated whereby partial flood remediation is achieved within the Pickering and Ajax SPA’s for the Regional storm by addressing the identified hydraulic constraints due to bridge conveyance capacity and the associated channel conveyance capacity limitations. As illustrated in the Regional Flood Process Map for Existing Conditions (**Figure 3.3**), the bridge and associated channel conveyance limitations for the CN Rail crossing, Go Transit crossing, eastbound and westbound Highway 401 crossings, Church Street crossing, Kingston Road crossing and the Brock Road crossing contribute to flooding within the Pickering and Ajax SPA’s. As such, a second scenario was modeled with widened

bridges and widened channels for the crossings using MIKE Flood to confirm the benefits regarding the extent of flooding based on these improvements alone.

As shown in **Figures 4.3** and **4.4**, the implementation of the noted flood remediation elements provides an improvement in the extent of flooding during the Regional storm, however, extensive flooding remains throughout much of the Pickering and Ajax SPA's due to the overtopping of the Pickering and Ajax Dykes, flow spilling across low areas along the west side of Duffins Creek between Kingston Road and Highway 401, flow spilling across low areas south of Mill Street and east of Church Street, and flow spilling across the low areas north of Finch Avenue and west of Brock Road. In addition, it was determined that the impacts of the proposed flood remediation elements would not cause any significant increase in water levels or number of buildings within the floodplain.

The most notable improvement in flooding due to the partial flood remediation scenario (Option 2) is the removal of over 250 residential dwellings from the floodplain within the Pickering SPA and the removal of approximately 15 residential dwellings and an apartment building from the floodplain within the Ajax SPA.

4.3 Option 3: Full Flood Remediation (Regional)

A third scenario was investigated whereby full flood remediation is achieved within the Pickering and Ajax SPA's for the Regional storm. As illustrated in the Regional Flood Process Map for Existing Conditions (**Figure 3.3**), widespread flooding during the Regional storm occurs within the Pickering and Ajax SPA's due to the following flood mechanisms:

- flow overtopping the Pickering and Ajax Dykes;
- flow spilling across low areas along the west side of Duffins Creek between Kingston Road and Highway 401;
- flow spilling across low areas south of Mill Street and east of Church Street;
- flow spilling across the low area along Church Street south of Mill Street;
- flow spilling across the low area north of Finch Avenue west of Brock Road;
- flow spilling across the low point in Brock Road north of Finch Avenue; and,
- the bridge and associated channel conveyance capacity limitations for the CN Rail crossing, Go Transit crossing, eastbound and westbound Highway 401 crossings, Church Street crossing, Kingston Road crossing and the Brock Road crossing.

As such, sequential flood remediation steps were implemented and modeled using MIKE Flood to confirm the minimum ultimate flood remediation requirements to achieve full flood remediation for the Regional storm.

The initial flood remediation step consisted of raising the Pickering and Ajax Dyke elevations, widening the bridges and associated channel sections for the CN Rail, Go Transit, eastbound and westbound Highway 401, Church Street, Kingston Road and the Brock Road crossings, raising the low area on Church Street south of Mill Street, extending the existing Ajax Dyke at the south end to Church Street, and constructing new dykes between Church Street and Mill Street and west of Duffins Creek between Kingston Road and the high point north of Highway 401. Based on the preliminary results, it is estimated that the Pickering Dyke would need to be raised by approximately 1.70 to 2.10 m (excl. freeboard) and the Ajax Dyke would need to be raised by approximately 1.80 to 2.60 m (excl. freeboard). As shown in **Figure 4.5 (a)**, flooding within the Ajax SPA is fully remediated but flooding is still present within the Pickering SPA due to flow spilling across the low areas north of Finch Avenue west of Brock Road and flow spilling across the low area on Brock Road north of Finch Avenue.

The second flood remediation step consisted of raising Brock Road at the low area north of Finch Avenue and constructing a dyke along the low areas north of Finch Avenue west of Brock Road in addition to the

flood remediation elements included in the initial step. As shown in **Figure 4.5 (b)**, flooding within the Pickering SPA continues to occur due to flow spilling across the low area on Kingston Road west of Duffins Creek.

The third flood remediation step consisted of raising Kingston Road at the low area west of Duffins Creek. As shown in **Figure 4.5 (c)** and **Figure 4.6**, the implementation of the noted set of flood remediation elements provides flood protection for virtually the entire Pickering and Ajax SPA's during the Regional storm. In addition, it was determined that the impacts of the proposed flood remediation elements would not raise upstream water levels significantly and would not flood additional buildings not currently residing within the floodplain.

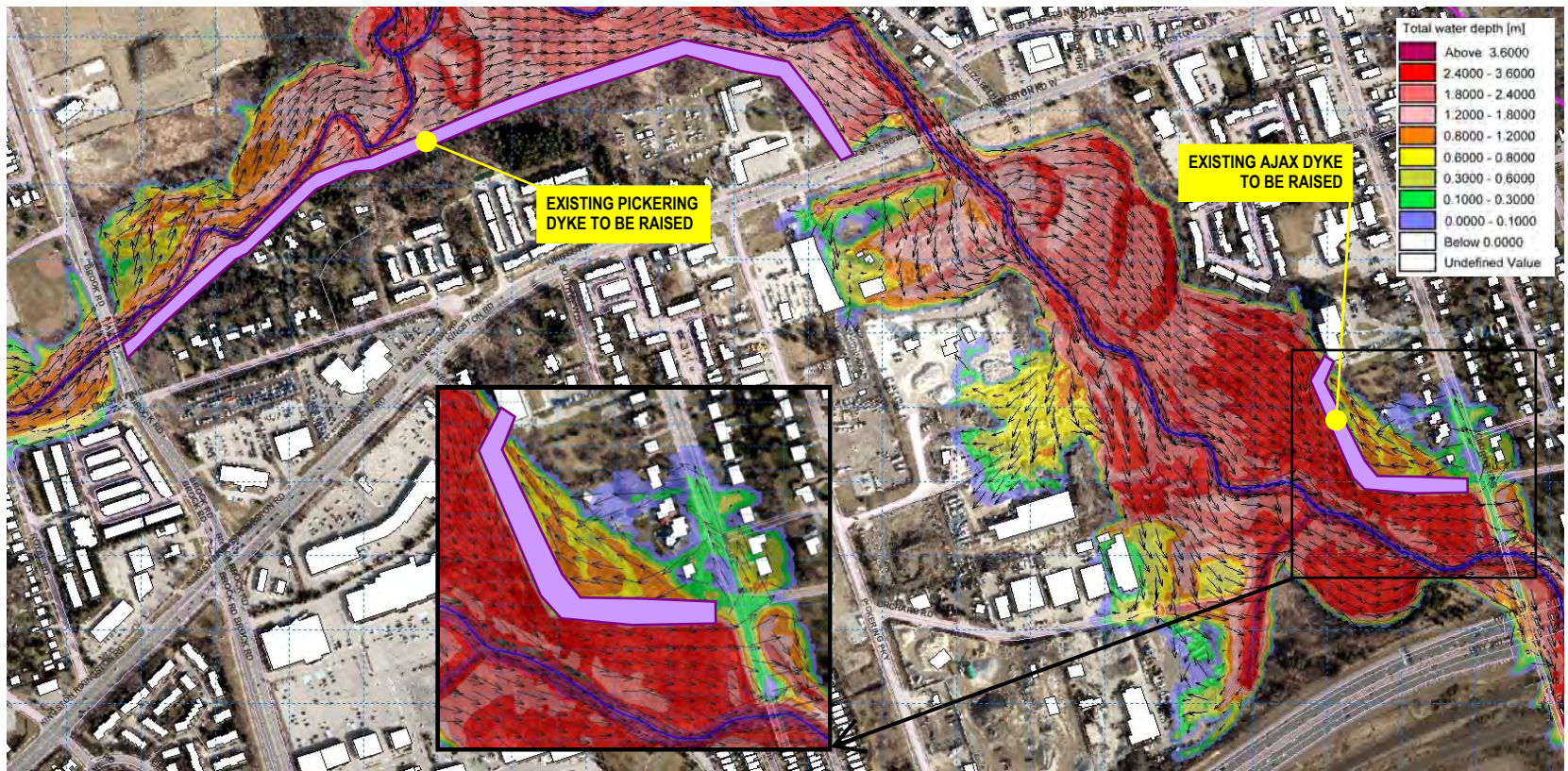


Fig 4.1a Raise Pickering and Ajax Dykes

Flooding at 3:30 hours

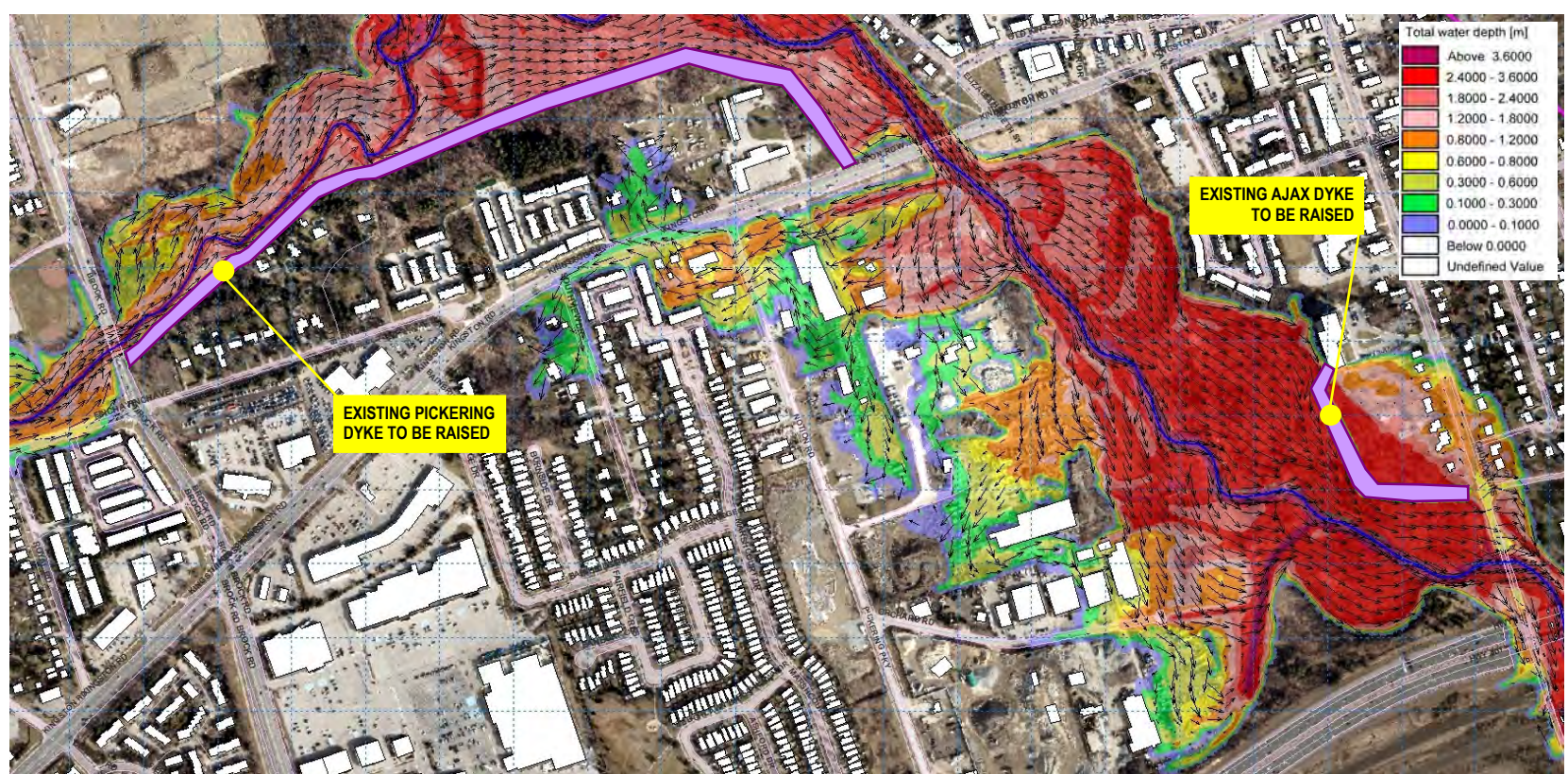


Fig 4.1b Raise Pickering and Ajax Dykes

Flooding at 5:15 hours

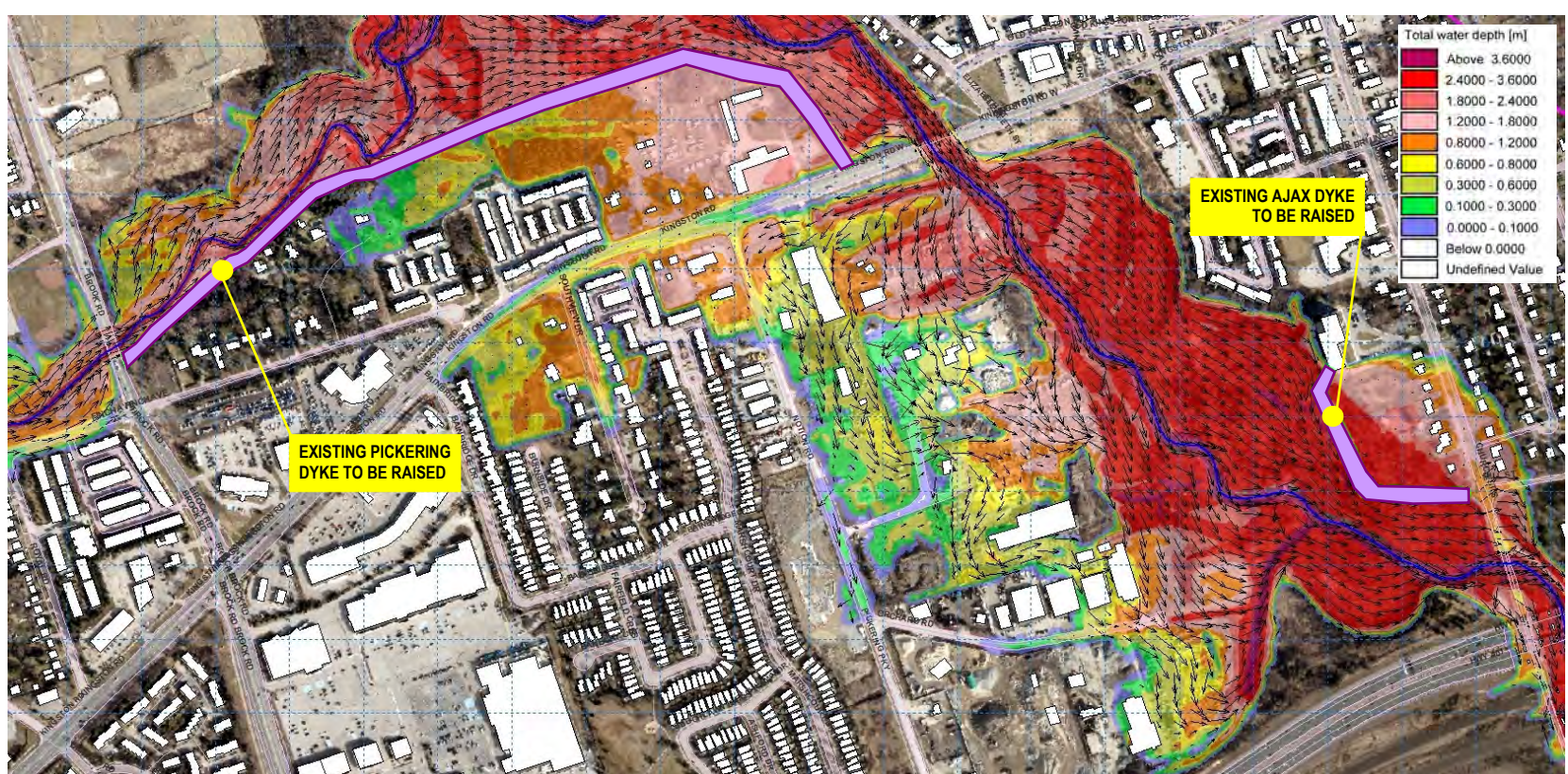


Fig 4.1c Raise Pickering and Ajax Dykes

Flooding at 15:00 hours

FIGURE 4.1
INTERMEDIATE DEVELOPMENT STEP FOR
OPTION 1 FULL FLOOD REMEDIATION (500-YR)
STEADY INFLOW HYDROGRAPH (500-YR STORM)

N

 26 March 2018

TORONTO AND REGION CONSERVATION
PICKERING-AJAX DYKE ASSESSMENT AND FLOOD REMEDIATION STUDY

 for The Living City



FLOOD REMEDIATION ELEMENTS INCLUDED:

- Raise Pickering and Ajax Dykes
- Construct New Dyke East of Notion Road
- Construct New Dyke at Church Street
- Raise road grade at Church Street

FIGURE 4.2
OPTION 1 : FULL FLOOD REMEDIATION (500 - YR)
500 - YR FLOOD DEPTH MAP
 STEADY INFLOW HYDROGRAPH (500 - YR STORM)

200 100 0 200 Meters

20 March 2018

Note:
 Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party

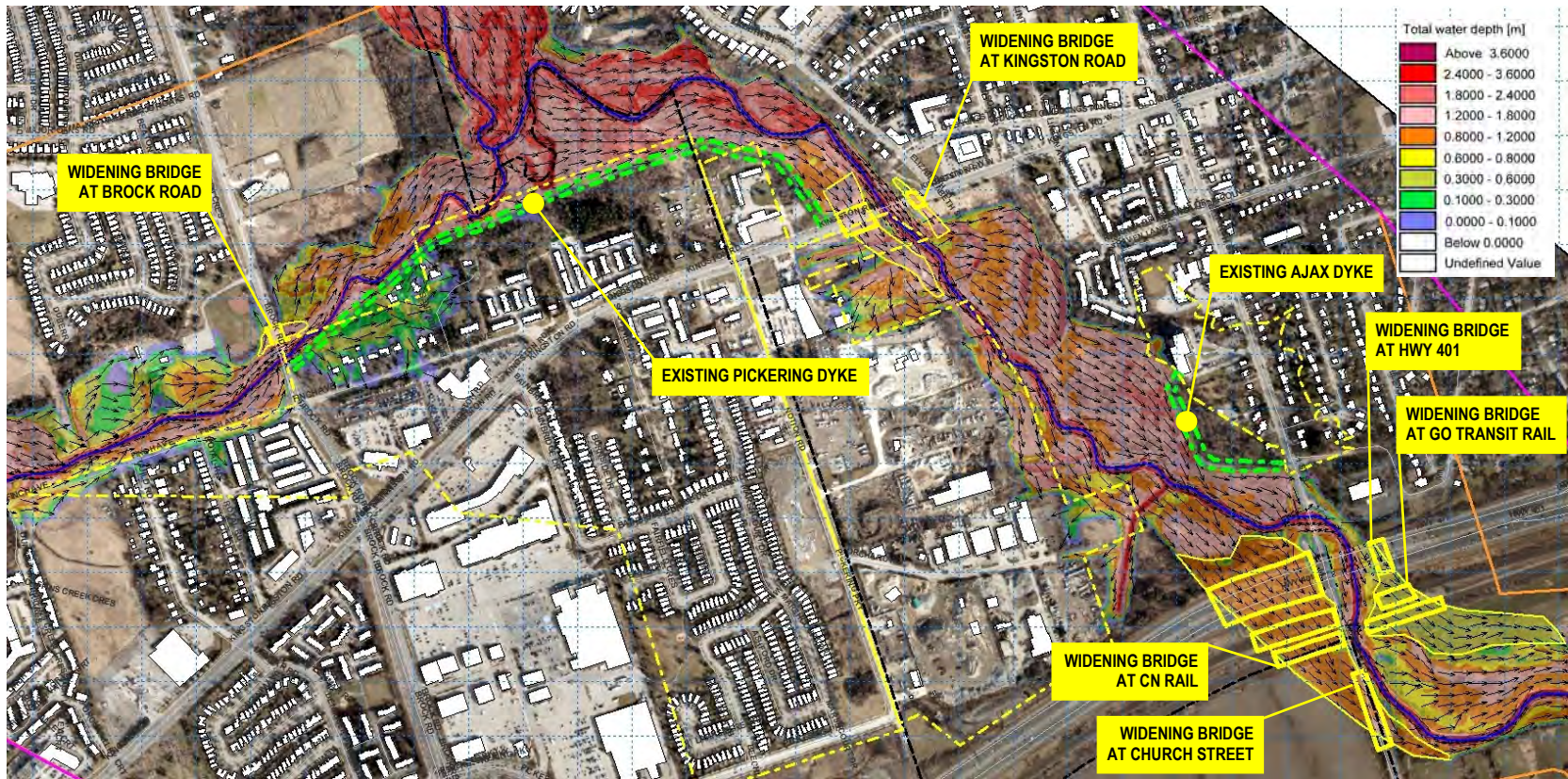


Fig 4.3a Widening Bridges and Channel

Flooding at 1:40 hours

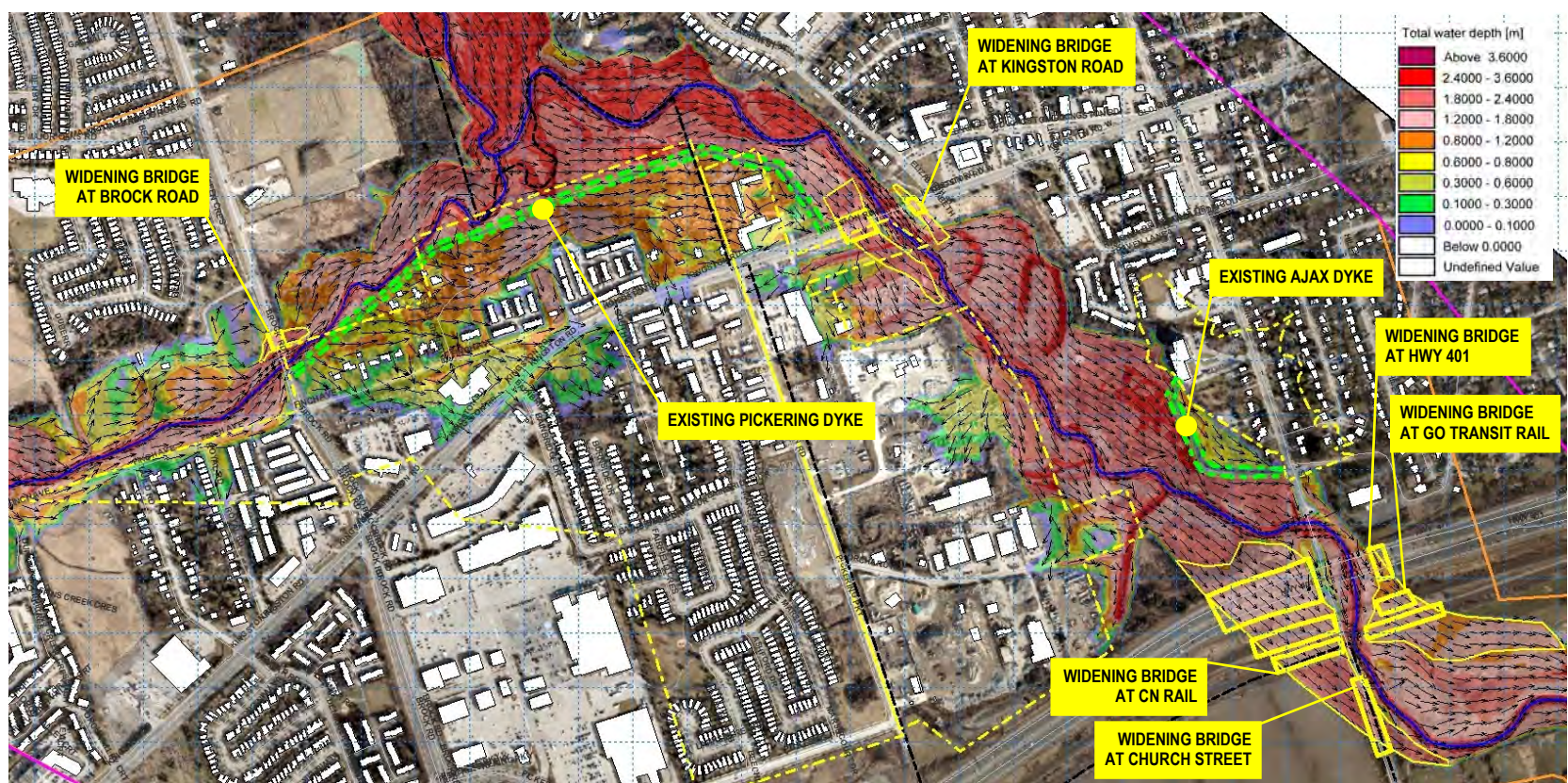


Fig 4.3b Widening Bridges and Channel

Flooding at 2:15 hours

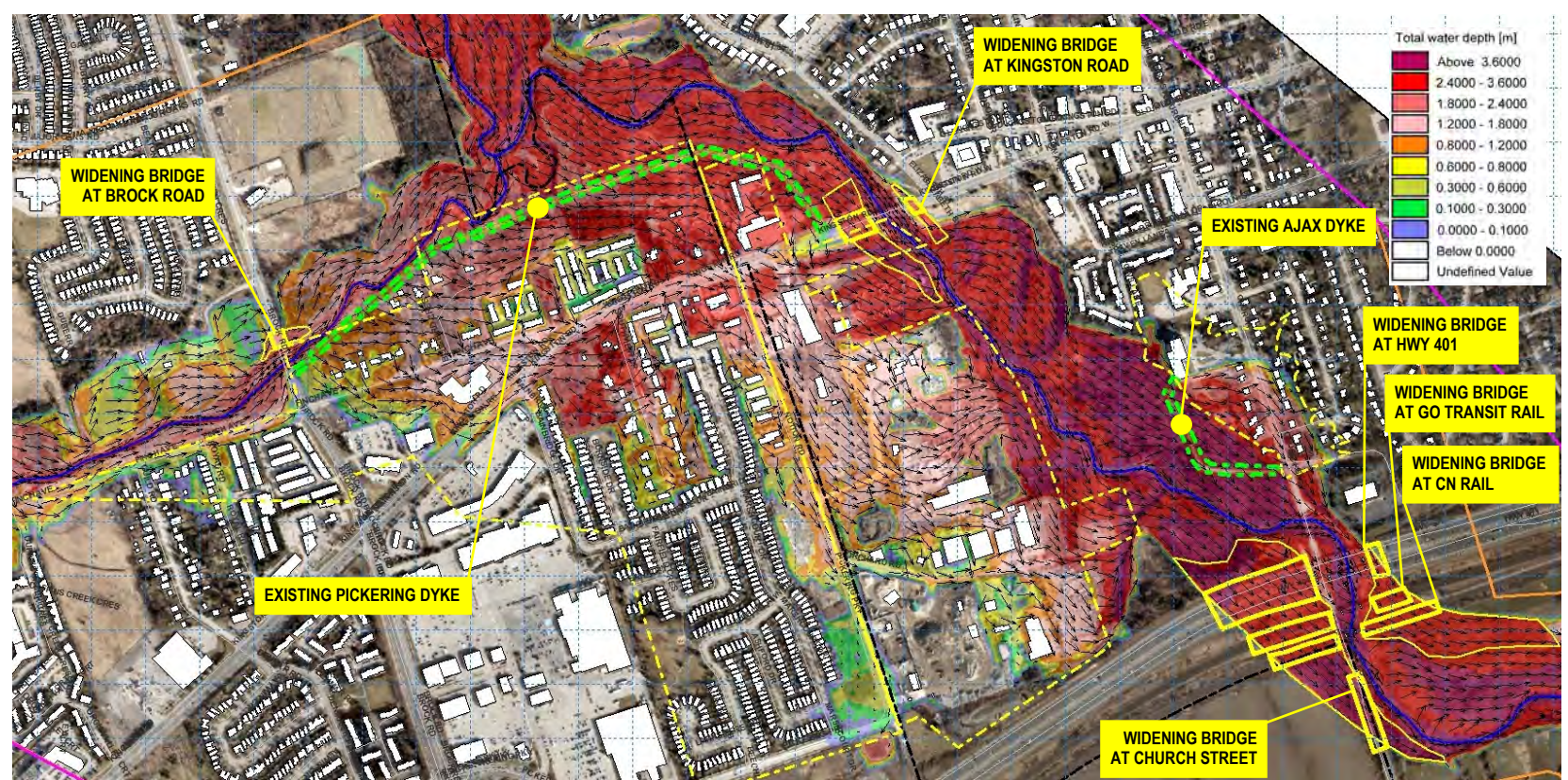


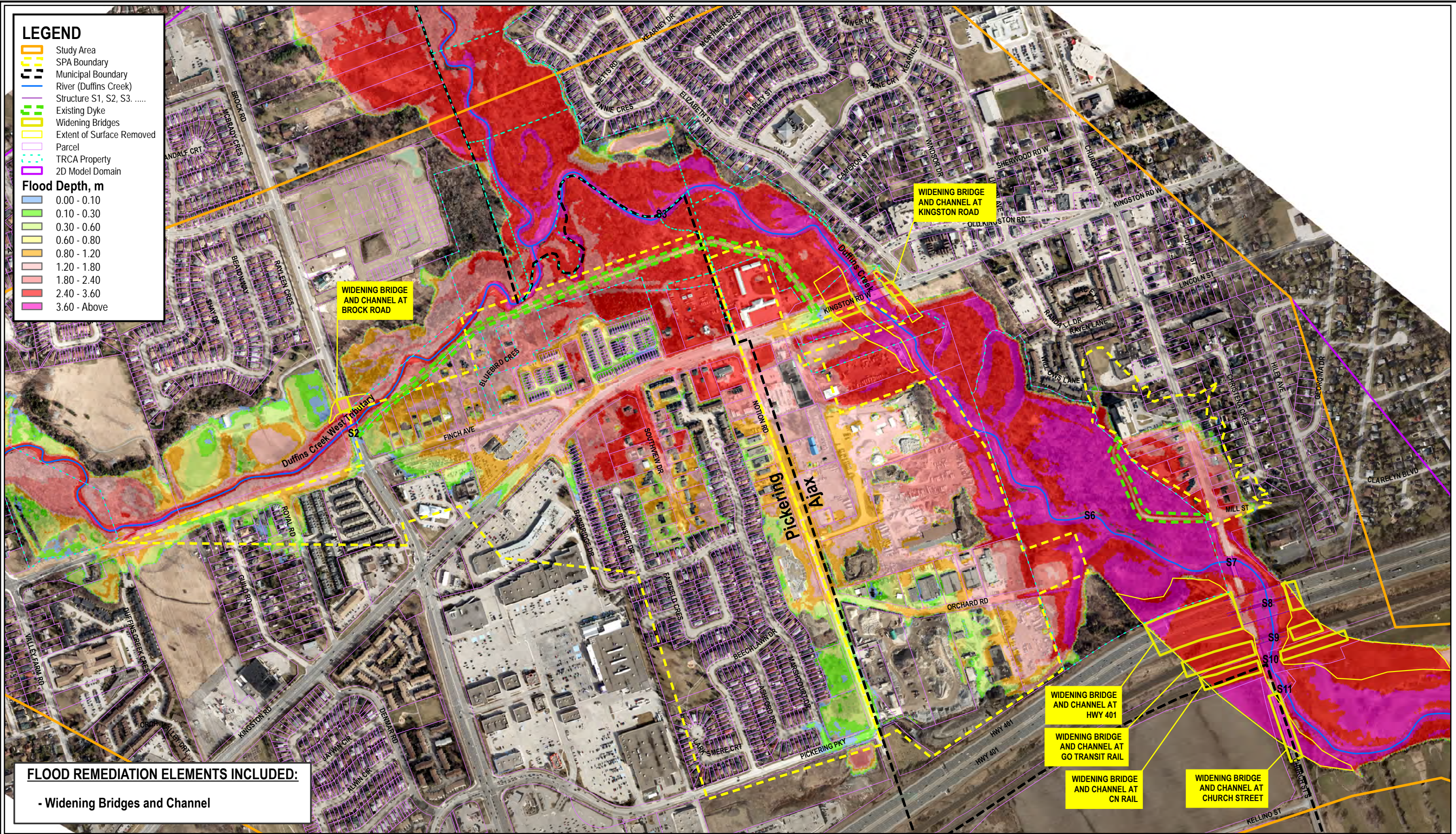
Fig 4.3c Widening Bridges and Channel

Flooding at 15:00 hours

FIGURE 4.3
INTERMEDIATE DEVELOPMENT STEPS FOR
OPTION 2 PARTIAL FLOOD REMEDIATION (REGIONAL)
 STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL STORM)

N

 26 March 2018



LEGEND

- Study Area
- SPA Boundary
- Municipal Boundary
- River (Duffins Creek)
- Structure S1, S2, S3,
- Existing Dyke
- Widening Bridges
- Extent of Surface Removed
- Parcel
- TRCA Property
- 2D Model Domain

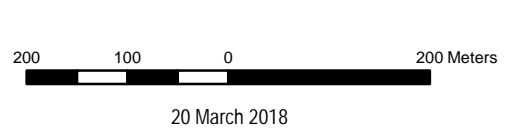
Flood Depth, m

- 0.00 - 0.10
- 0.10 - 0.30
- 0.30 - 0.60
- 0.60 - 0.80
- 0.80 - 1.20
- 1.20 - 1.80
- 1.80 - 2.40
- 2.40 - 3.60
- 3.60 - Above

FLOOD REMEDIATION ELEMENTS INCLUDED:

- Widening Bridges and Channel

FIGURE 4.4
OPTION 2 : PARTIAL FLOOD REMEDIATION (REGIONAL)
REGIONAL FLOOD DEPTH MAP
 STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL STORM)



Note:
 Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party

TORONTO AND REGION CONSERVATION
PICKERING-AJAX DYKE ASSESSMENT AND FLOOD REMEDIATION STUDY

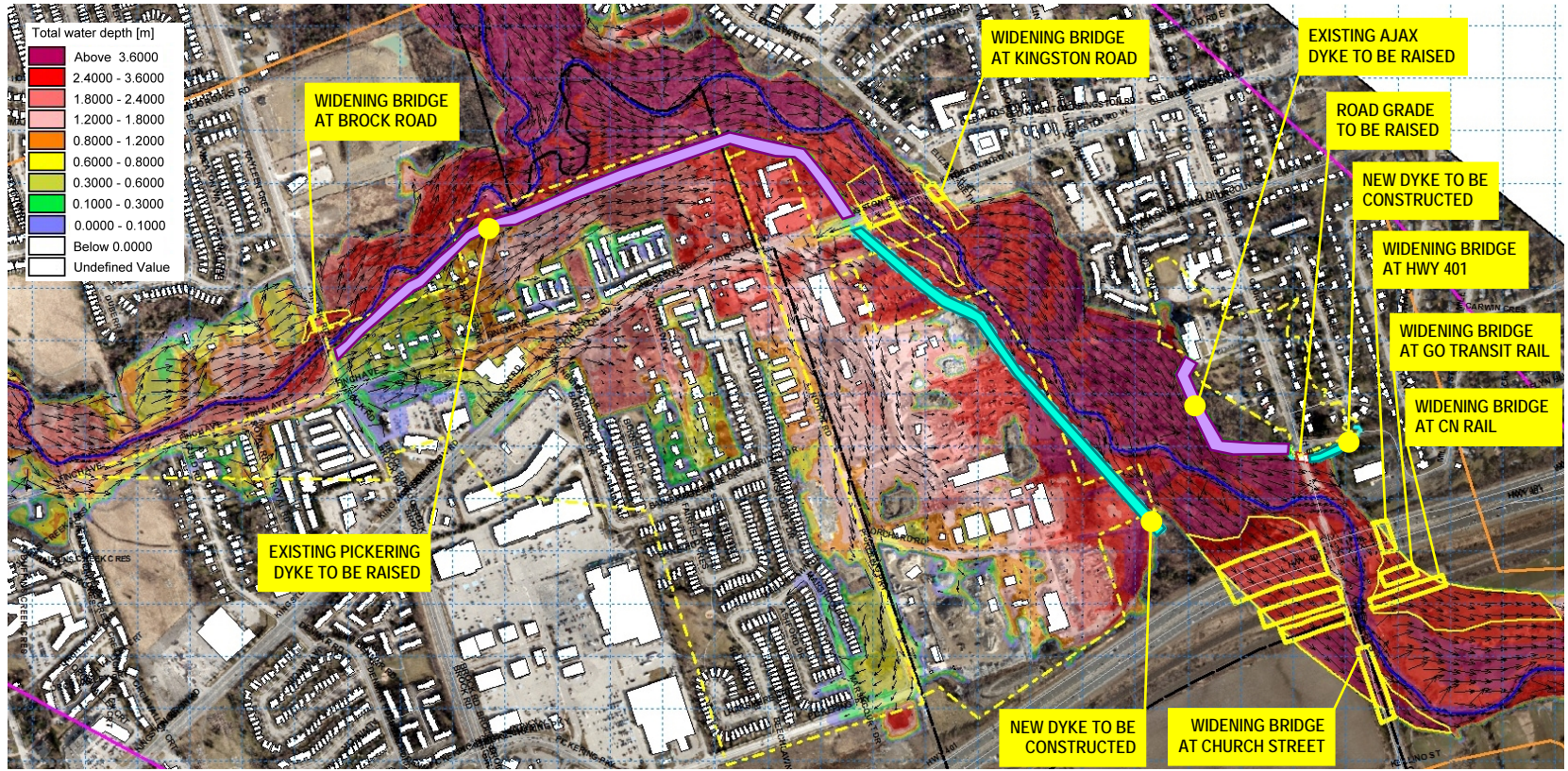


Fig 4.5a Widening Bridges and Channel, Raise Existing Dykes, Construct Two Dykes, Grade raise at Church



Fig 4.5b Widening Bridges and Channel, Raise Existing Dykes, Construct Three New Dykes, Grade raise at Church and Brock

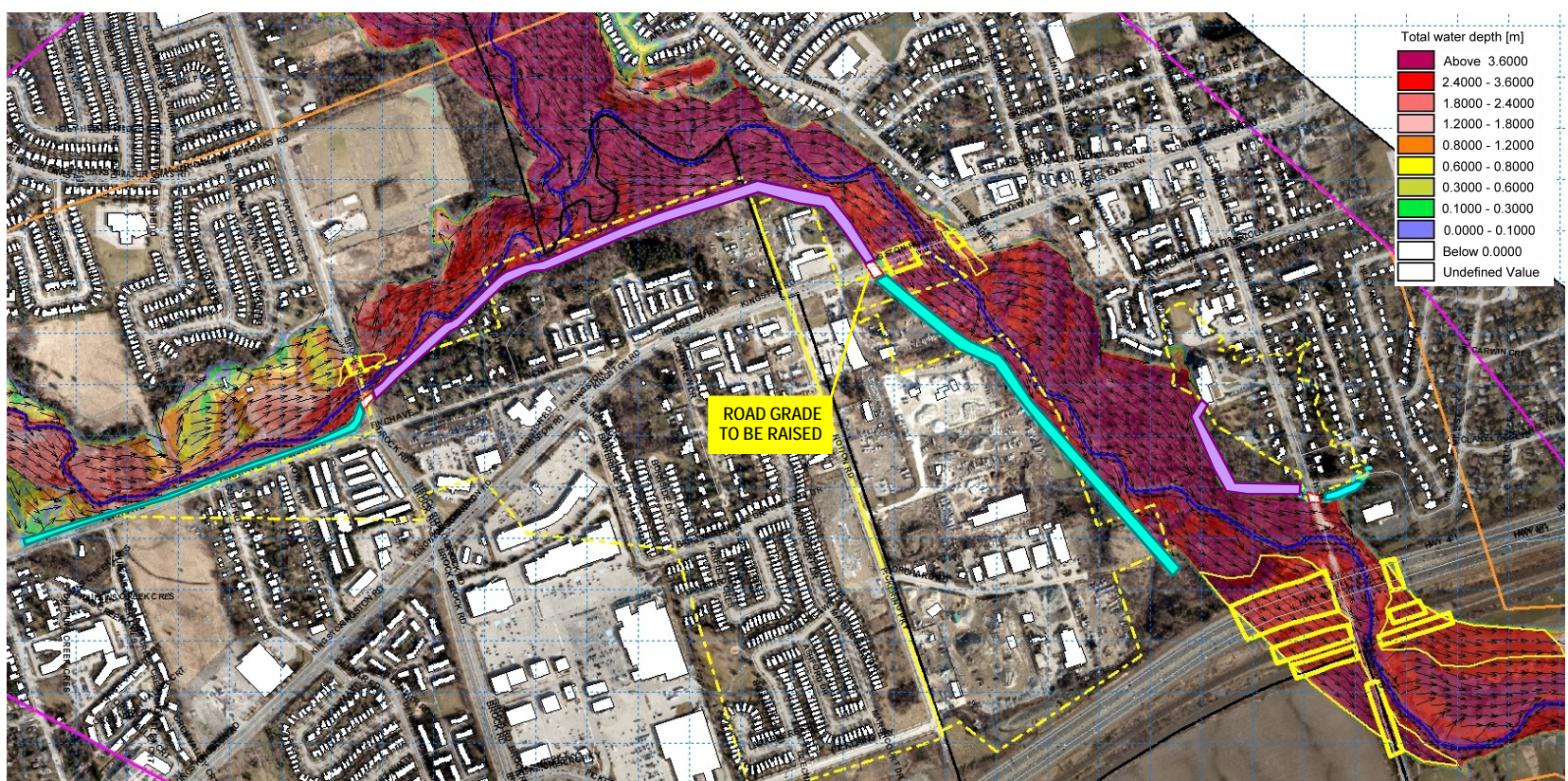


Fig 4.5c Widening Bridges and Channel, Raise Existing Dykes, Construct Three New Dykes, Grade raise at Church, Brock and Kingston Road

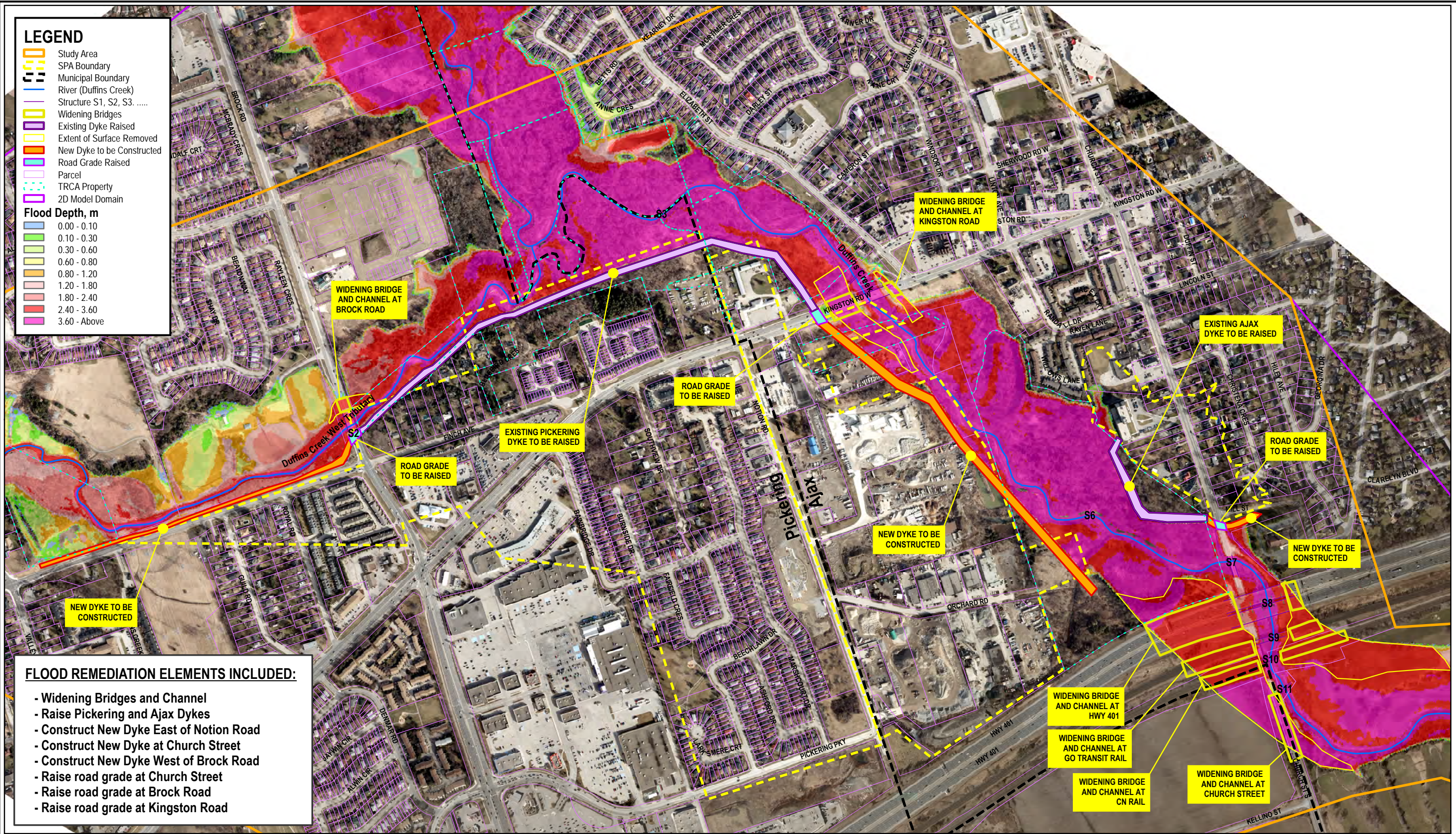
FIGURE 4.5
INTERMEDIATE DEVELOPMENT STEPS FOR
OPTION 3 FULL FLOOD REMEDIATION (REGIONAL)
STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL STORM)

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 26 March 2018

TORONTO AND REGION CONSERVATION
PICKERING-AJAX DYKE ASSESSMENT AND FLOOD REMEDIATION STUDY

 for The Living City



LEGEND

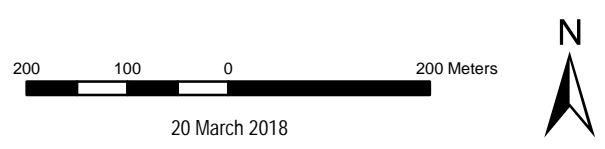
- Study Area
- SPA Boundary
- Municipal Boundary
- River (Duffins Creek)
- Structure S1, S2, S3,
- Widening Bridges
- Existing Dyke Raised
- Extent of Surface Removed
- New Dyke to be Constructed
- Road Grade Raised
- Parcel
- TRCA Property
- 2D Model Domain

Flood Depth, m

- 0.00 - 0.10
- 0.10 - 0.30
- 0.30 - 0.60
- 0.60 - 0.80
- 0.80 - 1.20
- 1.20 - 1.80
- 1.80 - 2.40
- 2.40 - 3.60
- 3.60 - Above

- FLOOD REMEDIATION ELEMENTS INCLUDED:**
- Widening Bridges and Channel
 - Raise Pickering and Ajax Dykes
 - Construct New Dyke East of Notion Road
 - Construct New Dyke at Church Street
 - Construct New Dyke West of Brock Road
 - Raise road grade at Church Street
 - Raise road grade at Brock Road
 - Raise road grade at Kingston Road

FIGURE 4.6
OPTION 3 : FULL FLOOD REMEDIATION (REGIONAL)
REGIONAL FLOOD DEPTH MAP
 STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL STORM)



Note:
 Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party

5.0 DISCUSSIONS REGARDING SCOPE OF FLOOD REMEDIATION WORKS REQUIRED AND RECOMMENDATIONS FOR FURTHER STUDY

The following sections provide further discussion regarding the scope of construction works required to achieve dyke rehabilitation and flood remediation within the Pickering and Ajax SPA's for the 500-yr and/or Regional storms. In addition, recommendations are provided for further study.

5.1 Scope of Flood Remediation Works Required

The results of the flood characterization, risk assessment and remediation investigations presented in the previous sections of this report indicate that the current level of flood protection afforded by the Pickering and Ajax Dykes is considerably reduced from the intended 500-yr level of flood protection as per the original flood mitigation design prepared by Simcoe Engineering. The reasons for this are discussed in the *MIKE Flood 1D-2D Model Development and Regulatory Floodplain Mapping, Pickering / Ajax SPA's* report (Valdor, March 2018) and include the following:

1. The tailwater conditions near the bottom of the study area used in the hydraulic model for the original dyke design were lower by approximately 0.8 to 0.9 m;
2. The most recent topographic survey and LiDAR revealed that the top elevations of the Pickering Dyke and the Ajax Dyke are lower than the original design elevations at many locations by up to approximately 0.10 m and 0.33 m, respectively;
3. The MIKE Flood hydraulic model is a two-dimensional model based on detailed topographic survey and LiDAR data that is more sophisticated and more accurate than the one-dimensional HEC-2 model utilized in the original dyke designs; and,
4. In addition, as identified in the *Dyke Level of Service and Rehabilitation Report, Pickering / Ajax SPA's* (Valdor, March 2018), the materials used in the construction of the Pickering and Ajax Dykes consist primarily of non-cohesive soil (*i.e.* sand/sandy gravel) that is not suitable for this type of dam facility and which fails to meet the requisite factor of safety (FOS) for a number of loading conditions/failure modes based on current standards.

As such, the deficiencies regarding the current level of flood protection afforded by the Pickering and Ajax Dykes are considerably worse than originally anticipated and extensive construction works will be required to achieve dyke rehabilitation and the 500-yr and/or the Regional level of flood remediation.

5.2 Recommendations for Further Study

As the required construction works to achieve dyke rehabilitation and the 500-yr and/or the Regional level of flood remediation for the Pickering and Ajax SPA's are much more extensive than those typically undertaken under the category of "dyke maintenance works" and, given the potential environmental, economic and other impacts associated with the required construction activities, it is recommended that further study be undertaken in accordance with the *Conservation Authority Class EA for Remedial Flood and Erosion Control Projects* (Conservation Ontario, 2002). It is recommended that the EA study consider the dyke rehabilitation requirements and preliminary flood remediation options to meet the intended level of service of the original design investigated in this study as a starting point from which to prepare a comprehensive set of design options for detailed evaluation. In this way, a preferred option can be selected that best addresses the identified deficiencies. The evaluation of design options should be completed using a carefully selected set of evaluation criteria (*e.g.* economic, social and environmental impacts, construction cost) and appropriate evaluation process based on discussions between the TRCA, Durham Region, the City of Pickering, the Town of Ajax and the Public.

6.0 SUMMARY AND CONCLUSIONS

Under the direction of the Toronto and Region Conservation Authority, Valdor Engineering has completed the *Flood Characterization and Preliminary Remediation Investigations, Pickering / Ajax SPA's* report. The key findings and results of the study are summarized as follows:

1. The results of the MIKE Flood model were used to characterize flooding and to assess the risk of flooding within the Pickering (Village East) SPA (Pickering SPA) and the Notion Road / Pickering Village SPA (Ajax SPA). Under existing conditions, the Pickering SPA experiences flooding commencing with the 350-yr design storm. It was identified that the Pickering Dyke overtops during the 350-yr storm but not during the 100-yr storm. Under existing conditions, the west portion of the Ajax SPA experiences localized flooding east of Notion Road adjacent Duffins Creek commencing with the 2-yr through 100-yr design storms. Under existing conditions, the Ajax Dyke overtops during the 100-yr storm but not during the 50-yr storm. Flooding within the Pickering and Ajax SPA's becomes extensive during the 350-yr and 500-yr design storms and Hurricane Hazel.
2. During the 500-yr storm in the Pickering SPA, approximately 15 residential type buildings and 2 industrial/commercial buildings are within the zone of high risk flooding. Over 400 residential type buildings and 12 industrial/commercial buildings are within the zone of high risk flooding in the Pickering SPA during the Regional storm. During the 500-yr storm in the Ajax SPA, approximately 13 residential type buildings and 3 industrial/commercial buildings are within the zone of high risk flooding. Approximately 23 residential type buildings and 25 industrial/commercial buildings are within the zone of high risk flooding in the Ajax SPA during the Regional storm.
3. Additional flooding mechanisms were identified that contribute to flooding during the 500-yr storm within the Pickering SPA. In addition to flow overtopping the existing Pickering Dyke, the identified flood mechanisms include flow spilling across low areas along the west side of Duffins Creek between Kingston Road and Highway 401.
4. Hydraulic constraints were identified that contribute to flooding during the Regional storm within the Pickering SPA, including: (1) bridge conveyance limitations associated with CN Rail, Go Transit, eastbound and westbound Highway 401, Church Street, Kingston Road and Brock Road; (2) channel conveyance constrictions primarily associated with the noted bridge crossings; (3) low points along the existing flood dyke between Brock Road and Kingston Road; (4) low areas along the north side of Finch Avenue west of Brock Road; (5) a low area along Brock Road north of Finch Avenue; (6) low areas along the west side of Duffins Creek between Kingston Road and Highway 401; and, (7) low areas along Kingston Road west of Duffins Creek.
5. Additional flooding mechanisms were identified that contribute to flooding during the 500-yr storm within the Ajax SPA. In addition to flow overtopping the existing Ajax Dyke, the identified flood mechanisms include flow spilling across: (1) a low area along Church Street south of Mill Street; and, (2) low areas south of Mill Street and east of Church Street.
6. Hydraulic constraints were identified that contribute to flooding during the Regional storm within the Ajax SPA, including: (1) bridge conveyance limitations associated with CN Rail, Go Transit, eastbound and westbound Highway 401, and Church Street; (2) channel conveyance constrictions primarily associated with the noted bridge crossings; (3) low points along the existing flood dyke west of Church Street; (4) a low area along Church Street south of Mill Street; and, (5) low areas south of Mill Street and east of Church Street.
7. Preliminary flood remediation options were investigated to better understand the extent of remedial works required to achieve a range of flood mitigation scenarios. The options investigated included:

- (1) full flood remediation for the 500-yr storm; (2) partial flood remediation for the Regional storm; and, (3) full flood remediation for the Regional storm. The results for Option 1 and Option 3 include flood protection for virtually the entire Pickering and Ajax SPA's during the 500-yr and Regional storms, respectively. The most notable improvement in flooding due to the partial flood remediation scenario (Option 2) is the removal of over 250 residential dwellings from the floodplain within the Pickering SPA and the removal of approximately 15 residential dwellings and an apartment building from the floodplain within the Ajax SPA.
8. It is noted that while flood dykes provide a "real" level of flood protection, the implementation of dykes is not recognized by the MNRF to achieve an official "flood free" designation and lands behind dykes are still considered to reside within the floodplain. In order to meet the MNRF criteria to achieve official "flood free" status, flood remediation works such as flood protection landforms (FPL's) or conveyance improvements are required. Unfortunately, due to the very large footprint required to implement FPL's, this measure is not considered viable within the study area due to the extensive existing development that would be impacted.
 9. The requirements to achieve the 500-yr level of flood remediation are extensive and costly and require further consideration and analysis beyond the scope of this study to confirm the impacts and viability of such an undertaking. The extent and costs associated with the partial and full flood remediation for the Regional storm would appear to be prohibitive but should also be considered for further study and assessed in greater detail.

7.0 RECOMMENDATIONS

The following summarizes the report recommendations:

1. As the required construction works to achieve dyke rehabilitation and the 500-yr and/or the Regional level of flood remediation for the Pickering and Ajax SPA's are much more extensive than those typically undertaken under the category of "dyke maintenance works" and, given the potential environmental, economic and other impacts associated with the required construction activities, it is recommended that further study be undertaken in accordance with the *Conservation Authority Class EA for Remedial Flood and Erosion Control Projects* (Conservation Ontario, 2002).
2. The EA study should consider the dyke rehabilitation requirements and preliminary flood remediation options, to meet the intended level of service of the original design, investigated in this study as a starting point from which to prepare a comprehensive set of design options for detailed evaluation such that a preferred option can be selected that best addresses the identified deficiencies regarding the current flood mitigation works constructed in the 1980's.
3. As a minimum requirement, it is important that the TRCA in association with the Region of Durham, the City of Pickering and the Town of Ajax assess all opportunities to reinstate the existing level of flood protection within the Pickering and Ajax SPA's to ensure the areas remain flood free for events up to and including the 500-yr storm and to minimize the risk to life and property.
4. Prior to the completion of the Class EA study to review in further detail, evaluate and select the preferred solution to achieve dyke rehabilitation and flood remediation for the 500-yr and/or Regional storms, the identified list of proposed dyke rehabilitation items (e.g. flap gate repairs and general maintenance items) included in the *Dyke Level of Service and Rehabilitation Report, Pickering / Ajax SPA's* (Valdor, March 2018) should be implemented as soon as possible.

8.0 REFERENCES

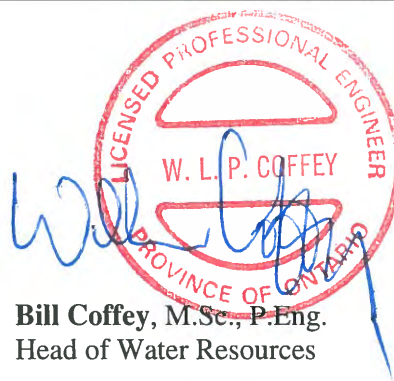
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Respectfully Submitted,

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This report was prepared by Valdor Engineering Inc. for the account of the Corporation of the Toronto and Region Conservation Authority. The comments, recommendations and material in this report reflect Valdor Engineering Inc.'s best judgment in light of the information available to it at the time of preparation. Any use of which a third party makes of this report, or any reliance on, or decisions made based on it, are the responsibility of such third parties. Valdor Engineering Inc. accepts no responsibility whatsoever for any damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

APPENDIX 'A'

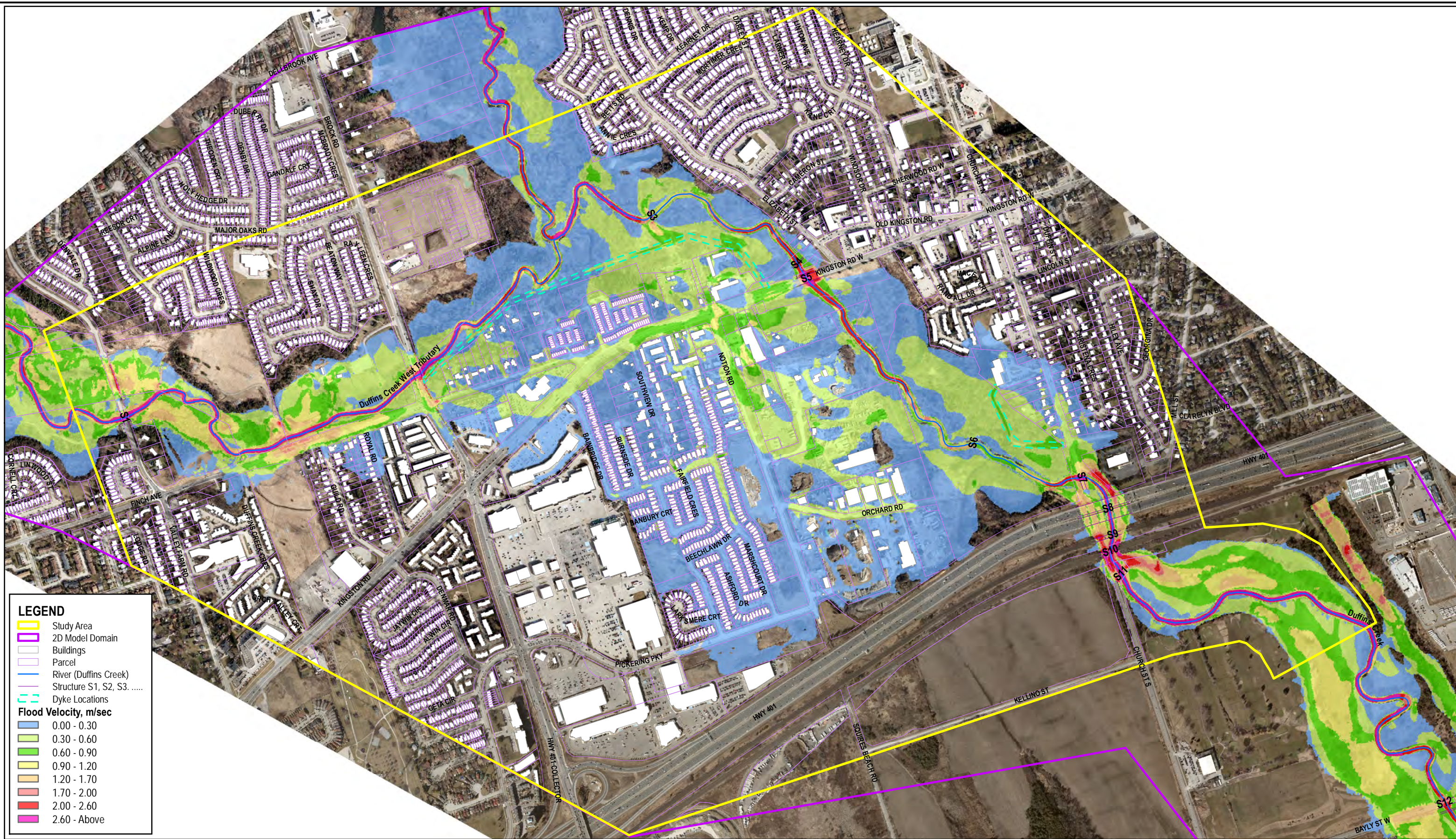
Supplementary Results and Figures

Flood Characterization and Preliminary Remediation Investigations Pickering / Ajax SPA

Toronto and Region Conservation Authority

Appendix 'A' Contents:

- **Figure A.1** Existing Regional Flood Velocity Map
- **Figure A.2** Existing 500-Yr Flood Velocity Map
- **Figure A.3** Existing Regional Flood Flow Direction & Location Map
- **Figure A.4** Existing Regional Flood Flow Direction Map at Location 1
- **Figure A.5** Existing Regional Flood Flow Direction Map at Location 2
- **Figure A.6** Existing Regional Flood Flow Direction Map at Location 3
- **Figure A.7** Existing 500-Yr Flood Flow Direction Map
- **Figure A.8** Existing 350-Yr Flood Flow Direction Map
- **Figure A.9** Existing 100-Yr Flood Flow Direction Map
- **Figure A.10** Existing 50-Yr Flood Flow Direction Map
- **Figure A.11** Flood Extent - Various Storms - Pickering SPA
- **Figure A.12** Flood Extent - Various Storms - Ajax SPA
- **Figure A.13** Existing 500-Yr Flood Risk Map - Pickering SPA
- **Figure A.14** Existing 500-Yr Flood Risk Map - Ajax SPA
- **Figure A.15** Existing Regional Flood Risk Map - Pickering SPA
- **Figure A.16** Existing Regional Flood Risk Map - Ajax SPA



LEGEND

- Study Area
- 2D Model Domain
- Buildings
- Parcel
- River (Duffins Creek)
- Structure S1, S2, S3,
- Dyke Locations

Flood Velocity, m/sec

- 0.00 - 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- 1.20 - 1.70
- 1.70 - 2.00
- 2.00 - 2.60
- 2.60 - Above

Figure A.1
REGIONAL FLOOD VELOCITY MAP
 (EXISTING CONDITION)
STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL)


250 125 0 250 Meters

01 December 2017


N

Note:
Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

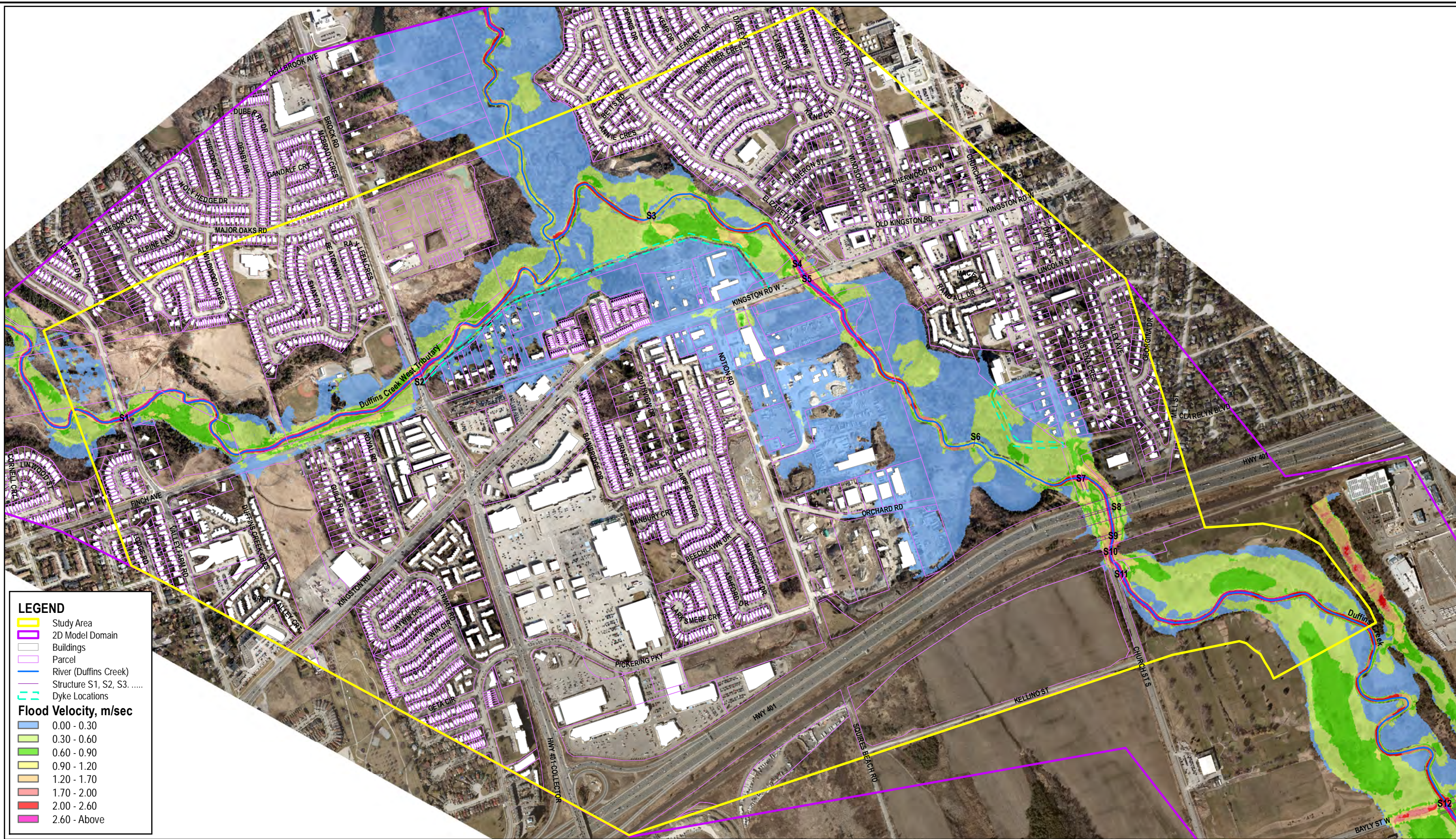
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LEGEND

- Study Area
- 2D Model Domain
- Buildings
- Parcel
- River (Duffins Creek)
- Structure S1, S2, S3,
- Dyke Locations

Flood Velocity, m/sec

- 0.00 - 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- 1.20 - 1.70
- 1.70 - 2.00
- 2.00 - 2.60
- 2.60 - Above

Figure A.2
500-YR FLOOD VELOCITY MAP
 (EXISTING CONDITION)

STEADY INFLOW HYDROGRAPH (500-YR STORM)



01 December 2017



Note:

Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

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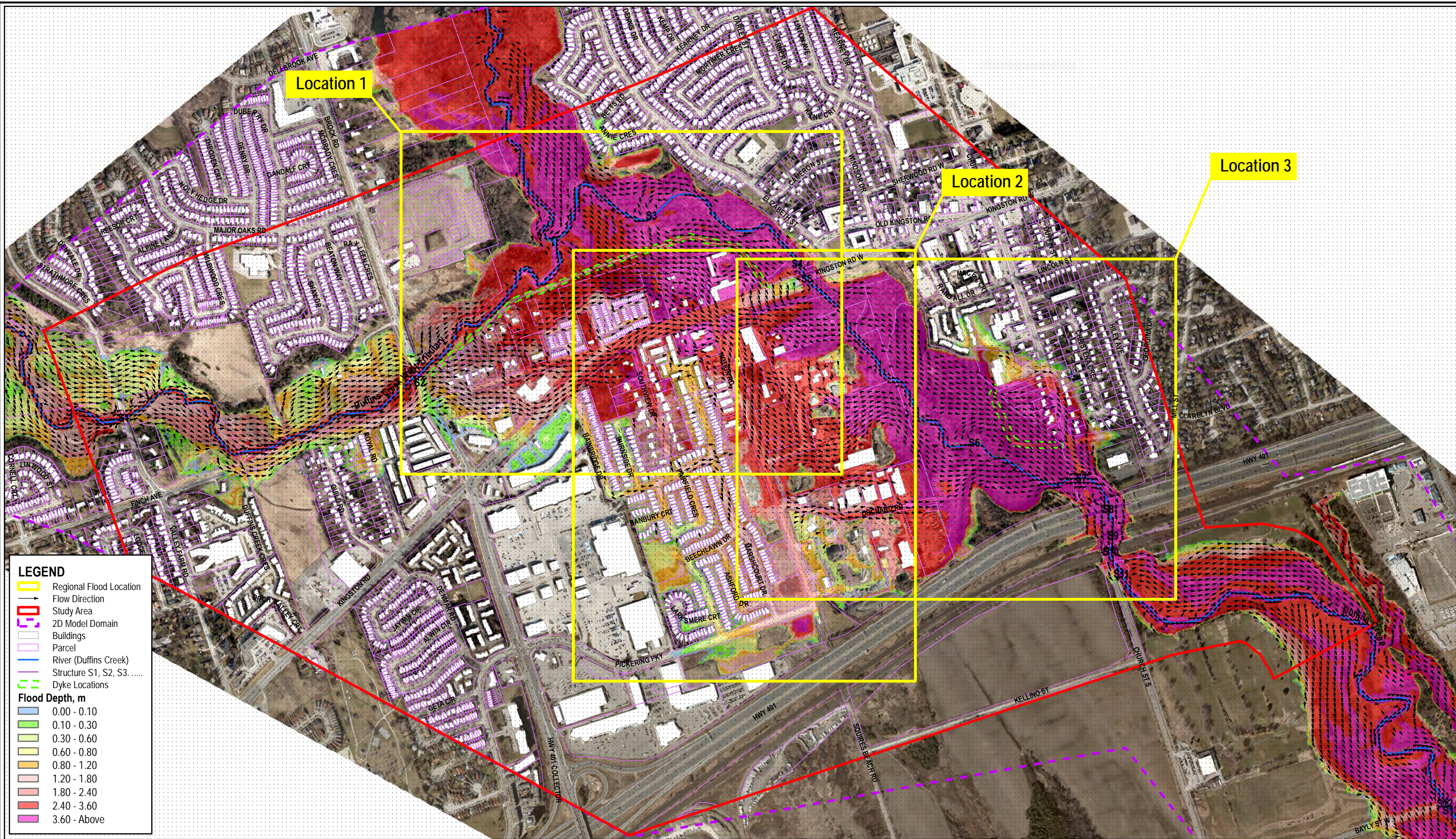
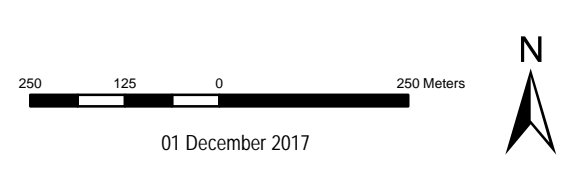


Figure A.3
REGIONAL FLOOD FLOW DIRECTION AND LOCATION MAP
 (EXISTING CONDITION)
STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL)



Note:
Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

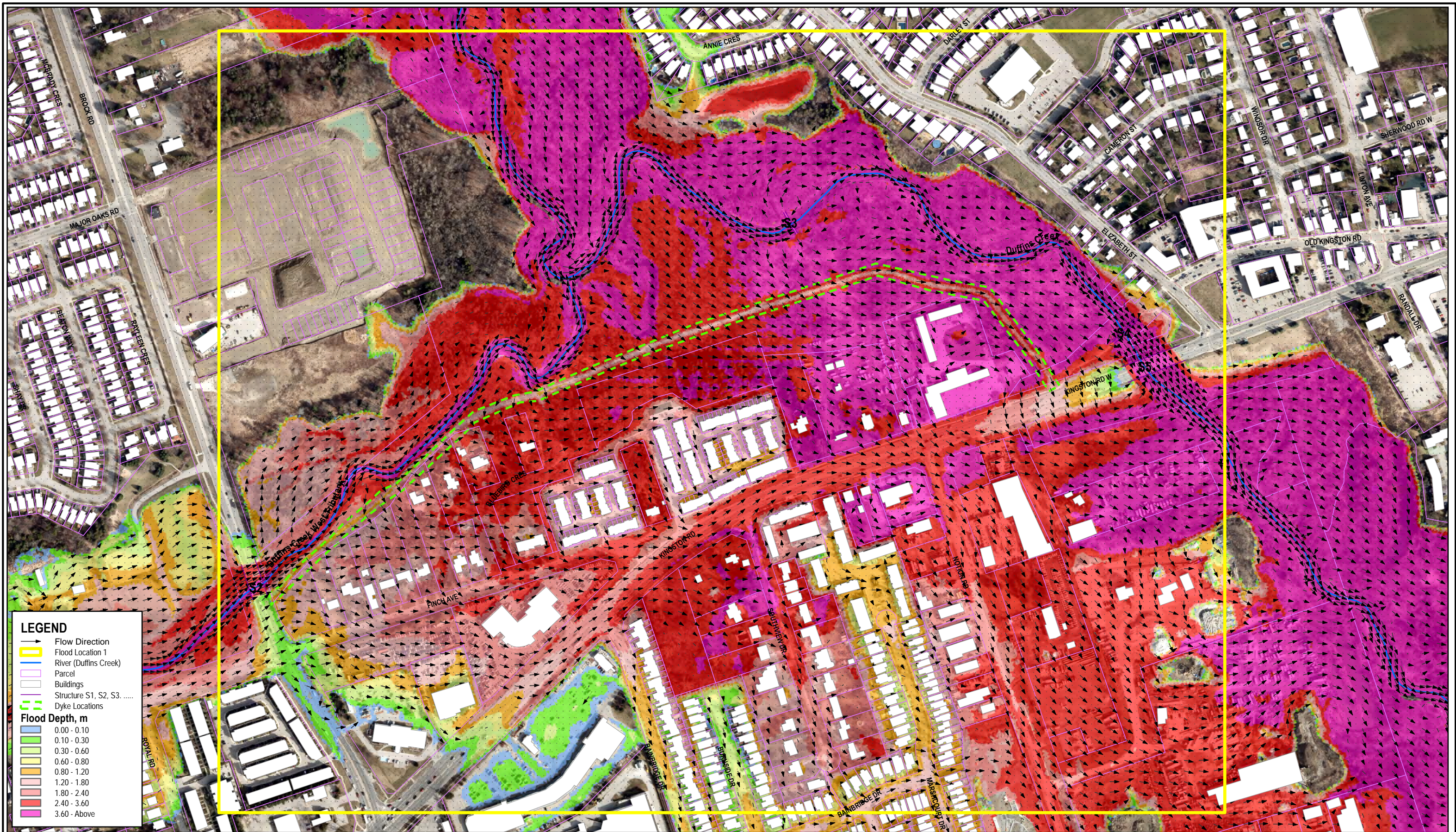


Figure A.4
REGIONAL FLOOD FLOW
 (Location 1 - Ref. Figure A.3)
 (EXISTING CONDITION)
 STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL)

100 50 0 100 Meters

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Note:

Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party



Figure A.5

REGIONAL FLOOD FLOW
(Location 2 - Ref. Figure A.3)

(EXISTING CONDITION)
STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 37.5 75 150 Meters

01 December 2017



Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party

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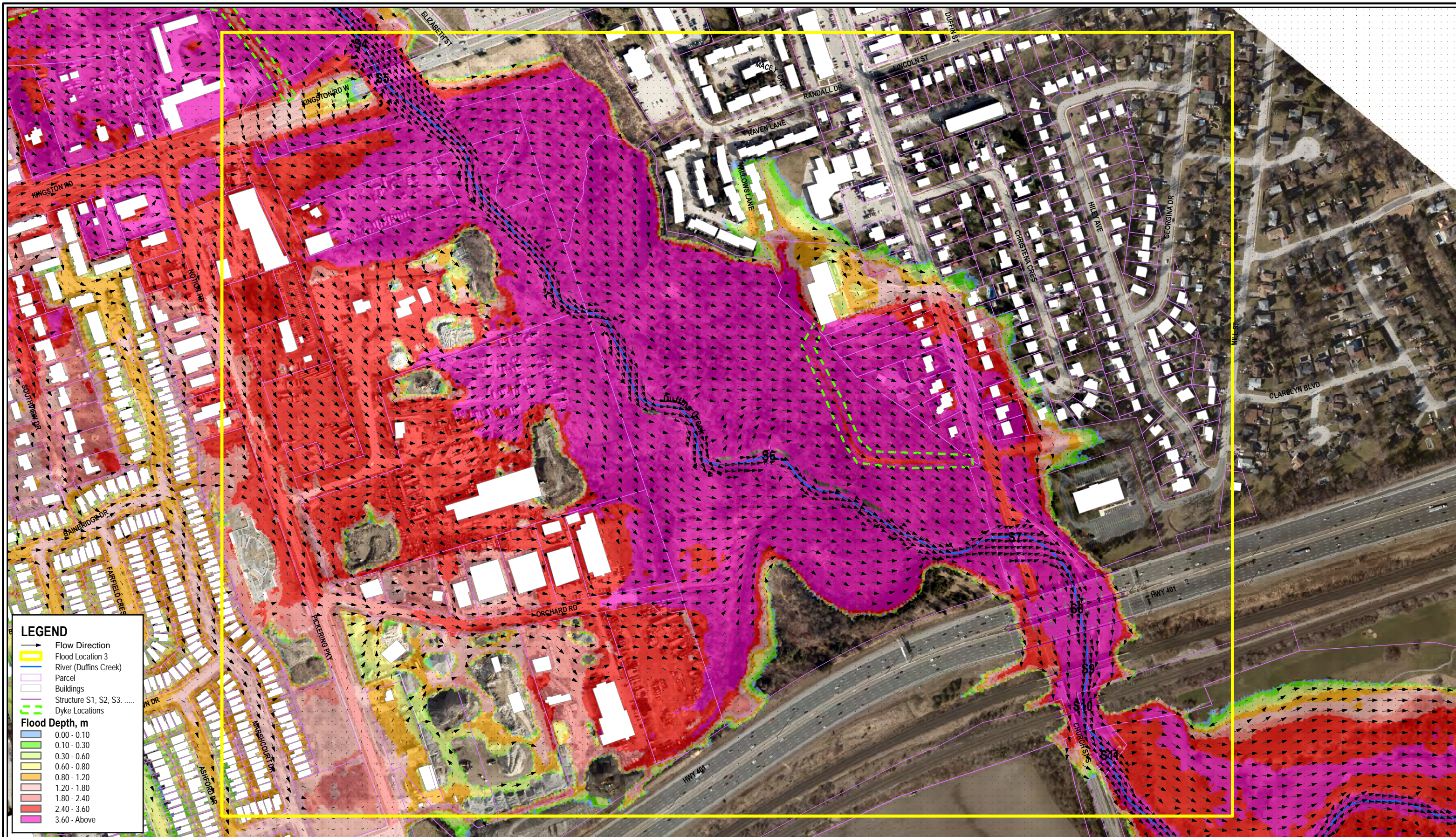


Figure A.6
REGIONAL FLOOD FLOW
 (Location 3 - Ref. Figure A.3)
 (EXISTING CONDITION)
 STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL)

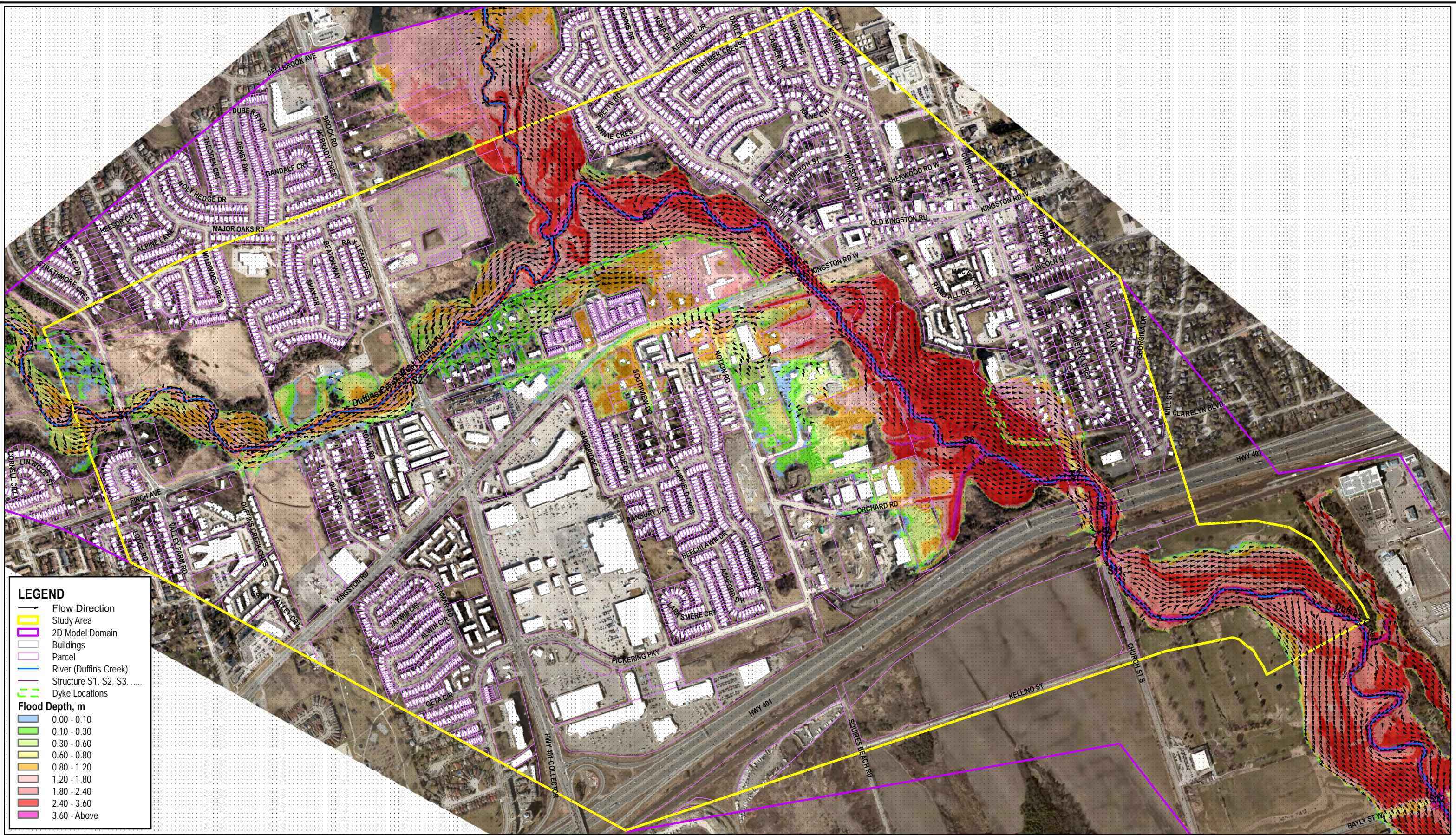


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Note:

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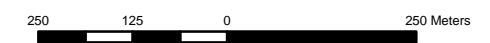
LEGEND

- Flow Direction
- Study Area
- 2D Model Domain
- Buildings
- Parcel
- River (Duffins Creek)
- Structure S1, S2, S3,
- Dyke Locations

Flood Depth, m

- 0.00 - 0.10
- 0.10 - 0.30
- 0.30 - 0.60
- 0.60 - 0.80
- 0.80 - 1.20
- 1.20 - 1.80
- 1.80 - 2.40
- 2.40 - 3.60
- 3.60 - Above

Figure A.7
500-YR FLOOD FLOW DIRECTION MAP
 (EXISTING CONDITION)
STEADY INFLOW HYDROGRAPH (500-YR STORM)



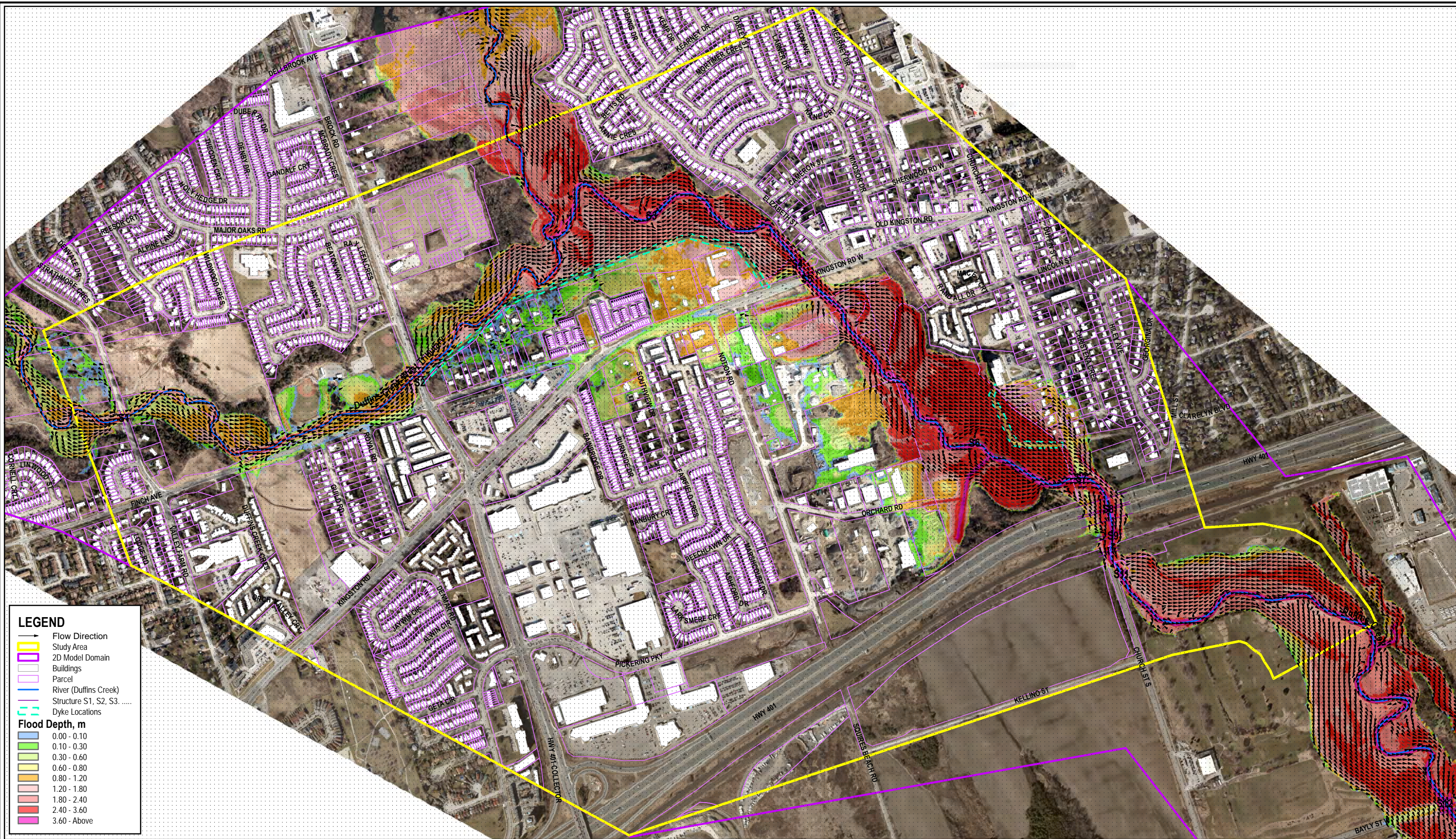
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Note:
Flood Depth Mapping based on 2015 LiDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

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LEGEND

- Flow Direction
- Study Area
- 2D Model Domain
- Buildings
- Parcel
- River (Duffins Creek)
- Structure S1, S2, S3,
- Dyke Locations

Flood Depth, m

- 0.00 - 0.10
- 0.10 - 0.30
- 0.30 - 0.60
- 0.60 - 0.80
- 0.80 - 1.20
- 1.20 - 1.80
- 1.80 - 2.40
- 2.40 - 3.60
- 3.60 - Above

Figure A.8
350-YR FLOOD FLOW DIRECTION MAP
 (EXISTING CONDITION)
STEADY INFLOW HYDROGRAPH (350-YR STORM)



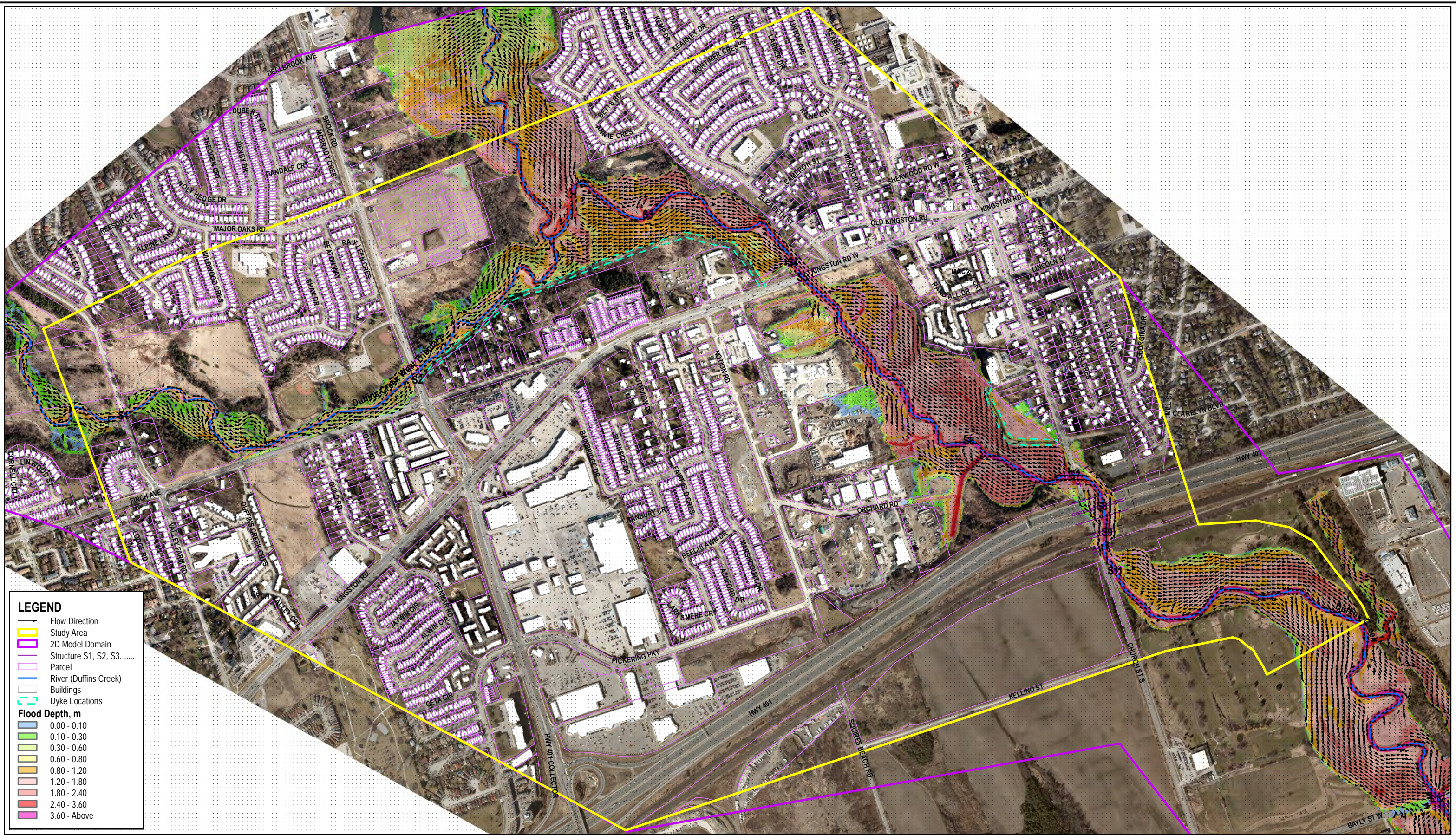
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Note:
Flood Depth Mapping based on 2015 LiDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

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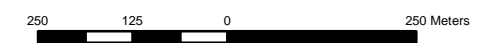
LEGEND

- Flow Direction
- Study Area
- 2D Model Domain
- Structure S1, S2, S3,
- Parcel
- River (Duffins Creek)
- Buildings
- Dyke Locations

Flood Depth, m

- 0.00 - 0.10
- 0.10 - 0.30
- 0.30 - 0.60
- 0.60 - 0.80
- 0.80 - 1.20
- 1.20 - 1.80
- 1.80 - 2.40
- 2.40 - 3.60
- 3.60 - Above

Figure A.9
100-YR FLOOD FLOW DIRECTION MAP
 (EXISTING CONDITION)
STEADY INFLOW HYDROGRAPH (100-YR STORM)



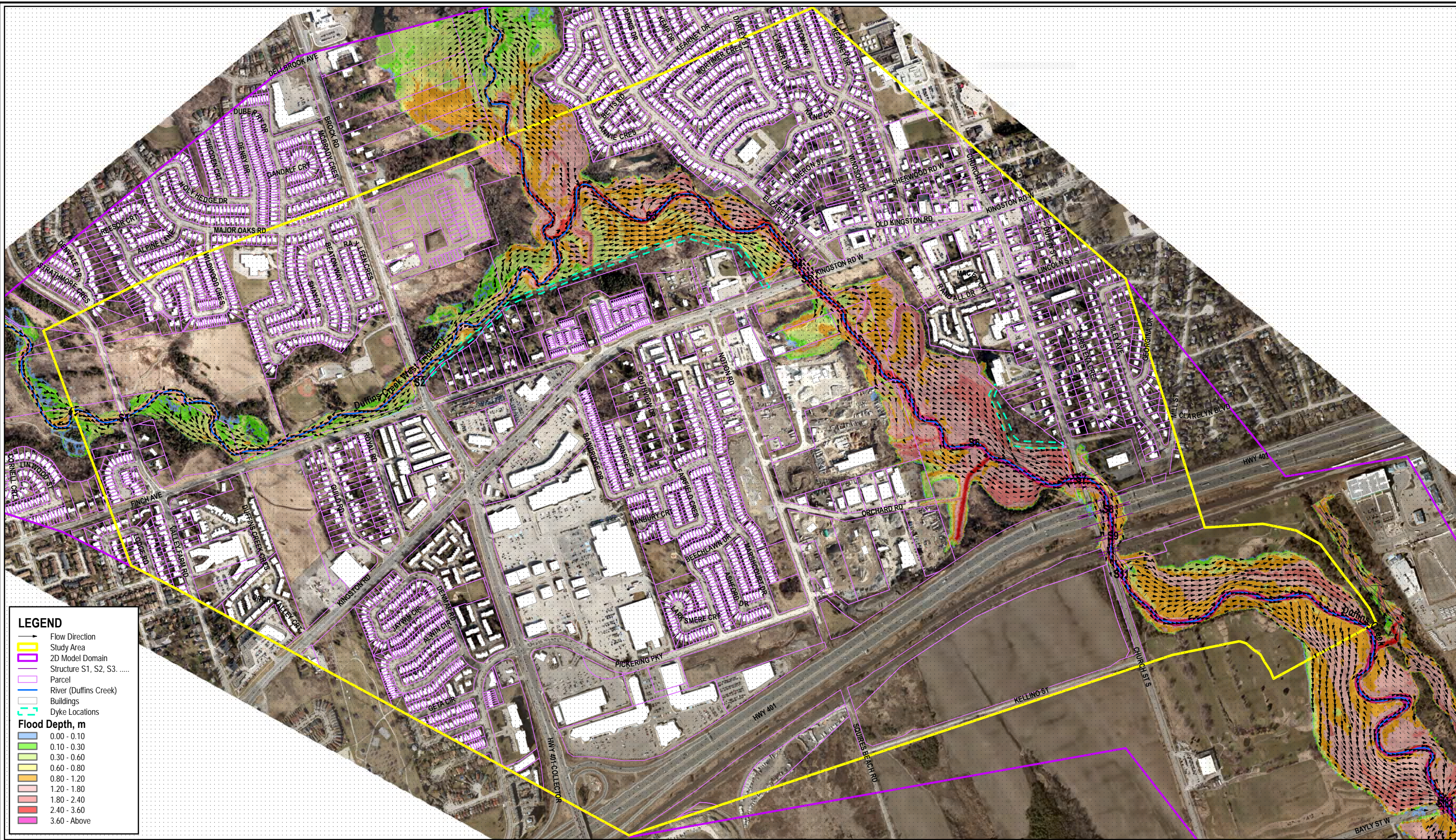
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Note:
Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

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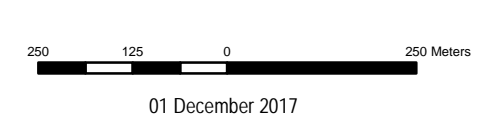
LEGEND

- Flow Direction
- Study Area
- 2D Model Domain
- Structure S1, S2, S3,
- Parcel
- River (Duffins Creek)
- Buildings
- Dyke Locations

Flood Depth, m

- 0.00 - 0.10
- 0.10 - 0.30
- 0.30 - 0.60
- 0.60 - 0.80
- 0.80 - 1.20
- 1.20 - 1.80
- 1.80 - 2.40
- 2.40 - 3.60
- 3.60 - Above

Figure A.10
50-YR FLOOD FLOW DIRECTION MAP
 (EXISTING CONDITION)
STEADY INFLOW HYDROGRAPH (50-YR STORM)



Note:
Flood Depth Mapping based on 2015 LiDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

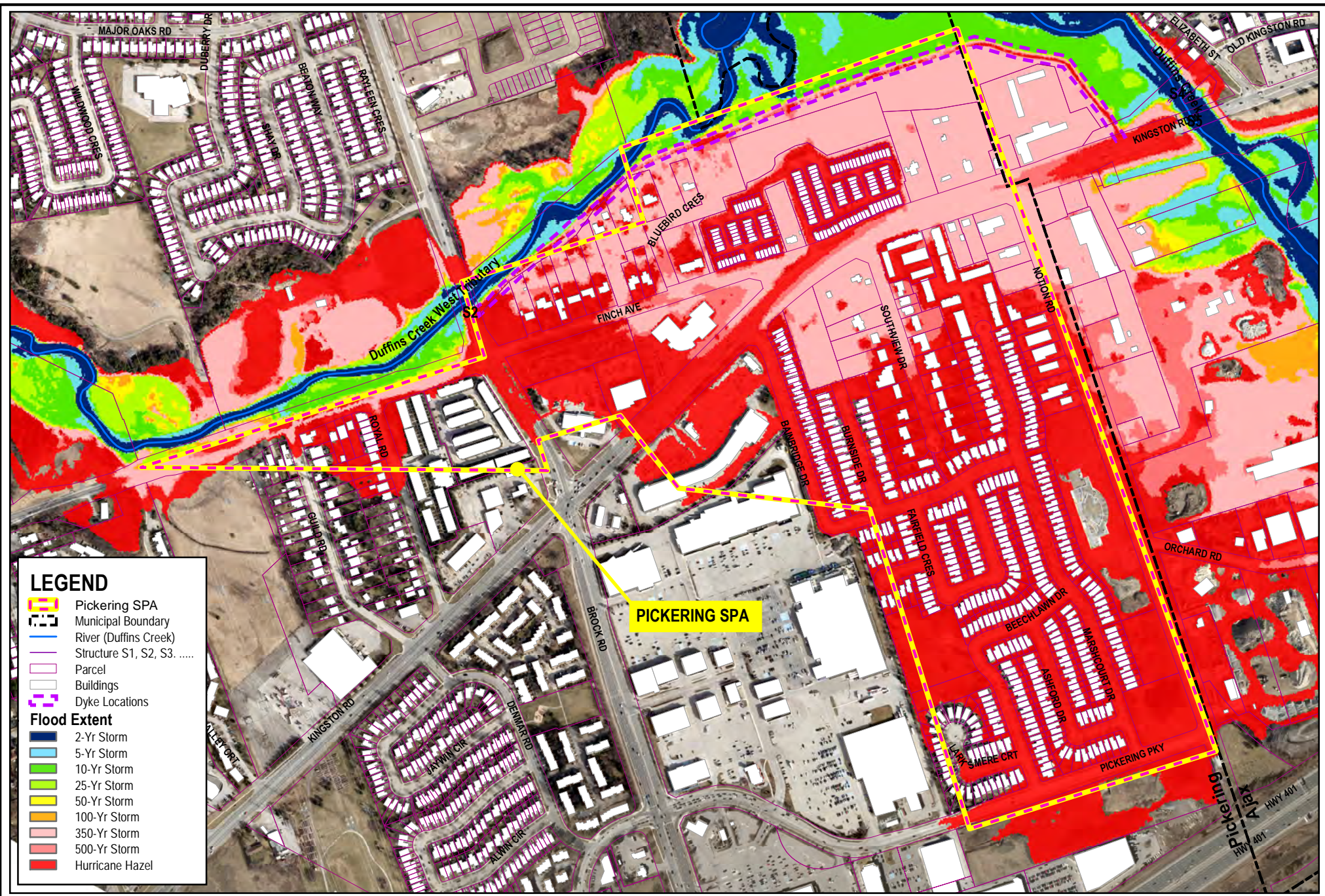
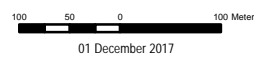


FIGURE A.11
FLOOD EXTENT CORRESPONDING TO VARIOUS STORMS
EXISTING CONDITION - PICKERING SPA
 (Hurricane Hazel, 500-yr, 350-yr, 100-yr, 50-yr, 25-yr,
 10-yr, 5-yr and 2-yr Storms)



01 December 2017



Note:
Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

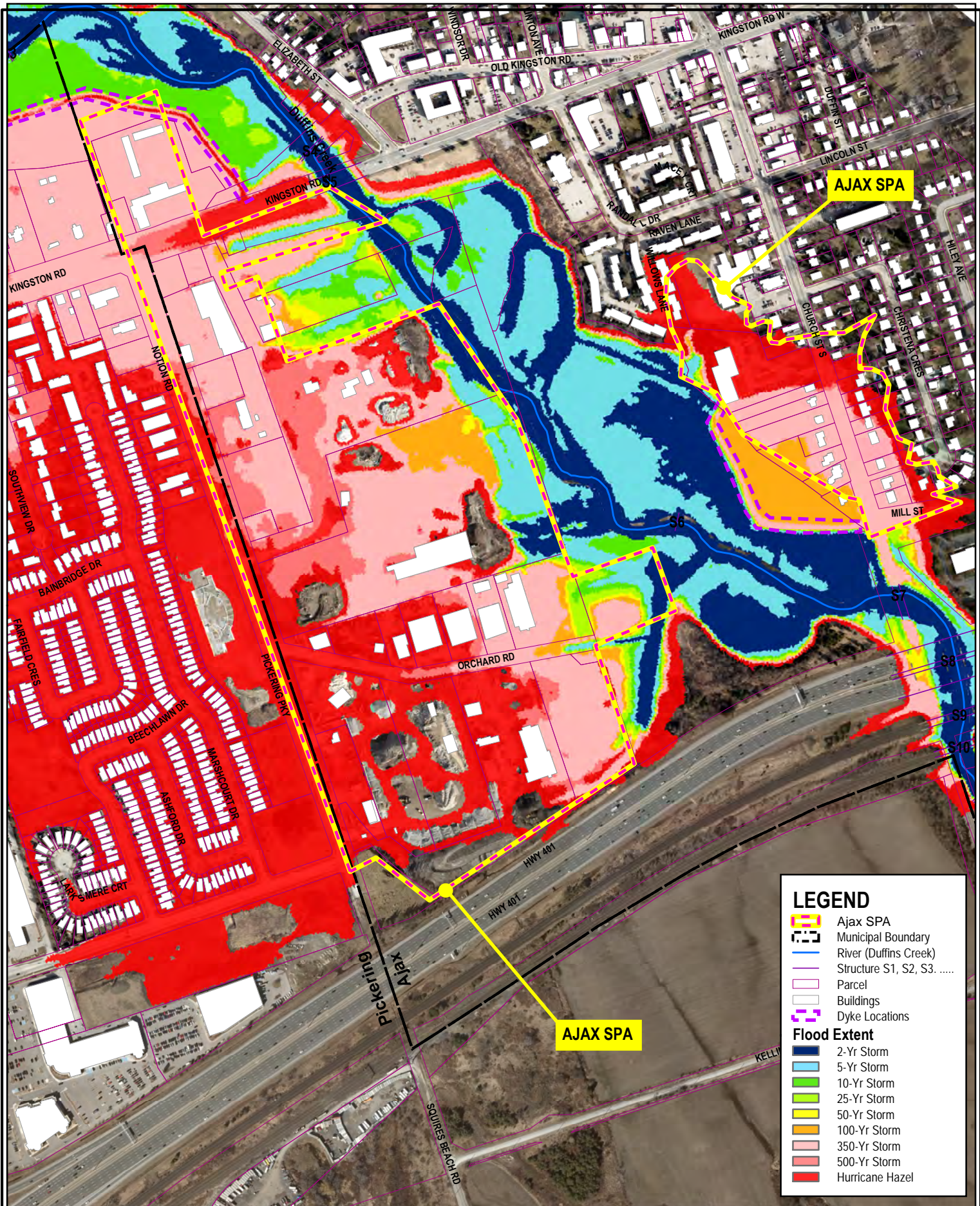


FIGURE A.12
FLOOD EXTENT CORRESPONDING TO VARIOUS STORMS
 EXISTING CONDITION - AJAX SPA
 (Hurricane Hazel, 500-yr, 350-yr, 100-yr, 50-yr, 25-yr,
 10-yr, 5-yr and 2-yr Storms)



01 December 2017



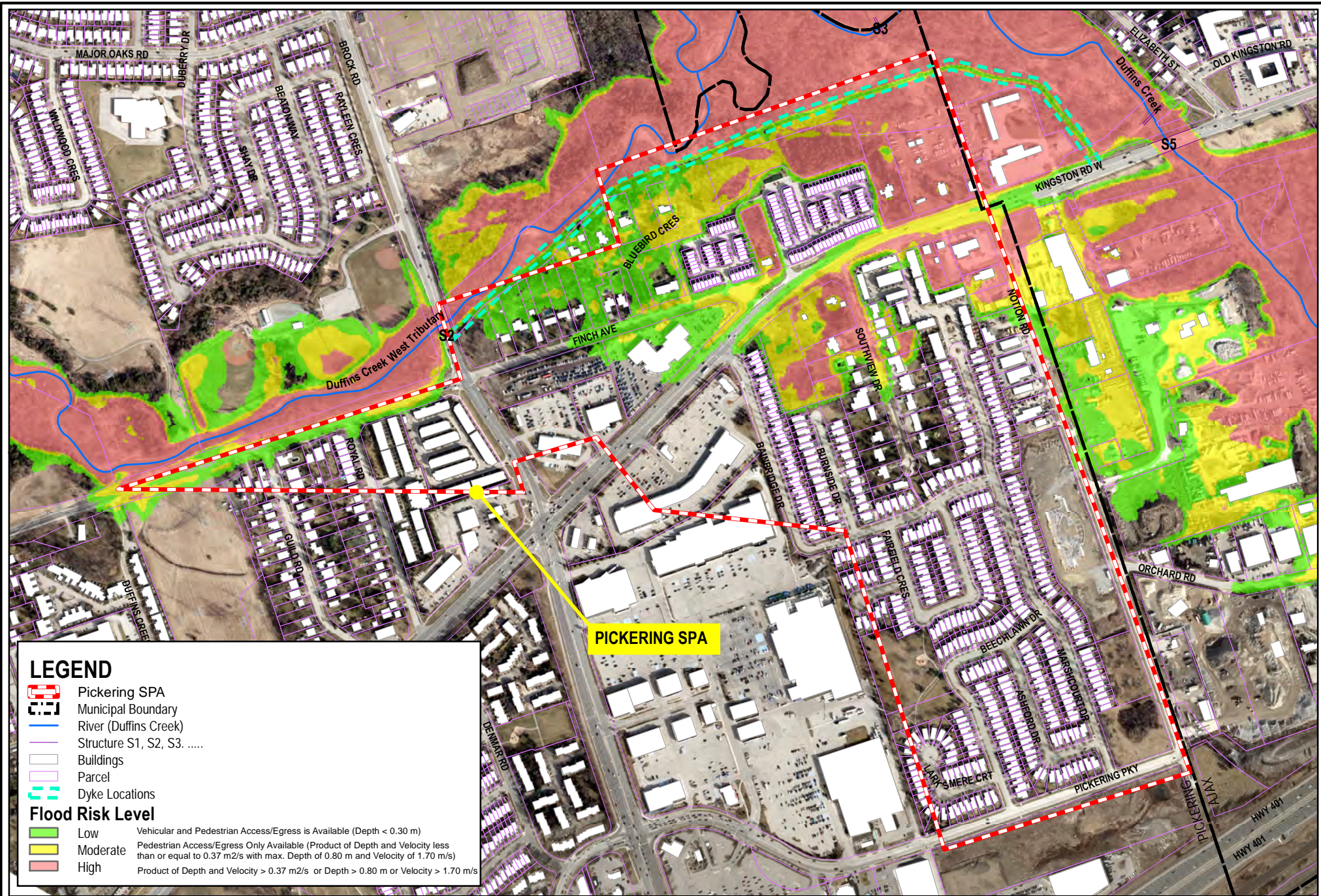


Figure A.13
500-YR FLOOD RISK MAP
 (EXISTING CONDITION - PICKERING SPA)
 STEADY INFLOW HYDROGRAPH (500-YR STORM)



Note:

Flood Depth Mapping based on 2015 LIDAR DEM and 2016 Orthophoto. This mapping is intended for the sole purpose of floodplain study. Any other use of this information by a third party requires verification and is at the sole risk of that party.

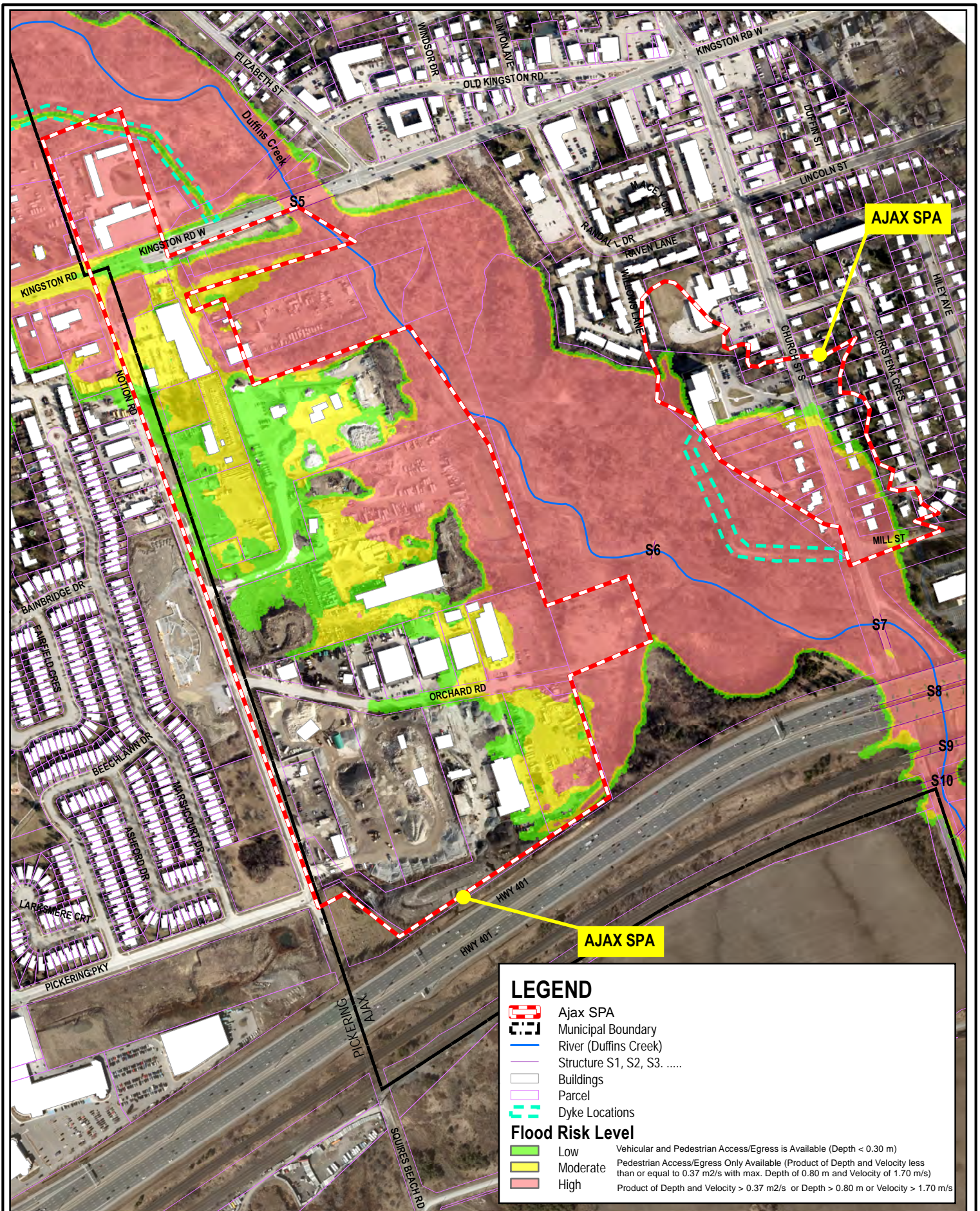
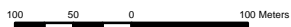


Figure A.14

**500-YR FLOOD RISK MAP
(EXISTING CONDITION - AJAX SPA)**

STEADY INFLOW HYDROGRAPH (500-YR STORM)

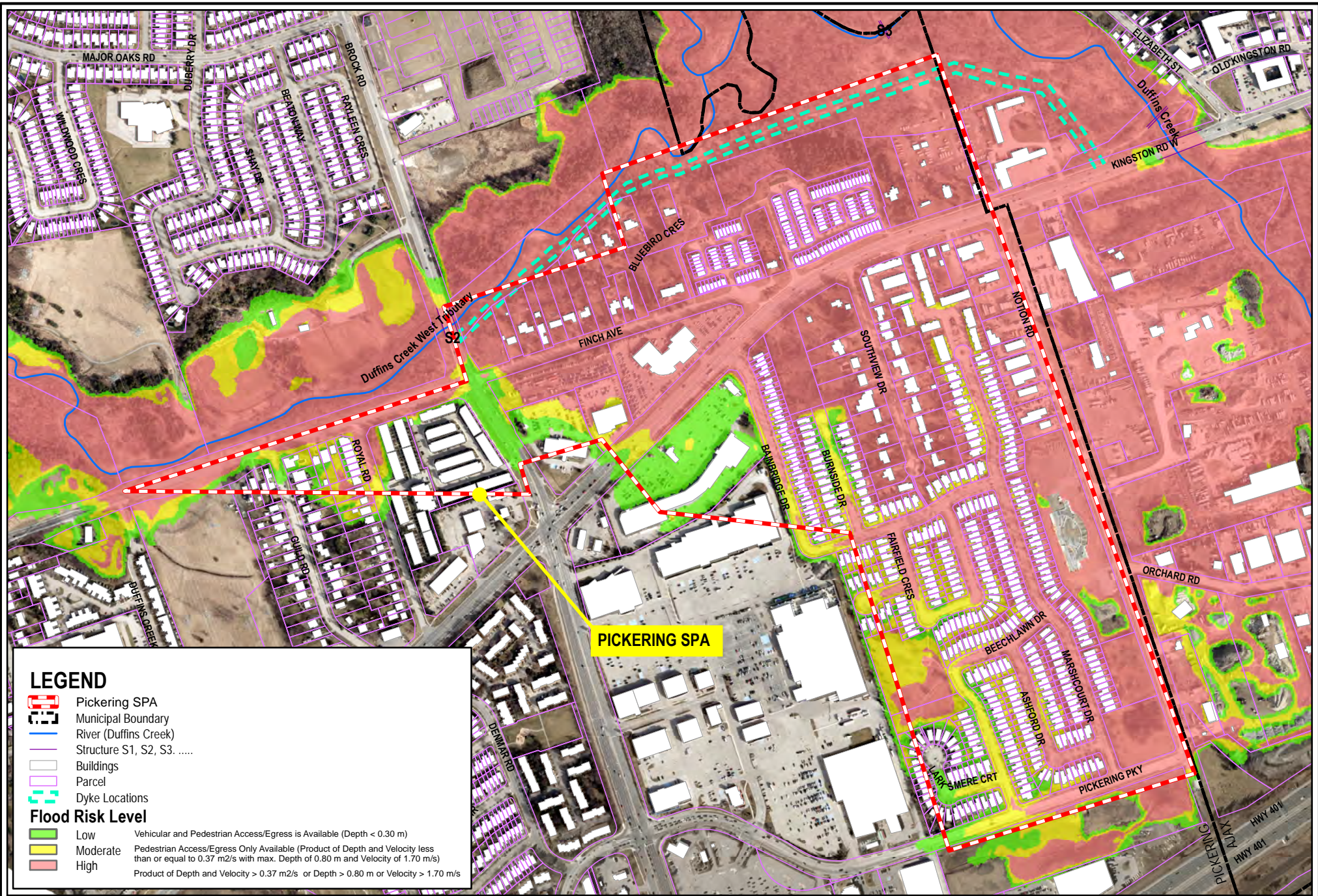


01 December 2017



TORONTO AND REGION CONSERVATION
PICKERING-AJAX DYKE ASSESSMENT AND FLOOD REMEDIATION STUDY





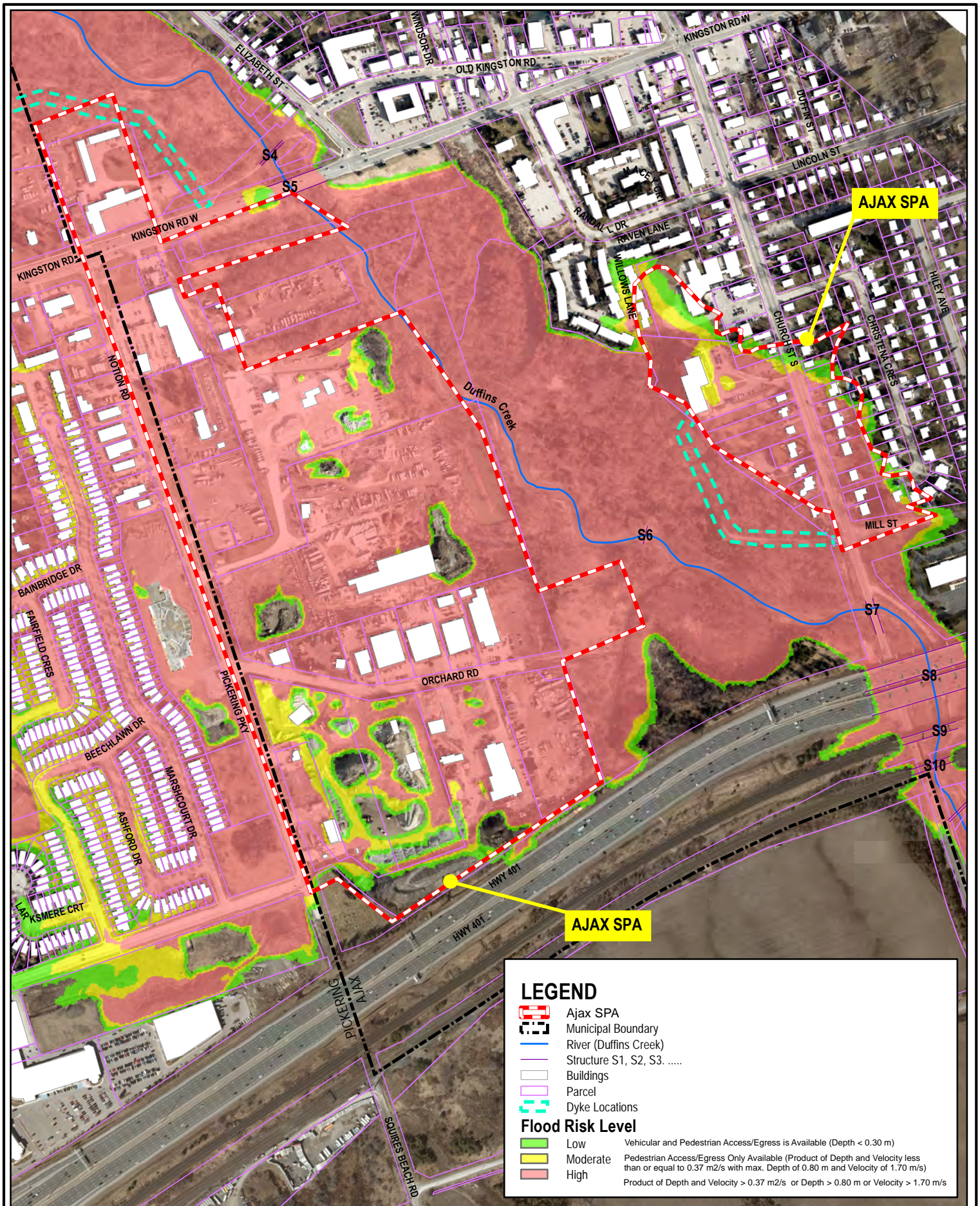


Figure A.16
REGIONAL FLOOD RISK MAP
 (EXISTING CONDITION - AJAX SPA)
 STEADY INFLOW HYDROGRAPH (HURRICANE HAZEL)



01 December 2017



APPENDIX 'B'

TRCA Correspondence, Meeting Minutes

**Flood Characterization and Preliminary Remediation Investigations
Pickering / Ajax SPA**

Toronto and Region Conservation Authority



12 February 2018
File: **17134**

Steering Committee Meeting #4
Pickering / Ajax SPA 2D Hydraulic Model and Dyke Assessment
TRCA

NOTES OF MEETING

Location:	TRCA – Don Room	
Date of Meeting:	08 February 2018 (11h00 – 12h30)	
Attendees:	Craig Mitchell	Toronto and Region Conservation Authority (TRCA)
	Ali Shirazi	Toronto and Region Conservation Authority (TRCA)
	Nick Lorrain	Toronto and Region Conservation Authority (TRCA)
	Qiao Ying	Toronto and Region Conservation Authority (TRCA)
	Sameer Dhalla	Toronto and Region Conservation Authority (TRCA)
	Nick Saccone	Toronto and Region Conservation Authority (TRCA)
	David Liu	GeoPro Consulting Limited (GeoPro)
	Tim	GeoPro Consulting Limited (GeoPro)
	Abdul Baten	Valdor Engineering (Valdor)
	Bill Coffey	Valdor Engineering (Valdor)

Introductions

1. Introductions were made.
2. The purpose of the meeting was to review the level of flood protection provided by the Pickering and Ajax Dykes along with the geotechnical assessment and preliminary rehabilitation options.

Project Discussions – Summary of Key Items

The following is a brief summary of the key items discussed at the meeting, including any required action items:

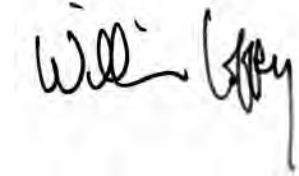
3. A presentation was given regarding the current level of flood protection provided by the Pickering and Ajax Dykes including the results from the geotechnical assessment and preliminary rehabilitation options. The following is a brief summary of the key findings:
 - a. Based on current flow information, the Pickering Dyke provides flood protection for the 100-yr storm flow and the Ajax Dyke provides flood protection for the 50-yr storm flow. Both dykes were originally designed to provide the 500-yr level of flood protection.
 - b. Dyke construction materials are predominantly non-cohesive soil (i.e. sand/sandy gravel), which is not suitable for this type of dam facility.
 - c. Both dykes are not meeting the required factors of safety (FOS) under a number of loading conditions/failure modes as per current standards.



-
- d. Due to predominately non-cohesive soil, the potential for failure under full drawdown condition for both dykes is considered to be high.
 - e. Dyke crest elevations at a number of locations are lower than design crest elevations by up to 10 cm at Pickering dyke and 33 cm at Ajax dyke, respectively.
 - f. A number of preliminary rehabilitation options were investigated to confirm what options can fit within the existing dyke footprint and meet the current loading/failure mode FOS criteria based on the current level of flood protection provided. The rehabilitation options included the following: (Option 1) – Do Nothing; (Option 2) - Partial Clay Core (within Existing Footprint); (Option 3) – Full Reconstruction of Earth Dykes (within Existing Footprint); (Option 4) - Sheet Pile Wall Installed at Top of Dykes (within Existing Footprint); (Option 5) – Retaining Walls Installed Either Side of Dykes (within Existing Footprint); (Option 6) – Sheet Pile Wall Installed at Wet Side Toe of Dykes (within Existing Footprint); and, (Option 7) – Geosynthetic Clay Liner with Rip Rap (beyond Existing Footprint).
 - g. Based on the identified options investigated, only Options 5 and 6 will fit within the existing footprint and meet the FOS criteria. The estimated construction costs for both Options 5 and 6 are high, however, the cost for Option 6 would be considerably less. The cross sectional flow area within the watercourse is slightly reduced with Option 6 and it would need to be confirmed that any impacts would be acceptable.
 - h. The estimated construction costs for Option 7 are moderate, however, the existing footprint would need to be widened by approximately 4 to 7 meters to meet the FOS criteria.
4. Following a series of discussions regarding the rehabilitation options investigated to date, it was agreed that Valdor/GeoPro would investigate an option similar to Option 4 but with the proposed sheet pile wall located half way down the slope on the wet side of the dyke. In order to reduce potential impacts on the cross sectional flow area within the watercourse, the existing material at the wet toe could be used as fill behind the sheet pile wall. Otherwise, the existing dyke materials would be left in place and the 2:1 slope on the dry side would be maintained and not disturbed in order to reduce the number of trees to be removed. The FOS of safety under the various loading/failure mode conditions would be calculated and a reduced FOS would be considered subject to acceptable flood risk. **Valdor/GeoPro to investigate a modified version of Option 4.**
 5. It was confirmed that the acquisition of additional lands to construct the dykes would be extremely challenging on a number of fronts and is not considered to be a viable option at this time.
 6. Due to the extent of works required to rehabilitate the dykes to the current level of flood protection and better, it was discussed whether the proposed dyke improvements should be completed following an EA process. The TRCA indicated that the proposed improvements could be completed in accordance with the *Conservation Authority Class EA for Remedial Flood and Erosion Control Projects* (Conservation Ontario, 2002). **The TRCA to review and confirm if this will be required.**
 7. It was agreed that Valdor/GeoPro will finalize the preliminary options including preliminary cost estimates to rehabilitate the dykes to the current level of flood protection (i.e. 100-yr protection for the Pickering Dyke and 50-yr protection for the Ajax Dyke). Flood mitigation options to provide the current 500-yr level of flood protection and the Regional level of flood protection are to be investigated and included in the *Flood Characterization and Remediation Report*. **Valdor/GeoPro to finalize the preliminary dyke rehabilitation options and cost estimates.**
 8. The TRCA plans to meet with the City of Pickering and the City of Ajax to present the results of the investigations to date and to discuss the options that have been investigated. **The TRCA to meet with the City of Ajax and City of Pickering.**
 9. The meeting was adjourned.

Notes Prepared By*:

VALDOR ENGINEERING INC.

A handwritten signature in black ink, appearing to read "Bill Coffey". The signature is written in a cursive style with a large, sweeping initial "B".

Bill Coffey, M.Sc., P.Eng.
Head of Water Resources

c: All Attendees and project team

*Any errors or omissions should be reported to the author in writing as soon as possible.

From: [Bill Coffey](#)
To: "[Qiao Ying](#)"; [Nick Lorrain](#)
Cc: [Abdul Baten](#)
Subject: RE: Pickering Ajax 2D Study - Meeting Agenda
Date: Thursday, March 22, 2018 7:09:00 PM

Hi Nick and Qiao,

Please find below a brief summary of our meeting discussions today. Thank you.

1. Valdor presented the results of the flood characterization and mitigation options.
2. Discussions were had regarding the flood mitigation options and it was agreed that the three options presented [500-yr Flood Mitigation (Full), Regional Flood Mitigation (Partial) and Regional Flood Mitigation (Full)] would be included in the *Flood Characterization and Remediation Report*. It was discussed how Flood Protection Landforms (FPL's) would be required in addition to the proposed bridge/channel conveyance improvements to satisfy MNR criteria for removal of the SPA from the Regional floodplain. Given the extensive footprint required for FPL's, this would not be a practical solution for this area given the extensive existing development that would be impacted.
3. The TRCA indicated that more detailed investigations and evaluation of options will be undertaken in a future study following the EA process.
4. Nick requested that discussion be included in the *Flood Characterization and Remediation Report* providing justification regarding the necessity for completing a further study following the EA process.
5. Nick requested that an overall Executive Summary Letter be included with the final submission tying all three reports together and providing overall recommendations including next steps moving forward.
6. The TRCA confirmed that very conceptual figures only are to be included in the Dyke Level of Service and Rehabilitation Report regarding the restoration of the Pickering and Ajax Dykes.
7. The TRCA confirmed the urgency to finalize all reports ASAP as deadlines are imminent in order to meet funding criteria.
8. The *MIKE Flood 1D-2D Model Development and Regulatory Floodplain Mapping Report* was finalized and hard copies submitted earlier in the week. The TRCA confirmed receipt.
9. It was agreed that the *Dyke Level of Service and Rehabilitation Report* and the *Flood Characterization and Remediation Report* would be submitted in draft form on 02 April 2018 for review by the TRCA.
10. The TRCA agreed to provide a quick review such that Valdor can finalize the reports and submit ASAP.
11. It was agreed that Valdor would attend a meeting with the municipalities and the TRCA to assist in the presentation of results and recommendations for this project.

Regards,

Bill Coffey, M.Sc., P.Eng.
Head of Water Resources
Valdor Engineering Inc.

From: Bill Coffey
Sent: Thursday, March 22, 2018 9:43 AM
To: 'Qiao Ying' <qiao.ying@trca.on.ca>; Nick Lorrain <NLorrain@trca.on.ca>
Cc: Abdul Baten <ABaten@Valdor-Engineering.com>
Subject: Pickering Ajax 2D Study - Meeting Agenda

Hi Qiao and Nick,

Please find attached the Agenda for today's meeting. See you then. Thank you.

Regards,

Bill Coffey, M.Sc., P.Eng.
Head of Water Resources
Water Resources / Environmental Engineer



VALDOR ENGINEERING INC.

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