

Prepared for:

City of Markham
Engineering Department
101 Town Centre Blvd.
Markham, ON, L3R 9W3

**Schedule B Municipal Class Environmental Assessment
– Project File Appendices
Mount Joy Creek Flood Mitigation**



Submitted by:

Aquafor Beech Limited

in association with

New Era Archaeology Inc.

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APPENDIX A: RAPID GEOMORPHIC ASSESSMENT

RAPID GEOMORPHIC ASSESSMENT

Watercourse: Mount Joy Creek

Reach boundaries: U/S - Anderson Avenue Culvert

D/S - Bur Oak Avenue Culvert

Form/ Process	Geomorphic Indicator		Present		FactorValue
	No.	Description	No	Yes	
Evidence of Aggradation (AI)	1	Lobate bar	√		0.43
	2	Coarse material in riffle embedded		√	
	3	Siltation in pools		√	
	4	Medial bars	√		
	5	Accretion on point bars	√		
	6	Poor longitudinal sorting of bed materials	√		
	7	Deposition in overbank zone		√	
Evidence of Degradation (DI)	1	Exposed bridge footings	√		0.30
	2	Exposed sanitary/storm sewer/pipeline etc	√		
	3	Elevated stormsewer outfall	√		
	4	undermined gabion basket/concrete apron/etc		√	
	5	Scour pools d/s of culverts/stormsewers	√		
	6	Cut face on bar forms		√	
	7	Head cutting due to knick point migration		√	
	8	Terrace cut through older bar material	√		
	9	Suspended armor layer visible in bank	√		
	10	Channel worn into undisturbed overburden/bedrock	√		
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc		√	0.67
	2	Occurrence of large organic debris		√	
	3	Exposed tree roots		√	
	4	Basal scour on inside meander bends	√		
	5	Basal scour on both sides of channel through riffle		√	
	6	Gabion baskets/concrete walls/armour stone etc. out flanked		√	
	7	Length of basal scour > 50% through subject reach	√		
	8	Exposed length of previously buried pipe/cable etc.	√		
	9	Fracture lines along top of bank		√	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		√	0.57
	2	Evolution of single thread channel to multiple channel	√		
	3	Evolution of pool-riffle form to low bed relief form	√		
	4	Cutoff channel(s)		√	
	5	Formation of island(s)		√	
	6	Thalweg alignment out of phase with meander geometry	√		
	7	Bar forms poorly formed/reworked/removed		√	
Stability Index (SI) = (AI+DI+WI+PI)/m				SI =	0.49

Where m=4, AI, DI, WI and PI are the normalized values of the aggradation, degradation, width enlargement and planimetric indices, respectively. The normalized value of each of the four FORM/PROCESS categories is computed as the sum of the GEOMORPHIC INDICATORS for which a Yes Determination is reported in the PRESENT column divided by n=the number of GEOMORPHIC INDICATORS used for each index. If a GEOMORPHIC INDICATOR is not applicable note n/a opposite this INDICATOR in the PRESENT column and reduce n by 1. For example, if there are no bridges in the reach then GEOMORPHIC INDICATOR No.1 "exposed bridge footing(s)" under EVIDENCE OF DEGRADATION (DI) is not applicable and the observer should record as n/a opposite this INDICATOR, reduce n to 9 and move on to the next INDICATOR.

* Performed by Aquafor Beech Limited

RAPID GEOMORPHIC ASSESSMENT

Watercourse: Mount Joy Creek

Reach boundaries: U/S - Harvard Way and Markham Road
D/S - Confluence w/ Tributary at Twin Culvert before Commercial Property

Form/ Process	Geomorphic Indicator		Present		FactorValue
	No.	Description	No	Yes	
Evidence of Aggradation (AI)	1	Lobate bar	✓		0.57
	2	Coarse material in riffle embedded		✓	
	3	Siltation in pools		✓	
	4	Medial bars	✓		
	5	Accretion on point bars	✓		
	6	Poor longitudinal sorting of bed materials		✓	
	7	Deposition in overbank zone		✓	
Evidence of Degradation (DI)	1	Exposed bridge footings	✓		0.20
	2	Exposed sanitary/storm sewer/pipeline etc	✓		
	3	Elevated stormsewer outfall		✓	
	4	undermined gabion basket/concrete apron/etc		✓	
	5	Scour pools d/s of culverts/stormsewers	✓		
	6	Cut face on bar forms	✓		
	7	Head cutting due to knick point migration	✓		
	8	Terrace cut through older bar material	✓		
	9	Suspended armor layer visible in bank	✓		
	10	Channel worn into undisturbed overburden/bedrock	✓		
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc		✓	0.22
	2	Occurrence of large organic debris	✓		
	3	Exposed tree roots	✓		
	4	Basal scour on inside meander bends	✓		
	5	Basal scour on both sides of channel through riffle	✓		
	6	Gabion baskets/concrete walls/armour stone etc. out flanked		✓	
	7	Length of basal scour > 50% through subject reach	✓		
	8	Exposed length of previously buried pipe/cable etc.	✓		
	9	Fracture lines along top of bank	✓		
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)	✓		0.29
	2	Evolution of single thread channel to multiple channel	✓		
	3	Evolution of pool-riffle form to low bed relief form		✓	
	4	Cutoff channel(s)	✓		
	5	Formation of island(s)	✓		
	6	Thalweg alignment out of phase with meander geometry	✓		
	7	Bar forms poorly formed/reworked/removed		✓	
Stability Index (SI) = (AI+DI+WI+PI)/m				SI =	0.32

Where m=4, AI, DI, WI and PI are the normalized values of the aggradation, degradation, width enlargement and planimetric indices, respectively. The normalized value of each of the four FORM/PROCESS categories is computed as the sum of the GEOMORPHIC INDICATORS for which a Yes Determination is reported in the PRESENT column divided by n=the number of GEOMORPHIC INDICATORS used for each index. If a GEOMORPHIC INDICATOR is not applicable note n/a opposite this INDICATOR in the PRESENT column and reduce n by 1. For example, if there are no bridges in the reach then GEOMORPHIC INDICATOR No.1 "exposed bridge footing(s)" under EVIDENCE OF DEGRADATION (DI) is not applicable and the observer should record as n/a opposite this INDICATOR, reduce n to 9 and move on to the next INDICATOR.

* Performed by Aquafor Beech Limited

RAPID GEOMORPHIC ASSESSMENT

Watercourse: Mount Joy Creek

Reach boundaries: U/S - Major Mackenzie Drive East Culvert
D/S - Markham Road Culvert

Form/ Process	Geomorphic Indicator		Present		FactorValue
	No.	Description	No	Yes	
Evidence of Aggradation (AI)	1	Lobate bar	✓		0.57
	2	Coarse material in riffle embedded		✓	
	3	Siltation in pools		✓	
	4	Medial bars	✓		
	5	Accretion on point bars	✓		
	6	Poor longitudinal sorting of bed materials		✓	
	7	Deposition in overbank zone		✓	
Evidence of Degradation (DI)	1	Exposed bridge footings	✓		0.00
	2	Exposed sanitary/storm sewer/pipeline etc	✓		
	3	Elevated stormsewer outfall	✓		
	4	Undermined gabion basket/concrete apron/etc	✓		
	5	Scour pools d/s of culverts/stormsewers	✓		
	6	Cut face on bar forms	✓		
	7	Head cutting due to knick point migration	✓		
	8	Terrace cut through older bar material	✓		
	9	Suspended armor layer visible in bank	✓		
	10	Channel worn into undisturbed overburden/bedrock	✓		
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc	✓		0.11
	2	Occurrence of large organic debris	✓		
	3	Exposed tree roots	✓		
	4	Basal scour on inside meander bends	✓		
	5	Basal scour on both sides of channel through riffle	✓		
	6	Gabion baskets/concrete walls/armour stone etc. out flanked		✓	
	7	Length of basal scour > 50% through subject reach	✓		
	8	Exposed length of previously buried pipe/cable etc.	✓		
	9	Fracture lines along top of bank	✓		
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		✓	0.43
	2	Evolution of single thread channel to multiple channel	✓		
	3	Evolution of pool-riffle form to low bed relief form		✓	
	4	Cutoff channel(s)	✓		
	5	Formation of island(s)	✓		
	6	Thalweg alignment out of phase with meander geometry	✓		
	7	Bar forms poorly formed/reworked/removed		✓	
Stability Index (SI) = (AI+DI+WI+PI)/m				SI =	0.28

Where m=4, AI, DI, WI and PI are the normalized values of the aggradation, degradation, width enlargement and planimetric indices, respectively. The normalized value of each of the four FORM/PROCESS categories is computed as the sum of the GEOMORPHIC INDICATORS for which a Yes Determination is reported in the PRESENT column divided by n=the number of GEOMORPHIC INDICATORS used for each index. If a GEOMORPHIC INDICATOR is not applicable note n/a opposite this INDICATOR in the PRESENT column and reduce n by 1. For example, if there are no bridges in the reach then GEOMORPHIC INDICATOR No.1 "exposed bridge footing(s)" under EVIDENCE OF DEGRADATION (DI) is not applicable and the observer should record as n/a opposite this INDICATOR, reduce n to 9 and move on to the next INDICATOR.

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**APPENDIX B: MOUNT JOY CREEK FLOOD MITIGATION
STAGE 1 ARCHAEOLOGY DRAFT REPORT**

Stage 1 Archaeological Assessment

Original Report

Mount Joy Creek Flood Mitigation

Part of Lots 18-20, Concession 7 and the Road Allowance
Between Lots 20 and 21, Concession 7 and Part of Lots 18-20,
Concession 8 (Former Township of Markham, County of York),
City of Markham, Regional Municipality of York

Project Information

Archaeological License: P1024 (Sarah MacKinnon MSc.)

MCM PIF#: P1024-0340-2025

Corporate File #: 275-2025

Development Project Designation #: N/A

April 7th, 2026



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EXECUTIVE SUMMARY

The City of Markham is addressing Mount Joy Creek flood mitigation, and as part of the process, New Era Archaeology Inc. was retained by Aquafor Beech Ltd. to complete a Stage 1 archaeological assessment and was given permission to access the project area to conduct all required archaeological fieldwork activities. This report describes the Stage 1 archaeological assessment for the Mount Joy Creek flood mitigation within Part of Lots 18-20, Concession 7 and the Road Allowance Between Lots 20 and 21, Concession 7 and Part of Lots 18-20, Concession 8 (Former Township of Markham, County of York), City of Markham, Regional Municipality of York. The study was conducted under Professional Archaeological License P1024 issued by the Minister of Citizenship and Multiculturalism (Ontario) to Sarah MacKinnon. The Stage 1 archaeological assessment was undertaken under the Class Environmental Assessment (1990). This report confirms that all the work conducted as part of this assessment conforms to the *Standards and Guidelines for Consultant Archaeologists* (S&G) (MCM 2011) and the *Ontario Heritage Act* (MCL 2005).

The Stage 1 archaeological assessment involved the review of historical records, available oral histories, historic maps and current aeriels. Both historic and current resources are consulted to identify areas of archaeological potential and activities conducted within the project area which have removed potential. This information is used to determine if the project area has archaeological potential, note areas of no potential, and recommend appropriate strategies for Stage 2 for areas of archaeological potential.

As a result of the Stage 1 archaeological assessment, it was determined that the project area has the potential for both Indigenous (pre-contact) and historic (post-contact) archaeological resources and Stage 2 archaeological assessment is required for the portions of the project area which retain archaeological potential (see Maps 13 and 14).

1. Stage 2 archaeological assessment by test pit survey at an interval of 5 meters is required for all areas which retain archaeological potential in accordance with Section 2.1.2 of the *Standards and Guidelines for Consultant Archaeologists* (2011) (see Maps 13 and 14).
2. Portions of the project area are assumed to have been deeply disturbed during major earthworks below the topsoil layer associated with the construction of the modern roads, residential and commercial developments. These disturbances and their exact extent are to be confirmed and documented during the Stage 2 archaeological assessment (see Maps 13 and 14).
3. Stage 2 archaeological assessment is not required for the portions of the project area which have been subject to previous archaeological assessment, and no further work is recommended (see Maps 13 and 14).

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PROJECT PERSONNEL

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1.0 PROJECT CONTEXT

1.1 DEVELOPMENT CONTEXT

The City of Markham is addressing Mount Joy Creek flood mitigation, and as part of the process, New Era Archaeology Inc. was retained by Aquafor Beech Ltd. to complete a Stage 1 archaeological assessment and was given permission to access the project area to conduct all required archaeological fieldwork activities. This report describes the Stage 1 archaeological assessment for the Mount Joy Creek flood mitigation within Part of Lots 18-20, Concession 7 and the Road Allowance Between Lots 20 and 21, Concession 7 and Part of Lots 18-20, Concession 8 (Former Township of Markham, County of York), City of Markham, Regional Municipality of York. The study was conducted under Professional Archaeological License P1024 issued by the Minister of Citizenship and Multiculturalism (Ontario) to Sarah MacKinnon. The Stage 1 archaeological assessment was undertaken under the Class Environmental Assessment (1990). This report confirms that all the work conducted as part of this assessment conforms to the *Standards and Guidelines for Consultant Archaeologists* (S&G) (MCM 2011) and the *Ontario Heritage Act* (MCL 2005).

1.2 HISTORICAL CONTEXT

1.2.1 General Indigenous Overview of Southern Ontario

The following section provides a brief generalized summary of the pre-contact and contact periods of southern Ontario as defined by the archaeological record.

Our general understanding of the pre-contact period is based on archaeological sites and archaeologists' interpretations and assumptions made through the examination of available cultural material, settlement patterns and radiocarbon dating. Only those sites which have both survived and have been found can contribute to our knowledge of the past as defined by archaeologists.

Changes in the archaeological record have been used to define technological and temporal divisions within the pre-contact period (Paleo, Archaic and Woodland Periods), which have been further divided. These divisions provide a general framework to help scholars understand and contextualize the past. The cultural complexities, subtle nuances and fluidity which spanned thousands of years over several generations cannot be accurately reflected in this generalized framework, nor is it completely preserved within the archaeological record. As new sites are discovered and/or previous sites are revisited, our understanding of the past may change as a result.

Paleo Period

As the glaciers that covered southern Ontario began to retreat approximately 12,500 years ago, the area became habitable, and Paleo hunting bands began arriving between 11,000 and 10,500 years ago, finding large meltwater lakes formed in the wake of this retreat. These lakes were accompanied by relatively barren tundra interspersed with areas of open boreal forest. Hunters focused on the large Pleistocene mammals, including mastodon, moose, elk, and especially the herds of caribou that roamed the area after following the retreating glaciers. Following these herds of animals, the Paleo groups travelled long distances and seldom stayed in one campsite for a significant length of time, leaving behind little material culture. Stone tools and the by-products of their flaked stone industry are virtually all that remain. There is a transition within the period from fluted points (Gainey, Barnes and

Crowfield) to unfluted points (Holcombe and Hi Lo) and then to unstemmed and stemmed (Lanceolate). Campsites from this period are frequently found adjacent to the remnant shorelines of large post-glacial lakes, indicating that camping sites were established along the shores of lakes to intercept migrating herds and take advantage of riverine resources. The water levels of the Lake Ontario basin fell during the early post-glacial period and subsequently rose again to modern levels, resulting in these campsites now being situated more than a kilometer into the lake. (Ellis et al., 1990).

Archaic Period

The Archaic Period (7,000 B.C – 1,000 B.C) saw a mixed needle and broadleaf forest cover established in Ontario, and nomadic hunter-gatherers hunted deer, moose, as well as other animals, fished and gathered plant resources while moving relatively large distances over the landscape during the year. From the archaeological record, the technological and cultural changes can be identified, including a wide variety of tools produced, which resulted in shifts in hunting strategies away from big game to adjust to a constantly evolving environment. During the Late Archaic period, hunter-gatherer bands most likely settled into familiar hunting territories. Two types of sites evolved as a result of their hunting patterns. Inland camps occupied by small groups of related families during the fall and winter, where they could harvest nuts and hunt deer, and the larger spring and summer settlements near river mouths, where groups came together to trade, exploit spawning fish resources and to bury their dead. Many of the ground stone tools have both social and symbolic functions; they had a day-to-day use, but their inclusion in burials ascribes to them a ceremonial intent. The archaeological record suggests that there was a marked population increase in this period as a result of the warmer environment, which was able to support a higher population (Ellis et al., 1990).

Woodland Period

The Woodland Period (1,000 B.C – 1600 A.D.), subdivided into Early, Middle and Late, is distinguished from the previous Archaic period with respect to settlement patterns and subsistence pursuits and is most specifically marked by the introduction of pottery in Ontario. Though the appearance of pottery provides a temporal marker for archaeologists, its use does not seem to have profoundly changed the hunter-gatherer lifestyle of the previous period during the early part of the period.

A transition to new tool forms and more elaborate decorative ceramic vessels marks the transition to the Middle Woodland period. Based on the regional ceramic vessel decorative and manufacturing techniques, the Middle Woodland period was divided into three complexes (Point Peninsula, Saugeen and Couture) (Spence et al., 1990). Trade and communication with other communities to the south is observed at this time with the adoption of burial mounds from the Hopewell culture and items from the Ohio Valley, like stone platform pipes appearing on sites in southern Ontario (Ellis et al., 1990).

By the end of the Middle Woodland period, there is evidence of the use of maize horticulture (Warrick, 2000). The first known evidence of maize use in southern Ontario dates to around 500 AD (Crawford and Smith, 1996) and is associated with the Princess Point culture that was focused around the Humber River, Grand River and Credit River (Fox, 1990). Later, Iroquoian-speaking groups of southern Ontario, known for their maize, are suggested to be descendants of the Princess Point people (Warrick, 2000). Initially, maize was more of a dietary supplement, and communities continued to disperse into smaller groups moving inland during the winter months (Williamson 1990). Not all cultural groups adopted horticulture to the same extent. The Algonquian speakers, like the Michi Saagiig (Mississauga Anishinaabeg), continued to focus on hunting, fishing, and gathering natural resources, remaining more mobile (Migizi, 2020).

Later, horticulture improved and expanded to include squash and beans, and was able to support larger populations, allowing settlements to increase. For those cultures that fully adopted horticulture, there was also a resulting shift in village location as more land suitable for agriculture was required. By 1300-1450 AD, these sites were more intensively occupied, becoming occupied year-round, with increased internal spatial and socio-political organization (Warrick, 2000; Dodd et al., 1990; Ellis et al., 1990). Some villages at this time were fortified with single or double palisade walls (Ellis et al., 1990). Seasonal and smaller camps were not abandoned by the cultural groups who adapted agriculture, as they would have been utilized for things like seasonal hunting and during trade or social gatherings (Ramsden, 1990). The period between 1450 and 1600 AD saw the movement of the ancestral Wendat communities along the north shore of Lake Ontario northward to the Lake Simcoe and Georgian Bay region (Ellis et al., 1990). This movement was not quick, occurring over many generations. Others, like the Michi Saagiig (Mississauga Anishinaabeg), who were less restricted by such intensive horticultural requirements, continued their established seasonal movements (Migizi, 2020). During this period, the socio-political organization of all the First Nations that the first explorers would meet and document evolved (Ellis et al., 1990).

Throughout the period, burial ceremonies became increasingly sophisticated, there was an increase in the trade of exotic items and expanded trade networks (Ellis et al., 1990; Spence et al. 1990) as well as increased inter-community relationships, land and resource sharing, marriages, allegiances, and integration (Ramsden, 1990; Ellis et al., 1990). Towards the end of the period, tensions were rising between First Nations, particularly the Iroquoian-speaking groups of southern Ontario and the Five Nations of New York, with the emergence of territories, which contributed to their northward movement into Simcoe County.

Contact Period

The start of the Contact period is marked by the appearance of early explorers and the emergence of the fur trade and the appearance of European goods, such as coins, glass beads, jewelry and axes on Indigenous sites around 1600 AD (Lennox and Fitzgerald, 1990). It also marks the beginning of change to the traditional culture and lifestyles of many communities inhabiting southern Ontario (Warrick, 2000).

Early explorers and missionaries, including Samuel de Champlain, who arrived in 1615, documented the First Nations they encountered on their journeys. Samuel de Champlain spent a fair bit of his time living and travelling with the Wendat, who were occupying villages within Simcoe County at that time, but also noted other groups, including one occupying the area between the Wendat and the Five Nations and noticing their neutrality, leading to them being referred to as the Neutral. Like other First Nations, the Neutral occupied larger villages and practiced agriculture. Subsequently, the French continued to visit and trade with the Neutral, and 1626 marked the first documented visit among the Neutral by Joseph de la Roche Daillon, a Recollect missionary. Samuel de Champlain also documented the Anishinaabeg, including the Michi Saagiig (Mississauga Anishinaabeg) and the Odawa (Ellis et al., 1990; Lennon and Fitzgerald, 1990).

Samuel de Champlain is thought to have first encountered the Odawa, who occupied an area along the northeastern shore of Georgian Bay in 1615. Later, Jesuit missionaries would also document the Anishinaabeg groups they encountered, noting their highly nomadic lifestyle, travelling great distances for trade items like furs. A mission was established at Sault Sainte Marie in 1648 for the Anishinaabeg groups of Manitoulin Island and those of the northeastern shore of Lake Huron. Mission work among groups like the Michi Saagiig continued in the late 17th century (Thwaites 1896).

The Contact period is also represented by smaller villages and longhouses as a result of population decline from the introduction of European diseases and increased warfare (Lennox and Fitzgerald, 1990). Tensions between First

Nations in southern Ontario between Lake Ontario and Lake Simcoe, and those in New York, rose as the pressures of the fur trade continued, as did tensions between the French, British and Dutch. The 1640s saw an increase in hostilities between the Five Nations Iroquois and the Wendat and their Algonquian allies, including the Nipissing and Odawa, which, together with disease, led to the dispersal of the Wendat, Petun and subsequently the Neutral, who occupied the Niagara Peninsula at the time of contact with Europeans, out of this area. The dispersal saw some Wendat migrate eastward into Quebec and others west and south into the United States, where they reside today (Gerrard 2014). During this time, some Anishinaabe communities moved further north to avoid the hostilities (Schmalz, 1977; Coyne, 1895; Lennox and Fitzgerald, 1990).

The Five Nations Iroquois then established limited settlements at strategic trading route locations on the north shore of Lake Ontario. This did not last long, as by the late 17th century, the Anishinaabeg (Ojibwa, Odawa, and Potawatomi), with help from the French, pushed the Five Nations Iroquois back to New York. The Anishinaabeg then reoccupied the area and were the sole cultural presence in southern Ontario (Coyne, 1895).

After the Seven Years' War between Britain and France ended in 1763, the overall control of the lands that now comprise Ontario and Quebec was ceded by France to the British, who continued to maintain forts at Kingston and Niagara. The influx of settlers after the American Revolution and the subsequent migration of Loyalist settlers convinced the British Crown to formally acquire new lands for settlement through a series of treaties with Indigenous groups.

The Anishinaabeg had established numerous villages throughout southern Ontario, establishing their control of the area and in doing so, it was with the Anishinaabeg that the British negotiated numerous treaties with (Ferris & Spence, 1995). Discrepancies and differing interpretations of the treaties led to additional treaties being signed, and others are still contested to this day.

Table 1: General Indigenous History Throughout Ontario

Period	Date Range	Diagnostic Material	Period Details
Paleo - ca. 9,000-7,000 B.C.			
Early	ca. 11,000-8,500 BC	Fluted projectile points	Nomadic hunters moved into Southern Ontario from the South-West.
Late	ca. 8,500-7,500 BC	Plano, Holcombe, Hi-Lo projectile points	
Archaic - 7,000-1,000 B.C.			
Early	ca. 7,000-6,000 BC	Bifurcate, Nettleing projectile points	- Small nomadic hunter-gatherer bands slowly transition to small territorial camps. - There is an increase in the use of localized material and the re-purposing of stone tools. - Local and long-distance trade networks appear leading to an influx of exotic material and goods, including natural copper and conch shells, often used as grave offering. - The bow and arrow are adopted towards the end of the period.
Middle	ca. 6,000-2,500 BC	Brewerton, Stanly, Side-notched projectile points	
Late	ca. 2,500-1000 BC	Lamoka, Adder Orchard, Genesee, Lamoka, Crawford Knoll, Innes, Hind projectile points	
Woodland - ca 1,000 B.C. - 1600 A.D.			
Early	ca. 1000-400 BC	Birdstones, Cache blades, Kramer, Meadowood projectile points	- Introduction of pottery. - Burial ceremonialism is also practiced.

Middle	ca. 400 BC - AD 500	Vanport, Snyder, Saugeen projectile points, Pseudo-scallop shell Pottery	- Increased sedentism and seasonal site reuse and emergence of horticulture. - More intricate burial ceremonialism adopted from Hopewell culture to the south, including the use of burial mounds. - More pottery decorative techniques appear including stamped and scalloped techniques. - Items from the Ohio Valley also start to appear including stone platform pipes, copper ear spoons and copper panpipes.
Transitional	ca. AD 500 - 900	Princess Point pottery, Triangular projectile points	- First Appearance of Corn. - Princess Point pottery decorative techniques included cord-wrapped stick and punctate. - Some of the largest burial mounds were also created by the Laurel.
Late - Early	ca. AD 900 - 1300	Glen Meyer Tanged-Triangular projectile point	- Small single-family houses change to larger multi-family longhouses within small village sites with the appearance of palisades at some. - Increase in corn agriculture. - Pottery vessels are thinner walled with improved manufacturing. - There is a switch in burial ceremonialism to the use of burial pits, a precursor to large ossuaries.
Late - Middle	ca. AD 1300 - 1400	Middleport projectile points	- Increase in village size and reliance on agriculture including corn, beans and squash. - Decrease in decorated pottery vessels and an increase in decorative pipes including effigy pipes. - Some sites still included a palisade.
Late - Late	ca. AD 1400 - 1600	Nanticoke, Daniels Triangular projectile points	- Village size increased and locations were strategically picked, to ensure enough arable land, with diets heavily dependent on agriculture, proximity to wood for both heating and building, proximity to water and a location which would be easily defendable. - Emergence of tribes and territories, which led to an increase in warfare. - Large ossuaries become common. - Towards the end of the period the first Europeans goods appear periodically in Ontario through trade networks with groups further east who were in contact with the first French explorers who had reach the St. Lawrence.
Contact-Historic ca. 1600-1700 A.D.			
European Contact	AD 1600-1650	Minimal European items	- Establishment of the fur trade. - Increase in warfare resulted in tribal dispersal leaving much of the area between Lake Ontario and Lake Simcoe with no permanent large villages. - The French arrive in Ontario with an increase in Jesuit missionaries and European goods.
Late	AD 1650- ca. 1800	Mixture of Indigenous and European items	- Iroquois used their conquered land of Southern Ontario as mainly hunting grounds with a few settlements located along the shoreline of Lake Ontario. - The Iroquois were then challenged and pushed out of the region by the Anishinaabeg (Ojibway, Chippewa, Odawa). - Trade with both English and French. - Numerous migrations and resettlements. - The end of this period there saw an influx of European and American settlers transitioning to the historic period.

1.2.2 Traditional Knowledge

Each First Nation has its own traditional knowledge of its traditions, territory, and history, including their movements, interactions with other communities, specific areas of significance, important ceremonies and customs, and how they subsisted in the past. The following traditional histories provided are also included here to provide a more wholesome picture, together with the archaeological record of the pre-contact and contact periods.

The following is a history of the Michi Saagiig as recounted by Gitiga Migizi, a respected Elder and Knowledge Keeper of the Michi Saagiig Nation.

The traditional homelands of the Michi Saagiig (Mississauga Anishinaabeg) encompass a vast area of what is now known as southern Ontario. The Michi Saagiig are known as “the people of the big river mouths” and were also known as the “Salmon People” who occupied and fished the north shore of Lake Ontario where the various tributaries emptied into the lake. Their territories extended north into and beyond the Kawarthas as winter hunting grounds on which they would break off into smaller social groups for the season, hunting and trapping on these lands, then returning to the lakeshore in spring for the summer months.

The Michi Saagiig were a highly mobile people, travelling vast distances to procure subsistence for their people. They were also known as the “Peacekeepers” among Indigenous nations. The Michi Saagiig homelands were located directly between two very powerful Confederacies: The Three Fires Confederacy to the north and the Haudenosaunee Confederacy to the south. The Michi Saagiig were the negotiators, the messengers, the diplomats, and they successfully mediated peace throughout this area of Ontario for countless generations.

Michi Saagiig oral histories speak to their people being in this area of Ontario for thousands of years. These stories recount the “Old Ones” who spoke an ancient Algonquian dialect. The histories explain that the current Ojibwa phonology is the 5th transformation of this language, demonstrating a linguistic connection that spans back into deep time. The Michi Saagiig of today are the descendants of the ancient peoples who lived in Ontario during the Archaic and Paleo-Indian periods. They are the original inhabitants of southern Ontario, and they are still here today.

The traditional territories of the Michi Saagiig span from Gananoque in the east, all along the north shore of Lake Ontario, west to the north shore of Lake Erie at Long Point. The territory spreads as far north as the tributaries that flow into these lakes, from Bancroft and north of the Haliburton highlands. This also includes all the tributaries that flow from the height of land north of Toronto like the Oak Ridges Moraine, and all of the rivers that flow into Lake Ontario (the Rideau, the Salmon, the Ganaraska, the Moira, the Trent, the Don, the Rouge, the Etobicoke, the Humber, and the Credit, as well as Wilmot and 16 Mile Creeks) through Burlington Bay and the Niagara region including the Welland and Niagara Rivers, and beyond. The western side of the Michi Saagiig Nation was located around the Grand River which was used as a portage route as the Niagara portage was too dangerous. The Michi Saagiig would portage from present-day Burlington to the Grand River and travel south to the open water on Lake Erie.

Michi Saagiig oral histories also speak to the occurrence of people coming into their territories sometime between 500-1000 A.D. seeking to establish villages and a corn growing economy – these newcomers included peoples that would later be known as the Huron-Wendat, Neutral, Petun/Tobacco Nations. The Michi Saagiig made Treaties with these newcomers and granted them permission to stay with the understanding that they were visitors in these lands. Wampum was made to record these contracts, ceremonies would have bound each nation to their respective responsibilities within the political

relationship, and these contracts would have been renewed annually (see Gitiga Migizi and Kapyrka 2015). These visitors were extremely successful as their corn economy grew as well as their populations. However, it was understood by all nations involved that this area of Ontario were the homeland territories of the Michi Saagiig.

The Odawa Nation worked with the Michi Saagiig to meet with the Huron-Wendat, the Petun, and Neutral Nations to continue the amicable political and economic relationship that existed – a symbiotic relationship that was mainly policed and enforced by the Odawa people.

Problems arose for the Michi Saagiig in the 1600s when the European way of life was introduced into southern Ontario. Also, around the same time, the Haudenosaunee were given firearms by the colonial governments in New York and Albany which ultimately made an expansion possible for them into Michi Saagiig territories. There began skirmishes with the various nations living in Ontario at the time. The Haudenosaunee engaged in fighting with the Huron-Wendat and between that and the onslaught of European diseases, the Iroquoian speaking peoples in Ontario were decimated.

The onset of colonial settlement and missionary involvement severely disrupted the original relationships between these Indigenous nations. Disease and warfare had a devastating impact upon the Indigenous peoples of Ontario, especially the large sedentary villages, which mostly included Iroquoian speaking peoples. The Michi Saagiig were largely able to avoid the devastation caused by these processes by retreating to their wintering grounds to the north, essentially waiting for the smoke to clear.

Michi Saagiig Elder Gitiga Migizi (2017) recounts:

“We weren’t affected as much as the larger villages because we learned to paddle away for several years until everything settled down. And we came back and tried to bury the bones of the Huron but it was overwhelming, it was all over, there were bones all over – that is our story.”

There is a misnomer here, that this area of Ontario is not our traditional territory and that we came in here after the Huron-Wendat left or were defeated, but that is not true. That is a big misconception of our history that needs to be corrected. We are the traditional people, we are the ones that signed treaties with the Crown. We are recognized as the ones who signed these treaties and we are the ones to be dealt with officially in any matters concerning territory in southern Ontario.

We had peacemakers go to the Haudenosaunee and live amongst them in order to change their ways. We had also diplomatically dealt with some of the strong chiefs to the north and tried to make peace as much as possible. So we are very important in terms of keeping the balance of relationships in harmony.

Some of the old leaders recognized that it became increasingly difficult to keep the peace after the Europeans introduced guns. But we still continued to meet, and we still continued to have some wampum, which doesn’t mean we negated our territory or gave up our territory – we did not do that. We still consider ourselves a sovereign nation despite legal challenges against that. We still view ourselves as a nation and the government must negotiate from that basis.”

Often times, southern Ontario is described as being “vacant” after the dispersal of the Huron-Wendat peoples in 1649 (who fled east to Quebec and south to the United States). This is misleading as these territories remained the homelands of the Michi Saagiig Nation.

The Michi Saagiig participated in eighteen treaties from 1781 to 1923 to allow the growing number of European settlers to establish in Ontario. Pressures from increased settlement forced the Michi Saagiig to

slowly move into small family groups around the present day communities: Curve Lake First Nation, Hiawatha First Nation, Alderville First Nation, Scugog Island First Nation, New Credit First Nation, and Mississauga First Nation.

The Michi Saagiig have been in Ontario for thousands of years, and they remain here to this day.

(Migizi et al., 2015)

The following history has been provided by Kawartha Nishnawbe First Nation.

Since time immemorial, Island 31 (Located in what is now known as Burleigh Falls) has been a cherished destination for our people, who travelled to Burleigh Falls for trapping, fishing, hunting, gathering, and onward on their journey to Kinoomaagewapkong (the place of the white teaching rocks, known now as The Petroglyphs). Later, its strategic location between Lovesick Lake and Stoney Lake made it ideal for various industries, providing work as guides for many men catering to tourists. Between 1909 and 1912, construction began on the “Big Dam,” prompting the Crown to forcibly remove our people from Island 31 to make way for the dam builders. This relocation moved our guiding families to Perry’s Creek, which came to be known as the “Campground.” Families who had travelled to live elsewhere in the winter time (as they would reside on Perry’s Creek and surrounding areas for the spring-fall months to harvest fish such as Walleye and hunt a variety of game including deer seasonally) began to stay the full year and make permanent residence throughout the winter months as well. The five families who remained to live in Burleigh Falls - Brown, Boast, Hoggarth, Jacob, and Johnson – established permanent residences, and today, their descendants are recognized as the Kawartha Nishnawbe First Nation.

Kawartha Nishnawbe First Nation are Michi-Saagiig and Chippewa, and part of the broader Anishinabek Nation. Kawartha Nishnawbe are signatories to the Rice Lake Purchase of 1818 (Treaty 20), but did not sign the subsequent Williams Treaties of 1923. Kawartha Nishnawbe First Nation is a Mississauga Treaty 20 First Nation that does not fall under the Indian Act and is not a reservation.

KNFN fought against a poaching charge against one of our members in 2002. Our harvesting rights were legally brought forward in the court case “R. vs. Johnson” in 2002. KNFN won the court battle with our lawyer Chris Ried; the member was not charged with poaching, this victory in court solidified our harvesting rights in the eyes of Western law including OPP/MNR and the Government of Ontario.

Known for being talented harvesters, particularly of the fish Ogaa (Walleye) this is done ethically (through the release of female fish and other methods) every year during the spring spawning run /fall feeding seasons through Burleigh Falls using methods such as angling and spearing. The Ogaa is represented on our First Nation’s Emblem.” - Kawartha Nishnawbe First Nation

The following history has been provided by the Chippewas of Rama First Nation.

The Chippewas of Rama First Nation are an Anishinaabe (Ojibway) community located at Rama First Nation, ON. Our history began with a great migration from the East Coast of Canada into the Great Lakes region. Throughout a period of several hundred years, our direct ancestors again migrated to the north and eastern shores of Lake Huron and Georgian Bay. Our Elders say that we made room in our territory for our allies, the Huron-Wendat Nation, during their times of war with the Haudenosaunee. Following the dispersal of the Huron-Wendat Nation from the region in the mid-1600s, our stories say that we again

migrated to our territories in what today is known as Muskoka and Simcoe County. Several major battles with the Haudenosaunee culminated in peace being agreed between the Anishinaabe and the Haudenosaunee, after which the Haudenosaunee agreed to leave the region and remain in southern Ontario. Thus, since the early 18th century, much of central Ontario into the lower parts of northern Ontario has been Anishinaabe territory.

The more recent history of Rama First Nation begins with the creation of the “Coldwater Narrows” reserve, one of the first reserves in Canada. The Crown intended to relocate our ancestors to the Coldwater reserve and ultimately assimilate our ancestors into Euro-Canadian culture. Underlying the attempts to assimilate our ancestors were the plans to take possession of our vast hunting and harvesting territories. Feeling the impacts of increasingly widespread settlement, many of our ancestors moved to the Coldwater reserve in the early 1830s. Our ancestors built homes, mills, and farmsteads along the old portage route which ran through the reserve, connecting Lake Simcoe to Georgian Bay (this route is now called “Highway 12”). After a short period of approximately six years, the Crown had a change of plans. Frustrated at our ancestors continued exploiting of hunting territories (spanning roughly from Newmarket to the south, Kawartha Lakes to the east, Meaford to the west, and Lake Nipissing to the north), as well as unsuccessful assimilation attempts, the Crown reneged on the promise of reserve land. Three of our Chiefs, including Chief Yellowhead, went to York under the impression they were signing documents affirming their ownership of land and buildings. The Chiefs were misled, and inadvertently allegedly surrendered the Coldwater reserve back to the Crown.

Our ancestors, then known as the Chippewas of Lakes Simcoe and Huron, were left landless. Earlier treaties, such as Treaty 16 and Treaty 18, had already resulted in nearly 2,000,000 acres being allegedly surrendered to the Crown. The Chippewas made the decision to split into three groups. The first followed Chief Snake to Snake Island and Georgina Island (today known as the Chippewas of Georgina Island). The second group followed Chief Aissance to Beausoleil Island, and later to Christian Island (Beausoleil First Nation). The third group, led by Chief Yellowhead, moved to the Narrows between Lakes Simcoe and Couchiching and eventually, Rama (Chippewas of Rama First Nation).

A series of purchases, using Rama’s own funds, resulted in Yellowhead purchasing approximately 1,600 acres of abandoned farmland in Rama Township. This land makes up the core of the Rama Reserve today, and we have called it home since the early 1840’s. Our ancestors began developing our community, clearing fields for farming and building homes. They continued to hunt and harvest in their traditional territories, especially within the Muskoka region, up until the early 1920’s. In 1923, the Williams Treaties were signed, surrendering 12,000,000 acres of previously unceded land to the Crown. Once again, our ancestors were misled, and they were informed that in surrendering the land, they gave up their right to access their seasonal traditional hunting and harvesting territories.

With accessing territories difficult, our ancestors turned to other ways to survive. Many men guided tourists around their former family hunting territories in Muskoka, showing them places to fish and hunt. Others worked in lumber camps and mills. Our grandmothers made crafts such as porcupine quill baskets and black ash baskets, and sold them to tourists visiting Simcoe and Muskoka. The children were forced into Indian Day School, and some were taken away to Residential Schools. Church on the reserve began to indoctrinate our ancestors. Our community, along with every other First Nation in Canada, entered a dark period of attempted genocide at the hands of Canada and the Crown. Somehow, our ancestors persevered, and they kept our culture, language, and community alive.

Today, our community has grown into a bustling place, and is home to approximately 1,100 people. We are a proud and progressive First Nations community.

1.2.3 Treaty Lands

The project area is located within an area covered originally by the Johnson-Butler Purchase of 1787-88. The Johnson-Butler Purchase encompassed a large tract of land along the north shore of Lake Ontario, and as deep as one could hear a gunshot (Rice Lake), leading to the Treaty to also be referred to as the “Gunshot Treaty”. The Treaty was made between the Crown and representatives of the Anishinaabe. The boundaries and harvesting rights of these early treaties were unclear. As a result, the Williams Treaties were signed in 1923 by representatives of the Crown and seven First Nations, including Lake Simcoe Chippewa First Nations (Beausoleil, Georgina Island and Rama) and Michi Saagiig (Alderville, Curve Lake, Hiawatha and Scugog Island), in an effort to settle unceded land issues and clarify the boundaries. The Williams Treaties cover an area of over 20,000 square miles from the north shore of Lake Ontario north along the east shore of Georgian Bay. Outstanding compensation, harvesting rights and the area surrendered were still being disputed until 2018, when a final agreement was reached between the Governments of Canada and Ontario and the Williams Treaties First Nations (Boileau, J. 2020, MIAFNER 2012-26, Wallace, S. 2020).

1.2.4 County of York General Historic Overview

The area of York Region was part of the Montreal District in the province of Quebec in 1788, however, it was subsequently subdivided, and the area became known as Nassau District. Though in 1791, when the province of Quebec was divided into Upper Canada and Lower Canada, the District became part of Upper Canada with most of what is now southern Ontario (Mulvany et al 1885).

Lieutenant-Colonel John Graves Simcoe was appointed the first Lieutenant-Governor of Upper Canada. He moved the capital from Newark (Niagara) to Toronto, which he renamed York in honour of the King’s son, Frederick the Duke of York. He moved the capital in order to provide it with more protection. In 1792, he divided Upper Canada into 19 Counties and created a road system. To establish and open the road system, Governor Simcoe brought troops over from England, posting them along these roadways and even employing them in other building operations. The establishment of a road system aided the development and prepared the County for an influx of settlement. One of the major roads he opened was Yonge Street, running between York and Lake Simcoe, and named after his friend Sir George Yonge. Yonge Street was a great asset, easing travel not only for the Military but also for early settlers. It also led to an increase in the economy and settlement within the interior of the County. Governor Simcoe also began opening Dundas Street, intended to assist communication throughout Upper Canada. The establishment of the Toronto harbour by Governor Simcoe would become a major center of trade, making Yonge Street ever more important. The first time Parliament was convened at York came a year after Governor Simcoe’s departure in 1797. Governor Simcoe would return to England, where he died before seeing all his grand plans come to fruition (Mulvany et al 1885).

The County’s topography is reminiscent of having once been submerged, with its noticeable ridges and thirteen ancient water margins located between Toronto and Lake Simcoe. The County of York continued to be well watered with a number of principal streams, including the Credit River, the Humber River, the Don River, Black River, Rouge River and the Holland River. Many of these rivers were travelling routes and sources of bountiful amounts of fish and other resources for the Indigenous groups who lived and travelled through the County. Later, these Rivers would become ideal locations for the establishment of mills. Settlements first grew up around these mills and later around market centers and railway stations. By the late 19th century, numerous businesses had been established in the County, including tanneries, carriage and furniture factories, woollen, paper, carding, saw and grist mills and cheese factories. Many industries were also established in York, including the lumber industry, which was one of the first to be established with a high demand for lumber within the County as well as overseas. Over

the decades, much of the County had been cleared of woods, leaving the lumber industry in decline (Mulvany et al 1885).

The County of York consisted of nine Townships in 1851, including Etobicoke, Vaughan, Markham, Scarborough, York, King, Whitchurch, Gwillimbury East and Gwillimbury North. The following year, York, Ontario and Peel Townships were united for municipal and judicial purposes, and a year after that, Ontario Township was separated from York and Peel, which remained joined until 1866. Later, the County would be divided into Etobicoke, Georgina, Gwillimbury East, Gwillimbury North, King, Markham, Scarborough, Vaughan, Whitchurch, York, and the City of Toronto. The flourishing City of Toronto brought settlers, industries, and businesses to the County (Mulvany et al 1885). The opening of the railway helped to bring settlers further north in the County and kick-started the tourism industry. Many places in York became tourist destinations, attracting people from all over. The population of the County continued to grow, and life became easier with technological advancements. New manufacturers and industries were also attracted to the County, bringing more economic growth. The growth of city centers led to a trend of people leaving the hardships of farming life behind for more specific occupations and opportunities in urban centers.

1.2.5 Township of Markham General Historic Overview

The Township of Markham encompasses 67,578 acres of land divided into 15 concessions and separated from the Township of Vaughan to the west by Yonge Street. The Township is well-suited for agriculture, with the majority of it being cultivable. Two main rivers flow through the Township, the Don and the Rouge. Although the survey of the Township did not begin until 1794, the third township to be marked out in the County, settlers began to settle here and there beginning around 1790 (Mercer et al 1885, H.C. Miles & Co., 1881).

The first attempt to establish a settlement began when William Berczy led sixty-four German families from Philadelphia to settle in what would become the Village of Markham in 1794. Their arrival may have occurred prior to the Township was surveyed. These sixty-four families had recently come from Hamburg by agents to settle on “Captain Williamson’s Demesne” in New York. The decision to move north into Canada was easy, given the prospect of owning land promised by Governor Simcoe to any E.U. Loyalist. In New York, they would continue to be tenants; moving north meant more opportunities. Mr. Berczy himself was an ambitious and energetic man, opening up a wagon road for pioneers between Philadelphia and Lake Ontario. The road to establishing a successful settlement was not an easy one, not only because there was no road open between York and Markham, but the settlement would have to be built from the ground up. The first obstacle was making their way from York to what would become the Village of Markham. The path of Yonge Street had already been marked but not cleared, so the sixty-four families began to clear the way, opening up Yonge Street. Unlike some of the other earlier settlers who travelled to their new homes by way of oxen and sleigh, they used horses and wagons. Their ingenious method of building their wagons with tightly spaced boards and caulked seams meant that they could remove the body from the carriage and transport the wheels, their family and supplies over small bodies of water and streams. Water was not the only obstacle; the rolling topography meant that steep hills had to be overcome. In order to get their heavy wagons loaded with supplies down steep hills, they employed a method called “tracking,” where ropes were tied around the load and around trees on either side of the road and used as a pulley system (Mercer et al 1885, H.C. Miles & Co., 1881). This method was also used to get their load up steep hills; however, it is often done with smaller loads at a time. After finally arriving in Markham Township on the Lots, which they had been granted, temporary shelters would have to be built, and the land cleared. Settling along the river provided them with the resources to establish both grist and saw mills. This river would also prove to be beneficial for acquiring supplies before Yonge Street became more easily travelled. Provisions were not easily procured during this time; great distances would have to be travelled. Supplies were mainly procured in New York State, as York was only a small hamlet at this time. The river they settled along would become known as the Rouge River, but they called it Big River. The first

mill built by Mr. Berczy here on Lot 4, Concession 3, was the first to be built in York County, and the subsequent mills were among the first as well. The settlers overcame adversity and were able to establish a prosperous community. In 1799, the *Gazetteer* described it as having “good mills and a thriving settlement of Germans”. Mr. Berczy seems to have been the backbone of the community, as after moving to Montreal, on account of not being able to get all the land patents originally promised, the mills lost their former value and were put up for sale in 1805. Mr. Berczy ran into financial trouble from which he could not recover and moved back to New York, where he passed away in 1813. The establishment and prosperity of this early German settlement helped to shape and grow the Township. Many other German families came to settle in the Township. This community would become the Village of Markham, whose growth is also owed to the opening of the Toronto and Nipissing Railway. The population of Markham grew to 895 in 1878. Two other villages that benefited from the railway were Unionville and Stouffville (Mercer et al 1885, H.C. Miles & Co., 1881).

Another early pioneer was Nicholas Miller, who built the first mill on the Humber and then settled on Lot 33, Concession 1, building a small grist mill on a tributary of the Don. The Township of Markham was also home to several prominent early settlers, including several French *émigrés* who resided in the Oak Ridges region. Not all of them were cut out for the pioneering lifestyle and returned to Europe (Mercer et al 1885, H.C. Miles & Co., 1881).

Four other larger villages included Thornhill, named after Mr. B. Thorn, who settled there in 1820 and grew to a population of around 700 by 1881, Unionville, the meeting place for the Township Council and a population of about 300 in 1881, Richmond Hill and Stouffville. The latter two villages would become partly within the Township of Vaughan with the establishment of new Municipalities. A number of smaller settlements were also established within the Township, including Dollar, Headford, Victoria Square, Buttonville, Brown’s Corners, Yarmley’s Corners, Almira, Cashell, Mongolia, Milnesville, Belford, Box Grove, Ceder Grove, Milliken, Haggerman’s Corners, Unionville and Gormerly many of which remained no larger than a hamlet (Mercer et al 1885, H.C. Miles & Co., 1881).

The population of the Township grew to 5,698 by 1842, and by 1847, there were enough children in the growing population to require the need for 27 common schools, more than any other township in the Home District. By 1850, the population had grown to 6,868 and 8,152 in 1871. However, the population declined to 6,375 in 1881 due to the separate Municipalities. The crops grown within the Township included a wider variety than in some other townships as a result of the soil quality. The principal agricultural staples were wheat, barley, oats, peas, beans, corn, potatoes, turnips, other root crops and hay. Livestock farming was also prominent with the raising of Clydesdale horses, Durham cattle, Cotswold sheep and Berkshire hogs (Mercer et al 1885).

The Township of Markham’s proximity to Toronto, a major market center, and the establishment of better roads aided its prosperity. Like many other Townships, hardships were met along the way, but Markham was able to overcome them, becoming the thriving Township it is today.

1.2.5 Historic Mapping

1.2.5.1 Nineteenth Century

Nineteenth-century maps were consulted to identify historic features within or within close proximity to the project area. While these maps can provide some insight into the presence of historic features and the historic environment, the information is limited to the level of detail and the data chosen to include on these maps. Often, these early maps were compiled based on subscription; therefore, the lack of information included on the map does not necessarily mean the absence of a historic feature in a given area. Additionally, the accuracy of the location of a historic feature is another concern, and its location is compared to later maps and aerial images using common points and features between all the maps. A site visit is also used to confirm the presence and location of any historic feature remaining today. The 1854, 1860 and 1878 maps illustrate the progression of settlement around the project area.

Map 2 from 1854 illustrates the project area on the historic Markham Rd between Markham and the historic village of Milnesville. This map illustrates the concentration of settlement along either side of Markham Rd, including within the project area. The further subdivision of some of the surrounding lots also shows the increased settlement within the area. Multiple watercourses can be seen surrounding the project area on this map, which would have contributed to the area's fertile soil. This map also includes wooded areas around the project area, noting that the area had not been entirely clear-cut.

There is a continuity from the 1854 map to that of Tremaine's 1860 map (Map 3); however, there is one main difference: only a limited number of structures are illustrated, two of which are within the project area. The concentrated settlement to the south of the project area, also included on the 1854 map, is noted as having a German Tannery, a factory and a school. By 1878 (Map 4), this settlement had grown and included a hospital. The Toronto Nipissing Railway, having been opened by 1878, is illustrated running through the eastern portion of the project area. Several of the structures illustrated both within and around the project area are shown with orchards, typical of 19th-century farmsteads.

Tables 2 and 3 below provide a summary of the features within close proximity to the project area, which indicate historic archaeological potential within the project area.

Table 2: Summary of Historic Features within Proximity to Project Area

1854 Map Features	1860 Map Features	1877 Map Features
• 2 Historic Roads • 24 Structures	• 2 Historic Roads • 3 Structures	• 2 Historic Roads • 11 Structures • Railway

Table 3: Summary of Historic Features within each Lot of the Project Area

Lot	Con	1854 Map Features	1860 Map Features	1877 Map Features
18	7	• Lot Owner: Christopher Reesor Es. • 1 Structure	• Lot Owner: James Hawkins • None shown	• Lot Owner: James Hawkins • 2 Structures
19	7	• Lot Owner: James Thomas • 3 Structures	• Lot Owner: James Thomas • 1 Structure	• Lot Owner: James Thomas • 1 Structure
20	7	• Lot Owner: William Clarry • 2 Structures	• Lot Owner: William Clarry • 1 Structures	• Lot Owner: James Thomas and Sinclair Holden • 1 Structure
18	8	• Lot Owner: Abraham Koch • 3 Structures	• Lot Owner: Estate of Abraham Koch • None shown	• Lot Owner: Jos. Koch • 1 Structure • Railway

19	8	- Lot Owner: Christopher Heisa 2 Structures	- Lot Owner: Christopher Heisa - None shown	- Lot Owner: Christopher Heisa 1 Structure - Railway
20	8	- Lot Owner: William Read 1 Structure	- Lot Owner: William Read - None shown	- Lot Owner: William Read - Railway

1.2.5.2 Twentieth Century

National topographic surveys were consulted to provide more detail about the project area and its surroundings. The survey from 1917 (Map 5) shows the project area within a rural environment consistent with the 19th-century maps. The survey also provides additional information on the natural environment. The topography slopes down to the watercourse. Several of the structures illustrated on the 19th-century maps are included in this survey, including within the project area.

A series of aerials (Maps 6-10) were also gathered, showing the transition of the project area from rural to urban. The aerial from 1954 (Map 6) shows multiple farm complexes within and surrounding the project area. By 1988 (Map 7), the majority of the eastern half had been subjected to development, including the construction of the electric plant in the northeast corner. Residential development expanded within and around the project area by 2005 (Map 8), and earthworks started in 2006 (Map 9) on large portions of the project area for future developments seen on the aerials from 2013 (Map 10) and 2024 (Map 14). The electrical plant had been removed by 2013, and the property was left vacant.

1.3 ARCHAEOLOGICAL CONTEXT

1.3.1 Previously Registered Sites

According to the Ministry of Citizenship and Multiculturalism, Archaeological Site Database (ASD), there are seventeen previously registered sites located within 1km of the project area. Of the seventeen, three are within the project area (AlGt-630, AlGt-231 and AlGt-209), two are within 50 meters (AlGt-259 and AlGt-257) and two are within 300 meters (AlGt-256 and AlGt-254). Table 4 below provides a summary of the sites within 1km of the project area.

Table 4: Previously Registered Sites within 1km

Borden Number	Site Name	Time Period	Affinity	Site Type	Proximity to Project Area (within)
AlGt-649	MMM North H2	Post-Contact	Euro-Canadian	homestead	1km
AlGt-630	Clarry West Site	Post-Contact	Euro-Canadian	farmstead	In Project Area
AlGt-604	Farley				1km
AlGt-585	The Joshua Miller site				1km
AlGt-538	Markham Pottery Site	Post-Contact	Euro-Canadian	manufacturing, midden, workshop	1km
AlGt-259		Pre-Contact	Aboriginal	findspot	50m
AlGt-258		Pre-Contact	Aboriginal	findspot	1km
AlGt-257		Pre-Contact	Aboriginal	findspot	50m
AlGt-256		Archaic, Middle	Aboriginal	findspot	300m

AlGt-254	Clendenen	Post-Contact	Euro-Canadian	homestead	300m
AlGt-232	Wismer Commons 8	Post-Contact	Euro-Canadian	Unknown	1km
AlGt-231	Wismer Commons 7	Pre-Contact	Aboriginal	findspot	In Project Area
AlGt-228	Wismer Commons 4	Post-Contact	Euro-Canadian	Unknown	1km
AlGt-227	Wismer Commons 3	Post-Contact, Pre-Contact	Aboriginal, Euro-Canadian	Unknown	1km
AlGt-210	Swan Lake	Archaic, Early	Aboriginal	findspot	1km
AlGt-209	James Hawkins	Post-Contact	Euro-Canadian	homestead	In Project Area
AlGt-163	Strickler	Post-Contact	Euro-Canadian	privy, farmstead, homestead	1km

1.3.2 Previous Archaeological Assessments

A search of the Ministry of Citizenship and Multiculturalism Archaeological report database identified eight previous assessments that have been completed entirely or partly within the project area and two previous assessments that have been completed within close proximity to the project area (within 50 meters). The two previous reports document archaeological assessments north of the project area on the northern side of Major Mackenzie Dr E. No archaeological resources were recovered during either assessment, and no further work was recommended (ACC 2024a, ACC 2024b). Table 5 below provides a summary of the previous archaeological assessment reports, which document work completed within the project area.

Table 5: Summary of Previous Archaeological Assessments

Reference & PIF#	Location	Stage	Assessment Summary	Results Summary	Recommendations
Archeoworks Inc. 2009 PIF#P029-588-2009	Road Allowance within the project area along Major Mackenzie Dr E	1-2	Test pit and pedestrian survey	No archaeological resources recovered	No further work
The Archaeologists Inc. 2020 PIF#P052-1017-2020	Northeast corner	1-2	Test pit survey	No archaeological resources recovered	No further work
ASI 2017 PIF#P057-0834-2016	Railway Corridor	1	Site visit	No archaeological potential – disturbed	No further work
D.R. Poulton & Associates Inc. 2009 PIF#P116-183-2009	Northeast corner east side of railway tracks	1-2	Test pit and pedestrian survey	Late historic Euro-Canadian refuse scatter was identified.	Historic scatter was determined not be a significant archaeological resource due to its late date and minimal artifacts and no further work recommended
WSP 2022 PIF#P365-0149-2021	Parking lot in southeast corner on the west side of the railway tracts and a small area in the very southeast corner	1	Site visit	No archaeological potential – disturbed	No further work
This Land Archaeology Inc. 2017 PIF#P379-0157-2017 & P379-0159-2017	Centrally within northern portion between Markham Rd, Macadam Rd. & Major Mackenzie Dr E	1-3	Stage 2 - Test pit and pedestrian survey Stage 3 – Test unit excavation	Stage 2 - Clarry West Site (AlGt-630) historic early – late 19 th century site identified Stage 3 – The Clarry West Site (AlGt-630) is suggested to represent the first occupation by Henry Shank followed by tenants before a brick home was built ca 1850s. The site represents a domestic site mainly dating to before 1870.	Stage 2 - Stage 3 Stage 3 – Stage 4 Excavation

This Land Archaeology Inc. 2017 PIF#P379-0162-2019	Centrally within northern portion between Markham Rd, Macadam Rd. & Major Mackenzie Dr E	4	Block excavation followed by mechanical topsoil stripping	9 cultural features concentrated around a root cellar were identified.	The Clarry West Site (AlGt-630) was fully excavated and documented and no further work is required.
ASI 2019 PIF#P1066-0109-2019	Northeast corner - Proposed extension of Anderson Ave north from Castlemore Ave.	1	Site visit	Areas of deep disturbance and areas of archaeological potential identified.	Stage 2 test pit survey at a 5m interval for areas of archaeological potential. No further archaeological assessment required for areas which do not retain archaeological potential

1.3.3 Archaeological Management Plan

The *Regional Municipality of York Archaeological Management Plan* (York Region 2014) illustrates areas of potential for Indigenous and/or historic archaeological resources within the Region. Only two small areas within the northern portion of the project area are shown to have archaeological potential; the remaining areas are shown to not have potential for archaeological resources (Map 11).

1.3.4 Natural Environment

1.3.4.1 Physiographic Region

The project area is situated within the Peel Plain physiographic region. The Peel Plain stretches 300 square miles across the Municipalities of York, Halton and Peel, consisting of clay soils and slopes gradually towards Lake Ontario. Deep valleys have been cut through the Peel Plain from a number of Rivers, including the Humber, Don, Credit and Rouge as well as smaller streams, including the Etobicoke, Bronte and Oakville Creeks. Till, containing large amounts of limestone and shale makes up the underlying geological material, but has been modified over much of the Plain by a veneer of clay of varying depths. This veneer of clay is thought to have been brought from the north and east by glacial meltwater. Although a generally heavier textured soil, the Peel Plain also includes trains of sandy alluvium bordering stream valleys in some places, including along the Credit River below Norval and the Humber River near Thistlethorn and Nashville. A small sandy tract also lies in Trafalgar Township in concessions VIII and IX and near Unionville. The Peel Plain, now mostly deforested, has caused the area to have a higher degree of evaporation, affecting the recharge of underground water supplies. Hardwood forests with a great wealth of species once stretched across the Plain. The deforestation of the Peel Plain corresponded with the rise in farmland and then subsequently in urbanization (Chapman and Putnam 1984: 174-176).

1.3.4.2 Topography

The topography within a project area can speak to the potential for Indigenous use in the past. Areas of elevated topography were chosen for settlement by some Indigenous groups. The topography can also note areas of past water or seasonal drainage. The 1917 topographic survey shows the project area as being relatively level (Map 5).

1.3.4.3 Water Resources

One of the main features that indicates the potential for archaeological resources is a project area's proximity to water. Potable water sources were essential for survival, and larger watercourses and bodies of water were utilized for easier travel. Watercourses were also used as landmarks by Indigenous groups. Later, when Europeans arrived, watercourses were also well-utilized and essential to early settlement.

A tributary of the Rouge River once flowed centrally through the project area, and another just west of the project area. These tributaries have since been redirected due to urban development. The proximity of water to the project area in the past suggests the potential for Indigenous occupation and land use in the area in the past.

1.3.5 Heritage Registry

A search of the City of Markham's Heritage Registry identified one designated property within the project area. The William Read House is located at 9899 Markham Rd. and is designated under Bylaw 2023-12 and 2002-168.

History Description

Situated in the Milnesville area, the William Read House is an excellent example of a Neo-Classical house from the second quarter of the 19th Century. The Read's were an early settler family, thought to have played an important role in the area as prosperous farmers. The house is two storeys in height with a hipped roof and a symmetrical 3-bay façade. The windows on the house are characterized by decorative wood lintels rather than the typical brick voussoirs seen on most brick buildings of this period. The main part of the house is rectangular in form with a rear one-storey kitchen wing with a gable roof. The house sits on a coursed, split fieldstone foundation, part of which has now been parged with cement. The house features a neo-classical doorway with sidelights and a transom. Originally the glass in the transom and the sidelights would have been divided. The house would have featured a six-panelled wood front door. The building is to be restored and incorporated into a commercial redevelopment on the property.

(Markham 2025: N/A)

1.3.6 Current Land Use and Field Conditions

The project area is approximately 87.7ha in size and consists of commercial and residential areas accessed by a series of roads, including Markham Rd, which bisects the project area. Additionally, the Metrolinx rail line runs along the eastern boundary. Major Mackenzie Dr. East bounds the northern limits of the project area, residential to the east and west and commercial and residential on the south.

2.0 SITE VISIT

An optional property site visit was not completed as part of the current Stage 1 assessment. The 2011 S&G Section 1.2 Standard 2 stipulates that the property inspection must be completed when weather conditions permit good visibility of land features and to not inspect the property when weather conditions (e.g. snow cover, frozen ground, excessive rain or drought) may reduce the chances of observing features of archaeological potential. As the project area was covered in snow, the optional property site visit was not completed.

3.0 ANALYSIS AND CONCLUSIONS

3.1 STAGE 1 ASSESSMENT RESULTS

The *2011 S&G Section 1.3* outlines the features indicating archaeological potential and features which have removed archaeological potential. The features which indicate archaeological potential include:

- Previously identified archaeological sites
- Water
- Elevated topography
- Pockets of well-drained sandy soil, especially near areas of heavy soil or rocky ground
- Distinctive land formations
- Resource areas
- Areas of early Euro-Canadian settlement
- Early historical transportation routes
- Properties listed on the Municipal Register or designated under the *Ontario Heritage Act*
- Local knowledge of possible archaeological sites, events, activities or occupations

Based on the background research, the project area has been evaluated as having archaeological potential given its proximity to water sources (tributaries), historic settlement structures, early historic transportation routes (rail and road), designated heritage property and previously registered archaeological sites (AlGt-630, AlGt-231, AlGt-209, AlGt-259, AlGt-257, AlGt-256 and AlGt-254 sites). None of the other features indicating archaeological potential are located within 300 meters of the Property.

The *2011 S&G* also note features which indicate archaeological potential has been removed, including:

- Quarrying
- Major landscaping involving grading below the topsoil
- Building footprints
- Sewage and infrastructure

Minor ground-altering activities such as gardening, landscaping and agricultural cultivation do not necessarily affect or remove archaeological potential. The project area has been subject to major landscaping associated with modern development, including the construction of several structures, roads and supporting infrastructure, removing archaeological potential from their footprints.

Additionally, low-lying and wet areas and areas of steep slope do not retain archaeological potential as per the *2011 S&G Section 2.1* and do not require further assessment. The project area does not contain areas of steep slope or low-lying and wet areas.

Table 6 provides a summary of the features within or within close proximity to the project area that indicate archaeological potential, features which have removed archaeological potential and features which do not retain archaeological potential. All of the other features indicating archaeological potential not included in the table are not located within close proximity.

Table 6: Summary of the Stage 1 Results

Features Indicating Archaeological Potential	Features Indicating Archaeological Potential Has been Removed	Features Not Retaining Archaeological Potential	Potential Remaining
Historic Potential • Historic Structures • Historic Road • Historic Railway • Previously Registered Sites • Designated Heritage Building Indigenous Potential • Water • Previously Registered Sites	Deep Disturbance: • Modern Roads • Residential and Commercial Structures and associated infrastructures (i.e. parking lots, landscaping)	• None	Historic & Indigenous

4.0 RECOMMENDATIONS

Given the Stage 1 results, Stage 2 archaeological assessment is required for the portions of the project area which retain archaeological potential (see Maps 13 and 14).

1. Stage 2 archaeological assessment by test pit survey at an interval of 5 meters is required for all areas which retain archaeological potential in accordance with Section 2.1.2 of the *Standards and Guidelines for Consultant Archaeologists* (2011) (see Maps 13 and 14).
2. Portions of the project area are assumed to have been deeply disturbed during major earthworks below the topsoil layer associated with the construction of the modern roads, residential and commercial developments. These disturbances and their exact extent are to be confirmed and documented during the Stage 2 archaeological assessment (see Maps 13 and 14).
3. Stage 2 archaeological assessment is not required for the portions of the project area which have been subject to previous archaeological assessment, and no further work is recommended (see Maps 13 and 14).

The recommendations noted above are subject to review and approval by the Ministry of Citizenship and Multiculturalism (MCM). It is an offence to alter an archaeological site without MCM concurrence. Any activities, including grading or otherwise, which may result in the destruction or disturbance of an archaeological site, are not permitted until MCM approval notice has been received.

5.0 ADVICE ON COMPLIANCE WITH LEGISLATION

- a. This report is submitted to the Minister of Citizenship and Multiculturalism as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Minister of Citizenship and Multiculturalism, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.
- b. It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeological Reports referred to in Section 65.1 of the *Ontario Heritage Act*.
- c. Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48(1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48(1) of the *Ontario Heritage Act*.
- d. The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.
- e. Archaeological sites recommended for further archaeological fieldwork or protection remain subject to Section 48 (1) of the *Ontario Heritage Act* and may not be altered, or have artifacts removed from them, except by a person holding an archaeological license.

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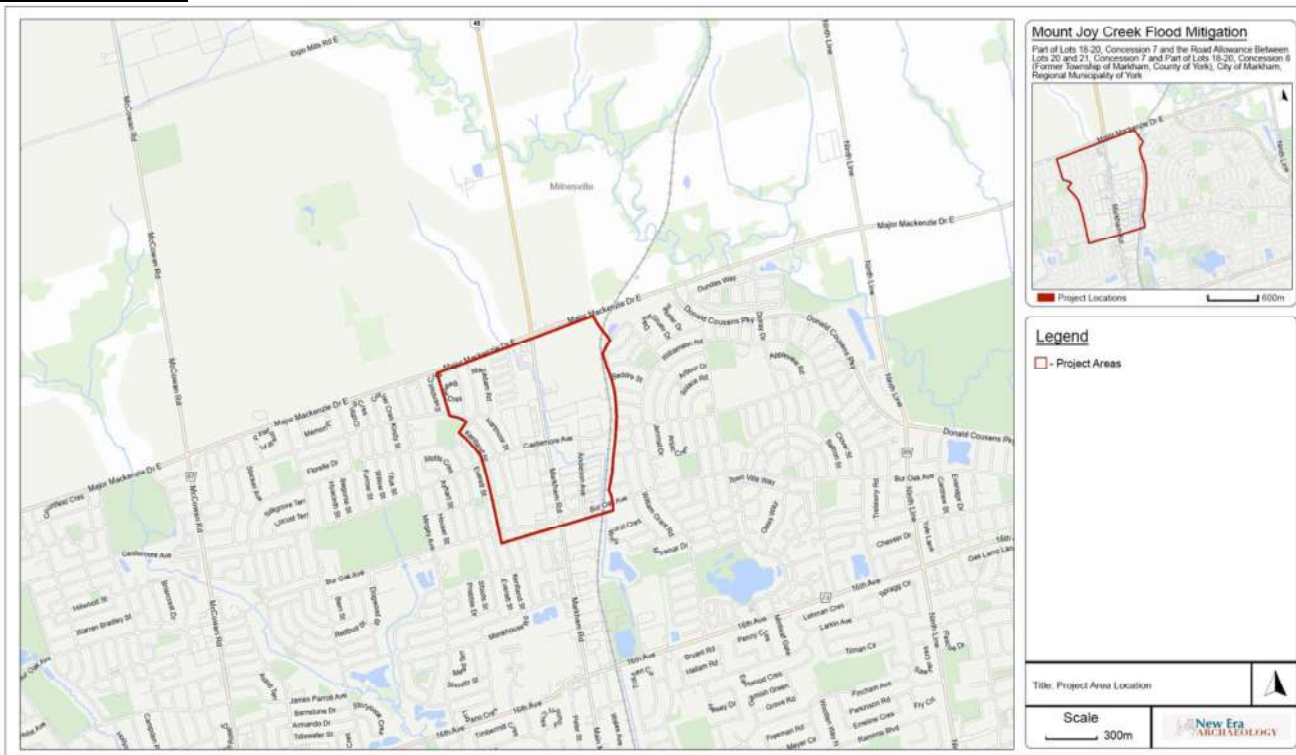
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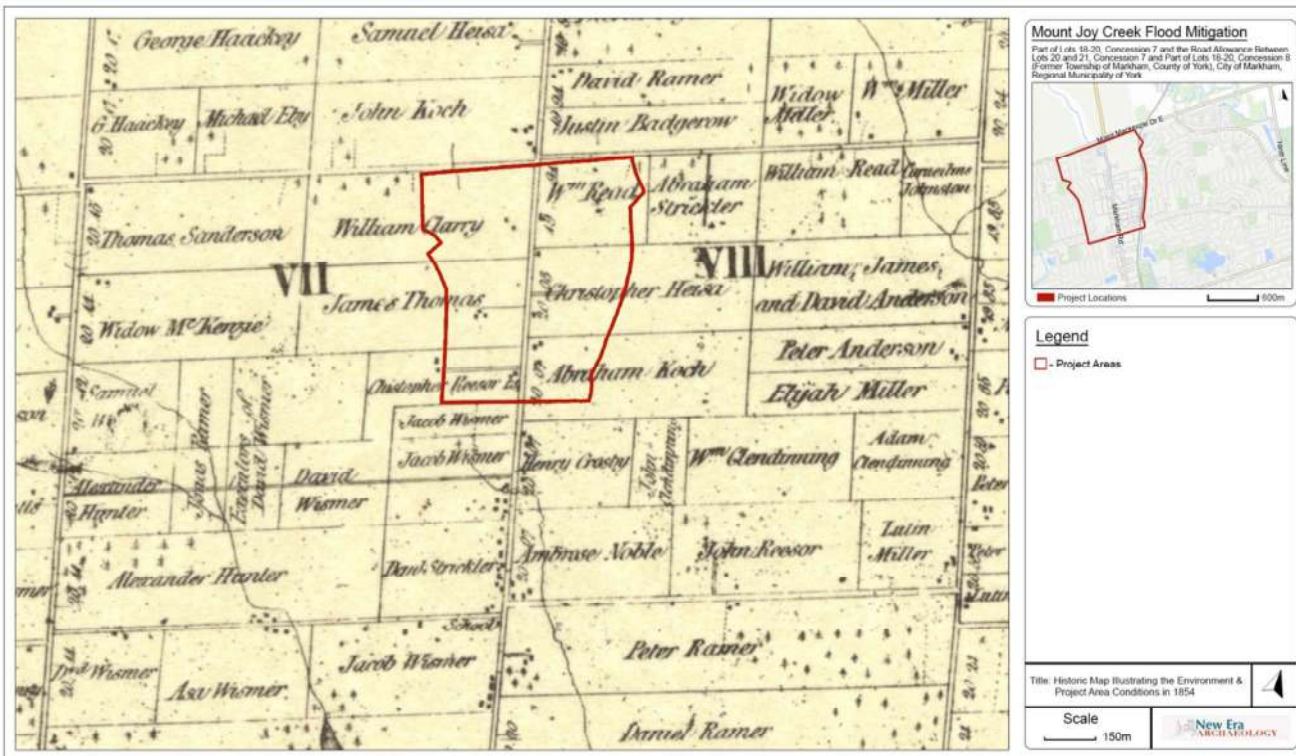
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7.0 MAPS

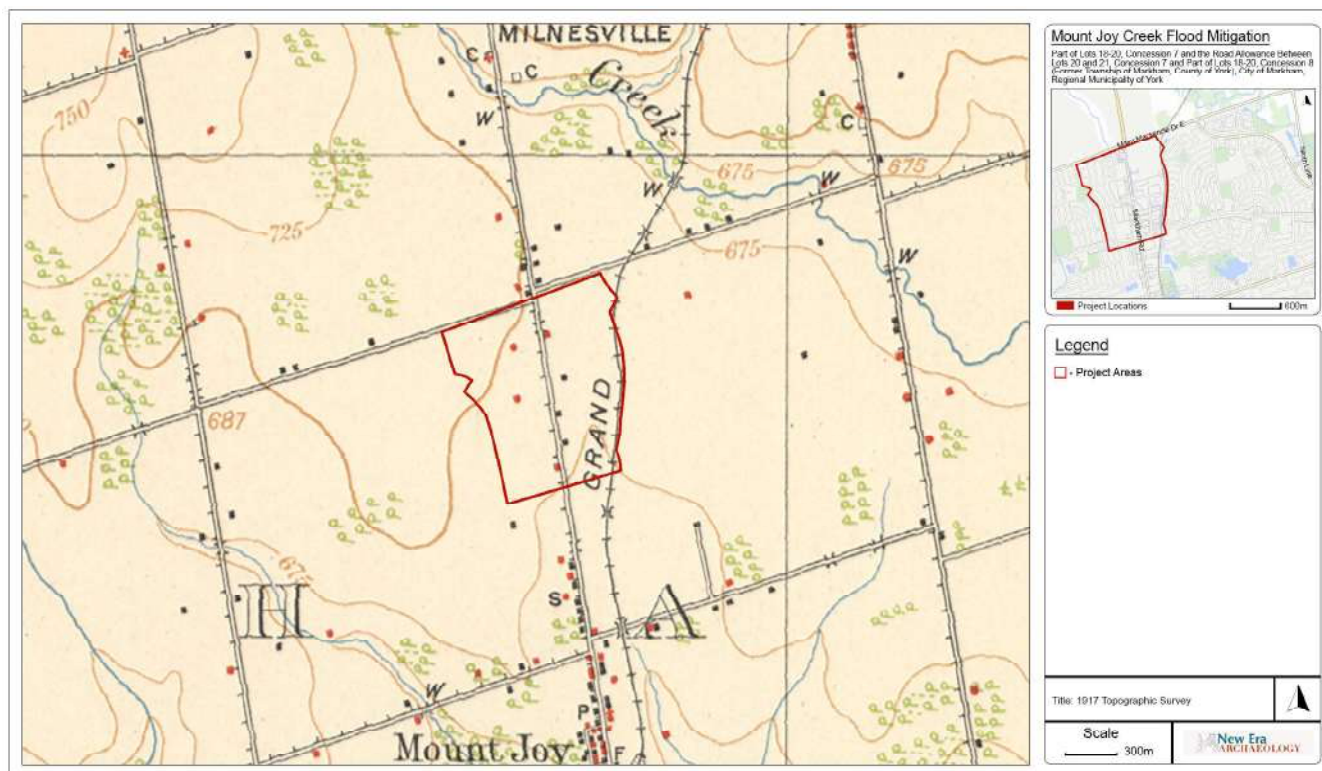


Map 1: Location of Project Area (Base Map: York Region 2024)



Map 2: Historic Map Illustrating the Environment Surrounding the Project Area in 1854 (McPhillips, George 1854)





Map 5: 1917 Topographic Map of the Environment Surrounding the Property Area (MNR 1917)



Map 6: Project Area Environment in 1954 (Base Map: York Region 2024)



Map 7: Project Area Environment in 1988 (Base Map: York Region 2024)



Map 8: Project Area Environment in 2005 (Base Map: York Region 2024)



Map 9: Project Area Environment in 2006 (Base Map: York Region 2024)



Map 10: Project Area Environment in 2013 (Base Map: York Region 2024)



Map 11: York Region Areas of Archaeological Potential (York Region 2024)

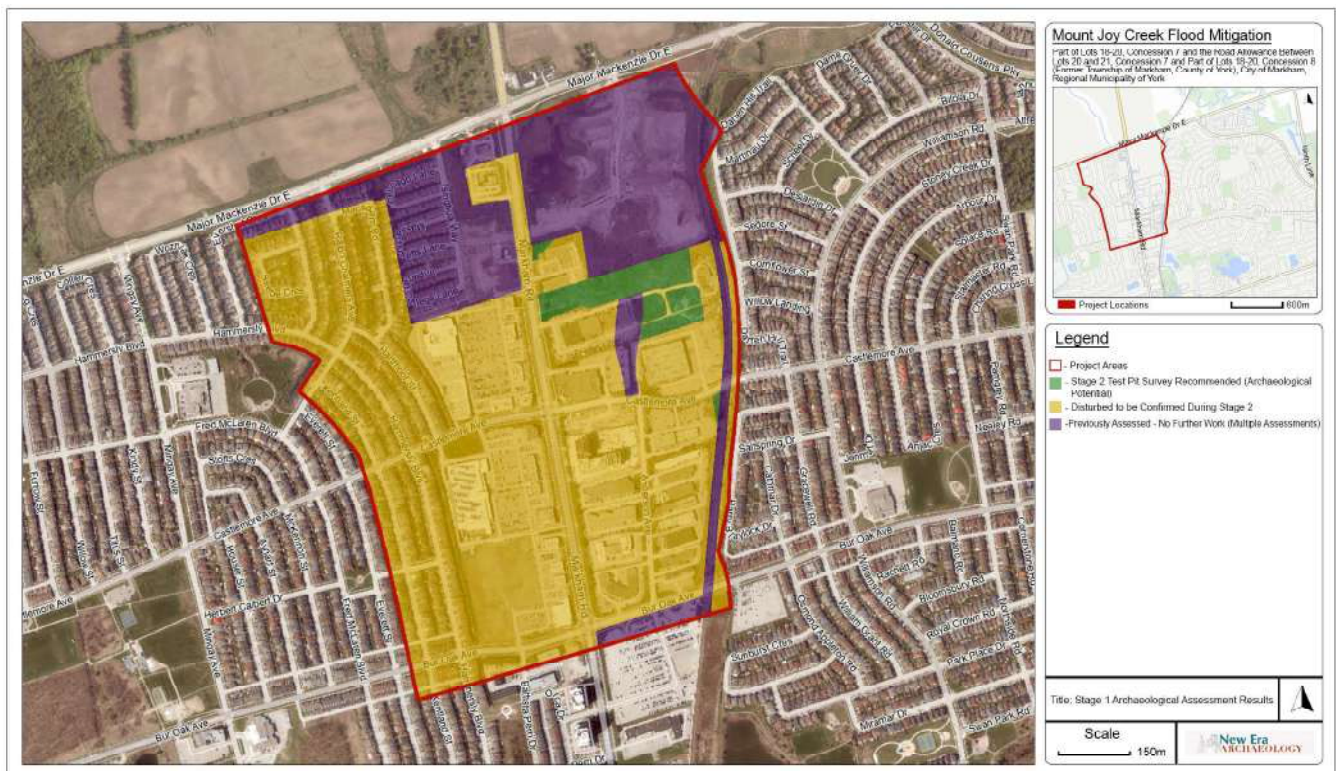
Figure 1: Study Area



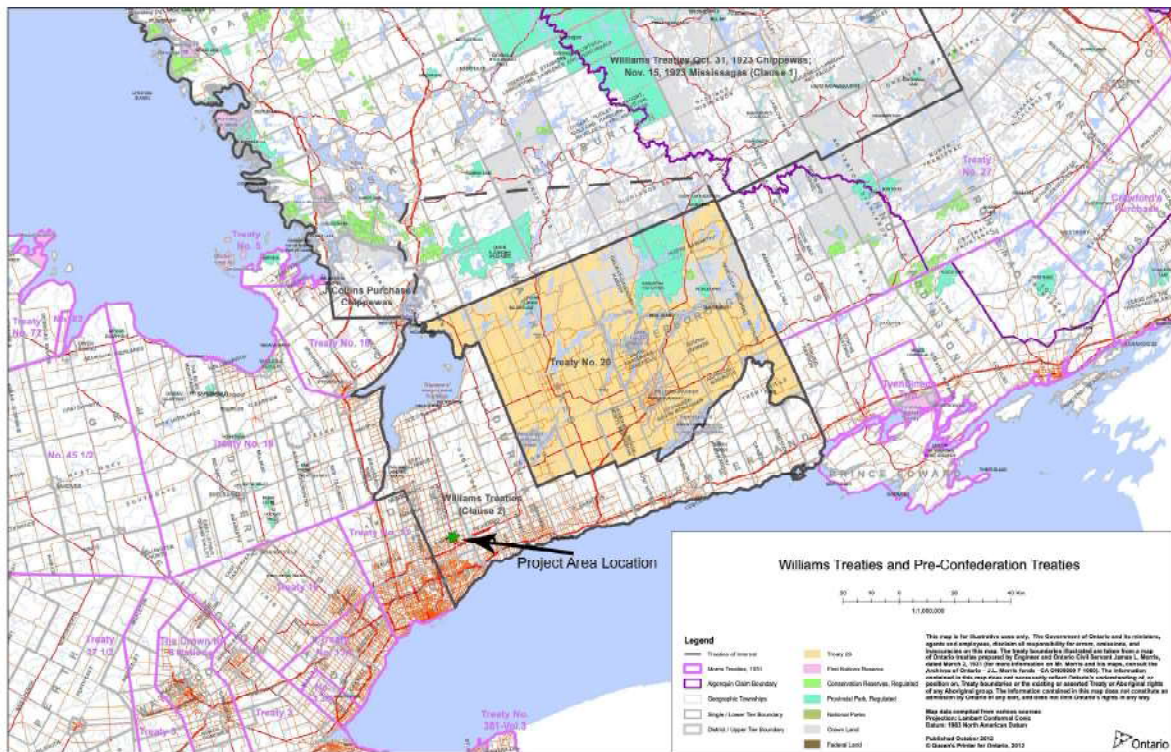
Map 12: Project Area (The Corporation of the City of Markham 2024)



Map 13: Stage 1 Results and Recommendations



Map 14: Stage 1 Results and Recommendations



Map 15: Williams Treaties

**APPENDIX C: TRCA'S MODELLING REPORT: HIGHWAY
48 AND MAJORMAC 2D MODELING**

MEMORANDUM

TO:	Nick Lorrain	DATE:	July 14, 2022
FROM:	Qiao Ying, Hyungjun Jo	CFN:	
RE:	City of Markham – Highway 48 and Major Mackenzie spill 2D Modelling		
CC:			

1.0 Introduction

The following presents the Highway 48/Major Mackenzie 2D modelling analysis completed in support of NDMP Intake 6 TRCA jurisdiction-wide spill analysis. The subject study area is located near the intersection of Highway 48 and Major Mackenzie Dr as shown in **Figure 1**.

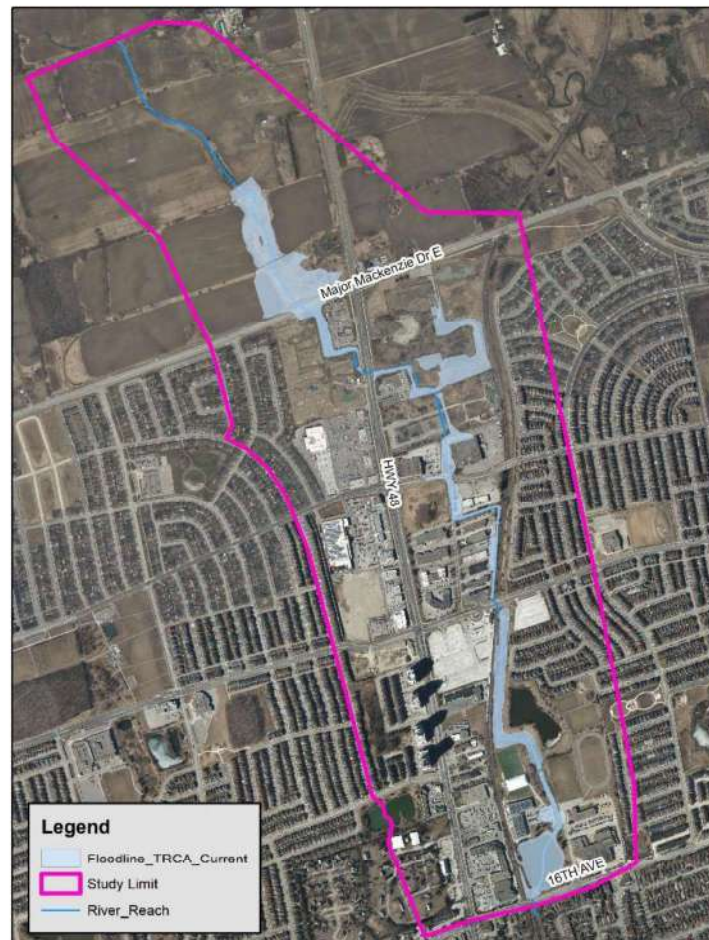


Figure 1 – Study Area Location Map

1.1 Background

A comprehensive mapping update was completed for Rouge River in two separate stages (March 2020) by Wood Canada Limited. The current study area is at the headwater of Exhibition Creek and was not covered by recent floodplain mapping update due to its complicated flood condition. The current floodlines as shown on Figure 1 were drafted in June 2013 (from Major Mackenzie Dr to Anderson Ave) but are in draft form (yellow lines). The floodlines north of Major Mackenzie (coloured in cyan) are estimated floodlines and do not reflect any engineered model outputs. This draft model identified three spills along this tributary of the Lower Rouge River (see **Figure 2**). Based on the latest topographic area (2015 and 2019 LIDAR), these spills may go in multiple directions. Therefore, a 1D HEC-RAS model is not applicable and a 2D modelling approach is more suitable to capture the spill and characterize flood conditions within the study area.



Figure 2 – Location of Spills in the Highway 48 and Major Mackenzie Study Area

2.0 Additional Background Information

Background information on crossing structures within the study area was collected from York Region and the City of Markham. The information was supplemented by a review of various grading plans, 2015 and 2019 LIDAR, and site visits which are discussed in detail below.

2.1 Major Grading Changes

The topographic information in this study is primarily based on the 2019 LIDAR data (taken during leaf-on period). Given that this area is mostly developed, the 2019 LIDAR was deemed appropriate to be used as a base topographic map. However, certain areas (creek corridors and areas north of Major Mackenzie) used 2015 LIDAR, by splicing this information into the 2019 LIDAR as it captures the leaf-off conditions. Another reason for using 2019 LIDAR was that there were considerable grading changes that occurred in specific locations since the 2015 LIDAR was taken. The changes were due to channel-realignment and three developments within the study area. The channel alignment and development locations are depicted in **Figure 3** and these changes were discussed below in details:



Figure 3 – May 2015 Image (Left) and June 2021 (Right)

- Exhibition Creek channel realignment/Mackenzie Creek Townhouse – 9900 Markham Rd

The channel alignment west of Highway 48 was prompted by Mackenzie Creek development at 9900 Markham Road, just southwest of the Major Mackenzie Dr and Highway 48 intersection. The 2015 and 2019 LIDAR and aerial image shows a clear change in the floodplain characteristics (see **Figure 4** and **Figure 5**). The re-aligned creek exhibits a more sinusoidal shape and a wider overall landform than the 2015 conditions.

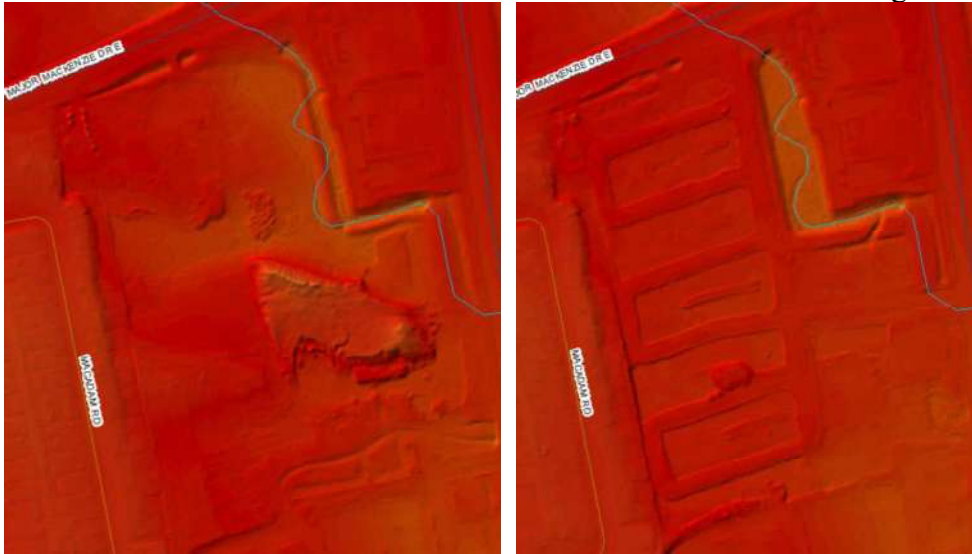


Figure 4 – 2015 (left) and 2019 (Right) LIDAR



Figure 5 – 2015 (left) and 2019 (Right) Aerial Image

- Onepiece Development – 9999 Markham Rd

Similarly, the channel alignment east of Highway 48 was impacted by the Onepiece development at 9999 Markham Road, which resulted in alterations to drainage patterns near and within the creek. **Figure 6** and **7** illustrates the changes to the land in LIDAR and aerial images. In this scenario, additional grading information was obtained in the form of a ground survey dated November 10, 2021. This information was used to supplement the 2015/2019 LIDAR by splicing it with the grading information. This ground survey indicated that a portion of the site (eastern half) was raised compared to the original 2019 LIDAR. The creek re-alignment works also incorporated a more sinusoidal form and wider overall landform.

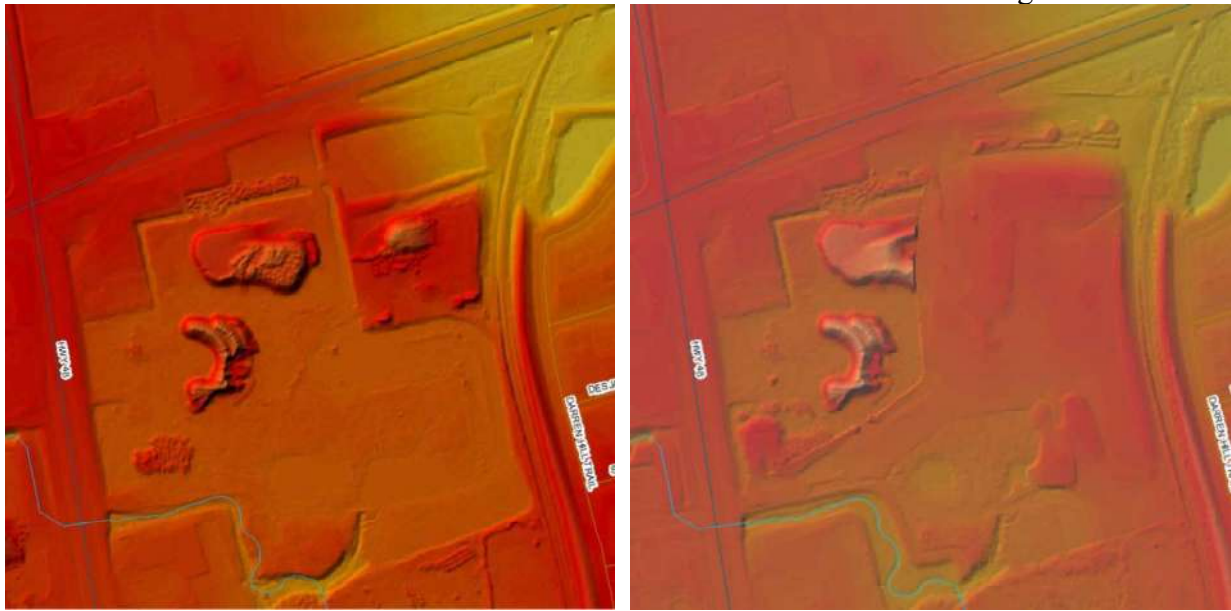


Figure 6 – 2019 (Left) and 2019 Spliced with Grading Plan (Right) LIDAR



Figure 7 – 2015 (Left) and 2021 (Right) Aerial Image

- Joy Station Condo by Liberty – 9781 Markham Rd

The last development area is the Joy Station Condo Development located at 9781 Markham Road. This development is located on the southeast corner of Castlemore Avenue and Highway 48. There is no direct impact to the creek, but the overland flow characteristic has been significantly altered by recent grading work. A grading plan dated February 2020 was spliced into the 2019 LIDAR to update this area (see **Figure 8**). It clearly shows that the property has been raised compared to the original 2019 LIDAR.

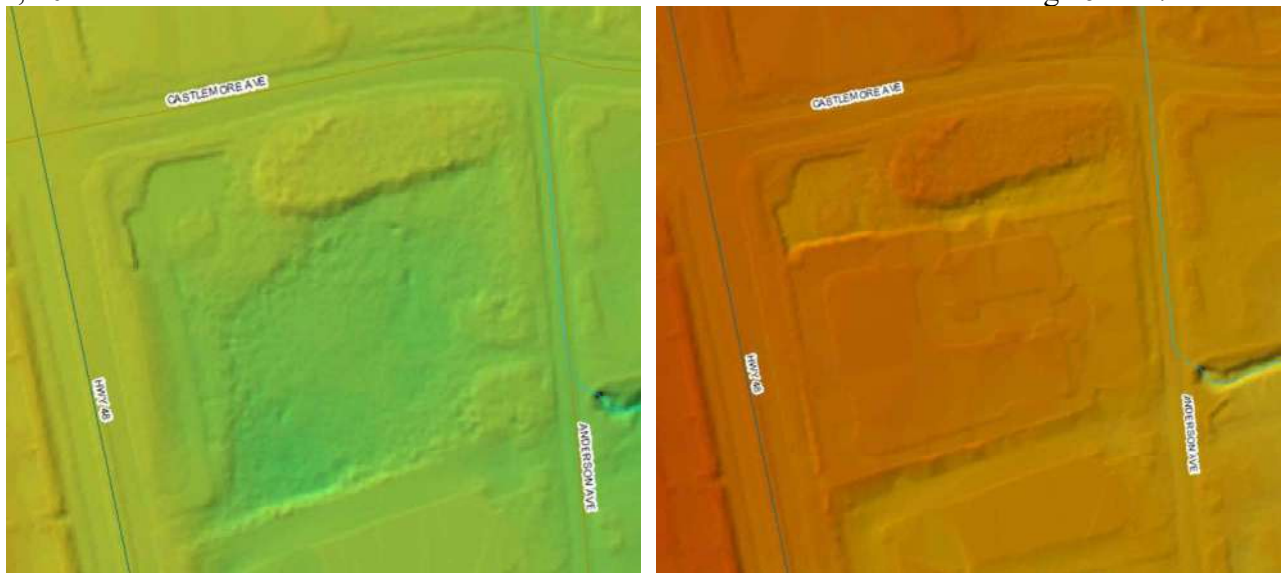


Figure 8 – 2019 (Left) and 2019 Spliced with Grading Plan (Right)

2.2 2015 LIDAR Spliced Areas

There were several areas that were identified to splice 2015 LIDAR data into the 2019 LIDAR base map. These areas are limited to natural cover areas where no changes have occurred since 2015 to avoid using 2019 LIDAR which was obtained during leaf-on period for canopy study purpose. The spliced areas are highlighted in **Figure 9**.

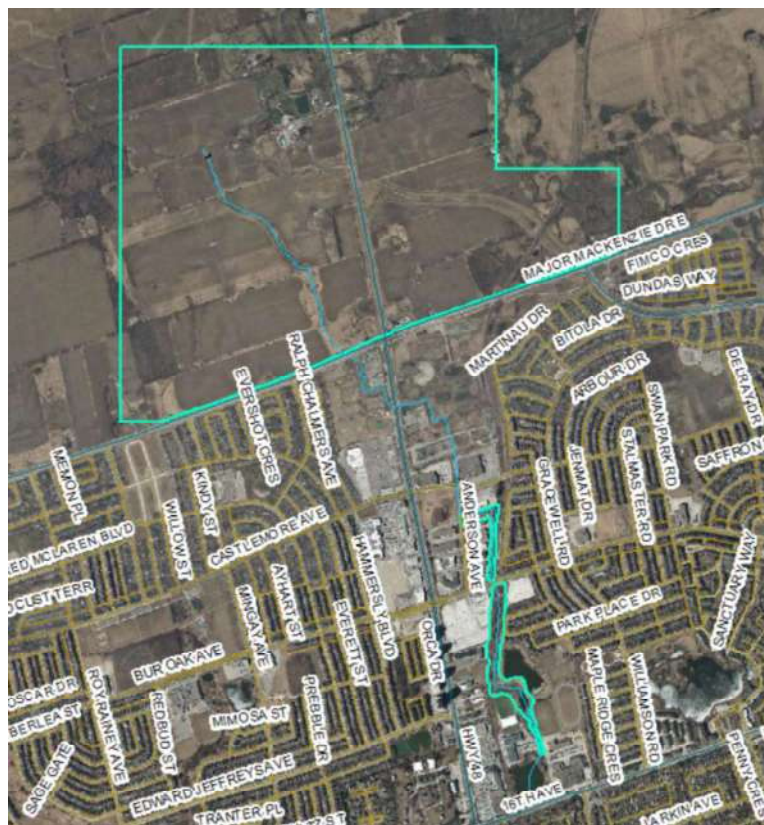


Figure 9 – Areas with 2015 LIDAR Spliced into 2019 LIDAR

2.3 Crossing Confirmation

There are three major crossings within the study area that required site confirmation to supplement the information obtained from the City and the Region. This included:

- Major Mackenzie Crossing, west of Highway 48
 - This was confirmed to be a circular corrugated steel pipe (CSP) that was 1.5 m in diameter (**Figure 10**).



Figure 10 – Crossing Location (Left) and Site Photo (Right)

- Highway 48 Crossing, south of Major Mackenzie
 - 3 m by 1.5 m box concrete culvert at upstream side, two circular CSP with 1.5 m and 1.05 m diameter, respectively at downstream side (**Figure 11** and **Figure 12**)
 - To be conservative, this crossing was coded into the model as two circular CSPs with 1.5m and 1.05m diameter, considering 3 bend losses (for a box culvert) (i.e., 0.818) as per FEMA – Hydraulic Design of Highway Culverts (April 2012)



Figure 11 – Location of Hwy 48 Crossing



Figure 12 – Upstream Face (Left) and Downstream Face (Right)

- Anderson Avenue Long Culvert
 - Two ellipse shaped corrugated steel pipe with 1.5 m span and 0.95 m rise at upstream face, one ellipse shape concrete pipe with 1.7 m span and 1.1 m rise at downstream face (see **Figure 13** and **Figure 14**)
 - To be conservative, this crossing was coded into the model as one ellipse concrete pipe with 1.7 m span and 1.1 m rise, including bend loss for one bend for pipe (i.e., 0.11) as per FEMA (April 2012)



Figure 13 – Location of Hwy 48 Crossing



Figure 14 – Upstream Face (Left) and Downstream Face (Right)



Figure 15 Hwy48/Major Mackenzie 2D Model Domain

3.0 Model Setup

The study area was modelled using the MIKE Flood interface that features the dynamic coupling of the MIKE HYDRO and MIKE 21 hydrodynamic modules. River reaches and all crossings were handled using the 1D MIKE HYDRO modelling routine, with overland surfaces being modelled using the 2D MIKE 21 modelling routine. MIKE Flood integrates these two models into a single dynamically coupled model.

Figure 15 shows the Hwy 48/Major Mackenzie 2D model domain. The downstream boundary was set as a water level that were taken from cross-section 959.45 located on Reach 2 of Exhibition Creek from the HEC-RAS model developed by Wood PLC. as part of the 2019 Rouge River Floodplain Mapping Update Phase II.

3.1 MIKE HYDRO 1D River Model

Only one river reach is modeled using the MIKE HYDRO 1D hydrodynamic (HD) module, i.e., Exhibition Creek with length of 3694.55m which ends at immediately upstream of 16th Avenue at Mt Joy Lake.

Cross-sections were cut in 10-20m spacing from 1-m 2019 LiDAR spliced with 2015 Lidar and only cover the main channel, i.e., upto top of bank as overbank areas were modeled in 2D domain. High density of spacing of cross-sections allows better capturing details of riverbanks where lateral exchange flows with 2D domain occur. In total six (6) crossings were included in 1D model, and 3 crossings were coded as a composite structure. i.e., crossing opening was coded as Culvert structure and road deck was coded as Weir structure.

Figure 16 uses Major Mackenzie crossing to show an example how a crossing is coded in 1D model using

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combination of Culvert structure and Weir structure.

There are 3 crossings coded in a different way, and they are rou_664, rou_705 and rou_706. These 3 crossings all have relative wide road deck or buried long pipes and grading on the road deck may be slopped, under such condition overtopped floodwater may travel away from the crossing and continue its way in multiple directions following the ground surface gradient. The approach of coding this type of crossing is to add a small reach at both upstream and downstream faces of a structure, and on each small reach add a Weir structure to represent the road deck of upstream face and downstream face and then link to 2D model using Standard Link. This approach would allow overtopped floodwater getting onto road deck from upstream face and travelling as per grading on the road deck and may return downstream channel via downstream link. **Figure 17** shows cross-sections and location of structures included in the 1D MIKE HYDRO model.

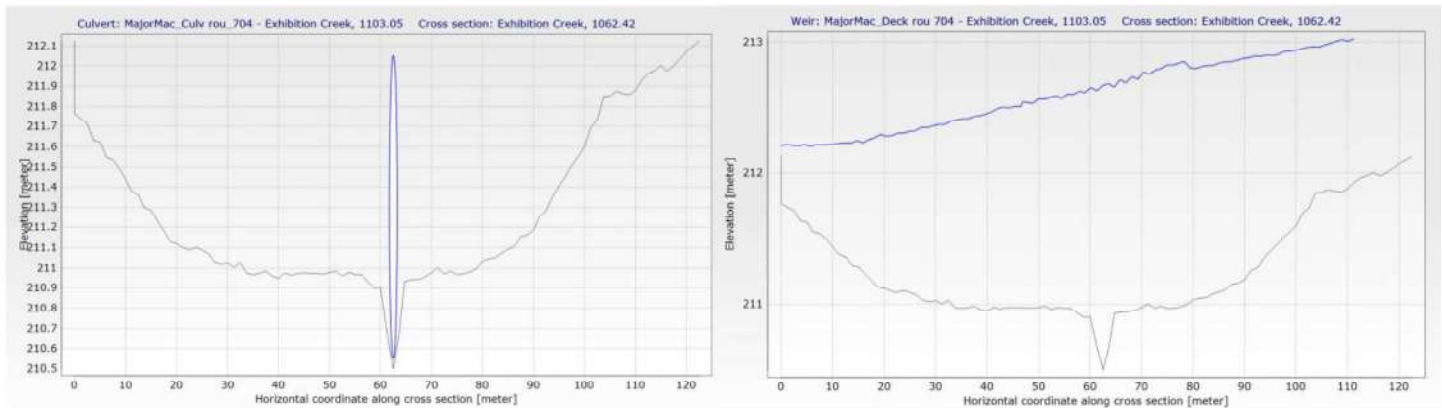


Figure 16 – Example of a composite structure of a Culvert Structure and a Weir Structure

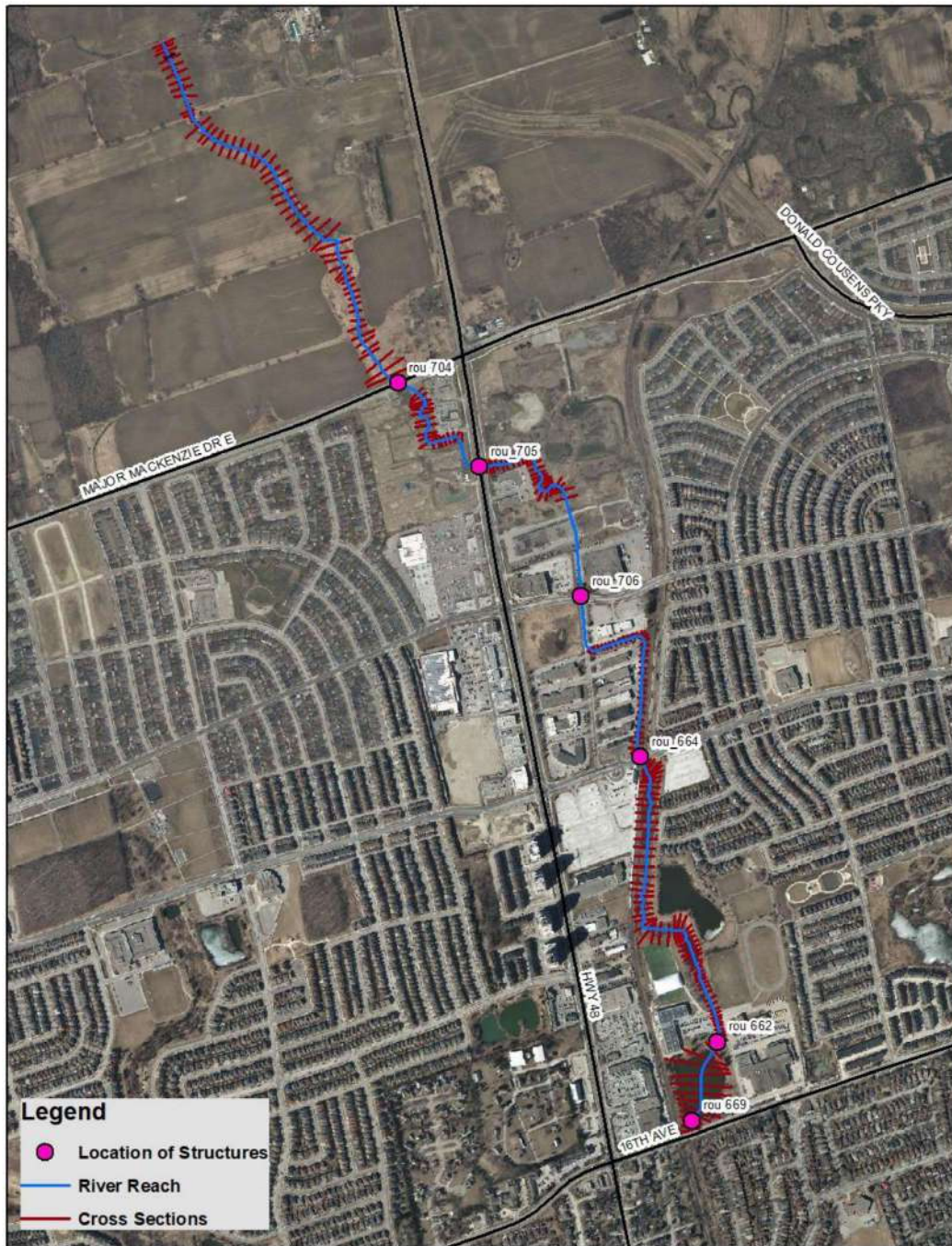


Figure 17 Location of 1D cross-sections and structures

Boundary Condition

All inflows are handled in 1D model, and total inflows were entered at the beginning of Exhibition Creek and incremental flows were entered as a point source along the reach and the steady peak flows were ramped for 1hr and then kept constant for 15hrs (see **Figure 18**). Downstream boundary is a Water Level boundary that was extracted from 2019 Rouge River HEC-RAS model as mentioned above. **Table 1** summarizes boundaries and their types, and **Figure 19** shows the location of flow nodes.

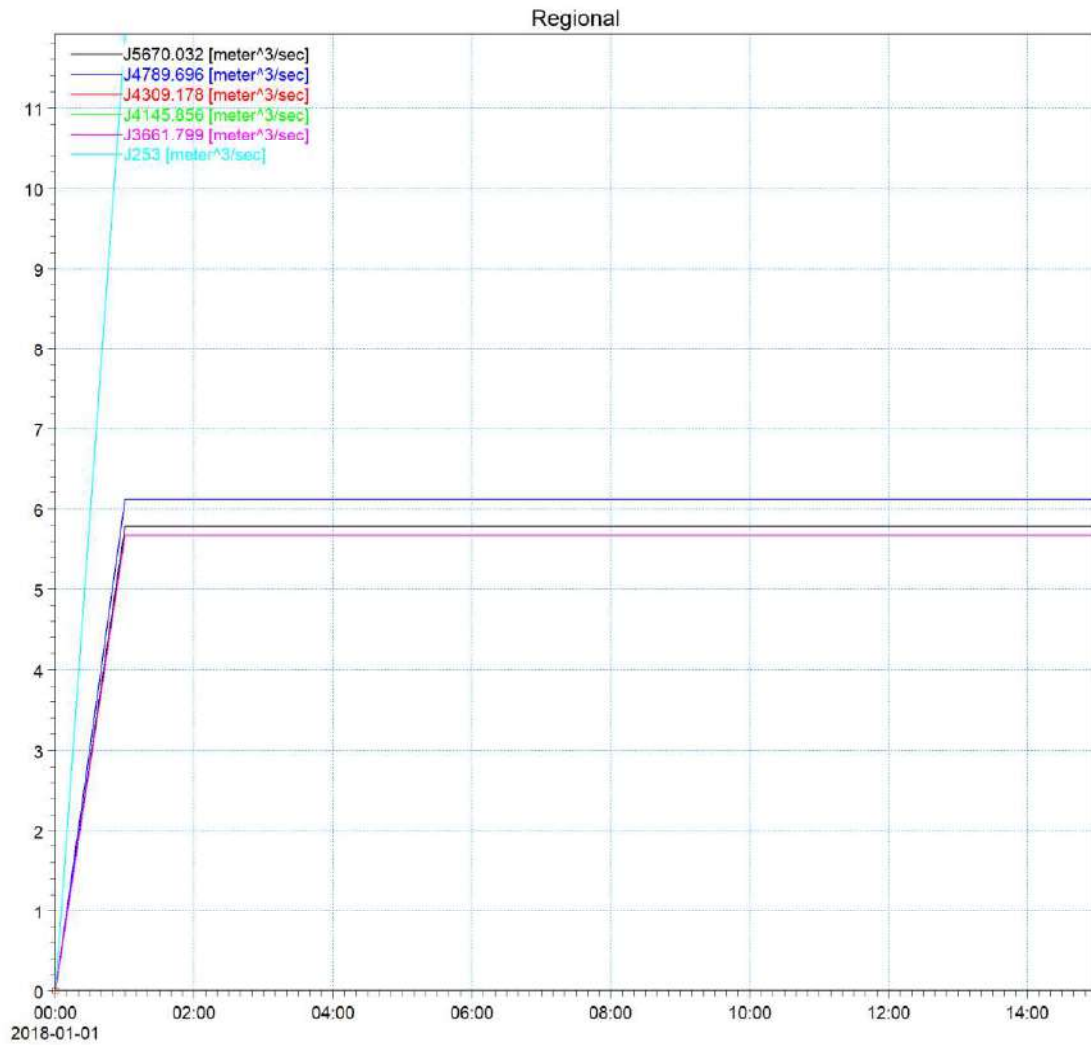


Figure 18 Regional peak flows applied in the 1D MIKE HYDRO model

Table 1 Boundary Conditions in 1D Model

Boundary ID	Flow Nodes	Boundary Type	Branch Name	Chainage (m)
Boundary 1	J5670.032	Total Inflow	Exhibition Creek	0
Boundary 11	J4789.696	Point Source	Exhibition Creek	1260
Boundary 12	J4309.178	Point Source	Exhibition Creek	2259
Boundary 13	J4145.856	Point Source	Exhibition Creek	2730
Boundary 14	J3661.799	Point Source	Exhibition Creek	2874
Boundary 15	J253	Point Source	Exhibition Creek	3443
Boundary 2		Water Level	Exhibition Creek	3694.55

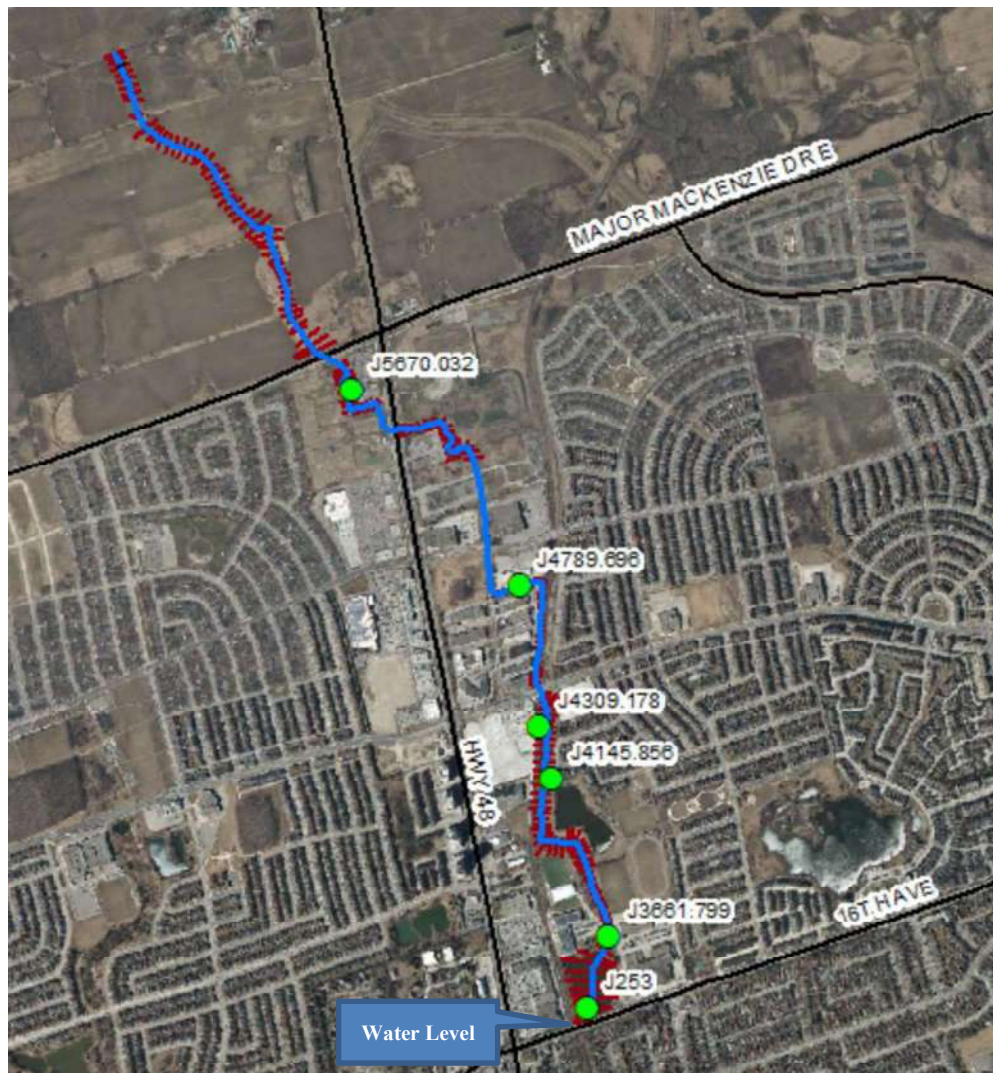


Figure 19 Location of Flow Nodes and Water Level Boundaries

3.2 MIKE 21 2D Overland Model

The overland area was modelled using MIKE 21 Flexible Mesh (FM) HD, which is a fully dynamic modelling system for 2D free-surface flows. The MIKE 21 editors were used to construct and store various basic and hydrodynamic data layers. The following are the main elements of the MIKE 21 model setup:

- Mesh Generation
- Roughness parameters
- Boundary conditions
- Model settings

Mesh Generation

MIKE 21 FM model uses a mesh-based bathymetry for hydrodynamic computations. The details and the desired accuracy of the model results depends on how the mesh has been designed. In addition, the mesh

resolution has a significant impact on the accuracy of the results. A high-resolution mesh is required to retain higher variability of the ground elevation surface. High resolution also required to represent in detail topographic features (such as channels, buildings, paved roads, walkways, retaining walls, flood walls, etc.). As such, the mesh was designed as follows:

- A high-resolution mesh size of 10m^2 was used along the roads as floodwater tends to follow the roads.
- A high-resolution mesh size of 16m^2 was used in the potential flood extent.
- A mesh size of 50m^2 was used in the rest of model area.

The building polygons were excluded from the mesh generation to avoid computational mesh triangulation from occurring within these polygons, and River reaches covered by cross-sections were also excluded from the mesh to avoid double-accounting for the conveyance, and finally 1m LiDAR data was interpolated to each mesh node (see **Figure 20** below).

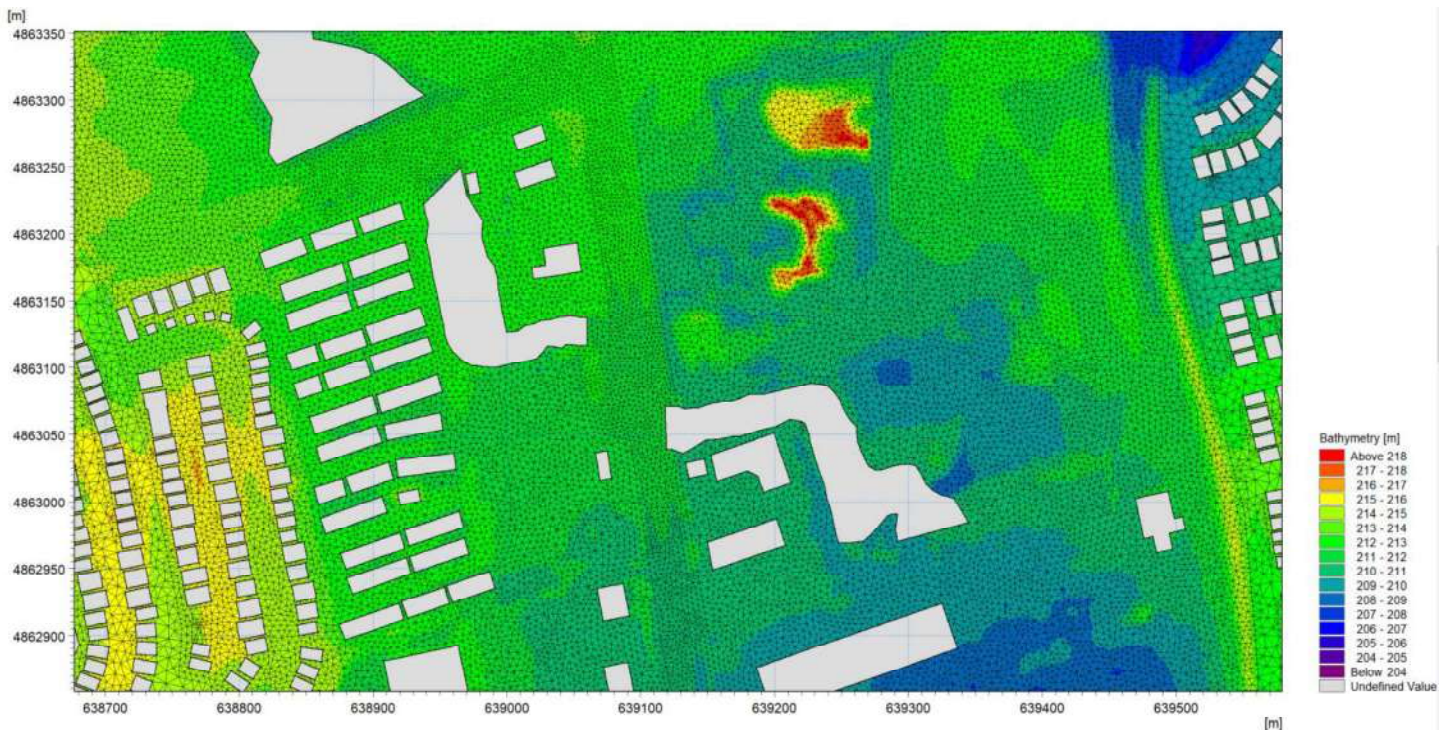


Figure 20 Close view of mesh around Hwy48/Anderson Ave. where major spills occur

Roughness Parameters

MIKE 21 uses roughness parameters for each mesh when completing computations. The land use map (see **Figure 21**) prepared using the TRCA's available land use/land cover information was converted into a MIKE 21 roughness map. In MIKE 21, the roughness was defined in terms of the MIKE system's Manning's resistance number (M), which is the inverse of the Manning's n roughness coefficient value (i.e., $1/n$). The Manning's resistance number (M-value) map was prepared based on the TRCA's standard roughness values; the corresponding Resistance numbers used in MIKE 21 are:

- Natural areas: 0.08 (M = 12.50)
- Roads and large parking areas: 0.025 (M = 40)
- Urban large pervious areas: 0.05 (M = 20)
- Streams/Waterbodies: 0.035 (M = 28.57)

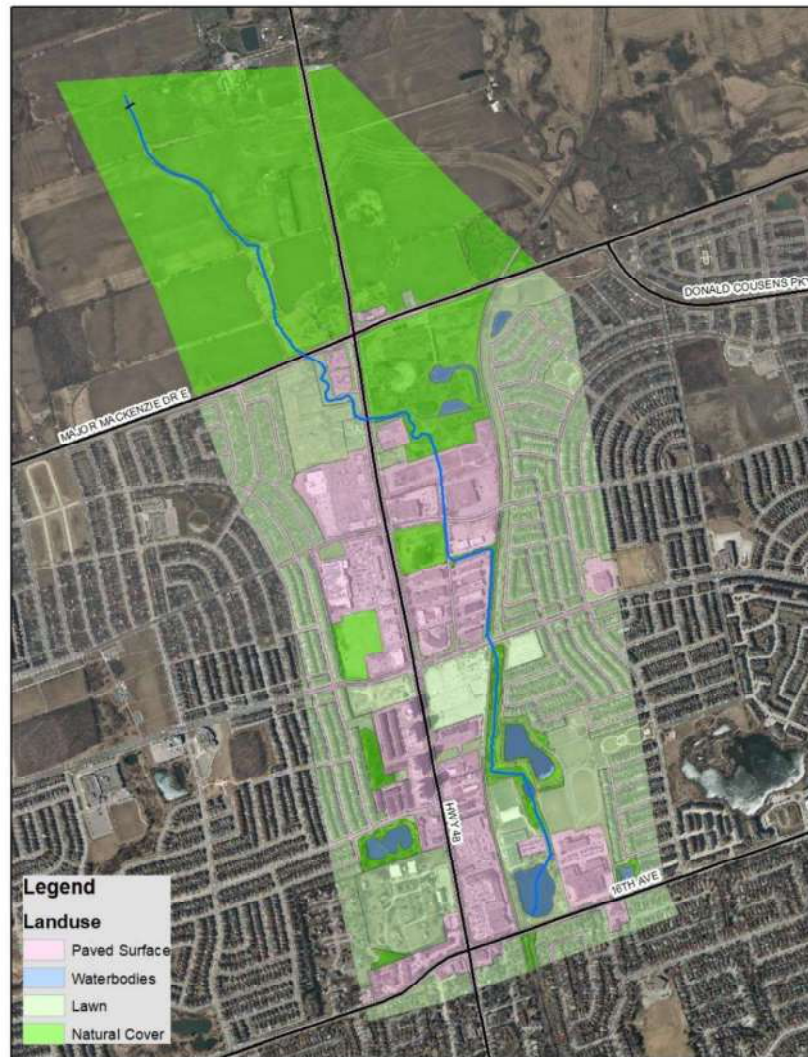


Figure 21 Landuse map in Hwy48/Major Mackenzie spill area

Boundary Conditions

Boundary conditions for the MIKE 21 model define how the flow and water levels will be controlled at the peripheral edges of the 2D model domain defined by the bathymetry limits. Since all inflows were handled in 1D model, there is no inflow boundaries defined in 2D model. Also, the outflow on Exhibition Creek was handled in 1D model using water level boundary and given that the flood condition is all contained in the model domain, so no open boundaries were defined within 2D model domain.

Model Settings

The MIKE 21 FM Flow Model setup contains descriptions of several parameters. The key parameters are simulation period, start and end time, time step interval, flooding and drying depths, output saving duration and saving interval details.

A 15-hour simulation period for both regional and design storms was used for the steady peak inflow hydrograph simulation. The simulation period was entered using an arbitrary start and end date and time with a

specified total number of time steps and time step interval. In this case, the total number of time steps was 108,000 for 2yr to 100yr and regional event with a time step interval of 0.5 seconds.

The drying and flooding depths used were 0.01m and 0.02m, respectively.

The dynamic outputs were saved with time interval of 1200 (i.e., 10min interval).

- The saving output variables were surface elevation, total water depth, U velocity (x-direction), V velocity (y-direction), and current speed.
- The dynamic output file type used was “2D (horizontal)” while the output format was selected as “Area Series” with only real wet areas that ensures the saving of specified information at every computational point.

3.3 1D and 2D Coupled Model

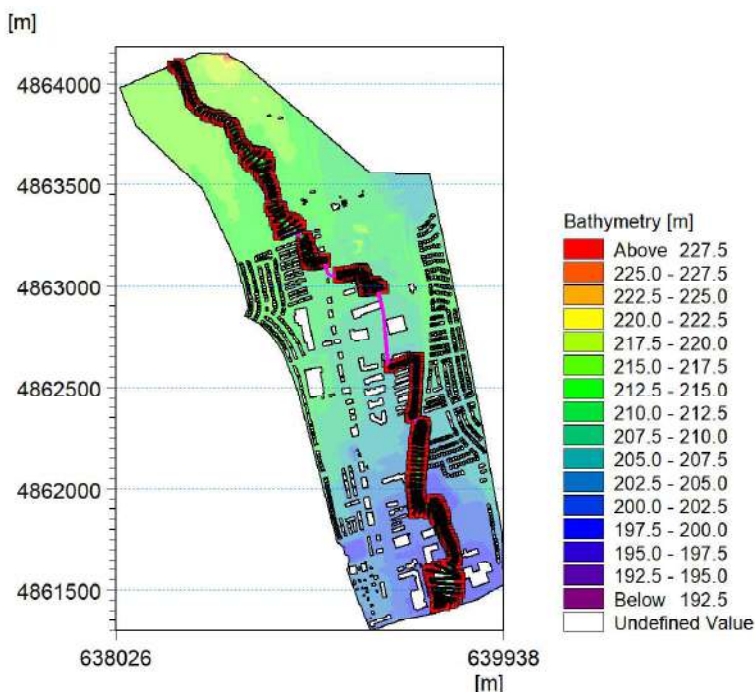


Figure 22 Lateral links used to connect 1D branch to 2D area

The final step for model setup was the integration of the 1D MIKE HYDRO model with the 2D MIKE 21 model using the MIKE Flood model interface. Lateral links were used to connect the branches in the 1D MIKE HYDRO model with the corresponding mesh elements of the 2D MIKE 21 model. A lateral link enables the coupling of the models at the left and right banks of the 1D channel with the 2D area. As mentioned in 1D River Model section, 3 crossings were coded differently using standard link to connect channel via Weir structure to 2D area (i.e. wide road deck), and a standard link would connect channel ends to few 2D elements which allows both flux and momentum transferring between 1D River and 2D Overland domains. This integration in MIKE Flood allows a seamless flow exchange between the 1D branches and the 2D area, thereby enabling the space and time-dependent dynamic simulation of flows as they would physically occur in real-world hydraulic systems.

Figure 22 (on left) shows the bathymetry of 1D and 2D coupled model, where the building areas are represented (blocked white cells) and the lateral link lines between the 1D and 2D models is shown as a series of red lines.

3.4 Model Results

Based on 2D model results, spills occur at three major locations (see **Figure 23**), and details about spill travelling routes for each spill are described as follows:

- **Spill#1: Spill at Major Mackenzie Dr. E**
Spill starts at 25yr storm event, and the regional spill amount is about 3.46m³/s (about 56% of total flow) which is mainly due to under-sized culvert and low point on Major Mackenzie Dr. Majority of the spill would end up into downstream side of channel and only small portion of spill would get into plaza at the south-west corner of Highway48 and Major Mackenzie Dr.

- **Spill#2: Spill at west side of Highway 48 near 9900 Markham Rd**



Spill starts at 25yr storm event, and there are two major spill points: 1) spill first starts at south bank which is mainly due to low point of a swale, and the regional spill amount from this location is about $4.75\text{m}^3/\text{s}$, and 2) spill later starts at north side of box-culvert inlet, and the regional amount is about $1.2\text{m}^3/\text{s}$, and spill amount from these two locations accounts for 58% of total inflow (see left image for two spill locations). Majority of the spills would travel along Highway48 and end up into industrial area on the east side of Highway48 and eventually get back into creek. Only small portion of spill (about $0.27\text{m}^3/\text{s}$) would get into condo area at the south-west corner of Highway48 and Bur Oak Ave. and it would continue its way

southwards and eventually drains into Mont Joy Lake before 16th Ave.

- **Spill#3: Spill at inlet of long buried pipes on Anderson Ave. near south end of 9999 Markham Rd property**

Spill starts at 5yr storm event. The regional spill amount is about $3.25\text{ m}^3/\text{s}$, which would travel southwards into industrial areas along Anderson Ave. and then would join the spill coming from Spill #2 at Bur Oak Ave. and eventually drains into Mont Joy Lake before 16th Ave. This spill is mainly due to undersized buried long pipes.

Figure 24 shows the steady Regional maximum water depth, **Figure 25** shows the steady Regional maximum water surface elevation and **Figure 26** shows the steady Regional maximum velocity.

Total water depth

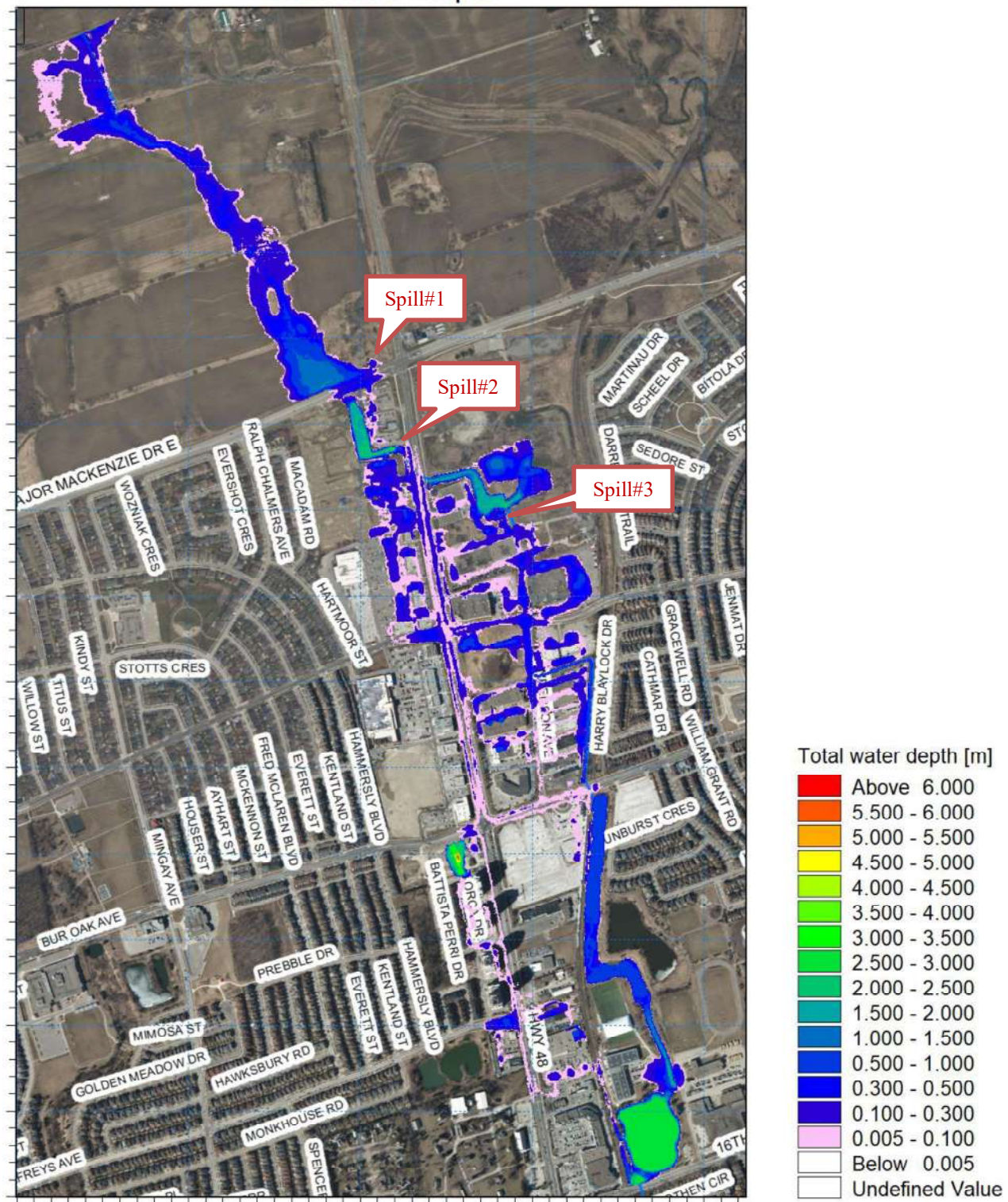


Figure 23 – Spill locations and flood depth

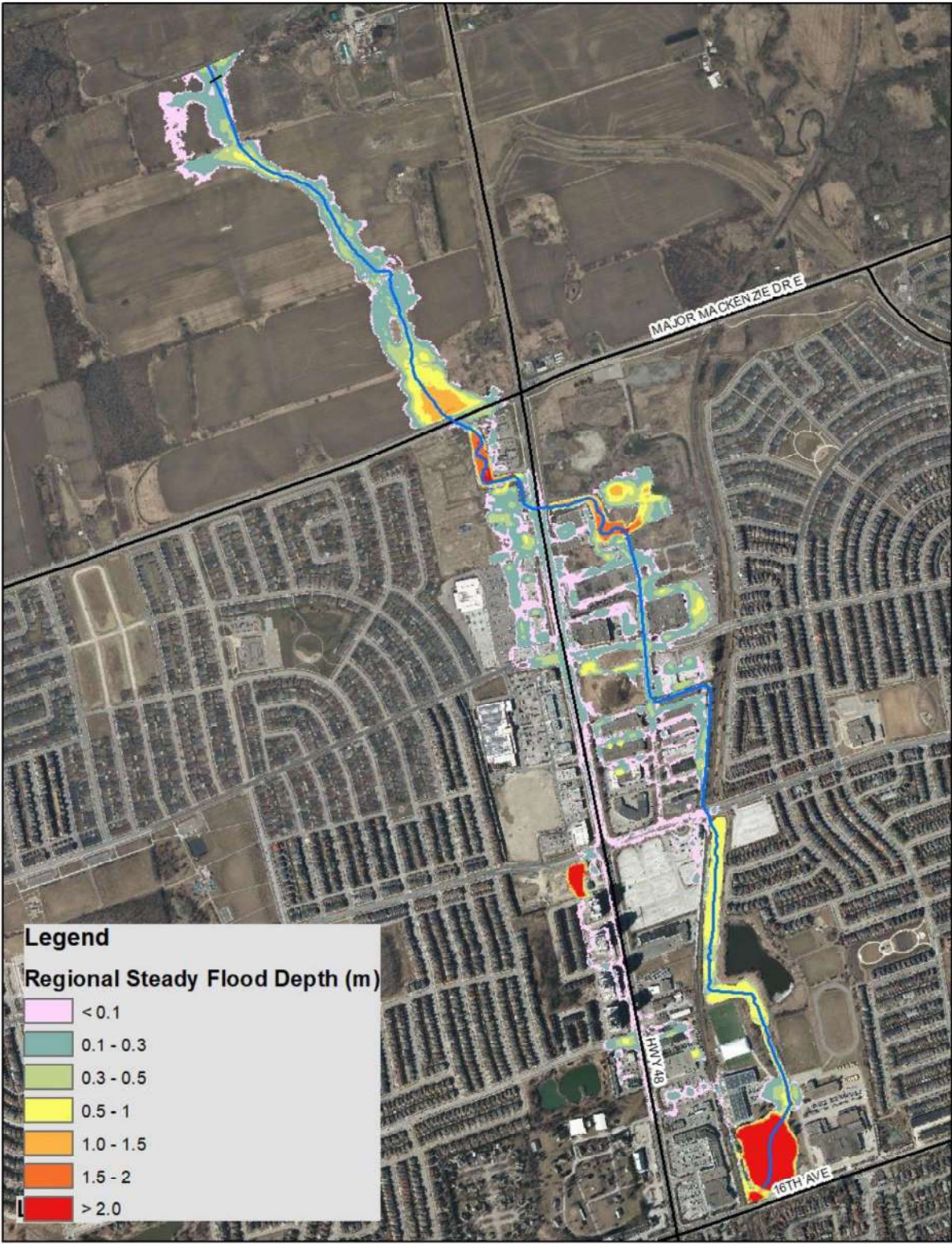


Figure 24 – Steady Regional, maximum water depth

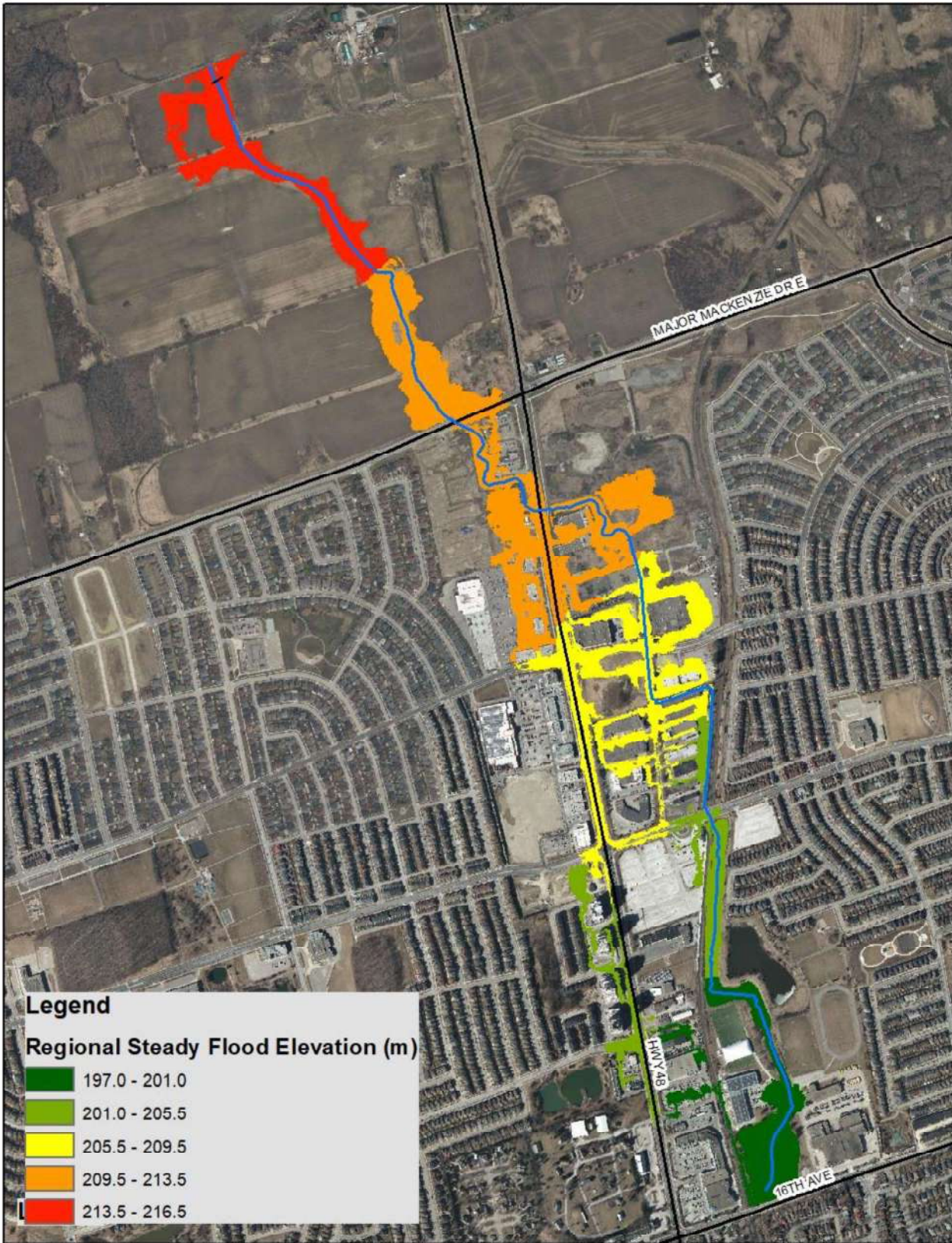


Figure 25 – Steady Regional, maximum water surface elevation



Figure 26 – Steady Regional, maximum velocity

4.0 Flood Risk Mapping

In terms of flood risk analysis, the 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. Based on work completed recently in other SPA's, the TRCA 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 Access/Egress is Available (depth <0.3m),
- **Moderate Risk** – Pedestrian Access/Egress ONLY Available (Product Depth and Velocity <0.37m²/s, Depth <0.8m and Velocity <1.7m/s,
- **High Risk** – Depth-velocity product > 0.37 m²/s or Depth >0.8m or Velocity >1.7m/s.

Figure 27 illustrates the distribution of Low-, Moderate- and High-risk flood areas within the domain; High-risk areas are generally confined to the channel except at six areas that lie in High-risk flood areas.

Figure 28 shows the distribution of Low-, Moderate- and High-risk flood areas north of Major Mackenzie Dr E, and the High-risk flood area lies mainly in the farm field immediately upstream of Major Mackenzie Dr E.

Figure 29 shows the distribution of Low-, Moderate- and High-risk flood areas between Major Mackenzie Dr E and Bur Oak Ave. and most of areas along the major overland flow paths lies in Low – and Moderate - risk flood area. The High – risk areas mostly lie within re-aligned channel as well as the depression adjacent to the realigned channel at the south end of 9999 Markham Rd property.

Figure 30 shows the distribution of Low-, Moderate- and High-risk flood areas between Bur Oak Ave and 16th Ave. and most of areas along the major overland flow paths lies in Low – and Moderate - risk flood area. The High – risk areas mostly lie within the channel/Lake, and the depression in a condo area at south-west corner of Hwy48 and Bur Oak Ave is in the High – risk area but spill amount into this area is very small (less than 1m³/s).

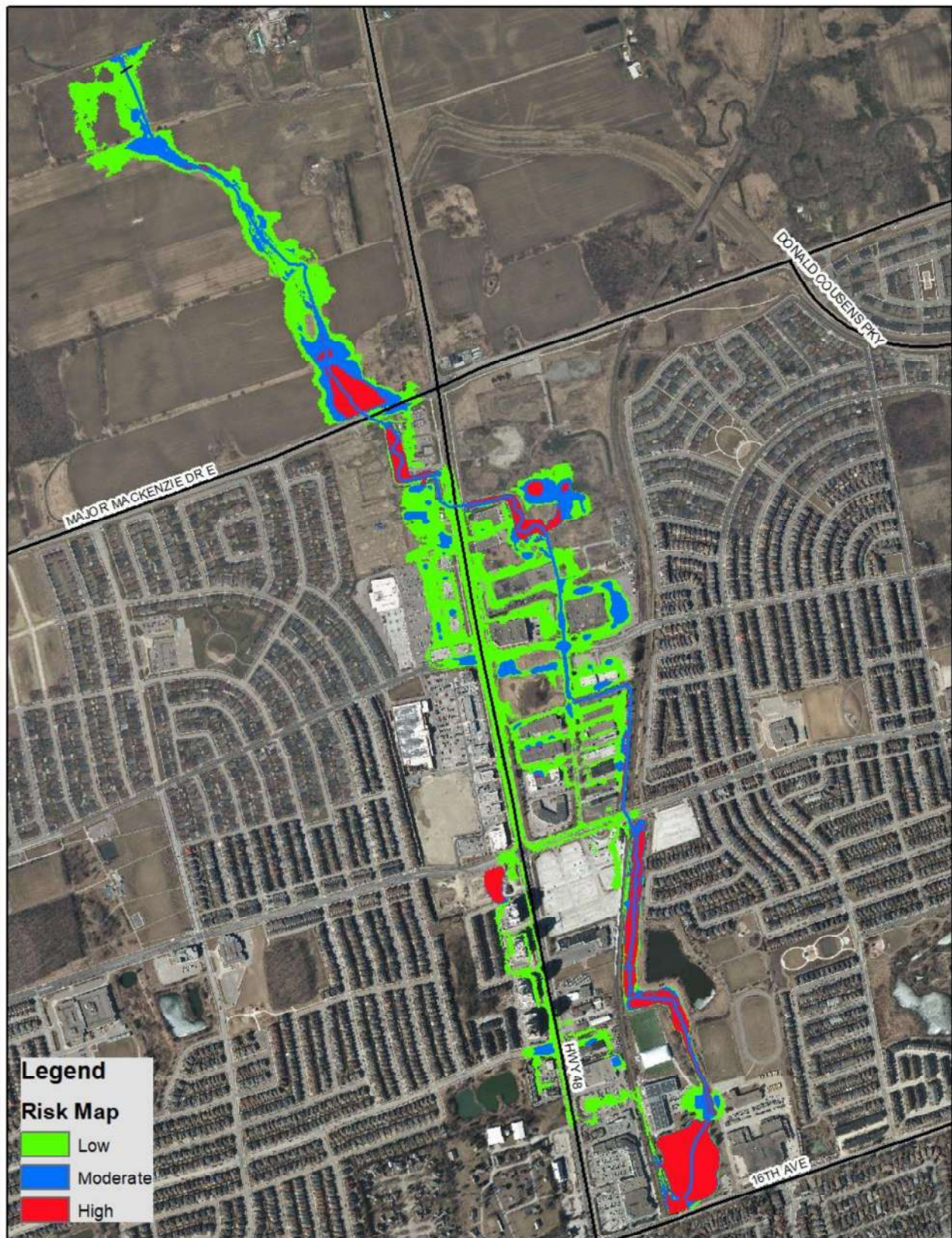


Figure 27 – Distribution of low- moderate- and high-risk flood areas

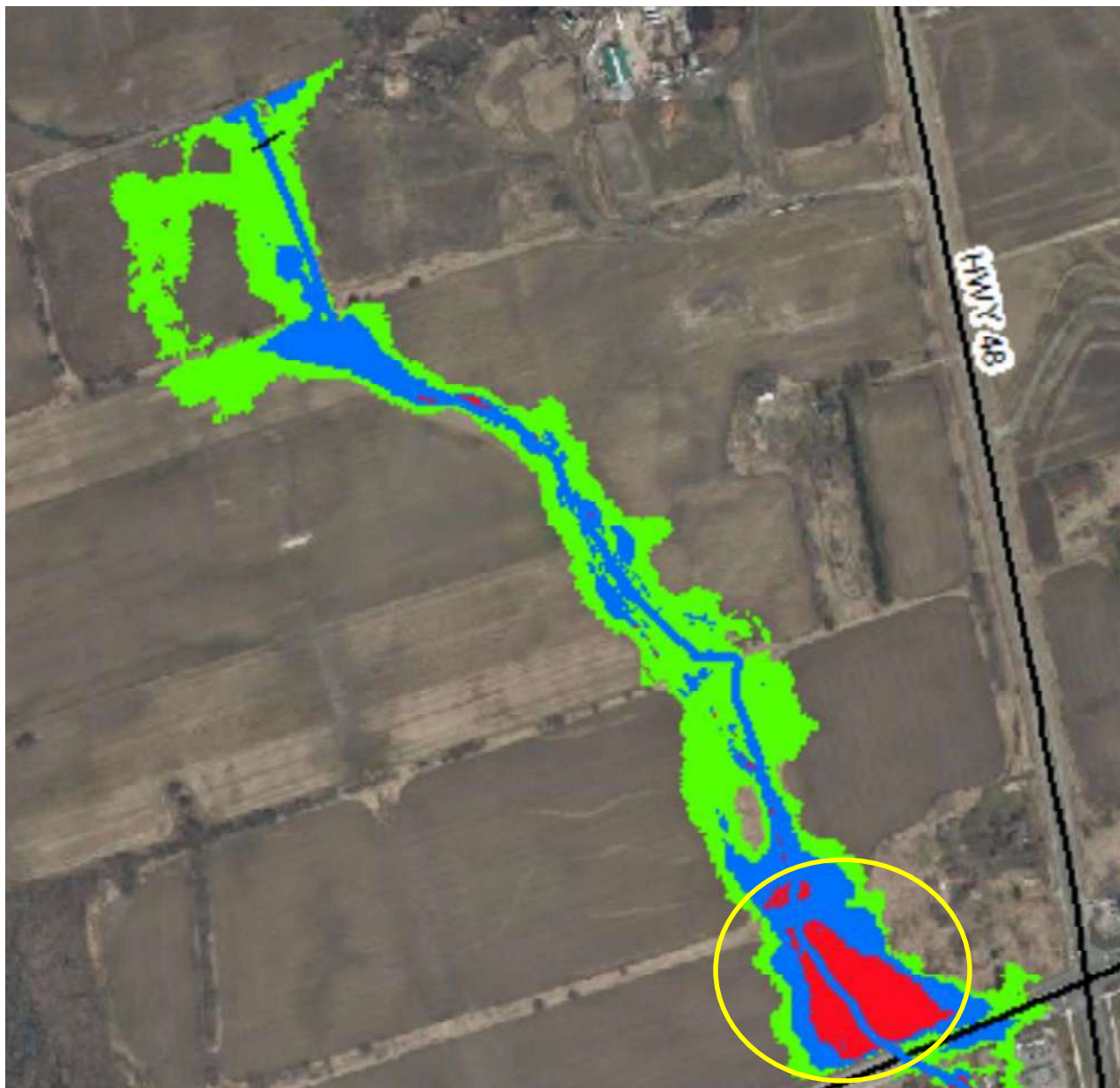


Figure 28 – Distribution of low- moderate- and high-risk areas north of Major Mackenzie Dr.



Figure 29 – Distribution of low- moderate- and high-risk flood areas along Hwy48 north of Bur Oak Ave.

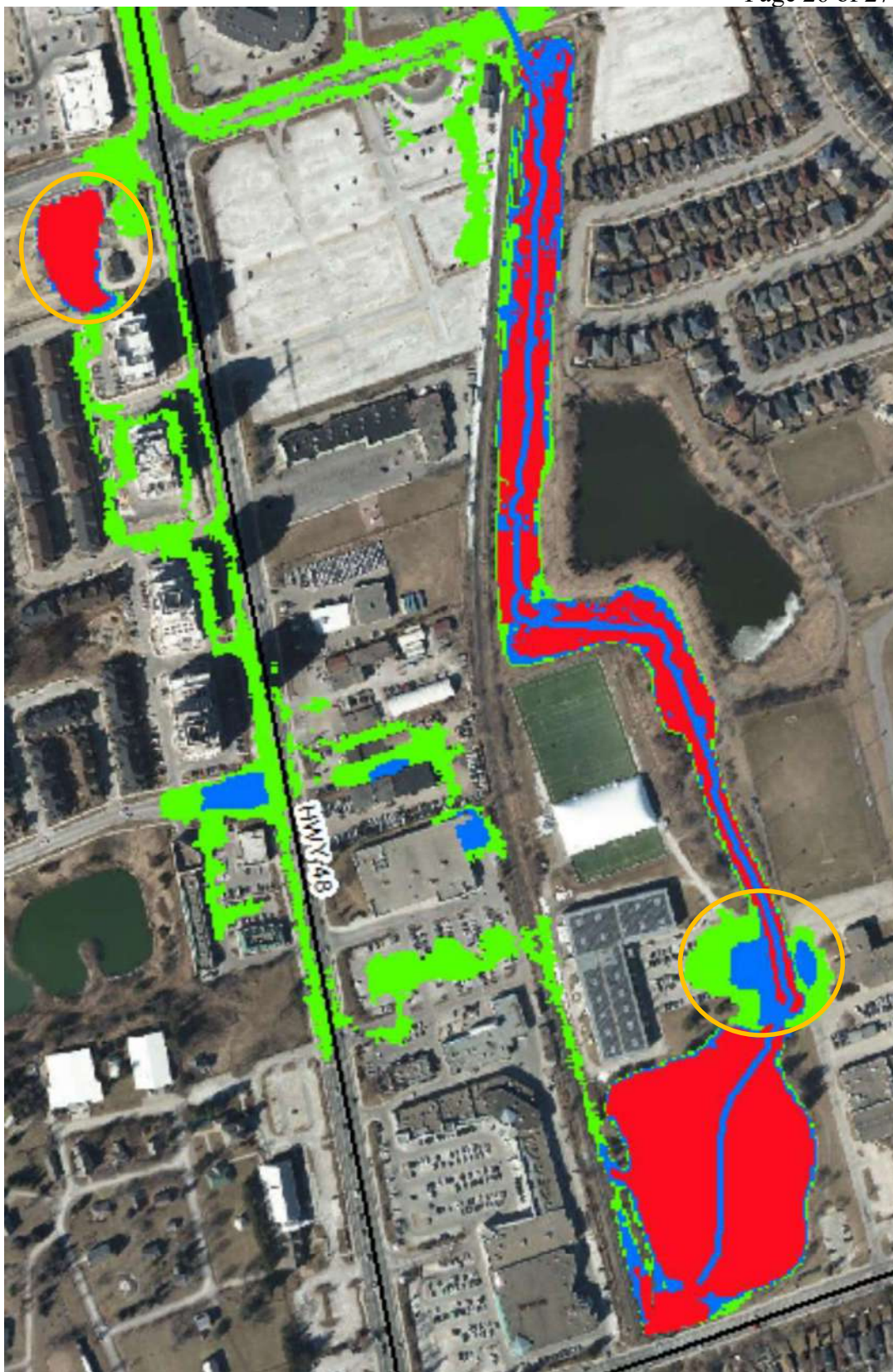


Figure 30 – Distribution of low- moderate- and high-risk flood areas along Hwy 48 south of Bur Oak Ave.

5.0 Conclusions

Three spills at Hwy48 and Major Mackenzie were identified in the previous floodplain mapping update. Among these three spills and based on the topography data, spill at west side of Hwy48 near 9900 Markham Rd and spill at inlet of Anderson Ave. buried long pipes near 9999 Markham Rd would travel long way further south and may get into industrial areas and residential areas. Given this, a 2D model is more appropriate to define the spill and model shallow overland flow. Therefore, a coupled 1D and 2D MIKE Flood model was built that incorporated all crossings, TRCA 1-m 2019 LiDAR data spliced with 2015 Lidar where natural channel are present plus new grading plans in number of newly built and newly approved developments. The results from the coupled model clearly show the extent of the spill and its flow paths. For floodplain mapping purposes, flood depth and flood extent from the coupled MIKE model should be updated for reach section of the Exhibition Creek north of 16th Ave.