Submitted to:

The City of Brampton

2 Wellington Street West
Brampton, Ontario
L6T 5C5

Final Report:

Master Environmental Servicing Plan: Highway 427 Industrial Secondary Plan Area ("Area 47")

submitted by:

Aquafor Beech Limited

09 May, 2016

Aquafor Beech Reference: 64608.1

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1 INTRODUCTION

The 427 Industrial Secondary Plan Area, known as the Secondary Plan "Area 47" lands were originally included within the City of Brampton's urban boundary with the adoption of the current City of Brampton Official Plan in 1993. Since that time, development to the south in Secondary Plan Area 41 and to the west in Secondary Plan Area 26 has continued to proceed in accordance with the planning framework set out by the City's Official Plan. As such, development and related infrastructure has advanced in proximity to the Secondary Plan Area 47.

On December 12, 2005, Brampton City Council approved the Response to Growth – Transition and Implementation Strategy. The approval of the strategy included the adoption of an Official Plan Amendment by Council (OPA93-256) that implemented the City's Growth Management Program. With the adoption of APC93-256, City staff was directed to prepare a Development Allocation Strategy for 2006 and beyond.

On June 16, 2008 a Status Report for the Area 47 Secondary Planning Area was presented to the Planning, Design and Development Committee and subsequently adopted by Council. The Status Report identified a study program to commence for secondary planning for Area 47 in 2008.

The Master Environmental Servicing Plan (MESP) is one of several component studies which have been undertaken in support of the secondary planning process for Area 47. The purpose of the MESP is to investigate and inventory the natural resources which could potentially be impacted by future urban development within the Area 47 Study Area and to identify constraints and opportunities associated with the proposed land use changes. The findings are then used to develop a comprehensive Management Plan, consisting of appropriate stormwater management and natural heritage strategies to protect the natural environmental resources of the study area as future land use changes take place. The study Terms of Reference are provided in the Appendix.

1.1 Study Area

The Area 47 lands are illustrated in **Figure 1.1**. The study area consists of approximately 1,200 hectares in the northeast portion of the City of Brampton, and is generally bounded by Mayfield Road to the North, Castlemore Road to the south, The Gore Road to the west, and Regional Road 50 to the east. The northerly study area boundary abuts the Town of Caledon and the easterly boundary abuts the City of Vaughan. The Area 47 lands lie within portions of the Humber River Watershed.

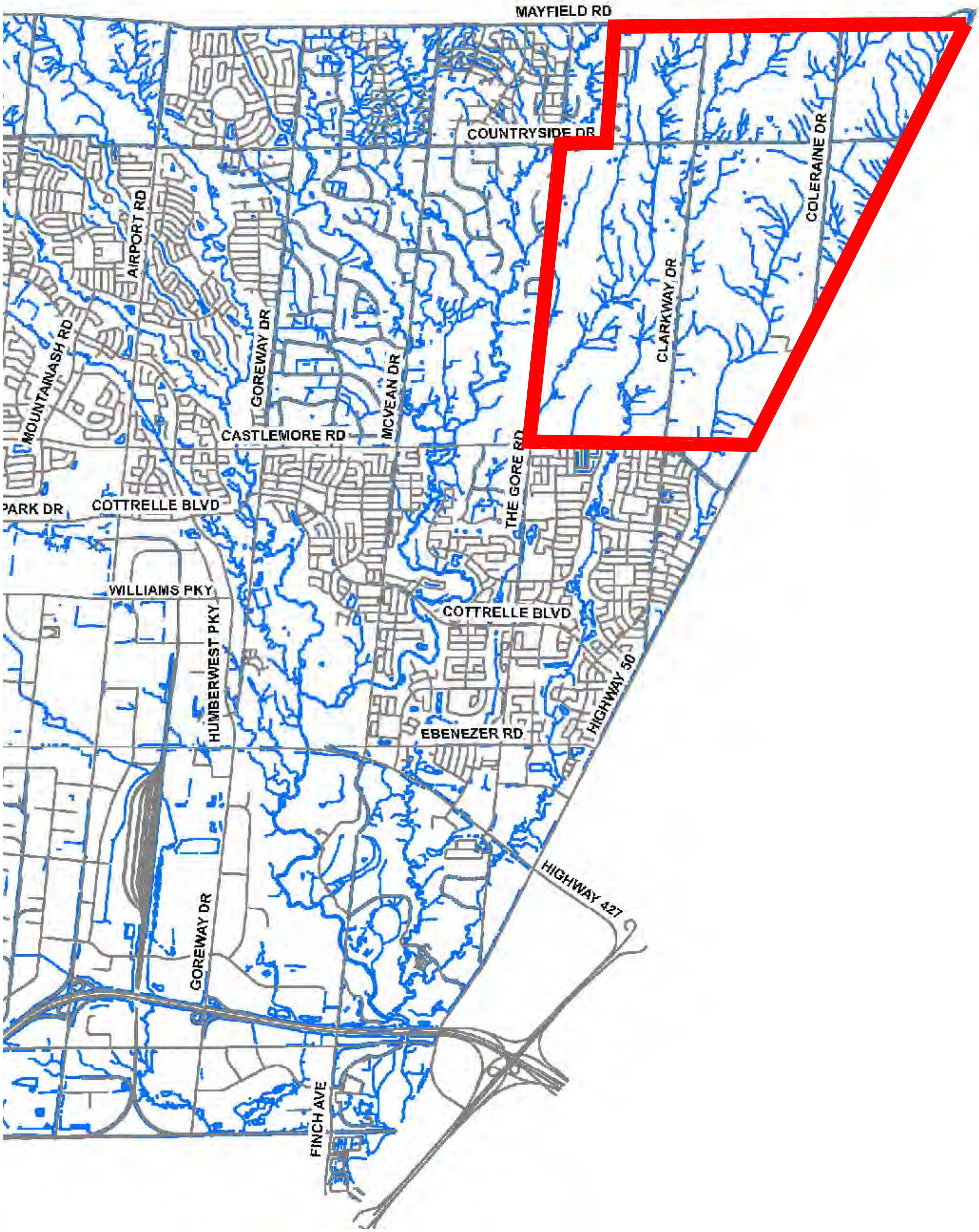


FIGURE 1.1 AREA 47 STUDY AREA

1.2 Land Use

Current Land Use

Current land use within the secondary plan area is primarily agricultural, with a mix of some private residences fronting onto the various roads that define the boundaries of the study area. There are also low density estate residential development areas located to the west of the study area. In addition, there is a small area of industrial development on Cadetta Road along the southeast edge of the study area.

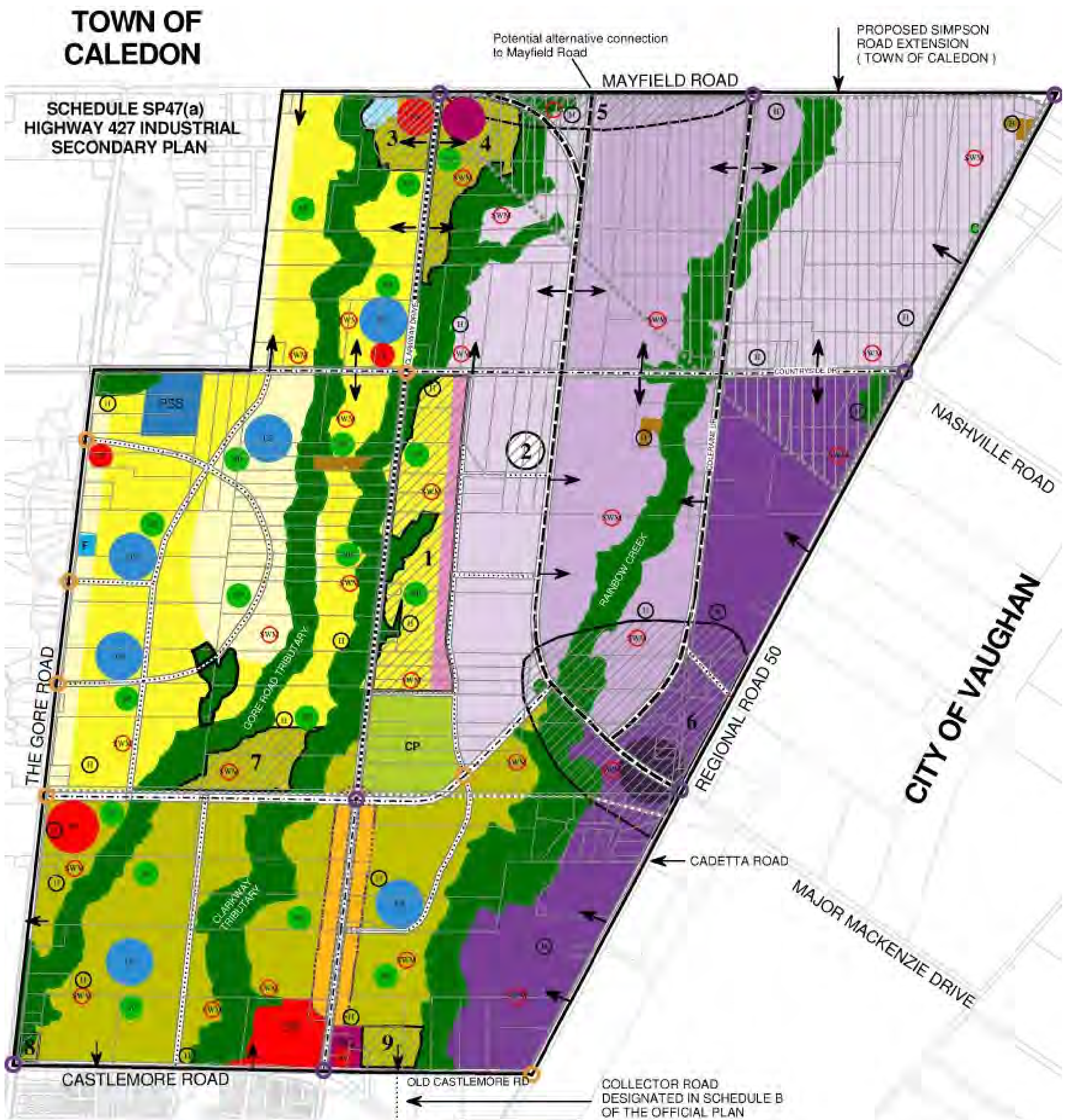
Proposed Land Uses

The city has developed a Proposed Land Use Plan through the various on-going component Secondary Plan Area studies as well as public and agency input. The city's current plan, dated December 2012, is illustrated in **Figure 1.2**.

As shown, the majority of the western half of the site, from The Gore Road to just east of Clarkway Drive, is generally designated for residential land use, including "executive residential", "low density residential" and "low/medium density residential". A variety of Neighbourhood Parks and a Community Park, along with a comprehensive pedestrian trail system, are proposed within this area. In addition, to open space uses, institutional uses which consists of schools, fire stations, and places of worship are also proposed. The majority of the lands to the east of Clarkway Drive are generally designated for employment land use, including "prestige industrial", "business park", and "logistics/warehouse /transportation". The Proposed Land Use Plan also identifies a preliminary network of arterial and collector roads.

The Community Design and Open Space Study (refer to **Figure 1.3**) further illustrates the recreational open space / parkland and identifies a preliminary trail network for the secondary plan area; proposed Multi-use Trails, proposed Multi-use Paths, Cross Valley Connections and Bike Lanes (on road).

It should be noted that the northeast corner of the Area 47 study area is also part of the Preliminary Route Planning Study Area for MTO's on-going GTA West Corridor EA Transportation Development Strategy.



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

RESIDENTIAL
- LOW DENSITY RESIDENTIAL
- LOW/MEDIUM DENSITY RESIDENTIAL
- EXECUTIVE RESIDENTIAL
- CLARKWAY DRIVE MIXED USE (RESIDENTIAL/RETAIL)
- MAIN STREET CHARACTER AREA

EMPLOYMENT
- OFFICE NODE
- LOGISTICS/WAREHOUSE/TRANSPORTATION
- BUSINESS PARK
- PRESTIGE INDUSTRIAL
- SERVICE EMPLOYMENT

COMMERCIAL
- DISTRICT RETAIL
- NEIGHBOURHOOD RETAIL
- CONVENIENCE RETAIL
- HIGHWAY COMMERCIAL
- SERVICE COMMERCIAL

ROAD NETWORK
- MAJOR ARTERIAL ROAD
- MINOR ARTERIAL ROAD
- ROAD ACCESS (POTENTIAL/CONCEPTUAL)
- COLLECTOR ROAD
- MAJOR COLLECTOR ROAD

NATURAL HERITAGE SYSTEM
- SIGNIFICANT WOODLANDS
- VALLEYLAND

RECREATIONAL OPEN SPACE
- COMMUNITY PARK
- NEIGHBOURHOOD PARK

INSTITUTIONAL
- PUBLIC SECONDARY SCHOOL
- CATHOLIC ELEMENTARY SCHOOL
- ELEMENTARY SCHOOL
- FIRE STATION
- PLACE OF WORSHIP

UTILITIES AND INFRASTRUCTURE
- TRANS CANADA PIPELINE
- CORRIDOR PROTECTION AREA

- PRIMARY GATEWAY
- HERITAGE RESOURCE
- SPECIAL POLICY AREA
- SECONDARY GATEWAY
- CEMETERY
- SWM FACILITY
- SPA 47 BOUNDARY

PROPOSED LANDUSES

FIGURE 1.2

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Figure 1.3: Community Design and Open Space

Open Space Network

Note: The final location of trail(s) and their lateral connection points will be assessed and determined through the approval of the Environmental Implementation Report (EIR) as part of the Block Plan process.

1.3 Study Objectives

The purpose of the MESP is to provide environmental and engineering input to the preparation of the Secondary Plan for Area 47. The key objectives of the study are summarized below:

Phase 1: Establish Environmental Conditions

- define existing environmental conditions;
- identify and evaluate the natural features and functions of the study area and their potential interrelationship with other natural features to define a Natural Heritage System; and
- develop constraints and opportunities mapping to identify developable lands, non-developable lands, and lands requiring further study or environmental mitigation before development can occur.

The findings from Phase 1 of the MESP study are presented in **Section 2** of the report.

Phase 2: Potential Future Development Impacts and Recommended Stormwater and Natural Heritage Management Strategies

- identify potential impacts to the natural heritage system (features and functions) from development of the secondary plan area, including stormwater and drainage impacts, and trails;
- formulate a comprehensive set of stormwater/drainage and natural heritage measures to mitigate the predicted impacts and to enhance the environmental resources of the area; and
- outline implementation and monitoring recommendations.

The environmental impacts and recommended management measures are outlined in **Sections 4** to **6** of the report. The collective stormwater management, trail and natural heritage strategies are then compiled into a recommended Master Environmental Servicing Plan to protect the Area 47 natural resources as the future land use changes take place. **Section 7** of the report summarizes the recommended MESP. Implementation and monitoring recommendations are outlined in **Sections 8** and **9**.

1.4 Planning Considerations – Policies and Legislation

Relevant items of legislation and policy that are enforced by municipal and other regulatory agencies to guide development as it relates to the natural environment are reviewed below.

Provincial Policy Statement

The Provincial Policy Statement (PPS) is issued under Section 3 of the Planning Act. The first PPS came into effect in March 2005, and the Province of Ontario updated the PPS in April 2014. The PPS is comprised of various polices on development and land use patterns, resource protection and management, and public health and safety. Generally speaking, the PPS policies serve to guide the formulation of municipal polices and regulations.

Policy 2.1 (Natural Heritage) requires that a development proposal for lands adjacent to natural heritage features "demonstrates that there will be no negative impacts on the natural feature or their ecological functions" for which the area is identified. The seven natural heritage features that need to be considered are:

1. Fish Habitat;
2. Significant habitat of endangered species and threatened species;
3. Significant wetlands;
4. Significant woodlands;
5. Significant valleylands;
6. Significant Wildlife Habitat; and,
7. Areas of Natural Scientific Interest (ANSIs).

The Ontario Ministry of Natural Resources (OMNR) maintains an active role in the management of both wetlands and fish communities throughout the province. OMNR continues to comment on proposals in the context of effects on fisheries community management and fish habitat as defined under the Lakes and Rivers Improvement Act (LRIA) approval process. However, recent changes to the act have been enacted such that approvals under certain sections of the Act are not required where a similar approval by a Conservation Authority is required. MNR is also responsible for protecting and managing endangered, threatened and other special status species and their habitats under the Endangered Species Act.

Policy 2.2 (water) directs planning authorities to "protect, improve or restore the quality and quantity of water" through the various practices. They are encouraged to use the watershed as the basis for planning and to identity features and functions within the watershed that are integral to the ecological and hydrological function of the watershed. Additionally, they are directed to minimize potential negative impacts that occur as cross-jurisdictional or cross-watershed boundaries and maintain linkages and functions among surface water, groundwater, hydrologic functions and natural heritage features and areas. They are also directed to implement the necessary restrictions on development and site alterations to protect, improve or restore designated vulnerable areas, vulnerable and sensitive surface and groundwater features and municipal drinking water supplies.

Planning authorities also promote the efficient and sustainable use of water resources in addition to ensuring that stormwater management practices minimize stormwater volumes and contaminant loads while maintaining or increasing the extent of vegetative and pervious surfaces.

Policy 3.1 (Natural Hazards) provides protection from unacceptable risk to public health, safety and/or property damage in areas of natural or human-made hazards. The PPS makes the following recommendations for development in relation to Natural Hazards:

1. Development shall generally be directed to areas outside of lands impacted by flooding and/or erosion hazards.
2. Development shall only be permitted within areas rendered inaccessible during flood and erosion hazards if appropriate safe access is demonstrated.

Development may be permitted in the flood fringe subject to appropriate flood proofing or another approved flood hazard standard.

Region of Peel

Section 2.3 of Peel Region's Official Plan (1996) outlines criteria used to define its Greenlands System, which is built of Core Areas, Natural Areas and Corridors, and Potential Natural Areas and Corridors. Elements of the Greenlands System include wetlands, woodlands, environmentally sensitive or significant areas, areas of natural and scientific interest, habitats of vulnerable, threatened and endangered species, valley and stream corridors, shorelines, natural corridors, and fish and wildlife habitats.

Section 2.4 of the Official Plan addresses the policies associated with natural hazards. Two key subsections within this section address Ravine, Valley and Stream Corridors (Section 2.4.3) and Riverine Floodplains (Section 2.4.4) respectively. Collectively, these policies commit the Region to work together with area municipalities and conservation authorities to achieve the following two objectives:

1. To prevent or minimize the risk to human life and property associated with flooding and/or slope instability: and,
2. To ensure the development and site alteration do not create new or aggravate existing Floodplain management problems along flood susceptible riverine environments.

Section 3.4 of the Official Plan addresses all water resources within the Region, including aquifers, streams, ponds, wetlands and lakes. Region Policy dictates that appropriate studies be undertaken to the satisfaction of the Region, area municipalities and conservation authorities for all planning initiatives that may have an immediate or cumulative impact on water resources and the related natural system.

City of Brampton

The City of Brampton Official Plan (OP 2006) was adopted by City Council on October 11, 2006. The OP depicts Land Use Designations on Schedule "A". The Area 47 lands are a mixture of Residential, Industrial, Estate Residential and Open Space designations. Both the Residential and Estate Residential areas are located on the westerly part of the secondary plan area while the Industrial area is situated on the north eastern portion. Most of the areas designated Open Space are associated with the various valley and watercourse corridors that cross the secondary plan area, including a tableland woodland that connects the Gore Road and Clarkway Tributary corridors. Schedule "A" also shows a portion of the secondary plan area as Corridor Protection Area, which is defined as lands protected for the potential accommodation of the Highway 427 extension and associated arterial road network.

Section 4.6 of the Official Plan addresses Natural Heritage and Environmental Management, and provides objectives and policies with regard to natural heritage system planning, natural area protection, environmental management, ground and surface water, buffers and stormwater management. Applicable policies of the OP that direct Area 47 include:

- Preparation of studies (Sec. 4.6.2) that includes refinement of Schedule D;
- Stormwater management (Sec. 4.6.3);
- Natural heritage system planning including linkages (Sec. 4.6.6) including Restoration Areas (4.6.6.15) that identify "no net loss and if possible a potential net gain in natural areas and features";
- No development and site alteration within valley and watercourse corridors, including hazard lands (Sec. 4.6.7);
- Natural Hazards (Sec. 4.6.7 and 4.6.15.5);
- Woodlands (Sec. 4.6.8), Wetlands (Sec. 4.6.9), Fish and Wildlife Habitat (Sec. 4.6.10)
- Environmental Buffers (Sec. 4.6.13)
- Trails (Sec. 4.5.6) – vital component of City's open space system, and designed to protect natural heritage system features, functions and linkages as well as pen space linkages.

In addition, Brampton's Woodlot Conservation By-law (316-2012) is referenced to identify all woodlots existing in the study area.

Schedule "D" of the OP depicts the Natural Heritage Features and Areas within the City of Brampton. Valley/Watercourse Corridors including many of the headwater drainage features and three small woodlands are designated by this schedule for Area 47 lands. Two of the woodlands are within the floodplains of the West Humber River and the Gore Road Tributary and one woodland feature links the Gore Road Tributary with the Clarkway Tributary just south of Countryside Drive and west of Clarkway Drive.

Toronto and Region Conservation Authority

The TRCA conducts reviews of planning processes associated with future development of properties which are located within its jurisdictional boundaries. The TRCA has developed Terms of Reference for the preparation of MESPs and this document was used as a partial guideline in the preparation of this MESP Report.

The TRCA is also responsible for administering the Development, Interference with Wetlands, Alterations to Shorelines and Watercourses Permit process, as per Regulation 166/06. This regulation falls under Ontario Regulation 97/04, which is also called the Generic Regulation (adopted May 2006). The Generic Regulation defines the areas of interest that allow Conservation Authorities to:

- Prohibit, regulate, or provide permission for straightening , changing, diverting or interfering in any way with the existing channel of a river, creek, stream, watercourse or changing or interfering with a wetland; and, Prohibit, regulate, or provide permission for development of the control of flooding, erosion, dynamic beaches, pollution or the conservation of land may be affected by the development.

The TRCA's Valley and Stream Corridor Management Program policies require that the precise limits of valley and stream corridors be established through the Block Plan process, and be legally defined through Plans of Subdivision and zoning by-laws. No buildings or structures are permitted within valley lands, except where structures are intended for flood and erosion control purposes.

Lastly, the TRCA'S Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines (Updated March 2009) were used to identify and classify headwater drainage features in the study area. Those features that are considered Features classified as “protection” or “conservation” will be maintained.

Endangered Species Act

The protection of species at risk (SAR) in Ontario is dictated primarily by the Endangered Species Act (ESA). The ESA protects both the species and its habitat. There are two types of habitat protection: general (Section 2(1)(b) of the ESA) and regulated (Section 2 (1)(a) of the ESA). Once a species is listed as Endangered or Threatened, a regulation specifying a species' habitat must be developed by the second anniversary (Endangered) or third anniversary (Threatened) of the date the species is officially listed. Before the habitat regulation has been devised, a general definition of habitat is employed and defined as:

> *"[A]n area on which the species depends, directly or indirectly, to carry on its life processes, including life processes such as reproduction, rearing, hibernation, migration or feeding."*

The general habitat regulation applies until a species-specific habitat regulation is created. Any activity that constitutes harm to an Endangered or Threatened species or damages its habitat must receive approval from the Ontario Ministry of Natural Resources and Forests (MNRF) under section 17(2)(c) of the ESA. In order to obtain a 17(2)(c) authorization proponents must demonstrate how an overall net benefit for the species will be attained, which often involves rehabilitation or restoration activities. Information on Endangered and Threatened species found within the Area 47 SPA is contained within Section 3.8.3.

Federal Fisheries Act

The Federal Fisheries Act is the key piece of legislation governing the protection of fisheries and aquatic habitat, including the any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery (Section 35). Proposed developments in and around fish habitat have the potential to result in a serious harm to fish and fish habitat. In these instances the proponent of the development is responsible for conducting a Self-Assessment, using criteria to determine if the project requires review by DFO. If review is deemed necessary, a Request for Review is submitted to DFO. If DFO decides that the project requires authorization under the Fisheries Act (usually only if the project cannot avoid or mitigate serious harm to fish), an application for project authorization must be submitted. The overall intent of the DFO is to achieve avoid, mitigate or offset harm to fish and fish habitat. In addition, DFO also administers portions of the Species At Risk Act that governs the protection and treatment of the habitats of endangered and threatened species.

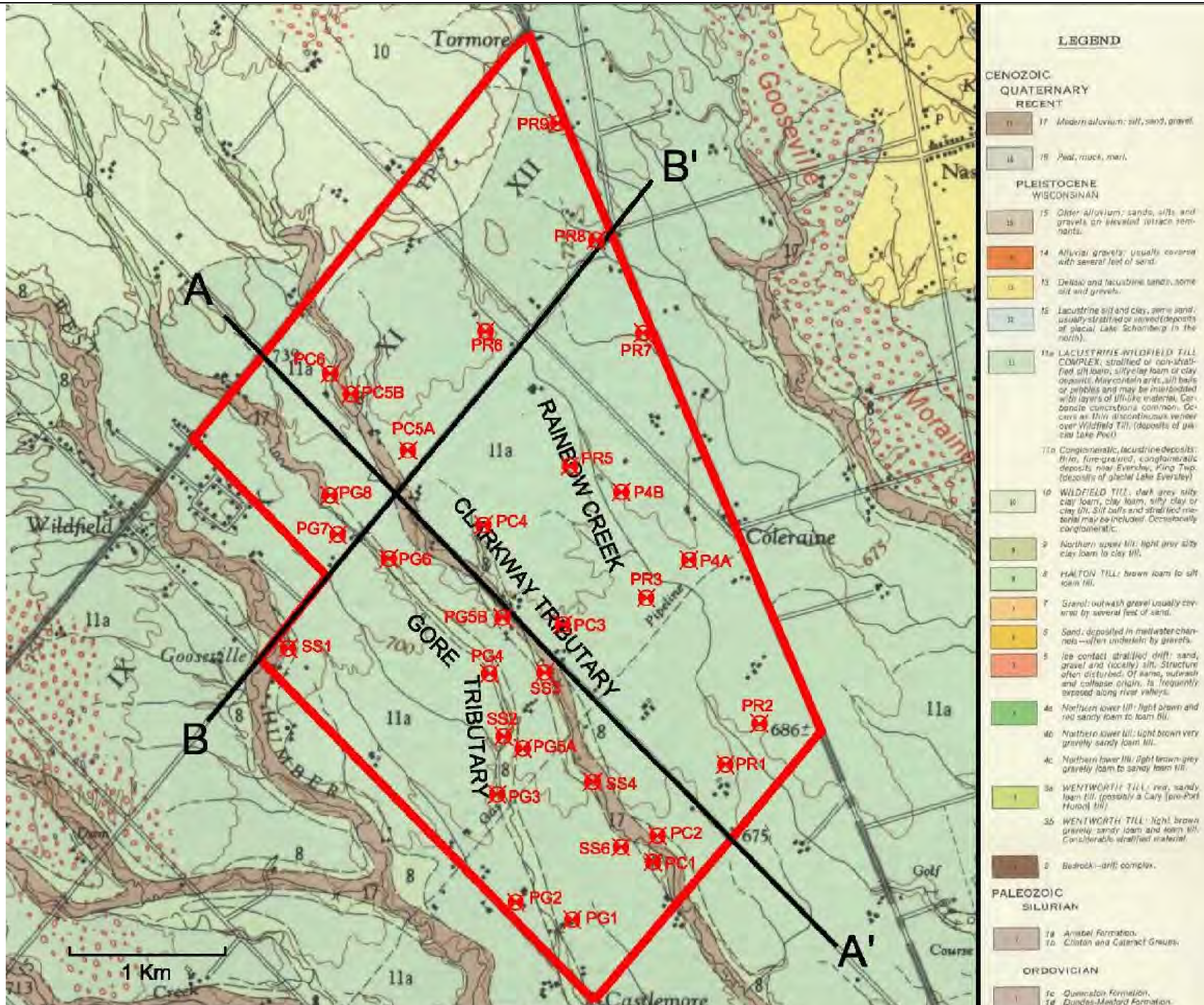
2 EXISTING ENVIRONMENTAL CONDITIONS

2.1 Groundwater Resources

2.1.1 Physiography and Surface Geology

The Area 47 study area is situated on the South Slope and Peel Plain physiographic regions, south of the Oak Ridge Moraine. The geology of Area 47 (Figure 2.1) consists of a veneer of clay-rich lake sediment (Peel Clay and Wildfield Lacustrine-Till Complex) overlying the Halton Till (White, 1975). The soils (Figure 2.2) are dominated by imperfectly drained stone-free clays of the Peel Series (Hoffman and Richards, 1953). The overburden thickness ranges from 5 metres at the north extremity (at Mayfield Road) to more than 25 metres in the central and southern part of the site.

The Halton Till consists mainly of silty sand, with variable proportions of sand (10-55%) and minor clay (White, 1975), attaining a thicknesses of up to 20 metres and often exposed along incised stream corridors. In these exposed floodplain areas, the Halton Till is composed of 50% silt and equal proportions of sand and clay (White, 1975).



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

CROSS SECTION

AME GEOTECHNICAL BOREHOLE (2012)

Source: Quaternary Geology of the Bolton Area, Ontario, Ontario Division of Mines, Report 117, 1975

N

SCALE: 1:25,000

QUATERNARY GEOLOGY AND CROSS SECTION LOCATIONS

FIGURE 2.1

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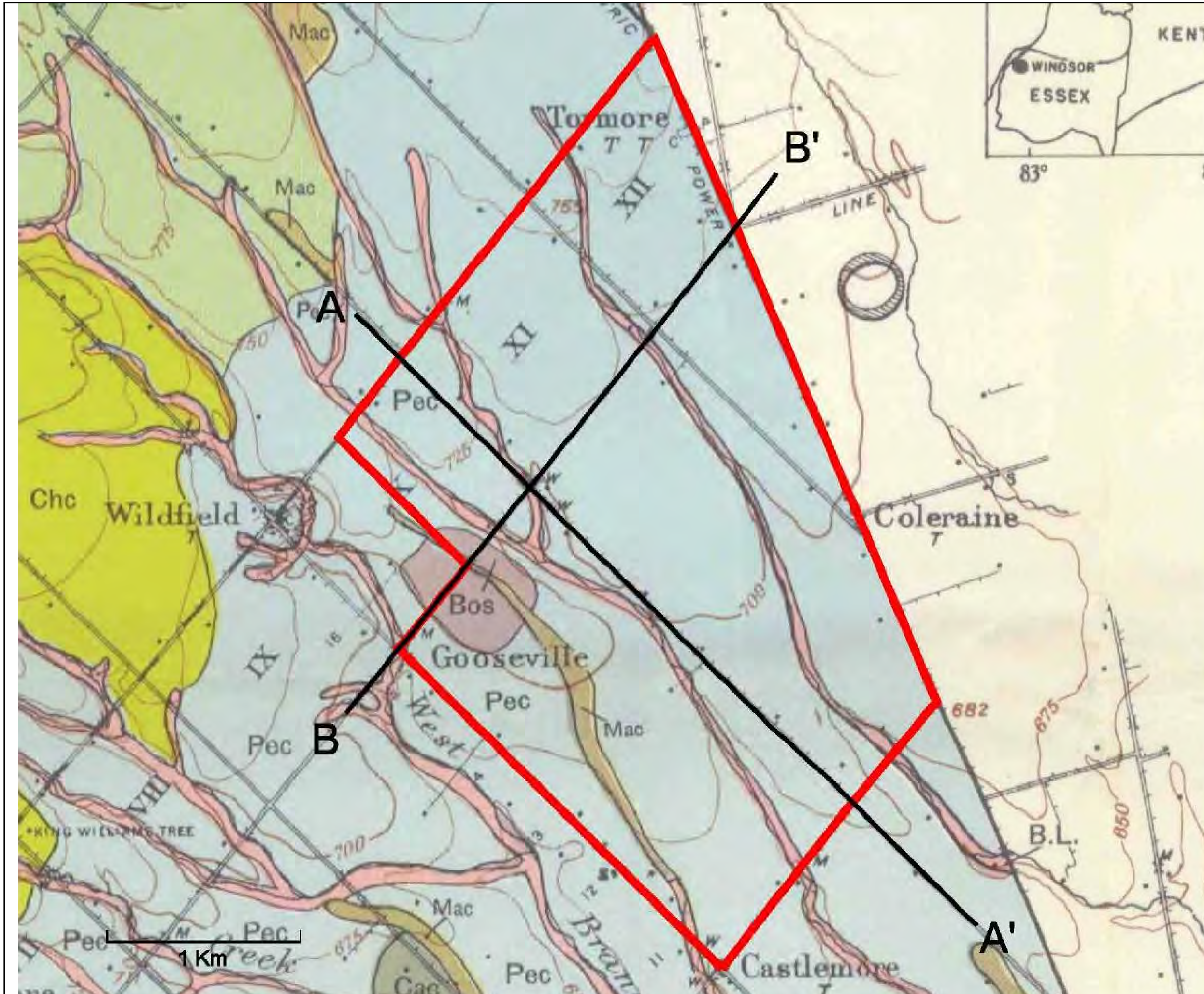

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

SOILS:	DRAINAGE:
PEEL CLAY TIL	IMPERFECT
MALTON CLAY TIL	POOR
CASHEL CLAY TILL	GOOD
CHINGUACOUSY LOAM	IMPERFECT
BOTTOM LAND	

Source: Report No. 18 - Soil Survey of Peel County, OMAFRA, 1953

N

SCALE: 1:25,000

SOILS

FIGURE 2.2

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2.1.2 Hydrogeologic Investigations and Monitoring

The hydrogeology of Area 47 was compiled and interpreted with the following information and data:

1. The Ministry of the Environment water well database was compiled to generate hydrogeologic cross-sections over Area 47. The water well database was also supplemented using information from 27 boreholes completed in December 2012 as part of geotechnical investigations in the study area. The geotechnical investigations are being undertaken to characterize soil and groundwater conditions at potential stormwater management pond locations and to assess slope stability along the study area watercourses (AME Materials Engineering, 2012; see Appendix A). The well and borehole locations are shown in Figure 2.3;

2. Cross-sections were constructed north-south along Clarkway Drive (Cross-section A-A': Figure 2.4) and east-west along Countryside Drive (Cross-section B-B': Figure 2.5). The purpose was to provide additional details for the conceptual model of the hydrostratigraphy;

3. The grain size and hydrometer results from 26 recovered soils were used to derive the hydraulic conductivity and percolation rates of the soils based on the model of Saxton and Rawls (2006);

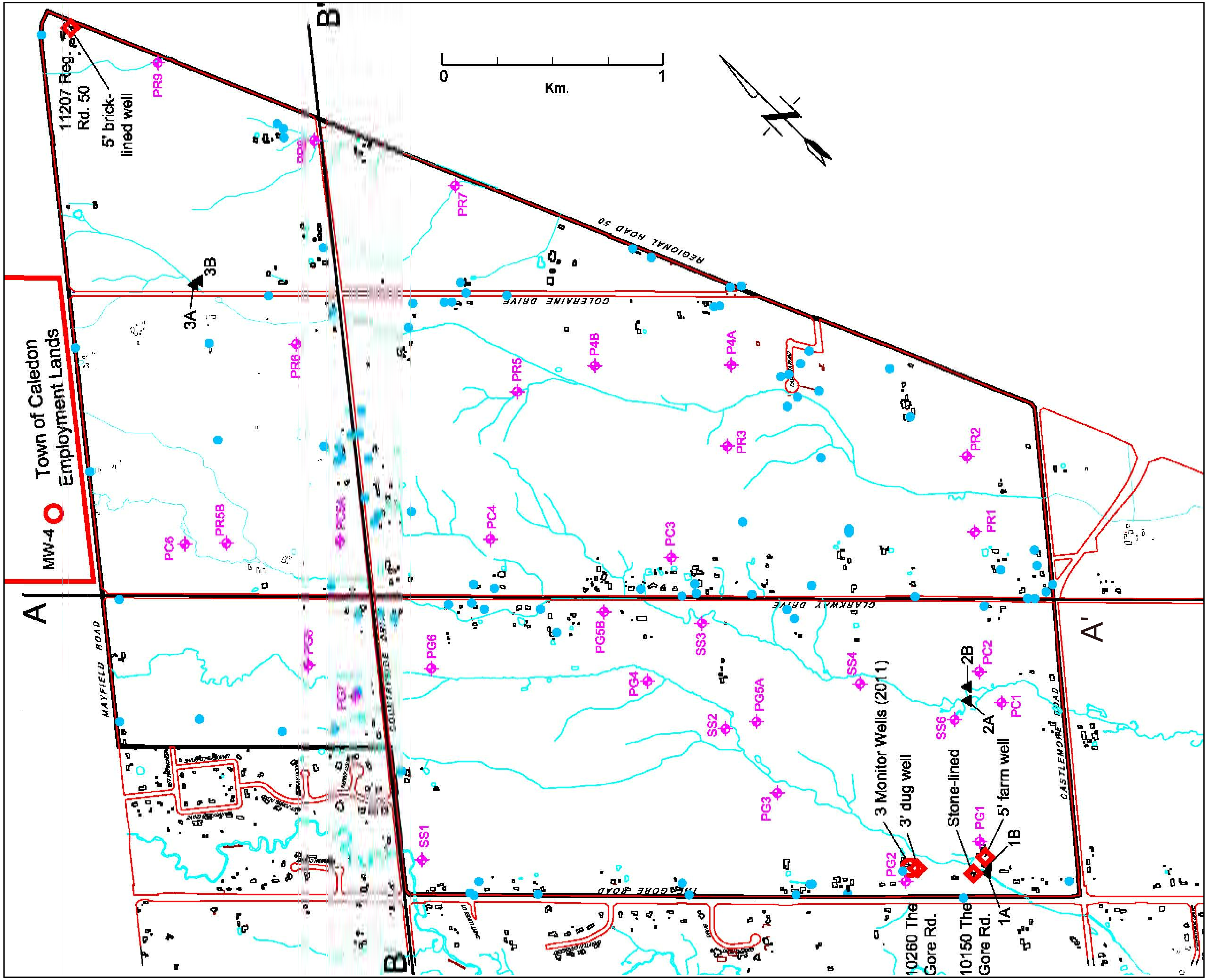
4. One borehole (P4) and monitor well (MW4) was advanced on the north side of Mayfield Road alongside the Clarkway Tributary in November 2009. The borehole reached a depth of 9.2 metres, advancing 3.4 metres into a weathered grey shale and fitted with a 5 metre screen (see Appendix B). The monitor well was instrumented with a pressure logger to read water levels hourly from December 16, 2009 to July 26, 2011. The purpose of the logger was to record seasonal and precipitation-related water level fluctuations at the northernmost extremity of the site;

5. A disused 3' domestic covered dug well at the civic address 10260 The Gore Road was instrumented with a 2nd pressure logger between August 30, 2010 and May 3, 2011. The purpose was to determine the seasonal fluctuations of the shallow water table and to assess responses to precipitation events;

6. Three sets of streambed and streambank hand-driven piezometers were installed May 2007 to measure in-stream water gradients. The locations (Figure 2.3) are in the Gore Tributary (1A & 1B), the Clarkway Tributary (2A & 2B) and int Rainbow Creek (3A & 3B). The purpose was to determine if the watercourses were gaining water from

groundwater discharge or losing water to the subsurface soils. The piezometers were monitored from May 22 to September 28, 2007. The streambed piezometers revealed that all streams (when flowing) were losing; and,

7. Four rounds of groundwater quality sampling were conducted at 3 locations on August 30 and December 12, 2010, and on May 3 and July 27, 2011. The locations were at 10150 and 10260 Gore Road and 11207 Regional Road 50. (Figure 2.3). One sample of groundwater was collected at the monitor well MW4 on Mayfield Road in July 2011. The purpose of the water sampling was to establish a baseline of the existing shallow groundwater quality, limited by permissions to access properties.



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

CROSS SECTION

PIEZOMETER

ESTABLISHED MONITOR WELL

DISUSED DUG WELL (used for monitoring)

AME GEOTECHNICAL BOREHOLE

WATER WELL (MOE Database)

SCALE: 1:25,000

WELL AND PIEZOMETER LOCATIONS

FIGURE 2.3

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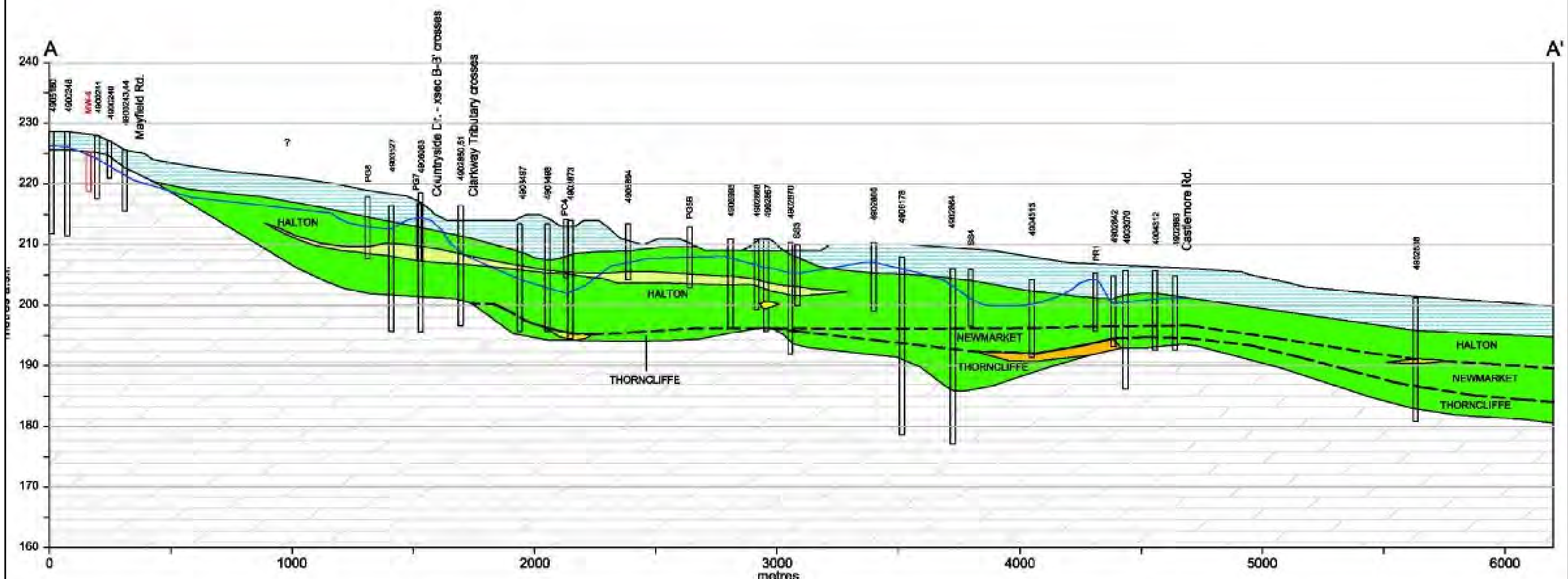

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STATIC WATER LEVEL
- SILT AND CLAY (WILDFIELD COMPLEX)
- TILL
- OAK RIDGE MORAINE AQUIFER COMPLEX (ORAC) SILT
- SAND
- SNAD AND GRAVEL
- GEORGIAN BAY FORMATION (grey-green and grey-blue shale, siltstone and limestone)

Source Data: Quarternary Geology of Southern Ontario. Ontario Division of Mines, 2008
Geological Report 117-Quaternary Geology of the Bolton Area Southern Ontario, Ontario Ministry of Natural Resources, 1975
Report No. 18 - Soil Survey of Peel County, OMAFRA, 1953. MOE Water Well Database. AME (2012, 2013)

Note: Relationship between Peel Clay/Wildfield and Halton Till approximate (base on water well logs)

CROSS-SECTION A-A'
Vertical Exaggeration 25x

FIGURE 2.4

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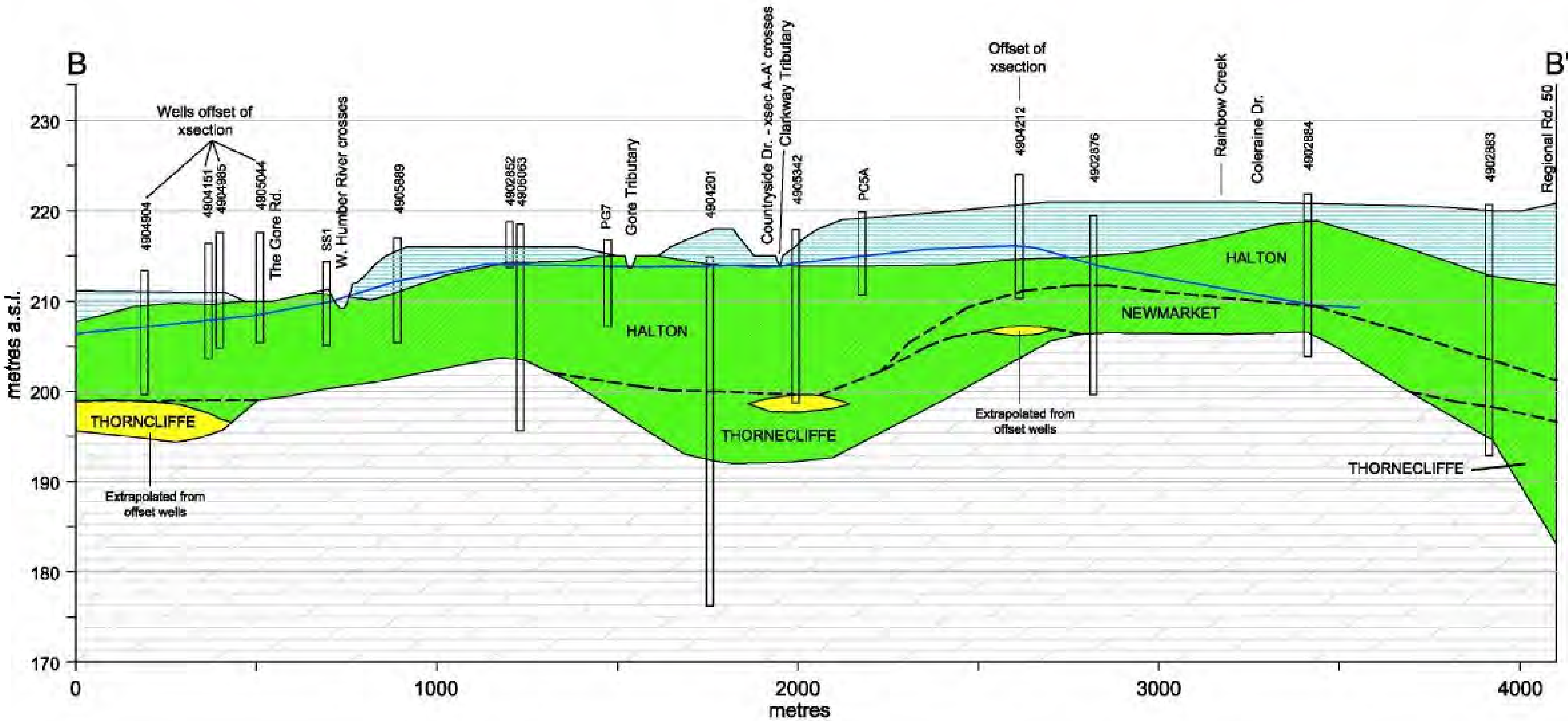

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STATIC WATER LEVEL
- SILT AND CLAY (WILDFIELD COMPLEX)
- TILL
- SAND and SLLTY SAND
- GEORGIAN BAY FORMATION (grey-green and grey-blue shale, siltstone and limestone)

Source Data: Quarternary Geology of Southern Ontario. Ontario Division of Mines, 2008
Geological Report 117-Quaternary Geology of the Bolton Area Southern Ontario, Ontario Ministry of Natural Resources, 1975
Report No. 18 - Soil Survey of Peel County, OMAFRA, 1953. MOE Water Well Database. AME (2012, 2013)

Note: Relationship between Peel Clay/Wildfield and Halton Till approximate (base on water well logs)

CROSS-SECTION B-B'
Vertical Exaggeration 25x

FIGURE 2.5

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2.1.3 Soils

The conceptual model of the subsurface was constructed with the Ministry of the Environment water well data. In addition, a total of 28 boreholes and wells drilled in 2009 and 2012 were incorporated. The locations of the boreholes and wells are shown in Figure 2.3. Two cross-sections have been constructed: a north-south cross-section A-A' follows Clarkway Drive (**Figure 2.4**) and an east-west cross-section follows Countryside Drive (**Figure 2.5**).

The cross-sections have been interpreted to conform to the conceptual model presented in the Humber River State of the Watershed Report (TRCA 2008) and hydrostratigraphic interpretations from Kassenaar and Wexler (2008). The deepest sediments are assigned to the Thorncliffe Formation, a partial aquifer consisting of sand, silt and clay deposited in bedrock lows. The top of the Thorncliffe Formation dips gently towards the south and is found at an elevation at or below 200 metres above mean sea level. There is no evidence of sediments assigned to Scarborough Formation aquifer on Area 47.

The Newmarket Till has been reported in the southern half of the property, beneath the Halton Till. The Newmarket Till consists of a massive, stony (3-10 % pebbles) and dense silty sand diamicton up to 10 m in thickness. Within the till, interconnected sand and silt lenses are reported, with fractures and joints providing the bulk of the limited permeability. None of the 28 boreholes report stones in the till layers; thus it is possible that the Newmarket Till was eroded by meltwater. The top of the Newmarket Till (where present) occurs at an elevation of above 200 metres.

There are several thin horizons of silt and silty sand in several water wells and three of the 27 geotechnical boreholes that are provisionally assigned to the distal portions of the Oak Ridge Moraine Aquifer Complex (ORAC), as shown in **Figure 2.4**.

2.1.4 Groundwater

Groundwater levels are generally under topographic control, with a groundwater divide running north-south across the property, dividing the Rainbow Creek Subwatershed to the east and the West Humber River Subwatershed to the west (**Figure 2.5**). Groundwater levels vary between 1 and 10 metres below the ground surface across the study area.

Groundwater levels were monitored for one year with pressure loggers, reading at 30-minute intervals in monitor well MW-4 and a disused dug well at 10260 Gore Road. Daily precipitation records were compiled from the Sandhill weather station until August, 2010, after which the daily precipitation records from Pearson Airport were used. The annual water level and precipitation records are summarized in **Figure 2.6** and **Figure 2.7**. The water levels in the dug wells were measured quarterly, at the same time water quality was sampled.

The range of water level changes in the monitored wells is summarized in **Table 2.1**. The responses of water levels in MW-4 to precipitation events are summarized in **Table 2.2** and the range of water levels in six geotechnical wells between December 2012 and March 2013 are shown in **Table 2.3**.

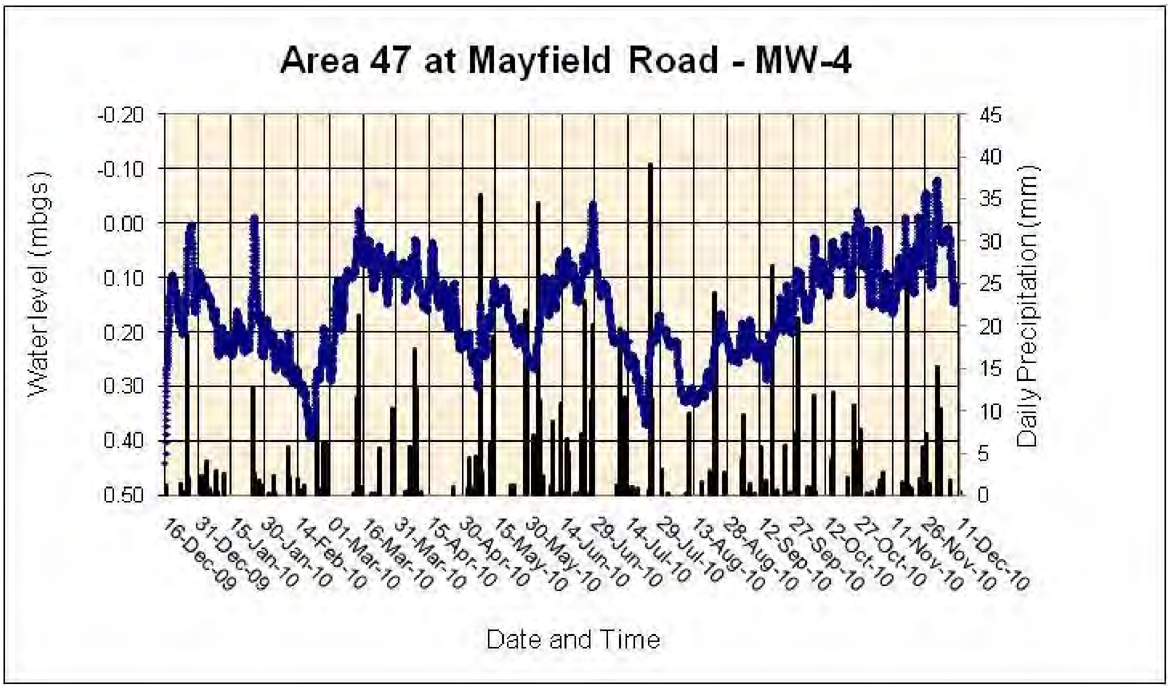


Figure 2.6: Water Levels and Precipitation records for Monitor Well MW-4 at Mayfield Road

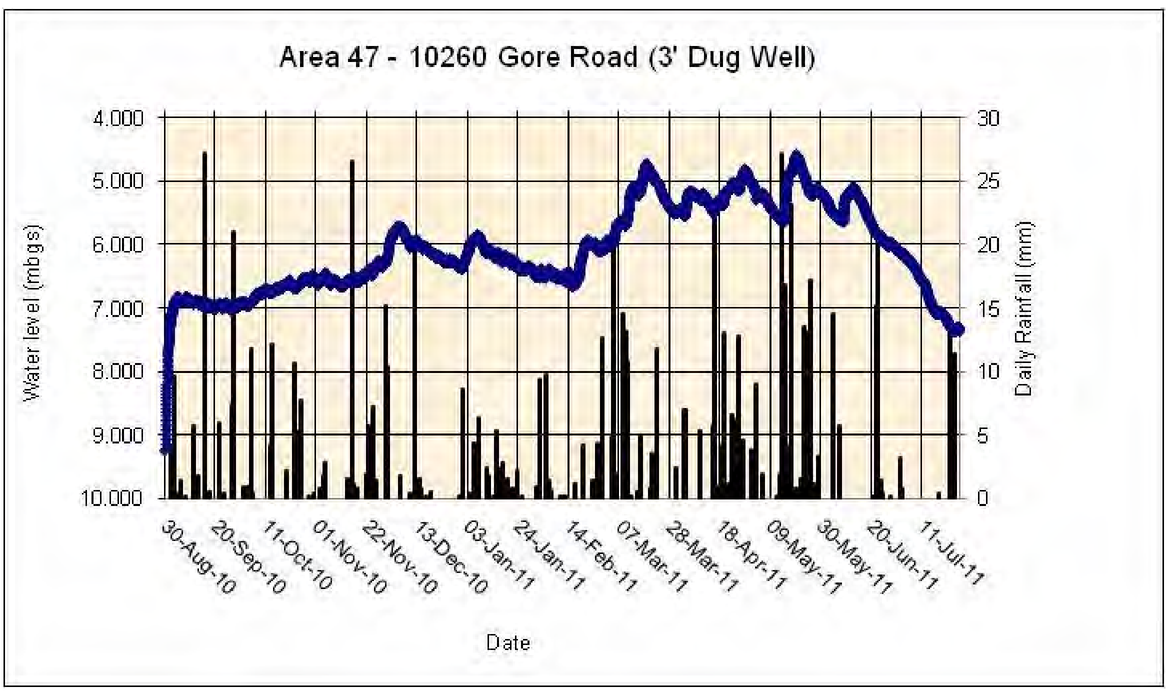


Figure 2.7: Water Levels and Precipitation records for Dug Well at 10260 Gore Road

Table 2.1: Minimum and Maximum Groundwater Levels in Monitored Wells

Well No.	Location	Minimum Water Level (mbgs)	Month	Maximum Water Level (mbgs)	Month and Year	Range (m)
10260 Gore Road	3-foot dug well	7.33	July 2011	4.70	May 2011	2.63
MW-4 (P4)	Mayfield Road	0.39	Feb. 10	-0.08	Dec. 10	0.47
11207 Regional Road 50	5-foot dug well	2.18	Sept. 2010	0.78	May 2011	1.4
10150 Gore Road	5-foot dug farm well	2.09	July 2011	0.58	May 2011	1.51

Table 2.2: Water Level Responses to Precipitation Events (Jan. – Nov. 2010) for MW-4

Start of Groundwater Rise	Water Level Peak Date and Time	Rainfall (mm)	Rise (m)	Duration (hrs)	Total drop Date and Time	Duration (hrs)	Comments
11/15/10 23:00	11/16/10 21:00	30	0.124	22	11/20/10 11:00	86	
5/6/10 22:58	5/8/10 2:58	35.4	0.153	28	5/9/10 20:58	42	1.2mm on previous day
10/5/10 16:00	10/6/10 17:00	20	0.088	25	10/9/10 2:00	57	
11/30/10 0:00	12/1/10 3:00	28.4	0.117	27	12/3/10 14:00	59	1 mm during drop period
1/24/10 0:58	1/25/10 3:58	12.8	0.172	27	1/26/10 22:58	43	3mm snow during drop period
3/12/10 12:58	3/13/10 21:58	33.8	0.1	33	3/15/10 23:58	50	Precipitation over 2 days

Table 2.3: Water Levels from Geotechnical Monitor Wells (December 2012 –March 2013)

Well No.	Screened In	Depth of Screen	December 3, 2012	March 19, 2013	Range (m)
PC2	Silty clay	4.0 – 7.5	1.27	1.24	0.03
PC3	Silty clay and silty sand	4.0 – 7.5	2.04	1.44	0.60
PR1	Silty clay and silty sand	4.0 – 7.5	0.90	0.71	0.21
P4B	Silty clay and silty sand	4.0 – 7.5	1.32	0.82	1.51
PR7	Silty clay, silty sand, clayey silt	4.0 – 7.5	1.31	1.29	0.02
PR9	Silty clay	4.0 – 7.5	3.1	2.52	0.58

Groundwater levels range from <1 metre to more than 7 metres below ground level, with seasonal fluctuations of 1.5 to 2.6 metres. The exception is MW-4 on Mayfield Road which is screened at the bedrock interface. This well has seasonal fluctuation of less than 0.5 metre.

Water level responses to several typical daily rainfall events are shown in Appendix B. In the dug well at 10260 Gore Road, water levels showed fairly rapid and moderate rises (up to 0.08m), occurring within one day of rainfall events. In March and May 2011, following several days of rainfall in excess of 10mm per day, the shallow water table rose by 0.55m.

2.1.5 Aquifers and Aquifer Vulnerability

There are two aquifers in Area 47. The majority of existing water wells obtain water at or near the bedrock interface at depths greater than 20 metres, presumably in sediments of the Thorncliffe Formation (or equivalent) and in the uppermost weathered portion of bedrock.

A second localized aquifer is found in discontinuous sand lenses within the Halton Till and/or in the silt layers assigned to the Oak Ridge Aquifer Complex (aka the ORAC Silts) at variable depths, but generally less than 10 metres. This shallow aquifer has provided sufficient water for domestic purposes.

The horizontal hydraulic conductivity (K_H) of the contact zone between till and shale bedrock was measured in monitor well MW4 (P4) by means of a slug test. The analysis revealed a value of $K_H = 1.5 \times 10^{-8}$ metre/second, an order of magnitude slower than modeled by

Kassenaar and Wexler (2008). It is likely that the vertical hydraulic conductivity (K_V) is appreciably higher in the ORAC silts, which are assigned a hydraulic conductivity of the order of 10^{-6} m./second.

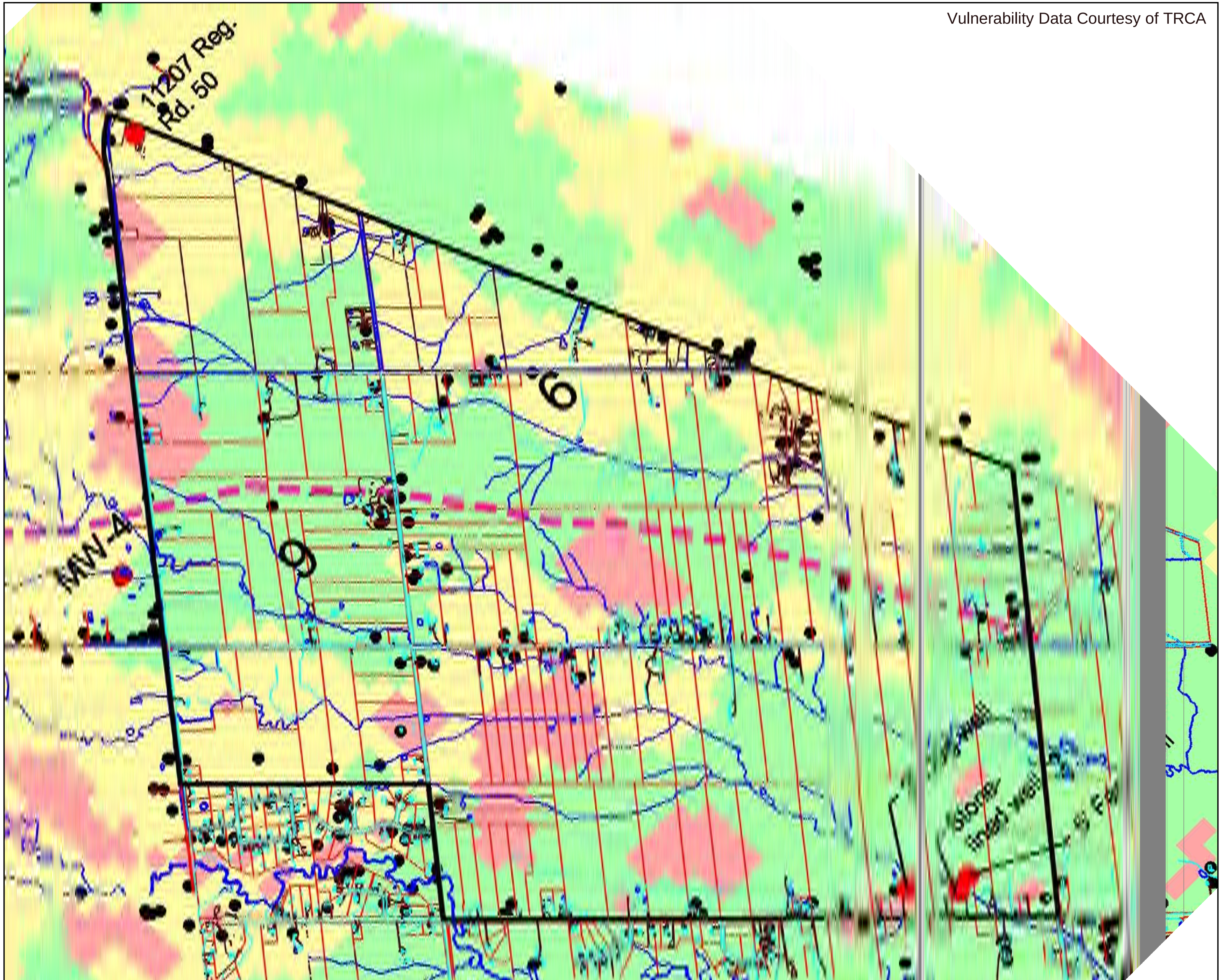
The hydrostratigraphy in Area 47 corresponds to 5 layers (after Kassenaar and Wexler, 2008):

- Layer 2 is the Halton Till Aquitard;
- Layer 3 is a thin layer of silt assigned to the Oak Ridge Aquifer Complex and/or weathered Newmarket Till). This unit is interbedded with the Halton Till;
- Layer 4 is the Newmarket Till Aquitard), present in the southeast of Area 47;
- Layer 5 (Thorncliffe Aquifer Complex) is present in the south part of the area, overlying bedrock; and
- Layer 8 is assigned to the weathered bedrock.

The aquifer vulnerability Index (AVI) was determined by TRCA based on the 3D hydrostratigraphic interpretation for each model layer (aquifers and aquitards). Modeled hydraulic conductivity was assigned to each layer and both observed and simulated water table and hydraulic heads were determined for each layer to confirm that all sediment layers greater than 2m thick are saturated.

The resulting map is reproduced in **Figure 2.8**. Area 47 spans a groundwater divide between the Rainbow Creek Subwatershed (to the east) and the West Humber River Subwatershed (to the west). The majority of the site is classified as having a low AVI. Zones of high AVI are shown on either side of the divide. As noted in the N-S cross-section in Figure 2.4, this is an area characterized by a shallow water table (in silt) and a shallow piezometric (in wells tapping bedrock). The classification of these areas of high AVI appear simply to be a result of a shallow water table, as the main aquifer (Thorncliffe Formation and bedrock) remains under 20 metres of impermeable till.

Given the thickness of Halton Till Aquitard across Area 47, there appear to be no significant constraints to promoting infiltration as part of any future stormwater management measures. Further, there no well head protection areas (WHPA) within the Area 47 lands (TRCA, 2012).



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREAS
HIGH AQUIFER VULNERABILITY
MEDIUM AQUIFER VULNERABILITY
LOW AQUIFER VULNERABILITY
MOE DATABASE WATER WELL
AQUAFOR MONITOR WELL
GROUNDWATER DIVIDE
6 RAINBOW CREEK WATERSHED
9 HUMBER WEST - EAST BRANCH WATERSHED

AQUIFER VULNERABILITY

FIGURE 2.8

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2.1.6 Water Quality

Groundwater quality was assessed in three dug wells (10150 and 10260 Gore Road and 11207 Regional Road 50) on four occasions (August 30, 2010 and December 12, 2010, and May 3 and July 27, 2011). Groundwater in MW-4 on Mayfield road was sampled on July 27, 2011. The results are presented in **Appendix B**.

Bacteria (total coliform and *E. Coli*) exceed drinking water criteria in all the dug wells sampled. Nitrate nitrogen in the farm well at 10150 Gore Road is also above drinking water standards. These exceedances are believed to represent a legacy of past agricultural practices.

2.1.7 Infiltration, Groundwater Recharge and Discharge

Groundwater recharge occurs as rainwater and snowmelt infiltrate through the soils into the groundwater table. The groundwater may then, in turn, serve other important functions such as supply of baseflow to local streams or recharge to deeper aquifers that supply local wells.

Based on the 2012 borehole logs, the property is characterized by, on average, 300 mm of topsoil and up to 1 metre of disturbed native soil containing traces of organic and rootlets, indicative of previous crop cultivation. The transition from brown (oxidized) and grey silty clay occurs at approximately 4 metres below ground surface. As the soil horizons below 1 to 4 metres are relatively dense and impermeable, runoff volumes tend to be high, and groundwater recharge and baseflows are limited.

In terms of groundwater discharge, intermittent flow conditions were observed on the stream reaches within Area 47, and it has been noted that, on several occasions during low flow periods, the flow in the Main Branch of the West Humber River has been zero downstream of the study area at Regional Road 107. It appears from the cross-sections that both The Gore Road Tributary and Clarkway Tributary do it intersect the silt layers, which may explain why groundwater discharge was interpreted to be a fraction of a litre/second in these tributaries (TRCA 2008, Figure 4-12).

2.1.8 Water Balance

A water balance was prepared to characterize the existing conditions of the study area. Evapotranspiration (ET) was calculated according to the Thornthwaite and Mather Model (Thornthwaite and Mather, 1957) which uses an accounting procedure to analyze the allocation of water among various components of the hydrologic system. Inputs to the model are monthly temperature and precipitation. Climate normal temperature and precipitation were derived from the Environment Canada monthly values 1971 – 2000 climate normals from the Albion Field Centre (281.9 m ASL).

Using a water retention value of 250 mm (corresponding to moderately- to deeply-rooted vegetation in a clay loam soil), the estimated annual evapotranspiration is approximately 543 mm (**Table 2.4**). The calculated value for ET corresponds to the value for Ecozone 562 from Agriculture and Agri-Food Canada (559 mm).

Table 2.4: Area 47 Actual Evapotranspiration (AET) and Water Balance

Month	Average Precipitation	Average Monthly Temperature	PET	Actual (AET)[1]	AET for Ecozone 562[2]
January	57.2	-7.5	0.0	0.0	0.0
February	45.5	-6.6	0.0	0.0	0.0
March	58.2	-1.6	0.0	0.0	0.0
April	66.6	5.6	30.24	30.24	30.3
May	69.3	12.3	76.20	75.30	74.3
June	70.4	17.1	108.36	105.40	107.6
July	76.4	19.8	128.70	116.40	115.4
August	75.4	19.0	115.20	100.40	104.2
September	69.8	14.3	71.76	70.80	77.4
October	67.4	8.0	37.05	37.05	37.9
November	74.5	2.1	7.20	7.20	10.5
December	61.4	-4.1	0.0	0.0	0.0
Total	**792.1**	-	-	**542.76**	**558.5**

[1] Thornthwaite & Mather calculation for clay soil and deeply-rooted vegetation (water holding capacity = 250 mm)

[2] Agriculture and Agri-Food Canada derived variables for Ecozone 562 (water retention = 250 mm)

The annual water surplus for the Area 47 study area is thus estimated to be 249.34 mm, representing the difference between precipitation (792.1 mm) and evapotranspiration (542.76 mm).

Average annual infiltration values were estimated by assuming infiltration factors suggested in the 2003 MOE Stormwater Management Planning and Design Manual. Assuming rolling topography (0.15), clayey soils (0.1), and cultivated cover (0.1), an infiltration factor of 0.35 was applied for the Area 47 lands. Application of this factor to the water surplus results in an estimated annual infiltration of 87.3 mm, or 11% of the total annual precipitation. The remainder, 162.1 mm, or 20% of the total annual precipitation, occurs as runoff.

The estimated annual infiltration value of 87 mm/year for the Peel Clay and Halton Till compares favourably to a value of 90 mm/year assigned by Kassenaar and Wexler (2008).

2.1.9 Summary – Groundwater Resources

The technical and field investigations demonstrate that the surface soils are relatively impermeable and remain so to depths up to 20 metres, and, as such, there is no significant groundwater recharge to the major aquifer at depths in excess of 20 metres below ground surface.

Water levels in shallow dug wells in Halton Till show that the water table rises moderately about 0.5 metre over a period of one to two days following significant precipitation events (>10 mm/day) and falls again over a period ranging from several days to several weeks. Infiltration to the shallow water table (where present) will occur, but it is slow.

There are no sensitive ecological features, such as significant wetlands or vulnerable groundwater systems (TRCA, 2012b). Area 47 is classified as a Low Volume Groundwater Recharge Area (LGRA) in which the soils have calculated infiltration rates considerably lower than 15 mm/hour, as determined by the textural model of Saxton and Rawls (2006).

Groundwater discharge to the intermittent watercourses is not significant, since the water table remains several metres below ground surface, as predicted by TRCA (2008, Figure 4-12).

Existing groundwater chemistry sampling indicates elevated levels of bacteria and nutrients, consistent with agricultural land uses.

In terms of constraints to future urban development and associated stormwater management requirements, future plans should include measures, where feasible, to minimize changes to the existing water balance. Given the thickness of Halton Till Aquitard across Area 47, there appear to be no significant constraints to promoting infiltration as part of any future stormwater management measures. However, such plans should consider high-risk land uses.

In keeping with general practice, it is preferable to discourage infiltration under certain land uses (potential “hot-spots”). Guidance can be found in the LID manual (Tables 1.4.3 and 2.8.1) and the TRCA Stormwater management Criteria.

It will be important to locate and abandon existing wells in accordance with O. Reg. 903, made under the Ontario water Resources Act, as development occurs.

2.2 Surface Water Resources

As illustrated in **Figure 2.9**, the Area 47 study area is drained by four main surface water features which flow southeast within the Area 47 study area and contribute water to the Humber River and West Humber River:

The Main Branch of the West Humber River

A short reach of the West Humber River drains southwesterly over approximately 270m near the western limit of the Area 47 study area, immediately upstream of The Gore Road.

The Gore Road Tributary of the West Humber River

The Gore Road Tributary is an intermittent tributary originating in the Town of Caledon north of the study area. The tributary flows south through Area 47 in a relatively well-defined valley from Mayfield Road, across Countryside Drive and then southwesterly to The Gore Road, just north of Castlemore Road. Ultimately, the Gore Road Tributary drains to its confluence with the West Humber River near the Claireville Reservoir, just north of Highway 407.

The Clarkway Tributary of the West Humber River

The Clarkway Tributary originates in the Town of Caledon north of the study area, and drains southwesterly through Area 47 from Mayfield Road, to the intersection of Countryside Drive and Clarkway Drive, and then to Castlemore Road at the south end of the study area. Through Area 47, the Clarkway Tributary is intermittent in nature and is contained within a valley which is ill-defined in some locations. Ultimately, the Clarkway Tributary drains to its confluence with the West Humber River near the Claireville Reservoir, just north of Highway 407.

Rainbow Creek Tributary of the Main Humber River

The Rainbow Creek Tributary is an intermittent tributary originating in the Town of Caledon north of the study area. The tributary flows southwest through Area 47 in an ill-defined valley with a wide floodplain from Mayfield Road to Coleraine Drive, then south across Countryside Drive. From here, the Rainbow Creek Tributary continues to drain southwest to Castlemore Road. Ultimately, the tributary drains to the main branch of Rainbow Creek and then to its confluence with the Humber River near Highway 407 and Islington Avenue. The Phase 1 field work has identified two areas of concern associated with the Rainbow Creek Tributary in Area 47. The first is a recent re-alignment that appears to have re-directed a short reach of this watercourse into the Coleraine Drive roadside ditch in the northeast portion of the study area (**Figure 2.9**). The second area of concern is comprised of existing buildings

/ lots which are located in the floodplain at the Cadetta Road industrial subdivision in the southeast portion of the study area (Figure 2.9).

<u>Regional Road 50 Drainage and Headwater Drainage Features</u>

In addition to the above primary drainage features, there are multiple smaller headwater drainage features (HDFs) within the study area. Portions of the eastern limits of the study area drain via HDFs southeast across Regional Road 50 to Rainbow Creek and Robinson Creek. HDF evaluations are discussed further in **Section 2.2.2**.

Of particular note is Robinson Creek Tributary 1, an intermittent headwater drainage feature that originates in Area 47 north of Countryside Drive. The tributary flows southeast and crosses Regional Road 50 within a short reach downstream of Countryside Drive, and joins Robinson Creek upstream of Major MacKenzie Drive in the City of Vaughan. This creek is characterized by a Regulatory Storm floodplain, and as described in Section 2.2.2, will be conserved in the future landscape.

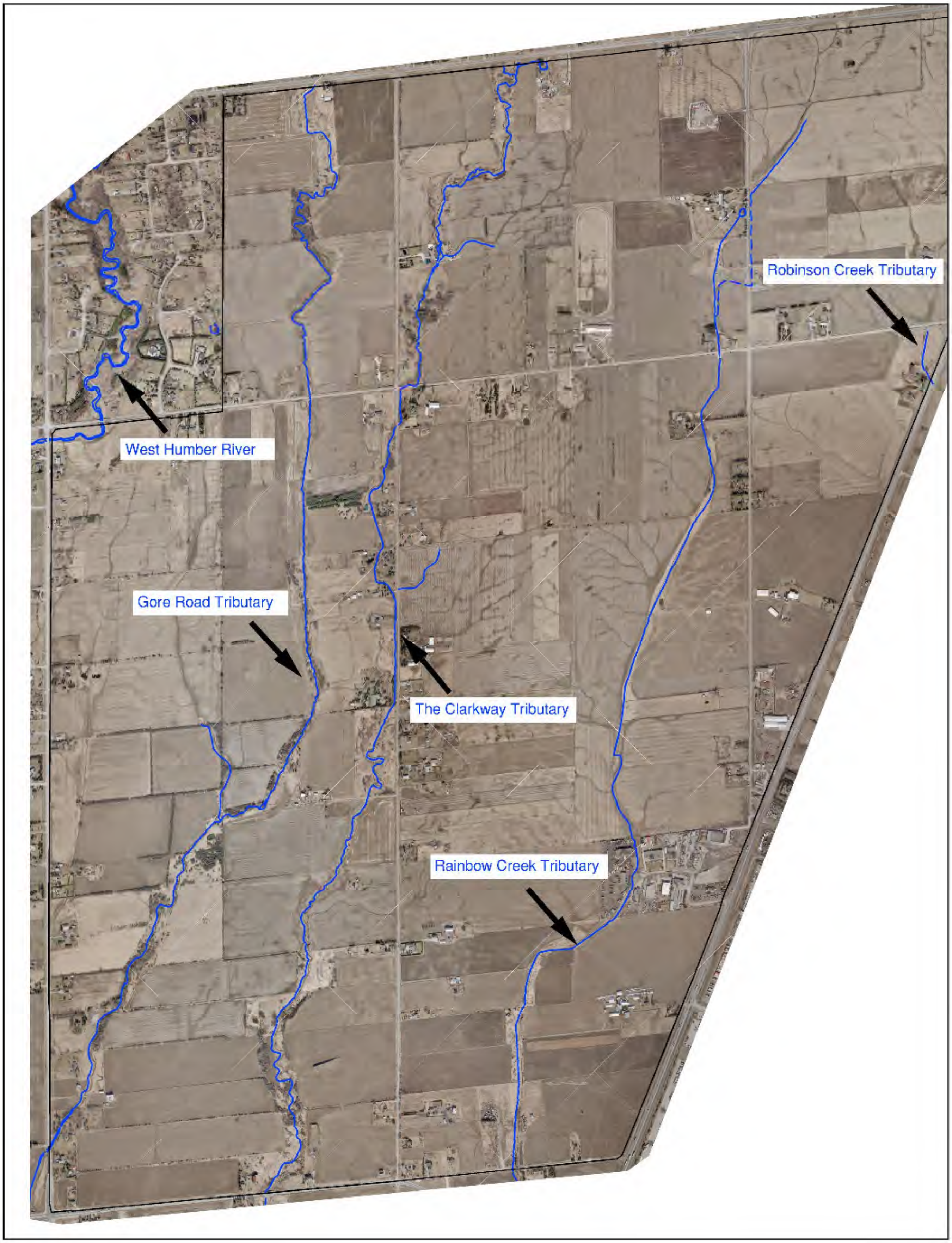

FIGURE 2.9 STUDY AREA WATERCOURSES

2.2.1 Existing Geomorphic Conditions

A geomorphic field investigation was completed in order to assess existing conditions and channel characteristics on the West Humber River, the Gore Road Tributary, the Clarkway Tributary, and Rainbow Creek Tributary within the study area. Surficial geology and watershed characteristics were reviewed to document the watercourse environment and to evaluate stream reaches. Meander belt and slope stability assessments were also completed to identify hazard land constraints. The characteristics of each of the major watercourses are described in the following sections. Smaller headwater drainage features are also characterized and evaluated in **Section 2.2.2**.

2.2.1.1 Geological Setting

Reference to surface geology mapping by Sharpe et al. (2001) indicates that the study area sediments primarily consist of fine lacustrine deposits (silt and clay of the Peel Plain), with clayey silt from Halton and Wildfield Till becoming predominant in the north and south. These sedimentary units represent a portion of the larger Lacustrine-Wildfield Till Complex formed by fluctuations of glacial ice and meltwater during deglaciation of the Lake Ontario basin. Generally, this sedimentary environment imparts fine and cohesive characteristics to both valley and upland soils, however channel bed material within the valleys is variable. Soil mapping also indicates the dominance of fine texture soils within the study area (**Figure 2.2**).

The West Humber River valley was formed by post-glacial incision into the complex glaciogenic deposits, resulting in a well-defined valley 5 to 10 metres below the surrounding uplands. The other tributaries occupy broad and discontinuous valleys, where well-defined valley walls are only encountered locally and many reaches have ill-defined valley sides. Valley floors generally consist of reworked fine alluvial sediments and locally exposed tills. Gravel and cobble are less abundant, but do occur locally in riffles and bank exposures. No exposed bedrock has been documented within the study area.

2.2.1.2 Drainage Network and Land Use

The watercourses traversing the secondary plan area all drain to the West Humber River with the exception of Rainbow Creek and the small headwater features adjacent to Regional Road 50 which drain to the Humber River, located to the east in the City of Vaughan. The Gore Road and Clarkway Tributaries outlet to the West Humber River approximately 7 km downstream of the study area and the Rainbow Creek Tributary outlets to the Humber River approximately 10 km downstream of the study area.

All the secondary plan area watercourses and (defined and ill-defined) valley corridors run roughly parallel to each other from the northwest to the southeast, although the West Humber River outside the study area exhibits a fairly sinuous valley form. Parallel drainage patterns are common within the West Humber watershed and across the Peel Plain. Within the study area, each of the watercourses appears to collect drainage from several agricultural swales and headwater drainage features. These smaller headwater drainage features are discussed further in **Section 2.2.2**.

Following European settlement and land clearing, the study area has remained largely agricultural with limited rural and industrial development. Residential development has occurred immediately west of the study area within the last decade. As such, historic channel impacts within the West Humber watershed were likely associated with modification of headwater swales, construction of agricultural drains, and restrictions by road crossings and culverts.

2.2.1.3 Reach Delineation

Reach delineation is an approach whereby a watercourse is spatially grouped by channel characteristics and processes. Stream reaches are lengths of channel that display relative homogeneity with respect to the controlling and modifying influences of channel form. As such, channel characteristics, functions and processes are relatively constant within a reach, and reaches can be used to help identify management objectives and restoration opportunities.

The reach characteristics of each of the major watercourses in the study area are summarized in **Table 2.5** and illustrated in **Figure 2.10** (West Humber River and Gore Road Tributary), **Figure 2.11** (Clarkway Tributary), and **Figure 2.12** (Rainbow Creek Tributary). Reaches were defined by key factors, including hydrology, gradient, geology, valley setting, sinuosity, and riparian vegetation. Reach verification was completed through a synoptic-level field investigation to document channel morphology, prominent channel processes, and channel stability. A photographic inventory was compiled for later reference and for illustrative purposes (**Figure 2.10**, **Figure 2.11**, **Figure 2.12**). A Rapid Geomorphic Assessment (RGA) (MOEE, 1999) was used to help characterize overall stability and dominant channel processes (see **Table 2.5**). Further detailed discussion for each of the four major watercourses is provided below.

2.2.1.4 West Humber River – Channel Characteristics and Influences

The West Humber River enters the study area briefly in the northwest corner, with a channel length of approximately 270 m. The identified channel reach extends from Gore Road to upstream of Countryside Drive beyond the study area limit. As such the dominant channel morphology did not change within the study area (i.e., only one reach, WH-1) (**Figure 2.10**). The channel was characterized by alternating wide/deep pools with fast flowing riffle-like features. The riffle features were generally narrow, however, the dominant low flow channel was often flanked by multiple flow paths around grassy clumps. The lengths of these channel features were highly variable. Bed material was mixed, with occurrence of coarse material (gravel to cobble size). Fine material and organic material were also noted in banks, grass bars, and within pools.

The low-flow channel appeared to be inset within a higher flow channel with defined banks (**Table 2.5**). The high-flow channel exhibited a moderate sinuosity, inset within the larger scale wandering of the valley corridor. During a field investigation, the channel was observed at near bankfull conditions (Photo on **Figure 2.10**). Flow conditions were locally restricted laterally by bridge crossings at The Gore Road and Countryside Drive. Upstream of Countryside Drive, the high-flow channel became more sinuous within the well-defined valley corridor. The valley bottom (width 80 – 100 m) was primarily grassy meadow with increased occurrence of trees and shrubs upstream of Countryside Drive, beyond the study area.

Within the study area the south valley wall is well-defined and exhibits erosion scars. Meander belt width and detailed geotechnical slope stability analyses were required to define development constraints in this area. These items are discussed further in **Section 2.2.1.9** and **Section 2.2.1.10**.

Table 2.5: Reach Characteristics and Field Observations

West Humber River

Reach	Length (m)	Channel Dimensions (m)*		Bed Material†	Slope (%)	Riparian Vegetation					RGA†† (0 – 1.0)	No. Private / Tractor Crossings	Artificial Straighten	Ditch / Entrenched	Meandering	Developed	Vegetation Dominated	Shear Dominated	Description
		Width (m)	Depth (m)			Crops	Marsh	Grass	Shrubs	Trees									
R-1	270	15	1.5	Ÿ	~0.3			ü			-	0			ü			ü	Riffle-Pool Channel

Clarkway Tributary

Reach	Length (m)	Channel Dimensions (m)*		Bed Material†	Slope (%)	Riparian Vegetation					RGA†† (0 – 1.0)	No. Private / Tractor Crossings	Artificial Straighten	Ditch / Entrenched	Meandering	Developed	Vegetation Dominated	Shear Dominated	Description
		Width (m)	Depth (m)			Crops	Marsh	Grass	Shrubs	Trees									
C-1 A	190	2.0	0.7	A Ÿ	0.14			ü	ü	ü	Transitional (0.31) – A	0	ü		ü			ü	A: Riffle-Pool Channel
B	225	2.8	0.7	B Ÿ	0.49			ü	ü	ü	Transitional (0.31) – A	0	ü		ü			ü	B: Riffle-Pool Channel
C-2	240	3.1	0.4	Ÿ	0.38	ü		ü	ü	ü	Transitional (0.29) – A, W^{M}	1	ü		ü			ü	Riffle-Pool Channel (modified)
C-3	1070	2.5	0.75	Ÿ	0.46	ü		ü	ü		Transitional (0.32) – A, D	1	ü	ü	~			ü	Meander-Riffle-Pool Rejuvenating
C-4	230	1.5	0.6	Ÿ	0.54			ü	ü		Transitional (0.34) – A, D	1			ü			ü	Riffle-Pool Channel
C-5 A	190	3.2	0.7	A Ÿ	0.53			ü	ü		Transitional (0.22) – A, D^{M}	0	ü					ü	A: Agricultural Ditch

Reach	Length (m)	Channel Dimensions (m)*		Bed Material†	Slope (%)	Riparian Vegetation					RGA†† (0 – 1.0)	No. Private / Tractor Crossings	Artificial Straighten	Ditch / Entrenched	Meandering Developed	Vegetation Dominated	Shear Dominated	Description
		Width (m)	Depth (m)			Crops	Marsh	Grass	Shrubs	Trees								
B	440	-	-	B Ÿ	0.034			ü	ü	ü	Transitional (0.33) – D, W^M	3	ü				ü	B: Roadside Ditch
C-6	720	2.5	0.7	Ÿ	0.42	ü	ü	ü	ü	ü	Transitional (0.32) – A, W	4	ü				ü	Variable: Ditch, Landscaped
C-7	160	-	-	Ÿ	0.85		ü	ü	ü	ü	-	0	ü				ü	Roadside Ditch
C-8	525	3	0.6	Ÿ	0.36			ü	ü	ü	Transitional (0.31) – A, P^M	0	ü				ü	Variable: Ditch, Landscaped
C-9	440	1.6	0.3	Ÿ	0.77			ü	ü		Transitional (0.29) – A, P^M	2	ü				ü	Channel (modified)
C-10	560	2	0.6	Ÿ	0.42			ü	ü	ü	Transitional (0.26) – D^M, W^M	0	?	P	ü		ü	Channel

Notes: *_Channel Dimensions_: MFP = Multiple Flow Paths – channel ill-defined †_Bed Material_: = Dominated by Fine Material (Sand, Silt, Clay); Ÿ = Occurrence of Coarse Material (Gravel, Cobble); ¡ = Organic Bed Material Prevalent

References: ††_RGA Stability Index_ (modified from MOEE, 1999): Stable (0.0 – 0.2); Transitional (0.2 – 0.4); In Adjustment (0.4 – 1.0).

Dominant Processes: A = Aggradation; D = Degradation; W = Widening; P = Planform Adjustment; ^{M} = Minor process.

Table 2.5**: Reach Characteristics and Field Observations (continued)**

<u>Gore Road Tributary</u>

Reach		Length (m)	Channel Dimensions (m)* Width (m)	Channel Dimensions (m)* Depth (m)	Bed Material†		Slope (%)	Riparian Vegetation: Crops	Marsh	Grass	Shrubs	Trees	RGA†† (0 – 1.0)	No. Private / Tractor Crossings	Artificial Straighten	Ditch / Entrenched	Meandering Developed	Vegetation Dominated	Shear Dominated	Description
G-1	A	250	-	-	A	Ÿ	0.12			ü	ü	ü	Stable (0.18) - A^{M}	2	ü				ü	A: Landscaped Swale
	B	170	1.8	0.5	B	¡	0.12			ü			Stable (0.18) - A^{M}	0	ü	ü		ü		B: Agricultural Swale
	C	490	4	1.5	C	Ÿ	0.49				ü	ü	In Adjustment (0.48) – A, W	0	ü	ü			ü	C: Riffle-Pool Channel
	D	580	4	1	D	¤	0.42			ü	ü	ü	Stable (0.16) - A^{M}	1	ü	ü	ü		ü	D: Agricultural Ditch
G-2	A	160	2.5	1	A	Ÿ	0.42			ü	ü	ü	Transitional (0.31) – A, W	0			ü		ü	A: Riffle-Pool Channel
	B	150	5	1.5	B	¤	0.52		ü	ü	ü		Transitional (0.26) – A, P	1	ü	ü		ü		B: Agricultural Ditch (Pond)
	C	1190	3	0.8	C	Ÿ	0.45	ü		ü	ü	ü	Transitional (0.26) – A, P	4	ü			ü		C: Agricultural Ditch
	D	320	-	-	D	¡	0.50	ü	ü	ü	ü	ü	-	0	ü	ü		ü		D: Agricultural Ditch (Swamped)
G-3		660	3.5	1	¤		038	ü		ü	ü	ü	Transitional (0.21) – A, P	0	ü	ü			ü	Agricultural Ditch
G-4	A	280	4	0.7	A	Ÿ	0.43				ü	ü	In Adjustment (0.58) – A, P	0			ü		ü	Channel (Forested)
	B	130	1.6	0.4	B	¡	0.28			ü	ü	ü	-	0			ü	ü		Variable: Swale, Channel
G-5		360	$(1.2)^{MFP}$	$(0.8)^{MFP}$	¡		0.58			ü	ü		Transitional (0.21) – A, P	0	ü			ü		Variable: Swale, Ditch

<u>Rainbow Creek Tributary</u>

Reach	Length (m)	Channel Dimensions (m)*		Bed Material†	Slope (%)	Riparian Vegetation					RGA†† (0 – 1.0)	No. Private / Tractor Crossings	Artificial Straighten	Ditch / Entrenched	Meandering Developed	Vegetation Dominated	Shear Dominated	Description
		Width (m)	Depth (m)			Crops	Marsh	Grass	Shrubs	Trees								
R-1	240	3	0.6	¤	~0.4			ü	ü	ü	Stable (0.16) - A^M	0	ü	ü		ü		Agricultural Ditch
R-2	940	$(0.8)^{MFP}$	$(0.2)^{MFP}$	¡	~0.4	ü		ü	ü		Stable (0.17) - A^M	1	ü			ü		Broad Agricultural Swale
R-3	325	(15)	(2)	¡	~0.4		ü				Stable (0.16) - A^M	1	ü	ü		ü		Trapezoidal Channel
R-4	1650	MFP	MFP	¡	~0.4	ü		ü	ü		Stable (0.13) - A^M	1	ü			ü		Broad Agricultural Swale
R-5	1025	MFP	MFP	¡	~0.4	ü		ü	ü	ü	Stable (0.17) - A^M	2	ü			ü		Variable: Swale, Ditch
R-6	750	MFP	MFP	¡	~0.4	ü					Stable (0.14) - A^M	0	ü			ü		Agricultural Swale

Notes: **Channel Dimensions*: MFP = Multiple Flow Paths – channel ill-defined †*Bed Material*: = Dominated by Fine Material (Sand, Silt, Clay); Ÿ = Occurrence of Coarse Material (Gravel, Cobble); ¡ = Organic Bed Material Prevalent

References: ††*RGA Stability Index* (modified from MOEE, 1999): Stable (0.0 – 0.2); Transitional (0.2 – 0.4); In Adjustment (0.4 – 1.0).

Dominant Processes: A = Aggradation; D = Degradation; W = Widening; P = Planform Adjustment; ^{M} = Minor process.

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STUDY AREA
- WATERCOURSE
- REACH BREAK (REACH 1B / REACH 1A)
- LOCAL BANK EROSION - SEDIMENT SOURCES
- STABLE SLOPE / EROSION SETBACK
- MEANDER BELTS
- PRIVATE/TRACTOR CROSSINGS

SCALE: 1:16,000

EXISTING STREAM MORPHOLOGY -TRIBUTARY CHARACTERIZATION: GORE ROAD TRIBUTARY & WEST HUMBER RIVER

FIGURE 2.10

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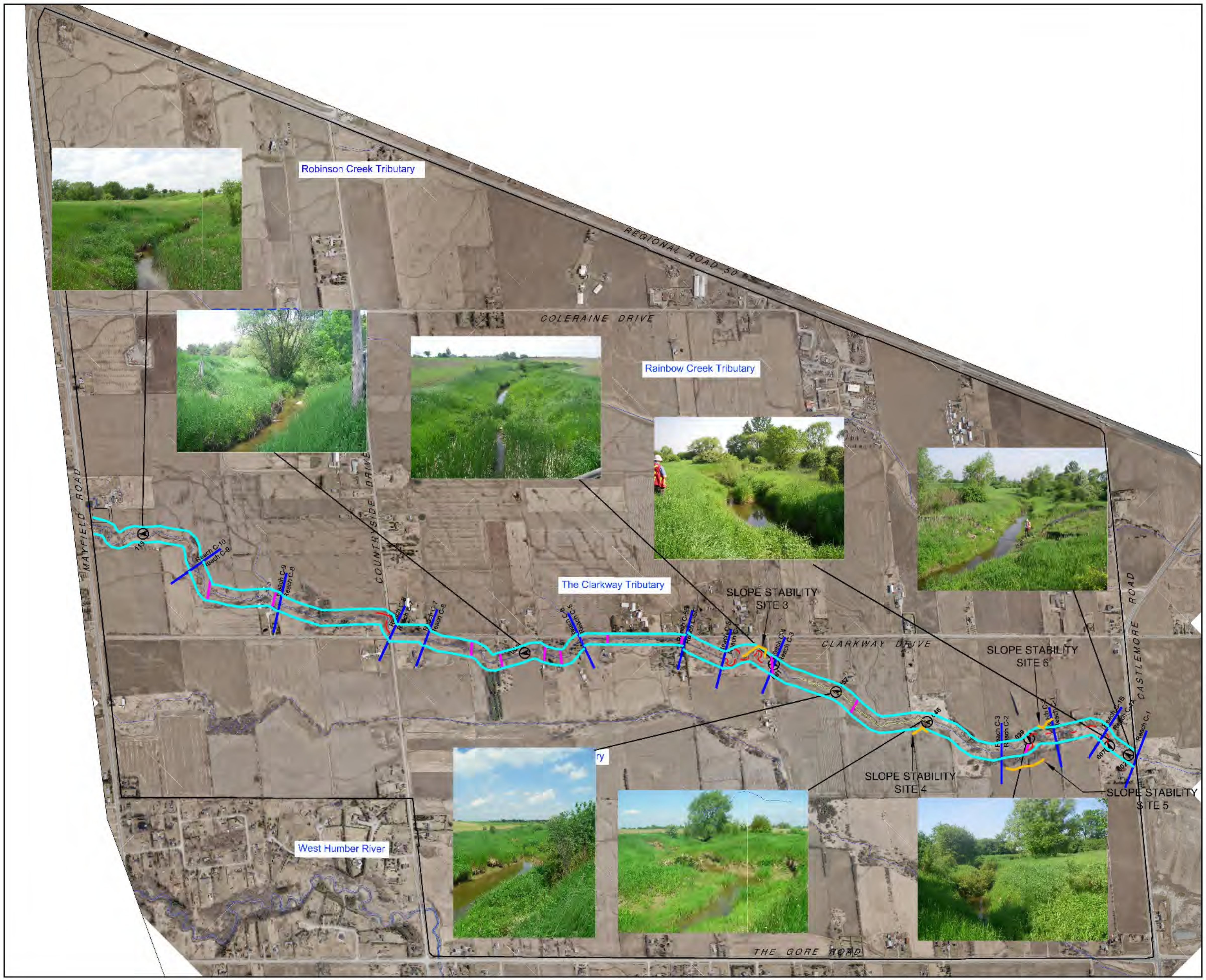

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STUDY AREA
- WATERCOURSE
- REACH BREAK
- LOCAL BANK EROSION - SEDIMENT SOURCES
- STABLE SLOPE / EROSION SETBACK
- NATURAL MEANDER REJUVENATION REACH (Clarkway Trib)
- MEANDER BELTS
- PRIVATE/TRACTOR CROSSINGS

SCALE: 1:16,000

EXISTING STREAM MORPHOLOGY -TRIBUTARY CHARACTERIZATION: CLARKWAY TRIBUTARY

FIGURE 2.11

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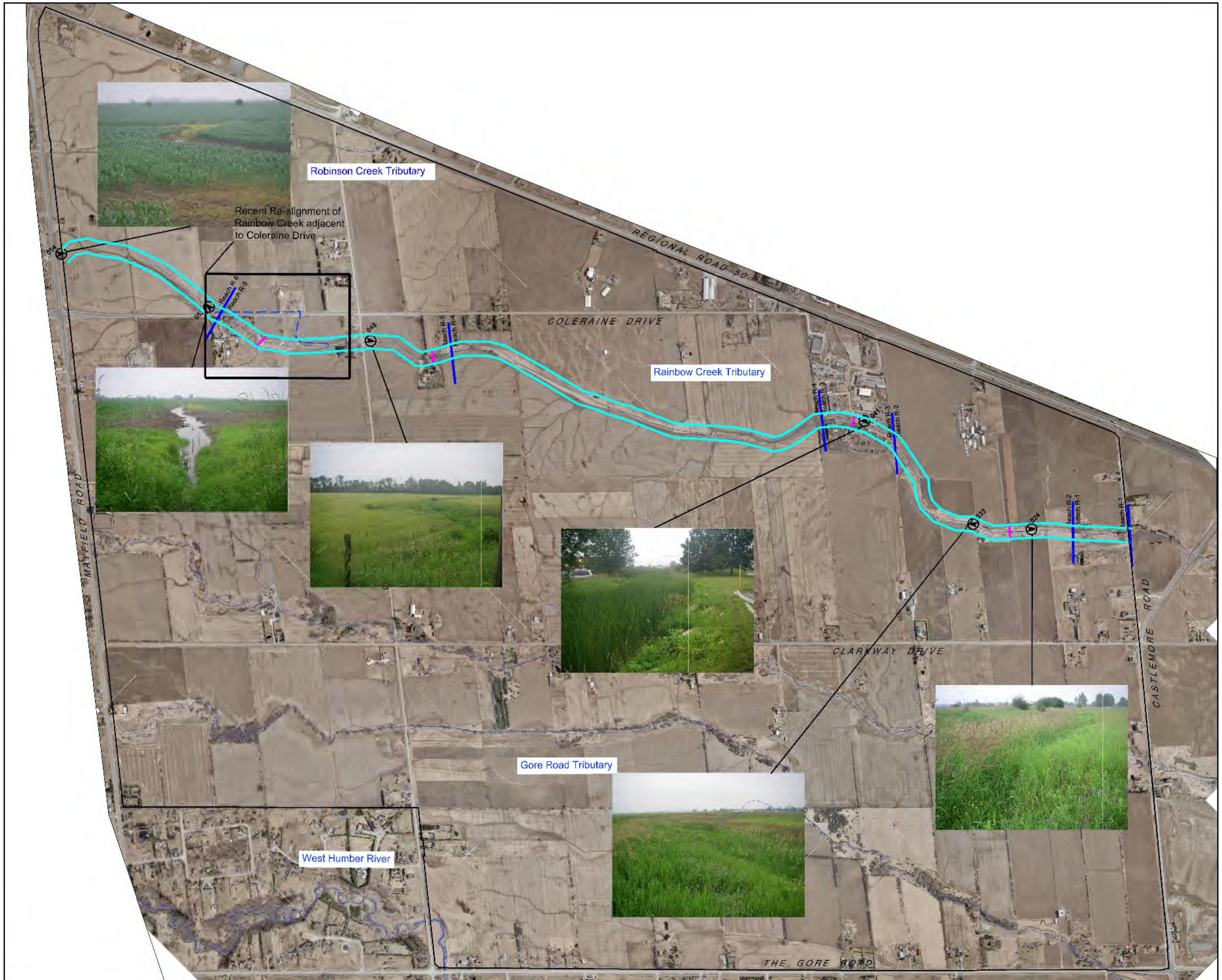

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STUDY AREA
- WATERCOURSE
- REACH BREAK (REACH 1B / REACH 1A)
- MEANDER BELTS
- PRIVATE/TRACTOR CROSSINGS

SCALE: 1:16,000

EXISTING STREAM MORPHOLOGY -TRIBUTARY CHARACTERIZATION: RAINBOW CREEK

FIGURE 2.12

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2.2.1.5 Gore Road Tributary – Channel Characteristics and Influences

The channel morphology of the Gore Road Tributary was divided into five primary reaches, with sub-reaches representing more detailed variations within each reach (**Figure 2.10**, **Table 2.5**). Reach G-1 was variable between landscaped, agricultural field, and wooded conditions, with stable ditch and swale conditions dominating. The major exception was Reach G-1C which exhibited notable aggradation and widening adjustments within the wooded conditions. Reach G-2 was also variable ranging from meandering wooded conditions to straightened agricultural ditches. Backwater and ponding conditions were evident in Reaches G-2B and D, with associated marsh vegetation noted. Reach 2C was highly impacted by numerous tractor crossings. Reach 3 was a partially straightened agricultural ditch, flanked by encroaching agricultural fields. Reach G-4A was a meandering channel in wooded conditions and showed evidence of aggradation and planform adjustments. Reach G-4B transitioned from wooded to grassy conditions, where Reach G-5 was dominantly grasses, representing an ill-defined agricultural swale/ditch.

Bed material was variable throughout the Gore Road Tributary, with dominantly fine materials mixing with locally available coarse material in channels or organic materials in the ill-defined marsh and swale conditions. With the exception of Reach G-1C which exhibited more generalized erosion, bank erosion was generally limited to meander bends. These locations were not considered to be erosion sites which require future intervention. Instead these erosion areas should generally be allowed to continue, providing natural sediment sources to the channels.

Due to historic straightening, ill-defined valleys, and potential erosion hazards, it is recommended that future planform adjustments, as defined by an appropriate meander belt, be accounted for when defining limits of future development adjacent to this watercourse. Also, during field investigations with TRCA and City of Brampton staff, a geotechnical slope stability investigation was recommended for a site in Reach G-2A. These meander belt and slope stability constraints are discussed further in **Section 2.2.1.9** and **Section 2.2.1.10**, respectively.

<u>Rapid Geomorphic Assessment</u>

Rapid Geomorphic Assessment results indicated most reaches scored as Stable to Transitional based on some evidence of aggradation or planform adjustments. The highest RGA scores for Reaches G-1C and G-4A, which were considered to be In Adjustment, were due to more significant evidence of Aggradation, Widening and Planform Adjustment. Most reaches appeared to be impacted by high inputs of fine sediment from the surrounding agricultural land use. Reaches G-1C and G-4A were generally wooded and appeared to be less recently impacted by deforestation and realignment. As such, these reaches seemed to be more sensitive to aggradation and channel adjustment.

2.2.1.6 Clarkway Tributary – Channel Characteristics and Influences

The channel morphology of the Clarkway Tributary was divided into 10 primary reaches, with sub-reaches representing more detailed variations within each reach (**Figure 2.11**, **Table 2.5**). Reach C-1 was a well-defined riffle-pool channel with some meander development, but may have been historically straightened. Reach C-2 exhibited large scale meandering (i.e., less straightened), but also appeared more recently modified by adjacent agricultural practices and a tractor crossing. Reach C-3 appeared to be a highly modified reach due to historic straightening; however, widespread meander rejuvenation was noted with this reach. Reach C-4 was a meandering and grass-dominated channel (i.e., deforestation), but did not appear straightened. Reach C-5 was characterized as a straightened agricultural ditch (C-5A) and a roadside ditch (C-5B) along Clarkway Drive. Reach C-6 exhibited variable conditions ranging from landscaped to highly entrenched ditches, while some local sections appeared less impacted. Reach C-7 was highly straightened and modified by two closely spaced road crossings: Clarkway Drive and Countryside Drive. Reaches C-8 and C-9 were variable channels and ditches due to modifications by landscaping, agriculture, road crossings, and an online pond (C-9). Reach C-10 appeared to be a less impacted grass-dominated channel, with only local evidence of straightening and artificial channelization.

Bed material throughout the watercourse was dominated by fine materials, with the occurrence of local coarse materials in most reaches. Marsh and organic bed conditions were noted, but were not extensive within any one reach. Bank erosion was identified in meandering reaches and was particularly active due to incipient meandering in Reach C-3. These locations were not considered to be erosion sites which require future intervention. Instead these erosion areas should generally be allowed to continue, providing natural sediment sources to the channels

Due to historic straightening, ill-defined valleys, and potential erosion hazards, it is recommended that future planform adjustments, as defined by an appropriate meander belt, be accounted for when defining limits of future development adjacent to this watercourse. Also, during field investigations with TRCA and City of Brampton staff, geotechnical slope stability investigations were recommended for sites in Reach C-2 (two sites), C-3 (one site), and C-4 (one site). These meander belt and slope stability constraints are discussed further in **Section 2.2.1.9** and **Section 2.2.1.10**, respectively.

Rapid Geomorphic Assessment

Rapid assessment results indicated that all reaches scored as Transitional, primarily based on evidence of Aggradation. Evidence of secondary processes such as Widening (e.g., C-2, C-5B, and C-10), Degradation (e.g., C-3, C-5, and C-10), and Planform Adjustments (e.g., C-8 and C-9) were also noted. Most reaches appeared to be impacted by high inputs of fine sediment from the surrounding agricultural land use, resulting in the prevalence of Aggradational processes.

Secondary processes are likely also due to the localized impacts of channel straightening and entrenchment by artificial channelization.

2.2.1.7 Rainbow Creek Tributary – Channel Characteristics and Influences

The channel morphology of Rainbow Creek Tributary was divided into six primary reaches (**Figure 2.12**, **Table 2.5**). Reach R-1 appeared to be highly straightened and channelized, resulting in a prevailing entrenched condition. Reach R-2 has transitioned into a broad agricultural swale, with poor channel definition dominated by meadow grass conditions. Reach R-3 represents a localized trapezoidal channel and culvert reach which transects a small flood-susceptible industrial area on Cadetta Road (see also **Section 2.2.3)**. The R-3 channel was choked with marsh-like vegetation, and no defined low-flow channel was observed. Reach R-4 was a broad agricultural swale, closely flanked by active agricultural fields. Reach R-5 exhibits variable channel and vegetated conditions ranging from landscaped to agricultural swales and a roadside ditch. Alternative flow-paths were identified in Reach R-5 at Coleraine Drive, where most upstream flow appears to have been re-directed to the east Coleraine Drive roadside ditch before rejoining the main watercourse west of the road (**Figure 2.12**). Reach R-6 was a highly modified agricultural swale within an agricultural field that appeared to have been recently ploughed.

Bed material throughout the watercourse was dominated by fine material and organics. Poor channel definition and organic bed material was generally associated with choking establishment of meadow grasses or marsh vegetation. All reaches appeared to show some evidence of aggradation, although bank erosion was generally not evident (but, very minor in Reach R-1).

Typically, meander belt limits would be used to define the extent of potential watercourse hazards due to future planform adjustments on streams with historic straightening, ill-defined valleys, and potential erosion hazards. However, meander belts do not generally apply to vegetation-dominated swale conditions. Further, it is recognized that meander belt hazards are not expected to govern the definition of development limits along the Rainbow Creek Tributary. Instead, flood hazards, as defined through the predominance of a very wide, shallow floodplain are expected to govern the limits of development. Nonetheless, meander belt calculations for the Rainbow Creek Tributary were undertaken in **Section 2.2.1.9**.

<u>Rapid Geomorphic Assessment (RGA and RSAT)</u>

Rapid assessment results indicated that the Rainbow Creek Tributary was largely stable (**Table 2.5**) with only minor evidence of aggradational processes observed due to sediment inputs from the surrounding agricultural lands. Channel processes are generally limited due to vegetation-dominated conditions and broad floodplain cross-sections.

2.2.1.8 Robinson Creek Tributary

The headwaters of the Robinson Creek Tributary are located in the northeast portion of the Area 47 study area (Figure 2.9). These features were assessed through TRCA's headwater drainage feature (HDF) protocol (see **Section 2.2.2**). Through this assessment, the tributary reach between Countryside Drive and Regional Road 50 was identified for conservation as defined by the Regulatory Floodplain (see **Section 2.2.3.4**).

2.2.1.9 Meander Belt Delineation

Meander belt constraints were identified for the West Humber River, the Gore Road Tributary, and the Clarkway Tributary through the Area 47 study area in order to protect future urban development from the hazards associated with potential planform adjustments of these watercourses. Preliminary meander belt widths are also provided for the Rainbow Creek Tributary, but this constraint does not strictly apply due to poorly developed channel conditions (see **Section 2.2.1.7**).

A meander belt is defined as the area that a channel currently occupies, or which it may be expected to occupy in the future. The degree to which a channel will meander depends upon the channel's environment and the collection of processes which are expected to occur. Although active meandering may not occur on all watercourses, channels will exhibit some degree of lateral expression within a geomorphically active corridor. Further, previously straightened channels may have ultimate lateral migration zones which might be re-attained if given enough time (i.e., natural channels are rarely straight). As such, it is preferable that expected bank erosion processes are preserved within an appropriate erodible corridor (Piégay et al. 2005). Meander belt delineation approaches (i.e., mapping and empirical) are the most accepted methods for defining a channel's erodible corridor (TRCA, 2001).

Historically widespread, watercourse straightening and artificial channelization within the study area and the greater West Humber River watershed limits the application of strict mapping procedures for meander belt delineation. As such, the TRCA empirical method was employed as a first estimate of meander belt widths:

$$Mb = -14.827 + 8.319 \ln (Ad \times \Omega)$$

Where Ad is the drainage area (km^2), Ω is the stream power (Wm-2), and Mb is the meander belt width (m). Stream power varies directly with estimates of channel slope and bankfull discharge. A meander belt width value (Mb) was calculated for all reaches in the study area (**Table 2.6**). As some reaches did not appear recently straightened, mapping procedures were also conducted to compare with empirical results. As shown in **Table 2.6**, the empirical meander belt width estimates are generally corroborated by the mapping results using the TRCA protocols for both the Gore Road and Clarkway Tributaries.

TRCA's Belt Width Delineation Procedures suggest that where physical information is lacking due to historic modifications, such as in Rainbow Creek, that a "surrogate" channel may be used to assess potential meander belt requirements. **Table 2.6** indicates that the empirical belt width estimate for Rainbow Creek corresponds closely to the mapping results for the Gore Road Tributary which has similar slope, drainage area, and hydrologic characteristics.

The resulting meander belts are illustrated in **Figure 2.10** (West Humber River and Gore Road Tributary), **Figure 2.11** (Clarkway Tributary), and **Figure 2.12** (Rainbow Creek Tributary).

Table 2.6: Meander Belt Delineation

Reach	Drainage Area (km^2)	Slope (m/m)	Bankfull Discharge (m^3/s)	TRCA Empirical Mb (m) †	TRCA Mapping Mb (m) ††
West Humber River					
WH-1	**-**	**-**	**-**	**-**	**120**
Clarkway Tributary					
C-1A	10.25	0.0015	6.16	**60**	-
C-1B	10.18	0.0049	6.16	**70**	-
C-2	9.87	0.0038	6.16	**67**	-
C-3	9.76	0.0046	6.16	**69**	-
C-4	9.16	0.0054	6.16	70	**72**
C-5A	8.97	0.0053	6.16	**69**	-
C-5B	8.91	0.00034	6.16	**46**	-
C-6	8.44	0.0043	6.16	**67**	-
C-7	8.01	0.0085	6.16	**72**	-
C-8	7.86	0.0036	6.16	**65**	-
C-9	7.65	0.0077	6.16	**71**	-
C-10	7.11	0.0042	6.16	**65**	-
Gore Road Tributary					
G-1A	6.04	0.0012	4.79	**52**	-
G-1B	5.99	0.0012	4.79	**52**	-
G-1C	5.95	0.0049	4.79	**63**	-
G-1D	5.57	0.0042	4.79	61	**65**

Reach	Drainage Area (km^2)	Slope (m/m)	Bankfull Discharge (m^3/s)	TRCA Empirical Mb (m) †	TRCA Mapping Mb (m) ††
G-2A	4.87	0.0042	4.79	**60**	-
G-2B	4.81	0.0052	4.79	**62**	-
G-2C	4.71	0.0045	4.79	**60**	-
G-2D	4.38	0.0050	4.79	**60**	-
G-3	4.28	0.0038	4.79	**57**	-
G-4A	3.99	0.0043	4.79	57	**63**
G-4B	3.81	0.0028	4.79	**53**	-
G-5	3.70	0.0058	4.79	**59**	-
Rainbow Creek Tributary					
R-1 to R-6	4.31	0.0040	4.50	**58**	-

Note: † Includes Empirical Erosion allowance of 2 standard deviations = 17.26 m

†† Includes Mapping Erosion allowance of preliminary Mb x 1.20

2.2.1.10 Slope Stability Hazard Assessments

During the spring and summer of 2011, staff from the City of Brampton, TRCA, and the Aquafor and Candevcon consulting teams completed a set of field investigations during which the Area 47 stream corridors and their valley features were identified. During these investigations, six locations were identified where further study into the long-term stability of the valley slopes was recommended:

- Stability Site No.1 – south bank of the West Humber River (Figure 2.10);
- Stability Site No. 2 – west bank of the Gore Road Tributary (Figure 2.10);
- Stability Sites No. 3, 4, 5, 6 – west and east banks of the Clarkway Tributary (Figure 2.11).

Geotechnical investigations were undertaken in the fall of 2012 and winter of 2013 by AME Materials Engineering at each of the six sites listed above. The geotechnical analyses included borehole investigations and modelling to establish a stable slope line which meets TRCA's policy guidelines against sliding failures. Where the stream was found to be within close proximity to the valley slope, a toe erosion allowance was also recommended in accordance with the MNRF Technical Guide – River & Streams: Flooding and Erosion Hazard Limit. The Geotechnical Investigation Report is included in **Appendix A**. The findings from the report are summarized in **Table 2.7**. The resulting hazard lands are discussed further in relation to the valley features in **Section 2.3**.

Table 2.7: Recommended Slope Stability Setbacks

Stability Site No.	Location	Recommended Long Term Stable Slope Line		Toe Erosion Allowance	Recommended Setback from Top-of-Bank
		Angle	Stability Setback		
1	West Humber River – south bank	1V:2.5H (21.8°)	5m from top-of-bank	8m	13m from top-of-bank
2	Gore Road Tributary – west bank	1V:2H (26.5°)	0.5m from top-of-bank	8m	8.5m from top-of-bank
3	Clarkway Tributary – west bank	1V:2.7H (20°)	0m from top-of-bank	8m	8.0m from top-of-bank
4	Clarkway Tributary – west bank	n/a – existing slope meets stability criteria		0m	n/a
5	Clarkway Tributary – west bank	n/a – existing slope meets stability criteria		0m	n/a
6	Clarkway Tributary – east bank	1V:2.5H (21.8°)	5m from top-of-bank	8m	13m from top-of-bank

2.2.2 Headwater Drainage Feature Assessment

Current Science, and Conservation Authorities and municipal policies recognize that urban development and activities can alter and/or eliminate headwater drainage features (HDFs) both individually and cumulatively, and have broad implications for water quality and quantity, recharge/infiltration, and overall health of downstream habitats and the aquatic and terrestrial integrity within watersheds.

TRCA's Evaluation, Classification and Management of Headwater Drainage Features Interim Guidelines (2009) outlines a three part methodology for the consistent evaluation and classification of the attributes and functions of HDFs in order to identify management recommendations for protection, conservation and mitigation. While the evaluation and classification is undertaken at the site specific scale, the management recommendations consider the cumulative effects on the drainage network, and are implemented through development design, including stormwater management and sustainable management practices. Where available, the HDF assessment must also take into consideration the recommendations of the relevant Fisheries Management Plan (FMP), Subwatershed or Watershed Plans.

During field investigations with TRCA and City of Brampton staff in 2011, several headwater drainage features (HDFs) were identified throughout the Area 47 study area for further investigation and evaluation. The locations of these HDFs are illustrated in **Figure 2.13**. Aquafor has subsequently completed assessments for each of these features. Most of the HDFs drain to the three main watercourses within the study area, namely the Gore Road Tributary, Clarkway Tributary, and Rainbow Creek Tributary. The assessment followed the procedures defined within the Evaluation, Classification, and Management of Headwater Drainage Features Interim Guidelines (TRCA, 2009) to categorize and to make management recommendations for each HDF under proposed future urbanization.

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

WATERCOURSE

HEADWATER DRAINAGE FEATURE (HDF)

SCALE: 1:16,000

HEADWATER DRAINAGE FEATURE LOCATIONS

FIGURE 2.13

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2.2.2.1 HDF Evaluation Methods

As recommended within the TRCA (2009) protocol, field identification and verification of HDFs was performed by TRCA planning and ecological staff during valley top-of-bank walks of the Gore Road Tributary, Clarkway Tributary, and Rainbow Creek Tributary in spring and summer of 2011. The TRCA was accompanied for these walks by representatives of the City of Brampton and consulting teams from Aquafor Beech and Candevcon.

During the field walks, the valley top-of-bank was delineated to identify future development constraints, and HDFs were marked at the intersection with the valley top of bank. In order to geographically reference the location of each HDF, numbered stakes were placed in the ground at the intersection and later surveyed. During the site walks, photos and notes were taken with regard to relevant discussion of HDF features.

The study area was then revisited later in 2011 and the TRCA (2009) HDF Assessment Protocol was applied to each feature. The majority of HDFs were defined as a single reach beyond the top-of-bank, and a consistent classification was applied to the extent of the feature. Where the features were more significant, reaches were delineated beyond the top-of-bank and each reach was classified accordingly.

The steps undertaken for each classification included: flow assessment; channel form; aquatic habitat assessment; vegetation and wetland assessment; and the linkages (referred to as Part 1, TRCA, 2009). Data collected during the evaluation is then used to identify the appropriate fish habitat classification as presented in Figure 2.23 (Part 2, TRCA, 2009), resulting in a suitable management recommendation for the specific HDF site (Part 3, TRCA, 2009). For each HDF, representative photos were taken where the assessment was performed at a representative location within the feature. This was generally beyond the pre-defined valley or constraint limits. An example is provided in **Figure 2.14** below with photos numbered in the following order:

1. Upstream – into table lands;
2. Downstream – into valley lands;
3. Bed material; and
4. Representative channel measurement location (where applicable).

The complete photo inventory is provided in **Appendix C**.

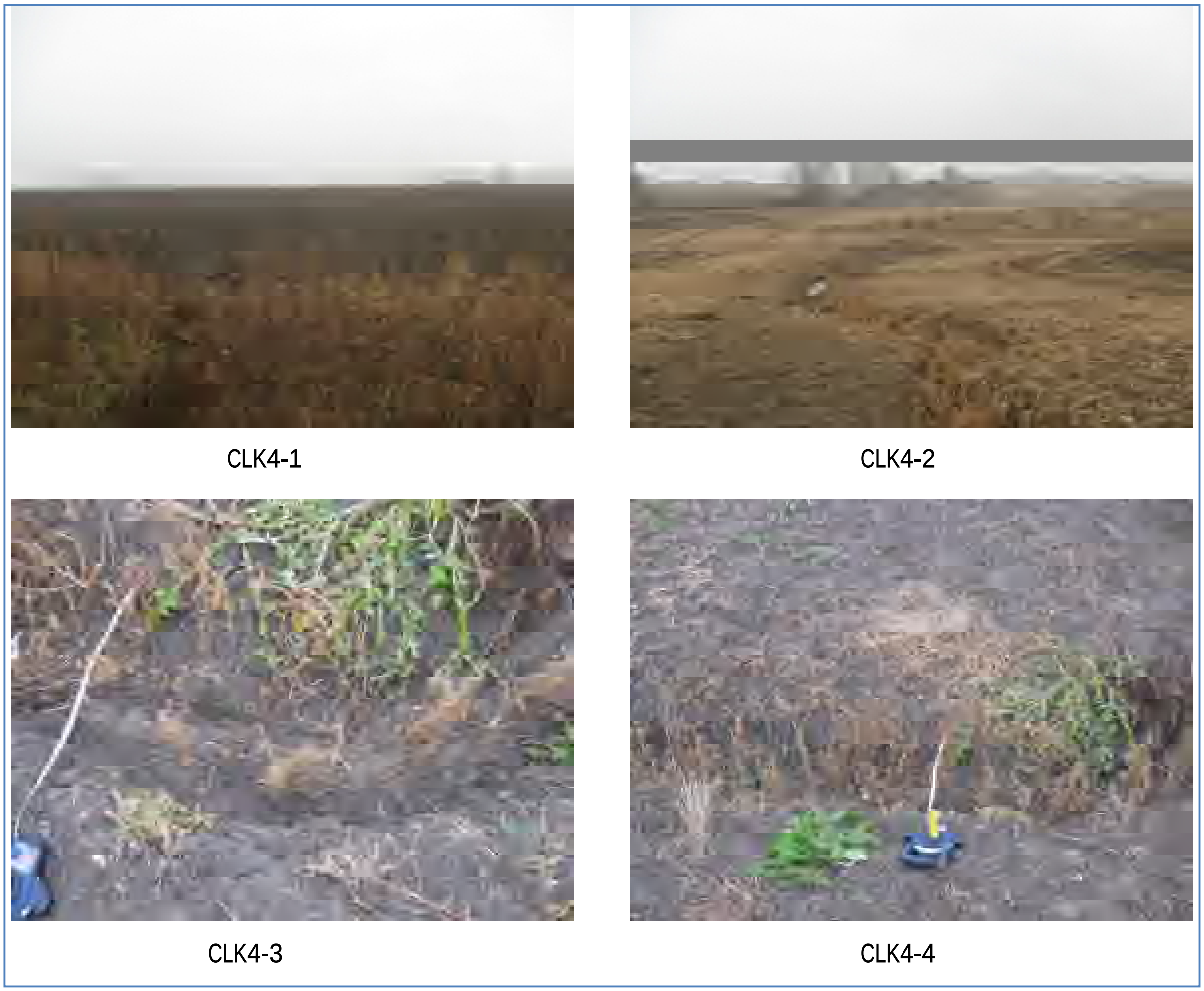

Figure 2.14: Photo Summary of Clarkway-4 Headwater Drainage Feature (HDF)

2.2.2.2 HDF Classification Results and Management Recommendations

During the screening top-of-bank walks, the TRCA, City and consulting teams identified a total of 44 HDFs within the Area 47 study extents. Each HDF was associated with one of the three primary tributaries running longitudinally through the site, with the exception of three HDFs which cross Regional Road 50. Of these three HDFs, two drain to Robinson Creek downstream of Regional Road 50, while the other drains to Rainbow Creek downstream of Regional Road 50. The HDF features are named and numbered accordingly. The breakdown includes:

- Clarkway Tributary – 16 HDFs;
- Gore Road Tributary – 17 HDFs;
- Rainbow Creek Tributary – 9 HDFs (one of which drains to Regional Road 50); and
- Robinson Creek Tributary (draining to Regional Road 50) – 2 HDFs.

The goal of each assessment was to determine the appropriate management technique as defined within TRCA (2009). The results of the HDF evaluations are presented in **Table 2.8**, **Table 2.9**, **Table 2.10** and **Table 2.11**. As shown, the management recommendations are developed using the following evaluations criteria:

- Flow class (no flow, intermittent, ephemeral, perennial);
- Representative size (width, depth);
- Vegetation;
- Linkages; and
- Aquatic habitat (none, simple contributing, complex contributing, seasonal, permanent).

Further descriptions of these evaluation criteria are defined within TRCA (2009). Based on the findings summarized in **Table 2.8**, **Table 2.9**, **Table 2.10** and **Table 2.11**, the Area 47 HDFs were assigned one of the following management recommendations:

- Protection;
- Conservation;
- Mitigation 1 / Mitigation 2; or
- No management.

Figure 2.15 illustrates the location and the resulting recommended management techniques for each of the HDFs.

Table 2.12 outlines the implications for future development planning associated with each of the management recommendations defined within TRCA (2009). In terms of constraints to future development within the Area 47 study area, the following is recommended:

- Those HDFs recommended for "Protection" should remain as open watercourses at their current location. Future stormwater management planning will require that flows be maintained to these features, via storm pond outfalls, LID swales or other techniques. These include:
    - Gore Road HDF 2 – Reach 1; and
    - Clarkway HDF 15 – Reach 1.

- Those HDFs recommended for "Conservation" should remain as open watercourses, and future stormwater management planning will require that flows be maintained to these features. Although not preferred, some modification/relocation of these features may be considered, to obtain a suitable storm pond outlet, for example. These include:
    - Gore Road HDF 2 – Reach 2;
    - Clarkway HDF 7 – Reach 1; and

    - Robinson Creek Tributary HDF 1 – Reach 1.

  Any proposed modifications to these features would require further analysis and approval from the City and TRCA.

- Rainbow HDF-4 is also recommended for "Conservation". This drainage feature was identified for assessment as an HDF as part of initial field surveys. However, further investigations have concluded that recent upstream drainage modifications at Coleraine Drive have diverted the main channel of the Rainbow Creek Tributary to this feature via the roadside ditch. Therefore, the feature should remain as an open watercourse until such time as potential future restoration measures are developed to define a permanent drainage solution at this location.

- HDFs classified as "Mitigation 1" or "Mitigation 2" could either remain as open watercourses provided that flows can be maintained (via stormwater pond outlets, LID swales or other techniques), or be replicated using well-vegetated urban swales or wetlands (Mitigation 1), or lot-level and conveyance stormwater techniques such as low impact development (LID) measures.

- Those HDFs with "No Management" classification could be eliminated and replaced with a traditional urban major-minor drainage system.

It should be noted that base mapping for the study area illustrates other small drainage features and/or ditches not covered by the HDF evaluations. During the top-of-bank field investigations these features were either not found or were deemed insignificant by Aquafor and TRCA staff. As such, these other small features have no management recommendations.

It is also important to note that HDF reaches located within the floodplains and valley corridors of the primary watercourses will be inherently protected and remain as open watercourses, regardless of the management recommendations made here. Future drainage designs should ensure that contributing drainage is maintained to these features. Stream and valley corridors are discussed in more detail in **Section 2.3**.

Table 2.8: Evaluation Results and Management Recommendation for Clarkway Tributary HDFs.

HDF No. & Reach No.	Management Recommendation	Flow Class	Representative W:D (m)	Vegetation	Linkages	Aquatic Habitat
Clarkway 1 ***Reach 1***	Mitigation 1	Intermittent	2.0 : 0.2	Hedgerow – 4m wide straightened corridor	Y	Complex Contributing
Clarkway 1 ***Reach 2***	Mitigation 2	Ephemeral	1.0 : 0.15	Agriculture	Y	Not Fish Habitat
Clarkway 2	No Management Required	Ephemeral	N/A – No Definition	Grasses	N	Not Fish Habitat
Clarkway 3	Mitigation 2	Ephemeral	1.7 : 0.2	In-channel grasses & surrounding agriculture	N	Not Fish Habitat
Clarkway 4 ***Reach 1***	Mitigation 1	Intermittent	0.75 : 0.4	Agriculture & longer grasses	Y	Complex Contributing
Clarkway 4 ***Reach 2***	No Management Required	Ephemeral	0.5 : 0.1	Agriculture	N	Not Fish Habitat
Clarkway 5	No Management Required	Ephemeral	0.8 : 0.25	Agriculture	N	Not Fish Habitat
Clarkway 6	No Management Required	Ephemeral	0.75 : 0.15	Agriculture	N	Not Fish Habitat
Clarkway 7 ***Reach 1***	Conservation 2	Intermittent	4.4 : 0.15	Grasses, shrubs, flowers	N	Simple Contributing Habitat
Clarkway 7 ***Reach 2***	Mitigation 2	Ephemeral	1.5 : 0.15	In-channel grasses & surrounding agriculture	N	Not Fish Habitat
Clarkway 8	No Management Required	Ephemeral	N/A – No Definition	Agriculture	N	Not Fish Habitat

HDF No. & Reach No.	Management Recommendation	Flow Class	Representative W:D (m)	Vegetation	Linkages	Aquatic Habitat
Clarkway 9	Mitigation 2	Ephemeral	1.0 : 0.22	Agriculture	N	Not Fish Habitat
Clarkway 10	No Management Required	Ephemeral	1.5 : 0.17	Agriculture	N	Not Fish Habitat
Clarkway 11	No Management Required	Ephemeral	N/A – No Definition	Agriculture	N	Not Fish Habitat
Clarkway 12	No Management Required	Ephemeral	0.8 : 0.2	Agriculture	N	Not Fish Habitat
Clarkway 13	No Management Required	Does Not Flow	N/A – No Definition	Grasses, shrubs	N	Not Fish Habitat
Clarkway 14	No Management Required	Ephemeral	1.1 : 0.17	Agriculture	N	Not Fish Habitat
Clarkway 15 *Reach 1*	Protection 2	Intermittent	1.5 : 0.3	Grasses, shrubs, flowers	Y	Seasonal Fish Habitat
Clarkway 15 *Reach 2*	Mitigation 1	Ephemeral	1.0 : 0.15	In-channel grasses & surrounding agriculture	Y	Complex Contributing Habitat
Clarkway 15 *Reach 3*	Mitigation 2	Ephemeral	0.75 : 0.15	Agriculture	N	Not Fish Habitat
Clarkway 16 *Reach 1*	Mitigation 1	Ephemeral	1.5 : 0.25	Agriculture and long grasses	Y	Complex Contributing Habitat / Simple Contributing Habitat
Clarkway 16 *Reach 2*	Mitigation 2	Ephemeral	0.7 : 0.1	Agriculture	N	Simple Contributing Habitat

Table 2.9: Evaluation Results and Management Recommendation for Gore Rd. Tributary HDFs

HDF No. & Reach No.	Management Recommendation	Flow Class	Representative W:D (m)	Vegetation	Linkages	Aquatic Habitat
Gore 0	Mitigation 2	Ephemeral	0.9 : 0.25	Agricultural	N	Simple Contributing
Gore 1	Mitigation 2	Ephemeral	0.7 : 0.25	Agricultural	N	Simple Contributing Habitat
Gore 2 ***Reach 1***	Protection 2	Perennial	2.2 : 0.65	10 to 20m of wooded corridor with agricultural lands beyond	Y	Permanent
Gore 2 ***Reach 2***	Conservation 2	Intermittent	1.5 : 0.3	Grasses and Shrubs	Y	Seasonal
Gore 2 ***Reach 3***	Mitigation1	Ephemeral	1.5 : 0.3	Grasses and Shrubs	Y	Complex Contributing Habitat / Simple Contributing Habitat
Gore 2 ***Reach 4***	Mitigation2	Ephemeral	1.5 : 0.4	Agricultural and grasses	Y	Simple Contributing Habitat
Gore 3	No Management Required	Ephemeral	0.65 : 0.1	Agricultural	N	Not Fish Habitat
Gore 4	Mitigation 2	Ephemeral	0.6 : 0.16	Agricultural	Y	Simple Contributing Habitat
Gore 5	Mitigation 2	Ephemeral	0.6 : 0.25	Agricultural	N	Simple Contributing Habitat

HDF No. & Reach No.	Management Recommendation	Flow Class	Representative W:D (m)	Vegetation	Linkages	Aquatic Habitat
Gore 6	No Management Required	Ephemeral	0.6 : 0.15	Agricultural	N	Not Fish Habitat
Gore 7	Mitigation 2	Ephemeral	1.0 : 0.2	Agricultural	N	Simple Contributing Habitat
Gore 8	No Management Required	Does Not Flow	N/A - No Definition	Agricultural	N	Not Fish Habitat
Gore 9	No Management Required	Ephemeral	N/A - No Definition	Agricultural	N	Not Fish Habitat
Gore 10	No Management Required	Does Not Flow	N/A - No Definition	Agricultural	N	Not Fish Habitat
Gore 11	No Management Required	Does Not Flow	N/A - No Definition	Agricultural	N	Not Fish Habitat
Gore 12	Mitigation 1	Intermittent	0.65 : 0.1	Agricultural	Y	Simple Contributing Habitat
Gore 13	No Management Required	Ephemeral / Does Not Flow	0.4 : 0.15	Agricultural	N	Not Fish Habitat
Gore 14	No Management Required	Does Not Flow	N/A - No Definition	Agricultural	N	Not Fish Habitat
Gore 15	No Management Required	Ephemeral	0.3 : 0.1	Agricultural	N	Not Fish Habitat
Gore 16	Mitigation 2	Ephemeral / Does Not Flow	0.5 : 0.1	Agricultural	N	Simple Contributing Habitat

Table 2.10: Evaluation Results/Management Recommendation for Rainbow Creek Tributary HDFs

HDF No. & Reach No.	Management Recommendation	Flow Class	Representative W:D (m)	Vegetation	Linkages	Aquatic Habitat
Rainbow 1	Mitigation 2	Ephemeral	4.0 : 0.1	Agricultural	N	Simple Contributing Habitat / Not Fish Habitat
Rainbow 2	No Management Required	Ephemeral	3.0 : 0.1	In-channel grasses & surrounding agriculture	N	Not Fish Habitat
Rainbow 3	No Management Required	Ephemeral	N/A - No Definition	Agricultural	N	Not Fish Habitat
Rainbow 4*	*Conservation 2**	*Intermittent /Permanent**	*4.5 : 0.5*	*Long Grasses and Instream Vegetation*	*Y*	*Complex Contributing Habitat / Seasonal*
Rainbow 5	No Management Required	Ephemeral	1.5 : 0.20	Agricultural	N	Not Fish Habitat
Rainbow 6 ***Reach 1***	Mitigation 1	Intermittent	1.5 : 0.25	Agricultural	Y	Complex Contributing Habitat
Rainbow 6 ***Reach 2***	Mitigation 2	Ephemeral	1.3 : 0.15	Agricultural	Y	Simple Contributing Habitat
Rainbow 7	No Management Required	Ephemeral	1.0 : 0.05	Agricultural	N	Not Fish Habitat
Rainbow 8	No Management Required	Ephemeral	1.0 : 0.05	Agricultural	N	Not Fish Habitat

HDF No. & Reach No.	Management Recommendation	Flow Class	Representative W:D (m)	Vegetation	Linkages	Aquatic Habitat
Rainbow 9 (Hwy 50)	Mitigation 2	Ephemeral	1.5 : 0.25	Agricultural Swale	Y	Simple Contributing Habitat

* Note: Rainbow-4 drainage feature was identified for assessment as an HDF as part of initial field surveys. However, further investigations have concluded that recent upstream drainage modifications at Coleraine Dr. have directed the main channel of the Rainbow Creek Tributary to this feature.

Table 2.11: Evaluation Results and Management Recommendation for Robinson Creek HDFs

HDF No. & Reach No.	Management Recommendation	Flow Class	Representative W:D (m)	Vegetation	Linkages	Aquatic Habitat
Robinson 1 ***Reach 1***	Conservation 2	Intermittent	2 : 0.4	Long native grasses and shrubs	Y	Complex Contributing
Robinson 1 ***Reach 2***	Mitigation 2	Ephemeral	2 : 0.3	Agricultural Swale	Y	Simple Contributing Habitat
Robinson 2	Mitigation 2	Ephemeral	1.5 : 0.3	Agricultural Swale	Y	Simple Contributing Habitat

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

WATERCOURSE

APPROXIMATE PHOTO LOCATION (See Appendix)

MANAGEMENT RECOMMENDATION:

PROTECTION

CONSERVATION 2

MITIGATION 1

MITIGATION 2

NO MANAGEMENT REQURIED

Note: All HDF features located within stream/valley corridors to be protected

SCALE: 1:16,000

HDF MANAGEMENT RECOMMENDATIONS

FIGURE 2.15

AQUAFOR PROJECT NO.: 64608

AquaforBeech Limited

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Table 2.12: Implications for Development Associated with Management Recommendations (adapted from TRCA, 2009).

	Must Remain Open	Able to Relocate	Maintain External Sources of Flow	Direct Connection Downstream	Replicate Using Enhanced Lot Level Conveyance
Protection 1	Yes	Not Permitted	Maintain	Maintain	N/A
Protection 2	Yes	Given Consideration, Not Preferred	Maintain	Maintain	N/A
Conservation 1	Yes	Given Consideration, Not Preferred	Maintain	Maintain	N/A
Conservation 2	Yes	Given Consideration	Maintain	Maintain	N/A
Mitigation 1	Preferred	Natural Channel Design not Required	Maintain	Maintain	Replicate Using well-vegetated Swales or Wetlands
Mitigation 2	Preferred	Natural Channel Design not Required	N/A	Preferred	LID Measures or Swales & Wetlands
No Management	No	N/A	N/A	N/A	N/A

2.2.3 Hydrology and Floodplain Hazard Lands

This section of the report reviews the hydrology of the Area 47 watercourses with the key objective of defining floodplain hazard constraints related to future urban development. The findings from a brief streamflow and rainfall monitoring program are also reviewed and compared to the findings from the water balance assessment from Section 2.1.8.

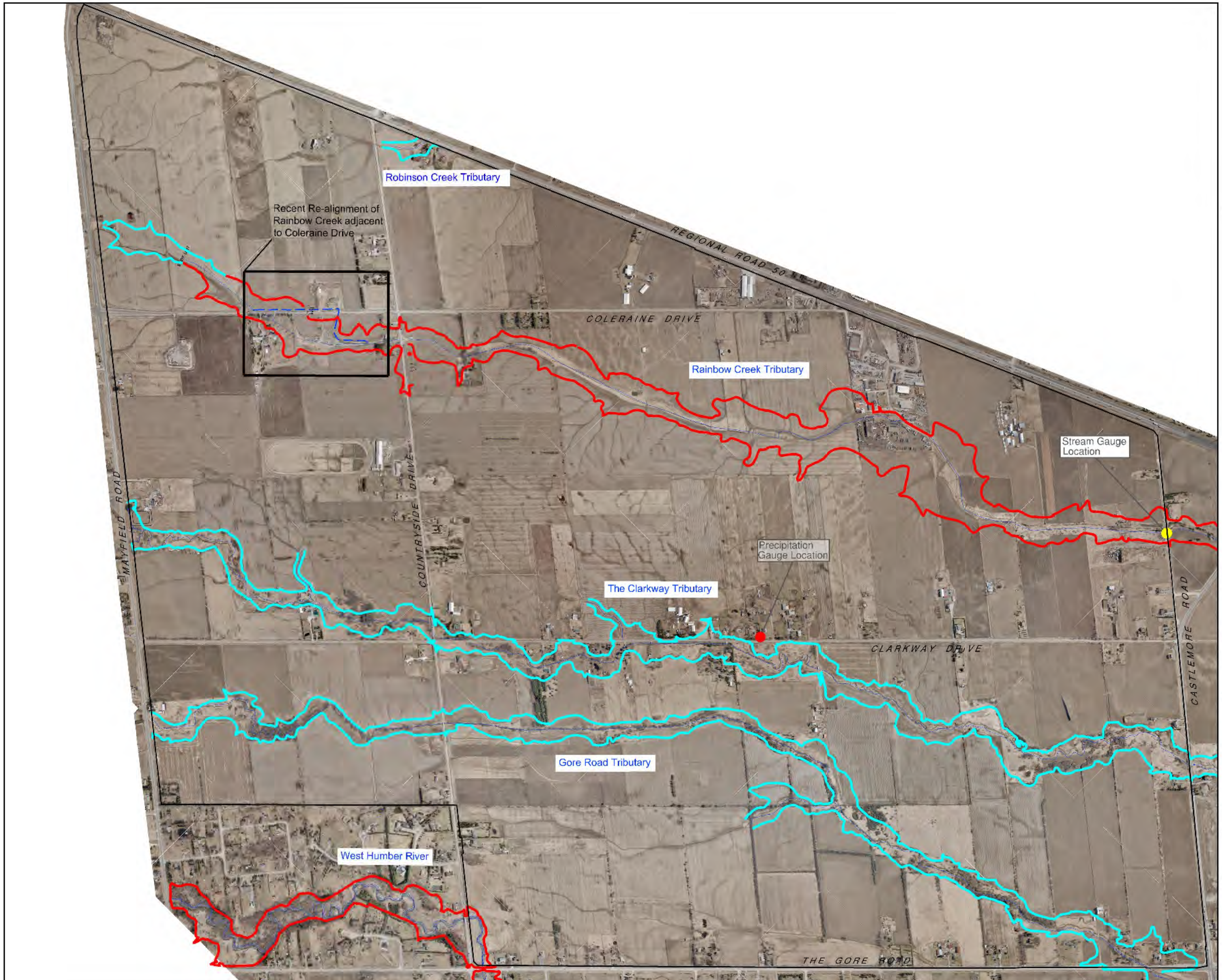
2.2.3.1 Streamflow and Rainfall Monitoring Program

As part of a preliminary Phase 1 MESP Study for Area 47 (Aquafor, 2009) a monitoring program was undertaken to collect precipitation and streamflow data within the study area. A precipitation gauge was installed near Clarkway Drive, south of Countryside Drive. A streamflow gauge was also installed on Rainbow Creek just upstream of Castlemore Rd (**Figure 2.16**).

Precipitation and streamflow data was collected in five minute intervals over the summer and fall of 2007. This year was one of the driest on record and offered very little meaningful data. Therefore, the monitoring program was undertaken again between July and October of 2008. This year was much more representative, with several rainfall-runoff events.

The raw water level readings from the Rainbow Creek Tributary monitoring gauge were converted to streamflow by first accounting for standing water depths and then translating the water levels to flow rates using a rating curve developed for the culvert crossing at Castlemore Road. The geometry of the low flow channel and culvert cross section at this location was established through field work and review of the Toronto and Region Conservation Authority's HEC-RAS hydraulic model for Rainbow Creek (see **Section 2.2.3.2**). The rating curve and gauge data plots are provided in **Appendix D**.

The total observed rainfall and runoff volumes over the 2008 monitoring period are compared in **Table 2.13**. The results from the water budget assessment for Area 47 (see **Section 2.1.8**) are also provided for comparison. As shown, although the runoff estimates derived from the streamflow gauge data are only relevant over the operative time periods, the results compare favourably with those from the water balance computations (see **Section 2.1.8**).



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STUDY AREA
- WATERCOURSE
- REGULATORY FLOODLINE (TRCA)
- REGULATORY FLOODLINE (AQUAFOR, 2013)
- 2007-2008 STREAMFLOW MONITORING LOCATION
- 2007-2008 PRECIPITATION GAUGE LOCATION

SCALE: 1:16,000

SURFACE WATER MONITORING AND FLOOD HAZARDS

FIGURE 2.16

AQUAFOR PROJECT NO.: 64608

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Table 2.13: Rainfall-Runoff Comparison

	Date / Time (Days)	Precipitation (mm)	Runoff (mm)	Rainfall-Runoff Coefficient
2008 Monitoring	07 July to 22 October (107 Days)	303.3	48.4	0.16
*Annual Water Balance**	*1971-2000* *Annual Climate Normals*	*792.1*	*162.1*	*0.20*

* See **Section** 2.1.8 for discussion of annual water budget

2.2.3.2 Floodplain Hazard Lands

Floodplain lands are regulated by TRCA and represent constraints to future urban development due to the inherent flood hazards that they represent. The primary function of a floodplain is the conveyance of flood waters during extreme storm events and spring melts. The extents and depths of a floodplain are dependent on the shape of the associated stream/ valley system, the flow rate and the presence of man-made structures (road crossings, buildings, etc.).

2.2.3.3 Flood Flows

The current Regulatory flood flows for the Humber River watershed were established using the SWMHYMO hydrologic model as part of TRCA's 2002 Humber River Hydrology Update Study (Aquafor Beech, 2002). The flood flow rates from the 2002 study within the Area 47 watercourses are summarized in **Table 2.14**. Regulatory flood flows for the primary Area 47 watercourses (i.e. West Humber River, Gore Road Tributary, Clarkway Tributary, and Rainbow Creek Tributary) are those resulting from Hurricane Hazel which is the Regional Storm used over most of southern Ontario.

The model scenario used in the 2002 study to define the flood flows was based on Municipal Official Plans at the time (i.e. 2002). Through a series of recent studies, the Town of Caledon has recommended an urban boundary expansion immediately north of Area 47 within the headwaters of the Clarkway Tributary which is beyond what was assumed in the 2002 Humber Hydrology Study to establish flow rates on the this watercourse.

The impact of Caledon's expanded urban area was modelled as part of the South Albion-Bolton Environmental Impact Study and Management Plan (Aquafor, 2012). The resulting updated flood flow rates on the Clarkway Tributary are also included in **Table 2.14**. As shown, the expanded urban area results in increased flood flows within the Clarkway Tributary, including the Regional Storm. As such, the 2012 South Albion-Bolton study concluded that stormwater ponds within the Caledon urban expansion area would require flood (quantity) control such that post-development flows are controlled to pre-development rates for all storm events up to and including the Regional Storm.

Table 2.14: Flood Flow Rates on Primary Area 47 Watercourses

Watercourse	Location	Study Source	Flow Node / Reference Location	Area (sq.km)	Flood Flow Rate (m^3/s)						
					2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	Regional
The Main Branch of West Humber	Countryside Dr. (Interpolated)	2002 Humber River Watershed Hydrology Update	38.2	31.6	11.5	18.9	23.4	29.7	34.4	39.3	126.3
The Gore Road Tributary	Mayfield Road	2002 Humber River Watershed Hydrology Update	41.3	5.9	3.8	5.7	7.1	8.9	10.3	11.7	34.5
	Countryside Drive	2002 Humber River Watershed Hydrology Update	41.2	6.6	4.1	6.3	7.9	10.0	11.6	13.2	37.7
	Castlemore Road	2002 Humber River Watershed Hydrology Update	41.0	8.8	4.8	7.7	9.8	12.6	14.6	16.7	47.6
The Clarkway Tributary	Mayfield Road	2002 Humber River Watershed Hydrology Update	43.2	6.2	8.3	13.8	18.6	23.1	26.3	29.5	48.7
		2012 South Albion-Bolton EIS & Management Plan*	43.2	6.6	11.3	18.1	22.8	29.6	34.5	39.8	69.4
	Castlemore Road	2002 Humber River Watershed Hydrology Update	43.0	9.6	6.2	9.0	11.1	13.8	16.7	19.7	73.2
		2012 South Albion-Bolton EIS & Management Plan*	43.0	10.1	10.1	15.4	19.5	24.7	29.4	34.3	92.2
Rainbow Creek Tributary	Coleraine Drive	2002 Humber River Watershed Hydrology Update	base of catchment 24.0	1.3	3.2	6.2	8.8	12	14.5	17.1	46.8
	Cadetta Road	2002 Humber River Watershed Hydrology Update	base of catchment 24.1	3.1	3.5	7.5	11.2	15.4	18.9	22.4	48.3
	Castlemore Road	2002 Humber River Watershed Hydrology Update	24.21	4.8	3.8	7.6	11.1	15.7	20.0	23.4	52.3

* Updated flood flow rates for Clarkway Tributary reflect urban boundary expansion in Town of Caledon.

2.2.3.4 Hydraulic Modelling and Floodplain Mapping

TRCA has established hydraulic models and Regulatory floodplain mapping over much of the Humber River watershed. The models and floodplain mapping are based on flood flows from the 2002 Humber Hydrology Update Study. Within the Area 47 study area, existing hydraulic models and TRCA Regulatory floodplain mapping covers the following reaches of the primary watercourses:

- The West Humber River Main Branch;
- The Clarkway Tributary from Castlemore Road northerly for approximately 1.5km; and
- The Rainbow Creek Tributary from Castlemore Road to just south of Mayfield Road.

TRCA's existing floodplain mapping for the Gore Road Tributary did not extend into Area 47.

The HEC-RAS hydraulic models associated with the above floodplain mapping were provided by TRCA and were then extended as part of this MESP to define the flood hazards over those reaches within Area 47 which did not already have floodplain mapping established. These reaches include:

- The Gore Road Tributary over the study area, from The Gore Road north to Mayfield Road;
- The Clarkway Tributary, from the end of the TRCA model (i.e. approximately 1.5km north of Castlemore Road) north to Mayfield Road; and
- The Rainbow Creek Tributary from the end of the TRCA model, north to Mayfield Road.

In addition to the above model extensions, the HEC-RAS models were also extended to define floodplain hazards for each of the following headwater drainage features (HDFs) which were identified for "Protection" or "Conservation" in **Section 2.2.2**. These HDFs were recommended to remain as open watercourses in the future urban landscape. These HDFs include:

<u>Protection:</u>

- Gore Road HDF 2 – Reach 1; and
- Clarkway HDF 15 – Reach 1.

<u>Conservation:</u>

- Gore Road HDF 2 – Reach 2;
- Clarkway HDF 7 – Reach 1; and
- Robinson Creek Tributary HDF 1 – Reach 1.

The Robinson Creek Tributary HDF was included within the TRCA HEC-RAS model for Rainbow Creek. For the remaining Gore Road and Clarkway HDFs, the "parent" tributary models were expanded to include the HDF reaches. Flood flows applied to each of these HDF's were estimated, on a drainage area basis, in proportion to their "parent" watercourses. The estimated Regional Storm flow rates applied to each of the HDFs is summarized in **Table 2.15**.

For those HDFs classified as "Conservation" it is understood that, although not preferred, some alteration and/or relocation may be considered through future stormwater management planning, such as modifications to achieve a storm pond outfall and maintain flows to the HDF, for example. If pursued, any modifications would require that the proposed channel provide sufficient capacity to convey the Regional Storm flood flows and maintain the existing flood storage volumes.

Table 2.15: Flood Flow Rates on Area 47 Headwater Drainage Features

Headwater Drainage Feature	"Parent" Subwatershed Flows				HDF Flow Estimates*	
	Name	Flow Node / Reference	Area (sq.km)	Regional Flow Rate (m^3/s)	Area (sq.km)	Regional Flow Rate (m^3/s)
Gore HDF-2	Gore Road Tributary	41.0	8.78	47.6	0.54	**5.9**
Clarkway HDF-7	Clarkway Tributary	43.0	9.60	73.2	0.39	**6.6**
Clarkway HDF-15	Clarkway Tributary	43.0	9.60	73.2	0.31	**5.6**
Robinson HDF-1 (to Reg.Rd. 50)	n/a - tributary Regional Flow provided by TRCA					**7.9**

* Flow estimates based on MTO equation for proportional drainage areas: Q2 = Q1 x (A2/A1)^0.75

Input for the model extensions consisted of flood flow rates and geometric data to define the drainage system, including channel cross-sections, bridge/culvert crossings and overflow (road) profiles. Provided below is a summary of the model extension setup:

- Cross-sections were developed from City of Brampton topographic base mapping;
- Surveys were completed to collect culvert opening dimensions, invert elevations, and overflow weir profiles of the roadway. Summary data from the surveys is provided in Appendix D. The following structures were coded into the model extensions:
    - Gore Road Tributary:
        - Castlemore Road – 12.2m wide bridge
        - The Gore Road – 9.3m wide bridge
        - Countryside Drive – 5.5m wide box culvert
        - Mayfield Road – 7m wide box culvert
    - Clarkway Tributary:
        - Private Crossing – 6.1m wide box culvert
        - Clarkway Drive – 6.5m wide box culvert
        - Countryside Drive – 5.5m wide box culvert
        - Mayfield Road – 5m wide box culvert
- TRCA's standard Manning's roughness values were applied. Values of 0.080 and 0.035 were applied for the overbanks and main channel, respectively; and
- The expansion and contraction coefficients were set to the recommended values of 0.1 and 0.3. These values were increased to 0.3 and 0.5 on the upstream and downstream sides of culvert crossing structures.

Regarding the modelling for the Clarkway Tributary, current MNR policy requires that Regulatory floodlines be mapped under the assumption that upstream stormwater control facilities are non-functional. Therefore, although future development in the Town of Caledon urban expansion area is expected to include quantity controls to address increased Regional Storm flood flows, the hydraulic modelling and floodplain mapping for the Clarkway Tributary are based on the updated uncontrolled 2012 flood flows that are listed **Table 2.14**.

HEC-RAS hydraulic model results are provided in **Appendix D**. For the Clarkway Tributary, a comparison between model results using the previous 2002 flood flow rates and the updated 2012 flood flows are also provided in **Appendix D**.

The resulting floodplain hazard lands, including those provided by TRCA and the floodplain mapping extension completed as part of this MESP study are illustrated in **Figure 2.16**. A larger scale plot is also provided at the back of the report. As shown, the West Humber River is contained within its well-defined valley corridor in the northwest portion of Area 47. The Gore Road Tributary and Clarkway Tributary are also relatively confined within their valley corridors even though the corridors are ill-defined in some places. The Rainbow Creek Tributary corridor is an ill-defined valley and, as a result, its floodplain is very wide and shallow in places, particularly through the existing small industrial subdivision at Cadetta Road. A portion of the road and surrounding properties are within the wide floodplain at this location.

As shown in **Figure 2.16**, the bridge/culvert crossings at Castlemore Road and Countryside Drive are overtopped at each of the Gore Road Tributary, Clarkway Tributary and Rainbow Creek Tributary. Portions of Clarkway Drive and the associated culvert structure for the Clarkway Tributary are also flood susceptible. Therefore, replacement of these existing culvert structures with larger, higher capacity openings are recommended as part of future road widening/improvement initiatives to reduce or eliminate flood-susceptibility.

As noted earlier in **Section 2.2.1.7** the Rainbow Creek Tributary drainage has been modified at Coleraine Drive (Reach 5), where most upstream flows appear to have been re-directed to the roadside ditch before rejoining the main watercourse further south and west of the road. The TRCA hydraulic model and Regulatory floodplain mapping do not reflect these recent works. Further hydraulic modelling work is therefore recommended to update the floodplain mapping as future planning and design proceeds in this area. This analysis is necessary for future development of this area or it could also be undertaken as part of future restoration works or in conjunction with future roadway and culvert improvement works that are scheduled for the area.

2.2.3.5 Rainbow Creek Tributary Floodplain

As illustrated in **Figure 2.16** (and calculated through the HEC-RAS hydraulic model in Appendix D), the Rainbow Creek Tributary corridor is defined by a wide and shallow floodplain, that includes a portion of Cadetta Road and the surrounding industrial properties. During the development of the MESP, Candevcon on behalf of the Area 47 Landowners Group approached the City of Brampton and TRCA to examine opportunities to modify / reconfigure the Rainbow Creek Tributary Regulatory Storm floodplain to achieve land use efficiencies, and to provide opportunities to improve both the stormwater drainage system and natural heritage system within the future landscape.

In general, the alteration and interference of valley and stream corridors, including modifications to watercourses, flood hazards, and lands within valley and stream corridors to accommodate or facilitate new development is not permitted through municipal and watershed policies. In order for the City and TRCA to consider such as option, the traditional approach of protecting the existing corridor, as defined by the wide shallow floodplain will have to be assessed against modifications that would result in:

- Permanent remediation and reduction of risk to existing development;
- Serve to improve public safety; and

- Demonstrate no negative impacts to the natural features and their ecological functions while also significantly and comprehensively improving ecological conditions and connections.

As such, the MESP examines a more proactive and innovative approach to NHS planning that will offer multiple ecological and engineering benefits to the City, TRCA and the landowners. Further discussion on recommendations for the Rainbow Creek corridor is provided in **Section 6**.

2.3 Stream and Valley Corridors

Watercourses are often associated with valley formations and together are comprised of inherent natural hazard features such as floodplain lands, meander belt/erosion hazards, and slope stability hazards. Together, these natural hazard land features form a set of stream and valley corridors that are to be protected or preserved in public ownership as future urban development proceeds.

During the spring and summer of 2011, staff from the City of Brampton, TRCA, and the Aquafor and Candevcon consulting teams completed a set of field investigations during which the Area 47 stream corridors and their valley features were identified. Where valley features were present, the physical crest of slope (referred to as top-of-bank) locations were staked and surveyed. The driplines of woodlands and other riparian vegetation features were included in the surveys wherever these features were found to extend beyond the physical crest of slope. The resulting Area 47 valley features, represented by the top-of-bank surveys are illustrated in Figure 2.17.

Towards the northwest portion of the study area, the West Humber River is contained in a well-defined valley. The Gore Road and Clarkway Tributaries were also found to have relatively well-defined valley features, with top-of-bank locations surveyed over much of the stream length. However in some areas of these tributaries, the valleys are ill-defined with no discernible top-of-bank features. The Rainbow Creek Tributary, by contrast, lacks a well-defined valley feature, with discernible top-of-bank locations identified and surveyed over only select reaches near Countryside Drive and Mayfield Road.

As illustrated in Figure 2.17, stream and valley corridors through the Area 47 study area were defined by the greater of the following features:

- The valley features as defined by surveyed top-of-bank locations;
- Floodplain hazard lands;
- Meander belt hazard lands; and
- Slope stability hazards.

Section 2.2.3.2 outlines the floodplain hazard lands, and **Section** 2.2.1.9 established meander belt hazard lands. Further geotechnical work was also undertaken to define slope stability hazards at six locations identified during 2011 field investigations with City and TRCA. The geotechnical investigation recommended setbacks from the top-of-bank location at four of these six sites (**Section** 2.2.1.10). Additional buffers to be applied to the valley corridors are discussed in **Section 3.10**.

The locations of the stream and valley corridors defined through the field work and analyses of this study (Figure 2.17) were found to be relatively consistent with the valleylands depicted within Schedule D of the City of Brampton's Official Plan. In both cases, stream and valley corridors are defined along the following:

- The West Humber River;
- The Gore Road Tributary, including headwater drainage feature Gore Road HDF 2 – Reaches 1 and 2;
- The Clarkway Tributary, including headwater drainage features Clarkway HDF 7 – Reach 1, and Clarkway HDF 15 – Reach 1;
- The Rainbow Creek Tributary; and
- The headwater drainage feature Robinson Creek Tributary HDF 1 – Reach 1.

The City's Official Plan Schedule D also identifies a valleyland feature along the westerly limit of the Area 47 study area which connects to the West Humber River valley immediately adjacent to the Gore Road. Historically, the small headwater drainage feature, HDF Gore-0 **(**Figure 2.15**)**, through this area may have once drained west across The Gore Road and into the West Humber River. However, air photography and mapping indicate that this feature simply drains to the roadside ditch at this location. From here, the drainage continues south along the ditch until discharging into the Gore Road Tributary north of Castlemore Road. This drainage pattern was confirmed during the 2011 field investigations with City and TRCA staff. Further, no discernible valley formation was found.

Therefore, for the purposes of establishing limits of future urban development within Area 47, the stream and valley corridor lands as developed through the analyses and field work of this study and illustrated in Figure 2.17 are carried forward.Special Policy Areas (SPAs)

Three (3) Special Policy Areas (SPAs) have been identified for the Clarkway Tributary that recognize opportunities to improve corridor functions through future grading modifications. A Block Plan Environmental Implementation Report (EIR), submitted to the satisfaction of the City in consultation with TRCA, will address grading opportunities and constraints to improve the ecological features of the Clarkway Tributary and its associated headwater drainage features (HDFs). The areas are illustrated in Figure 2.17 and are discussed below:

- Area A – The area has an ill-defined surveyed top-of-bank and therefore the limits of the Clarkway Tributary valley corridor in this location will be refined.

- Area B – The norther limits of the landform associated with the Clarkway Tributary HDF 16-1 Is identified as an "Area of Grading Opportunity and Constraint". The surveyed top-of-bank within this area (Figure 2.17) may be refined subject to compensation for any change to the extent of the Natural Heritage System in this area. Compensation will be based on a minimum 1:1 ha of tableland area in a location and configuration that improves ecological features and functions. The mitigation/compensation must also include restoration planting.

- Area C – The northern limits of the Clarkway Tributary HDF 15-2 may be refined but must address the maintenance of contributing flows and ecological functions to the downstream portion of HDF 15-1 and the Clarkway Tributary.

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STUDY AREA
- WATERCOURSE
- REGULATARY FLOODPLAIN
- MEANDER BELT
- SURVEYED TOP-OF-BANK
- STABLE SLOPE / EROSION SETBACK
- STREAM AND VALLEY CORRIDOR
- A SPECIAL POLICY AREAS

SCALE: 1:16,000

STREAM AND VALLEY CORRIDORS

FIGURE 2.17

AQUAFOR PROJECT NO.: 64608

AquaforBeech Limited

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2.4 Ecological Resources

The existing natural heritage features present in the Area 47 study area contrast strikingly with pre-settlement conditions. Analysis of 19th century surveyor records throughout the Greater Toronto Area (e.g. Mersey & Puddister, 2003) has revealed a landscape blanketed by deciduous and mixed forest, almost all of which has been cleared for agricultural land uses in the study area. As will become clear below, much of the remaining natural heritage features have resulted from or are maintained by anthropogenic disturbances (i.e. cultural thickets, cultural meadows) and/or are narrow and restricted to watercourse corridors. Nevertheless, remnant patches containing regionally rare biota have endured, and ample opportunities to link, restore and enhance the ecological integrity of the study area are available.

A number of field surveys were conducted in 2012 to inventory and record the type, pattern and significance of natural heritage features and functions and resident biota within the study area. Breeding bird surveys were conducted by North-South Environmental Incorporated. Field surveys included:

- Three-season botanical inventory (2 person days)
- Ecological Land Classification vegetation community delineation (20 person days)
- Hedgerow assessment (4 person days)
- Breeding bird surveys (12 person days)
- Amphibian monitoring surveys (6 person days)
- Aquatic habitat characterization
- Mussel surveys (1 person day)
- Natural/Agricultural pond surveys (2 person days)

In total, 31 field days (equalling 47 person days) were spent on the terrestrial and aquatic resource aspects of this report. Fieldwork dates are listed below in **Table 2.16**.

Table 2.16: Terrestrial and Aquatic Resources Fieldwork Dates, 2012

Month	Day
March	28
April	13, 20
May	8, 9, 25, 29
June	7, 8, 25, 29
July	6, 9
August	15, 16, 21, 22, 23, 24, 28, 30
September	5, 7, 10, 12, 13, 17, 20, 21, 24, 27

2.4.1 Botanical Inventory

Methodology

A comprehensive three-season botanical inventory was completed covering all natural and semi-natural features within the study area, excluding areas where access was denied. A spring botanical survey was completed on May 8th and 9th targeting spring ephemerals. Summer and fall botanical surveys were completed in conjunction with Ecological Land Classification (ELC) vegetation community delineation during the months of August and September. A few previously unobserved species were noted during the hedgerow assessment conducted the last week of September.

A comprehensive list of all vascular flora observed in the study area is found in Appendix E. Nomenclature, wetness coefficient and conservatism coefficient follow the Ontario Plant List (Newmaster et al., 1998). Regional and native status is derived from the Toronto and Region Conservation Authority's (TRCA) Local Rank ("L-rank") system (TRCA, 2009).

Results

A total of 280 vascular plant taxa (including 7 hybrids) were recorded in the study area. One hundred and forty-one (141) (50.4%) taxa are considered native to the TRCA watershed (L1-L5), 130 (46.4%) are non-native (L+) and 9 (3.2%) are of questionable status (L+?). Common hyacinth (*Hyacinthus oreintalis*) has not been assigned an L-rank but is non-native and therefore treated as such. Despite the relatively even split in overall percentage, non-native species far outweigh natives in terms of coverage and biomass.

Coefficient of Conservatism (CC) values provide a useful metric for measuring the quality of a natural heritage system. Each native taxon in southern Ontario has been assigned a CC between 0 and 10 as determined by a panel of botanical experts (Oldham et al., 1995). Species with high tolerance to a wide range of ecological parameters (e.g. shade, moisture, nutrients, etc.) and disturbance regimes (e.g. flooding, cutting, etc.) are assigned low CC's (0-3). Species with CC's between 4 and 6 thrive in more specialized ecological communities but can tolerate disturbances. Lastly, species confined to a narrow set of habitats (e.g. bog, tallgrass prairie, etc.) and with low disturbance tolerance are afforded high (7-8) or very high (9-10) CC's. It follows that areas with a low mean CC (i.e. ≤3) are typically composed of ruderal species in "poorer quality" habitats. Non-native species are not typically included in the calculation of mean CC.

As a wetland species occupying recently exposed mudflats, ditch stonecrop (*Penthorum sedoides*) is found in more specialized communities and is therefore afforded a Conservatism Coefficient of 4.

Of the 141 taxa native to the TRCA watershed, five (5) were not included in the mean CC calculation because they were not found to be regenerating. This includes white spruce (*Picea glauca*; CC = 6), red pine (*Pinus resinosa*; CC = 8), eastern white cedar (*Thuja occidentalis*; CC = 4), red oak (*Quercus rubra*; CC = 6) and cinnamon fern (*Osmunda cinnamomea*; CC = 7). Freeman's maple (*Acer X freemanii*) has not been afforded a CC and is also left out of the calculation. Of the remaining 135 native taxa, 62 (45.9%) have low conservatism coefficients (0-3). Seventy (70) taxa (51.9%) have moderate conservatism coefficients (4-6). Only three (3) species (2.2%) have high conservatism coefficients (7-8) and no species have very high coefficients (9-10). The mean CC of 3.39 is fairly low, and reflects the preponderance of early-successional habitats in the study area.

It is necessary to highlight that the mean Coefficient of Conservatism is simply an aggregate floristic value for the entire study area which masks heterogeneity at the ecosite/vegetation type scale. Despite the low mean CC, species with higher conservatism coefficients occupying high-quality remnant habitats exist in the study area (see **Section 2.4.4** for a discussion on observations of significant flora). In addition, mean CC is simply one metric employed to evaluate the quality of a natural area, and should be considered in tandem with the other assessments (hedgerow, significant wildlife, etc.) offered in this study.

2.4.2 Ecological Land Classification

Methodology

The application of Ecological Land Classification (ELC) for Southern Ontario consists of describing, classifying and delineating ecological units under the guidance of a standardized protocol (Lee et al., 1998). A wide array of physiographic data – substrate type and depth, moisture regime, topography, floral composition, stand structure, wildlife observations and disturbance, amongst others – are collected and synthesized to produce a detailed community account. Once each separate community has been described using ELC, the collective composition and health of a natural heritage system is elucidated along with opportunities to restore and link fragmented units.

All natural and semi-natural vegetation communities were classified within the study area using methods outlined in "Ecological Land Classification for Southern Ontario: First Approximation and Its Application" (Lee et al., 1998). The methods used are consistent with data collection standards defined by the Toronto and Region Conservation Authority (2007). Each community was not only described and delineated, but a comprehensive botanical survey was performed to complement spring botanical surveys undertaken in early May, 2012.

As is often the case, several vegetation communities present in the study area do not readily conform to ELC's classification system. First, ELC sets the minimum mappable unit at 0.5 hectares, but smaller units may be mapped at larger scales (e.g. 1:2,000) or if the community is particularly noteworthy. Many communities (and inclusion/complex units) below the 0.5 ha size threshold were delineated in this study because: 1) they were discernible on field maps, and/or 2) they were wetlands.

Polygon 101 is simply a thin ring of cattails surrounding a dugout agricultural pond. These small communities were always mapped if the emergent wetland vegetation was fairly consistent along the pond margins.

A second concern was that some fields exhibited signs of an emerging cultural meadow but lacked clear evidence of abandonment from agriculture. Asters and goldenrods generally indicate a field was not tilled or cut the previous season, but they were not always present. When in doubt, these fields were always mapped unless evidence of a current agricultural use was readily apparent (e.g. cut vegetation, alfalfa dominated, etc.).

Third, every effort was made to map all wetland units, no matter how large or small. Panicled aster (*Symphyotrichum lanceolatum* syn. *Aster lanceolatus*), for example, was often found dominating small wet pockets within cultural meadows. Because this species is listed as an obligate wetland indicator within the Ministry of Natural Resources and Forests' (MNRF) draft list of wetland plants (2011a), wherever patches of panicled aster were discernible on field maps they were mapped as either a meadow marsh inclusion or (where large enough) community.

Finally, there were certain challenges associated with mapping the communities that occupy the many dugout agricultural ponds dotting the study area. Wherever at least a thin ring of continuous vegetation (most often cattails) more or less completely surrounded a pond, it was mapped. Aquatic communities within these ponds were mapped separately whenever absolute coverage of floating or submerged macrophytes exceeded 25% in areas less than 2 metres of water depth. Otherwise, aquatic communities (and the species therein) were subsumed within the adjacent shallow marsh occupying the pond margin.

Despite detailed fieldwork, in some cases a particular vegetation community could not be circumscribed to the level of vegetation type. All of the mineral cultural thickets are dominated by European buckthorn (***Rhamnus cathartica***), for example, which is not included as a vegetation type in ELC's first approximation. In these cases, communities were circumscribed to the most detailed level of refinement possible. In areas where property access was not granted, a combination of air photo interpretation along with visual surveys from property boundaries (wherever possible) was employed.

<u>Results</u>

A total of 112 polygons were described and delineated in the study area, amounting to 24 different ecosites/vegetation types. Full ELC surveys were conducted in 107 polygons. For the remaining five (5) polygons where access was either explicitly denied or unattainable (e.g. consistently locked gate), three (3) were characterized from adjacent areas (polygons 102, 109 and 110), and two (2) were characterized exclusively by air-photo (polygons 107 and 108).

Agricultural land uses dominate the study area, primarily corn and soybean and to a lesser extent alfalfa and wheat. Most vegetation communities are confined to lands along and adjacent to the four study area watercourses (West Humber River, Gore Road Tributary, Clarkway Tributary and Rainbow Creek). Cultural meadows have developed on abandoned agricultural lands and formerly manicured lawns. Shallow marshes and aquatic communities occupy the many dugout agricultural ponds.

A brief description of each ecosite/vegetation type is offered below. A list of all ELC polygons, including their respective ELC code and total area can be found in Appendix F. Detailed ELC vegetation mapping is found in Appendix G**.** Scanned copies of all ELC fieldsheets can be reviewed in Appendix H.

Cultural Communities

Dry-Moist Old Field Meadow (CUM1-1)

Polygons: 1, 5, 9, 10, 12, 15, 17, 18, 23, 24, 27, 30, 36, 40, 44 (inclusion), 47, 51, 54, 56, 59, 60, 62, 63, 65, 66, 69, 71, 72, 75, 84, 88, 89, 90, 95, 99, 110

Old field meadows are, by a considerable margin, the largest and most frequent vegetation community present in the study area. These communities have developed on abandoned agricultural fields and formerly manicured lawns as well as other cleared lands that are in the early stages of succession. Polygon 89 (see top inset photo) appears as a soybean field on air-photos as recently as August, 2009. Typical dominant species include tall goldenrod (*Solidago altissima*), smooth brome (*Bromus inermis ssp. inermis*), field sow-thistle (*Sonchus arvensis ssp. arvensis*), Canada thistle (*Cirsium arvense*) and (in moister spots) panicled aster. Other common old field associates include New England aster (*Symphyotrichum novae-angliae* syn. *Aster novae-angliae*), common milkweed (*Asclepias syriaca*), cow vetch (*Vicia cracca*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), Canada blue grass (*Poa compressa*) and Kentucky blue grass (*Poa pratensis ssp. pratensis*). Jerusalem artichoke (*Helianthus tuberosus*) is often abundant along the upper banks of watercourses. Depending on the time since clearance, scattered stems of hawthorn (*Crataegus* spp.), European buckthorn and green ash (*Fraxinus pennsylvanica*) may also be present. Predictably, not one significant plant taxa was found in an old field meadow community. Finally, a recently built beaver dam and lodge have been constructed on the Clarkway Tributary in polygon 71, resulting in a small ponded area.

Mineral Cultural Woodland (CUW1)

Polygons: 3, 11, 14, 42, 55, 109

The few cultural woodlands present in the study area have undergone heavy anthropogenic disturbance. Each has been planted to some degree with either non-native species such as Norway spruce (*Picea abies*) and scotch/scots pine (*Pinus sylvestris*), or species native to Ontario but rare in the TRCA watershed such as eastern white pine and red pine. In the case of polygon 42, the non-native hybrid white willow (*Salix X rubens*) and common lilac (*Syringa vulgaris*) are widespread in the canopy and understory. Typical groundcover species that dominate include tall goldenrod and yellow avens (*Geum aleppicum*). In addition, every cultural woodland has a watercourse flowing through it (although they tended to be dry during site visits), with panicled aster often abundant along the banks. Overall, these communities are young and have not yet undergone natural thinning and replacement as a result of ecological succession.

Mineral Cultural Savannah (CUS1)

Polygons: 0, 4, 57, 61

These communities were either previously cleared and are regenerating (polygons 0 and 4) or occur as plantations with 25%-35% absolute tree cover (polygons 57 and 61). Polygon 61 (see inset photo) has been extensively cut, with many of the cuttings discarded throughout the community (along with brush piles). Dominant canopy species (which differed amongst polygons) include Manitoba maple (*Acer negundo*), hybrid white willow, white ash (*Fraxinus americana*), silver maple (*Acer saccharinum*) and scotch/scots pine. The groundcover is replete with common old field meadow species.

Hawthorn Cultural Savannah (CUS1-1)

Polygons: 20, 31

Hawthorns are fairly common throughout the study area, including One-seeded hawthorn (*Crataegus monogyna*), dotted hawthorn (*Crataegus punctata*), long-spined hawthorn (*Crataegus macracantha*), and others unidentifiable to species. Hawthorn cultural savannas represent areas where hawthorns comprise a large proportion of relative shrub coverage. European buckthorn also tends to dominate in these communities and is regenerating at a much higher rate than the hawthorns. As is usually the case in cultural communities, the dominant groundcover species are typical of old field meadows including tall goldenrod, smooth brome, Jerusalem artichoke (along watercourse margins) and elecampane (*Inula helenium*). Both communities are located within floodplain terraces, and polygon 31 harbours Michigan lily.

Mineral Cultural Thicket (CUT1)

Polygons: 6, 21, 28, 33, 41, 48, 49, 68, 70, 97

A range of shrub cover was observed in the mineral cultural thickets, with some polygons barely exceeding

25% (e.g. polygon 70) and others with nearly 100% (e.g. polygon 21). European buckthorn is the dominant shrub in all ten (10) mineral cultural thicket polygons. Biological diversity is severely restricted in these areas, to the extent that at times no other woody species are present and absolute groundcover coverage is far below 1% (see inset photo of polygon 48).

Most of these communities were either cleared or actively farmed as recently as 1960, as illustrated on historical aerial photographs. The gnarly buckthorn parent plantings can sometimes be found hidden amongst the thick regeneration. In other cases, buckthorn co-dominates with hawthorns (often the non-native one-seeded hawthorn). Where present, the dominant groundcover species typically consist of garlic mustard (*Alliaria petiolata*), yellow avens and bittersweet nightshade (*Solanum dulcamara*). Despite the sheer dominance by buckthorn at the expense of native flora, polygon 6 contains remnant scatterings of Michigan lily and Canada violet (*Viola canadensis*), polygon 21 contains shagbark (*Carya ovata*) hickory and running strawberry-bush (*Euonymus obovata*), and polygon 31 contains Michigan lily and running strawberry-bush.

<u>Raspberry Cultural Thicket (CUT1-5)</u>

Polygon: 21(inclusion)

Dense thickets of raspberry afford plentiful supplies of soft mast to birds and mammals, thereby functioning as important feeding habitat. Only one (1) raspberry cultural thicket is present in the study area, which has developed as an inclusion in a buckthorn dominated mineral cultural thicket. Examination of the pedicels and peduncles revealed no tipped glands, and therefore the species is wild red raspberry (*Rubus strigosus* syn. *Rubus idaeus ssp. melanolasius*) rather than European red raspberry (*Rubus idaeus ssp. idaeus*). Absolute coverage of raspberry is roughly 80%.

<u>White Pine Coniferous Plantation (CUP3-2)</u>

Polygons: 58, 80

The two (2) white pine coniferous plantations differ markedly in health. Polygon 58 is a long, rectangular plantation dominated by white spruce and to a lesser extent white pine, with silver maple planted along wetter sections on the northern margin. Great horned owl has been observed by the landowner, and pellets were noted along the southern margin during the spring botanical survey. Very limited thinning (natural or anthropogenic) has occurred, with small openings occupied by tall goldenrod and smooth brome. This community functions as a connective corridor between the Gore Road Tributary and Clarkway Tributary.

In stark contrast, the red pine which co-dominates with white pine in polygon 80 is declining heavily. Red pine has limited tolerance to wet soil, and is suffering branch dieback. As a result, the landowner is thinning and burning stems from the declining areas. The white pine appears to be in good health as a result of drier soil conditions where they are planted.

Coniferous Plantation (CUP3)

Polygons: 76, 82

These communities consist of plantations that cannot be assigned a particular ELC vegetation type. Both polygons were small and dominated by Norway spruce. Polygon 76 also consists of a dense red pine, eastern white pine and green ash canopy, which greatly restricts groundcover establishment. Polygon 82 (see inset photo) has been heavily disturbed by windthrow, recent harvesting and garbage disposal. This community has a denser groundcover layer of goldenrods, asters, garlic mustard and bittersweet nightshade, owing to greater light penetration.

Red Pine Coniferous Plantation (CUP3-1)

Polygon: 77

The one red pine coniferous plantation consists of both planted (red pine, white spruce, silver maple, etc.) and naturally-occurring (cottonwood, *Populus deltoides*) species in the canopy. This is the only site planted with jack pine (*Pinus banksiana*) in the study area. Groundcover coverage is thicker near the plantation margins, consisting of common meadow species such as smooth brome and tall goldenrod. It has undergone some moderate disturbance, including dumping (brush, household garbage) and soil rutting from farm machinery.

Deciduous Cultural Plantation (CUP1)

Polygon: 44

Polygon 44 is not easily classified. Mid-age white poplar (*Populus alba*) plantings are scattered throughout the community, but the presence of green ash and basswood (*Tilia americana*), scattered saplings of American elm (*Ulmus americana*) and shagbark hickory, as well as spring ephemerals in the understory points to remnant forest conditions. Nevertheless, given the poplar plantings and dominance by the invasive Manitoba maple and European buckthorn it was considered more appropriate to label this community "cultural". Gore Road Tributary meanders through this polygon (see right inset photo), but was completely dry during the site visit in late summer.

Wetland Communities

Cattail Mineral Shallow Marsh (MAS2-1)

Polygons: 0 (inclusion), 16 (inclusion), 23 (complex 2), 24 (inclusion), 26, 39, 41 (inclusion), 53, 55 (inclusion), 69 (inclusion), 74, 75 (inclusion), 78, 83, 91, 92, 96, 101, 102, 108

Cattail mineral shallow marsh is the dominant wetland community in the study area. Cattails compete best in permanent or semi-permanent standing water, and as such these communities generally occupied mucky swales (see top inset photo) or formed a ring around dugout pond margins. Both species of cattail – the native broad-leaved cattail (*Typha latifolia*) and non-native narrow-leaved cattail (*Typha angustifolia*) – are usually present. The hybrid cattail (*Typha X glauca*) was observed in polygon 92 (see bottom inset photo). Barnyard grass (*Echinocloa crusgalli*), rice cut grass (*Leersia oryzoides*) and purple loosestrife (*Lythrum salicaria*) are often associates. The deeper sections of some of the agricultural ponds are occupied by shallow aquatic communities and/or offer feeding and resting areas for waterfowl and sandpipers.

Willow Mineral Thicket Swamp (SWT2-2)

Polygons: 2, 19, 20 (complex), 22 (complex), 35, 62 (complex), 63 (inclusion), 86, 105

Most willow mineral thicket swamps in the study area are best described as small, dense stands of sandbar willow (*Salix exigua* syn. *Salix interior*). Wooly-headed willow (*Salix eriocephala*) is often an associate, while the groundcover consists of a range of facultative and obligate wetland species that vary considerably between sites. Some communities contain species (often in abundance) that are either rare or absent from the remainder of the study area, including crested sedge (*Carex cristatella*; polygon 19), fowl blue grass (*Poa palustris*; polygon 22), cut-leaved water-horehound (*Lycopus americana*; polygon 22), ditch stonecrop (*Penthorum sedoides*; polygon 35), blunt spike-rush (*Eleocharis obtusa*; polygon 35), nodding beggar-ticks (*Bidens cernua*; polygon 35), variegated horsetail (*Equisetum variegatum ssp. variegatum*; polygon 86) and sago pondweed (*Stuckenia pectinata* syn. *Potamogeton pectinatus*; polygon 86).

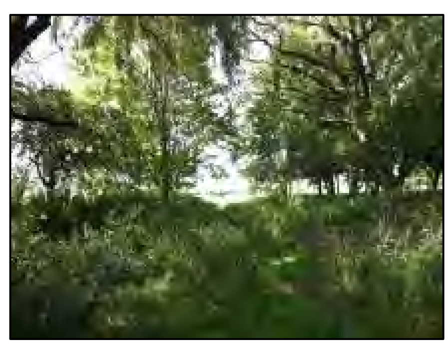
Swamp Maple Deciduous Swamp (SWD3-3)

Polygon: 3 (inclusion)

Located as an inclusion within a mineral cultural woodland, only a single swamp maple deciduous swamp exists in the study area. This community does not extend beyond the margins of a dugout agricultural pond. Only Freeman's maple and to a lesser extent hybrid white willow are present.

Willow Mineral Deciduous Swamp (SWD4-1)

Polygons: 7, 29, 64, 81, 98



Long stretches of Gore Road Tributary are flanked by narrow willow mineral deciduous swamps dominated by hybrid white willow (polygons 7, 29) or weeping willow (*Salix X sepulcralis*; polygon 64). These communities did not conform well to ELC classification because both obligate wetland and obligate upland species are present depending upon one's position along the bank. Nevertheless, the preponderance of panicled aster and reed-canary grass along many sections provides a strong rationale for classifying these polygons as swamp rather than cultural woodland. The remainder of these communities (polygons 64, 81 and 98) surround small dugout ponds.

Waterweed Submerged Shallow Aquatic (SAS1-2)

Polygon: 7 (inclusion)

Located along a deeper section of Gore Road Tributary as an inclusion within a willow mineral deciduous swamp, this community is dominated by Canada waterweed (*Elodea canadensis*) with lesser duckweed also present. Ponding of the tributary at this site is potentially attributable to a debris jam about 75 metres downstream.

<u>Reed-canary Grass Mineral Meadow Marsh (MAM2-2)</u>

Polygons: 8, 20 (inclusion), 37, 43, 50, 67, 79, 85

Reed-canary grass mineral meadow marshes are widespread throughout the study area. It is believed that two separate and indistinguishable varieties of reed-canary grass occur in Ontario, one native and the other a European cultivar used primarily for forage which is much more common. As is often the case (see inset photo of polygon 67), the European cultivar can form dense monotypic stands thereby outcompeting most if not all native species. Panicled aster, tall goldenrod, cattails, and barnyard grass are associated with these communities.

<u>Forb Mineral Meadow Marsh (MAM2-10)</u>

Polygons: 1 (inclusion), 12 (complex), 16, 18A, 22, 23 (complex 1), 30 (inclusion), 31 (inclusion), 32, 46, 47 (complex), 73, 87

Panicled aster is the dominant species in every forb mineral meadow marsh community. Other co-dominant facultative and obligate wetland plants include reed-canary grass, tall goldenrod and creeping bent grass (*Agrostis stolonifera*), and wetland sedges such as crested sedge and fox sedge (*Carex vulpinoidea*). On many occasions, panicled aster absolute coverage approaches 90% or greater (see inset photo of polygon 73). Many of these communities are inclusions or complexes occupying small, wet sites within broader old field meadow communities.

Bulrush Organic Shallow Marsh (MAS3-2)

Polygon: 25

Located along a meandering section of the West Humber River designated as occupied habitat of the endangered Redside Dace, this community contains a variety of rare species both for the study area as well as the TRCA watershed. The sluggish waters of the West Humber are suitable for the colonization of emergent and aquatic vegetation. Soft-stemmed bulrush is the dominant species, with rice cut grass and common arrowhead (*Sagittaria latifolia*) also in abundance. Three (3) regional species of concern are present, including long-leaved pondweed (*Potamogeton nodosus*), common coontail (*Ceratophyllum demersum*) and giant bur-reed (*Sparganium eurycarpum*), and this is the only known location of black bulrush (*Scirpus atrovirens*) in the study area.

Mineral Meadow Marsh (MAM2)

Polygons: 13, 34, 52, 60 (inclusion), 89 (inclusion), 104

Marsh communities in which a mix of forb and graminoid species are dominant have been labeled mineral meadow marsh. The dominant species are primarily site specific and include reed-canary grass, purple loosestrife, rice cut grass, panicled aster, tall goldenrod, barnyard grass, and small-flowered willow herb (*Epilobium parviflorum*). There are two (2) common reed (*Phragmites australis*) dominated inclusions (polygons 60 and 89), as well as one (1) creeping bent grass (*Agrostis stolonifera*) dominated community (polygon 104). Most of these communities are located along the highly-disturbed Rainbow Creek, with agricultural lands flanking both sides (see inset photo). Switchgrass (*Panicum virgatum*) occurs in polygon 13, but may have originated from a seed mix.

Mineral Shallow Marsh (MAS2)

Polygons: 38, 93

Both mineral shallow marsh communities surround dugout agricultural ponds with fluctuating water levels. Polygon 38 (see inset photo) is dominated by common water-plantain (*Alisma rivale* syn. *Alisma plantago-aquatica*), barnyard grass and nodding beggar-ticks, while polygon 93 is dominated by rice cut grass, spike-rush (*Eleocharis* sp.)

and reed-canary grass. A muskrat lodge is present in polygon 38 (see inset photo), and the presence of muskrat likely helps to limit the growth of cattails in this community.

Bedrock Shallow Marsh (MAS1)

Polygon: 94

Only a single bedrock ecosite exists in the study area; a bedrock shallow marsh surrounding an agricultural pond dominated by spike-rush, broad-leaved cattail and rice cut grass. Other species present include hybrid white willow, blue vervain (*Verbena hastata*), wooly-headed willow and Canada waterweed. Given the deep glaciolacustrine and till deposits throughout the study area, it is more likely that the impenetrable soil layer encountered in the field is either fill used to line the pond or a dense till or hardpan. Beaver chew marks are present, and a wildlife trail leads from the adjacent agricultural field into the pond (see inset photo).

Duckweed Floating-leaved Shallow Aquatic (SAF1-3)

Polygons: 12 (inclusion), 100, 103, 107

Like most of the other aquatic communities, duckweed floating-leaved shallow aquatic communities are restricted to dugout agricultural ponds. One of the communities (polygon 100) is occupied exclusively by lesser duckweed with barely 25% coverage. Polygon 103 (see inset photo) is 100% covered by an assortment of lesser duckweed, dotted watermeal and Columbia watermeal. Extensive coverage by these free floating species is highly indicative of eutrophic conditions, whereby nutrient-laden fertilizers are washing into the pond from the adjacent soybean fields.

Pondweed Mixed Shallow Aquatic (SAM1-2)

Polygon: 106

There is only one pondweed mixed shallow aquatic community in the study area, which is dominated by sago pondweed with smaller amounts of lesser duckweed. This community is partially surrounded by a willow mineral thicket swamp.

Upland Communities

<u>Fresh-Moist Lowland Deciduous Forest (FOD7)</u>

Polygon: 45

The highly altered nature of the study area has given rise to only one (1) forest community class. The canopy of this fresh-moist lowland deciduous forest is dominated by Manitoba maple and green ash, with European buckthorn in the understory. Garlic mustard, tall goldenrod and yellow avens dominate the ground layer. The presence of hawthorns and abundance of invasive trees and shrubs suggests that this community may have been cleared and is regenerating, although its history is not altogether clear.

2.4.3 Hedgerow Assessment

<u>Methodology</u>

A comprehensive assessment of all hedgerows in the study area was completed during the last week of September. Each hedgerow was given a unique identifier beginning with the letter "H" and followed by a number (1, 2, etc.). Dominant species, width, continuity, age, disturbance, health and connectivity were recorded for each hedgerow. These categories are elucidated in greater detail below.

It should be noted that the section of hedgerows along the north-western boundary of the study area (i.e. between Countryside Drive and Mayfield Road) was not assessed because the hedgerow is contained within adjacent properties and is therefore outside the study area.

Dominant Species

The dominant species were recorded for the canopy, shrub/understory, and groundcover layers (when present). No more than 5 species are recorded in any one layer.

Width

To explore hedgerow structure, the width of each hedgerow (i.e. rows of stems) was also noted, which includes rows of both trees and shrubs. A hedgerow with one row of trees and one row of shrubs would be labelled "double stem width", as would a hedgerow with two rows of trees.

Continuity

Hedgerow continuity was classified into one of the following four categories:

- Continuous canopy – No gaps between tree and/or shrub/understory cover;
- Mostly continuous canopy – A few gaps present which are typically only a few metres wide;
- Relatively sparse canopy – Gaps are frequent and usually greater in size than a “mostly continuous canopy”;
- Sparse canopy – Hedgerow is gap dominated, very limited tree or shrub/understory cover exists.

These continuity categories were usually augmented by a qualifier, such as “continuous canopy but short” or “mostly continuous canopy with some gaps”.

The above photo is an example of a mostly continuous canopy, while the photo below typifies a relatively sparse canopy.

Age

Similarly, four categories are used to classify hedgerow age (from youngest to oldest): young, immature, mid-aged, mature. In cases where a hybrid category is used (e.g. immature/mid-aged), the first identifier better characterizes the hedgerow. No simple, straightforward definition for the individual age categories can be offered, and there were further complications associated with comparing the age of shrub-dominant versus tree-dominant hedgerows. Nevertheless, a best effort was made by the Aquafor Beech Ltd. ecologist using professional experience.

Disturbance

Typical disturbances recorded include degree of establishment by invasive species, soil disturbance (e.g. ploughing), presence of garbage, and windthrow.

Health

Hedgerow health is partitioned into four categories: excellent, good, fair, and poor. These categories correspond to aggregate health rather than the condition of any individual stem. Hedgerows in “excellent” or “good” health do not exhibit any visible signs of major decline or stress (major twig/branch dieback, chlorosis, proliferation of woody vines, etc.). Broken limbs and other minor/moderate stresses that affect one or two stems do not measurably affect the health classification. Hedgerows in “fair” or “poor” health show more widespread evidence of decline.

Connectivity

Ecological connectivity relates to whether a hedgerow provides a linkage between two (or more) vegetation communities.

Results

The results of the hedgerow assessment are provided in Appendix I. Each hedgerow is identified on the ELC mapping found in Appendix G. A synopsis of the assessment follows.

Nearly every single hedgerow in the study area has been colonized by the invasive European buckthorn (see inset photo of H26). Of the 88 hedgerows assessed, 85 (96.6%) contained buckthorn, and in most cases it was the dominant woody species by both number of stems and coverage. Sixteen (18.0%) hedgerows contained the invasive one-seeded hawthorn. Many hedgerows lacked tree cover entirely, and were dominated exclusively by shrubs (European buckthorn and hawthorns). Where present, the tree canopy was generally composed of a mix of American elm, Manitoba maple, green ash, Norway maple (*Acer platanoides*), silver maple, Norway spruce or white spruce. Common shrubs apart from buckthorn and one-seeded hawthorn were dotted hawthorn, long-spined hawthorn and various unidentifiable hawthorns. Given the high light penetration along hedgerow margins, smooth brome and tall goldenrod were predictably the dominant groundcover species.

A majority of the hedgerows were single stem in width, with some double or triple (and fewer still quadruple or quintuple). To reiterate, hedgerow width in this assessment includes rows of both trees and shrubs. Because shrubs occupy far less space than trees, hedgerows with three or more rows of shrubs may still be less than or equivalent to the width of a single, mature row of trees in terms of canopy coverage.

Very few of the hedgerows were entirely continuous, although many were mostly continuous with only limited gaps. Thirty-two (32) (33.3%) hedgerows were considered mid-aged, 25 (28.4%) were immature, 15 (17.0%) were young and 3 (3.4%) were mature. The remainder were hybrid categories, including 11 (12.5%) mid-aged/immature or immature/mid-aged and 2 (2.3%) young/immature.

Very few of the hedgerows within the study area connect NHS features. Of these, the only hedgerow that may provide a linkage to another subwatershed (provided rehabilitation measures were applied) is H19. This hedgerow is located close to the TCPL lands in the south western portion of the study area, and extends from the Gore Road Tributary west to the Gore Road.

Rural residential properties, with some remnant hedgerows, are present west of Gore Road in this area. Under the proposed land use plan, the TCPL lands will act as a suburban green space and potentially a wildlife corridor, which could functionally mitigate the loss of H19.

Establishment of invasive species and ploughing were the two most widespread disturbances. Many of the hedgerows were actually planted with invasive species, while in others invasive species have colonized from the surrounding area. Ploughing can sever root systems, thereby limiting a plants' ability to obtain water and nutrients from the soil. A few hedgerows were overrun with riverbank grape (*Vitis riparia*) and thicket creeper (*Parthenocissus inserta*), which limits light penetration (and therefore photosynthesis).

2.4.4 Significant Flora

Methodology

Several rare plant taxa were observed across the study area over the course of the three vegetation assessments (botanical inventory, ELC community delineation, hedgerow assessment). In this study, "significant flora" consists of taxa that fall into at least one of the following two categories:

- Assigned an S-rank between S3 (Vulnerable) and S1 (Critically Imperilled) by the Natural Heritage Information Centre
- Assigned an L-rank between L3 and L1 (Regional Species of Concern) by the Toronto and Region Conservation Authority

Significant flora are also treated as "species of conservation concern" in this report, and are therefore afforded habitat protection under the PPS as Significant Wildlife Habitat (see **Section** 3.8.2). No observations of flora listed under Regulation 230/08 of Ontario's *Endangered Species Act* as endangered, threatened or special concern, or under Schedule 1 of the federal *Species at Risk Act* as endangered, threatened, or special concern were recorded from the study area.

Results

One (1) taxon has been afforded an NHIC S-rank between S3 and S1. Twenty (20) plant taxa are considered regional species of concern under TRCA's L-rank scheme. Each is discussed individually in greater detail below, with all recorded locations plotted on Figure 2.18 and on the vegetation community mapping in **Appendix G**.

Amethyst Aster (*Symphyotrichum X amethystinum* syn. *Aster X amethystinus*) – S3

Amethyst aster is a naturally occurring hybrid between New England aster and heath aster (*Symphyotrichum ericoides* syn. *Aster ericoides*). It has the characteristic purple flowers and clasping leaves of New England aster, with the tiny, congested leaves of heath aster. Only one individual was found along the border of a reed-canary grass mineral meadow marsh (polygon 50). NHIC has labelled this species S3?, meaning the rank is uncertain and may be subject to modification when more is learned about its distribution. TRCA does not consider amethyst aster a regional species of concern (L4).

Freeman's Maple/Swamp Maple (*Acer X freemanii*) – L3

Freeman's maple is a naturally occurring hybrid between silver maple (*Acer saccharinum*) and red maple (*Acer rubrum*). It more closely resembles silver maple in both morphology (i.e. leaf shape) and habitat (i.e. floodplains and surface-ponding swamps). This species was recorded in wetland sites as well as along creek margins in otherwise upland sites, including a swamp maple deciduous swamp inclusion (polygon 3), mineral cultural savannah (polygon 4), willow mineral thicket swamp (polygon 19), reed-canary grass mineral meadow marsh (polygon 50) and mineral cultural woodland (polygons 42, 55). Provided the moisture regime is not altered, Freeman's maple will likely persist in its current locations.

Shagbark Hickory (*Carya ovata*) – L3

A Carolinian species near its northern limit in the study area, the presence of shagbark hickory hints at a mighty pre-settlement forest that once covered the subwatershed. Today, this species persists as a few scattered stems along a valley slope amongst a European buckthorn dominated mineral cultural thicket (polygon 21) and white poplar dominated deciduous cultural plantation (polygon 44). This species more often thrives on dry upland sites intermixed with oaks, but it can also be found (as in the case here) on rich, moist soils along hillslopes or within valleys.

Shagbark hickory regeneration is compromised by the prevalence of European buckthorn, which may form dense monotypic stands in only a few decades following establishment. Neither shagbark hickory nor any other native tree species is likely to play a major ecological role in the study area without active management that occludes the spread of buckthorn.

Climbing Bittersweet (*Celastrus scandens*) – L3

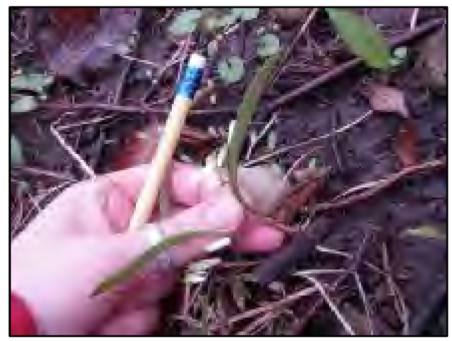
As its common name implies, climbing bittersweet is a woody vine occupying a wide range of habitats, including shores, dune thickets, streamsides, roadsides and fencerows. A single individual was found within a small clearing in a mineral cultural thicket (polygon 49). Its berries range from dull orange to bright red, and when present make observation straightforward even from a far distance. Given its wide ecological amplitude, climbing bittersweet is not likely to be impacted by development unless the thicket community in which it is present (which provides structural support) is altered.

Common Coontail (*Ceratophyllum demersum*) – L3

Unlike many submerged aquatic species coontail is readily distinguishable from beyond the water's edge, owing to its conspicuous "bushy" habit (resembling that of a raccoon's tail). This species was found in a bulrush organic shallow marsh (polygon 25) occupying a section of the West Humber River, alongside a number of other relatively conservative species (at least for this subwatershed) such as long-leaved pondweed and softstem bulrush (*Schnoeplectus tabernaemontanii* syn. *Scirpus validus*).

Most submerged aquatic species cannot endure high flow velocities, and as such the persistence of coontail (and other macrophytes) at this site is contingent upon maintenance of the flow regime. Increased streamflows that result from the expansion of impermeable cover upstream could deleteriously impact this shallow marsh community. Although upstream reaches of the West Humber River are outside the Area 47 study area, efforts to limit impermeable cover in close proximity to this section of the West Humber River is advised.

<u>Virginia Spring Beauty (*Claytonia virginica*) – L3</u>



Virginia spring beauty occupies upland and occasionally lowland deciduous forests. It is a quintessential spring ephemeral, disappearing by early summer. This species was recorded in only one location in the study area: a deciduous cultural plantation (polygon 44) near the border of a fresh-moist lowland deciduous forest (polygon 45). Given its abundance at this site, garlic mustard is a significant threat to spring beauty's persistence. White-tailed deer may even facilitate the spread of garlic mustard by browsing on spring beauty and other native flora. Human activity (i.e. trampling, picking, etc.) is not presently a concern for this species but may be in future years when this area is encapsulated by development.

<u>Silky Dogwood (*Cornus amomum ssp. obliqua*) – L3</u>

The blue berries (see inset photo) and light brown pith of Silky Dogwood help distinguish it from the similar red-osier dogwood (*Cornus sericea* syn. *Cornus stolonifera*). Although it is almost always associated with wet sites (marshes, swamps, fens, stream borders, etc.) this individual was found within a hedgerow (H14) in what is unmistakably an upland site. It is possible that it belongs to subspecies *Cornus amomum* ssp. *amomum*, which has been found along hedgerows in Michigan (Reznicek et al., 2011). Assuming this hedgerow is buffered from development (thereby retaining current light levels), this species is not expected to be impacted by development.

Running Strawberry-bush (*Euonymus obovata*) – L3

Like shagbark hickory, running strawberry-bush is a Carolinian species much more prevalent in southwestern Ontario than the Greater Toronto Area. It is a prostrate shrub occupying a wide range of deciduous forests, from mesic uplands to swamps. This species may form dense colonies where conditions are favourable, but in the study area only a few individuals were observed in two separate European buckthorn dominated mineral cultural thickets (polygons 21 and 33). There is a general lack of suitable habitat (i.e. deciduous forest, cultural thicket) in the study area for running strawberry-bush to expand, and the areas that remain suitable are being overwhelmed by European buckthorn and garlic mustard.

Michigan Lily (*Lilium michiganense*) – L3

Standing at a height of 1.5 metres with showy orange flowers (inset photo), Michigan Lily is unmistakable. It is found in moist areas such as wet meadows and stream borders, and can tolerate both open and shaded conditions. It was found exclusively along the margins of Clarkway Tributary and Gore Road Tributary, in a hawthorn cultural savannah (polygon 31), mineral cultural thicket (polygons 6 and 33; see inset photo of polygon 33) and mineral cultural meadow (polygon 62). Protection of the moist margins along Clarkway Tributary is sufficient to safeguard this species at its known locations.

Marsh Purslane (*Ludwigia palustris*) – L3

Marsh purslane thrives along lake margins, streams and shallow water, often on recently-exposed soil. This species was recorded in a number of locations along dried-out Clarkway Tributary and Gore Road Tributary creek beds, including a willow mineral deciduous swamp (polygons 7 and 35; see inset photo), mineral meadow marsh (polygon 34), deciduous cultural plantation (polygon 44) and fresh-moist lowland deciduous forest (polygon 45). Pockets of exposed moist soil are critical to the maintenance of this obligate wetland species, and more permanent flows in Clarkway Tributary and Gore Road Tributary may reduce suitable habitat.

Cinnamon Fern (*Osmunda cinnamomea*) – L3

The presence of separate fertile and sterile fronds and small tufts of hair at pinnae bases helps to distinguish cinnamon fern from the similar interrupted fern (*Osmunda claytoniana*). No natural individuals of this species were recorded from the study area; only a single planted individual adjacent to an abandoned home along Highway 50. As such, this record is not mapped.

Switchgrass (*Panicum virgatum*) – L3

Records of switchgrass in the study area are curious because this species is typically associated with tallgrass prairies and oak savannas. That both records are from highly disturbed swales bisecting agricultural fields – a forb mineral meadow marsh (polygon 13) and cattail mineral shallow marsh (polygon 39) – signals an agricultural origin. Switchgrass is available in forage crop seed mixes, and as such some individuals may have spread from adjacent agricultural fields. Because the origin of this species (i.e. natural versus anthropogenic) cannot be ascertained with certainty, all switchgrass locations in the study area are mapped.

White Spruce (*Picea glauca*) – L3

White spruce is primarily a northern species with a very limited distribution in southern Ontario. It occurs in swamps, mixed forests, along fen borders and on sandy and rocky shorelines. All known locations of white spruce represent plantings (see inset photo), and as such none are mapped.

Red Pine (*Pinus resinosa*) – L3

Red Pine normally occupies well-drained sandy plains and rock outcrops. Like white spruce, all records of this species are plantings and therefore no locations are mapped.

Long-leaved Pondweed (*Potamogeton nodosus*) – L2

Submerged and floating macrophytes are extremely rare in the study area, making these records of long-leaved pondweed particularly significant. This species can be distinguished from the similar floating pondweed (*Potamogeton natans*) by the lack of a subcordate/cordate leaf base. It was found at only two sites in the study area: a high-quality bulrush organic shallow marsh (polygon 25), and within a pocket of standing water along Gore Road Tributary in a mineral meadow marsh (polygon 34). Management recommendations for this species are the same for coontail, namely maintaining the current flow regime in the West Humber River. More permanent flows in Gore Road Tributary may expand suitable habitat for long-leaved pondweed in the study area.

Flat-stemmed Pondweed (*Potamogeton zosteriformis*) – L2

Unlike long-leaved pondweed which has floating leaves, flat-stemmed pondweed is an entirely submerged macrophyte. As suggested by the common name, its unique flat stem makes identification fairly straightforward. This species was found at two sites: a cattail mineral shallow marsh inclusion (24) and an agricultural pond ringed with a mineral shallow marsh (polygon 93). Again, maintenance of the current flow regime in the West Humber River is critical for this species' persistence in the study area.

Narrow-leaved Bur-reed (*Sparganium emersum ssp. emersum*) – L3 and Giant Bur-reed (*Sparganium eurycarpum*) – L3

Bur-reeds flourish in a variety of wet habitats with permanent or semi-permanent standing water, including shores, fens, and stream borders. Even vegetatively bur-reeds can be distinguished from cattails (with which they are often associated) by the presence of a conspicuous keel along the centre of each leaf blade. Narrow-leaved bur-reed has a slightly smaller fruiting body with a single stigma per beak, while giant bur-reed (inset photo) has a larger fruiting body with two stigmas per beak. Narrow-leaved bur-reed was recorded from a mineral meadow marsh (polygon 34) and a reed-canary grass mineral meadow marsh (polygon 43), while giant bur-reed was found in the bulrush organic shallow marsh (polygon 25) associated with long-leaved pondweed and coontail. Assuming these sites remain permanently saturated, both bur-reed species will likely persist in their current locations.

Great Duckweed (*Spirodela polyrhiza*) – L3

Great duckweed is difficult to separate from other free-floating aquatics without careful inspection. Its underside is a deep maroon colour, while a purplish dot marks its upperside where the roots are fastened below. This species was found floating atop a dugout pond occupied by a cattail mineral shallow marsh (polygon 92) along Mayfield Road, and should remain as long as there is standing water present for most of the year.

Canada Violet (*Viola canadensis*) – L3

Violets are notoriously difficult to separate without the benefit of a flower. Canada violet is notable for being white-flowered with a "yellow throat" at the base of the corolla. As a spring ephemeral, this species is found in moist deciduous forests where it blooms in early spring to take advantage of direct sunlight that penetrates before leaf-out. It was found in a mineral cultural thicket (polygon 6). Like Virginia spring beauty, competition with garlic mustard and herbivory are perhaps the main threats to this species at present, while trampling may be a future concern if developments are adjacent.

Dotted Watermeal (*Wolffia borealis*) – L3

Watermeals (i.e. the *Wolffia* genus) are a collection of the smallest flowering plants on Earth. They can be separated from other free-floating aquatics by their lack of roots. Dotted watermeal was found as an associate with Columbia watermeal (*Wolffia columbiana*) and lesser duckweed (*Lemna minor*) in a duckweed floating-leaved shallow aquatic community (polygon 103; see inset photo). An abundance of free-floating aquatics often indicates elevated dissolved nutrient levels (i.e. eutrophic conditions), which are likely feeding the pond from a large soybean field upslope. Given that eutrophic conditions are ecologically unfavourable, improving the quality of surface runoff at this site is warranted. Dotted watermeal abundance may decline, but the species would form part of a more diverse and resilient ecological community.

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STUDY AREA
- Woodland/Forest/Plantatoin
- Cultural Meadow
- Wetland (Marsh)
- Wetland (Shallow aquatic)
- Wetland Forested (Swamp)
- Mid-Successional Community - Cultural Thicket
- Amethyst Aster
- Canada Violet, Michigan Lily
- Climbing Bittersweet
- Common Coontail, Long-leaved Pondweed, Giant Bur-reed
- Dotted Watermeal
- Flat-stemmed Pondweed
- Freeman's Maple
- Great Duckweed
- Long-leaved Pondweed
- Marsh Purslane
- Marsh Purslane, Narrow-leaved Bur-reed
- Michigan Lily
- Narrow-leaved Bur-reed
- Running Strawberry-bush
- Shagbark Hickory
- Silky Dogwood
- Spring Beauty
- Switchgrass

SCALE: 1:16,000

VEGETATION COMMUNITIES AND RARE FLORA - OVERVIEW

FIGURE 2.18

AQUAFOR PROJECT NO.: 64608

Aquafor Beech Limited

BRAMPTON Flower City brampton.ca

2.4.5 Significant Fauna (Incidental Observations)

Methodology

Incidental observations of significant fauna occurred during the botanical, ELC, and hedgerow surveys. In this study, “significant fauna” consists of taxa that fall into at least one of the following two categories:

- Assigned an S-rank between S3 (Vulnerable) and S1 (Critically Imperilled) by the Natural Heritage Information Centre
- Assigned an L-rank between L3 and L1 (Regional Species of Concern) by the Toronto and Region Conservation Authority

Significant fauna are also treated as “species of conservation concern” in this report, and are therefore afforded habitat protection under the PPS as Significant Wildlife Habitat (see **Section** 3.8.2). Observations of fauna listed under Regulation 230/08 of Ontario’s *Endangered Species Act* as endangered, threatened or special concern, or under Schedule 1 of the federal *Species at Risk Act* as endangered, threatened, or special concern are discussed in **Section** 3.8.3. Observations of regionally significant and area-sensitive birds that occurred during breeding bird surveys are discussed in **Section** 2.4.6

Results

No fauna with an NHIC S-rank between S3 and S1 were incidentally observed. Two (2) species incidentally observed (snapping turtle and chimney crayfish) are listed L2 by TRCA, and four (4) species (great blue heron, northern leopard frog, yellow-bellied sapsucker, wood duck) are listed L3. Each is discussed individually in greater detail below, with all recorded locations plotted on Figure 2.19**.** An additional four (4) birds classified as L3 were found during breeding bird surveys: brown thrasher, clay-coloured sparrow, vesper sparrow, and American redstart. These species and the accompanying observations are discussed in greater detail in **Section** 2.4.6.

Wood Duck (*Aix sponsa*) – L3

Wood ducks nest in cavities excavated by woodpeckers along woodland streams and ponds. They forage on insects, aquatic invertebrates, small fish and aquatic vegetation. A pair was observed in a bedrock shallow marsh (polygon 94) occupying a dugout agricultural pond adjacent to Countryside Drive.

Great Blue Heron (*Ardea herodias*) – L3

Great blue heron is a large colonial nesting waterbird which feeds on small fish, amphibians, rodents, aquatic invertebrates, crayfish, snails and carrion in wetland and aquatic habitats. This species was observed within wet pockets of two (2) dry-moist old field meadows (polygons 47 and 66) and a bedrock shallow marsh (polygon 94). No nesting colonies were observed in the study area.

Snapping Turtle (*Chelydra serpentina*) – L2

Snapping turtle inhabits permanent bodies of water, such as shallow weedy inlets and bays, mud-bottomed ponds and lakes, and slow streams with dense aquatic vegetation. This species is fairly tolerant of polluted waters. One (1) juvenile was found within a mineral meadow marsh (polygon 34) along a dry section of Gore Road Tributary. It is believed to be a juvenile rather than a hatchling on the basis of its size (i.e. hatchlings are generally smaller). This observation is described in greater detail in **Section 3.8.2**.

Chimney Crayfish (*Fallicambarus fodiens*) – L2

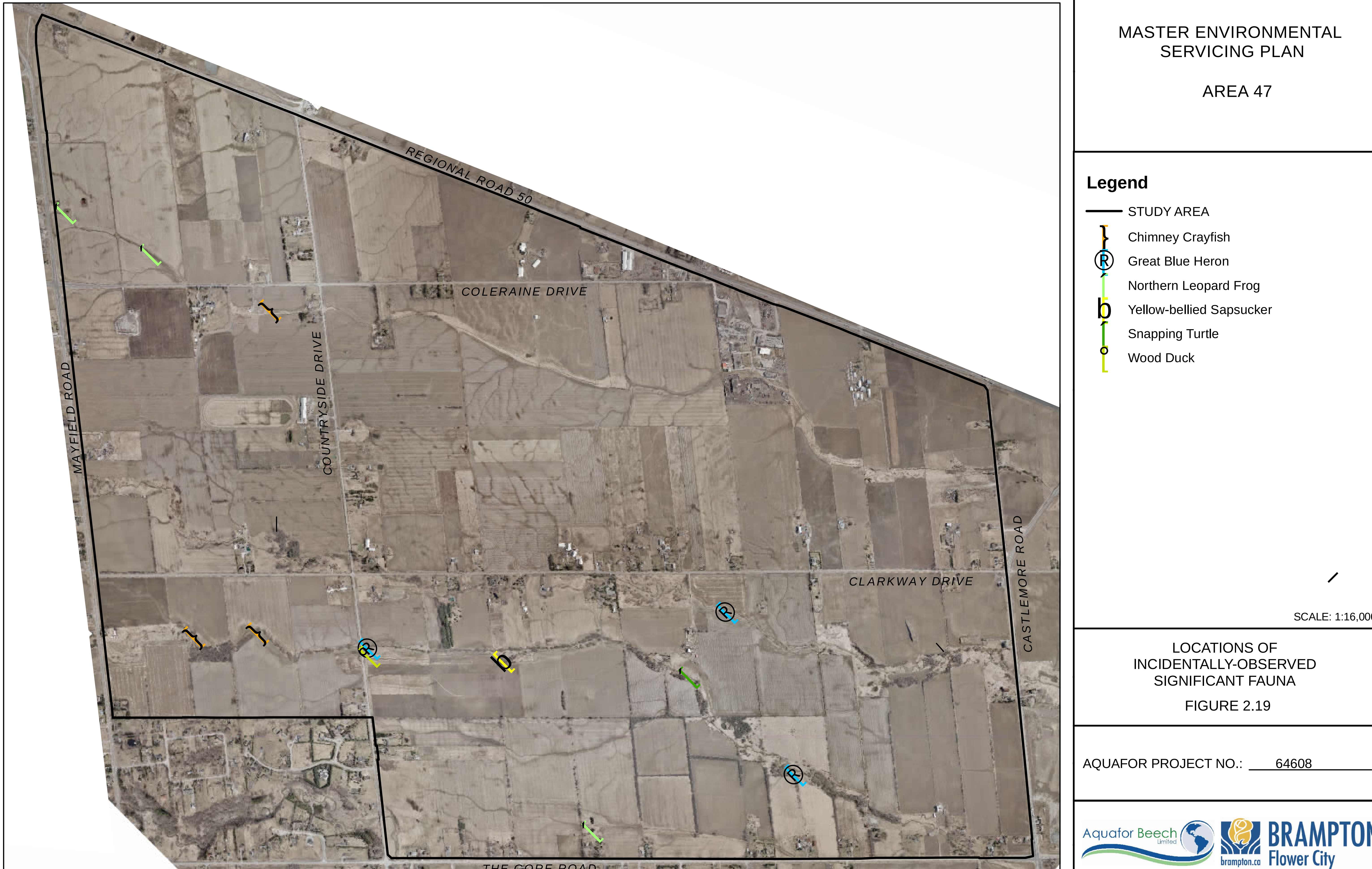
Unlike most species of crayfish, chimney crayfish can be found in both aquatic and semi-terrestrial environments. This species constructs burrows underground below the water table, with entry at the surface marked by a mound (i.e. chimney) of mud pellets (see inset photo). Multiple chimneys were found along dry sections of Gore Road Tributary in a mineral cultural thicket (polygon 6) and willow mineral deciduous swamp (polygon 7), and adjacent to Rainbow Creek in a forb mineral meadow marsh (polygon 16).

Northern Leopard Frog (*Rana pipiens*) – L3

Northern leopard frogs inhabit open wetland habitats such as marshes, bogs, lakes and stream meadows, and are also found foraging in adjacent hayfields and suburban lawns. This species consumes a variety of terrestrial invertebrates. It was found in a mineral shallow marsh (polygon 38), and an adjacent dry-moist old field meadow (polygon 40). An additional observation was made during the 2007 breeding amphibian surveys in a pond (access not granted during 2012 field-work) adjacent to a forb mineral meadow marsh (polygon 73).

Yellow-bellied Sapsucker (*Sphyrapicus varius*) – L3

Yellow-bellied sapsuckers make vertical or horizontal rows of small holes in tree bark to harvest the sap (and any insects which are attracted to it). Sapsucker holes were observed in a mineral cultural thicket (polygon 28).



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LOCATIONS OF INCIDENTALLY-OBSERVED SIGNIFICANT FAUNA

FIGURE 2.19

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Aquafor Beech Limited

BRAMPTON Flower City brampton.ca

2.4.6 Breeding Bird Surveys

North-South Environmental (NSE) was retained in May of 2012 to conduct surveys for bird species at risk (Bobolink, Eastern Meadowlark and Barn Swallow) within the study area. This survey followed up previous bird surveys conducted by NSE in 2007. Additional observations of species that could be considered qualifying species for Significant Wildlife Habitat (SWH) were also recorded.

Methods

Three rounds of breeding bird point count surveys were conducted 250 m apart within the type of habitat where SAR were previously reported, i.e. in pastures and hayfields. Locations of point counts are shown in Figure 2.20. Each point count was conducted for 10 minutes during which all individuals of each species seen and heard were recorded. Point counts were conducted in all areas that were used as hayfields during the 2012 year (hayfields are typically rotated as a crop within agricultural landscapes, such that fields used for hay in 2007 were not necessarily used for hay in 2012). Additional surveys were conducted from roads surrounding the study area to survey lands to the southwest where additional SAR habitat was noted outside the study area, on the west side of Gore Road. Fields east and south of Area 47 were investigated but no SAR habitat was noted in these locations.

Two rounds of area-searches were conducted along each tributary, and in any other natural areas apart from potential SAR habitat. Approximate locations of area-sensitive or otherwise significant species noted during area-searches were mapped on an aerial photograph of the site or located with a hand-held GPS unit. Point count surveys in hayfields frequently overlapped habitat along tributaries so some observations of species outside hayfields and pastures were obtained during point count surveys.

All surveys were conducted between dawn and approximately 10:00 a.m., in weather with no precipitation and wind estimated between 0 and 3 on the Beaufort Scale. Surveys were divided among four surveyors, so the surveys were divided into quadrants. The first round of point counts and area searches were conducted during the “early” part of the breeding bird survey window, which is recommended by Environment Canada as the period between May 24th and June 13th (MNR, 2011b). The second round of point count surveys was conducted (for SAR only) between the “early” period and the “late” period. The third round of point count surveys, and another round of area searches, was conducted during the “late” period for bird surveys, between June 13th and July 10th. **Table 2.17** provides dates for breeding bird surveys for each quadrant within Area 47.

Table 2.17: Dates for SAR surveys and Area-searches

Area	Dates Surveyed (2012)
Northwest	25 May; 8 June; 6 July
South	25 May, 8 June, 6 July
Northeast	25 May, 7 June, 29 June
East	25 May, 14 June, 9 July

Multiple visits were conducted (according to protocols developed by MNR for assessing habitat for Species at Risk) to ensure that early and late breeding birds were recorded and to provide additional breeding evidence if possible. Breeding evidence was assessed for all species according to the following protocols developed by Bird Studies Canada (2001):

> **Observed** is defined as a species observed in its breeding season outside its nesting habitat (no evidence of breeding). Presumed migrants should not be recorded.
>
> **Possible** breeding is defined as an observation of any of the following: 1) a species observed in its breeding season in suitable nesting habitat 2) singing male heard, or breeding calls heard, in its breeding season in suitable nesting habitat
>
> **Probable** breeding is defined as an observation of any of the following: (1) a pair in breeding season in suitable habitat, (2) permanent territory presumed through registration of territorial song on at least two days, a week or more apart, at the same place or (3) courtship or display between a male and a female or two males, including courtship feeding or copulation; visiting probable nest site; agitated behaviour or anxiety calls of an adult; brood patch on an adult female or cloacal protuberance on an adult male; nest building or excavation of a nest hole.
>
> **Confirmed** breeding is defined as observation of any of the following: (1) a distraction display or injury feigning; (2) used nest or egg shell found (occupied or laid within the period of the study); (3) recently fledged young or downy young, including young incapable of sustained flight; (4) adults entering or leaving nest site in circumstances indicating occupied nest (e.g., adult carrying fecal sac; adult carrying food for young), or (5) nest containing eggs, or nest with young seen or heard.

Searches for greater certainty of breeding evidence mainly focused on obtaining evidence of territorial behaviour, as this is relatively simple to accomplish by noting a bird in the same place on two occasions at least a week apart. There were no additional efforts to find nests or young (to confirm breeding) as such searches are very labour-intensive, and observations of probable breeding are considered sufficient for this type of survey.

Surveys for barn swallows were conducted by scrutinizing barns within the study area during point count surveys and area-searches. In addition, a dedicated survey for barn swallows was conducted throughout the study area on June 8^{th}, 2012 to ensure that no barns were missed. The study team did not enter any structure during the surveys, as some barns within the study area were in an advanced state of disrepair, but evidence of breeding barn swallows was obtained with binoculars. A conservative approach was taken such that confirmed breeding was assumed if barn swallows were noted flying into and out of the structure.

Approximate numbers of breeding birds were determined by recording the maximum number seen on each round of surveys, attempting to exclude any birds that were already counted in previous point counts. This is a rough estimate, given that the 250 m distance between point counts required by MNR means there is considerable overlap in calls and songs heard, especially for bobolink which are numerous, semi-colonial, highly active and territorial so tend to move throughout fields and even between different fields in field complexes.

Results

Sixty-two (62) bird species have been noted during breeding bird surveys of the study area in 2007 and 2012 surveys, 55 for which there was evidence of breeding. A list of each species observed including rarity status and location of observation can be found in Appendix J. Most birds were common, adaptable species of small patches of forests, thickets, hedgerows, and riparian corridors typical of intensively used agricultural lands. The most abundant birds were, for example, song sparrow, American goldfinch, American robin, red-winged blackbird and gray catbird.

Forty-six (46) species were seen in 2007 surveys within the same area (only one 2007 survey was conducted so this is likely the reason that fewer species were seen). Species recorded in 2007 that were not recorded in 2012 were black-billed cuckoo, American kestrel, orchard oriole and great-crested flycatcher. The absence of these species may not be particularly significant. American kestrel (ranked L3 by TRCA) may only be occasional foragers within the study area, as they forage a considerable distance from the nest site. Orchard orioles tend to be erratic in their choice of nest sites, with little fidelity between years. There is little habitat for great-crested flycatcher in the study area, as it is a forest species. Black-billed cuckoo is a species ranked L3 by TRCA. This species could have been overlooked, as they call infrequently. However, Black-billed cuckoos feed on hairy caterpillars and increase greatly in numbers with outbreaks of caterpillars, so they could have been more numerous in 2007 if it was an outbreak year.

Twelve (12) significant species were observed. Four (4) species are designated national and/or provincial SAR: bobolink, eastern meadowlark, barn swallow and eastern wood-pewee. In addition to bobolink, four (4) species considered locally significant by TRCA (determined by TRCA L-Ranks of L1 to L3) were observed: brown thrasher, clay-coloured sparrow, vesper sparrow and American redstart. All are species of successional habitats. They were generally found in remnant natural features such as along tributaries. The eight significant species noted within Area 47 are listed in **Table 2.18**. An additional four (4) species are considered area-sensitive according to MNR: northern harrier, white-breasted nuthatch, blue-gray gnatcatcher and savannah sparrow.

The location of all breeding-related observations of significant bird species (non-SAR) is found in **Figure 2.21**. Savannah sparrow, an area-sensitive species, was not mapped as it was abundant and widespread in all habitats (including croplands) throughout the study area. The lone northern harrier observation was not mapped because there was no evidence of breeding.

Table 2.18: Significant Species noted in 2012 Surveys

Species	Significance	Habitat in Study Area	Number of Individual Species
Bobolink	L3, Nationally/Provincially Threatened, area-sensitive	grasslands (primarily hayfields) (see Figure 3.6)	155
Eastern Meadowlark	Nationally/Provincially Threatened, area-sensitive	grasslands (primarily hayfields) (see Figure 3.7)	7
Barn Swallow	Nationally/Provincially Threatened	grasslands (foraging), barns (breeding) (see Figure 3.8)	9 (nest sites)
Eastern Wood-Pewee	National/Provincial Special Concern	forest (see Figure 2.21)	1
Brown Thrasher	L3	thickets, primarily along tributaries (see Figure 2.21)	8
Clay-coloured Sparrow	L3	thickets, primarily along tributaries (see Figure 2.21)	4
Vesper Sparrow	L3	grasslands, primarily hayfields (see Figure 2.21)	5
American Redstart	L3, area-sensitive	young woodland/thicket (along tributary) (see Figure 2.21)	1

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

Locations of Breeding Bird Point Counts

SCALE: 1:16,000

LOCATIONS OF BREEDING BIRD POINT COUNTS

FIGURE 2.20

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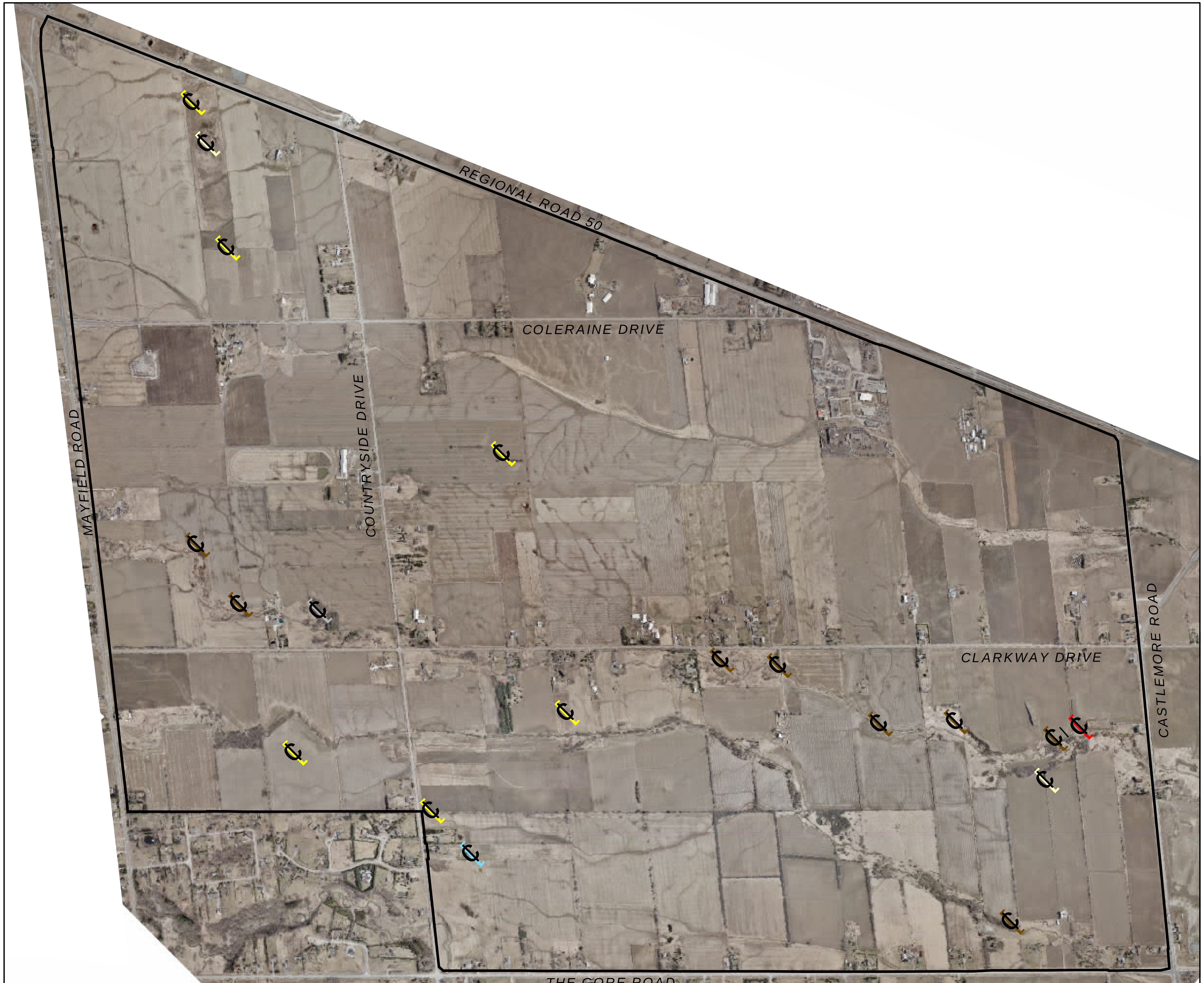

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

Legend

- STUDY AREA
- American Redstart
- Brown Thrasher
- Clay-coloured Sparrow
- Eastern Wood-pewee
- Vesper Sparrow
- White-breasted Nuthatch

Note: The habitats of Endangered and Threatened Species are illustrated in separate species-specific figures. See Section 2.4.2.3.

SCALE: 1:16,000

LOCATIONS OF BREEDING-RELATED OBSERVATIONS OF SIGNIFICANT BIRDS

FIGURE 2.21

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2.4.7 Amphibian Surveys

Methodology

The Area 47 study area was surveyed for calling amphibians over their entire breeding season following Marsh Monitoring Program (MMP) protocols (Bird Studies Canada, 2012). To further assess the isolated ponds located throughout the study area for possible amphibian breeding habitat, an additional 14 calling amphibian stations were added to the five (5) stations surveyed in 2007 for the Phase I Report (2009). These additional locations were chosen based on the results of a reconnaissance-level Pond Assessment completed on April 13, 2012 (see **Section 2.4.8.4**). Only Station A was visited in both 2007 and 2012.

Stations A-E were visited on the evenings of April 24th, May 24th, and June 5th 2007. Station A was revisited along with Stations F-S on the evenings of April 20th, May 29th and June 25th 2012. The location and survey direction for Stations A-S are summarized in **Table 2.19** and can be seen in **Figure 2.22**.

Results

Over the course of three site visits in both 2007 and 2012, American toad (*Bufo americanus*), green frog (*Rana clamitans*), and northern leopard frog (*Rana pipiens*) calls were heard. The species name, call code (1-individual calls; 2-individual and small groups; 3-full chorus) and number of individuals were recorded and summarized in **Table 2.20**. Throughout the study area, calling amphibians were heard from a total of 11 Stations.

All three frog species are considered common and widely distributed throughout the West Humber Watershed. These species are generally tolerant of urbanization, provided that floodplain water features and watercourses are maintained. Beyond the West Humber subwatershed area, all three (3) species are considered widespread and stable. Neither the Committee on the Status of Species at Risk in Ontario (COSSARO) nor the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has assessed the status of the Green Frog or American Toad. The Northern Leopard Frog is currently listed as Not at Risk under the Ontario Endangered Species Act (2007) and the Ontario population as Not at Risk under the Federal Species at Risk Act. The International Union for Conservation of Nature (IUCN) lists the global status of all three species as Least Concern.

Table 2.19: Calling Amphibian Survey Locations

Station	Zone	Easting	Northing	Accuracy (m)	Bearing (^{o})	Year Surveyed
A	17T	604791	4851063	±9	38	2007; 2012
B	17T	604000	4851185	-	-	2007
C	17T	604504	4852110	-	-	2007
D	17T	606548	4851034	-	-	2007
E	17T	605924	4850292	-	-	2007
F	17T	604980	4850336	±7	210	2012
G	17T	604973	4850521	±5	337	2012
H	17T	604485	4851965	±4	143	2012
I	17T	604377	4851992	±4	328	2012
J	17T	604272	4852063	±3	222	2012
K	17T	603834	4852544	±4	127	2012
L	17T	603715	4852126	±4	225	2012
M	17T	603475	4852461	±5	192	2012
N	17T	603417	4852520	±6	196	2012
O	17T	604471	4852291	±4	134	2012
P	17T	603521	4854137	±5	115	2012
Q	17T	604514	4852394	±4	30	2012
R	17T	605399	4852963	±3	314	2012
S	17T	604271	4855058	±3	141	2012

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA
WATERCOURSE
2007 SURVEY LOCATIONS
2012 SURVEY LOCATIONS
2007 AND 2012 SURVEY LOCATIONS

SCALE: 1:16,000

LOCATIONS OF AMPHIBIAN CALLING STATIONS

FIGURE 2.22

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Table 2.20: Amphibians heard using MMP Protocols (2007 and 2012)

Date	Station	Species Name	Number of Individuals	Call Code (1-3)
4/24/07	A	Green Frog	4	1
	B	Green Frog	5	1
		Northern Leopard Frog	1	1
	C	Green Frog	2	1
	D	American Toad	2	1
		Green Frog	1	1
	E	American Toad	1	1
		Green Frog	1	1
5/24/07	A	Green Frog	1	1
	B	Green Frog	2	1
	D	Green Frog	2	1
6/05/07	A	Green Frog	3	1
	B	Green Frog	4	1
4/20/12	M	American Toad	5-6	2
	N	American Toad	>8	3
5/29/12	A	Green Frog	2	1
	J	Green Frog	3	1
	K	Green Frog	5-7	2
		American Toad	1	1
	L	Green Frog	7-8	2

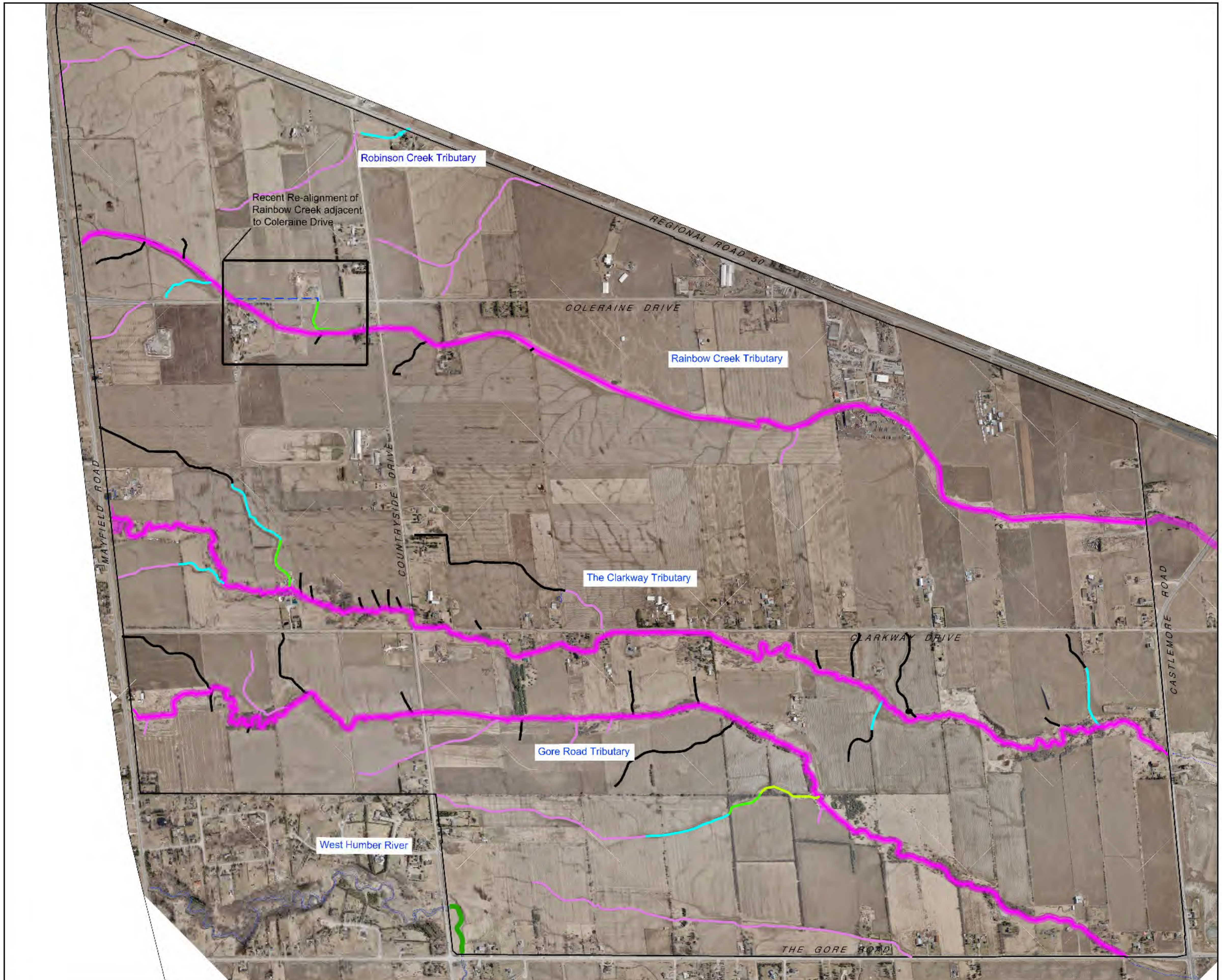
Date	Station	Species Name	Number of Individuals	Call Code (1-3)
	M	Green Frog	2	1
	N	Green Frog	4	1
6/25/12	A	Green Frog	1	1
	K	Green Frog	3-4	1
	L	Green Frog	2	1
	M	Green Frog	4-5	1
	N	Green Frog	4-5	1
	P	Green Frog	2	1

2.4.8 Aquatic Resources

The Humber River Fisheries Management Plan (MNR and TRCA 2005) (HRFMP) summarizes existing fish communities, identifies current limitations and impacts on aquatic habitats and establishes fish community targets and habitat improvement measures for all of the Humber River and its tributaries. The three tributaries located within the study area (i.e. Gore Road Tributary, the Clarkway Tributary and Rainbow Creek) are classed as small riverine warmwater habitat, while the West Humber River is classed as intermediate warmwater habitat (Figure 2.23). The HRFMP defines these habitat types as follows:

Small Riverine Warmwater Habitat**:** This habitat type is comprised of watercourses draining less than 10 square km. For the most part, these are first and second order tributaries draining the Peel Plain. Due to the dominance of clay soils, infiltration rates and corresponding groundwater discharge rates are low. Many of these tributaries are either reduced to standing pools or completely dry up during summer months. The low baseflow to average annual flow (approaching zero) suggests that these tributaries have unstable flow regimes with stream levels fluctuating wildly after rainfall. Water temperatures are also unstable and typically exceed 25 C in summer. These watercourses generally lack fish species with specialized feeding habits and piscivores. Sensitive species that may be present include Iowa darter and redside dace.

Intermediate Warmwater Habitat: This habitat type also generally includes watercourses draining the Peel Plain, but generally are 3rd and 4th order streams draining 10 - 300 square km. Since infiltration and baseflow is low, some of these streams also dry up or become standing pools in some summers, particularly those in the West Humber Subwatershed. Both flow regimes and temperature regimes tend to be moderately to highly unstable due to low baseflows and high storm flows. Very few piscivorous fish or specialized feeders are found in this habitat category and sensitive species include rainbow darter and redside dace.



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

WATERCOURSE CLASSIFICATION:

SMALL WARMWATER

INTERMEDIATE WARMWATER

HEADWATER DRAINAGE FEATURE CLASSIFICATION

PERMANENT FISH HABITAT

SEASONAL FISH HABITAT

COMPLEX CONTRIBUTING FISH HABITAT

SIMPLE CONTRIBUTING FISH HABITAT

NOT FISH HABITAT

SCALE: 1:16,000

AQUATIC HABITAT CLASSIFICATION

FIGURE 2.23

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2.4.8.1 Aquatic Habitat Characteristics

There are four (4) watercourses located within the study area. The West Humber River, Clarkway and Gore Road Tributaries are located within the West Humber River Subwatershed, while Rainbow Creek Tributary is located with the Upper Main Humber River Subwatershed. There are also Headwater Drainage Features (HDFs) of Rainbow Creek and Robinson Creek Tributaries located in the northeast portion of the Area 47 lands draining to Regional Road 50 (See **Section 2.2.2.2**). Reach characteristics for each tributary are detailed in Table 2.5.

West Humber River (Main Branch)

The West Humber River is located within the West Humber River Subwatershed and crosses the study area in the northwesterly corner. The watercourse is permanently flowing, has a well-defined channel, riparian and floodplain area and a well-defined valley along its length. The stream channel has a meandering pool:riffle type of morphology with generally fine to medium grained substrates, consisting of sands and gravels with occasional cobbles. Stream banks are typically till material and are generally protected only by forbs and grasses. The channel is moderately stable and there is an area of valley wall erosion within the study area (see Figure 2.10). See **Section 2.2.1.4** for further details regarding channel characteristics.

Clarkway Tributary

The Clarkway Tributary is located within the West Humber River Subwatershed and flows through the central portion of the Study Area. It has the largest drainage area of the three tributaries upstream of Castlemore Road. The watercourse has a well-defined channel, riparian and floodplain area and an ill-defined valley along much of its length. Its channel form has been modified fairly extensively where it flows along Clarkway Drive. Because of the size of the watercourse and its valley/floodplain characteristics, its channel form has not been substantially altered by agricultural practices, but it has been channelized and straightened like a municipal drain in a number of locations. A total of eleven (11) private/tractor crossings were observed on this tributary (see Figure 2.11).

The stream channel has a meandering pool/riffle to flat type of morphology with generally fine grained substrates, consisting of silts and sands with occasional cobbles. Stream banks are typically sand-silt-clay and are generally protected only by forbs and grasses. The channels are moderately unstable, and show evidence of minor downcutting, bank erosion, and channel abandonment; primarily in reaches C-1B, C-2, and C4 (see Figure 2.11 for locations). The stream gradient is low.

The riparian zone is largely open grassland/meadow with scattered shrubs and trees, however there are some short sections of forest cover, primarily deciduous. See **Section 2.2.1.6** for further details regarding channel characteristics.

Gore Road Tributary

The Gore Road Tributary is located within the West Humber River Subwatershed and flows through the westerly portion of the Study Area. It has the second largest drainage area of the three tributaries upstream of Castlemore Road. It is an intermittent watercourse throughout the study area. The watercourse has a well-defined, swale-like channel that is extensively vegetated with wet meadow and emergent wetland vegetation. The watercourse has an ill-defined valley feature and stream banks are generally low and heavily vegetated with grasses and forbs. The channel has been extensively modified for agricultural purposes, but has been maintained as an agricultural drain-like feature. A total of seven (7) private/tractor crossings were observed on this tributary (see Figure 2.10).

The stream channel has a linear riparian wetland type of morphology with generally fine grained and organic substrates, and abundant vegetation, in some cases primarily terrestrial grasses. Stream banks are typically formed by surface soils and vegetated with forbs and grasses. The channels are stable, and show little evidence of any downcutting or bank erosion (erosion was observed primarily in reach G-3 but also reaches G-1D, G-2A, and G-4A). There are some small online pools/ponds throughout the length of the feature within the study area. The stream gradient is low. See **Section 2.2.1.5** for further details regarding channel characteristics.

Rainbow Creek Tributary

Rainbow Creek is located in the Upper Main Humber River Subwatershed and drains the easterly portion of the study area. Rainbow Creek has the smallest drainage area north of Castlemore Road. It is essentially an agricultural swale for much of its length except in the vicinity of Castlemore Road, where it has a linear riparian wetland form. Non-agricultural vegetation communities within Rainbow Creek are primarily characterized by meadow marsh with some cultural meadow. The creek corridor has limited representation of floating-leaved shallow aquatic, cultural plantation and cultural woodland communities. On croplands within the area, the creek transitions between an uncultivated to a cultivated swale. A total of four (4) private/tractor crossings were observed on this tributary (see Figure 2.12). See **Section 2.2.1.7** for further details regarding channel characteristics.

2.4.8.2 Fisheries Surveys

Methodology

The Ministry of Natural Resources (MNR) did not authorize fisheries surveys for this study, stating that background information and the fisheries information provided within the Humber River Fisheries Management Plan (HRFMP) is sufficient for the purpose of a Master Environmental Servicing Plan (MESP). Background fisheries information was obtained from the Toronto and Region Conservation Authority (TRCA) and the MNR and is summarized in **Table 2.21**. Data collected prior to 1962 was omitted from this report, with the exception of Rainbow Creek as there was no data after 1962. Locations of fisheries surveys are illustrated in **Figure 2.24**.

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA
WATERCOURSE
FISH SURVEY LOCATIONS

SCALE: 1:16,000

LOCATIONS OF FISHERIES SURVEYS

FIGURE 2.24

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Table 2.21: Historical Fisheries Data obtained from the TRCA and MNR*

Fish Dot # (Site Code) & Location	Resource	Year	Common Name	Scientific Name	# Captured	Status
HUFMP09 West Humber	TRCA	2004	White Sucker	*Catostomus commersoni*	7	G5;S5
			Common Shiner	*Luxilus cornutus*	10	G5;S5
			Bluntnose Minnow	*Pimephales notatus*	50	G5;S5
			Fathead Minnow	*Pimephales promelas*	4	G5;S5
			Blacknose Dace	*Rhinichthys atratulus*	15	G5;S5
			Creek Chub	*Semotilus atromaculatus*	15	G5;S5
			Rock Bass	*Ambloplites rupestris*	22	G5;S5
			Rainbow Darter	*Etheostoma caeruleum*	14	G5;S4
			Fantail Darter	*Etheostoma flabellare*	74	G5;S4
			Johnny Darter	*Etheostoma nigrum*	18	G5;S5
HUFMP11 Clarkway	TRCA	2004	White Sucker	*Catostomus commersoni*	9	G5;S5
			Bluntnose Minnow	*Pimephales notatus*	1	G5;S5
			Fathead Minnow	*Pimephales promelas*	1	G5;S5
			Blacknose Dace	*Rhinichthys atratulus*	9	G5;S5
			Creek Chub	*Semotilus atromaculatus*	32	G5;S5
			Brook Stickleback	*Culaea inconstans*	65	G5;S5
			Pumpkinseed	*Lepomis gibbosus*	1	G5;S5
			Johnny Darter	*Etheostoma nigrum*	1	G5;S5
HU018WM Humber River (downstream	TRCA	2004	White Sucker	*Catostomus commersoni*	13	G5;S5
			Fathead Minnow	*Pimephales promelas*	13	G5;S5
			Creek Chub	*Semotilus atromaculatus*	27	G5;S5

Fish Dot # (Site Code) & Location	Resource	Year	Common Name	Scientific Name	# Captured	Status
of confluence with the Rainbow Creek Trib)			Brook Stickleback	*Culaea inconstans*	8	G5;S5
		2007	White Sucker	*Catostomus commersoni*	6	G5;S5
			Fathead Minnow	*Pimephales promelas*	2	G5;S5
			Creek Chub	*Semotilus atromaculatus*	22	G5;S5
			Lepomis Sp.		1	
		2010	White Sucker	*Catostomus commersoni*	38	G5;S5
			Fathead Minnow	*Pimephales promelas*	28	G5;S5
			Creek Chub	*Semotilus atromaculatus*	198	G5;S5
			Green Sunfish	*Lepomis cyanellus*	29	G5;S4
			Brown Bullhead	*Ameiurus nebulosus*	1	G5;S5
			Pumpkinseed	*Lepomis gibbosus*	1	G5;S5
108 (165) West Humber	MNR	1972	White Sucker	*Catostomus commersoni*	1	G5;S5
			Common Shiner	*Luxilus cornutus*	6	G5;S5
			Bluntnose Minnow	*Pimephales notatus*	8	G5;S5
			Blacknose Dace	*Rhinichthys atratulus*	1	G5;S5
			Creek Chub	*Semotilus atromaculatus*	3	G5;S5
			Rock Bass	*Ambloplites rupestris*	2	G5;S5
			Rainbow Darter	*Etheostoma caeruleum*	2	G5;S4
			Fantail Darter	*Etheostoma flabellare*	1	G5;S4
			Johnny Darter	*Etheostoma nigrum*	6	G5;S5
		1983-1985	White Sucker	*Catostomus commersoni*	30	G5;S5
			Common Shiner	*Luxilus cornutus*	47	G5;S5
			Bluntnose	*Pimephales notatus*	71	G5;S5

Fish Dot # (Site Code) & Location	Resource	Year	Common Name	Scientific Name	# Captured	Status
			Minnow			
			Blacknose Dace	*Rhinichthys atratulus*	11	G5;S5
			Creek Chub	*Semotilus atromaculatus*	64	G5;S5
			Rock Bass	*Ambloplites rupestris*	27	G5;S5
			Rainbow Darter	*Etheostoma caeruleum*	8	G5;S4
			Fantail Darter	*Etheostoma flabellare*	19	G5;S4
			Johnny Darter	*Etheostoma nigrum*	45	G5;S5
			Fathead Minnow	*Pimephales promelas*	8	G5;S5
244 Gore Rd	MNR	1995	No Fish Captured			
322 (83) Rainbow	MNR	1946	Creek Chub	*Semotilus atromaculatus*	3	G5;S5
323 (82) Rainbow	MNR	1946	No Fish Captured			
472 (133) HDF near Gore Road	MNR	1972	Fathead Minnow	*Pimephales promelas*	175	G5;S5
			Northern Hogsucker	*Hypentelium nigricans*	16	G5;S4
			Blackchin Shiner	*Notropis heterodon*	1	G5;S5
474 Gore Rd	MNR	1972	No Fish Captured			
613 (136) Gore Rd	MNR	1970	Fathead Minnow	*Pimephales promelas*	19	G5;S5
614 (134) Clarkway	MNR	1994	Blacknose Dace	*Rhinichthys atratulus*	16	G5;S5

Fish Dot # (Site Code) & Location	Resource	Year	Common Name	Scientific Name	# Captured	Status
615 (136) Gore Rd	MNR	1970	Fathead Minnow	*Pimephales promelas*	19	G5;S5
780 Gore Rd	MNR	2004	Brook Stickleback	*Culaea inconstans*	8	G5;S5
781 Clarkway	MNR	2004	Fantail Darter	*Etheostoma flabellare*	1	G5;S4
			Longnose Dace	*Rhinichthys cataractae*	2	G5;S5
			Northern Pearl Dace	*Semotilus margarita*	24	G5;S5

* The fish dot # corresponds with the Site ID as it appears on the MNR Aurora District's Fish Dot map. The Site Code is the original code given to the sampling site.

G – Global status, with G5 secure to G1 critically imperilled

S – Ontario status, with S5 secure to S1 critically imperilled; S4 – apparently secure

Results

All fish species caught within the study area are considered secure both globally and within the Province of Ontario. Most of the species caught are considered to be tolerant, warmwater species, with the exception of Rainbow Darter which is considered to be more sensitive to disturbance. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has classified Rainbow Darter as Group 2 Intermediate Priority for Assessment, and it is listed as a Species of Conservation Concern in the HRFMP.

No Species at Risk were caught within the study area; however, the West Humber River flowing through the northwest portion of the study area has been designated by the MNR as regulated habitat for Redside Dace under the Endangered Species Act, 2007. Historically, a small headwater drainage feature, HDF Gore-0, adjacent to the Gore Road, may have once drained west across The Gore Road and into the West Humber River. However, air photography and mapping indicate that this feature simply drains to the roadside ditch at this location. From here, the drainage continues south along the roadside ditch until discharging into the Gore Road Tributary north of Castlemore Road. This drainage pattern was confirmed during 2011 field investigations with City and TRCA staff. Therefore, the feature is not designated as regulated habitat for Redside Dace as it no longer flows into the West Humber River (Bobak, personal communication).

2.4.8.3 Mussel Surveys

Methodology

The Toronto and Region Conservation Authority (TRCA) collected a large number of mussels in surveys conducted downstream of the study site, south-west of the Castlemore Road and Gore Road intersection. These findings suggest mussels may reside within the watercourses of the study area. To detect the presence of mussels within the study area, a qualitative mussel survey was conducted on September 13, 2012 in accordance with the Protocol for the Detection and Relocation of Freshwater Mussel Species at Risk in Ontario Great Lakes Area (Mackie et al. 2008). In consultation with the TRCA, large pools and road crossings were surveyed for each watercourse, in late August when the water level was low thereby facilitating the detection of mussels within the watercourse. The locations of mussel surveys are illustrated in Figure 2.25.

Results

Survey results can be found in **Table 2.22**. Three species and 21 indiviual mussels were identified within the study area. All three species (Giant Floater, Cylindrical Papershell, Eastern Elliptio) are considered secure globally and within the province of Ontario. No Species at Risk were identified within the study area.

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

WATERCOURSE

MUSSEL SURVEY LOCATIONS

SCALE: 1:16,000

LOCATIONS OF MUSSEL SURVEYS

FIGURE 2.25

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Table 2.22: Location and Results of Mussel Surveys

Site Name	UTM			Mussels (number of individuals)	Status
	Zone	Easting (m E)	Northing (m N)		
WH-1	17T	603349	4851920	Eastern Elliptio (2)	G5;S5
				Giant Floater (4)	G5;S5
GM-1	17T	605228	4849786	No Mussels	-
GM-2	17T	605225	4849737	No Mussels	-
GM-3	17T	605014	4850332	No Mussels	-
GM-4	17T	603876	4852539	Giant Floater (4)	G5;S5
GM-5	17T	604282	4852101	No Mussels	-
GM-6	17T	602992	4853434	No Mussels	-
CM-1	17T	604078	4852837	Giant Floater (2)	G5;S5
				Cylindrical Papershell (2)	G5;S4
CM-2	17T	604163	4852742	Cylindrical Papershell (1)	G5;S4
CM-3	17T	605977	4850232	No Mussels	-
CM-4	17T	604924	4851978	No Mussels	-
CM-5	17T	603487	4854060	No Mussels	-
CM-6	17T	604098	4852884	Giant Floater (2)	G5;S5
CM-7	17T	603952	4853064	Giant Floater (4)	G5;S5
RM-1	17T	605383	4852911	No Mussels	-
RM-2	17T	606680	4850787	No Mussels	-
RM-3	17T	604187	4854950	No Mussels	-

G – Global status, with G5 secure to G1 critically imperilled

S – Ontario status, with S5 secure to S1 critically imperilled; S4 – apparently secure

2.4.8.4 Headwater Drainage Features

Headwater drainage features (HDFs) within the study area were classified using evaluation criteria located within the Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines (2009) (see **Section 2.2.2**). As stated in **Section 2.4.8.2**, the Ministry of Natural Resources and Forestry (MNRF) did not authorize fisheries surveys, stating that background information and the fisheries information provided within the HRFMP is sufficient for the purpose of an MESP. Therefore, the habitat classification of each HDF (**Figure 2.23**) is based largely on other evaluation criteria and a qualitative field assessment of aquatic habitat. The HDF management recommendations are illustrated in **Figure 2.15.**

2.4.8.5 Natural and Agricultural Ponds

Methodology

A preliminary screening of ponds within the Area 47 study area was completed on March 28, 2012. Twenty-one (21) ponds were identified as warranting further investigation (**Figure 2.26**). Accordingly, fieldwork on April 13, 2012 focused on characterizing these 21 ponds identified through the preliminary screening process. As recommended by the TRCA, pond characterization focused primarily on habitat suitability for breeding amphibians. Aquatic habitat assessments for fish habitat suitability were completed as appropriate; however, no fish surveys were performed (see **Section 2.4.8.2**). Incidental wildlife observations were also recorded as part of the pond assessment. Since many of the 21 ponds are located within identified constraints (e.g. floodplain), the focus of the fieldwork was not so much to determine whether or not the ponds will be retained but rather to identify an appropriate management regime.

Several of the ponds investigated as part of the abovementioned exercise, as well as several that were not investigated as part of the exercise, qualify as significant wildlife habitat (see **Section 3.8.2**). Information on vegetation community assemblage and the presence of regionally rare flora was collected through vegetation community surveys and botanical inventories, which were completed separately from the fauna-specific pond surveys discussed in this section. Where applicable; *i.e.* ponds CP-4 and RP-1, as well as ELC polygon 93, which was not assessed for fauna based on its isolation from other NHS features; the presence of rare flora is indicated in the results table. Similarly, ELC polygon 3 is considered to be an amphibian woodland breeding pond. ELC polygon 3 was not included in the pond investigation described in the paragraph above, as the pond would already be protected within the NHS due to its inclusion within a significant woodland what was within a valley and floodplain. For ease of readership, ponds which qualify for retention as part of the NHS based on their function as significant wildlife habitat are included in the results table in this section.

Results

Table 2.23 provides general characteristics of each pond investigated in the field as part of the aforementioned fauna-specific study or other studies such as botanical surveys. Ponds identified as appropriate for calling amphibian surveys were investigated accordingly; the results of these surveys are found in **Section 2.4.7**.

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

WATERCOURSE

PONDS ASSESSED

SCALE: 1:16,000

PONDS EXAMINED FOR HABITAT SUITABILITY FOR BREEDING AMPHIBIANS

FIGURE 2.26

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Table 2.23: Assessment of Ponds within the Study Area

Pond ID	UTMs	Pond Type	Approximate Dimensions		Water Level	Water Colour	Vegetation within/ overhanging pond		Landscape	Online?	Wildlife Observations (I=incidental observation)	Permanent Fish Habitat Potential	Observations
			Length (m)	Width (m)			Type	%					
GP-1	604977 mE 4850347 mN	Excavated pit/ ditch	25	10	>50% full	Tea-coloured	Trees	100	-Upland forest -Agricultural field/meadow	No – 30 m from watercourse	No	Unlikely	• >1 m deep • Adjacent disturbed habitat potential for milk snake
GP-1.5	604974 mE 4850526 mN	Natural swale/ depression	8	5	>50% full	Tea-coloured	Trees	90	-Upland forest -Agricultural field/meadow	No	No	No	• Deepest section approximately 45cm • Mosquito larvae • No evidence of amphibian eggs
GP-2	604789 mE 4851068 mN	Natural swale/ depression	30	25	>50% full	Tea-coloured	Trees Scrub/Shrub Emergent	10 50 5	Emergent/ shrub Agricultural field/meadow	No	Green frog tadpoles (I)	Possibly	• No evidence of amphibian eggs • High potential to function as hylid and toad breeding habitat
GP-3	604485 mE 4851966 mN	Natural swale/ depression	20	10	<50% full	Tea-coloured	Scrub/shrub Emergent	90 10	-Agricultural field/meadow	No – approx 50m from Gore Trib	No	No	• Max depth 30 cm • No evidence of adult, eggs or larval amphibians • Potential for breeding of hylid frogs with suitable hydro period
GP-4	604384 mE 4851995 mN	Natural swale/ depression	20	15	< 50% full	Tea-coloured	Trees Scrub/shrub Emergent	5 40 50	-Agricultural field/meadow	No – approx 10m from Gore Trib	Several adult ranid frogs (I)	Unlikely	• Minimum 30 m of natural cover • Potential for hylid, ranid and American toad breeding assuming suitable hydroperiod
GP-5 (ELC polygon 28)	604278 mE 4852059 mN	Natural swale/ depression	30	20	>50% full	Tea-coloured	Trees Scrub/Shrub	70 25	-Agricultural field/meadow	No – approx 30m from Gore Trib	• Green Frog Tadpoles (I) • Green Frog breeding	Possibly	• >1 m deep in sections • Prone to sediment from adjacent agricultural field • Amphibian breeding likely, calls heard during calling amphibian surveys • Significant wildlife habitat: amphibian woodland breeding pond

Pond ID	UTMs	Pond Type	Approximate Dimensions		Water Level	Water Colour	Vegetation within/ overhanging pond		Landscape	Online?	Wildlife Observations (I=incidental observation)	Permanent Fish Habitat Potential	Observations
			Length (m)	Width (m)			Type	%					
GP-6	603862 mE 4852516 mN	Natural swale/ depression	25	20	>50% full	Tea-coloured	Trees Scrub/Shrub Emergent	10 30 5	-Agricultural field/meadow	N0 – Outlet to Gore Trib ~5m east	• Green Frog breeding • Freshwater mussels (I) • Several 10-15cm mammal burrow entrances (I) • Coyote spotted south-east (I)	Likely	• >1 m deep • No evidence of amphibian tadpoles or eggs • Amphibian breeding likely, calls heard during calling amphibian surveys • Presence of mussels suggests permanent fish habitat
GP-7	603695 mE 4852086 mN	Excavated pit/ ditch	30	25	>50% full	Tea-coloured	Trees Emergent	10 70	-Agricultural field/meadow	No	• Green Frog breeding • Green Frogs (I)	Unlikely	• No evidence of amphibian eggs • Amphibian calls heard during calling amphibian surveys • >1 m deep
GP-8 GP-9	Not assessed												• Ponds surrounded on 4 sides by manicured lawn
GP-10	603475 mE 4852460 mN	Excavated pit/ ditch	Landowner permission not granted						-Agricultural field/meadow -Surburban	Yes (HDF)	• Green Frog breeding • Canada geese (I)	Unlikely	• Bordered largely by manicured lawn • Eastern edge 10 m riparian habitat • East property agriculture – i.e row crops • Amphibian calls heard during calling amphibian surveys • Potential as American Toad breeding habitat • Pond forms on-line drainage swale – Swale dry at time of assessment

Pond ID	UTMs	Pond Type	Approximate Dimensions		Water Level	Water Colour	Vegetation within/ overhanging pond		Landscape	Online?	Wildlife Observations (I=incidental observation)	Permanent Fish Habitat Potential	Observations
			Length (m)	Width (m)			Type	%					
GP-11	603412 mE 4852518 mN	Excavated pit/ ditch	Landowner permission not granted						-Agricultural field/meadow -Surburban	Yes (HDF)	• Green Frog breeding • Canada geese (I)	Unlikely	• Surrounded by manicured lawn – no riparian cover • East property agriculture – i.e. row crops • Pond forms on-line drainage swale – Swale dry at time of assessment • Amphibian calls heard during breeding amphibian surveys • Likely breeding habitat for American Toads
GP-12	603642 mE 4852486 mN	Pond does not exist											• Swale/drainage ditch extends along eastern edge of property
CP-1	605280 mE 4851117 mN	Pond does not exist											• Part of floodplain
CP-2	604452 mE 4852331 mN	Could not access land							-Agricultural field/meadow -Surburban	No	Green Frog breeding	Unlikely	• Row crops to North, West and East • Lands to the south-west fallow • Pond surrounded by mature deciduous trees and a few conifers • Adjacent land dedicated to form buildings/storage of farm equipment • Amphibian calls heard during calling amphibian surveys
CP-3	604358 mE 4852412 mN	Pond does not exist											• Wide floodplain • Manicured lawn to the north
CP-4 (ELC polygon 92)	603534 mE 4854127 mN	Excavated pit/ ditch	25	25	>50% full	Tea-coloured	Trees Emergent	25 25	-Agricultural field/meadow -Surburban	No – outlet to Clarkway Trib	Green Frog breeding	Unlikely	• Emergent riparian vegetation with shrubs • Amphibian calling heard during calling amphibian surveys • Contains regionally rare flora (duckweed)

Pond ID	UTMs	Pond Type	Approximate Dimensions		Water Level	Water Colour	Vegetation within/ overhanging pond		Landscape	Online?	Wildlife Observations (I=incidental observation)	Permanent Fish Habitat Potential	Observations
			Length (m)	Width (m)			Type	%					
CP-5	604598 mE 4852503 mN	Excavated pit/ ditch	20	15	>50% full	Mud-coloured	Emergent	5	-Agricultural field/meadow	No	No	No	• Livestock pond • Adjacent lands livestock fields • Row crops to the south and east • Separated from drainage swale by ~30 m (dry at time of assessment)
RP-1 (ELC polygon 103)	605395 mE 4852977 mN	Excavated pit/ ditch	25	15	>50% full	Algae-green	Floating-leaved aquatic	95	-Agricultural field/meadow	No	No	Unlikely	• No evidence of amphibian use • No riparian vegetation • Adjacent land entirely row crops • Separated from Rainbow Creek by ~10 m • Low potential to function as amphibian breeding habitat • Possible turtle hibernation site • Contains regionally rare flora (dotted watermeal)
RP-2	604642 mE 4854094 mN	Pond does not exist											• Appears as if pond has been filled in
RP-3	604314 mE 4855009 mN	Excavated pit/ ditch	20	20	<50% full	Tea-coloured	Emergent	5	-Agricultural field/meadow	No	No	Unlikely	• Likely no more than 75 cm deep • No evidence of amphibian use • Entirely surrounded by row crops • No riparian vegetation
Ponds not assessed as part of this specific investigation, but deemed significant for other reasons:													
ELC polygon 3	603954 mE 4853226 mN	Excavated pit	45	28	<50% full	-	Overhanging and emergent	75	Forest	No	No	-	• Amphibian woodland breeding pond in a significant woodland located within a valley
ELC polygon 93	605666 mE 4853367 mN	Excavated pit	8	10	<50% full	-	Submergent	50	Agricultural	No	No	-	• Isolated from other NHS features • Contains regionally rare flora (flat-stemmed pondweed)

2.4.8.6 Aquatic Habitat Management

Section 4.5.12.4 of the City of Brampton's Official Plan (2012) states that the City of Brampton will reference the Fisheries Management Plan prepared by the relevant Conservation Authorities to define fish habitat and their management requirements. The Humber River Fisheries Management Plan (HRFMP; 2005) prepared by the Ontario Ministry of Natural Resources (MNR) and the Toronto and Region Conservation Authority (TRCA) (2005) identifies the following Fish Management Zones and target fish communities for the drainage features within the study area (Figure 2.27):

- West Humber River: Fish Management Zone 7 - Redside Dace and Darter species; and
- Gore Road Tributary, Clarkway Tributary, Rainbow Creek Tributary: Fish Management Zone 4 - Darter species.

Each management zone in each subwatershed is managed for a certain aquatic community which is dependent upon the physical characteristics of that subwatershed. Information is provided within the HRFMP on general characteristics, important or limiting physical characteristics, management direction and targets for each zone. The HRFMP further identifies rehabilitation priorities within each subwatershed of the Humber River that are based on the identified Fish Management Zones (See **Section 5.2.2.2**).

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

FISH MANAGEMENT ZONES:

FMZ 4 - Darter Species

FMZ 7 - Redside Dace & Darter Species

FMZ - Humber Fish Management Zone

HDF MANAGEMENT RECOMMENDATION:

PROTECTION

CONSERVATION 2

MITIGATION 1

MITIGATION 2

NO MANAGEMENT REQURIED

SCALE: 1:16,000

AQUATIC HABITAT MANAGEMENT

FIGURE 2.27

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3 Development of the Area 47 Natural Heritage System

The 2014 Provincial Policy Statement (PPS), developed under the Planning Act directs municipal land use planning activities related to matters of provincial interest. Section 2.1 outlines the natural heritage component of the PPS, beginning with a preamble:

> *Ontario's long-term prosperity, environmental health, and social well-being depend on conserving biodiversity, protecting the health of the Great Lakes, and protecting natural heritage, water, agricultural, mineral and cultural heritage and archaeological resources for their economic, environmental and social benefits* (MMAH, 2014)

Section 2.1.2 goes further, averring that:

> *The diversity and connectivity of natural features in an area, and the long-term* ecological function *and biodiversity of* natural heritage systems, *should be maintained, restored or, where possible, improved, recognizing linkages between and among* natural heritage features *and* areas, surface water features *and* ground water features (emphasis retained).

As a result, the PPS not only champions the protection of a natural heritage system and individual natural heritage features (e.g. wetlands, woodlands, valleylands, wildlife habitat, etc.) but also the linkages that connect them into a broader Natural Heritage System (NHS). The NHS approach is effective because it acknowledges that natural heritage features have strong functional ties to one another, as well as to other physical features in the overall landscape.

The province offers technical guidance to implement the natural heritage policies of the PPS through the Natural Heritage Reference Manual (NHRM, 2010). The first edition of the NHRM, published by MNR in 1999, recognizes the development of a natural heritage system as a comprehensive approach to defining and protecting natural heritage features. The most recent edition of the NHRM released in 2010, places greater emphasis on planning for natural heritage systems and providing connectivity amongst disparate features and remains relevant for PPS 2014. The NHRM itself is an advisory document outlining what planning authorities (e.g. municipalities, conservation authorities) should consider when reviewing development proposals for impacts on natural heritage features. Much of the spirit and substance of the NHRM has been incorporated into Section 4.6 (Natural Heritage and Environmental Management) of the City of Brampton's Official Plan 2006 (OP) and Section 2 (The Natural Environment) of the Regional Municipality of Peel's Official Plan (2012).

Within its OP (2006), Brampton (the City) defines an NHS as:

> *…a system made up of natural heritage features and areas, linked by natural corridors which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems. Land use planning in the City of Brampton needs to consider not only natural heritage features, but also the functions and linkages they provide, including those of adjacent lands* (p. 4.6 – 14).

The following features have been identified as chief components of the City's natural heritage system:

- Valleylands and Watercourse Corridors
- Woodlands and the Urban Forest
- Wetlands
- Environmentally Sensitive/Significant Areas
- Areas of Natural and Scientific Interest
- Fish and Wildlife Habitat
- Greenbelt Plan Natural System

It is the purpose of this MESP to offer a framework to guide the development of lands and natural heritage system planning so that significant natural heritage features, along with their linkages and respective functions, are protected, restored and (where appropriate) enhanced.

Resulting from fieldwork outlined in **Section 2.4.1**, Aquafor Beech Limited has identified all natural heritage features in the study area based on criteria outlined in the City's OP (2006). Where appropriate, Peel Region's (the Region's) Greenlands System criteria outlined in Section 2.3 of its OP (2012) are also employed to characterize components of the NHS. Restoration areas, defined in Section 4.6.6 of the City's OP (2006) as having "the potential to be enhanced, improved or restored to a natural state" are also included in the NHS for future consideration of enhancement opportunities. Of primary importance is that the City will strive to achieve no net loss and if possible a net gain in natural heritage features and areas. The remainder of **Section** 3 summarizes the development of the NHS. All NHS features and associated buffers are then subsequently summarized in **Section 3.12** in the context of environmental opportunities and constraints to development.

3.1 Valleylands and Watercourse Corridors

The City outlines its policies in respect of valleylands and watercourse corridors in Section 4.6.7 of its OP (2006) and indicates that '*valleylands and watercourse corridors are an integral part of the ecosystem and … the City's overall open space network'* …. '*public ownership will permit the long term protection of the natural heritage system to ensure environmental, economic and social values that will improve the quality of life in the City'*. …. and lands designated on Schedule "D" of the Official Plan are intended *'primarily for the preservation and conservation of the natural features, functions and linkages'*.

Schedule "D" identifies Rainbow Creek Tributary, Clarkway Tributary and the Gore Road Tributary as valley / watercourse corridors. Robinson Creek Tributary is depicted as a watercourse on the mapping.

The Region's OP (2012) also aids to define "valley and stream corridors" as:

> *[t]he natural resources associated with the river systems characterized by their landform, features and functions, and include associated ravines. Valley corridors and ravines are distinguished from stream corridors by the presence of a distinct landform* (p. 59).

Valley and stream corridors are classified into two categories: Core Areas and Natural Areas and Corridors (NAC). Criteria used to define valley and stream corridors into these two categories are outlined below.

Core Areas

- Main branches, major tributaries, and watercourses draining directly to Lake Ontario:
    - Mapped from their outlet to the furthest upstream extent of their defined valley landform (i.e. to limit of crest of slope).
    - Only the Clarkway Tributary is defined as a Core Area on Schedule "A" of the Region's OP.

Natural Areas and Corridors (NAC)

- All other Valley and Stream Corridor features that do not meet the criteria as a Core Area, e.g. Rainbow Creek Tributary, Gore Road Tributary and Robinson Creek Tributary.

The Toronto and Region Conservation Authority (TRCA) also regulates development within and adjacent to river and stream valleys (whether or not a watercourse is present) through its "development, interference with wetlands and alterations to shorelines and watercourses" regulation under section 28 of the Conservation Authorities Act.

The West Humber River is considered a "main branch" while Gore Road Tributary, Clarkway Tributary and Rainbow Creek are considered "major tributaries". As such, these watercourses are considered core valley and stream corridors.

As discussed in **Section 2.3**, and in accordance with City of Brampton, Region of Peel and TRCA policies, the Area 47 stream and valley corridor systems have been defined through top-of-bank field surveys, floodplain delineation, stable slope investigations, and meander belt definition. The resulting stream and valley corridor systems are illustrated in **Figure 2.17**.

The Community Design framework as illustrated on **Figure 1.3**, depicts an Off Road pathway system associated with the Gore Road, Clarkway and Rainbow Creek Tributary corridors. Where feasible, the City seeks opportunities to locate trails within and across valley corridors, adjacent to natural features (e.g. in buffers) and in coordination with SWM facilities and parkland, to provide a complete network for neighbourhood connectivity, diverse user experience and passive environmental education. The City's OP recognizes that while trails are a vital component of City's open space system, they must be located and designed to protect natural heritage system features, functions and linkages.

3.2 Significant Woodlands

The City's policies in respect of significant woodlands are summarized in Section 4.6.8 of the OP (2006) and illustrated on Schedule "D". Sec. 4.6.8.1 indicates that prior to development, ' *natural heritage system studies or vegetative assessments will be required to evaluate and make recommendations for the protection of woodlands and how they can be maintained, restored and/or enhanced through sensitive subdivision and site design'*. Significant woodlands are to be identified based on direction contained in either the NHRM or municipal approaches that "achieve or exceed the same objective" (p. 21). Accordingly, this report references Section 2.3.2 (Woodlands) of the Region's OP (2012) in order to identify significant woodland features in the study area.

The Region's OP (2012) designates woodlands into three categories: Core Areas, Natural Areas and Corridors (NAC) and Potential Natural Areas and Corridors (PNAC). The criteria used to define each category are summarized in Table 1 of the Region's OP (2012, p. 72–75). The definition of "woodland" is expressly broad, and includes "woodlots, cultural woodlands, cultural savannahs, plantations and forested areas" (p. 283). As such, all polygons assigned with any of the above ELC community series' were evaluated for inclusion within the NHS as significant woodlands. Cultural thickets were not considered because they are not included in the definition of "woodland" above.

The Region's OP (2012) also contains provisions that enable exclusion of areas that otherwise meet significant woodland criteria. Pertinent here is the fact that areas dominated by invasive species (e.g. European buckthorn, etc.) may be excluded from significant woodland designation, as they threaten the ecological function or biodiversity of native communities. Because all ten

(10) cultural thickets are dominated by European buckthorn, this is further rationale for not including these areas as candidates for significant woodland status.

Woodlands that meet Peel's Core Areas, NAC's or PNAC's criteria will be considered "significant" and are included in the NHS mapping and described in Table 3.1 below. The criteria used to define each category are outlined below. For further clarity, the study area is located within the "Urban System" as outlined in Schedule D of the Region's OP (2012).

Core Areas

- Size
    - Rural System: Any woodland =/> 16 ha
    - Urban System Any woodland =/> 4 ha
- Age
    - Any woodland =/> 4 ha containing at least 0.5ha of woodland in native trees older than 100 years and having late successional characteristics (excludes plantations
- Significant Species and Communities
    - Any woodland =/> 4 ha that supports any of the following:
        1. Any G1, G2, G3, S1, S2 or S3 plant or animal species, or community as designated by NHIC; or
        2. any species designated by COSEWIC or COSSARO as *Threatened, Endangered* or of *Special Concern*; or
        3. The following forest communities: FOC 1-2, FOM 2-1, FOM 2-2, FOM 6-1, FOD 1-1, FOD 1-2, FOD 1-4, FOD 2-2, FOD 2-3, or FOD 6-2

Natural Areas and Corridors (NAC)

- Size
    - Rural System: Any woodland =/> 4 ha up to 16 ha
    - Urban System Any woodland =/> 2 ha up to 4 ha
- Age
    - Any woodland =/> 0.5 ha and less than 4 ha and containing at least 0.5ha of woodland in native trees older than 100 years and having late successional characteristics (excludes plantations)
- Linkage
    - Any woodland =/> 0.5 ha supporting a significant linkage function, as determined through a natural heritage study approved by the Region or area municipality

- Proximity
    - Any woodland =/> 0.5 ha within 100m of another significant feature supporting a significant ecological relationship between the features
- Surface Water Quality
    - Any woodland =/> 0.5 ha within 30 m of a watercourse, surface water features or any wetland that is or can be identified as a wetland in accordance with the Ontario Wetland Evaluation System (OWES)
- Significant Species and Communities
    - Any woodland =/> 4 ha that supports any of the following:
        1. any G1, G2, G3, S1, S2 or S3 plant or animal species, or community as designated by NHIC; or
        2. any species designated by COSEWIC or COSSARO as *Threatened, Endangered* or of Special Concern; or
        3. The following forest communities: FOC 1-2, FOM 2-1, FOM 2-2, FOM 6-1, FOD 1-1, FOD 1-2, FOD 1-4, FOD 2-2, FOD 2-3, or FOD 6-2

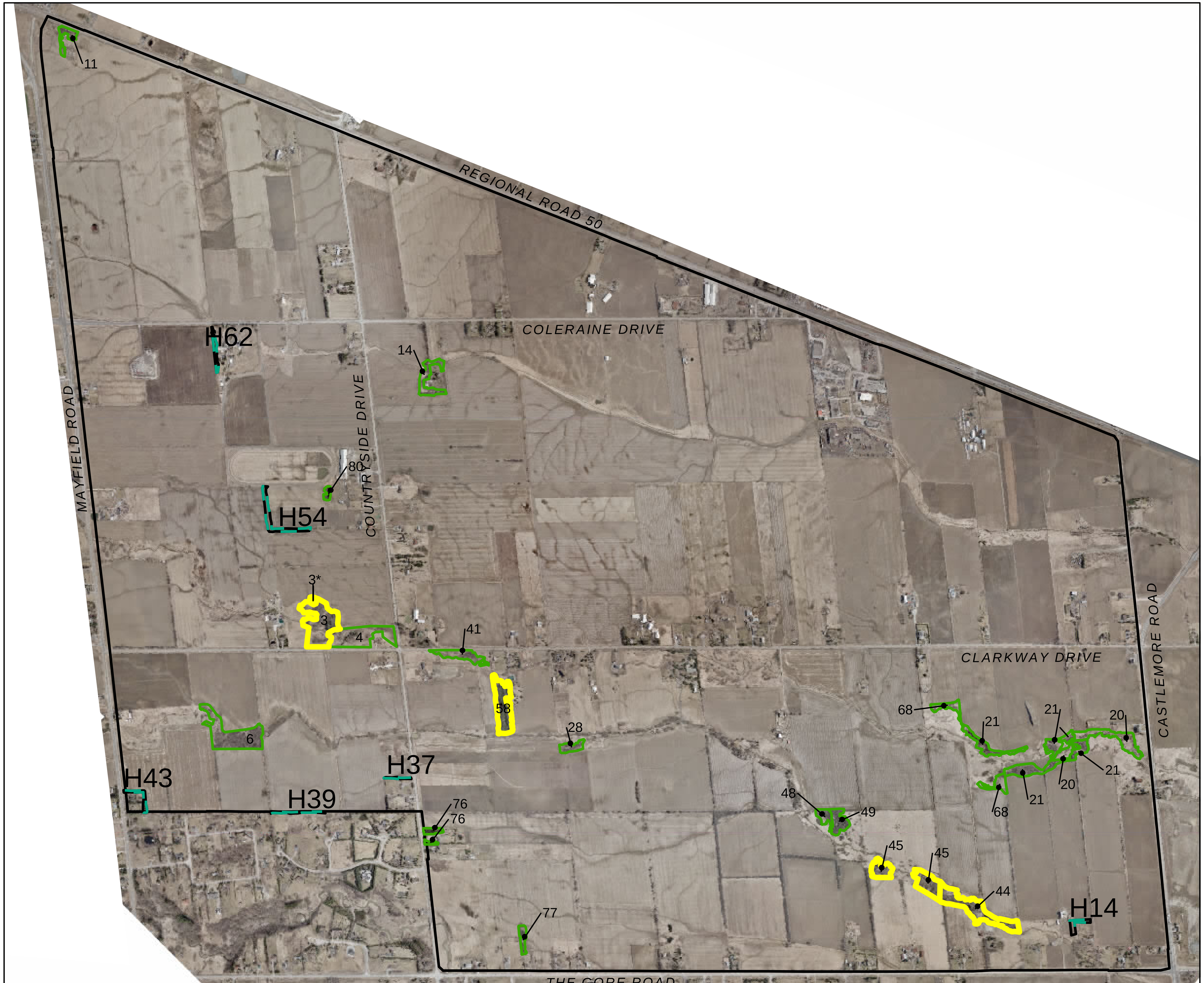
Potential Natural Areas and Corridors (PNAC)

- Size
    - Cultural Woodlands and cultural savannas =/> 4ha in the Rural System and =/> 2 ha in the Urban System and Rural Service Centres
- Linkage
    - Core and Natural Areas and Corridors criteria apply
- Proximity
    - Core and Natural Areas and Corridors criteria apply
- Surface Water Quality
    - Core and Natural Areas and Corridors criteria apply
- Significant Species and Communities
    - Core and Natural Areas and Corridors criteria apply

Based on the above criteria, **Table 3.1** provides a list of woodland communities that are considered significant (i.e. Core Areas, NAC and PNAC) and the rationale for designation. No Core Areas have been identified in the study area. A map of all woodlands in the study area, including significant woodlands and potentially retainable hedgerows is provided in **Figure 3.1**.

Table 3.1: Significant Woodland Communities

ELC Polygon	Size (ha)	Type of Feature	Rationale for Designation of Significant Woodlands
3 – cultural woodland (swamp maple deciduous swamp inclusion included)	2.12	PNAC	Size: Cultural woodland =/> 2 ha in the Urban System Proximity: Woodland is =/> 0.5 ha and within 100m of a significant valleyland (i.e. Core Valley and Stream Corridor) as defined by Peel Region's OP Surface Water Quality: Woodland is =/> 0.5 ha and within 30 m of a watercourse
44 – cultural plantation (old field inclusion not included) 45 – deciduous forest *these polygons are connected and should be considered a single woodland unit	2.47	NAC	Size: Woodland is =/> 2 ha in the Urban System Proximity: Woodland is =/> 0.5 ha and within 100m of a significant valleyland (i.e. Core Valley and Stream Corridor) as defined by Peel Region's OP Surface Water Quality: Woodland is =/> 0.5 ha and within 30 m of a watercourse
58 – cultural plantation Note: this feature is designated as a woodland on Schedule D the City of Brampton's OP (2006)	1.29	NAC	Proximity: Woodland is =/> 0.5 ha and within 100m of a significant valleyland as defined by Peel Region's OP Linkage: Woodland is =/> 0.5 ha and provides the only natural area connection between Gore Road Tributary and Clarkway Tributary Surface Water Quality: Woodland is =/> 0.5 ha and within 30 m of a watercourse



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STUDY AREA
- Woodlands
- Significant Woodlands
- Hedgerows Recommended for consideration for retention

SCALE: 1:16,000

WOODLANDS

FIGURE 3.1

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3.3 Woodlands

In addition to protecting significant woodlands, the City conserves woodlands through its Woodlot Conservation By-Law (316-2012) that identifies treed areas encompassing at least 0.2 hectares with at least one of the following:

1) 200 trees, of any size, per 0.2 hectare;
2) 150 trees, measuring over five (5) centimetres DBH, per 0.2 hectare;
3) 100 trees, measuring over twelve (12) centimetres DBH, per 0.2 hectare; or
4) 50 trees, measuring over twenty (20) centimetres DBH, per 0.2 hectare.

The By-law defines "tree" broadly to include any woody plant "which has reached or can reach a height of at least 4.5 metres at physiological maturity". Therefore all cultural thickets in the study area must be considered for inclusion in the NHS as woodlands including those that contain European buckthorn and hawthorns, as these species may reach or exceed 4.5 metres in height. In addition, there are no provisions for the exclusion of woodlands dominated by invasive species, unlike the woodlands definition in the Region's OP (2012).

There are sixteen (16) woodland communities in the study area, which also includes the four (4) significant woodlands under the Region's OP (2012) criteria. It is noted that some of the woodland communities include more than one vegetation unit (i.e. see polygon 21) wherein each unit contains at least 200 "trees". A map of all woodlands in the study area is provided in Figure 3.1. Note that some of the woodlands are designated as such in Schedule D of the City of Brampton's Official Plan; the MESP has identified additional woodlands within the study area.

1. *Polygon 3* – cultural woodland (including swamp maple deciduous swamp inclusion)
2. *Polygon 4* – mineral cultural savannah
3. *Polygon 6* – mineral cultural thicket
4. *Polygon 11* – mineral cultural woodland
5. *Polygon 14* – mineral cultural woodland
6. *Polygon 20* – hawthorn cultural savannah (excluding reed canary grass mineral meadow marsh or willow mineral thicket swamp).
7. *Polygon 21* – mineral cultural thicket (excluding raspberry thicket inclusion, four of the eight polygons meet the woodlot criteria)
8. *Polygon 28* – mineral cultural thicket
9. *Polygon 33* – mineral cultural thicket

10. *Polygon 41* – mineral cultural thicket (excluding shallow marsh inclusion)
11. *Polygon 44* – cultural plantation (excluding old field inclusion)
12. *Polygon 45* – deciduous forest (both polygons meet the woodlot criteria)
13. *Polygon 48* – mineral cultural thicket
14. *Polygon 49* – mineral cultural thicket
15. *Polygon 58* – cultural plantation
16. *Polygon 68* – mineral cultural thicket (one of the two polygons meets the woodlot criteria).

Note that some wooded communities (e.g. small plantations such as ELC polygons 76, 77 and 80) in the study area did not satisfy the City of Brampton's definition of woodland and thus are not included in the list above; they are illustrated on Figure 3.1 for context**.**

3.4 Wetlands

Policies related to wetlands and wetland protection are found in Section 4.6.9 of the City's OP (2006). The City recognizes that "*wetlands are a very important component of the natural heritage system with respect to both land and water related ecosystems including water quality and quantity, flood management, habitat for terrestrial and aquatic plants, fish and wildlife, food chain support and social and economic benefits*." Schedule D identifies wetlands ranging from Provincially Significant to locally significant and unevaluated wetlands (designated as Other Wetlands). Sec. 5.2 of OP (page 5 – 25) defines wetlands as:

> "*Lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants. The four major types of wetlands are swamps, marshes bogs and fens. Periodically soaked or wet lands being used for agricultural purposes, which no longer exhibit wetland characteristics, are not considered to be wetlands for the purposes of this definition*."

Sec. 4.6.9.3 of the OP states that "*based on the recommendations of the watershed plans, subwatershed studies, environmental studies and natural heritage system studies, an evaluation of the significance of the wetlands will be undertaken. The City will require that those wetlands that are recommended for protection be maintained, restored and/or enhanced through sensitive subdivision and site design, including appropriate stormwater management and sustainable management practices. The City will give consideration to wetland creation as mitigation for the loss of locally significant and unevaluated wetlands based on the recommendations of these studies.*"

This definition is consistent with the definition found in Ontario's Wetland Evaluation Manual (OWES) (MNR, 1994, p. 5) and the Region of Peel Official Plan (2012) (p. 283).

Like significant woodlands, the Region classifies wetlands into Core Areas, Natural Areas and Corridors (NAC), and Potential Natural Areas and Corridors (PNAC).

Core Areas

1) Provincially Significant Wetlands and Significant Coastal Wetlands

Natural Areas and Corridors (NAC)

2) Evaluated non-Provincially Significant Wetlands

Potential Natural Areas and Corridors (PNAC)

3) Unevaluated wetlands

In addition to Peel Region's Greenlands System, Toronto and Region Conservation Authority (TRCA) regulates activities within and adjacent to wetlands through its "development, interference with wetlands and alterations to shorelines and watercourses" regulation under section 28 of the Conservation Authorities Act. TRCA approval is required for development activities within wetlands and may only be granted if the control of flooding, erosion, dynamic beaches, pollution or the conservation of land will not be affected by the development. Development activities within 120 metres of provincially significant wetlands and 30 metres from all other wetlands (not including areas previously approved for development under the Planning Act) also require TRCA approval.

There are no evaluated wetlands (provincially significant or otherwise) in the study area. As such, all wetlands that have been identified during ELC vegetation community delineation are classified Other Wetlands / PNAC (e.g. unevaluated). The majority of the Other Wetlands / PNAC wetlands are located within Valleylands and Watercourse Corridors and will therefore be protected through the associated buffers and development setbacks. For those Other Wetlands / PNAC wetlands located outside of the Valleylands and Watercourse Corridors, further consultation with the City of Brampton and TRCA is recommended as part of future development planning to determine the details of compensation for the loss of these tableland features.

Criteria related to the consideration of each wetland community's inclusion within the NHS include:

- Ecologic function under present conditions;
- Anticipated ecologic function post-development; and
- Location on the landscape in relation to other NHS features (e.g. tributary corridors).

A list of all wetland ELC polygons in the study area is provided below in **Table 3.2**, many of which are restricted to areas within valleylands and watercourse corridors. A map of all wetlands, including ponds investigated for amphibian breeding habitat (as also shown in **Figure 2.26)** in the study area is provided in **Section 3.4.1**. Further information on ponds is contained in the proceeding subsection.

Table 3.2: List of Wetland Polygons by ELC Ecosite/Vegetation Type

ELC Ecosite/Vegetation Type	Total Number of ELC Polygons	Wetland ELC Polygons
Cattail Mineral Shallow Marsh	17	0 (inclusion), 16 (inclusion), 23 (complex), 24 (inclusion), 26, 39, 53, 55 (inclusion) 69 (inclusion), 74, 75 (inclusion), 78, 83, 91, 92, 96, 101
Willow Mineral Thicket Swamp	9	2, 19, 20 (complex), 22 (complex), 35, 62 (complex), 63 (inclusion), 86, 105
Swamp Maple Deciduous Swamp	1	3 (inclusion)
Willow Mineral Deciduous Swamp	5	7, 29, 64, 81, 98
Waterweed Submerged Shallow Aquatic	1	7 (inclusion)
Reed-canary Grass Mineral Meadow Marsh	8	8, 20 (inclusion), 37, 43, 50, 67, 79, 85
Forb Mineral Meadow Marsh	13	1 (inclusion), 12 (complex), 16, 18A, 22, 23 (complex), 30 (inclusion), 31 (inclusion), 32, 46, 47 (complex), 73, 87
Bulrush Organic Shallow Marsh	1	25
Mineral Meadow Marsh	5	13, 34, 52, 89, 104
Mineral Shallow Marsh	2	38, 93
Bedrock Shallow Marsh	1	94
Duckweed Floating-leaved Shallow Aquatic	3	12 (inclusion), 100, 103
Pondweed Mixed Shallow Aquatic	1	106

3.4.1 Natural/Agricultural Ponds

As described in **Section 3.4**, above, unevaluated wetlands are regulated by the TRCA and qualify as Potential Natural Areas and Corridors under the City of Brampton's OP (2006). According to the definitions of the Ontario Wetland Evaluation System and the Ecological Land Classification System for Southern Ontario, ponds supporting wetland vegetation and with water depths less than 2 m are considered wetlands. Accordingly, this section provides an overview of the ponds investigated for amphibian habitat as part of the site characterization detailed in **Section 2.4.8.5** as well as 3 other ponds identified through the vegetation community classification exercise (ELC), including an analysis of their ecological function, position on the landscape, and recommended retention status. In total, 12 ponds are recommended for retention and inclusion in the NHS, 11 are not recommended for retention as part of the Area 47 NHS, and 1 (GP-11) is recommended for retention on lands outside of the Area 47 NHS.

Each pond's candidacy for inclusion within the NHS was based on consideration of the following:

- Ecologic function under present conditions;
- Anticipated ecologic function post-development; and
- Location on the landscape in relation to other NHS features (e.g. tributary corridors).

Of the 21 ponds screened for amphibian habitat it was determined that ponds GP-2, GP-5, GP-6, GP-7, GP-10, GP-11 and CP-4 were actively being used by calling amphibians as breeding habitat. The presence of giant floaters within pond GP-6 (same location as mussel monitoring location GM-4) also suggests it functions as permanent fish habitat, as the life cycle of aquatic mussels requires a host fish during the larval stage. The giant floater is a habitat and host-generalist, meaning it can use a number of fish species as a host and is fairly adaptable to ecological disturbances (Cummings and Mayer 1992).

Aquafor Beech Limited recommends protecting ponds CP-2, GP-2, GP-4, GP-5, and GP-6 as amphibian breeding and fish habitat. Although ponds GP-7, GP-10, and CP-4 contained breeding amphibians, these ponds will either be cut off from the NHS by proposed transportation infrastructure and/or they are too far removed from adequate foraging habitat to warrant further protection of amphibian habitat post-development, though some may be included within the NHS for other reasons such as their location within a floodplain. For example, pond CP-4 will likely not function as amphibian habitat post-development due to its isolation from the greater NHS due to a proposed road, though it will likely still function as habitat for significant flora. However, the pond is contained within a floodplain and is this protected as part of the NHS. Pond GP-11 currently supports amphibian breeding, but is not considered part of the Area 47 NHS per se due to its location outside of the study area. It is nevertheless recommended that activities/development within Area 47 not negatively impact this pond. Pond GP-4 did not contain breeding amphibians; however, in the opinion of Aquafor Beech Limited, its proximity to Gore Road Tributary and Pond GP-5 warrants further protection as it has the potential to add to the ecological function of the NHS over the medium and long-term.

ELC polygon 3 and ponds GP-1, GP-1.5, and RP-3 are included within the NHS due to their location within a valley and/or floodplain.

Ponds CP-4 (ELC polygon 92) and RP-1 (ELC polygon 103), as well as ELC polygon 93 (which was not included in the fauna-centric pond assessment due to its isolation from NHS features by Coleraine Road), contain significant flora (Figure 3.5). Pond RP-1 is located within the NHS associated with Rainbow Creek; it is thus recommended that the pond be retained due to the potential for the pond's long-term viability and connection to the NHS. As previously mentioned, pond CP-4 is located within a floodplain. ELC polygon 93 will be further isolated from the NHS post-development. Accordingly, it is recommended that the rare species present in ELC polygon 93 be transplanted to suitable habitat within areas connected to the greater NHS to allow for the proliferation and long-term viability of significant flora within the pond. Recommendations for transplanting rare species are contained within **Section 6.3.1**.

Ponds GP-8 and GP-9 were not accessed as part of the pond assessment. Their tableland location and isolation from other NHS features warrants their removal. Pond CP-5 and ELC polygon 92 have limited ecologic function and are located in tableland locations that are separated from the nearest NHS valleys by Clarkway Road and Coleraine Drive, respectively. As such it is anticipated that the ponds' ecological function will continue to be limited; consequently these ponds are not recommended for retention. Ponds GP-12, CP-1, CP-3, and RP-2 were not able to be located during surveys; it is assumed that they no longer exist.

Table 3.3 provides a summary of the recommendations for the inclusion of each of the ponds described in **Table 2.23** within the NHS. Ponds included within the NHS are illustrated in **Figure 3.3**. As with the recommended tableland wetland removals, further consultation with the City of Brampton and TRCA is recommended as part of future development planning to determine the details of compensation for the loss of tableland natural heritage features, including ponds. Accordingly, ponds have been accounted for in the proposed natural heritage feature removal and compensation calculations (**Table 5.1** to

Table 5.4).

Table 3.3: Assesment of Natural/Agricultural Ponds for Inclusion in the NHS

<table>
<tr><th>Pond ID</th><th>General Location</th><th>Protected as part of Area 47 NHS?</th><th>Rationale</th></tr>
<tr><td>GP-1</td><td>Stream/Valley corridor</td><td>Yes</td><td>Contained within a valley.</td></tr>
<tr><td>GP-1.5</td><td>Stream/Valley corridor</td><td>Yes</td><td>Contained within a valley.</td></tr>
<tr><td>GP-2</td><td>Stream/Valley corridor</td><td>Yes</td><td>Contained within a valley and functions as amphibian breeding habitat.</td></tr>
<tr><td>GP-3
(ELC polygon 63*)</td><td>Stream/Valley corridor</td><td>Yes</td><td>Contained within valley.</td></tr>
<tr><td>GP-4
(ELC polygon 62*)</td><td>Stream/Valley corridor</td><td>Yes</td><td>Could function as amphibian breeding habitat and contains rare flora. Located within a valley.</td></tr>
<tr><td>GP-5
(ELC polygon 28)</td><td>Stream/Valley corridor</td><td>Yes</td><td>Functions as amphibian breeding habitat. Located within a valley.</td></tr>
<tr><td>GP-6
(ELC polygon 94)</td><td>Stream/Valley corridor</td><td>Yes</td><td>Functions as amphibian breeding habitat and fish habitat. Located within a valley.</td></tr>
<tr><td>GP-7
(ELC polygon 75*)</td><td>Tableland</td><td>No</td><td>Will likely not function as breeding habitat in a post-development scenario. Isolated from other NHS features.</td></tr>
<tr><td>GP-8</td><td>Tableland</td><td>No</td><td rowspan="2">Ponds were not assessed due to land access denial. Both are isolated from other NHS features. Pond GP-9 is located on residential land adjacent to the study area.</td></tr>
<tr><td>GP-9</td><td>Tableland</td><td rowspan="3">No, but retained outside of Area 47</td></tr>
<tr><td>GP-10</td><td>Tableland</td><td>Unsuitable for amphibian breeding and isolated from greater NHS. Pond GP-10 is located on residential land adjacent to the study area.</td></tr>
<tr><td>GP-11</td><td>Tableland</td><td>Pond GP-11 is located in estate residential lands outside of the study area. Limited function as breeding habitat in a post-development scenario; currently supports green frog.</td></tr>
<tr><td>GP-12</td><td>n/a</td><td>n/a</td><td>Pond does not exist.</td></tr>
<tr><td>CP-1</td><td>n/a</td><td>n/a</td><td>Pond does not exist.</td></tr>
<tr><td>CP-2
(ELC polygon 35)</td><td>Stream/Valley corridor</td><td>Yes</td><td>Contained within a valley and functions as amphibian breeding habitat.</td></tr>
<tr><td>CP-3</td><td>n/a</td><td>n/a</td><td>Pond does not exist.</td></tr>
<tr><td>CP-4
(ELC polygon 91)</td><td>Stream/Valley corridor</td><td>Yes</td><td>Will not function as breeding habitat in a post-development scenario. However, the pond contains regionally rare flora and is located within a floodplain.</td></tr>
<tr><td>CP-5</td><td>Tableland</td><td>No</td><td>Limited ecologic function.</td></tr>
<tr><td>RP-1
(ELC polygon 103)</td><td>Stream/Valley corridor</td><td>Yes</td><td>Located within NHS associated with Rainbow Creek. Contains rare flora.</td></tr>
<tr><td>RP-2</td><td>n/a</td><td>n/a</td><td>Pond does not exist.</td></tr>
<tr><td>RP-3
(ELC polygon 38)</td><td>Stream/Valley corridor</td><td>Yes</td><td>Limited ecologic function, but within floodplain.</td></tr>
<tr><td>ELC polygon 3*</td><td>Stream/Valley corridor</td><td>Yes</td><td>Functions as an amphibian woodland breeding pond; located in a significant woodland within a valley.</td></tr>
<tr><td>ELC polygon 92</td><td>Tableland</td><td>No</td><td>Contains rare flora, but isolated from adjacent NHS features. Mitigation is recommended.</td></tr>
<tr><td>ELC polygon 93</td><td>Tableland</td><td>No</td><td>Contains rare flora, but isolated from adjacent NHS features. Mitigation is recommended.</td></tr>
</table>

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

Wetlands

(PONDS ASSESSED

Note: Wetland/pond communities 3* and 28 (GP-5) are considered amphibian woodland breeding ponds. Significant species, some of which are reliant on wetlands, are illustrated on Figures 2.19, 2.20, and 2.22.

SCALE: 1:16,000

LOCATIONS OF WETLANDS

FIGURE 3.2

AQUAFOR PROJECT NO.: 64608

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MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

Tableland wetlands/ponds to be retained

Wetland/pond communities proposed for removal

SCALE: 1:16,000

WETLANDS RECOMMENDED FOR RETENTION

FIGURE 3.3

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3.5 Environmentally Sensitive/Significant Areas

Environmentally Significant Areas are identified by the relevant Conservation Authority according to their established criteria and would be reflected on Schedule D of the City's OP. There are no Environmentally Sensitive/Significant Areas designated by TRCA within the study area.

3.6 Areas of Natural and Scientific Interest

Areas of Natural and Scientific Interest (ANSIs) are designated by the MNRF and include sites of particular ecological or geological significance and would be reflected on Schedule D of the City of Brampton's OP (2006). There are no ANSIs (either Earth Science or Life Science) within the study area.

3.7 Greenbelt Plan Natural System

The Greenbelt Act (2005) and respective Greenbelt Plan spell out land use restrictions placed on a wide swath of land on the outskirts of the Greater Golden Horseshoe, and including the Oak Ridges Moraine and Niagara Escarpment. The Greenbelt Plan does not extend into the study area.

3.8 Fish and Wildlife Habitat

Section 4.6.12 of the City of Brampton's OP (2006) recognizes that fish and wildlife habitat within Brampton is linked to and forms part of the larger regional and provincial natural heritage system. Of particular relevance are areas considered significant wildlife habitat as defined by MNR (2000), habitat for species at risk, and fish habitat in accordance with the federal Fisheries Act.

Section 4.6.12.1 of Brampton's OP states that "*Development and site alteration in significant habitat of threatened or endangered species listed in the regulations under the provincial Endangered Species Act is not permitted in accordance with the Provincial Policy Statement*" The OP has not clarified whether "significant" habitat in this context is consistent with the notion of general or "regulated" habitat as defined in the Endangered Species Act (ESA). Regardless, an ESA-consistent definition of SAR habitat is used in developing the NHS, and a more detailed discussion on SAR habitat is provided in **Section 3.8.3**. As well, a more detailed discussion on significant wildlife habitat is provided in **Section 3.8.2**. The extent of fish habitat within the study area is described below.

3.8.1 Fish Habitat

Fish habitat, as defined by the Fisheries Act (2007) and the Region of Peel Official Plan (2012), is any area on which fish depend directly or indirectly in order to carry out their life processes, including spawning grounds, nursery areas, rearing areas, food supply areas and migration areas.

Section 4.6.12.4 of the City's OP (2006) states that the Humber River Fisheries Management Plan (HRFMP; 2005) prepared by the Ontario Ministry of Natural Resources (MNR) and Toronto and Region Conservation Authority (TRCA) will be used to define fish habitat and management requirements. There are four (4) higher order watercourses within the Area 47 lands: Gore Road Tributary, Clarkway Tributary, Rainbow Creek and the West Humber River. The HRFMP classifies Gore Road Tributary, Clarkway Tributary and Rainbow Creek as small Riverine warm water fish habitat, whereas the West Humber River is classified as intermediate warm water habitat. All four (4) watercourses are protected as valleylands and watercourse corridors within the City of Brampton's Natural Heritage System (Schedule D; City of Brampton Official Plan 2006).

3.8.2 Significant Wildlife Habitat

Significant wildlife habitat is broadly categorized by MNR as: 1) seasonal concentration areas, 2) rare vegetation communities or specialized habitats for wildlife, 3) habitats of species of conservation concern excluding endangered and threatened species habitat, and 4) animal movement corridors (MNR, 2000). As stipulated in the PPS, development and site alteration is not permitted in significant wildlife habitat unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions. Aquafor Beech Limited assessed the availability of significant wildlife habitat across the study area with reference to the Significant Wildlife Habitat Technical Guide (SWHTG).

The subwatershed is heavily dominated by agricultural land uses and culturally influenced vegetation communities. As such, the study area does not contain rare vegetation communities (e.g. alvars, tallgrass prairies, etc.) or significant wildlife habitat features related to larger, higher-quality wetlands (e.g. waterfowl staging areas, waterfowl nesting, bullfrog concentrations areas, etc.). All areas that either contain elements of specialized wildlife habitat, or actually meet the criteria as specified by MNR, are described below.

There are three (3) significant wildlife habitat features present in the study area: colonial nesting bird sites (barns with actively nesting barn swallow), woodland amphibian breeding ponds, and habitat for species of conservation concern. The barns and other built features with nesting barn swallows are protected under section 10 of the Endangered Species Act (see **Section 3.8.3**), and are illustrated in **Figure 3.8**. The two (2) woodland amphibian breeding ponds (an inclusion in ELC polygon 3 and polygon 28/GP-5) qualify as significant wildlife habitat and therefore are recommended for retention. These woodland ponds are illustrated in **Figure 3.4**. Three (3) dugout agricultural ponds which provide habitat for regionally rare flora (ELC polygons 92, 93, 103) also qualify as significant wildlife habitat; these ponds are illustrated in **Figure 3.5**. Further discussion regarding the retention status of these ponds is contained within **Section 3.4.1**.

Seasonal Concentration of Animals

Winter Deer Yards **- Not Present**: Deep snow restricts deer mobility in winter, which increases their susceptibility to predation. As a result, deer will congregate in areas of dense conifer cover (e.g. hemlock, cedar, spruce, etc.) where much of the snow is intercepted by tree boughs in the canopy. These areas – known as deer yards – should be composed of at least 60% canopy cover and may be surrounded by deciduous forest or agricultural areas which provide food in times of lighter snow accumulation. Only one white pine coniferous plantation (ELC polygon 58) in the study area contains enough thick conifer coverage to warrant consideration as a potential deer yard. Nevertheless, much of it is edge habitat and it is probably not large enough (1.29 ha) to provide adequate shelter from predators and cold winds of winter. In addition, yarding in general tends to be less frequent in southern Ontario, which does not develop a deep enough snow pack (i.e. at least 40 cm for more than 60 days is considered minimum criteria for yarding).

Colonial Bird Nesting Sites **- Present:** Certain birds nest together in large habitat-specific colonies, such as banks and cliffs (e.g. swallows), trees/shrubs (e.g. egrets, herons) or on the ground (e.g. gulls, terns). Barns occupied by barn swallows are present in the study area and are illustrated in Figure 3.8, and this species and its nesting habitat are described in greater detail in **Section** 3.8.3. Apart from barn swallows, there are no colonial bird nesting sites in the study area. Green heron was observed in three wetland communities (ELC polygons 20, 31 & 35), however no nests were found. No bank swallow or northern rough-winged swallow nests were present along an eroding bank in ELC polygon 34 (see inset photo), the only potentially suitable site found.

Raptor Winter Feeding and Roosting Areas **– Possible:** Birds of prey such as hawks and owls feed in open areas including hayfields and meadows which may contain sizable small mammal populations. Mixed and coniferous woodlands adjacent to these open areas may provide suitable roosting sites. One (1) white pine coniferous plantation (ELC polygon 58) and its adjacent meadows and agricultural fields is a suitable wintering area for raptors. Great horned owl has been observed by the landowner, and pellets were noted along the southern margin during the spring botanical survey. However, this site is fairly small and may not support a large enough assemblage of raptors to be considered significant. Further studies should be conducted to determine abundance and whether additional species are present.

Rare Vegetation Communities/Specialized Habitats for Wildlife

Habitat for Area-sensitive Species **– Not Present:** Area sensitive species require large tracts of habitat to breed. Seven (7) area-sensitive birds were observed during breeding bird surveys. Bobolink, eastern meadowlark, savannah sparrow, and northern harrier are area-sensitive species of open habitats, blue-gray gnatcatcher and white-breasted nuthatch utilize forest habitats, and American redstart is found in young woodland/thicket habitats. Area sensitive open country species were found throughout the study area.

There is little direction in the SWHTG in regards to minimum thresholds for qualification as habitat for area-sensitive species (e.g. area, number of species observed, etc.). Nevertheless, the draft Ecoregion 6E criteria (MNR, 2012) specifies that open country and forest habitats with area-sensitive species should be greater than 30 ha, and that such sites cannot be actively farmed. There is no open country or forest habitat in the study area that is both, greater than 30 ha and not actively farmed. On this basis, habitat for area-sensitive species is deemed not present.

***Foraging Areas with Abundant Mast* – Not Present**: A wide variety of birds and mammals forage on fruit and nuts. Forests containing beech, hickory and oak supply energy-rich mast for building fat reserves needed for winter survival. Dense thickets of raspberry, blackberry and blueberry afford plentiful supplies of berries for summer consumption. No significant acorn/nut producing areas are present in the study area, however two sizable raspberry thickets are present. The first is a small patch (not an inclusion) within an old field meadow (polygon 1). The second is a raspberry cultural thicket inclusion in a larger mineral cultural thicket (polygon 21).Both sites are fairly small (<0.05 ha), and therefore are not considered suitable for inclusion as a significant wildlife habitat.

***Amphibian Woodland Breeding Ponds* – Present:** Both permanent and ephemeral woodland ponds may support a variety of frog and salamander species. Two dugout woodland ponds offer confirmed or likely amphibian breeding habitat. Calling green frogs and tadpoles were observed in a dugout pond in a mineral cultural thicket (polygon 28/Pond GP-5). This pond contains brush and submerged vegetation where females can deposit eggs (see inset photo). Additionally, adult frogs were observed in the vicinity of a swamp maple deciduous swamp inclusion (polygon 3) (amphibian calling surveys not conducted at this site). Both ponds are along the woodland edge, and due to a lack of fallen logs in the vicinity aren't expected to support ambystomatid salamanders. The location of amphibian woodland breeding ponds is illustrated in Figure 3.4. Both of these ponds are included within the NHS.

***Turtle nesting habitat* – Possible:** Preferred turtle nesting sites are generally unvegetated and contain coarser substrates (e.g. sand or fine gravel). Ideally these sites are close to water and away from roads. One juvenile snapping turtle was observed along a dry section of Gore Road Tributary in a mineral meadow marsh (polygon 34; see inset photo). This individual is considered a juvenile rather than a hatchling on the basis of its size (i.e. hatchlings are generally smaller). The almost complete lack of water along this section of the Gore Road Tributary makes this juvenile particularly vulnerable to desiccation.

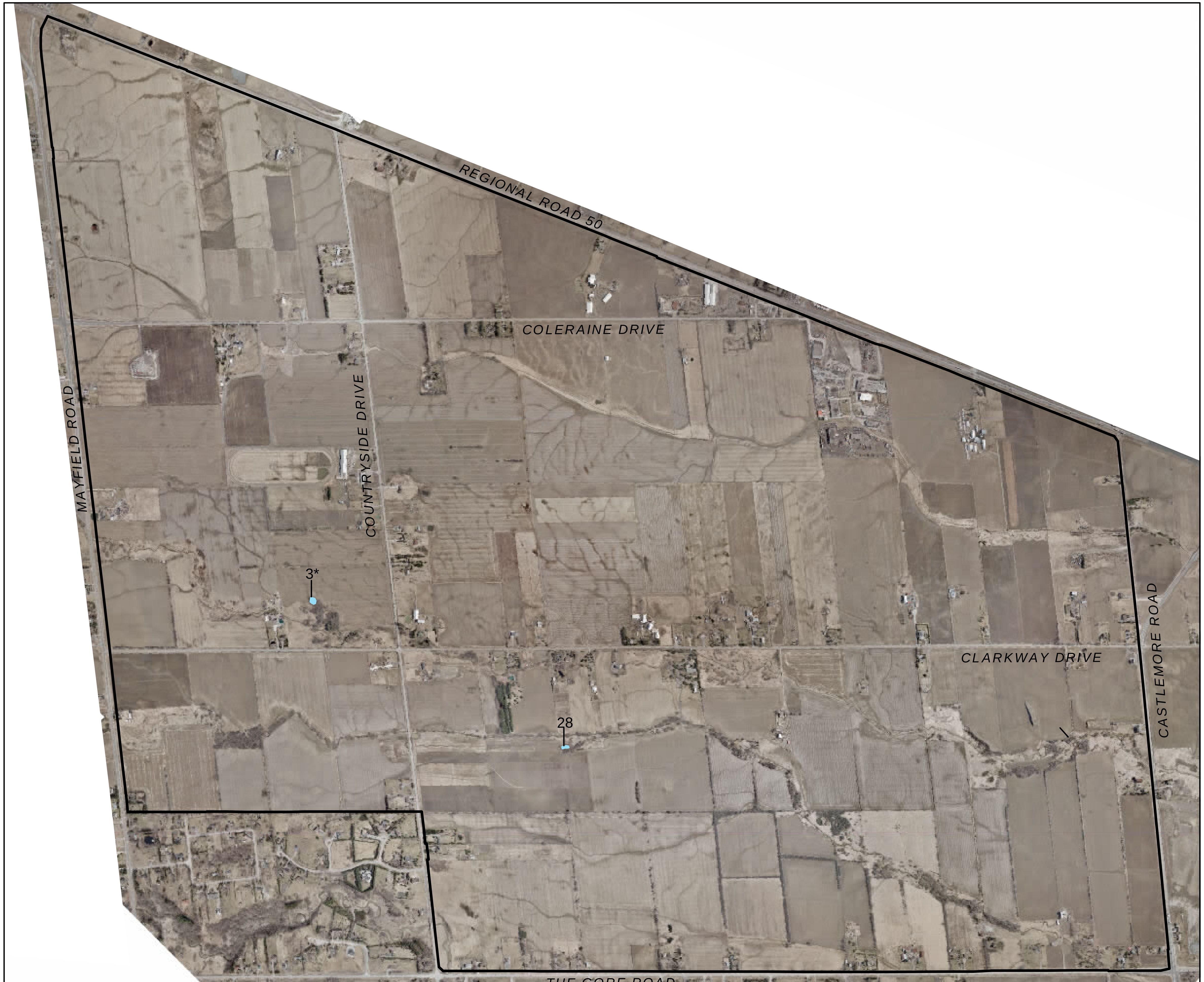
The thick clay deposits in this community (and throughout the study area) would not be considered "preferred" nesting substrate; nevertheless, snapping turtles are known to use whatever is available. Because no nesting sites (or potentially suitable sites) were discovered, turtle nesting habitat in the study area is considered possible. Possible turtle nesting habitat has been included within the NHS, with the exception of anthropogenic sites such as roadsides. The location of the Snapping Turtle observation was shown previously in **Figure 2.19**.

***Specialized raptor nesting habitat* - Possible:** The white pine coniferous plantation (polygon 58) that may act as a raptor winter feeding and roosting area may also support nesting habitat, particularly for species that prefer a mix of woodland and open habitat (e.g. great-horned owl). This woodland has been assessed as significant and is included within the NHS.

***Mink denning sites* – Possible:** Minks occupy a variety of wetland habitats, along with adjacent woodland slopes. Dens are typically excavated within a creek bank or under logs and other debris. Old beaver or muskrat dens may also be used. One individual was observed along a creek in a hawthorn cultural savannah (polygon 31), although no den was found. Given the dearth of potential habitat beyond this community and adjacent meadow marshes, it is possible that mink den nearby the observation.

<u>Habitats for Species of Conservation Concern</u>

***Provincially and Regionally Rare Flora* – Present:** As outlined in **Section 2.4.4** and **Section 2.4.5**, provincially and regionally rare species are present across the study area. The vast majority of these observations occurred within features covered by the City's and/or Peel's NHS criteria (e.g. Valleylands and Watercourse Corridors, Significant Woodlands, etc.). However, the Natural/Agricultural Ponds assessment identified three (3) dugout agricultural pond wetlands on the tablelands that contain regionally rare aquatic flora, and therefore qualify as significant wildlife habitat. The location of these and other wetland ponds is illustrated in the wetland mapping in **Figure 3.2**.



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

Woodland Amphibian Breeding Ponds

SCALE: 1:16,000

LOCATIONS OF WOODLAND AMPHIBIAN BREEDING PONDS

FIGURE 3.4

AQUAFOR PROJECT NO.: 64608

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MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

Agricultural Ponds with Rare Flora

SCALE: 1:16,000

LOCATIONS OF AGRICULTURAL PONDS CONTAINING REGIONALLY RARE FLORA

FIGURE 3.5

AQUAFOR PROJECT NO.: 64608

Aquafor Beech Limited

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3.8.3 Species at Risk

The protection of species at risk (SAR) in Ontario is dictated primarily by the Endangered Species Act (ESA). The stated purposes of the ESA are:

1. *To identify species at risk based on the best available scientific information, including information obtained from community knowledge and aboriginal traditional knowledge.*
2. *To protect species that are at risk and their habitats, and to promote the recovery of species that are at risk.*
3. *To promote stewardship activities to assist in the protection and recovery of species that are at risk.*

A scientific body known as the Committee on the Status of Species at Risk in Ontario (COSSARO) is tasked with identifying threats to species present in Ontario and classifying those deemed at risk as extirpated, endangered, threatened or special concern. Endangered and threatened species receive recovery strategies, which provide science-based recommendations that aid in their protection and future recovery. These species are also protected from being killed, harmed or harassed (s. 9) and also receive habitat protection (s. 10). Alternatively, special concern species receive management plans rather than recovery strategies and are not subject to species or habitat protection.

A regulation specifying a species' habitat must be developed by the second anniversary (endangered) or third anniversary (threatened) of the date the species is officially listed. Before the habitat regulation has been devised, a general definition of habitat is employed and defined as:

> *"an area on which the species depends, directly or indirectly, to carry on its life processes, including life processes such as reproduction, rearing, hibernation, migration or feeding"*

Any activity that constitutes harm to an endangered or threatened species or damages its habitat must receive approval from the Ministry of Natural Resources (MNR) under section 17(2)(c) of the ESA. In order to receive a 17(2)(c) authorization, a proponent must demonstrate that an overall net benefit for the species will be attained, which often involves rehabilitation or restoration activities. The MNRF should be consulted for all aspects of potential impacts to SAR habitat.

Further provisions protecting SAR in Ontario are found in the Provincial Policy Statement (PPS) developed under the Planning Act. The PPS stipulates that development and site alteration are not permitted in the habitat of endangered species and threatened species.

The federal Species at Risk Act (SARA) also affords protection to extirpated, endangered, threatened and special concern species. Like its provincial counterpart, SARA protects endangered and threatened species from being killed, harmed and/or harassed, and does not extend these prohibitions to special concern species. Alternatively, SARA only protects the "critical habitat" of such species rather than their general habitat, which is much more restrictive. Further, SARA pertains exclusively to federal land and "federal species" (i.e. migratory birds and fish). Therefore, non-federal species dwelling on provincial or private land are not protected under SARA. Finally, there are fewer species considered at risk in Ontario under SARA as compared to the ESA. Although a scientific body (the Committee on the Status of Endangered Wildlife in Canada, or COSEWIC) is also tasked with classifying species under SARA, the final decision to add a species to the act is determined by the Minister of the Environment. Many species are left off of SARA because the economic impacts of their protection are deemed unacceptably high.

Results

A total of seven (7) provincial and federal species at risk (SAR) were observed or are known to occur in the study area. These species and their respective ESA, COSEWIC and SARA status are provided in **Table 3.4**.

A more detailed discussion of each species, including its biology, habitat requirements and protection under the ESA, is provided below.

Table 3.4: Status of Species at Risk in the Study Area

Species	ESA status	COSEWIC status	SARA status
Redside Dace (*Clinostomus elongatus*)	Endangered	Endangered	Endangered
Bobolink (*Dolichonyx oryzivorus*)	Threatened	Threatened	No Status
Eastern Meadowlark (*Sturnella magna*)	Threatened	Threatened	No Status
Barn Swallow (*Hirundo rustica*)	Threatened	Threatened	No Status
Eastern Wood Pewee (*Contopus virens*)	Special Concern	Special Concern	No Status
Snapping Turtle (*Chelydra serpentina*)	Special Concern	Special Concern	Special Concern
Monarch Butterfly (*Danaus plexippus*)	Special Concern	Special Concern	Special Concern

Redside Dace

The short stretch of the West Humber River within the north-westerly corner of the study area has been designated by the MNR as regulated habitat for Redside Dace under the Endangered Species Act, 2007. In accordance with Section 29.1 of Ontario Regulation 242/08, prescribed habitat of Redside Dace will include lands that are within 30 metres beyond the meander belt of an occupied watercourse. Therefore, in accordance with this Regulation, a 30 metre buffer beyond the meander belt is recommended for this reach of the West Humber River. In addition, it is the City of Brampton's understanding that the lower reaches of the Rainbow Creek Tributary may be considered contributing habitat to Redside Dace. Accordingly, any works in this area require consultation with the MNRF should demonstrate an overall benefit to the species.

Per Section 4.6.12.1 of the City of Brampton's Official Plan (2006), development and site alteration in significant habitat of vulnerable, threatened or endangered species is not permitted in accordance with the Provincial Policy Statement.

Bobolink

Approximately 155 bobolink were noted throughout the study area. Generally, bobolink were recorded as “probable” nesters in all areas of habitat, as territorial behaviour was noted throughout the study area and they were seen in the same habitat on at least two visits. One bobolink was noted with fledglings: an indication of confirmed breeding. They occurred abundantly in all fields farmed for hay in 2012. A few were noted in pastures but generally they occurred in much lower numbers (or were absent) in pastures, probably because they were intensively used and cattle tend to trample nests. In addition, a few bobolink were noted in winter wheat crops. Only 15 were noted within cultural meadows along tributaries, probably because patches of cultural meadow were very small.

Many fewer bobolink were noted on the third visit than on the first two visits (see **Appendix J**). There are likely two reasons for this. Hay was harvested in most fields by the third visit in early July, 2012. Hay had been baled by this visit so it is estimated that the cut probably took place in late June (later than in many areas of Ontario, where the first cut of hay is generally harvested by early June). The second reason was that where bobolink were seen, they were noticeably less active and less vocal later in the season, probably because they were feeding young.

The most important threats to bobolink in Ontario include intensification of agriculture, with grasslands being converted to row crops less suitable for habitat and pastures being used more intensively to pasture larger numbers of cattle. Early haying is also noted as a threat to bobolink (COSEWIC, 2010).

As a threatened species, bobolink and its habitat are protected by the ESA wherever they occur in Ontario. Specific habitat regulations have not been issued for these species yet so the general definition of habitat would apply. Generally, bobolink habitat is usually interpreted as the grassland area (i.e. ELC vegetation type or ecosite) in which they were found during the breeding season, as this is the area in which they are assumed to be breeding. However, bobolink (and eastern meadowlark) are species of open landscapes so they may depend on grasslands in an open, agricultural setting. They may be intolerant of surrounding development. They are extremely rare in urban settings. The prescribed habitat for these species will be better understood when specific habitat regulations are drafted. Areas which may be considered bobolink breeding habitat (and are therefore protected by the ESA) are illustrated in Figure 3.6. Further guidance from MNRF in regards to the extent of bobolink habitat within the study area based on 2012 observations is recommended.

Eastern Meadowlark

Eight (8) eastern meadowlarks were noted within the study area. This species occurred in the same habitat as bobolink (hayfields and, to a lesser extent, cultural meadow), but in much lower numbers, and in fewer areas. In addition to hayfields, it was noted in two areas of cultural meadow habitat, as well as in the centre of a horse track. This species, though area-sensitive, is less so than Bobolink and is also tolerant of some shrubby growth within fields. Breeding evidence was estimated as probable for all but one eastern meadowlark noted within the study area, based on the fact that they were seen on two visits, as well as on one territorial interaction seen between two individuals.

Eastern meadowlark was not seen in hayfields after the hay was harvested toward the end of June. The most important threats to eastern meadowlark in Ontario include intensification of agriculture, with grasslands being converted to row crops less suitable for habitat and pastures being used more intensively to pasture larger numbers of cattle. Early haying is also noted as a threat to eastern meadowlark (COSEWIC, 2011a).

As a threatened species, eastern meadowlark and its habitat are protected by the ESA wherever they occur in Ontario. Specific habitat regulations have not been issued for these species yet so the general definition of habitat would apply. Generally, eastern meadowlark habitat is usually interpreted as the grassland area (i.e. ELC vegetation type or ecosite) in which they were found during the breeding season, as this is the area in which they are assumed to be breeding. Areas which may be considered eastern meadowlark breeding habitat (and therefore protected by the ESA) are illustrated in **Figure 3.7**. Further guidance from MNR in regards to the extent of eastern meadowlark habitat within the study area based on 2012 observations is recommended.

Barn Swallow

Barn swallows were noted in eight (8) of the barns within the study area, with one additional nest site noted under a farm bridge over the Gore Road Tributary (see **Figure 3.8**). Generally, between 1 and 7 swallows were noted flying in and out of each site. Barn swallows used intact barns as well as some barns that were in an advanced state of disrepair. The determining factor appeared to be the presence of an opening and suitable nest sites (a wall, with an overhanging roof). A number of incidental observations of barn swallows flying overhead were also made during ELC community delineation, within polygons 1, 4, 5, and 14. In polygon 14, the barn swallows were perched on a television antenna atop a house. These records are also illustrated on **Figure 3.8**.

Barn swallows are still relatively common in Ontario but are declining at a significant rate (COSEWIC, 2011b). The reasons for the decline are not clear. This species depends on human structures for breeding, though it is occasionally known to breed in natural sites like tree cavities and caves (and probably relied on these before human settlement in North America). One cited threat is the replacement of wooden barns with steel barns without an opening through which Barn Swallows can access nest sites. Other threats include a decline in insects, or possibly pesticide use on breeding grounds or wintering grounds (COSEWIC, 2011b).

Barn swallows forage on aerial insects, and therefore areas of high insect abundance near breeding habitat, especially cattle pastures and ponds or open wetlands, are likely important for nest success. They also require a source of mud with which to build nests (COSEWIC, 2011b).

Habitat regulations for barn swallow have been more difficult to define. Generally, as for other species that depend on human structures for breeding such as chimney swifts, the human-made structure in which they nest is considered the habitat that requires protection. However, though other elements of habitat such as foraging areas are noted as important, there is little guidance concerning what should be protected, particularly since barn swallows have been shown to forage an average of approximately 170 m, ± 120 m, from the nest sites (Brown and Brown, 1999) but also have been reported to extend foraging areas up to 1.2 km from the nest (COSEWIC, 2011b). This species can be tolerant of urban conditions. If nest sites are available on buildings they can be seen foraging on nearby lawns and over ponds and golf courses (pers. exp.). Further guidance from MNR in regards to the extent of barn swallow habitat within the study area based on 2012 observations is recommended.

Eastern Wood-Pewee

One (1) eastern wood-pewee was noted within the study area. It was noted only once, on the first survey (May 25th) in 2012, and is thus considered a possible breeding species, though late migrants are also possible during surveys in late May (and this species is a late migrant) so it could have been passing through the site. However, it was noted in approximately the same area during surveys in early June 2007 where it was reported singing from trees along the tributary in two places. The 2012 observation is mapped alongside other significant bird observations in Figure 2.21

This species nests in a variety of deciduous and mixed forests and forest edges, is not area-sensitive, and is relatively general in its habitat requirements though it reportedly occurs less frequently in woodlots with surrounding development than in those without surrounding houses (Friesen et al. 1995). It is often observed in urban ravines, and therefore has some degree of tolerance to urban development (pers. exp.). However, some signs of declines led to the species' being evaluated as special concern by COSEWIC in December 2012. Reasons for the decline are not clear but it is an aerial insectivore, a guild of birds that has declined throughout North America. Another threat that has been cited is foraging by White-tailed Deer (McCarty 1996).

COSEWIC designated eastern wood-pewee as special concern in December, 2012. However, this species has not yet been listed on Schedule 1 of SARA. As a special concern species, the critical habitat protection provisions of the federal *Species at Risk Act* do not apply. Eastern Wood-pewee was listed as special concern after a review by COSSARO in winter/spring, 2013. Special concern species are not protected under the ESA. However, they are protected under the PPS under the provisions for Significant Wildlife Habitat.

Confirmed habitat for eastern wood-pewee consists of a significant woodland located within the greater Clarkway Tributary valley system. These features are protected within the NHS. The woodland is within an area where the greatest constraint to development is defined by the top-of-slope, which in most cases extends past the limits of the woodland.. Due to the species' relative tolerance to urban conditions and the location of the woodland, it is the opinion of Aquafor Beech Limited that the buffers to the greatest constraints to development are sufficient for the protection of eastern wood-pewee habitat. In recognition of the significance of this habitat and the potential impacts of pedestrian access, the MESP recommends that adjacent minimum buffer widths be increased from 10 m to 15 m in areas where trails are proposed.

Snapping Turtle

Snapping turtle inhabits permanent bodies of water, such as shallow weedy inlets and bays, mud-bottomed ponds and lakes, and slow streams with dense aquatic vegetation. This species is fairly tolerant of polluted waters. One (1) juvenile was found within a mineral meadow marsh (polygon 34) along a dry section of Gore Road Tributary. This observation is described in greater detail in **Section** 3.8.2, and is mapped in Figure 2.19.

Because snapping turtle is listed as special concern under the ESA, habitat protection does not extend to this species. However, turtle nesting habitat as well as habitat for species of conservation concern (including special concern species) is protected as Significant Wildlife Habitat. Based on the one (1) observation of snapping turtle (see **Section** 3.8.2**)** and its habitat preferences, it is expected that snapping turtle habitat in the subwatershed is sufficiently protected as it is restricted to the valleylands/watercourse features of the NHS.

Monarch Butterfly

Multiple observations of monarch butterfly were noted throughout the study area, from polygons 1, 7, 14, 20, 31, 43, 57, 59 and 71. Given the time of year (late summer) these sites would be used for nectaring rather than depositing eggs. Most (if not all) cultural meadows in the study area provide suitable nectaring habitat for monarch.

This species requires a variety of habitats, including overwintering sites (in Mexico), breeding areas, staging areas and nectaring areas. Breeding areas are confined to meadows with species in the Asclepias genus, and commonly include common milkweed (inset photo) and swamp milkweed (*Asclepias incarnata*). Staging areas are generally found on the north shores of the Great Lakes and along other large barriers to migration, where monarchs roost and feed to gain energy. Nectaring areas include meadows dominated by a mix of forb species (asters, goldenrods, etc.) providing food throughout the summer.

Because monarch butterfly is listed as special concern under the ESA, habitat protection does not extend to this species. Migratory butterfly stopover areas that meet criteria as Significant Wildlife Habitat are protected, however no such sites exist in the study area. As a special concern species, monarch breeding and foraging habitat (no matter what size) may also be protected as Significant Wildlife Habitat. The majority of the monarch habitat in the Area 47 study area consists of foraging habitat, with scattered patches of common milkweed present in many of the cultural meadows. Large swaths of monarch foraging habitat exists within the valleyland/watercourse corridors, and therefore are protected within these features in the NHS.

3.8.3.1 NHIC Screening for Species at Risk

To ensure that all species at risk potentially present in the study area are adequately identified, a screening of the Natural Heritage Information Centre (NHIC) web-based database was conducted to compliment field observations. The screened 1 km squares include: 17PG05_43, 17PG05_44, 17PG05_45, 17PG05_53, 17PG05_54, and 17PG05_55.

Two (2) additional species at risk not observed during field activities were identified: Cerulean warbler (*Dendroica cerulean*) and Jefferson X blue-spotted salamander (Jefferson dominated). Neither of these species is expected to be present in the study area, as outlined in **Table 3.5**.

Table 3.5: NHIC Screening for Species at Risk

Scientific Name	English Name	COSEWIC Status	COSSARO Status	First Observed	Last Observed	Comments
Dendroica cerulea	Cerulean Warbler	END	SC	11/06/1962	11/06/1962	Habitat for this species includes mature deciduous upland or swamp forest with interior conditions. This habitat is not present in the study area
Ambystoma hybrid pop. 1	Jefferson X Blue-spotted Salamander, Jefferson genome dominates	END	END	27/04/1978	27/04/1978	This species breeds in ephemeral woodland breeding pools found in mature deciduous forest with ample downed woody debris. This habitat is not present in the study area.

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

Bobolink Breeding Observations

Bobolink Habitat

SCALE: 1:16,000

BOBLINK BREEDING HABITAT

FIGURE 3.6

AQUAFOR PROJECT NO.: 64608

Aquafor Beech Limited

BRAMPTON Flower City brampton.ca

MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

Eastern Meadowlark Breeding Observations

Eastern Meadowlark Habitat

SCALE: 1:16,000

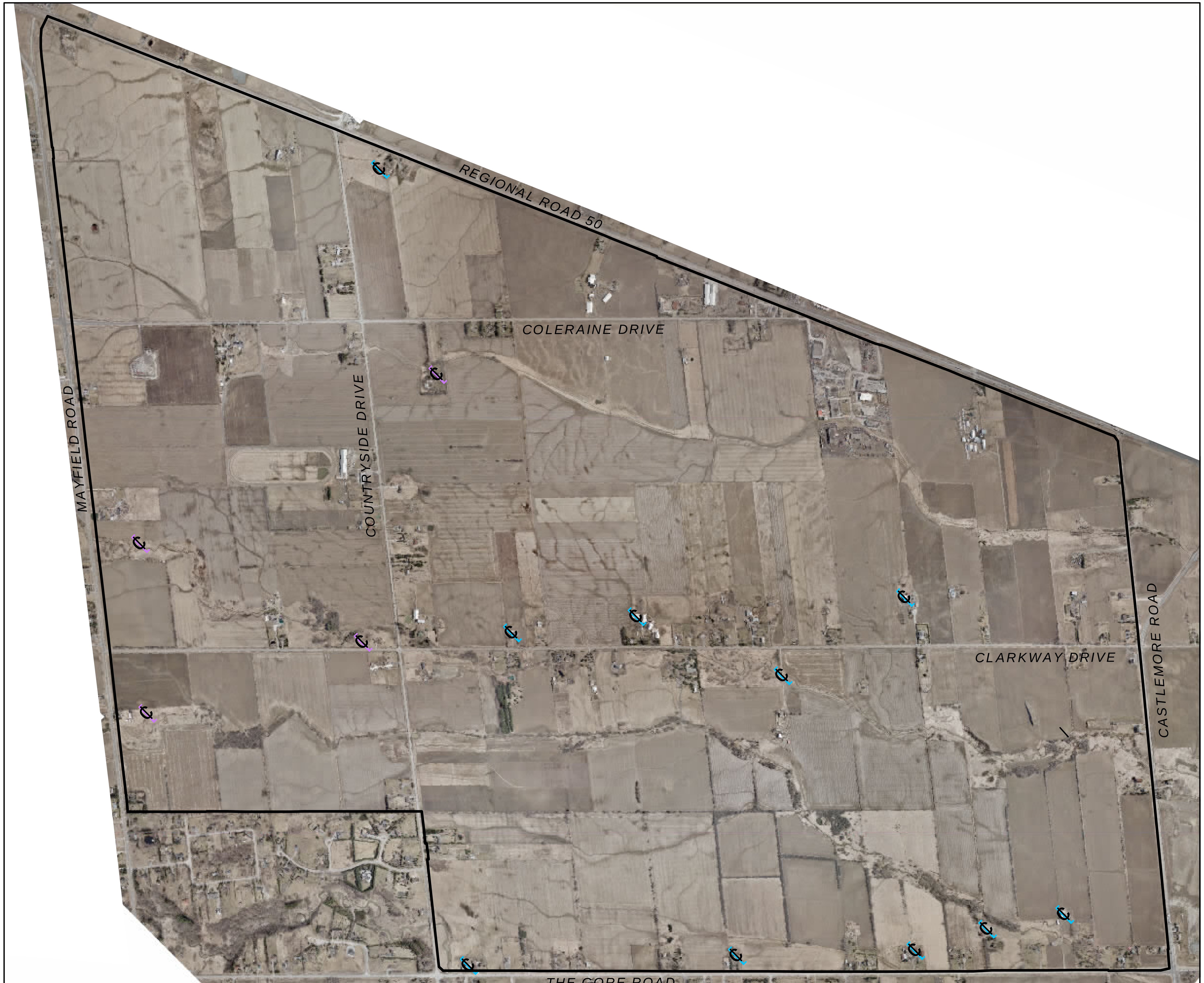
EASTERN MEADOWLARK BREEDING HABITAT

FIGURE 3.7

AQUAFOR PROJECT NO.: 64608

Aquafor Beech Limited

BRAMPTON Flower City brampton.ca



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA

Barn Swallow Nesting Sites

Barn Swallow Incidental Observations

SCALE: 1:16,000

BARNS AND OTHER STRUCTURES WITH ACTIVELY NESTING BARN SWALLOWS

FIGURE 3.8

AQUAFOR PROJECT NO.: 64608

Aquafor Beech Limited

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Permits and Authorizations under the Endangered Species Act

A proposal to develop within the habitat of redside dace, bobolink, eastern meadowlark and barn swallow can be obtained (pending approval from MNRF) by showing an overall benefit for the species under section 17 (2)(c) of the ESA. It is thus recommended that the MNRF be consulted for all aspects of removal of habitat for species protected by the ESA. It is understood at the time of writing that the landowners' group is conducting further studies related to SAR and is in negotiation with the MNRF. Further discussion regarding the preferred approach to SAR habitat protection/compensation within the Area 47 lands is found in **Section 0**.

3.9 Hedgerows

As detailed in **Section 2.4.3** and **Appendix I**, very few hedgerows in the study area are worthy of preservation. Hedgerows dominated by European buckthorn and one-seeded hawthorn should be removed to reduce potential seed sources that may spread into adjacent natural heritage features. A list of six (6) hedgerows that are recommended for preservation should be considered for incorporation into future development such as: park blocks, stormwater management pond designs, line the back/side yards of proposed residential areas, or delineate future restoration areas for natural feature mitigation / compensation. These hedgerows are described below, and illustrated in Figure 3.9. Recommendations are reiterated in **Section 5**. Note that hedgerows are illustrated on the same map as vegetation communities, in **Appendix G**.

- *H14* – This hedgerow contains the regionally rare silky dogwood (*Cornus amomum*) as well as mid-aged silver maple trees. Norway maple, European buckthorn and other invasive woody species should be manually removed and replaced with native woody cover. Should the retention of this hedgerow not be possible, the silky dogwoods could be transplanted to a suitable location within the NHS. Should transplanting efforts fail, compensation plantings of the same species, grown either from cuttings or seed from the individuals found in the study area by a local nursery, should be considered.

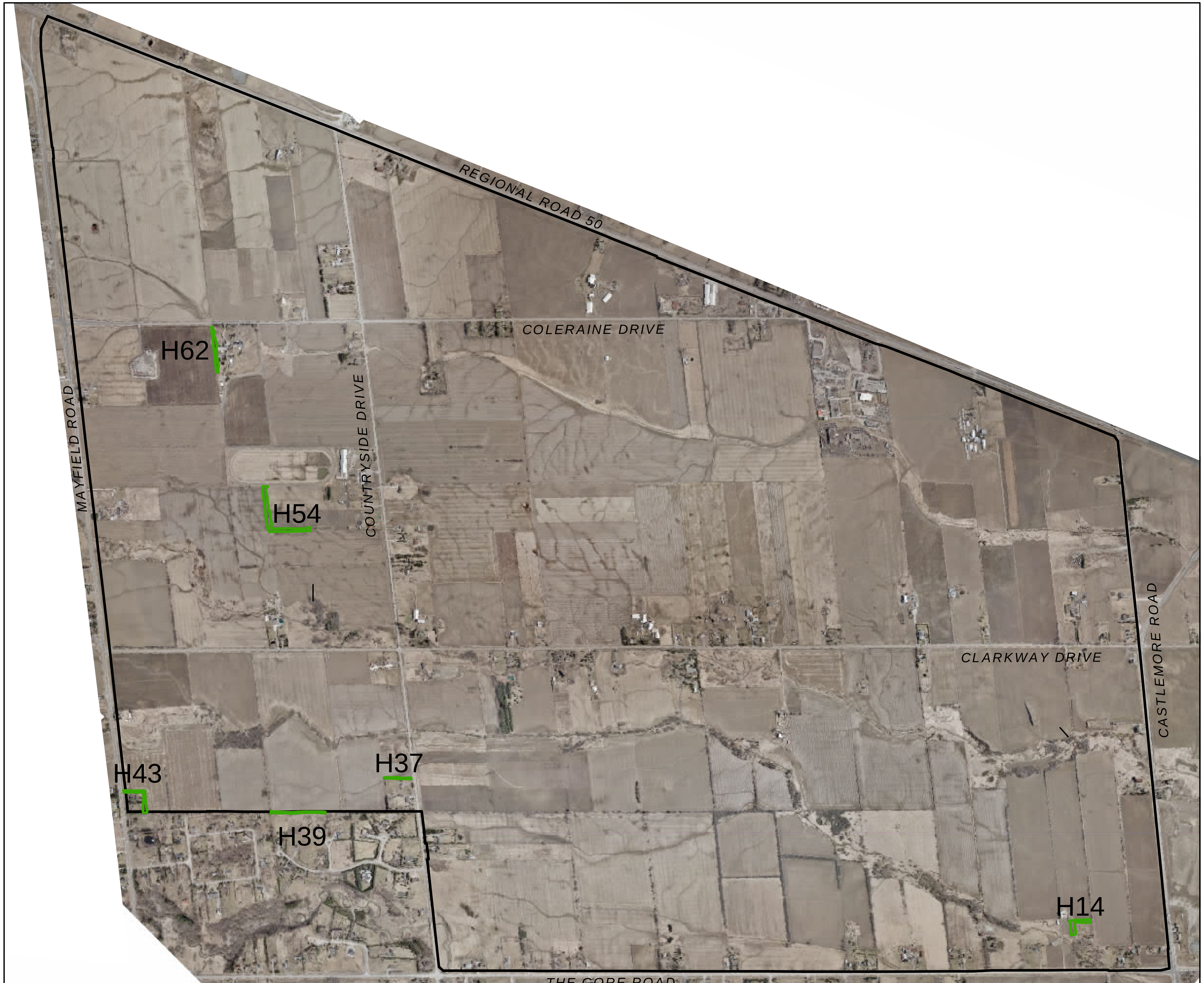
- *H37* – This is the only hedgerow dominated by wetland species, as it conveys water. Pussy willow (*Salix discolor*) and wooly-headed willow are the dominant woody species, with New England aster, grass-leaved goldenrod (*Euthamia graminifolia*) and panicled aster dominating the groundcover.

- *H39* – This hedgerow was not assessed as it is located on private property adjacent to the study area. It is recommended that development activities within the Area 47 study area not negatively impact this hedgerow.

- *H43* – Healthy, mature eastern white pine, cottonwood and silver maple dominate this hedgerow. Manitoba maple, European buckthorn and tartarian honeysuckle (*Lonicera tatarica*) and garlic mustard should be manually removed.

- *H54* – This hedgerow is highly recommended for preservation. It contains a mixture of mature silver maple, red pine, green ash and white spruce, and also contains choke cherry (*Prunus virginiana*) which is relatively rare in the study area. The exotic Norway spruce is also present in the canopy but does not typically spread into natural areas and therefore should be retained. Where present in the understory, European buckthorn should be removed manually.

- *H62* – This is another well-established hedgerow with minimal invasive species. Red pine, green ash, cottonwood and hybrid white willow dominate the canopy, while eastern white cedar and white pine are present in the understory. The groundcover is manicured lawn.



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

Hedgerows

STUDY AREA

SCALE: 1:16,000

HEDGEROWS RECOMMENDED FOR CONSIDERATION FOR RETENTION

FIGURE 3.9

AQUAFOR PROJECT NO.: 64608

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3.10 Buffers

Buffers are vegetated physical separations between natural features and development areas intended to preserve the ecological integrity of natural features and their associated processes (Ontario Ministry of Natural Resources, 2010). The City of Brampton requires the establishment of conservation buffers and setbacks to protect natural heritage features including hazardous lands. A buffer refers to the distance between a natural heritage feature(s) or hazard land(s) and the adjacent land uses, and is considered to be an integral component of the natural heritage system.

Vegetated buffer zones can be effective in mitigating adverse impacts (e.g. noise, light, pollution, etc.) to individual natural heritage features and the NHS itself. Brampton's Official Plan (2006) mandates a minimum 10 metre buffer from natural heritage features, which may be extended where ecologically warranted, as demonstrated through an appropriate study. The 10 m buffer is measured from the greater of:

- predicted crest of slope (combination of the 100 year, erosion and/or meander belt width hazard and stable slope);
- stable top of bank;
- predicted meander belt width;
- drip line of woodlands, urban forest features or other significant vegetation,
- wetland;
- Environmentally Sensitive/Significant Area or Area of Natural and Scientific Area; and
- the Regulatory Floodplain, in combination with ensuring an appropriate vertical buffer/freeboard.

Section 4.6.13.8 (OP 2006) identifies that a "*buffer of up to and/or in excess of 10 metres may be refined from the buffer required in policy 4.6.13.7 as warranted, based on the results of environmental studies*".

The City intends that buffers remain in a natural condition and are enhanced through vegetative plantings which are intended to support ecological features and functions of the adjacent natural area. Per Policy 5.4.1.2 of the Area 47 Secondary Plan, grading within buffers is generally not permitted. Limited infrastructure and minor grading (i.e. 1-2m) may be considered on a case-by-case basis within NHS buffers provided that: a) it is demonstrated that form and function of the natural heritage feature to be buffered would not be impacted; and, b) disturbed areas within the buffer are restored with native plantings. The City will examine in consultation with the developer / landowner, on a case-by-case basis as necessary, opportunities to avoid the creation of slopes on private land adjacent to environmental buffers, as a result of grading (i.e. cutting or filling) to facilitate development. Rear property boundaries may be adjusted accordingly, as agreed to by the developer / landowner and the City.

In addition to a 10 m horizontal buffer, TRCA policy also requires a 0.5 m vertical buffer from the Regulatory Floodplain. The vertical buffer may be achieved as a result of natural grades within the 10 m buffer and/or grading associated with development at the edge of the 10m buffer. Again, grading solutions would be examined and agreed to between the City and developer / landowner, on a case-by-case basis.

As previously noted the City's trail network may be located within natural features, particularly valley corridors, and / or buffers adjacent to natural features, as illustrated on Figure 1.3. Further examination of trail locations with regard to the valley corridors and buffers will be required through future block planning and environmental studies, as outlined in **Section 8** of this MESP.

Buffer recommendations for NHS features are discussed below. The relationship between buffers and trails is discussed in **Section** 5.2.

Terrestrial Resources

Valleylands and Watercourse Corridors

Buffers along valleylands and watercourse corridors are intended primarily to maintain a stable top-of-slope and/or reduce the threat of flooding-related property damage. In past experience, TRCA has prohibited development within 10 metres of the stable top-of-slope for valleylands with stable slopes. As such, Aquafor Beech Limited recommends that 10 metres beyond the stable top-of-slope is a reasonable buffer width for valleylands within the study area. Recommended buffers along watercourse corridors are described in greater detail below.

Woodlands and Woodlots

Buffers provide myriad services for significant woodland and woodlot features in the NHS. These can include:

- Extension of edge, thus increasing potential for woodland interior conditions to develop; Protection of wildlife use (MNR, 2010);
- Protection of the root zone of edge trees;
- Reduction in the effects of hydrological changes from site alterations;
- An area where trees and limbs can fall without causing damage (tree fall zones); and
- Filtering of contaminants such as nutrients from lawn fertilizers.

Currently, the study area contains very little (if any) interior forest habitat exists, and few large, mature trees line the edges of the significant woodlands and woodlots. As such, a vegetated buffer of a minimum 10 metres (planted with suitable woody edge species) is recommended to safeguard forest ecosystem functions. To reduce risks of property or infrastructure damage as a result of tree fall, at buffer extended to the width of the tree fall zone plus one metre in areas where the tree fall zone is more than 9 metres could be considered as part of future studies (e.g. EIS).

Landscape Connections

Where the MESP identifies opportunities to enhance or create terrestrial landscape connections between corridors (refer to **Section 8.2.6**), the terrestrial connections shall be sized and designed to ensure that the corridor functions are adequately protected from adjacent land use impacts.

Wetlands

Wetland buffers assist in maintaining existing drainage patterns and help to assimilate nitrate and phosphate loadings in runoff from surrounding developments. As a result, wetlands situated at the toe of long or steep slopes may require a much larger buffer than those in relatively flat areas.

Wetlands situated within valleylands in the study area are adequately protected by the 10 metre stable top-of-slope buffer recommendation. A few others are considered amphibian breeding ponds and are thereby subject to that buffer recommendation (see below). The few wetlands occurring outside these areas are either dugout agricultural ponds with limited ecological function, or narrow swales through agricultural fields. Tableland wetlands recommended for retention (i.e. ELC Polygons 87 and 96) are subject to the minimum 10 metre buffer.

Species at Risk Habitat

Many of the hayfields and cultural meadows used by bobolink and eastern meadowlark as breeding habitat are slated for development, subject to an ESA authorization from MNR. The barns used by barn swallows for nesting will also be removed. As such, it is not necessary to recommend specific buffer widths for these sites. In addition, buffer widths for SAR habitat should be site-specific. Specific buffer recommendations can be offered for any retained bird SAR habitats through future Environmental Impact Studies.

Habitat for federal and provincial special concern species (eastern wood-pewee, snapping turtle and monarch butterfly) is not protected under SARA or the ESA. Where these areas are encapsulated within other NHS features (e.g. valleylands), the respective buffer width recommended for that feature would apply.

Habitat for Species of Conservation Concern

Several locally rare species have been recorded within the Area 47 SPA. Many of these species occupy edge habitat or disturbed areas, and do not warrant the implementation of buffer widths above the recommended 10 metre buffers. In areas where there are development-sensitive species (e.g. Eastern Wood-pewee, Chimney Crayfish) or concentrations of multiple species of conservation concern, it is recommended that 15 m buffer widths be employed in areas where recreational trails are proposed. As shown in **Figure 2.18, Figure 2.19,** and **Figure 2.21**; the majority of species of conservation concern were recorded within the Gore Road Tributary.

Aquatic Resources

Fish Habitat

The Ministry of Natural Resources and Forestry (MNRF) recommends the establishment and/or retention of natural vegetated cover for the protection of fish habitat (Natural Heritage Reference Manual (NHRM) 2010). When adjacent to fish habitat, the NRHM (2010) recommends a minimum vegetated riparian buffer of 15 metres on each side of a warmwater stream, and a minimum vegetated riparian buffer of 30 metres on each side of a coldwater stream. To define the limit of development, the City of Brampton Official Plan (2006) recommends a minimum 10 metre buffer width from the predicted meander belt of a watercourse, expanded as required to maintain riparian stream functions.

As such, a 10 metre wide natural vegetated buffer measured from the predicted meander belt, to a width no less than 15 metres measured from the bankfull channel in accordance with the NHRM (2010), is recommended to protect fish and mussel habitat and riparian habitat functions within Gore Road Tributary, The Clarkway Tributary, and Rainbow Creek Tributary. A 15 metre buffer is also recommended for all headwater drainage features identified for protection, as these features function as permanent or seasonal fish habitat. Per the MNRF's ESA habitat regulations, buffers to habitat for Redside Dace are 30 m from the meander belt. The resulting aquatic resource buffers are not illustrated in a dedicated figure in this report, as watercourses are contained within valleys and floodplains associated with the tributary 'corridors" (the exception being the West Humber Tributary**)**. Per policy 4.5.12.3 of the City of Brampton's Official Plan (2006), harmful alteration of fish habitat without authorization is prohibited and a principal of no net loss of productive capacity of fish habitat is advocated in accordance with the *Federal Fisheries Act*. Development and site alteration in fish habitat shall not be permitted except in accordance with Provincial and Federal requirements.

Ponds

As discussed in **Section 3.4.1** (see summary **Table 3.3**), several ponds are included in the NHS based on their proximity to natural features and/or their ecological function. This subsection outlines the recommended minimum buffer widths for ponds recommended for retention that are not otherwise surrounded by the greater NHS.

The following subsection discusses buffers to ponds on the basis of their function as habitat for wildlife (i.e. amphibians and fish). In many cases, the natural/agricultural ponds screened by Aquafor Beech Limited were contained within identified constraints (i.e. floodplain, valley corridor) and generally will be adequately protected by these natural features and their associated buffers, as described above. It is recommended that ponds identified as important habitat for breeding amphibians should be incorporated into the Natural Heritage System and managed appropriately, as applicable.

Consistent with NHRM (2010) recommendations, as is recommended for wetlands, Aquafor Beech Limited recommends a 10 metre buffer around ponds that function as wildlife habitat to help protect habitat from future land use changes. If ponds function solely as amphibian breeding habitat, the 10 metre buffer width, preferably densely planted with evergreen trees, will help reduce the light and noise impacts related to development which has been shown to alter the breeding behaviour of calling amphibians (Baker and Richardson 2006).

Summary

Buffers surrounding natural features within the Area 47 Natural Heritage System must be consistent with policies outlined in the City of Brampton's Official Plan (2006), the TRCA watershed policies and the Natural Heritage Reference Manual (2010). These buffers are summarized in **Table 3.6**, below. The Area 47 Natural Heritage System, including all recommended buffers, is presented in **Section 3.12**.

Table 3.6: Recommended Minimum Natural Feature Buffer Widths

Natural Resource	Recommended Minimum Buffer*	Comments
Valleylands & Watercourse Corridors	10 m from stable top-of-slope, Regulatory floodplain, meander belt, and vegetation dripline. (Additional buffer may be required to ensure minimum 0.5 m vertical freeboard from Regulatory flood level).	The buffer recommendation is consistent with the City of Brampton's Official Plan (2006) and TRCA's policies.
Significant Woodlands & Woodlots	10 m	The buffer recommendation is consistent with both the City of Brampton's Official Plan (2006) and the Natural Heritage Reference Manual (2010).
Wetlands	For wetlands in valleylands, see Valleylands and Watercourse Corridors recommended buffer; for wetlands that are agricultural ponds recommended for retention, 10 m beyond bankfull width on all sides of the pond; for all others, TRCA and MNR should be consulted in regards to whether a formal wetland evaluation using OWES protocols is required for the study area	These buffer recommendations are consistent with both the City of Brampton's Official Plan (2006) and the Natural Heritage Reference Manual (2010).
Species at Risk Habitat	Species and site-specific	The buffer recommendation is consistent with the Natural Heritage Reference Manual (2010).
Fish Habitat	10 m beyond predicted meander belt; no less than 15 m beyond bankfull channel width; Redside dace habitat (West Humber River): 30m beyond the predicted meander belt	These buffer recommendations are consistent with both the City of Brampton's Official Plan (2006) and the Natural Heritage Reference Manual (2010).
Ponds	10 m beyond bankfull width on all sides of pond	This buffer width will apply to those ponds incorporated and/or created as part of the NHS.

*15m buffers are to be applied in areas 1 – 5, as illustrated in Figure 5.5.

3.11 Opportunities for Development

The MESP has identified the elements of a Natural Heritage System (NHS) for the Area 47 study area based on the following provincial and municipal legislative mandates:

- The Provincial Policy Statement 2014
- Section 4.6 (Natural Heritage and Environmental Management) of Brampton's Official Plan (OP)
- Brampton's Woodlot Conservation By-Law (316-2012)
- Section 2 (The Natural Environment) of Peel Region's Official Plan
- TRCA's "Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses" Regulation
- MNR's Significant Wildlife Habitat Technical Guide
- The Endangered Species Act

The NHS is a hierarchal assemblage of valleylands and watercourse corridors, woodlands, woodlots, wetlands, ponds, significant fish and wildlife habitat, species at risk habitat and landscape connections. Many of these areas are depicted on the City's OP Schedule D and are considered Natural Areas and Corridors (NAC) and Potential Natural Areas and Corridors (PNAC). The Clarkway Tributary is shown as Core Greenland on Schedule A of Peel's OP. In order to preserve the ecological integrity of the NHS and other significant environmental features, development opportunities and constraints are identified and summarized in **Section** 3.12**.**

The Highway 427 Industrial Secondary Plan was approved by City of Brampton Council on September 10, 2014 (By-law 261-2014 to implement OP2006-105) and is depicted on Figure 1.2 (Schedule SPA 47 (a)). The Secondary Plan as approved generally delineates the extent of natural areas and features based on the draft 2013 MESP, with the exception of the Rainbow Creek Tributary which is illustrated as per Schedule D of the OP. The completion of the MESP will mean refinement of Schedule SPA 47 (a) as development proceeds through future Block and/or Tertiary Planning and associated environmental studies.

Depending on the nature of the development proposal, developable lands may be subject to Environmental Implementation Reports (EIRs) or Environmental Impact Statements (EIS's) at the direction of planning authorities in consultation with the TRCA. According to Brampton's Official Plan:

> *Development and site alteration shall not be permitted on lands adjacent to the natural heritage features and areas identified on Schedule "D" unless an Environmental Implementation Report and/or Environmental Impact Study has been prepared to the satisfaction of the City and Conservation Authority and the report and/or study has*

demonstrated that there will be no negative impacts on the natural feature or its ecological function (p. 4.5 – 14)

Brampton's Pathways System creates a unique linkage between the city's natural and built environments. The city's pathways and trails are critical infrastructure to support active transportation, a fundamental aspect of creating healthy communities, to allow people to move around the city by means other than personal vehicles. The City and our conservation partners provide on and off-road multi-use paths as well as a trail network through the majority of Brampton's valley and watercourse corridors and active parklands. These trails connect residents, visitors and employees to local and regional destinations such as; schools, shopping, recreation centres; employment areas, and other municipalities. With greater accessibility comes the need for appropriate design, construction and maintenance of trails adjacent to and within the natural heritage and open space systems and green infrastructure. Trail planning and design includes but is not limited to; ecological features, site drainage, viewscapes, accessibility, safety, visibility, aesthetics, sustainability, maintenance, access, etc.

The approved MESP recommendations will be used to both direct future development including stormwater management and trails, and as a reference to assist in scoping subsequent studies (including but not limited to EIR/EISs) within the study area.

3.12 Summary of Existing Conditions, Constraints and Opportunities

The existing environmental resources within the Area 47 study area were inventoried in order to identify key features and functions to define development constraints and delineate a natural heritage system, to establish baseline conditions for the assessment of potential impacts from future urban development, and to identify potential future environmental restoration and enhancement opportunities.

As described, Schedule SPA 47(a) of the Area 47 Secondary Plan has been approved (refer to Figure 1.2) and it is evident that future development and infrastructure will impact the protection and/or connection of some natural features, particularly isolated tableland woodlots, hedgerows, wetlands and ponds, and headwater drainage features. A more formal discussion of impacts to the NHS and related management recommendations are described in **Section 5.1**. The Plan also identifies general requirements for stormwater management facilities and recreational open space. Through future development planning, opportunities should be examined to place these municipal land uses in relationship to the natural heritage system to connect and / or buffer natural areas to enhance natural functions.

A summary of the key environmental features and functions of the natural heritage system is provided below, and development constraints and opportunities for the study area have been summarized in **Table 3.7, Table 3.8,** and illustrated in **Figure 3.10**. Natural heritage features proposed for removal are detailed in **Table 5.1**, **Table 5.2**, **Table 5.3**, and

Table 5.4. A large-scale reproduction of **Figure 3.10** is provided at the back of the report.

- Soils within the study area are relatively impermeable and remain so to depths up to 20 metres, with no significant groundwater recharge. Streamflow and piezometer monitoring indicate that groundwater discharge to the intermittent watercourses is not significant. However, constraints to future urban development and associated stormwater management requirements, require that future development plans include measures, where feasible, to maintain existing site and feature water balances. It will also be important to locate and decommission existing wells in accordance with O. Reg. 903, made under the Ontario Water Resources Act, as development occurs.

- The existing stream morphology of the Area 47 study area watercourses were investigated and characterized. Many stream reaches have been impacted by agricultural drainage, cultivation and modification by road infrastructure. In terms of stability, the streams are generally classified as stable to transitional. Natural meander evolution should be allowed to continue. Meander belt widths were identified in order to protect future urban development from the hazards associated with potential planform adjustments of these watercourses. Where future stream restoration works are required, natural channel design methods are recommended. Examples may include road reconstruction projects, restoration of the Rainbow Creek Tributary crossing at Colerain Drive and any future channel improvements intended to remove the Cadetta Road subdivision from the floodplain.

- Geotechnical investigations were undertaken for slope stability at six valley wall sites identified during field investigations and setbacks beyond the top-of-bank locations were recommended at four of those sites (**Table 2.7**).

- Headwater drainage features were identified, inventoried, and evaluated using TRCA Guidelines (**Table 2.8 to Table 2.11**). Two HDF reaches (Gore 2-1, Clarkway 15-1) were recommended for "Protection" and should remain as open watercourses at their current locations. Three HDF reaches (Gore 2-2, Clarkway 7-1, Robinson-1) were classified as "Conservation" and should also remain as open features, however, some modification/relocation may be considered as part of future planning including stormwater management. Other HDFs were classified as "Mitigation 1" or "Mitigation 2" and could either remain open or be replicated using urban lot-level and conveyance stormwater techniques such as low impact development (LID) measures, swales or wetlands.

- The Regulatory floodplain limits were identified as constraints to future development through a combination of TRCA modelling and mapping as well as modelling and mapping extensions completed as part of this study. Portions of Clarkway Drive and the Cadetta Road industrial subdivision are within the existing Clarkway Tributary and Rainbow Creek Tributary floodplain hazard lands, respectively. Future road improvement works and stream restoration works represent opportunities to reduce flood hazards through the construction of larger bridge/culvert crossing structures and improved channel conveyance.

- TRCA hydraulic modelling and floodplain mapping for the Rainbow Creek Tributary at Coleraine Drive does not reflect recent re-alignment works to divert drainage to the roadside ditch at this location. The floodplain mapping and associated stream corridor constraints will therefore need to be refined as part of any future channel realignment / restoration works or in conjunction with any roadway or culvert improvement works in the area.

- Stream and valley corridors encompass floodplain hazard lands, slope stability hazards, meander belts, and valley features. Corridors were defined and mapped through field work and analyses for the following:

  - the West Humber River;

  - The Gore Road Tributary, including headwater drainage feature Gore Road HDF 2 – Reach 1 and 2;

  - the Clarkway Tributary, including headwater drainage features Clarkway HDF 7 – Reach 1, and Clarkway HDF 15 – Reach 1;

  - the Rainbow Creek Tributary; and

  - the headwater drainage feature Robinson Creek Tributary HDF 1 – Reach 1.

- The terrestrial resources of the study area were inventoried and evaluated through extensive field investigations and monitoring, including botanical inventories, ELC classification, hedgerow assessments, breeding bird surveys, agricultural pond assessments and amphibian monitoring. Key findings include:

- The majority of the woodlots, woodland, and wetlands within the study area are confined to the stream and valley corridors and form the foundation of the NHS;

- One tableland woodland links the Gore Road Tributary and Clarkway Tributary should be protected and buffered. Opportunities to expand and enhance this existing terrestrial connection between two major corridors in Area 47 are to be examined as part of the mitigation / compensation for loss of other tableland features, as well as potential opportunities to address SAR habitat net benefits, if required;

- There are six hedgerow features that are recommended for consideration for incorporation into the future urban landscape. It is recommended that one of the six hedgerows, directly adjacent to the study area, is not impacted by development within the Area 47 lands;

- One hedgerow (H39) and multiple plantings abut the secondary plan area along the northwest boundary generally located within the existing estate residential development. Several other hedgerows have been identified for retention consideration (See **Figure 3.9**). Future block planning should examine the application of buffers to protect these hedgerows/trees from new development as applicable. Should protection of these hedgerows/trees not be possible valuable plant material should be transplanted to a suitable location where the plant(s) can persist over the long term.

- H19 contains a rare shrub (silky dogwood). Should retention of H19 be deemed possible, any restoration efforts near the silky dogwood should not result in the shading out of this species. In either case, it is recommended that opportunities for the propagation of silky dogwood in other suitable areas of the subwatershed be explored;

- The other existing hedgerow features consist primarily of invasive hawthorn and buckthorn species may be considered for removal as part of future urban development. Compensation for the loss of tableland vegetation is required in accordance with the City's Vegetation Assessment Guidelines. A conceptual compensation/enhancement planting strategy is provided in **Section 5.2.2 –** Restoration/Enhancement;

    - Three breeding bird species found within the study area are considered provincially Threatened Species at Risk: bobolink, eastern meadowlark, and barn swallow. Three additional species of concern found in Area 47 include eastern wood-pewee, snapping turtle, and monarch butterfly. A Species at Risk Strategy is being prepared as part of a concurrent exercise on behalf of the Landowners' Group in consultation with the MNRF, which is expected to be completed after the submission of the Area 47 MESP. As such, this MESP does not contain a Species at Risk Strategy. See **Section 0** for further details;

    - Twelve ponds are recommended for inclusion in the NHS, and one off-site pond is proposed for protection. Another eleven ponds are proposed for removal, and mitigation is required (see **Table 5.1**, **Table 5.2**, and **Table 5.3**);

    - All of the wetland vegetation features in the study area are local wetlands. Those wetland areas within stream and valley corridors would be protected, while future consultation with the City of Brampton and TRCA is recommended to confirm the protection or removal status of those wetland features located outside of the corridors; and

    - There are no Environmentally Significant Areas (ESAs) or Areas of Natural and Scientific Interest (ANSIs) in the study area.

- Aquatic resources were inventoried through review of previous fish surveys, mussel surveys and agricultural pond assessments. Key findings include:

    - The West Humber River is classified as an intermediate warmwater stream, and is designated by MNR as regulated habitat for Redside Dace under the Endangered Species Act. The Humber River Fisheries Management Plan identifies the West Humber River as "fish management zone 7" with Redside Dace and Darter species as target fish communities;

    - The Gore Road Tributary, Clarkway Tributary, and Rainbow Creek Tributary are classified as small warmwater streams, and identified by The Humber River Fisheries Management Plan as "fish management zone 4" with Darter species as target fish communities;

    - Three species of mussels were identified within the study area, all of which are considered secure globally and within the province of Ontario;

- In addition to being used by calling amphibians, one agricultural pond, GP-6, may also function as fish habitat;
- Consistent with the Humber River Fisheries Management Plan, opportunities to improve fish habitat through riparian plantings were identified over portions of the Gore Road and Clarkway Tributaries, and virtually the entire reach of the Rainbow Creek Tributary; and
- An opportunity to improve fish passage on the Gore Road Tributary was identified via the future removal of an existing agricultural crossing with a perched culvert.

- The above natural resources and habitat findings were used to define and map Natural Heritage System (NHS) features within the Area 47 study area. The Area 47 NHS includes the following recommended minimum buffer widths:
  - Valley and stream corridors – 10 m. Note that a minimum 0.5 m vertical freeboard over the Regulatory flood level is required. Therefore, if the vertical freeboard is not available via the natural grades within the standard 10 m horizontal buffer, additional buffer width will be required.;
  - Significant woodlands and other woodlands – 10 m;
  - Wetlands to be preserved – 10 m;
  - Agricultural ponds to be preserved – 10 m;
  - Breeding bird species at risk habitat (Bobolink, Eastern Meadowlark, Barn Swallow) – site specific to be determined through future consultation with MNRF;
  - Planned trails located in areas of ecological sensitivity/significance are subject to minimum 15 m buffer widths, as illustrated in Figure 5.5; and
  - Fish habitat:
    - 30 m beyond meander belt width for Redside Dace habitat (West Humber River)

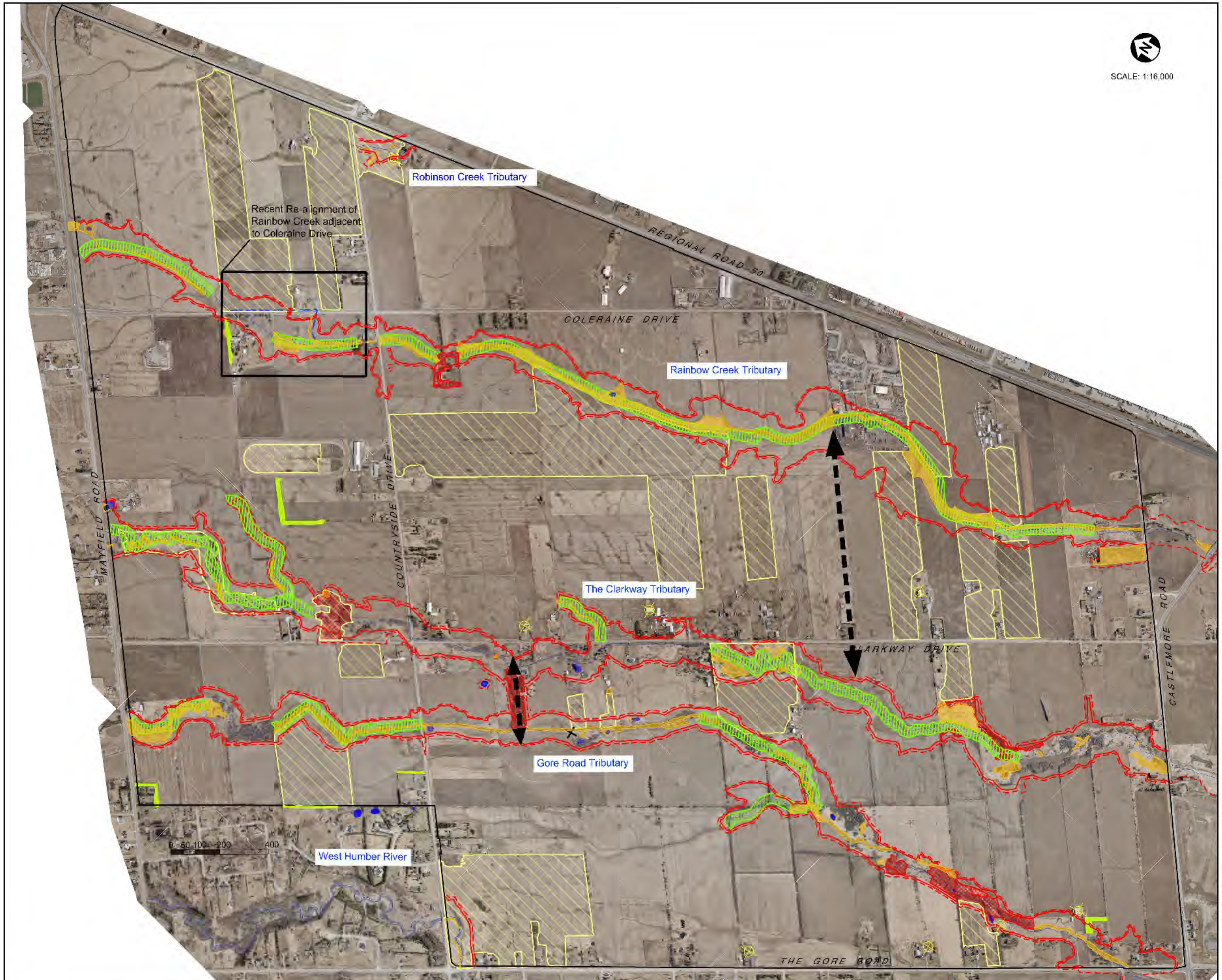
- Greater of 10 m beyond meander belt width or 15 m from bankfull channel for other watercourses (Gore Road Tributary, Clarkway Tributary, Rainbow Creek Tributary, HDFs to remain open).

Table 3.7: Summary of Natural Heritage System Constraints and Opportunities

Environmental Resources	Protection (No Development or Site Alteration)	Mitigation / Compensation Or Subject to Further Study	Opportunities for Enhancement and Restoration
Groundwater		- decommission existing wells	- minimize changes to existing site and feature-specific water budgets through source and conveyance control LID measures to promote infiltration/reuse and reduce runoff
Stream Morphology	- lands within the meander belts of the West Humber River, The Gore Road Tributary, Clarkway Tributary, and Rainbow Creek Tributary. - HDFs to be preserved as open watercourses (Table 2.8 **to** Table 2.11): • Protection (no modification /relocation) Gore Road HDF 2- Reach 1, Clarkway HDF 7- Reach 1; • Conservation (potential modification/relocation) - Gore Road HDF 2- Reach 2, Clarkway HDF 15- Reach 1, and Robinson Tributary HDF 1- Reach 1	- other HDFs classified as "Mitigation" could remain as open watercourses, provided that flows can be maintained (via stormwater pond outflows, or other methods for example), or replicated using urban lot-level and conveyance stormwater techniques such as LID measures, swales or wetlands.	- Rainbow Creek at Coleraine Drive (realignment) and Cadetta Road (flood relief) (see Section 2.2.3.5) - riparian planting enhancements in grass-dominated reaches
Hydrology / Floodplain Hazards	- Regulatory floodplain hazard lands of the West Humber River, The Gore Road Tributary, Clarkway Tributary, and Rainbow Creek Tributary - Regulatory floodplain "expansion" of the Clarkway Tributary reflecting an increased floodplain hazard area due to urban boundary expansion in the Town of Caledon - Regulatory floodplain extensions on HDFs classified as "Protection": Gore Road HDF 2- Reach 1, Clarkway HDF 7- Reach 1 - Regulatory floodplain storage and conveyance capacity to be preserved for any potential modification/relocation of HDFs classified as "Conservation": Gore Road HDF 2- Reach 2, Clarkway HDF 15- Reach 1, and Robinson Tributary HDF 1- Reach 1)		- Future road improvement works for crossing at The Gore Road, Clarkway and Rainbow Creek Tributaries represent opportunities to reduce flood hazards and stream restoration works through the construction of larger bridge / culvert crossing structures and improved channel conveyance

Environmental Resources	Protection (No Development or Site Alteration)	Mitigation / Compensation Or Subject to Further Study	Opportunities for Enhancement and Restoration
Stream and Valley Corridors	- lands within stream and valley corridors plus a 10 m buffer as measured from the greater of : • Regional Storm Floodplain hazard lands (additional buffer will be required to ensure minimum 0.5 m vertical freeboard if not available via the natural grades within the standard 10m horizontal buffer); • Slope stability hazards; • Meander belts; • Surveyed top-of-bank		- Examine opportunities for modification of the Rainbow Creek Tributary corridor to achieve land use efficiencies and improve the natural heritage system and stormwater drainage within the future landscape - Examine Rainbow Creek Tributary re-alignment and restoration opportunities as part of future roadway improvements at Coleraine Drive Examine opportunities to create connection between the Gore Road and Clarkway Tributaries through green land uses, eg. SWM ponds, schools, and parks.
Terrestrial Resources (Woodland / Wetlands)	- Identified woodland and woodlot features plus 10 m buffer, including tableland woodland area linking The Gore Road and Clarkway Tributaries; - Preservation of five (5) hedgerow features within the Area 47 SPA and one (1) hedgerow feature located on existing estate lot residential development - Wetlands within stream and valley corridors and select tableland wetlands and ponds protected through 10 m corridor buffer - Significant wildlife habitat is primarily contained within valley systems, though some habitat for rare flora and fauna is present in isolated ponds.	- Woodlands to be retained on the landscape will require the completion of a feature-based water balance. - Removal of hedgerows (with invasive species) and other tableland vegetation (e.g. tree groups, trees) will require 3:1 planting ratio to mitigate the loss of tree canopy - Wetlands (and ponds) retained on the landscape will require the completion of a feature-based water balance. - Wetlands located outside of stream and valley corridors – evaluation requirements to support preservation or removal to be confirmed with City of Brampton and TRCA. Wetland removals will be subject to a 1:1 replacement ratio. -Protection of significant wildlife habitat within valleys to eb acheived through protection of valley features. For habitat isolated from valleys, future studies should consider feasibility of transplant or transfer of significant species to valley corridors.	- native plantings within buffer zones - Enhancement of tableland woodland connection between the Gore Road and Clarkway tributaries to expand/enhance NHS linkage (see **Section 8.2.6**), and strategic placement of soft land uses (e.g. parks and SWM ponds) adjacent to wildlife corrdiors/linkages. Opportunities to mitigate loss of tableland natural heritage features to be examined onsite, e.g. parks naturalization, species transplant, etc. - Rainbow Creek corridor naturalization (See **Section 5**) - Invasive species management plan(s).

Environmental Resources	Protection (No Development or Site Alteration)	Mitigation / Compensation Or Subject to Further Study	Opportunities for Enhancement and Restoration
Terrestrial Resources (Species at Risk Habitat)	Cultural meadows and successional communities Anthropogenic features	Species at Risk – Bobolink and Eastern Meadowlark habitat requirements to be determined through consultation with MNRF Species at Risk – Barn Swallow habitat requirements to be determined through consultation with MNRF A Species at Risk management plan is currently ongoing (completed by others on behalf of the landowners' group)	Species at Risk Strategy to determine protection, compensation and net benefit in accordance with MNRF requirements and in consultation with City of Brampton and TRCA Examine opportunities to combine / expand terrestrial connections between the Gore Road and Clarkway Tributaries
Aquatic Resources	- West Humber River – 30 m buffer beyond meander belt for protection of Redside Dace habitat - The Gore Road Tributary, Clarkway Tributary, Rainbow Creek Tributary: buffer width for protection of warmwater fish habitat - 10m buffer beyond meander belt / no less than 15m from bankfull channel. - agricultural ponds GP-2, GP-4, GP-5 & GP-6 plus 10 m buffer	- Ponds retained on the landscape will require the completion of a feature-based water balance.	- riparian plantings in grass-dominated reaches, particularly the Rainbow Creek Tributary - removal of fish barrier at agricultural crossing of The Gore Road Tributary (perched culvert)



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STUDY AREA
- WATERCOURSES

PRESERVATION (NO DEVELOPMENT)

- STREAM/VALLEY CORRIDOR

Composed of:
- Floodplan hazard lands
- Meander belt
- Valley Features (Top of bank)
- Erosion and slope stability setbacks

- AGRICULTURAL PONDS TO BE PROTECTED
- SIGNIFICANT WOODLANDS/WOODLOTS
- WETLAND FEATURES TO BE RETAINED
- NATURAL FEATURE BUFFERS

- Valley/stream corridor +10m
- Significant Woodlots/woodlands +10m
- Agricultural ponds +10m
- Wetlands +10m
- Fish habitat
  - -For Gore Rd Trib/Clarkway/Rainbow and HDF's:
  - Meander belt+10m, no less than 15m for warmwater habitat
  - -For West Humber River:
  - Meander belt+30m for Reside Dace habitat

MITIGATION/DEVELOPMENT SUBJECT TO FUTURE STUDY

- SAR-BOBOLINK/EASTERN MEADOWLARK HABITAT - MNR consultation
- SAR-BARN SWALLOW NESTS - MNR consultation

OPPORTUNITIES FOR ENHANCEMENT AND RESTORATION

- HEDGEROWS TO PROTECT, WHERE FEASIBLE
- RIPARIAN PLANTINGS
- FISH BARRIER REMOVAL
- RESTORATION - RAINBOW CREEK AT COLERAINE DRIVE
- WILDLIFE CORRIDORS

ENVIRONMENTAL OPPORTUNITIES AND CONSTRAINTS TO DEVELOPMENT
FIGURE 3.10

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Table 3.8: Summary of Land Area within the Area 47 SPA Natural Heritage System

	Robinson Creek	Rainbow Creek	Clarkway Tributary	Gore Road Tributary	West Humber River	Area 47 SPA Natural Heritage System	
						Area (ha)	% of Total Study Area
NHS without proposed Rainbow Creek corridor							
Area (ha) of natural heritage features to be protected	2.56	74.44*	79.08	61.18	1.71	218.96	18.04%
Area (ha) of natural heritage features proposed for removal and mitigation	0.77	0.80	0.63	1.00	0.10	3.30	0.27%
Total (ha):	*3.33*	*75.24*	*79.71*	*62.18*	*1.81*	*222.26*	*18. 31%*

*excludes the area of floodplain currently occupied by the Cadetta Road development.

4 STORMWATER IMPACTS AND MANAGEMENT RECOMMENDATIONS

Existing and proposed land uses within the Area 47 study area were reviewed in **Section 1**. As noted, the western portion of the study area will be developed with a mix of residential land uses and associated neighbourhood amenities, while the eastern portion will be developed primarily with industrial / employment land uses. A potential 400-series highway extension is also anticipated within the northeast portion of Area 47, however MTO has not yet established the exact alignment and location of this GTA West Highway corridor.

Environmental baseline conditions within Area 47, including development constraints and environmental opportunities, were defined in **Section 2**. This chapter provides a brief review of the potential impacts of future urban development on the natural resources of the study area, together with a series of recommended management measures to mitigate these impacts. Collectively these stormwater management and natural heritage strategies comprise the recommended Master Environmental Servicing Plan (MESP) to protect the Area 47 natural resources as the future land use changes take place. The elements of the MESP are summarized in **Section 7**.

4.1 Potential Stormwater Impacts

This section provides a brief overview of the general stormwater impacts which are directly associated with changes to the hydrologic regime due to urban development. This includes impacts to:

- the overall hydrologic cycle or water balance;
- water quality;
- stream erosion; and
- flooding.

Note that, in addition to the direct impacts noted above, stormwater impacts from urban development can also have a significant effect on many other natural resources including aquatic and terrestrial communities and their habitat. Stormwater impacts and other urban development impacts to the Natural Heritage System are discussed in further detail in **Section 5**.

4.1.1 Potential Impact to Groundwater and Water Balance

As discussed in **Section** 2.1.1, field investigations and technical work demonstrate that the surficial soils are relatively tight clays and silts and remain so to depths of several metres. As such, the annual groundwater recharge is relatively low, estimated at approximately 80mm. Nonetheless, maintaining the existing groundwater recharge volumes and minimizing changes to the overall site (and feature-based) water budgets are required.

Without controls, the impervious surfaces associated with future urban development will reduce the capacity of the site to infiltrate rainfall events into the groundwater system, creating an increase in the volume of surface water runoff instead (Figure 4.1). This alteration to the water budget, in turn, can contribute to increased rates of flooding, erosion, and pollutant loadings. The corresponding reduction in groundwater levels can also result in reduced supplies of clean, cool baseflows to area streams, thereby negatively impacting downstream aquatic communities. As such, mitigating the impacts to the overall site and feature-based water balances is a requirement of development approval.

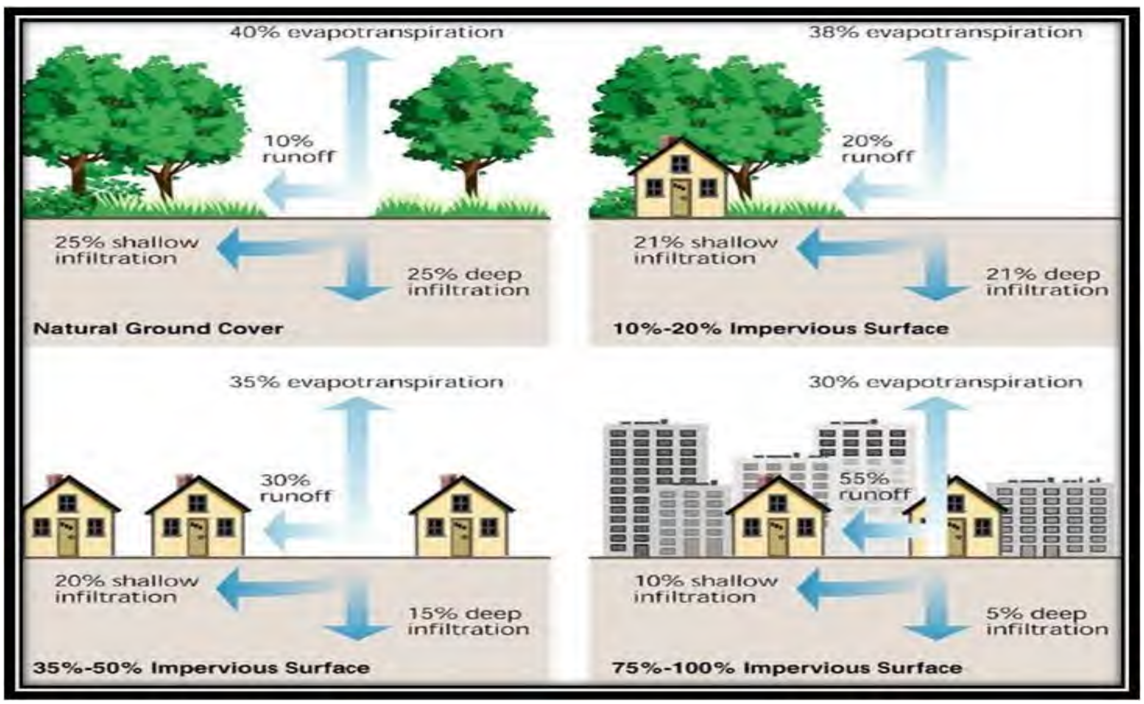


Figure 4.1: Example of General Water Budget Impacts Due to Development

4.1.2 Potential Impact to Water Quality

The protection of surface water quality within the study area is a key objective. Water quality has a strong influence on the health of fish and other aquatic communities, and also determines the suitability of water for drinking, recreation, fishing, wildlife and general aesthetics.

Stormwater runoff from urban sources typically contains elevated levels of contaminants such as sediment (ie. suspended solids), nutrients (eg. phosphorous, etc.), metals (eg. copper, lead, zinc, etc.), and bacteria. Therefore, without controls, future urban development will result in increased pollutant loadings to the area streams. This, in turn, can contribute to degraded aquatic habitat and increased health risks associated with various recreation activities (Figure 4.2).

Figure 4.2: Water Quality Impacts

4.1.3 Flood and Erosion Impacts

With urbanization there is a typical hydrologic response from the developed land. This generally involves an increase in peak flow rates and runoff volumes, and a decrease in the time-to-peak flow. These effects commonly occur with increased impervious surface areas and improved stormwater drainage systems which are typical of the change from rural to urban land use. The increased runoff volumes and flow rates can result in increased rates of erosion and flooding (

Figure 4.3).

Figure 4.3: Examples of Flooding and Erosion Impacts

4.2 Stormwater Management and Drainage Recommendations

Stormwater management and drainage recommendations for the Area 47 study area have been formulated through consideration of the proposed future urban development and its impact on the existing environmental resources of the area, together with input from TRCA, City, and landowner representatives. The recommendations consist of works required to mitigate the potential impacts and meet the necessary minimum control and protection requirements outlined in the 2012 TRCA Stormwater Criteria document, while also taking advantage of opportunities to provide additional environmental enhancements. Key components of the strategy include:

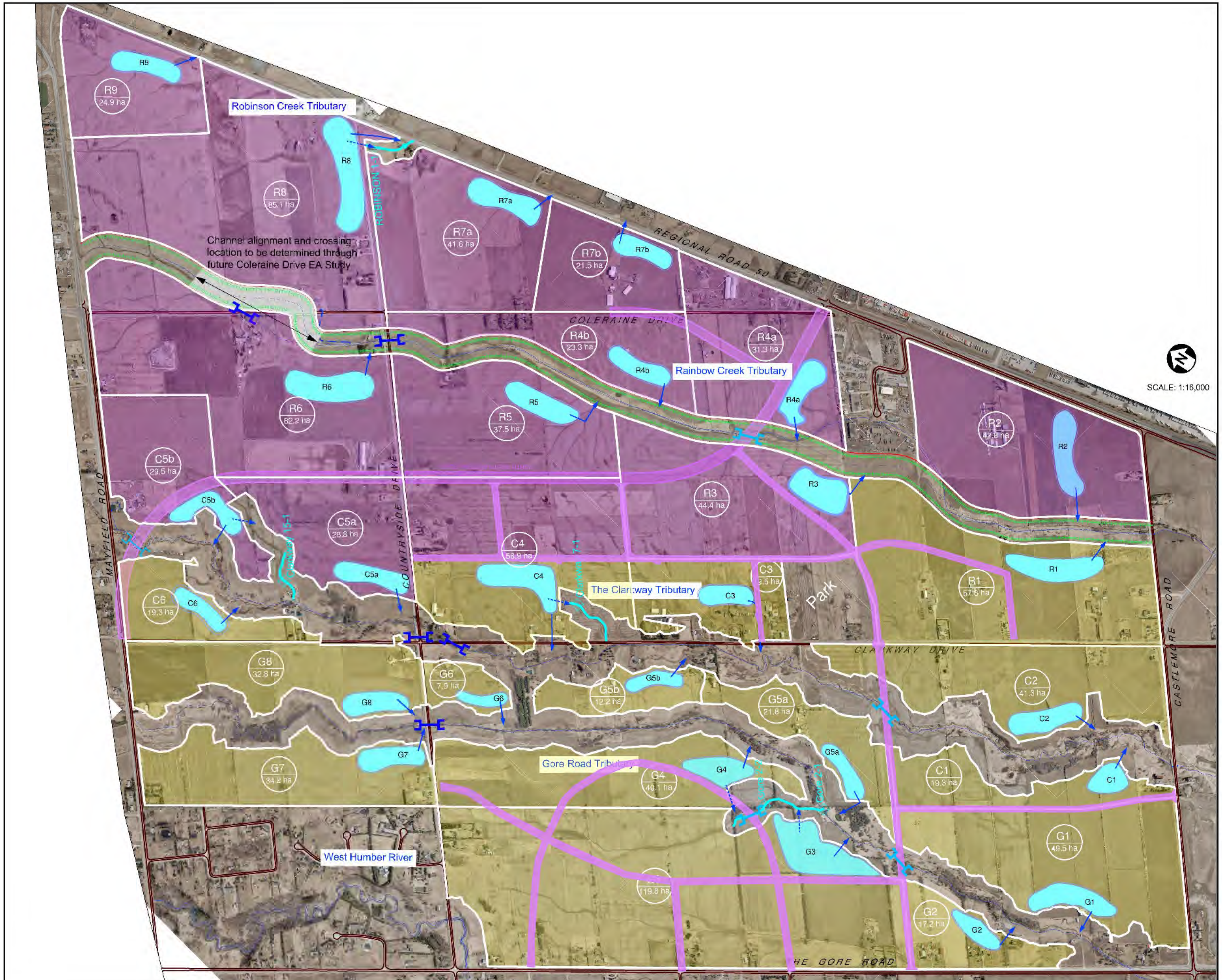
- provision of low impact development (LID) measures to maintain site and natural feature water balances and to provide water quality, erosion control and environmental benefits. These LID measures would be incorporated into individual sites (i.e. source control LIDs) and within the drainage network itself (i.e. conveyance control LIDs). Further, the LID measures would serve to mitigate the loss of headwater drainage features, where appropriate, by replicating their conveyance and water quality functions;

- provision of stormwater management ponds at the end of the drainage network (i.e. "end-of-pipe" controls) for water quality, erosion control, and flood (quantity) control. Design of the stormwater management ponds will also provide opportunities to integrate the community pathways system into the ponds to create neighbourhood connectivity;

- provision of adequately sized roadway crossing structures over the study area streams to allow for flood conveyance and improved fish/wildlife passage; and

- stream restoration and grading works on the Rainbow Creek Tributary to ensure permanent remediation and reduction of risk to existing development, improve public safety, improve the ability to outlet adjacent stormwater facilities, and enhance the environmental features, functions and quality of the corridor. .

The above works are illustrated conceptually in Figure 4.4. Further details with respect to each of the above stormwater management and drainage recommendations are provided below.



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STUDY AREA
- WATERCOURSE
- PROPOSED ROAD
- RESIDENTIAL LANDUSE
- EMPLOYMENT LANDUSE
- STORMWATER MANAGEMENT POND
- PROPOSED OUTLET
- OPTIONAL OUTLET (H.D.F)
- CATCHMENT BOUNDARY
- MAINTAIN CONTRIBUTING FLOWS TO PROTECTION/CONSERVATION HDFs

WATERCROUSE CROSSING IMPROVEMENTS

- NEW CROSSING
- REPLACEMENT
- RAINBOW CREEK CORRIDOR RESTORATION AND ENHANCEMENT

LID SOURCE AND CONVERYANCE CONTROLS:

- MINIMUM 5MM RETENTION
- APPLIES TO ALL DEVELOPMENT LANDS
- ALTERNATIVE LID MEASURES:

LID METHODS:	RESIDENTIAL LANDUSE	EMPLOYMENT LANDUSE
Valley Swale*	✔	✔
Rear/side lot grassed swale/Bio swale*	✔	✔
Soakaway Pits/Infiltartion Chambers	✔	✔
Bioretention cells/Rain Garden	✔	✔
Permeable Pavement	✔	✔
Rainwater Harvesting	✔	✔
Green Roofs	✖	✔
Filter Strips	✖	✔

*Note:
Loss of any HDF features (see "Mitigation" Classification - Figure 2.15) to be mitigated through use of LID swales. Length of LID swales to meet or exceed length of HDFs removed (Table 3.4)

STORMWATER MANAGEMENT AND DRAINAGE RECOMMENDATIONS

FIGURE 4.4

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4.2.1 Stormwater Management Ponds

Stormwater ponds utilize a permanent pool of water for quality control by settling pollutants in the form of suspended sediments from the stormwater runoff. In addition to providing water quality control, stormwater ponds also provide temporary extended detention storage above the permanent pool to attenuate runoff and control outflow rates in order to prevent increased flooding and erosion on the downstream receiving streams.

4.2.1.1 Stormwater Pond Locations

Within Area 47, runoff will be directed via the storm drainage network to a series of "end-of-pipe" stormwater ponds. **Figure 4.4** illustrates conceptual stormwater pond locations and the associated catchment areas to each. The proposed stormwater ponds will be designed to provide the required water quality, quantity and erosion control for development in the upstream catchments and future road improvements. These facility locations have been selected based on a cursory assessment of the general topography of the study area, existing drainage patterns, and the proposed development and arterial road patterns available at the time of the study. However, it is understood that the exact number of ponds, their locations and sizes are subject to future refinement as more detailed planning and design proceeds as part of future block planning studies. These factors will ultimately depend on the future local road network, location and depth of suitable pond outlets, fragmentation of land ownership, and ability to co-ordinate the timing of the various development sites.

Selection of the conceptual stormwater pond locations also considered the existing drainage patterns in order to minimize drainage diversions and maintain the drainage areas contributing to each of the watercourse systems to the extent possible. Existing and Proposed summary drainage plans for each of the major watercourse systems are provided in **Appendix K** which demonstrate that the proposed changes to the overall contributing drainage areas are negligible.

In order to maintain flows to the upstream reaches of those headwater drainage features (HDFs) that are to be maintained as open watercourses, consideration may be given to outleting flows from select stormwater ponds to these features. The stormwater pond locations illustrated in **Figure 4.4** could allow flows to be maintained to the HDFs as outlined in **Table 4.1**. Depending on the ultimate stormwater drainage system configuration and design of the adjacent subdivision, these stormwater ponds may be configured with a primary outlet to the adjacent main valley systems, while maintaining baseflows to the HDF features via a secondary outlet. Other options for maintaining flows to HDF features may include the use of foundation drain collection systems and/or use of lot-level and conveyance LID measures to direct clean rooftop and overland runoff to these features.

Table 4.1: Options for Maintaining Baseflows to HDF Features via SWM Ponds

HDF (see **Section 2.2.2)**	**Contributing SWM Pond (Figure 4.4)**
Protection (no modification/relocation)	
Gore 2-1	SWM Pond G3 and/or G4
Clarkway 15-1	SWM Pond C5b
Conservation (potential future modification/relocation)	
Gore 2-2	SWM Pond G3 and/or G4
Clarkway 7-1	SWM Pond C4
Robinson 1-1	SWM Pond R8

As illustrated in **Figure 4.4**, the Area 47 stormwater management ponds and associated infrastructure will be located on the tablelands, outside of the development constraint areas such as natural areas and valley corridors and associated environmental buffers. As per City Policy 5.4.1.2 of the Area 47 Secondary Plan, grading within buffers is generally not permitted. However, the City will consider proposals for minor grading within environmental buffers along those portions of the valley corridors with no identified slope stability / erosion hazards, significant wildlife habitat or vegetation communities.

The facilities will be designed with sediment forebays to receive inflows from the contributing drainage system, consisting of storm sewers, swales or other conveyance LID measures. Outlet structures will discharge to the adjacent stream/valley and will be sized to capture and release the necessary storage volumes, as described in **Section 4.2.1.2**. The basic components of a stormwater management pond and its typical location relative to a stream corridor are illustrated in **Figure 4.5**.

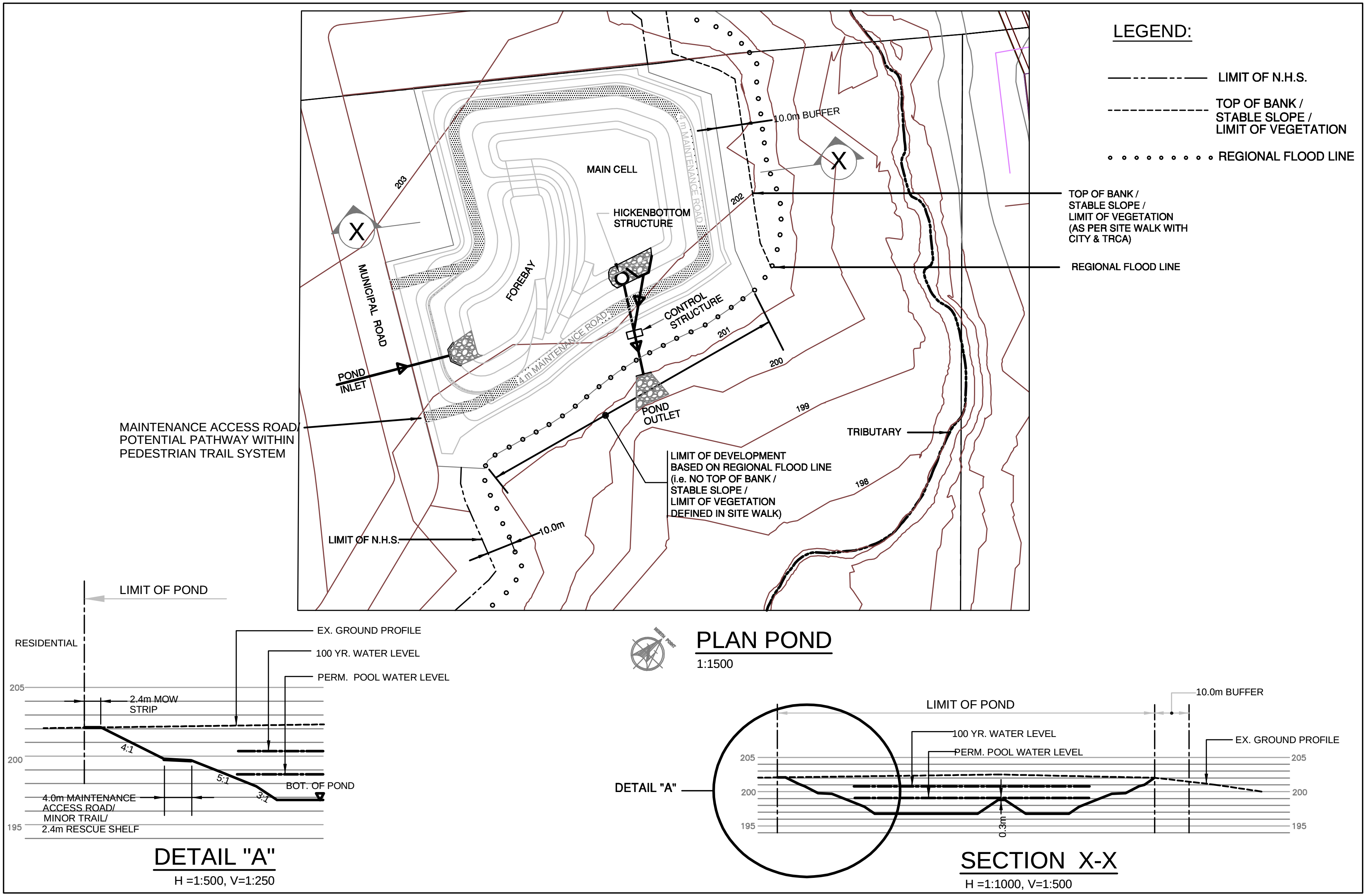


Figure 4.5: Typical SWM Pond Design

4.2.1.2 Stormwater Pond Control Targets and Sizing

Stormwater management targets to be applied over the Area 47 study area were developed through consultation with TRCA and associated hydrologic modelling. The water quality control, erosion control, and flood control targets which were established are outlined below together with conceptual storage volumes required to meet these targets.

Water Quality Control

A significant portion of the nutrients and metals found in stormwater runoff are in the form of small particles attached to the suspended sediment. Therefore, removal of the sediment with stormwater management ponds will reduce the steam loadings for many contaminants. The 2003 MOE Stormwater Management Planning and Design Manual defines specific water quality control targets for stormwater facilities. The targets are based on:

- the type of facility (stormwater pond, infiltration practice, etc.);
- the land uses within the contributing area (in terms of an impervious component); and
- the level of control required.

Regarding the last point, for all lands within the Humber River Watershed, TRCA requires "Level 1" or "Enhanced" level of protection, defined as 80% long-term suspended solids removal. Regarding the second point above, impervious levels used to represent various land uses were defined by TRCA through the recent Humber River Hydrology Update study. The values, summarized in **Table 4.2**, were derived through a land use assessment completed on recent urban development in the greater Toronto area.

Table 4.2: TRCA Impervious Levels

Land use Classification	Total Impervious Area	Directly Connected Impervious Area
Park	10%	10%
Executive Residential	50%	40%
Medium/Low Density Residential	60%	50%
Clarkway Drive Mixed Use (Residential Retail)	80%	80%
Industrial	95%	95%
Commercial	95%	95%
Institutional	80%	75%

To achieve the target of Enhanced water quality control for a typical medium density residential development with an impervious component of 60%, for example, the MOE Manual specifies a target storage volume of 205 m^3/hectare, of which:

- 165 m^3/ha is permanent pool storage; and
- 40 m^3/ha is extended detention, or “active” storage.

For a typical industrial or commercial development with an impervious component of 95%, a storage volume of 260 m^3/hectare is required, of which:

- 220 m^3/ha is permanent pool storage; and
- 40 m^3/ha is extended detention, or “active” storage.

It should be noted that the overall active storage required within the ponds will be governed by the larger requirements for erosion and flood control (see below). Therefore, the small amount of active storage specified above can be incorporated into the larger erosion and flood control storage requirements.

Erosion Control

Although the Area 47 watercourses are not currently experiencing any significant ongoing erosion beyond natural migration patterns, they may be susceptible to increased rates of erosion without future stormwater controls. TRCA staff were consulted regarding erosion control requirements within this portion of the Humber River watershed. Per the 2012 TRCA Stormwater Criteria document, a minimum 5mm of stormwater retention is required in order to reduce runoff volumes and minimize downstream erosion potential. This control is to be provided through the use of on-site or conveyance LID techniques. Further discussion of these measures is provided in **Section 4.2.2**.

Erosion Control for Gore Road Tributary, Clarkway Tributary, Rainbow Creek Tributary

For the Area 47 lands, sufficient extended detention storage is also required within future stormwater facilities to capture and release runoff from a 25mm storm event over 48 hours for all facilities discharging to the main watercourse/valley systems. From a fluvial geomorphology perspective, the capture and gradual release of all storm events up to the 25mm event would provide control for over 90% of all storm events in a typical year.

Erosion Control for HDFs

As noted earlier, outflows from some stormwater ponds may discharge in whole or in part to smaller HDF features in order to maintain flows to these features. Given that these HDF features may be more sensitive to changes in hydrology than the main watercourses in the study area, further study is recommended to define the allowable outlet rates to these features as follows:

- TRCA recommends consultation with Planning Ecology staff to confirm the appropriateness of directing stormwater pond discharges to the HDFs. If the approach is acceptable, an erosion assessment consistent with the methodology identified in TRCA's Stormwater Management Criteria document will be required as part of future functional plans (EIRs / EISs) at the Block Planning stage.
- For this MESP, an interim erosion control target using the most stringent criteria in TRCA's jurisdiction is to be applied; detain and release runoff from a 25 mm storm event over 120 hours, together with retention of 5 mm from all impervious surfaces.

SWM Pond Erosion Control Targets

Assuming a runoff coefficient of 0.6 for future residential land uses, the following conceptual targets were identified:

- 150 m^3/ha of extended detention storage;
- an average release rate of 0.87 L/s/ha (to main watercourse/valley systems); and
- an average release rate of 0.35 L/s/ha (to HDFs).

Assuming a runoff coefficient of 0.9 for future industrial / commercial land uses, the following conceptual targets were identified:

- 225 m3/ha of extended detention storage;
- an average release rate of 1.30 L/s/ha (to main watercourse/valley systems); and
- an average release rate of 0.52 L/s/ha (to HDFs).

In addition to the extended detention requirements noted above, the 2012 TRCA Stormwater Criteria document requires a minimum of 5mm of retention be applied to all development lands in order to reduce runoff volumes, and to minimize impacts to groundwater recharge and the overall water balance.

Flood Control

Consistent with current TRCA requirements in the West Humber River and Rainbow Creek subwatersheds, future development will also require flood (quantity) control facilities to attenuate post-development stormwater runoff rates to pre-development levels for the 2-year through 100-year storm events. TRCA defines the pre-development release rates for the Humber River watershed through a series of unit flow relationships which were established as part of the 1997 Humber River Watershed Hydrology/Hydraulics and Stormwater Management Study. The applicable unit flow relationships for the Area 47 lands are as follows:

$$\text{100-year release rate: } Q = 29.912 - 2.316 \ln(A)$$

$$\text{50-year release rate: } Q = 26.566 - 2.082 \ln(A)$$

$$\text{25-year release rate: } Q = 22.639 - 1.741 \ln(A)$$

$$\text{10-year release rate: } Q = 17.957 - 1.373 \ln(A)$$

$$\text{5-year release rate: } Q = 14.652 - 1.136 \ln(A)$$

$$\text{2-year release rate: } Q = 9.506 - 0.719 \ln(A)$$

Note: Q – unit flow (L/s/ha – litres per second per hectare), A – area in hectares (ha)

Hydrologic analyses were completed using the SWMHYMO hydrologic to estimate the active storage requirements to meet the above erosion and flood control targets for each of the Area 47 stormwater ponds. SYMHYMO modelling parameters are summarized in Appendix K.

It is understood that future grading plans may identify specific areas within a development where directing drainage to the planned stormwater ponds is impractical. In any such cases where lands may need to drain uncontrolled to a receiving watercourse, a sufficient amount of over-control will be required within the stormwater ponds to “compensate” for the uncontrolled areas. Target outflows from the pond will need to be developed such that the combined outflow from the uncontrolled and controlled areas does not exceed the release rate defined through the unit flow relationships for the total area.

Conceptual Stormwater Pond Sizing

The characteristics of the each of the conceptual Area 47 stormwater ponds are summarized in **Table 4.3**, including storage targets for water quality control, and storage and release rate targets for erosion and flood control. As shown:

- permanent pool storage requirement for water quality control range from approximately 150 m^3/ha (executive residential) to 220 m^3/ha (employment land uses);

- extended detention storage requirements for erosion and flood control range from approximately 500 m^3/ha, on average, for ponds serving residential lands to approximately 600 m^3/ha, on average, for ponds serving employment lands.

For those stormwater ponds which may discharge to smaller HDFs, additional erosion control storage targets are identified. For the purposes of this MESP, the conceptual targets listed in **Table 4.3** assume that all of the stormwater pond outflows are directed to the HDFs. However, it is understood that the ultimate designs may direct only a portion of the flows to the HDFs via a secondary outlet for the purposes of maintaining baseflows to these features. As shown, the more stringent erosion control criteria result in marginally larger overall storage requirements. It is understood that the release rate targets to HDFs are subject to review and approval by TRCA and may be refined through future detailed erosion assessments at the next functional design planning level.

Based on the above storage requirements, conceptual pond footprint areas were also estimated for each facility. As shown in **Table 4.3**, land requirements for stormwater ponds are estimated to occupy between roughly 4% to 11% of the catchment service area. As noted above, the ultimate sizing and land requirements for the ponds will vary and can be affected by a number of design factors such as grading, slopes, storage depths, access roads, drying areas, and the shape/configuration of the facilities.

TABLE 4.3: CONCEPTUAL STORMWATER MANAGEMENT POND CHARACTERISTICS

Pond # or Catchment	Estimated Drainage Area (ha)	Predominant Landuse	Impervious (%)	Receiving Watercourse	Water Quality Control (Level 1 / Enhanced)								Extended Detention for Flood (Quantity) Control								Total Storage Volume* (m3)	Conceptual Pond Footprint Area** (ha)	Conceptual Pond Footprint as percentage of Catchment Area (%)	Pond # or Catchment
									Extended Detention for Erosion Control															
									Erosion Control				2-Year Control				100-Year Control							
					Perament Pool Storage for water quality		Extended Detention for Water Qualtiy		Release Rate		Storage Volume		Release Rate		Storage Volume		Release Rate		Storage Volume					
					(m^3/ha)	(m^3)	(m^3/ha)	(m^3)	(m^3/s)	(L/s/ha)	(m^3)	(m^3/ha)	(m^3/s)	(L/s/ha)	(m^3)	(m^3/ha)	(m^3/s)	(L/s/ha)	(m^3)	(m^3/ha)				
The Gore Road Tributary																								The Gore Road Tributary
G1	49.5	Residential	60%	Gore Rd Trib.	165	8,172	40	1,980	0.043	0.9	7,426	150	0.332	6.7	10,070	203	1.033	20.9	24,610	497	32,782	2.7	5.5%	G1
G2	17.2	Residential	66%	Gore Rd Trib.	177	3,047	40	688	0.015	0.9	2,575	150	0.128	7.4	3,670	213	0.400	23.3	8,700	506	11,747	1.4	8.2%	G2
G3	119.8	Residential	60%	Gore Rd Trib.	165	19,826	40	4,792	0.104	0.9	17,964	150	0.726	6.1	24,690	206	2.255	18.8	60,770	507	80,596	5.3	4.4%	G3
				HDF G2 (optional)	165	19,826	40	4,792	0.042	0.3	17,964	150	0.726	6.1	24,890	208	2.255	18.8	60,870	508	80,696	5.3	4.4%	
G4	40.1	Residential	53%	Gore Rd Trib.	149	5,966	40	1,604	0.035	0.9	6,022	150	0.275	6.9	7,660	191	0.858	21.4	19,070	476	25,036	2.3	5.6%	G4
				HDF G2 (optional)	149	5,966	40	1,604	0.014	0.3	6,022	150	0.275	6.9	7,720	193	0.858	21.4	19,100	476	25,066	2.3	5.6%	
G5a	21.8	Residential	58%	Gore Rd Trib.	161	3,506	40	872	0.019	0.9	3,265	150	0.159	7.3	4,260	195	0.496	22.7	10,510	482	14,016	1.6	7.2%	G5a
G5b	12.2	Residential	58%	Gore Rd Trib.	161	1,959	40	488	0.011	0.9	1,826	150	0.094	7.7	2,400	197	0.294	24.1	5,830	478	7,789	1.1	9.2%	G5b
G6	7.9	Residential	54%	Gore Rd Trib.	153	1,207	40	316	0.007	0.9	1,187	150	0.063	8.0	1,500	190	0.199	25.2	3,660	463	4,867	0.9	11.2%	G6
G7	34.2	Residential	56%	Gore Rd Trib.	156	5,336	40	1,368	0.030	0.9	5,130	150	0.238	7.0	6,740	197	0.743	21.7	16,790	491	22,126	2.1	6.1%	G7
G8	32.8	Residential	63%	Gore Rd Trib.	171	5,594	40	1,312	0.029	0.9	4,926	150	0.230	7.0	7,040	215	0.717	21.9	16,890	515	22,484	2.1	6.4%	G8
Clarkway Drive Tributary																								Clarkway Drive Tributary
C1	19.3	Residential	60%	Clarkway Drive Trib.	165	3,186	40	772	0.017	0.9	2,890	150	0.142	7.4	4,020	208	0.444	23.0	9,680	502	12,866	1.5	7.7%	C1
C2	41.3	Residential	72%	Clarkway Drive Trib.	187	7,731	40	1,654	0.036	0.9	6,202	150	0.282	6.8	9,560	231	0.880	21.3	22,360	541	30,091	2.6	6.3%	C2a
C3	19.5	Residential	69%	Clarkway Drive Trib.	183	3,571	40	779	0.017	0.9	2,921	150	0.144	7.4	4,360	224	0.449	23.0	10,240	526	13,811	1.6	8.0%	C3
C4	58.9	Employment	83%	Clarkway Drive Trib.	205	12,096	40	2,356	0.077	1.3	13,245	225	0.387	6.6	15,390	261	1.205	20.5	33,950	576	46,046	3.5	5.9%	C4
				HDF C7 (optional)	205	12,096	40	2,356	0.031	0.5	13,245	225	0.387	6.6	15,540	264	1.205	20.5	34,020	578	46,116	3.5	5.9%	
C5a	28.8	Employment	95%	Clarkway Drive Trib.	222	6,400	40	1,152	0.037	1.3	6,477	225	0.204	7.1	8,090	281	0.637	22.1	17,330	602	23,730	2.2	7.6%	C5a
C5b	29.5	Employment	95%	Clarkway Drive Trib.	222	6,556	40	1,180	0.038	1.3	6,639	225	0.209	7.1	8,280	281	0.651	22.1	17,760	602	24,316	2.2	7.5%	C5b
				HDF C15 (optional)	222	6,556	40	1,180	0.015	0.5	6,639	225	0.209	7.1	8,350	283	0.651	22.1	17,800	603	24,356	2.2	7.5%	
C6	19.3	Residential	63%	Clarkway Drive Trib.	170	3,287	40	772	0.017	0.9	2,888	150	0.142	7.4	4,110	213	0.444	23.0	9,830	509	13,117	1.5	7.8%	C6
Rainbow Creek Tributary																								Rainbow Creek Tributary
R1	57.6	Residential	68%	Rainbow Creek Trib.	180	10,391	40	2,304	0.050	0.9	8,643	150	0.380	6.6	12,840	223	1.183	20.5	30,570	531	40,961	3.2	5.6%	R1
R2	42.8	Employment	95%	Rainbow Creek Trib.	222	9,512	40	1,712	0.056	1.3	9,623	225	0.291	6.8	12,000	280	0.907	21.2	25,790	603	35,302	2.9	6.7%	R2
R3	44.4	Employment	89%	Rainbow Creek Trib.	213	9,476	40	1,776	0.058	1.3	9,987	225	0.301	6.8	11,860	267	0.938	21.1	25,820	582	35,296	2.9	6.5%	R3
R4a	31.3	Employment	95%	Rainbow Creek Trib.	222	6,956	40	1,252	0.041	1.3	7,039	225	0.220	7.0	8,750	280	0.686	21.9	18,760	599	25,716	2.3	7.4%	R4a
R4b	23.3	Employment	95%	Rainbow Creek Trib.	222	5,178	40	932	0.030	1.3	5,235	225	0.169	7.2	6,490	279	0.526	22.6	13,900	597	19,078	1.9	8.2%	R4b
R5	37.5	Employment	95%	Rainbow Creek Trib.	222	8,334	40	1,500	0.049	1.3	8,447	225	0.259	6.9	10,500	280	0.808	21.5	22,540	601	30,874	2.6	7.0%	R5
R6	62.2	Employment	95%	Rainbow Creek Trib.	222	13,823	40	2,488	0.081	1.3	13,986	225	0.406	6.5	17,500	281	1.265	20.3	37,720	606	51,543	3.8	6.1%	R6
Hwy.50 Tributaries (Robinson / Rainbow HDFs)																								Robinson Creek Tributary
R7a	41.6	Employment	95%	Hwy 50/Rainbow Trib HDF	222	9,245	40	1,664	0.022	0.5	9,360	225	0.270	6.5	11,750	282	0.841	20.2	25,300	608	34,545	2.8	6.8%	R7a
R7b	21.5	Employment	95%	Hwy 50/Rainbow Trib HDF	222	4,778	40	860	0.011	0.5	4,838	225	0.155	7.2	6,030	280	0.484	22.5	12,860	598	17,638	1.8	8.4%	R7b
R8	85.1	Employment	95%	Robinson Creek Trib. HDF	222	18,912	40	3,404	0.044	0.5	19,148	225	0.485	5.7	24,220	285	1.509	17.7	52,850	621	71,762	4.9	5.7%	R8
R9	24.9	Employment	95%	Hwy 50/Robinson Trib HDF	222	5,534	40	996	0.013	0.5	5,603	225	0.132	5.3	7,080	284	0.414	16.6	15,630	628	21,164	2.0	8.2%	R9

* Total Volume includes permanent pool storage plus extended detention storage for flood control

** Actual footprint areas will depend on physical constraints including grading / storm sewer inverts / outlet (creek) elevations, etc. For conceptual purposes, the pond footprint areas were estimated assuming a 3:1 length to width flowpath, max. water de pth of 2.5m, and included allowances for sideslopes, etc.

4.2.1.3 Geotechnical Considerations

Geotechnical investigations were undertaken by AME Materials Engineering in November 2012 to characterize the soils and groundwater conditions at the conceptual stormwater pond locations. Recommendations from the investigations include the potential requirement for active dewatering and installation of clay liners during construction at select stormwater pond locations. Details are provided in the Geotechnical Investigation Report (AME, June 2013), included in Appendix A.

4.2.2 Low Impact Development Measures

For this area of the Humber River Watershed, TRCA requires that a stormwater target of 5mm of retention be applied to all development lands in order to minimize downstream erosion impacts, as well as impacts to groundwater recharge and the overall water balance. The corresponding reduction in stormwater runoff volumes also provides water quality control benefits to the receiving streams. This target may be achieved using a variety of stormwater management practices collectively referred to as low impact development (LID) measures.

LID methods may also be used to mitigate the removal of appropriately-classified small headwater drainage features. As discussed earlier in **Section 2.2.2**, several small HDFs were evaluated and classified as “Mitigation 1” or “Mitigation 2” according to TRCA HDF Assessment Protocol. Within the future development lands, these HDF features can be replicated in the urban drainage network using lot-level and conveyance LID techniques.

There are many definitions that have been developed in an attempt to define Low Impact Development, with the most widely accepted definition being that used by the United States Environmental Protection Agency (EPA, 2007):

> *Low Impact Development (LID) is a stormwater management strategy that seeks to mitigate the impacts of increased runoff and stormwater pollution. LID comprises a set of site design approaches and small scale stormwater practices that promote the use of natural systems for infiltration, evapotranspiration, and reuse of rainwater. These practices can effectively remove nutrients, pathogens and metals from stormwater, and they reduce the volume and intensity of stormwater flows.*

LID techniques mimic natural systems as rain travels from the roof to the stream by applying a series of practices across the entire development site before discharge to receiving water body. Real-world LID designs typically incorporate a series of LID practices in a 'treatment train' approach to provide integrated treatment of runoff from development sites.

LID practices are considered at the earliest stage of site design, are installed during construction and sustained in the future as a low maintenance natural system. Each LID practice incrementally reduces the volume of stormwater on its way to the stream. In doing so, LID practices can be applied to meet stormwater management targets not only for water balance, but also for water quality and geomorphic objectives.

LID practices, together with traditional end-of-pipe stormwater facilities can be applied to achieve an overall stormwater management system which provides better performance, is more cost effective, has lower maintenance burdens, and is more protective during extreme storms than conventional stormwater practices alone. Several LID practices may be needed on each site to get all the required storage and attenuation.

It should also be noted that LID practices may be beneficial in order to meet objectives beyond the field of stormwater management such as energy/water conservation, reduce-reuse of materials, ozone protection and reduction of the effects of urban heat islands.

Following the "treatment train" approach, stormwater runoff from Area 47 development lands including open space / parkland will receive preliminary treatment through the use of lot-level and conveyance LIDs before discharging to "end of pipe" stormwater ponds. Included in Figure 4.4 is a summary of various types of LID methods which may be applied to meet the 5mm water balance target over the Area 47 residential and employment development lands.

In order to ensure the continued operation of such drainage features over the long-term, it is strongly recommended that the LID measures be located within public lands first, including parks and public rights-of-way, followed by private lands.

LID Swales

Although the LID design targets may be achieved through the use of any combination of the various LID methods, one technique that may be particularly suitable for use in Area 47 is the use LID swales. This may include the use of a network of rear/side lot bioswales to drain future urban lots and public parklands, before discharging to downstream stormwater ponds, stream corridors and/or HDFs. The use of swale features within valley slopes to drain rear lots may also be considered for those lands which would drain directly to a valley feature rather than a stormwater pond (e.g. rear lots).

In addition to meeting the water balance targets for Area 47, swales may also be utilized to mimic the general conveyance function of small headwater drainage features which are to be removed as part of future urban development.

Table 4.4 summarizes the lengths of those HDFs that were evaluated and classified as "Mitigation 1" or "Mitigation 2" (**Section 2.2.2**) within each of the proposed future drainage catchments **(Figure 4.4).** As shown, up to 4.8km, 2.1km and 2.8km of HDFs could potentially be replaced within the Gore Road Tributary, Clarkway Tributary and Rainbow Creek Tributary drainage areas, respectively. As these catchments are developed, the proposed removal of any of the HDFs will require that an equal or greater length of swales be constructed within the future stormwater drainage system and connected to the natural heritage system to replicate the function of those HDFs that are lost.

Note that valley swales and bioswales would represent the preferred technique to mitigate the loss of HDF features, but are only one of many alternative LID methods which may be used to achieve the water balance target of 5mm over the study area. Further descriptions of swales and other LID methods are reviewed below. These methods may be used individually or in combination to achieve the water balance and HDF mitigation targets for a given site.

Table 4.4: Summary of HDFs Requiring Mitigation Through Use of LID Swales Connected to the NHS

Catchment No.	Headwater Drainage Feature Length (m)	
	Mitigation 1	Mitigation 2
Gore Road Tributary		
G1	0	0
G2	0	0
G3	323	2599
G4	0	218
G5a	0	0
G5b	0	0
G6	0	0
G7	0	309
G8	1320	0
Totals:	**1,643**	**3,125**
Totals (Mitigation):	**4,768**	
Clarkway Tributary		
C1	0	0
C2	58	387
C3	0	0
C4	735	0
C5a	10	84
C5b	0	548
C6	10	265
Totals:	**813**	**1,284**
Totals (Mitigation):	**2,096**	
Rainbow Creek Tributary		
R1	0	0
R2	0	0
R3	0	0
R4a	0	0
R4b	0	0
R5	0	0
R6	40	300
R7	0	1069
R8	0	698
R9	0	672
Totals:	**40**	**2,738**
Totals (Mitigation):	**2,779**	

Bioswales / Dry Swales

Bioswales, also known as dry swales, are essentially bioretention cells that are configured as a linear channel. They are a media filter system that temporarily stores and filters the desired stormwater runoff volume. The vegetation within the swales slows the runoff to allow sedimentation, filtration, and infiltration into the underlying filter media and soils. They rely on an engineered media bed to provide runoff reductions and improvement in water quality.

Although they are technically classified as a form of conveyance control, bioswales can be used as a network of linear lot-level LID measures when designed to collect and convey runoff through the rear/side yards of a residential subdivision, or within a larger industrial / commercial development site.

Bioswales have been used in the recent design of the nearby Bram East and Vales developments. A representative LID swale design schematic from the Bram East lands development is provided in Figure 4.6. As shown, stormwater runoff from the contributing lots is collected and filtered through the engineered media that composes the bed of the swale. The filtered stormwater then drains to a gravel storage area at the base of the bioswale where it can infiltrate into the surrounding native soils. This storage area is sized to capture the target 5mm runoff retention volume from the contributing site. Excess filtered runoff above the 5mm target is conveyed via a perforated underdrain to the traditional downstream urban stormwater system, typically composed of a storm sewer network discharging to an end-of-pipe stormwater pond. Excessive runoff from large storm events is conveyed within the upper vegetated swale profile to the traditional storm sewer collection network. Where feasible, rear/side lot LID bioswales may also be used to convey clean runoff directly to HDF features that are to be protected.

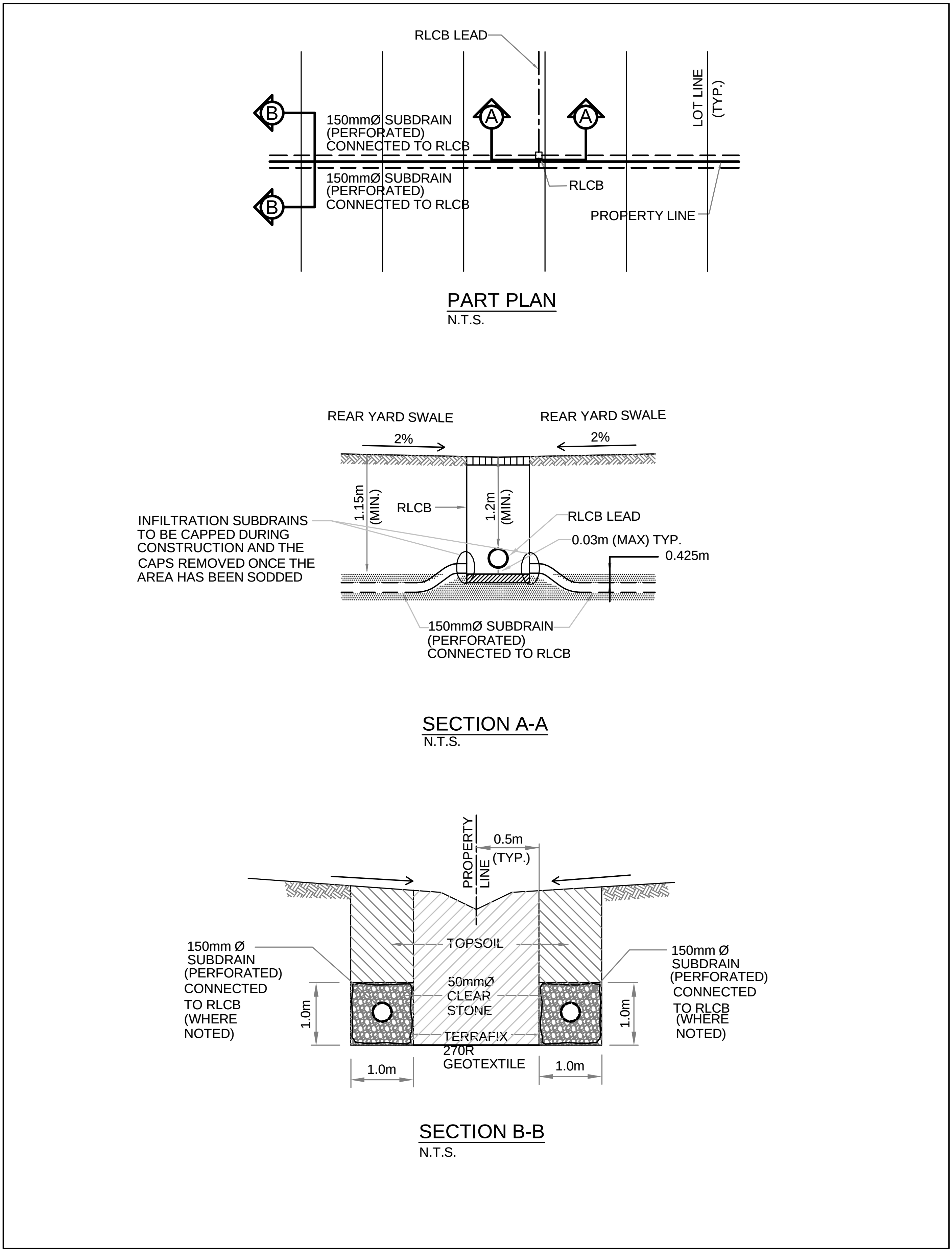


Figure 4.6: Typical LID Swale Design

Valley Slope Swales

The creation of valley slope swales within City of Brampton stream corridors has also recently been implemented as a means of mitigating the loss of HDFs (**Table 4.4**). This would be most appropriate for rear-lots draining directly to a valley system, rather than receiving treatment via an end-of-pipe stormwater management pond. The rear-lot drainage would be collected and directed to the stream valley via swales created within the side slopes of the valley feature.

Such designs also promote the supply of primary inputs (nutrients, leaf litter, insects, etc.) directly to the stream corridor. Designs may also include pocket wetland creation at the swale outlets to further mimic the function of the lost HDFs as well as controlling erosion. A representative valley slope swale design that was recently implemented as part of a development in the City of Brampton is illustrated in **Figure 4.7.**

The use of valley slope swales adjacent to future development within Area 47 will depend on the potential for disturbance to the valley. The existing grade of the slope face as well as presence of sensitive vegetation features will affect the feasibility of these measures.

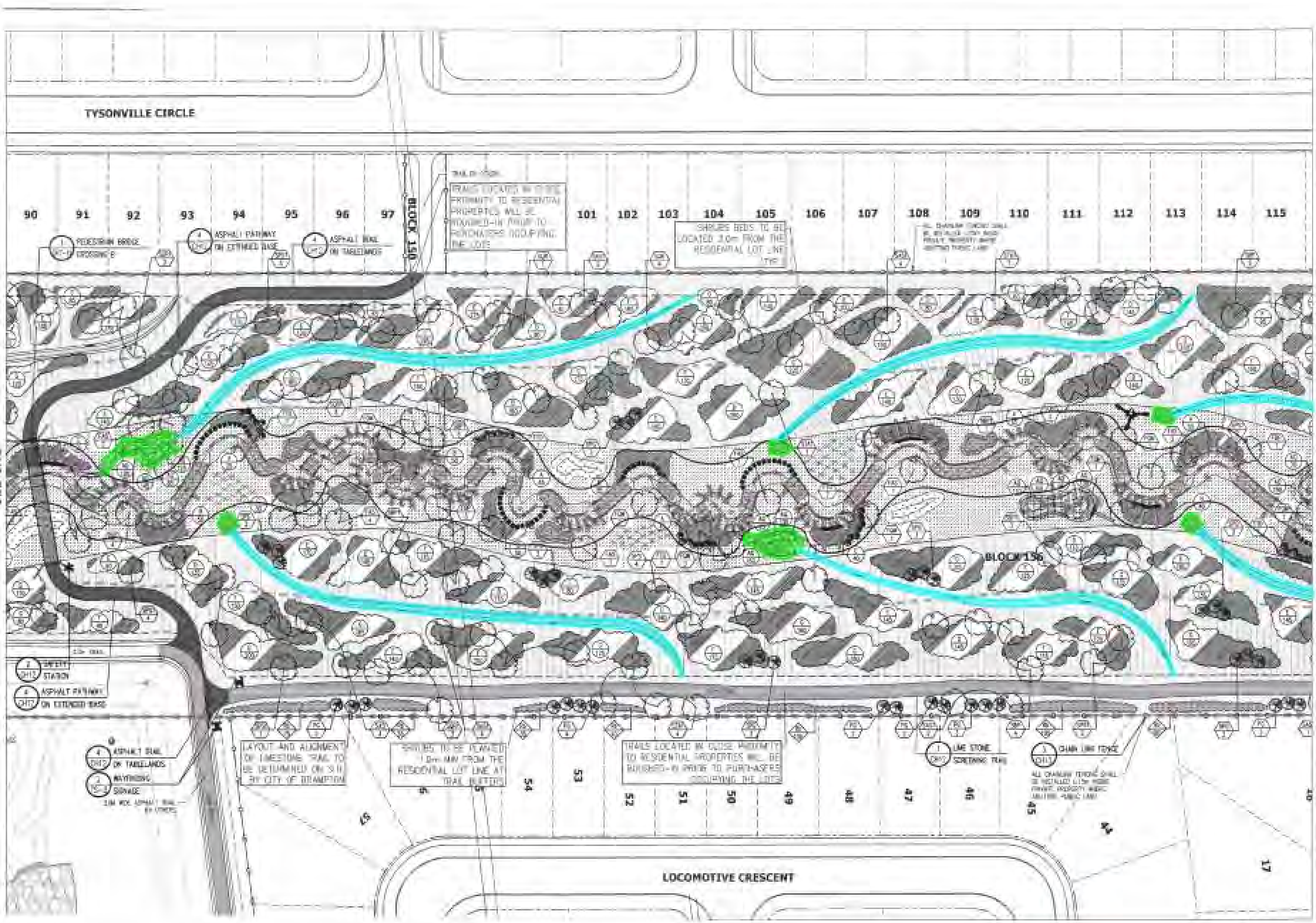
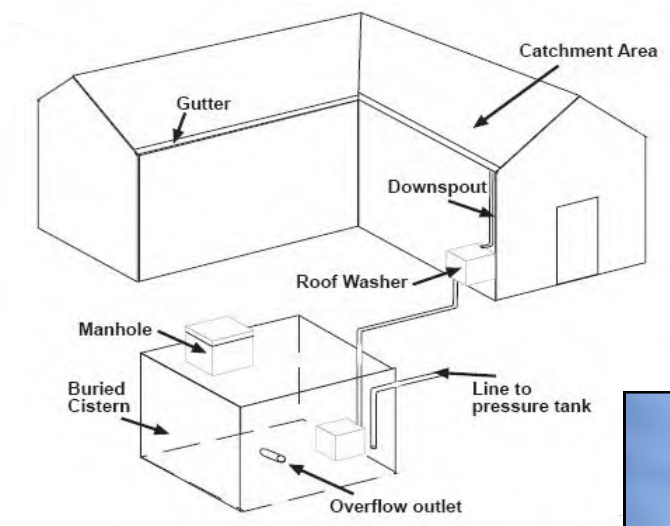


Figure 4.7 Example of a Valley Slope Swale Design

Source: City of Brampton, Mount Pleasant Secondary Plan Area

Rainwater Harvesting



Rainwater harvesting is the process of intercepting rain that falls on a catchment surface, such as a rooftop, and conveyed to a storage tank for later use. This LID is applicable for both future residential and employment land use areas.

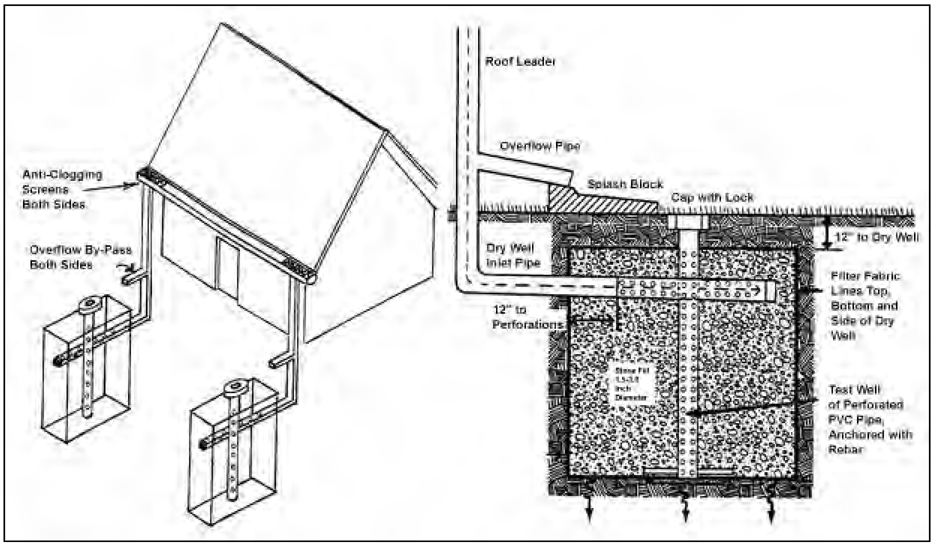
Storage tanks can range in size from rain barrels for residential land uses to large cisterns for industrial or commercial land uses. The harvested rainwater can be used inside the building for non-potable water uses, or for outdoor uses such as irrigation.

Green roofs

Green roofs or rooftop gardens consist of a thin layer of vegetation and growing medium installed on top of flat or gently sloped roofs associated with industrial, commercial or institutional land uses.

This LID acts like a lawn or meadow by storing rainwater in the growing medium. A large portion of this stored water is then evapotranspirated away by the plants. In addition to minimizing changes to the water balance, this LID is also beneficial in terms of building insulation.

Soakaway Pits



Soakaway pits and infiltration chambers are stone-filled trenches or galleries that are constructed below grade within residential yards, under parking lots, parks or sports fields. Typically these LID's store and infiltrate runoff discharged from rooftop areas via a downspout or swale. Note that many <u>open bottomed</u> pre-manufactured systems would be classified as sub-set of soakaway pits and infiltration chambers and are considered LID.

Bioretention Systems / Rain Gardens

Bioretention systems are landscaped areas which capture, temporarily store, and treat stormwater runoff by passing it through engineered soil filter media. The primary component of a bioretention cell is the filter bed with a mixture of sand, soil, and organic material as filtering medium. Pre-treatment, such as a settling forebay or grass filter strip, precedes the filter bed to remove particles that would otherwise clog the filter bed. Within Area 47, this LID is most applicable to future employment land uses where the systems can be worked into the landscaping to treat runoff from parking areas.

This LID can also be used in residential land uses in the form of rain gardens, however, long-term ponding of stormwater within residential lots is often discouraged. Consideration may be given to using this LID method within residential development areas if the systems are located in the front yard along the boulevard.

Depending the on native soils, a bioretention system may include an underdrain which conveys the filtered stormwater to the storm drain system.

Filter (Buffer) Strips

Vegetated filter strips are gently sloping vegetated areas that treat runoff as sheet flow from adjacent impervious surfaces. This LID functions by slowing runoff velocities, filtering suspended sediment, and allowing some infiltration into the underlying soils.

Within the Area 47 study area, filter strips may be used within the future employment lands as a pre-treatment practice for parking lot runoff before it is conveyed into adjacent biofilter or grassed swale systems. The filter strips also provide a convenient area for snow storage and treatment. Salt tolerant plantings should be used.

Permeable Pavement

Permeable pavement systems are an alternative to traditional impervious pavements which allow stormwater to drain through into a stone reservoir where it is infiltrated into the native soil. They can be used for low traffic roads, parking lots, driveways and paths. There are several forms of this LID:

- permeable interlocking concrete pavers;
- plastic or concrete grid systems;
- pervious concrete; and
- porous asphalt

This type of LID is most applicable to employment land uses where the systems can be used to take advantage of the large impervious parking areas and where pervious landscaped areas are limited. These systems can also be used for residential driveways.

Depending the on the native soils, permeable pavement systems may include an underdrain which conveys the filtered stormwater to the storm drain system.

4.2.3 Rainbow Creek Tributary Corridor Modification

As previously noted, the existing Rainbow Creek stream corridor lacks a defined valley feature over most of its reach, has poor channel definition and very little riparian cover other than meadow grasses. Because of the lack of a valley feature, the Regulatory Storm floodplain is very wide and shallow in places and impacts the existing industrial development on Cadetta Road

Generally, as prescribed by municipal and watershed policies, development is to be setback from the greater of the following: 10 m from the long term stable top of slope, stable toe of slope, Regional Storm floodplain, meander belt, and contiguous natural features and areas that contribute to the conservation of land. Under existing conditions, the Rainbow Creek stream corridor would be defined as 10m inland from the Regional Storm floodplain, including a vertical freeboard of 0.5 meters that can be achieved as a result of natural grades within the 10m buffer and/or grading associated with development at the edge of the 10m buffer. Given the existing Greenfield land base associated with the Rainbow Creek Tributary corridor, this is the City of Brampton and TRCA's preferred NHS option.

However, during the course of the study, the Landowners Group have proposed an option to reconfigure / modify the Rainbow Creek Tributary corridor to achieve land use efficiencies, and to provide opportunities to improve both the stormwater servicing and natural heritage system within the future landscape.

In order for the City of Brampton and TRCA to consider corridor modifications and associated grading works this study will need to demonstrate that:

- Acceptable justification has been provided at a subwatershed scale through the completion of a comprehensive environmental study (i.e. MESP/EIR);
- The modifications have been evaluated on a valley or stream corridor reach basis; and

- The modifications are acceptable and the control of flooding, erosion, pollution and the conservation of land will not be affected.

A preliminary design concept for the restoration and enhancement works, together with environmental objectives and design targets are discussed in greater detail in **Section 6.**

4.2.4 Watercourse Crossings

Future development of the Area 47 lands will include the construction of both new roadways and widening improvements to existing roadways, and an on and off Road pathways system. As a result, new bridge/culvert stream crossing structures and pedestrian bridges will be required where the road and trail networks cross the study area streams.

The future crossing improvements represent opportunities to reduce existing flood hazards, remediate existing channel morphology impacts, improve fish and wildlife passage, and provide for active transportation. The future design of road crossings should consider TRCA's draft Road Crossing Guidelines document. Design requirements to be considered include the following:

- Hydraulic requirements – the crossings should be sized to meet the City's criteria for capacity and/or frequency of flooding based on the road classification (i.e. arterial, collector, etc.). For example, arterial roads are to be flood-free;

- Floodplain impacts – future EA studies in support of road designs will be required to provide modelling to define the minimum hydraulic sizes for the proposed crossings that have a zero increase in upstream and/or downstream flood levels.;

- For new crossings on the Rainbow Creek Tributary at Coleraine Drive and Countryside Drive, the structures should be designed to eliminate the potential for spill of floodwaters that currently exist at these locations, as well as restoration of the recently re-aligned stream at Coleraine Drive;

- Stream morphology – the crossings should be sized to allow for ongoing morphologic processes and include appropriate sized natural stone to prevent scouring, where necessary. TRCA's Road Crossing Guidelines document should be considered, including requirements to span erosion hazards;

- Fish and wildlife passage – the crossings should consist of open-bottom structures with a defined low-flow channel to allow for fish passage. The crossings should also provide sufficient overbank area to allow for small wildlife passage. A minimum crossing width of two times the bankfull channel width is suggested; and

- Pedestrian trail access – where feasible, with regard to the bridge/culvert design, trails should be designed to go under road crossing structures.

The locations of anticipated new watercourse crossing structures are illustrated on Figure 4.4. Future block planning will build on the Community Design framework plan (Figure 1.3) to specifically locate the pathway system within and across the valley corridors.

4.2.5 Summary: Proposed Stormwater Management and Drainage Recommendations

The stormwater management and drainage recommendations developed for the Area 47 study area follow the concept of a "treatment train" approach to control and release of stormwater runoff from the future development lands while also taking advantage of opportunities to provide additional environmental benefits. The key components of the strategy were illustrated conceptually in Figure 4.4 and include:

- 5mm of rainfall for all impervious surfaces is to be retained on-site and treated using LID source and conveyance control measures to mitigate water balance impacts, and to provide water quality, erosion control and environmental benefits.

- Design of LID swales (rear/side lot bioswales or valley slope swales) connected to the natural heritage system to mitigate the loss of headwater drainage features;

- End-of-pipe stormwater management ponds with permanent pool and extended detention storage for water quality, erosion control, and flood (quantity) control;

- Corridor restoration and grading works on the Rainbow Creek Tributary valley to enhance the environmental quality of the corridor, reduce existing flood impacts, and to improve the ability to outlet adjacent stormwater facilities (see also **Section 6**); and

- Adequately sized future roadway crossing structures to allow for flood conveyance and improved fish/wildlife passage.

The respective benefits and stormwater/drainage design targets for each of these measures are summarized in **Table 4.5**.

Table 4.5: Summary of Stormwater Management Strategy Components for the Area 47 Lands

Components:	Groundwater Resources	Water Quality	Erosion/Flood Control	Aquatic/Terrestrial Resources
Low Impact Development (LID) Source and Conveyance Controls:				
Targets:	- 5mm of of rainfall for all impervious surfaces to be retained on-site and treated using LID measures. - several LID options exist to meet target. LID bioswales may serve dual purpose of meeting 5mm retention target and mitigating loss of HDFs. - replicate function of HDFs to be removed - see Table 4.4 for target lengths to be mitigated through use of LID swales connected to the NHS. - options include: network of rear/side yard LID bioswales outletting to valleys or protected HDFs, and/or creation of valley slope swales outletting to pocket wetlands. - location within public lands is preferred over private lands.			
Benefits:	- minimize changes to existing site and feature-based water balance and groundwater recharge rates;	- improved water quality through removal of suspended sediments and associated contaminants	- reduced stormwater runoff volumes and corresponding reduction in erosion potential	- protect baseflows and improved water quality - opportunity to continue supply of nutrients to valley watercourses
End-of-Pipe Stormwater Management Ponds				
Targets:		- Level 1 (Enhanced) water quality control – see Table 4.3 for targets based on land use /imperviousness	- extended detention to capture and release runoff from 25mm event over 48 hours (main watercourse valleys) or 120 hours (HDFs). - post-to-pre runoff control for flooding. - see Table 4.3 for storage and release rate targets	
Benefits:		- improved water quality through settling and capture of suspended contaminants	- prevent increased rates of flooding and erosion in downstream receiving streams.	- improved water quality
Watercourse Crossing Structure Improvements				
Target / Works:			- refer to TRCA draft Road Crossing Guidelines - size openings to meet the city's criteria for capacity and/or frequency of flooding based on the road classification - size openings to prevent increases to existing flood levels - sizing to consider clearance requirements for trails	- refer to TRCA draft Road Crossing Guidelines - open bottom culvert designs with defined low-flow channel - minimum opening of two times the bankfull width
Benefits:			- potential to eliminate existing spills on Rainbow Creek at Coleraine Drive and Countryside Drive	- improved fish and wildlife passage
Rainbow Creek Stream Restoration and Grading Works				
Targets: Benefits:	(Refer to **Section 6** for details)			

5 NATURAL HERITAGE SYSTEM IMPACTS, MITIGATION AND MANAGEMENT RECOMMENDATIONS

The proposed land uses illustrated in **Section 1.2** have the potential to impact the natural heritage features within and adjacent to the general subwatershed study area. Impacts may result from direct loss of natural features and functions as a result of the development of the secondary plan area (e.g. construction activities such as clearing grading, infrastructure such as road, water and waste water servicing) or direct and indirect activities as a result of the future community (e.g. occupancy issues such as encroachment, dumping of waste material, creation of unauthorized trails, pets, etc.).

Sections 4.6.6.20 and 4.6.6.21 of the City of Brampton's Official Plan state that the City will strive to achieve no net loss of natural heritage features and areas, and will seek to achieve a net gain where possible. Removal of natural heritage features are to be avoided and can only occur when justified through an appropriate study (e.g. a subwatershed study, Environmental Implementation Study, etc.). Furthermore, in accordance with Policy 4.6.6.29 (ii), when considering development proposals, the City of Brampton will consider the protection, enhancement, or restoration of wildlife habitat, including streams, ponds, marshes, valleylands, and woodlands. The following section outlines the specific and potential impacts associated with the development of the study area with respect to the following environmental categories:

- Natural Heritage System Impacts
- Species at Risk
- Significant Flora
- Significant Fauna
- Fisheries and the Aquatic Environment

The potential impacts as described below for each of the general categories listed above are associated with the proposed development of new residential, commercial, institutional, parkland, and industrial business park land uses; including transportation infrastructure within the Area 47 subwatershed Study Area.

5.1 Natural Heritage System Impacts

The following potential impacts relate largely to the impacts associated with road infrastructure and land use changes associated with development (adapted from TRCA, 2004):

- Direct loss of floral and faunal habitat;
- Reduced species richness and abundance;
- Soil compaction along the forest edge resulting from vehicle and machinery operations;
- Reduced stability of landforms composed of unconsolidated material;
- Increased windthrow along forest edges;
- Tree/shrub root stress and possible decline as a result of re-grading/fill placement along forest edges;
- Loss of canopy cover/shade, resulting in an increase in light penetration;
- Sunscald and frost cracking on trees with thinner bark due to changes in light penetration, which weaken tree defences;
- Changes in forest microclimates (increased temperatures, decreased soil moisture) resulting in desiccation;
- Greater susceptibility to invasion by non-native species, pathogens, etc.;
- Changes in drainage which may affect aquatic and wetland habitats; and
- Loss of native seed bank.

Despite the retention of the majority of the natural features on the landscape, without the implementation (and in some cases, enforcement) of mitigation measures, development may potentially impact the features and functions of the NHS. Parts of the Area 47 NHS proposed for removal include select tableland features (including wetlands, ponds, hedgerows and other vegetation) and areas of road crossings SWM pond outfalls. The specifics of these impacts, including area calculations, are detailed below, as well as opportunities to address net ecological benefits to the NHS.

As previously noted, Brampton's Pathways System links the city's natural and built environments and is critical infrastructure to support active transportation, connect neighbourhood and reduce the use personal vehicles. Many of the City's trails go through valley and watercourse corridors, and trail planning and design must include but is not limited to; conserving ecological features and functions, bridge crossings, site drainage, viewscapes, accessibility, safety, visibility, aesthetics, sustainability, and maintenance.

5.1.1 Mitigation of Natural Heritage Features Proposed for Removal

The following subsection provides a detailed account of the natural heritage features that are proposed for removal. **Table 5.1**, **Table 5.2**, and **Table 5.3** details those features proposed for removal /partial removal, the area of these features, an overview of the features' ecological functions, and recommendations for mitigation of natural features and functions. Excluded from the aforementioned tables is cultural meadow habitat. As was done in the assessment of natural cover for the proposed realigned Rainbow Creek corridor, meadow communities were excluded from the analysis due to their transitional nature. It is assumed that the loss of meadow communities will be addressed by the forthcoming Species at Risk mitigation plan. A summary of the post-development status of ELC communities within the study area is contained within

Table 5.4**Table 5.4**. Proposed natural heritage feature losses are illustrated in **Figure 5.1**.

Modifications of the proposed Rainbow Creek corridor are included in **Table 5.3** to aid reviewers in identifying the full extent of loss to the natural heritage system, and to emphasize how natural features and functions will be mitigated in the Rainbow Creek catchment area and/or elsewhere in the secondary plan area.

An analysis of potential hedgerow removals is not included, as the final outcome of the vegetation assessment and mitigation requirements will be determined at a subsequent planning stage (e.g. Block Plan). The calculations below assume that road crossings within valleys will consist of bridge crossings. Accordingly, the area calculations in **Table 5.1, Table 5.2,** and **Table 5.3** exclude lands within the NHS associated with valley crossings.

Unless otherwise noted, compensation for natural heritage features lost in a given tributary corridor is to be provided for within the same catchment. That is, mitigation for lost natural heritage features adjacent to the Gore Road Tributary should occur within lands adjacent to the Gore Road Tributary, etc. Where possible, to retain hydrologic contributions to natural heritage features within valley systems, it is recommended that wetland and pond mitigation/restoration occur within their respective catchments provided the extant catchment is hydrologically connected to a tributary corridor. Where the wetland's or pond's catchment is not hydrologically connected to a valley feature, the recommended location for the compensation wetland or pond defaults to the feature's respective tributary corridor.

Potential locations for restoration, including but not necessarily limited to areas for mitigating the loss of natural features, is provided in **Figure 5.2**. The figure is intended to guide the restoration/mitigation process, and is not necessarily prescriptive. The goal is to reach a balance between the proposed land uses and overall ecologic benefit to the NHS. As such, suggested restoration areas are concentrated in peninsulas of land surrounded on three sides by NHS, and areas near SWM ponds and proposed wildlife corridors. Restoration and mitigation/compensation is to be developed in consultation with the City of Brampton and the TRCA as part of the Block Plan and/or Site Plan stage.

Table 5.1: Tableland Natural Heritage System Features and Proposed Removals and Mitigation Measures - West Humber Tributary and Robinson Tributary

West Humber Tributary					Robinson Tributary				
NHS Feature # and Size/Length (ha/m)		**Features/Functions to Conserve/Enhance**	**Proposed Removal (ha/m)**	**Proposed Mitigation†**	**NHS Feature # and Size/Length (ha/m)**		**Features/Functions to Conserve/Enhance**	**Proposed Removal (ha/m)**	**Proposed Mitigation†**
Woodlands and Plantations									
77	0.27	Winter cover for wildlife.	0.27	Replacement woodland to include large proportion of coniferous trees to provide winter wildlife cover. In consideration of the habitat needs of Redside Dace, it is recommended that woodland replacement occur within the Gore Road Tributary and not the West Humber.	**11**	0.36	Habitat for common species such as American toad and groundhog; fallen logs and snags present.	0.36	Replacement woodland to include fallen logs and habitat for resident amphibians in restored deciduous riparian woodland within Robinson Creek corridor. Woody cover will benefit water quality. Given the limited space in the Robinson Creek corridor, it is recommended that a portion of the area required for restoration be accounted for in enhancements to the tableland woodland in the Rainbow Creek corridor (ELC 14).
		Subtotal:	*0.27*				*Subtotal:*	*0.36*	
Wetlands									
26	0.43	Cattail marsh adjacent to meadow.	0.43	Replace with marsh adjacent to meadow amphibian foraging habitat, preferably associated with the Gore Road Tributary NHS (restoration opportunities within the West Humber Tributary are limited).	**12***	0.25	Marsh surrounded by meadow. Habitat for common species such as American toad and song sparrow.	0.25	Robinson Creek is isolated from other NHS features, and thus it is not desirable to create habitat to *attract* wildlife to the area (resident wildlife will be sustained and benefited from extant wetland communities and proposed woodland cover outlined in 11, above). It is thus recommended that mitigation for communities 12*, 23, and 101 occur adjacent to one of the three major tributaries in the study area.
					23*	0.20	Wetland complex with forb meadow marsh and cattail shallow marsh amongst meadow. Evidence of use by mammals, amphibians, and avifauna.	0.10	
					101	0.02	Isolated cattail shallow marsh surrounded by agricultural field.	0.02	
		Subtotal:	*0.43*				*Subtotal:*	*0.37*	
Ponds									
N/A					**N/A**				
Mid-Successional Communities (cultural thicket and cultural savannah)									
N/A					**N/A**				
HDFs									
N/A					**N/A**				
Total Natural Heritage Features Proposed for Removal			**0.70 ha**		Total Natural Heritage Features Proposed for Removal			**0.73 ha**	
Total HDF Length Proposed for Removal			**0 m**		Total HDF Length Proposed for Removal			**0 m**	

† Per the City of Brampton's policies, there is to be no net loss of NHS features. As such, proposed mitigation assumes a 1:1 area replacement ratio for NHS features proposed for removal. Furthermore, it is recommended that compensation for lost tableland features occur within tablelands adjacent to the NHS.

Table 5.2: Tableland Natural Heritage System Features and Proposed Removals and Mitigation Measures – Gore Road Tributary and Clarkway Tributary

Gore Road Tributary					Clarkway Tributary				
NHS Feature # and Size/Length (ha/m)		**Features/Functions to Conserve/Enhance**	**Proposed Removal (ha/m)**	**Proposed Mitigation†**	**NHS Feature # and Size/Length (ha/m)**		**Features/Functions to Conserve/Enhance**	**Proposed Removal (ha/m)**	**Proposed Mitigation†**
Woodlands and Plantations									
76	0.25	Coniferous plantation with limited ecologic function.	0.25	Creation of conifer-dominated woodland that provides winter wildlife cover. Could be part of east-west woodland linkage enhancement.	**80**	0.13	White pine coniferous plantation with some wet pockets.	0.13	Creation of conifer-dominated woodland/swamp that provides winter wildlife cover. A tableland location adjacent to ELC Polygons 3 and 4 of the Clarkway Tributary should be considered.
		Subtotal:	*0.25*				*Subtotal:*	*0.13*	
Wetlands									
73 north‡	0.44	Forb mineral marsh along HDF Gore 2-3.	0.44	Replicate function as it relates to HDF Mitigation 1. Investigate opportunities for tableland wetland creation near protected HDFs to enhance 2˚ inputs to watercourses.	**60***	0.03	Meadow marsh within a cultural meadow.	0.03	To be included in tableland areas adjacent to NHS wetlands as an amphibian habitat enhancement feature.
73 south‡	0.45	Forb mineral marsh along HDF Gore 0.	0.45	As communities 73(south), 74, 100, & 107 are in close proximity to one another, their mitigation is treated collectively to allow for greater ecological benefit to the NHS. It is recommended that a minimum 0.51 ha wetland complex consisting of a pond with adjacent swamp and meadow marsh be created adjacent to the NHS. Suggested primary target species include northern leopard frog; secondary target species include avifauna and chimney crayfish. In addition, it is recommended that resident amphibians from ponds be transferred to this or other suitable habitat within the NHS.	**69***	0.04	Isolated shallow cattail marsh surrounded by meadow. Limited ecologic function.	0.04	
74	0.02	Isolated cattail dominated irrigation pond.	0.02		**78**	0.03	Irrigation pond, cattail shallow marsh. Limited ecologic function.	0.03	As communities 81, 78, 85, 86, 105, 106, & 108 are in close proximity to one another and isolated from valleys, their mitigation is treated collectively. Community 102 is included as it is assumed that a larger habitat will benefit muskrat, and the species' habitat needs overlap with those of belted kingfisher. Mitigation recommendations include the creation of min 0.75 ha pond surrounded by deciduous swamp in an area adjacent to NHS. Pond is to provide habitat for belted kingfisher and muskrat (e.g. pond with adjacent exposed banks and aquatic vertebrate/invertebrate prey) and amphibians. Pond should be deep enough to allow for amphibian hibernation. Open water may also provide foraging
100	0.02	Isolated farm pond dominated by duckweed.	0.02						
107	0.04	Isolated farm pond dominated by cattails; confirmed habitat for northern leopard frog (L3).	0.04		**81**	0.05	Willow swamp on edges of farm pond; habitat for belted kingfisher.	0.05	
98	0.02	Willow swamp on edges of farm pond.	0.02	Creation of swamp habitat adjacent to NHS. Aquafor suggests the wet area between ELC 96 and ELC 58 as candidate area for swamp restoration.	**85**	0.48	Reed canary grass meadow marsh with limited ecologic function.	0.48	

Gore Road Tributary					Clarkway Tributary				
NHS Feature # and Size/Length (ha/m)		Features/Functions to Conserve/Enhance	Proposed Removal (ha/m)	Proposed Mitigation†	NHS Feature # and Size/Length (ha/m)		Features/Functions to Conserve/Enhance	Proposed Removal (ha/m)	Proposed Mitigation†
					86	0.07	Willow swamp on edges of farm pond.	0.07	opportunities for barn swallow.
					102	0.02	Duckweed-dominated shallow aquatic community with resident muskrat.	0.02	
					105	0.02	Mineral thicket swamp along edge of ELC polygon 106.	0.02	
					106	0.02	Pondweed mixed shallow aquatic community surrounding deep pond.	0.02	
					108	0.06	Cattail marsh in pond surrounded by trees.	0.06	
		Subtotal:	*0.99*				*Subtotal:*	*0.82*	
Ponds									
GP-7 (ELC 75*)	0.02	Cattail mineral shallow marsh provides breeding habitat for amphibians.	0.02	Opportunity exists for amphibian habitat creation in lands adjacent to the NHS. It is recommended that the loss of these ponds be mitigated by the creation of a minimum 0.04 ha of wetland/ponds conducive to amphibian breeding. Wildlife relocation may be necessary.	**CP-5**	0.03	Excavated livestock pond with limited ecologic function.	0.03	It is recommended that a minimum 0.03 ha pond be created in tablelands adjacent to wetland complexes within the NHS as a means of enhancing the ecologic function of the small wetlands within the Clarkway Tributary corridor.
GP-8	0.02	Pond was not assessed due to land access denial.	0.02						
		Subtotal:	*0.04*				*Subtotal:*	*0.03*	
Mid-Successional Communities (cultural thicket and cultural savannah)									

Gore Road Tributary					Clarkway Tributary				
NHS Feature # and Size/Length (ha/m)		**Features/Functions to Conserve/Enhance**	**Proposed Removal (ha/m)**	**Proposed Mitigation†**	**NHS Feature # and Size/Length (ha/m)**		**Features/Functions to Conserve/Enhance**	**Proposed Removal (ha/m)**	**Proposed Mitigation†**
61	0.19	Sugar maple dominated cultural savannah with limited ecologic function.	0.19	Replicate savannah habitat with rich native understory. Could be appropriate in lands adjacent to valleys connected by east-west woodland linkage as a means of attracting wildlife.	**97**	0.50	European buckthorn dominated thicket with little ecologic function.	0.25	Adjacent to the Clarkway Tributary NHS, restore entire thicket habitat using native shrubs, preferably those which produce fruit. This restoration initiative could be an opportunity for propagating silky dogwood (locally rare) from stock originating from hedgerow H19.
		Subtotal:	*0.19*				*Subtotal:*	*0.25*	
HDFs									
Gore 3	323 (Mit. 1) + 2599 (Mit. 2)	Primary (i.e. water quantity) and secondary (e.g. leaf litter, insects, etc.) inputs into watercourse.	2922	To be mitigated through creation of equivalent length of LID swales (e.g bioswales and/or valley slopes swales connected to NHS).	**Clarkway 2**	58 (Mit. 1) + 387 (Mit. 2)	Primary (i.e. water quantity) and secondary (e.g. leaf litter, insects, etc.) inputs into watercourse.	445	To be mitigated through creation of equivalent length of LID swales (e.g bioswales and/or valley slopes swales connected to NHS).
Gore 4	218 (Mit. 2)		218		**Clarkway 4**	735 (Mit. 1)		735	
Gore 7	309 (Mit. 2)		309		**Clarkway 5a**	10 (Mit. 1) + 84 (Mit. 2)		94	
Gore 8	1320 (Mit. 1)		1320		**Clarkway 5b**	548 (Mit. 2)		548	
					Clarkway 6	10 (Mit. 1) + 265 (Mit. 2)		275	
		Subtotal:	*4769*				*Subtotal:*	*2097*	
Total Natural Heritage Features Proposed for Removal			**1.46 ha**		Total Natural Heritage Features Proposed for Removal (ha)			**2.03 ha**	
Total HDF Length Proposed for Removal (m)			**4769 m**		Total HDF Length Proposed for Removal (m)			**2097 m**	

† Per the City of Brampton's policies, there is to be no net loss of NHS features. As such, proposed mitigation assumes a 1:1 area replacement ratio for NHS features proposed for removal. Furthermore, it is recommended that compensation for lost tableland features occur within tablelands adjacent to the NHS.

‡ It was agreed through meetings with the regulatory agencies that ELC Polygons 74 south and 74 north, which are located along HDFs scheduled for removal, would not be included in natural cover statistics nor would they be candidates for NHS cover mitigation/replacement. Accordingly, their combined area (0.89 ha) has not been included in the calculations shown in Tables 3.8, 5.4, 6.6, 6.8, or 7.1. The Polygons are included in Table 5.2 above for information purposes only.

Table 5.3: Tableland Natural Heritage System Features and Proposed Removals and Mitigation Measures – Rainbow Creek Tributary and Proposed Rainbow Creek Corridor

Rainbow Creek Tributary					Proposed Realigned Rainbow Creek Corridor				
NHS Feature # and Size/Length (ha/m)		Features/Functions to Conserve/Enhance	Proposed Removal (ha)	Proposed Mitigation†	NHS Feature # and Size/Length (ha/m)		Features/Functions to Conserve/Enhance	Proposed Removed‡ (ha)	Proposed Mitigation
Woodlands									
N/A					**82**	0.11	Small coniferous plantation adjacent to riparian area has minor contributions to water quality in Rainbow Creek, as well as provision of winter wildlife cover.	0.11	Mitigation for woody cover will be achieved through extensive restoration throughout the proposed Rainbow Creek corridor, as detailed in **Section 6**.
							Subtotal:	*0.11*	
Wetlands (excluding ponds)									
89*	0.05	Mineral meadow marsh dominated by invasive species (phragmites) and surrounded by meadow.	0.05	Mitigation to include creation of wetland/pond in combination with mitigation measures for ELC 92 & 93 (0.14 total ha). Disposal of invasive species (incl. roots) off-site is recommended.	**13**	0.58	Meadow marsh dominated by reed canary grass; ecologic function likely limited to hydrology.	0.58	Mitigation for wetland losses will be achieved through extensive restoration throughout the proposed realigned Rainbow Creek corridor, as detailed in **Section 6**. Additional mitigation considerations include: the transplant/rescue of rare flora and fauna to suitable habitats within the Rainbow Creek corridor; and the removal of invasive species (including roots), with off-site disposal.
					16 & 16*	0.9	Intermittent marsh swale provides habitat for rare fauna (i.e. chimney crayfish).	0.9	
					37	0.13	Meadow marsh dominated by reed canary grass is connected to habitat for rare fauna (ELC 38).	0.13	
					38	0.13	Meadow marsh dominated by reed canary grass is habitat for rare fauna (i.e. northern leopard frog).	0.13	
					39	0.29	Riparian shallow marsh is habitat for rare fauna (i.e. northern leopard frog).	0.29	
					50	6.96	Reed canary grass meadow marsh covers extensive riparian area. Ecologic function primarily related to hydrology, though is also habitat for rare flora (i.e. dotted watermeal, Freeman's maple, & amethyst aster).	6.96	

Rainbow Creek Tributary					Proposed Realigned Rainbow Creek Corridor				
NHS Feature # and Size/Length (ha/m)		**Features/Functions to Conserve/Enhance**	**Proposed Removal (ha)**	**Proposed Mitigation†**	**NHS Feature # and Size/Length (ha/m)**		**Features/Functions to Conserve/Enhance**	**Proposed Removed‡ (ha)**	**Proposed Mitigation**
					52	1.21	Dredged swale dominated by agricultural grasses. Evidence of use by common bird species, coyote, and American toad. Partially located within an industrial development.	1.21	
					53	0.42	Riparian shallow cattail marsh.	0.42	
					83	0.03	Cattail mineral shallow marsh on edge of farm field with little ecologic function.	0.03	
					89*	0.05	Mineral meadow marsh dominated by invasive species (phragmites) and surrounded by meadow.	0.05	
			Subtotal:	*0.05*				*Subtotal:*	*10.70*	
Ponds									
ELC 92	0.02	Isolated cattail marsh is habitat for rare flora (i.e. great duckweed).	0.02	It is recommended that mitigation include the creation of wetland/ponds that will provide suitable habitat for the rare species present in communities 92 & 93 and amphibians. Mitigation is to include transplanting of rare species to created pond or suitable extant habitat elsewhere in the NHS.	**RP-1 (ELC 103)**	0.04	Floating-leaved shallow aquatic ecosystem is habitat for rare flora (i.e. dotted watermeal).	0.04	It is recommended that mitigation measures include the creation of offline ponds or pond within the floodplain. Pond(s) should be able to support amphibian breeding. Dotted watermeal should be transplanted to an area where it would not get washed downstream during a flood event (see mitigation notes for ELC 92 & 93).
ELC 93	0.07	Isolated shallow marsh is habitat for rare flora (i.e. flat-stemmed pondweed).	0.07		**RP-3 (ELC 38)**	0.22	Ecologic function limited to hydrology; pond is within floodplain.	0.22	
					ELC 92	0.02	Isolated cattail marsh is habitat for rare flora (i.e. great duckweed).	0.02	It is recommended that mitigation include the creation of wetland/ponds that will provide suitable habitat for the rare species present in communities 92 & 93 and amphibians. Mitigation is to include transplanting of rare species from ELC 92, 93 & 103 to a created pond or suitable extant habitat elsewhere in the NHS. It is suggested that the created pond(s) be located near ELC 87.
					ELC 93	0.07	Isolated shallow marsh is habitat for rare flora (i.e. flat-stemmed pondweed).	0.07	
			Subtotal:	*0.09*				*Subtotal:*	*0.35*	
Mid-Successional Communities (cultural thicket and cultural savannah)									
N/A					**N/A**				

Rainbow Creek Tributary					Proposed Realigned Rainbow Creek Corridor				
NHS Feature # and Size/Length (ha/m)		**Features/Functions to Conserve/Enhance**	**Proposed Removal (ha)**	**Proposed Mitigation†**	**NHS Feature # and Size/Length (ha/m)**		**Features/Functions to Conserve/Enhance**	**Proposed Removed‡ (ha)**	**Proposed Mitigation**
HDFs									
Rainbow 6	40 (Mit. 1) + 300 (Mit. 2)	Primary (i.e. water quantity) and secondary (e.g. leaf litter, insects, etc.) inputs into watercourse.	340	To be mitigated through creation of equivalent length of LID swales (e.g. bioswales and/or valley slopes swales connected to NHS).	**Rainbow 4**	252 (Cons. 2)	Primary (i.e. water quantity) and secondary (e.g. leaf litter, insects, etc.) inputs into watercourse.	252	To be mitigated through creation of equivalent length of LID swales (e.g bioswales and/or valley slopes swales connected to NHS).
Rainbow 7	1069 (Mit. 2)		1069		**Rainbow 6**	40 (Mit. 1) + 300 (Mit. 2)		340	
Rainbow 8	698 (Mit. 2)		698		**Rainbow 7**	1069 (Mit. 2)		1069	
Rainbow 9	672 (Mit. 2)		672		**Rainbow 8**	698 (Mit. 2)		698	
					Rainbow 9	672 (Mit. 2)		672	
		Subtotal:	*2779*				*Subtotal:*	*3031*	
Total Natural Heritage Features Proposed for Removal			**0.14 ha**		Total Natural Heritage Features Proposed for Removal			**11.20 ha**	
Total HDF Length Proposed for Removal			**2779 m**		Total HDF Length Proposed for Removal			**3031 m**	

† Per the City of Brampton's policies, there is to be no net loss of NHS features. As such, proposed mitigation assumes a 1:1 area replacement ratio for NHS features proposed for removal. Furthermore, it is recommended that compensation for lost tableland features occur within tablelands adjacent to the NHS.

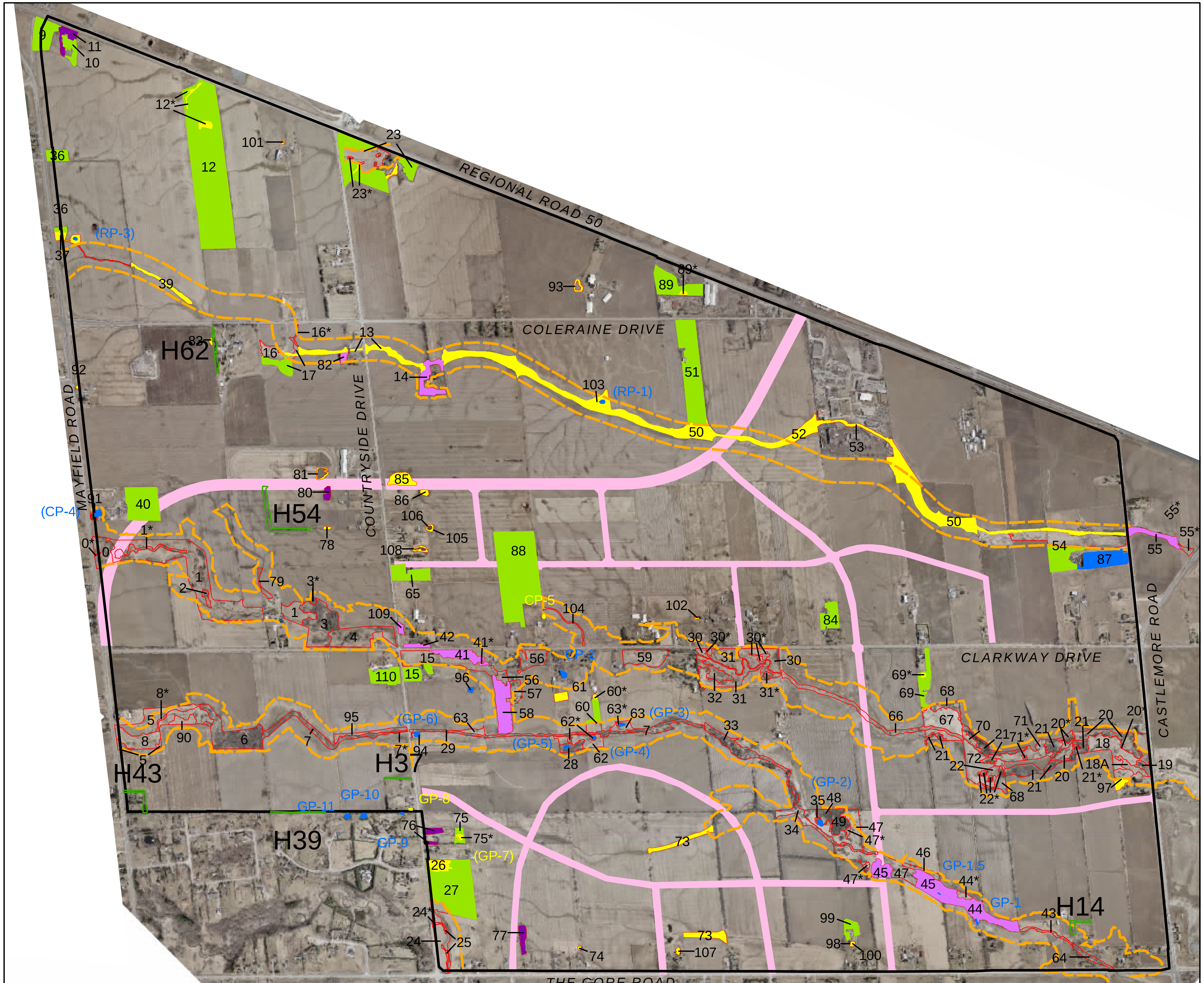
‡ Includes features outside of the proposed realigned corridor as well as features within the realigned corridor that will be impacted by the proposed works.

Table 5.4: Post-development Status of Vegetation Communities within the Entire Study Area

Vegetation Community Type	Post-Development Status of Vegetation Communities within the Study Area			Total Area of Natural Features Proposed for Removal
	Retained	Partially Retained	Removed	
Woodland/forest/ plantation	ELC Polygons 3, 14, 41, 42, 44, 45, 55, 58, 82 & 109. (7.78 ha total)	n/a	ELC Polygons 11, 76, 77, & 80. (1.01 ha total)	**1.01 ha**
Wetland: swamp †	ELC Polygons 2, 3*, 7, 19, 20*, 22*, 29, 35/CP-2, 62*/GP-4, 63*/GP-3, 64 & 71*. (3.78 ha total)	n/a	ELC Polygons 81 & 98. (0.07 ha total)	**0.07 ha**
Wetland: marsh, shallow aquatic, and ponds‡	ELC Polygons 0*, 1*, 7*, 8, 13, 16, 16*, 18A, 22, 24*, 25, 30*, 31*, 32, 34, 37, 38/RP-3, 39, 41*, 43, 46, 47*, 50, 52, 53, 55*, 67, 79, 83, 87, 91/CP-4, 92, 93, 94/GP-6, 96, 103/RP-1. Ponds GP-1, GP-1.5 & GP-2. (15.66 ha total)	ELC Polygon 23*. (0.04 ha)	ELC Polygons 12*, 23* (in part), 26, 60*, 69*, 74, 75*/GP-7, 78, 85, 86, 89*, 100, 101, 102, 105, 106, 107 & 108. Ponds CP-5 & GP-8. (1.84 ha total)	**1.84 ha**
Mid-successional Communities **	ELC Polygons 0, 4, 6, 20, 21, 21*, 28/GP-5, 31, 33, 48, 49, 57, 68 & 70. (15.04 ha total)	ELC Polygon 97. (0.31 ha)	ELC Polygon 61 and part of 97. (0.38 ha total)	**0.38 ha**
			Total:	**3.30 ha**

† Includes both deciduous treed swamp and deciduous thicket swamp.
‡ Does not include ELC Polygon 73 north and south (HDFs Gore 2-3 and Gore 0, 0.89 ha) or ponds that are adjacent to/outside of the study area (i.e. Ponds GP-9, GP-10, and GP-11). Note that these ponds are isolated from the greater NHS and were assessed as having minor ecological function (See **Table 3.3**).
** Includes both cultural thicket and cultural savannah. Meadow communities are not included.

Note that post-development as described in **Table 5.4** above <u>does not</u> account for the proposed realignment of the Rainbow Creek Corridor. Natural feature area statistics related to the proposed realignment are detailed below in **Section 6.3.**



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- HEDGEROWS TO PROTECT WHERE FEASIBLE
- STUDY AREA
- NATURAL HERITAGE SYSTEM
- WOODLANDS TO BE RETAINED
- WOODLAND/FOREST/PLANTATION TO BE REMOVED
- WETLAND/POND COMMUNITIES PROPOSED FOR REMOVAL
- TABLELAND WETLANDS/PONDS TO RETAINED
- TABLELAND MEADOWS
- VEGTATION COMMUNITIES
- PROPOSED ROADS

SCALE: 1:16,000

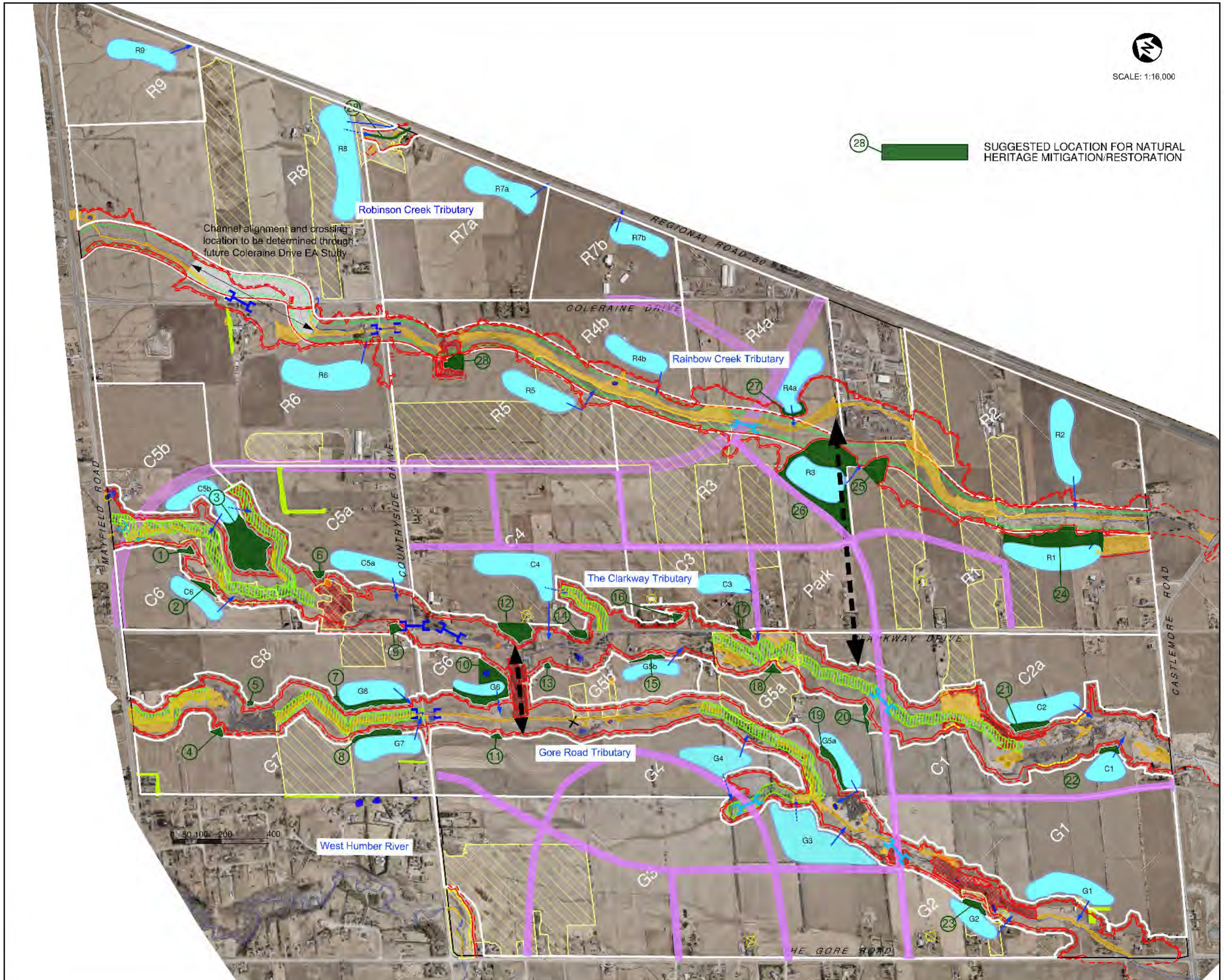
VEGETATION COMMUNITIES PROPOSED FOR REMOVAL

FIGURE 5.1

AQUAFOR PROJECT NO.: 64608

Aquafor Beech Limited

BRAMPTON Flower City brampton.ca



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

STUDY AREA
WATERCOURSE
PROPOSED ROAD

NATURAL HERITAGE STRATEGY

NO DEVELOPMENT

Protect Natural Heritage System:

STREAM/VALLEY CORRIDOR
SIGNITICANT WOODLANDS/WOODLOTS
WETLAND FEATURES TO BE RETAINED
AGRICULTURAL POND TO BE PROTECTED
NATURAL FEATURE BUFFERS

FUTURE STUDY TO ASSESS DEVELOPMENT/ PROTECTION STATUS

SAR HABITAT/NESTS
- MNR consultation

ECOSYSTEM PROTECTION/ENHANCEMENT

PROOSED 100m - 105m RAINBOW CREEK CORRIDOR RESTORATION AND ENHANCEMENT
HEDGEROWS TO PROTECT, WHERE FEASIBLE
RIPARIAN PLANTINGS
FISH BARRIER REMOVAL
WILDLIFE CORRIDORS

STORMWATER MANAGEMENT AND DRAINAGE

STORMWATER MANAGEMENT FACILITIES

STORMWATER MANAGEMENT POND
-Level 1 water quality control
-Erosion Control (25mm/48hrs)
-Post-to-Pre flood control

CATCHMENT BOUNDARY

LID Source and Conveyance Controls:
- 5mm retention over all development lands
- LID swales to mitigate loss of HDFs

DRAINAGE/ECOSYSTEM ENHANCEMENT

WATERCOURSE CROSSINGS IMPROVEMENTS
-- NEW
-- REPLACEMENT

SUGGESTED LOCATIONS FOR RESTORATION/MITIGATION ACTIVITIES
FIGURE 5.2

AQUAFOR PROJECT NO.: 64608

AquaforBeech Limited

BRAMPTON Flower City

5.1.2 Species at Risk

Terrestrial and Wetland Species

Six (6) terrestrial species at risk were observed in the study area: bobolink, eastern meadowlark, barn swallow, eastern wood-pewee, snapping turtle, and monarch butterfly. Discussions regarding the legal definition of species at risk habitat and legislative requirements of the Endangered Species Act (2007) can be found in **Section 1.4**. Management options are discussed in **Section 0**.

Potential and expected impacts associated with land development on these species include, but are not limited to:

Habitat Loss

Direct habitat loss as a result of land use change is perhaps the most direct impact associated with development. Meadows once used for breeding, foraging, roosting and other activities will no longer be suitable after conversion to urban uses. The removal of barns may reduce the number of suitable nesting sites for barn swallow, which rarely occupies more natural nesting sites (e.g. tree cavities) (Cadman et al., 2007).

Edge Effects

Alterations to forest community boundaries can initiate changes within forest edge habitat. Edge habitats tend to have greater light penetration, altered microclimatic regime, and are points of entry for invasive flora and fauna, and are often not suitable habitat. Such changes may adversely impact eastern-wood pewee habitat.

Road Mortality

Wildlife collisions with vehicles are common, and higher speeds may result in greater frequency of collisions. Snapping turtles are often killed crossing roads in the spring when seeking suitable nesting sites. Birds and butterflies also frequently collide with vehicles.

Trails

The planning and design of future trails adjacent to species at risk habitat will need to consider setbacks in accordance with MNRF requirements.

Auditory Impacts

Birds communicate through song to attract mates, establish breeding territories and/or signal a predator is nearby. Noise emanating from human settlements, particularly roads, may disturb birds leading to their abandonment of sites adjacent to urban areas. Songbird abundance has been shown to decline in the vicinity of chronic anthropogenic noise (Bayne et al., 2008).

Light Pollution

Both sunlight and starlight play a role in migratory cues that direct neotropical birds toward breeding destinations. Light pollution may disrupt these cues, resulting in collisions with lit buildings. In addition, urban lighting and "sky-glow" may facilitate predation by raccoons, opossums and other predators in urban environments.

Invasive Species

Landowners may unwittingly plant invasive species for landscaping purposes, and the seeds of these plantings can disperse into adjacent natural areas and proliferate. This may reduce insect (particularly caterpillar) abundances and diversity, which are typically not able to feed on non-native species. Invasive plants may also outcompete milkweed, thereby reducing suitable breeding sites for monarchs. In addition, domestic and feral cats are known to predate heavily on birds, and their numbers may increase in communities adjacent to residential areas.

Trail Use

Both authorized and unauthorized trail use may disrupt any of the above species at risk during sensitive periods in their life cycle, such as breeding or nesting.

Ecological Succession

Without active management (e.g. mowing, clearing) or other large-scale disturbances (e.g. fire), cultural meadows and cultural savannahs will eventually revert to forest communities. None of the grassland birds observed within the study area or the monarch butterfly have a particularly high tolerance for woody cover.

Persecution

Due to their occasional and perceived aggressive habit, snapping turtles are often persecuted by humans. It is also lawful in Ontario to hunt snapping turtles.

Aquatic Species (Redside Dace)

Potential and expected impacts associated with land development on redside dace (regulated and contributing habitat) includes, but is not limited to:

- ***Habitat loss*** **-** Overhanging and riparian vegetation is important both as a source of cover that shades the water and protects the redside dace from predators, and as habitat for the insects that redside dace eat. Removal of riparian vegetation could increase stream temperatures, result in a loss of cover and reduce the area considered suitable for insect reproduction. Habitat can also be impacted by anthropogenic activities such as encroachment. Changes in a watershed's flow regime can results in changes to in-channel structure (e.g., dimensions of riffles, pools, bankfull width) which support redside dace life processes. Decreases to groundwater inputs can reduce base flow, which negatively impacts redside dace.

- ***Siltation*** **-** Redside dace are specialized visual feeders. Their primary food consists of terrestrial insects, especially adult flies. Redside dace leap out of the water to obtain prey. An increase in siltation as a result of land use change (increased run-off; and subsequent erosion; decreased groundwater infiltration) may affect the ability of redside dace to see and capture their prey. Redside dace require gravel substrate and a combination of riffles and pools to carry out their life processes. Fine particles that settle out onto the stream bed may cover gravel and decrease pool depth.

- ***Water Quality*** **-** Exact physiological tolerances of Redside Dace to the key physical and chemical water quality parameters are not known. Although the tolerance of redside dace to pollutants is unknown, urban development poses the potential risk of exposing local populations to household chemicals and storm water run-off. The discharge of water from urban development stormwater management facilities into redside dace habitat should not exceed 25 mg/L of TSS above the background stream level of total suspended solids. Discharge temperatures for stormwater management facilities connected to redside dace streams should be below 24°C and have dissolved oxygen (DO) concentrations of at least 7 mg/L.

- ***Temperature*** **–** As a coolwater species, redside dace are sensitive to temperature increases caused by development activities such as vegetation clearing and SWM. The preferred temperature of Redside Dace is less than 24°C. Rising temperatures may also affect spawning, which occurs in spring when the water temperature reaches 16 to 18°C. Decreased groundwater inputs to the watercourse can also increase water temperautres. Some studies have suggested that the nutrient requirements of fish increase are positively correlated with water temperature increases (Heinonen, 1984). Thus, in addition to creating habitat conditions unsuitable for redside dace, temperature increases may also cause an increased need for feeding which could result in increased competition among all species of fishes.

Given the above potential impacts, the protection of habitat through an appropriate stream and valley corridor and associated buffers, as well as appropriate SWM facility design and ongoing maintenance, will be important to the protection of redside dace as well as other aquatic communities.

5.1.3 Significant Flora

There are 21 species of locally significant flora in the study area. See Figure 2.18 for the locations of these observations.

Apart from the wildlife-specific impacts (e.g. road mortality, auditory impacts and light pollution), potential and expected impacts associated with land development on these 21 plant taxa are similar to those outlined for species at risk, including but not limited to:

- Habitat Loss (including potential loss of dugout agricultural ponds harbouring flat-stemmed pondweed, dotted watermeal, and common coontail)
- Edge Effects
- Invasive Species
- Trail Use
- Ecological Succession

One additional impact is also noted:

- Habitat Degradation in response to Changes in the Hydrologic Regime

Many observations of significant flora were made along dry sections of the three tributaries (e.g. marsh purslane) or within the West Humber River in the northwest corner of the study area (e.g. giant bur-reed, long-leaved pondweed, flat-stemmed pondweed). Higher velocity flows, greater salt and nutrient loading, and siltation are typically associated with land development, which may negatively impact these aquatic species. The stormwater management recommendations, discussed in **Section** 4.2 above, include stormwater management controls, including LIDs in order to minimize impacts to these environmental resources.

5.1.4 Significant Fauna

There are six (6) species of locally significant fauna in the study area. Two (2) are ranked L2 (snapping turtle and chimney crayfish), and four (4) are ranked L3 (wood duck, great blue heron, leopard frog, yellow-bellied sapsucker). See Figure 2.19 for the location of these observations. Potential and expected impacts associated with land development on these six (6) significant fauna are consistent with those described for wildlife species at risk described in **Section** 5.1.2 including:

- Habitat Loss
- Edge Effects
- Road mortality
- Auditory Impacts
- Light Pollution
- Invasive species
- Trail use
- Persecution


Great Blue Heron

5.1.5 Fisheries and Aquatic Environment

In general, potential impacts on fisheries and the aquatic environment are associated with both long-term and short-term impacts from proposed land use changes, roads, watercourse crossings (bridges and culverts, surface and subsurface infrastructure) as well as general construction activities.

Potential Impacts may include, but are not limited to:

- Reductions in watercourse channel length resulting from culvert and bridge type crossings and the potential impacts to fish habitat and migration through the creation of fish barriers (impacts can vary based on the proposed structure – open-span bridge vs. culvert);
- Short-term disruption or long-term loss of riparian habitat from construction activities and watercourse crossings;
- Hydrologic impacts due to land use changes from agricultural to urban including changes to baseflows and flow rates;
- Sediment releases and thermal enrichment during construction activities such as general land clearing and grading, construction of infrastructure such as road, water and waste water servicing; and
- Water quality impacts resulting from non-point source pollution associated with runoff discharges from impervious surfaces

The stormwater management and drainage recommendations, discussed in **Section** 4.2 above, include stormwater controls, stream restoration works and culvert/bridge crossing improvements which all provide direct and indirect benefits to fisheries.

5.2 Natural Heritage System Management Recommendations

5.2.1 Management/Mitigation

The conversion of the existing mosaic of agricultural lands, headwater drainage features and cultural vegetation communities in the Area 47 lands to industrial, commercial and residential land uses has the potential to degrade the ecological features and functions of the recommended Natural Heritage System (NHS). The most effective measure for protecting the NHS is to avoid development and site alteration within the NHS itself and adhere to the buffer guidelines offered in **Section 3.9**. Where this isn't possible, a range of potential mitigation measures are listed below (adapted and expanded from TRCA, 2004 with suggestions from the City of Brampton):

Conservation:

- Direct development activities away from significant and/or sensitive natural heritage features and functions;
- Mitigate the loss of natural features (i.e. woodlands, wetlands, and ponds that provide significant wildlife habitat) on a 1:1 ha basis. Natural features created as compensation will be located and designed to improve NHS features, functions and linkages;
- Per Policy 5.4.1.2 of the Area 47 Secondary Plan, grading within buffers is generally not permitted. It is recommended that grading not be located next to sensitive NHS features and/or functions, and that grading within buffers be considered on a case-by-case basis by the relevant review agencies;
- Headwater drainage features and functions will be conserved, maintained and mitigated as determined through the application of TRCA's Evaluation, Classification and Management of Headwater Drainage Features Guidelines, January 2013.
- Retain natural drainage patterns;
- Retain shrubs and groundcover wherever possible;
- Retain stumps within 5 m of the new edge to allow for vegetative regeneration from the existing seed bank;
- Compensation planting (3:1) for the removal of tableland vegetation (i.e. trees and hedgerows);
- Develop and execute rescue plans for significant vegetation and wildlife found in features recommended for removal; and
- Retain dead or dying trees for wildlife benefit, provided there is no potential for property damage.

***Restoration / Enhancement*:**

- Prune shallow-rooted trees to avoid windthrow;
- Plant salt-tolerant species along the edges of parking lots and roads to mitigate the effects of salt spray and runoff on existing natural vegetation;
- Plant early-successional species along woodland edges to provide protection to woodland edges;
- Enhancement plans for hedgerows and wetlands to be protected;
- Ensure consistency with the City of Brampton's Woodlot Edge Management (724) and Woodlot Protection (725) design guidelines; and
- Discourage chemical fertilizer and pesticide use, especially in areas draining to natural areas or groundwater recharge areas.

Construction:

- Avoid construction staging areas adjacent to natural heritage features; Install sturdy, well-marked tree protection fencing at an appropriate distance past the dripline of retainable trees and include provisions for tree protection on design drawings; Encourage the use of the Bird-Friendly Development Guidelines (City of Toronto, 2007) in building design at the site plan stage;
- In-stream works should be minimized as much as possible and constrained to periods that are least sensitive to the resident fish community;
- In-stream and near-stream works should adhere to warmwater construction timing window of July 1st to March 31st; In-stream and near-stream work within the West Humber River will take place during the redside dace timing window of July 1st to September 15th;
- When possible, complete in-stream and crossing construction during dry conditions; When not possible, watercourse should be diverted around work area following a proper fish-rescue program;
- Construction staging areas should be located outside of the natural heritage system;
- All vehicle and machine fuelling and maintenance will be carried out a minimum of 30 metres from any watercourse; and,
- Construction phasing should be optimized in a manner in which all impacts can be mitigated.

Given that most of the ecological features are contained within the valley and watercourse corridors, impacts will most likely be related to encroachment (e.g. dumping, unauthorized trails, etc.), artificial lighting, road crossings, physical and thermal barriers to fish migration and the influx of salt into the watercourses. Potential management measures for these negative impacts could include the following:

1) The use of fencing or natural barriers to prevent encroachment;
2) Creation of a trail network;
3) Minimize artificial lighting and use dark sky lighting;
4) Locating and designing of road crossings across the NHS;
5) Removal of barriers to fish migration and the installation of bottom-draw structures to reduce thermal impacts within watercourses;
6) Adherence to the Region of Peel's Salt Management Plan (2003) and the City of Brampton's Salt Management Guidelines;
7) Development and implementation of an Invasive Species Management Plan; and,
8) Protection of tableland vegetation outside the NHS where practical.

These measures are described in further detail below.

Fencing or Natural Barriers to Encroachment

Permanent rear lot/development fencing should be considered to prevent uncontrolled access and encroachment into adjacent natural areas. Hard barriers (i.e. steel fence) should be considered between commercial/industrial areas and the NHS. Opportunities for wildlife passage should be incorporated into hard barriers adjacent to natural areas, and live fencing should be encouraged where feasible. It is recommended that species selection for live fencing include woody species with thorns (e.g. *Crataegus* spp., *Rubus* spp., *Rosa* spp., *Zanthoxylum americanum*) to discourage encroachment into natural areas. The final recommendations regarding the type of fencing and potential offsetting of the fence onto public lands to preclude fence alterations/gate installation should be developed during subsequent planning stages.

Artificial Lighting

Aquafor Beech Limited recommends minimizing artificial light penetrating into natural areas and the sky at night. As described in **Section** 5.1.2, artificial light at night can have negative effects on wildlife, in particular bats, birds, amphibians, and reptiles in urban environments. The alteration of the natural variation in diurnal and nocturnal light intensities and spectral properties of lights has the potential to disrupt the physiology, behavior and ecology of reptiles and amphibians (Buchanan et al. 2008). Furthermore, research has also shown that artificial night lighting may enhance the invasive potential of some species (Perry et al. 2008). To further protect the NHS from the effects of urban development, Aquafor Beech Limited recommends using low mast lighting directed downward and/or shielded to minimize light projection into the NHS (often referred to as directional lighting systems) as illustrated in Figure 5.3 below. Further resources regarding directional lighting are available on the International Dark Sky Association website: www.darksky.org.

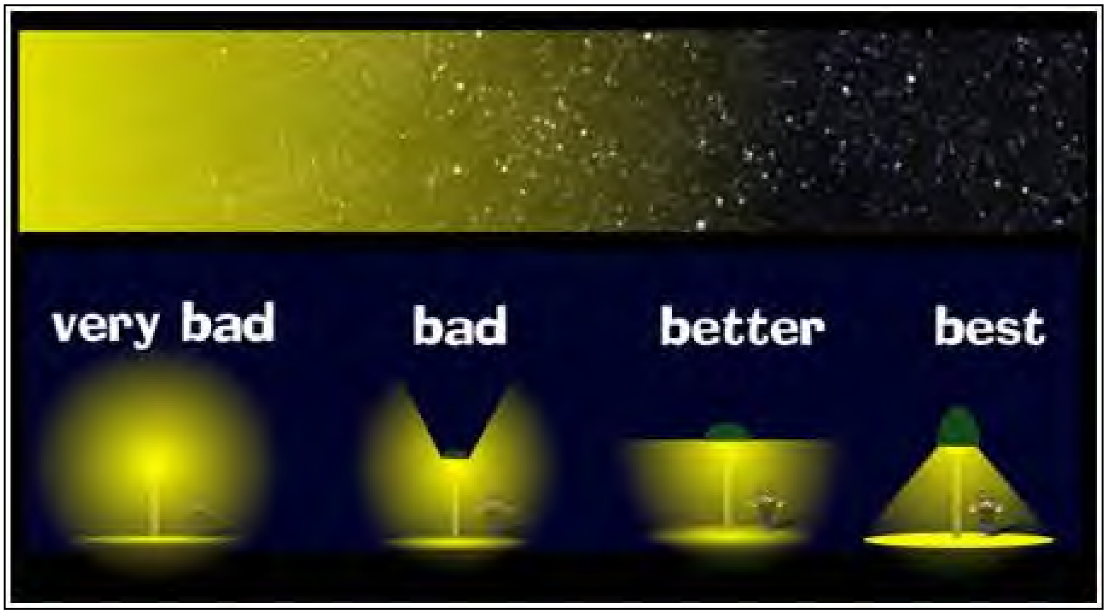


Figure 5.3: Examples of lighting options and their associated areas of light pollution (University of Florida IFAS Extension)

Road Crossings

To minimize the potential impacts of road crossings on the features and functions of watercourses, Aquafor Beech Limited recommends that the following requirements be addressed in subsequent higher-level studies:

- As much as possible, future road crossings should make use of existing crossings where they do not conflict with other sensitive features (e.g. significant flora, etc.).
- Road crossings should avoid significant and/or sensitive aquatic habitat, including riparian wetlands;
- To the extent possible, road crossings should be located within watercourse reaches subject to previous disturbances and/or those where the disturbance or removal of riparian vegetation can be minimized;
- Crossing structures should be perpendicular to the watercourse and should not be placed where the stream meanders;
- Crossing structures should be perpendicular to the valley / watercourse corridor and should not be placed where stability and erosion hazards could be increased;
- If culverts are used, they should be either open-bottomed or embedded a minimum of 20% with material similar to adjacent segments lining the bed.
- Crossings should be wide enough to allow for small wildlife passage during dry weather flow conditions. A minimum span of two times the bankfull width is recommended.

The structures required for the proposed road crossings will be determined at the detailed design stage. The type of crossing structure to be used will be based on site-specific conditions. From a hydraulics perspective, watercourse crossings should have adequate openings to convey design flows with the required freeboard and clearances without increasing floodwaters in the existing channel upstream of the structure and without increasing the erosion and scour potential downstream.

Barriers to Fish Migration

Instream barriers are natural or man-made obstacles within a watercourse that restrict the upstream movement of fish and other aquatic organisms, restricting access to spawning, nursery or feeding habitats or temperature refuges. Aquafor Beech Limited biologists identified an instream barrier within Gore Road Tributary; a perched culvert functioning as an agricultural crossing that likely restricts the upstream movement of fish within Gore Road Tributary.

The HRFMP identifies the mitigation of instream barriers as a priority within both the Upper Main and West Humber River Subwatersheds. To mitigate the instream barrier, removal of the culvert and cinder block agricultural crossing of Gore Road Tributary is recommended.

A non-structural barrier to fish movement could also form as a result of the warming of water directly downstream of a stormwater (SWM) pond (TRCA 2005). In this case, the movement of aquatic organisms (including fish) upstream would be restricted due to the thermal impact of the pond outlet on the watercourse. One method of reducing this thermal impact is to convert the outlet structure of a SWM pond to a bottom draw where cooler water from the bottom is drawn to the outlet and the surface water remains (TRCA 2005). Downstream aquatic communities would also benefit from the higher oxygen content of cooler water.

Salt Management

Snow and ice on roads, parking lots and sidewalks have a dramatic impact on public safety, road capacity, and travel times. The use of salt to reduce the effects of accumulated snow and ice helps maintain travel safety. Given the relatively high proportion of impervious surfaces associated with proposed land uses and associated need of salt for de-icing purposes, all watercourses within the Area 47 lands are expected to receive increased salt loadings particularly during spring melt conditions. Such ‘pulse’ events have the potential to negatively affect riparian habitat, calling amphibians and downstream fish populations. Accordingly, future studies and development plans should follow salt management guidelines within the Region of Peel Road Salt Management Plan (2003) and the City of Brampton’s Salt Management Guidelines. In addition, Aquafor Beech Limited recommends the use of salt-tolerant, preferably native or non-invasive, vegetation such as Eastern Red Cedar (*Juniperus virginiana*) and Hawthorn (*Crataegus* spp.) along roads and bordering parking lots to help mitigate the effects of road salt on vegetation within the study area.

Vegetation Outside of the NHS

Hedgerows, tree groupings and individual trees that comprise the urban forest which are located outside of the NHS should be incorporated into development/lot design where practical. Where not possible, the removal of this vegetation will be mitigated by a minimum of 3:1 planting (per the City's Guidelines for the Assessment of Tableland Vegetation, August 2014) and monitor edge plantings to ensure effectiveness and survivorship. Consideration of plantings should be to support natural heritage system functions as determined through future development.

The hedgerow assessment in **Section 2.4.3** offers a list of hedgerows recommended for retention.

Trees and other valuable vegetation on properties designated as Cultural Heritage Sites should be preserved if at all reasonable and should be assessed by the project arborist as well as the City of Brampton's Heritage and Forestry staff prior to removal.

Trails

The City of Brampton's PathWays Master Plan (2006) was created as part of a strategic initiative to create unique communities and is intended to provide walkable, pedestrian scaled and bike-friendly neighbourhoods that connect internally and to adjacent areas. The PathWays Master Plan respects and has regard for the natural and cultural heritage of Brampton. The Area 47 Community Design Framework identifies a preliminary pathways concept as illustrated in Figure 5.4, below**.**

The trail network will be detailed further as part of the Block Plan process for each designated block plan area within the Area 47 SPA.

There are three (3) types of trail designations within the conceptual open space network (definitions taken from the PathWays Master Plan, 2006):

- Multi-Use Paths (Class 1 and 2) are dedicated off-road facilities for pedestrians and in-line skaters as well as non-motorized vehicles such as bicycles and may be located within the boulevard and / or NHS. This is the only Class of path intended for such users.

- Bike Lanes (Class 3) are dedicated 1.5m on road bikes lanes provided on both sides of the road surface.

Figure 5.4: Conceptual Open Space Network, including Trail Locations
(reproduced from the Community Design and Open Space Study by MTBW)

Open Space Network

Note: The final location of trail(s) and their lateral connection points will be assessed and determined through the approval of the Environmental Implementation Report (EIR) as part of the Block Plan process.

An extensive Class 2 pathway is proposed for the Area 47 Community Design Framework that is primarily based on north-south trails along the Gore Road, Clarkway and Rainbow Creek Tributary corridors, with east-west off road linkages on Mayfield Road, E-W Connector and Castlemore Road, as illustrated in **Figure 5.4**. On road bike lanes are shown for Countryside Drive.

Typically the City's pathways are designed as a 3.0 metre wide asphalt path allowing for two-way movement. In order to guide the design process for all trails, the following is recommended:

- Where trails are proposed within the NHS, future block planning will need to qualify valley and watercourse corridor constraints that will direct the location and design of the trail, including crossings such as: avoiding slope and erosion hazards; protecting sensitive ecological functions, wetlands, riparian vegetation and wildlife habitat, and ensuring accessibility in and out of the corridor;

- Where it has been determined that a trail cannot be located within the corridor, they should be located in buffer areas to the extent possible (see subsection on *Trails in Buffers* below for further information);

- Final trail locations in buffers should be based on field assessments that consider habitat sensitivity, potential habitat for species at risk and locally rare species, ecologically sensitive areas, and connections to existing trails, provided those trails are located in ecologically suitable locations (see subsection on *Trails in Buffers* below for further information);

- Ensure trails do not fragment significant and sensitive natural heritage features, especially wetlands, and SAR and significant wildlife habitat. Generally, where the tributary corridors are very narrow their wildlife corridor potential may be compromised by multiple bisections;

- Watercourse crossings (east-west) and lateral trail connections beyond the NHS are critical to connect neighbourhoods, and connect residents to local destinations such as; schools, shopping, recreation centres and employment areas;

- Trail design should be done in a sensitive and cost effective manner to help limit any adverse impacts to the NHS, while affording public access and appreciation of the natural environment in keeping with City objectives;

- The trail construction footprint should be kept to a minimum. Standard construction best management practices should be employed and the timing of trail construction should consider sensitive wildlife activities such as breeding;

- Waste/recycling/compost disposal bins should be provided in the vicinity of the trail; and

- To reduce trail associated impacts (e.g. dumping of waste material, creation of informal trails, disturbance of wildlife, etc.), it is recommended that environmental stewardship measures include signage at trail access points and at key points. In areas of passive restoration, signs reading “Natural Regeneration Area, please keep off” could be installed at a low cost. Other signage should encourage the public to protect the natural environment (i.e. stay on marked trail, no dumping of waste) and provide an educational experience (i.e. offer facts about ecological communities along the trail).

Trails in Buffers

A trail system has been proposed throughout the Area 47 SPA. Some of the proposed trails are to be located adjacent to existing and proposed roads, while others are proposed within the Natural Heritage System. Generally, pending detailed field reviews, it is recommended that trails be located within the buffer to the Natural Heritage System wherever possible and also consider the ecological sensitivity of the area where trails are proposed.

In recognition of the sensitivity of some of natural heritage features within the NHS, as a means of mitigating the potential impacts of adjacent trails it is recommended that buffer widths be increased from the minimum 10 metres to 15 metres near areas of ecological sensitivity. Based upon the information collected through field studies, Aquafor Beech Limited has identified six (6) areas of ecological sensitivity within the NHS, as described in **Table 5.5.** These areas are illustrated in **Figure 5.5,** below.

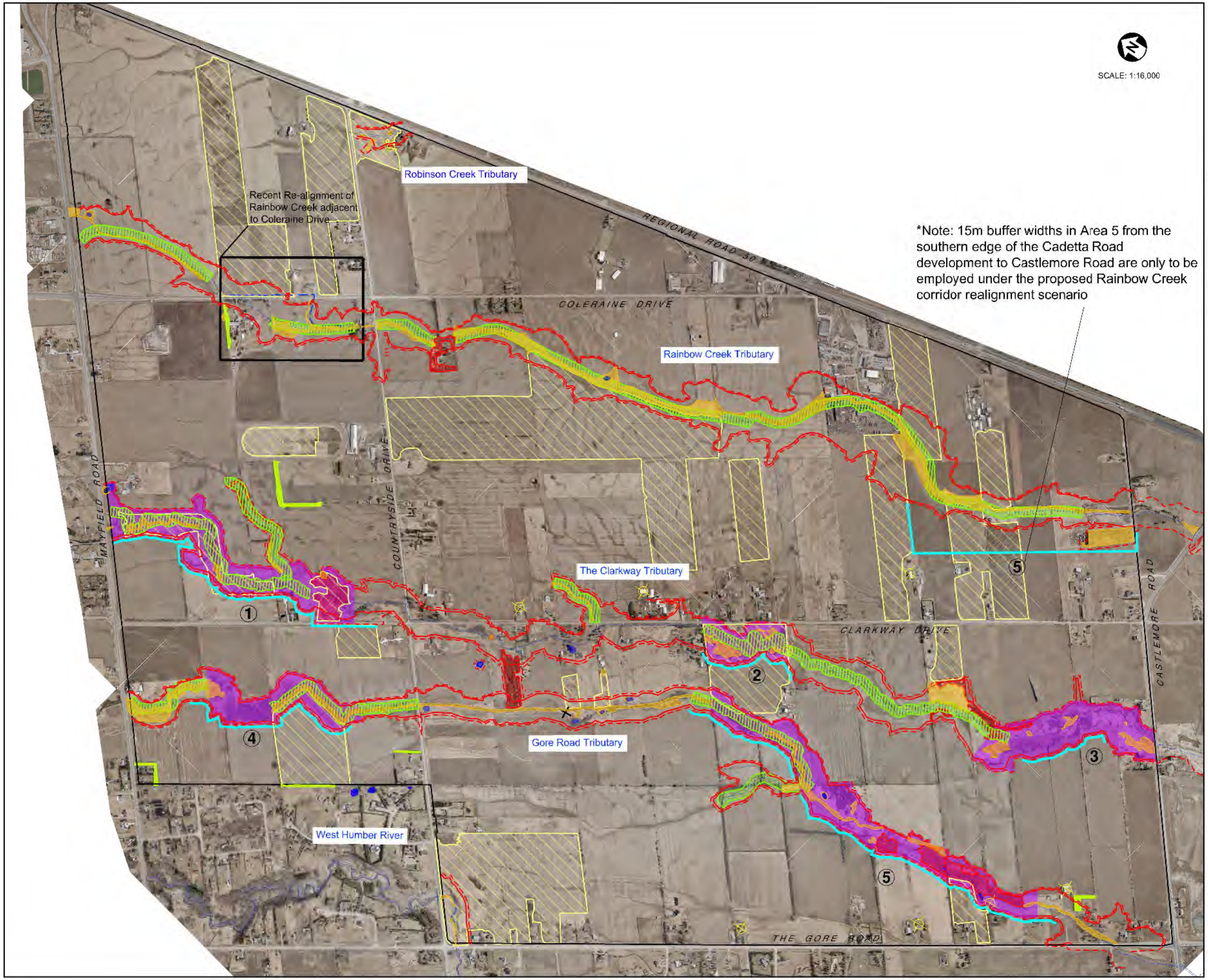
Trails adjacent to the Rainbow Creek Realignment

The proposed 5 m wide trail adjacent to the revised Rainbow Creek Corridor, which extends from Castlemore Road to the TCPL location, will avoid sensitive restoration areas. As such, the proposed trail is permitted within the 10 m buffer at the lower reach of the 100 m corridor, while in the more sensitive wooded areas upstream the trail will be located outside of the buffer for a total corridor width of 105 m.

Table 5.5: Ecologically Sensitive Areas Requiring minimum 15 m buffers to Mitigate Potential Impacts of Trails

Area Number	Reason(s) for Ecological Sensitivity
1	• Species at Risk: Bobolink and Eastern Meadowlark habitat*, Eastern Wood-pewee in significant woodland • Sensitive rare species: Chimney Crayfish
2	• Species at Risk: Bobolink and Eastern Meadowlark habitat*
3	• Sensitive rare species: American Redstart • Woodland/wetland/meadow complex
4	• Species at Risk: Eastern Meadowlark* • Sensitive rare species: Chimney Crayfish, Michigan Lily • Swamp/meadow marsh complex, includes a Significant Woodland
5	• Species at Risk: Snapping Turtle • Sensitive rare species: Spring Beauty, Michigan Lily, Running Strawberry Bush • Concentration of locally rare species. In addition to those listed above, these include: Marsh Purslane, Narrow-leaved Bur-reed, Marsh Purslane, Long-leaved Pondweed, Climbing Bittersweet, Shagbark Hickory, Silky Dogwood, Brown Thrasher, and Great Blue Heron. • Relatively extensive woodland/wetland/meadow complex, includes Significant Woodlands
6	• Realigned Rainbow Creek Tributary, Segment 1 – The buffer width from Castlemore Road to the TCPL corridor will be variable from the minimum 10 m to 15 m in order to accommodate the proposed pedestrian trail. Minimum buffer widths from the TCPL corridor to the southern extent of the Cadetta Road development shall be 10 m, and 15 m thereafter to Castlemore Road. Opportunities will be examined through the future Block Plan EIR process to incorporate the pedestrian trial in other appropriate public land uses that are located adjacent to the Rainbow Creek corridor, *e.g.* stormwater management facilities. • The map below (Figure 5.5) shows the approximate extent of the lands described above on the recommended NHS (i.e., NHS without the proposed realigned Rainbow Creek corridor).

*Note: It is recommended that the suitability of trails in areas known to support Bobolink and Eastern Meadowlark



MASTER ENVIRONMENTAL SERVICING PLAN

AREA 47

LEGEND:

- STUDY AREA
- WATERCOURSES

PRESERVATION (NO DEVELOPMENT)

- STREAM/VALLEY CORRIDOR

Composed of:
- Floodplan hazard lands
- Meander belt
- Valley Features (Top of bank)
- Erosion and slope stability setbacks

- AGRICULTURAL PONDS TO BE PROTECTED
- ECOLOGICALLY SENSITIVE AREAS 1-5
- SIGNIFICANT WOODLANDS/WOODLOTS
- WETLAND FEATURES TO BE RETAINED
- NATURAL FEATURE BUFFERS
  - Valley/stream corridor +10m
  - Significant Woodlots/woodlands +10m
  - Agricultural ponds +10m
  - Wetlands +10m
  - Fish habitat
    - -For Gore Rd Trib/Clarkway/Rainbow and HDF's: Meander belt+10m, no less than 15m for warmwater habitat
    - -For West Humber River: Meander belt+30m for Reside Dace habitat

MITIGATION/DEVELOPMENT SUBJECT TO FUTURE STUDY

- SAR-BOBOLINK/EASTERN MEADOWLARK HABITAT - MNR consultation
- SAR-BARN SWALLOW NESTS - MNR consultation

OPPORTUNITIES FOR ENHANCEMENT AND RESTORATION

- HEDGEROWS TO PROTECT, WHERE FEASIBLE
- RIPARIAN PLANTINGS
- FISH BARRIER REMOVAL
- RESTORATION - RAINBOW CREEK AT COLERAINE DRIVE
- 15m BUFFER TO MITIGATE POTENTIAL IMPACTS OF TRAILS
- LINEAR EXTENT OF THE RECOMMENDED MINIMUM 15m BUFFER WIDTHS

AREAS REQUIRING INCREASED BUFFER WIDTHS TO MITIGATE POTENTIAL IMPACTS OF PROPOSED TRAILS
FIGURE 5.5

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5.2.2 Restoration/Enhancement

The following subsections outline restoration and enhancement recommendations for the Area 47 SPA. The restoration of Rainbow Creek is addressed separately in **Section 6**.

5.2.2.1 Terrestrial Resources

There are four primary opportunities for protection and enhancement of the terrestrial features in the study area.

First, Section 4.6.6.9 of Brampton's OP (2006) identifies that restoration areas will be added to the natural heritage system through the guidance provided in watershed plans, subwatershed studies, natural heritage system studies and site specific studies that address no net loss and a potential net gain in the natural heritage system.

As detailed in **Section 5.1.1**, there is a proposed (potential) loss of 3.30 ha* of tableland natural features including woodlands, wetlands, ponds, mid-successional communities. Mitigation for the loss of these communities, along with HDFs, should be addressed on a *minimum* 1:1 ha provision of these features (statistic excludes meadows). Other tableland vegetation features such as hedgerows and other trees are subject to a minimum 3:1 replacement ratio. Opportunities include the creation of new vegetation communities adjacent to the natural heritage system and/or creating/strengthening east-west connections between watercourse corridors.

*Does not consider what would be lost as a result of the proposed realignment of the Rainbow Creek corridor.

Second, plantings within buffer zones around NHS features (e.g. significant woodlands, etc.) will help maintain these features and their associated functions by mitigating disturbances. Third, six (6) existing hedgerows features are worthy of consideration for preservation and could be incorporated into future park or stormwater management blocks, or along future property lines. It is further recommended that impacts to hedgerow H39, located adjacent to the study area, be avoided. Fourth, invasive species should also be removed from the significant woodlands and woodlots, as well as the five hedgerows recommended for retention. In areas with significant invasive species infestation, it is recommended that an invasive species management plan be developed at a subsequent planning stage. The mitigation/enhancement measures outlined in **Table 5.1**, **Table 5.2**, and **Table 5.3** are expanded upon in the subsections below.

<u>Creation of Natural Features</u>

Brampton's OP policies identify no net loss and a potential net gain in the natural heritage system. Proposed removal of natural features to facilitate development (that are deemed acceptable to the City and TRCA), must be mitigated by restoration areas that will be added to the natural heritage system. Guidance for these removals and restoration area compensation will be provided by comprehensive environmental studies such as the MESP.

Section 5.1.1 (Table 5.1, Table 5.2, and **Table 5.3)** identifies the proposed (potential) loss of tableland woodlands, wetlands, ponds, mid-successional communities, and headwater drainage features, and the opportunities to create new vegetation communities adjacent to the Area 47 Natural Heritage System, including creating and / or strengthening east-west connections between NHS watercourse corridors.

Mitigation is based on a 1:1 ha provision of natural features. In accordance with TRCA's Evaluation, Classification and Management of Headwater Drainage Features Guidelines Approved July 2013 (finalized January 2014), the contributing functions of headwater drainage features may be mitigated through lot level conveyance measures (e.g. vegetated swales) connected to the natural heritage system, as feasible and/or Low Impact Development (LID) stormwater options.

<u>Creation / Strengthening of East-West Linkages</u>

Corridors are important components of the natural heritage system, especially in anthropogenically altered landscapes with fragmented natural heritage features. Linkages allow for plant and wildlife movement among environmental features, support hydrological and nutrient cycling, and contribute to the overall integrity and connectivity of the Natural Heritage System. The three largest tributaries in the study area and their associated valleys constitute significant north-south corridors. Two (2) locations in the study area have been identified as east-west linkages, as follows:

Tableland woodland between the Gore Road Tributary and Clarkway Tributary

Ecological connectivity between the Gore Road and Clarkway Tributaries is presently limited to an upland woodland located approximately 380 m south of Countryside Drive (inset photo). It is at this location that the distance between the two tributaries is narrowest. Accordingly, the woodland represents an opportunity for wildlife movement between the two corridors. It is recommended that enhancements to this corridor include understory tree and shrub plantings within the woodland, floodplain plantings, and associated buffer plantings in addition to restoration plantings around the proposed SWM pond (pond G6) and extant wetland/pond (ELC polygon 96). Opportunities for enlarging this linkage area through enhancement plantings should be considered as a mitigation measure to compensate for the loss of natural heritage features, including but not necessarily limited to those in the tablelands.

In order to attract wildlife to the linkage the linkage should contain a high proportion of fruit- and nut-bearing shrubs, woody debris, as well as water features such as permanent and semi-permanent pools should be incorporated into the restoration design. It is further recommended that the land use plan for the surrounding lands consider less-intensive development uses such as schools and parks for the lands north and south of this corridor as a means of increasing the potential for wildlife use of the corridor. Bisection of and/or development within the linkage are not recommended.

Trans Canada Pipeline Lands

In addition, opportunity exists for the creation of an east-west corridor between the Clarkway and Rainbow Creek tributaries along the Trans Canada Pipeline (TCPL) lands – an 18 m wide corridor extending from the Gore Road to Regional Road 50. A wildlife corridor can be achieved through ecological restoration and enhancement within and adjacent to the TCPL lands and locating wildlife-compatible "soft" land uses such as parks and SWM blocks adjacent to the corridor. Further information on this future corridor, including the proposed corridor width, is contained within **Section 6.3**.

Both of the linkages described above are illustrated in **Figure 3.10** and **Figure 7.1**.

Buffer Plantings

As outlined in **Section 3.9**, vegetated buffers are recommended at varying distances (e.g. 10m, 15m, etc.) around natural features that comprise the NHS. Planting plans in these areas should include a diverse mix of site-appropriate native species. Planting a diversity of species/genera/families reduces the risk of widespread losses associated with pest outbreaks. Attention to a species' physiological attributes (e.g. moisture tolerance, light requirements, etc.) helps to ensure longevity of the plantings. This is particularly important for riparian plantings (see **Section 5.2.2.2** below) where a pronounced moisture gradient may exist between the bank and adjacent areas. Fast growing, early-successional species with tolerance to urban conditions should be planted along woodland/woodlot boundaries to ensure buffer benefits become realized over a shorter timescale.

Removal of Invasive Species

The ten (10) cultural thickets in the study area are dominated by European buckthorn and many also contain scattered patches of one-seeded hawthorn, Manitoba maple and garlic mustard. It is strongly recommended that these areas be cleared of non-native vegetation and replanted with native species. Extra consideration should be afforded to cultural thickets that exist along valleylands (as the removal of non-native woody cover may increase erosion) and those near woodland amphibian breeding ponds (e.g. polygon 28). A number of the cultural thickets dominated by European buckthorn are considered woodlots under the City's Woodlot

Conservation By-law, and are therefore included in the NHS. More detailed restoration plans for these areas should be considered in the later stages of planning.

5.2.2.2 Aquatic Resources

Opportunities for enhancement to aquatic resources exist within the study area. Consistent with recommendations in the HRFMP, opportunities exist for riparian plantings within all four watercourse corridors to achieve the target goal of 75% woody vegetation. A barrier to fish passage has also been identified for mitigation at an existing agricultural crossing with a perched culvert on the Gore Road Tributary. Enhancement opportunities also exist for agricultural ponds that are to be retained on the landscape.

Policy 4.6.12.4 of the City of Brampton's Official Plan (2006) states that the City of Brampton will reference the Fisheries Management Plan prepared by the relevant Conservation Authorities to define fish habitat and their management requirements. The Humber River Fisheries Management Plan (HRFMP; 2005) prepared by the Toronto and Region Conservation Authority (TRCA) identifies rehabilitation priorities within each subwatershed of the Humber River that are based on the identified Fish Management Zones (See **Section 2.4.8.6**).

In addition to highlighting proposed rehabilitation needs for the management zones within each subwatershed, the HRFMP allocates the following priorities to each identified rehabilitation need:

> **High –** those rehabilitation strategies that are considered to be in greatest need within the management zone to achieve the conditions necessary to re-establish and/or maintain the target species, and are considered achievable.
>
> **Medium –** those rehabilitation strategies that are considered to be in need by of lesser immediate importance within the management zone to achieve the conditions necessary to re-establish and/or maintain the target species, and are considered achievable.
>
> **Low –** those rehabilitation strategies that are considered of least immediate importance within the management zone to achieve the conditions necessary to re-establish and/or maintain the target species, and/or may not be considered currently achievable die to a lack of opportunity.

Table 5.6 outlines high and medium priority rehabilitation needs for the management zones within each subwatershed relevant to the Area 47 MESP, as recommended within the HRFMP.

Table 5.6: Proposed Rehabilitation needs for Fish Management Zones within each Subwatershed

<table>
<tr><th>Subwatershed</th><th>Watercourse</th><th>Fish Management Zone 4</th><th>Fish Management Zone 7</th></tr>
<tr><td>Upper Main Humber River</td><td>Rainbow Creek</td><td>• Achieve 75% woody vegetation in riparian corridor (medium)
• Protect existing wetlands (high)
• Create wetlands identified in TRCA’s Terrestrial Natural Heritage Strategy (medium)
• Identify sites for wetland creation (medium)
• Install bottom draw outlets or subsurface drainage on SWM facilities (high)
• Protect and enhance existing water budget (high)
• Maintain or enhance existing baseflow (high)
• Reduce sediment run-off during construction periods (high)
• Implement best management practices for all land uses (medium)
• Identify additional barriers and assess stream crossings for fish passage (medium)
• Monitor fish and benthic communities to assess fish passage and aquatic community trends (high)</td><td rowspan="3">• Not Applicable</td></tr>
<tr><td rowspan="3">West Humber River</td><td>The Clarkway Tributary</td><td rowspan="2">• Achieve 75% woody vegetation in riparian corridor (medium)
• Protect existing wetlands; rehabilitate or restore wetlands where degraded or eliminated (high)
• Create wetlands identified in TRCA’s Terrestrial Natural Heritage Strategy (medium)
• Identify sites for wetland creation (medium)
• Implement recommendations of Brampton Stormwater Retrofit Study (high)
• Install bottom draw outlets or subsurface drainage on SWM facilities (high)
• Protect and enhance existing water budget (high)
• Determine instream flow requirements for target species (high)
• Maintain or enhance existing baseflow (medium)
• Reduce sediment run-off during construction periods (high)
• Implement best management practices for all land uses (medium)
• Identify additional barriers and assess stream crossings for fish passage (high)
• Mitigate one barrier on private property annually (medium)
• Conduct aquatic habitat and species surveys at Mayfield Road east and west of Humber Station Road (High)</td></tr>
<tr><td>Gore Road Tributary</td></tr>
<tr><td>West Humber River</td><td>• Not Applicable</td><td>• Achieve 75% woody vegetation in riparian corridor (medium)
• Protect existing wetlands; rehabilitate or restore wetlands where degraded or eliminated (high)
• Create wetlands identified in TRCA’s Terrestrial Natural Heritage Strategy (medium)
• Identify sites for wetland creation (medium)
• Implement recommendations of Brampton Stormwater Retrofit Study (high)
• Install bottom draw outlets or subsurface drainage on SWM facilities (high)
• Protect and enhance existing water budget (high)
• Determine instream flow requirements for target species (high)
• Maintain or enhance existing baseflow (medium)
• Reduce sediment run-off during construction periods (high)
• Implement best management practices for all land uses (medium)
• Identify additional barriers and assess stream crossings for fish passage (high)
• Mitigate one barrier on private property annually (medium)
• Implement recommendations of Redside Dace Recovery Strategy
• Conduct aquatic habitat and species surveys at Countryside Drive east of The Gore Road (high)</td></tr>
</table>

To address these rehabilitation priorities, the following restoration opportunities are recommended within the study area:

Riparian Plantings

In addition to recommendations within the HRFMP, the Humber River Watershed Plan (TRCA 2008b) recommends that efforts to protect and restore natural cover within the West Humber Subwatershed focus on designated natural heritage system (NHS) lands in existing developed areas and approved urban growth areas. Consistent with recommendations within the HRFMP and the Humber River Watershed Plan, Aquafor Beech Limited has identified locations within the study area that would benefit from riparian plantings within the fisheries buffer (Figure 3.10). To increase natural cover throughout the recommended NHS, site-specific restoration/planting plans should be prepared by a qualified professional (e.g. botanist, ecologist or landscape architect) to guide recommended enhancement activities. It is recommended that riparian planting plans include high canopy shade trees, subcanopy/mid-level and understory shrubs, and herbaceous ground cover.

As a result of riparian habitat plantings, watercourses would incur thermal benefits, erosion stability, habitat creation and run-off filtration. Although riparian plantings would benefit all watercourses within the study area, the Rainbow Creek Tributary is identified as a high priority for these restoration works. As noted in **Section** 4.2, more extensive stream restoration and grading works are recommended along the Rainbow Creek Tributary to provide ecological, stormwater, and drainage/servicing benefits. The current riparian habitat that makes up the Rainbow Creek corridor is almost entirely grasses and open space. Planting woody vegetation as part of the recommended stream restoration works would provide extensive aquatic habitat benefits within the watercourse as well as to downstream reaches.

This MESP also recommends that dense riparian plantings of native evergreen trees such as eastern white cedar (*Thuja occidentalis)* be incorporated into the buffers surrounding ponds G2, G4, G5 and G6. An increase in the amount of noise and light resulting from a change in land use from primarily agriculture to that of residential and/or commercial/industrial may affect the breeding behaviour of calling amphibians (Baker and Richardson 2006). Evidence shows that buffer vegetation and width, respectively, are important factors in reducing light and noise impacts. Harris (1986) concluded that a mature treed evergreen buffer of approximately 6 metres would reduce noise from adjacent infrastructure by 4-6 decibels (db) per metre. Typical street traffic noise is 70 db; therefore, assuming an average 5 db reduction per metre of buffer, it is recommended that at least a 10 metre wide dense planting of eastern white cedar or equivalent native evergreen be planted within the riparian buffer of these ponds to help preserve amphibian breeding habitat.

Fish Barriers

It is recommended that the perched culvert acting as an agricultural crossing on Gore Road Tributary (Figure 5.6, below) be removed completely, allowing for improved fish/aquatic organism movement potential. There also may be some opportunity for localized stream restoration at this location.

Figure 5.6: **Fish Barrier on the Gore Road Tributary**

Rainbow Creek Tributary

Subsequent to discussions with the TRCA, City of Brampton, and the landowners' group; it was decided that the length of Rainbow Creek Tributary within the study area will be subject to a comprehensive restoration plan involving the realignment of the channel and extensive ecological restoration within a constructed valley. Further information on the Rainbow Creek Tributary restoration is found in **Section 6**, below**.**

Geomorphology

Based on a geomorphic evaluation of watercourse conditions within the study area, a number of strategies are recommended to improve watercourse conditions:

- Riparian conditions should be improved through tree and shrub plantings in grass-dominated reaches, as per aquatic and terrestrial habitat objectives;
- Identified locations of bank erosion should continue functioning as natural sediment sources to the channels (specifically coarse sediments);
- Areas of natural meander evolution and rejuvenation should be allowed to continue (e.g., Clarkway Tributary Reach C-3) within an adequately sized erodible corridor (i.e., meander belt width);
- Channel alignment and restoration measures should be developed for those reaches where recent modifications have realigned / impacted the watercourse (e.g. Rainbow Creek Tributary Reach R-5 directed in Coleraine Drive roadside ditch);
- Local channel restoration is recommended to remove private watercourse crossings, specifically historic and active tractor crossings which are frequent in some reaches; and
- Management objectives should discourage basin sources of fine sediments (silt and clay) from entering the watercourses during construction.

6 RAINBOW CREEK RESTORATION / ENHANCEMENT

As noted in **Section 2**, the existing Rainbow Creek stream corridor lacks a defined valley feature over most of its reach, has poor channel definition and very little riparian cover other than meadow grasses. This is in contrast to the Gore Road and Clarkway Tributary corridors which have better defined valleys and riparian cover. Because of the lack of a valley feature, the Rainbow Creek Regional Storm floodplain is very wide and shallow in places, and impacts to existing land uses are evident, i.e. industrial development on Cadetta Road (Figure 2.17). The channel has also been altered extensively, including a recent re-alignment via the roadside ditch adjacent to Coleraine Drive.

As prescribed by City of Brampton and TRCA policies, development is setback from the greater of the environmental hazards, contiguous vegetation (dripline) and a minimum 10 m environmental buffer. Under existing conditions, the Rainbow Creek stream corridor would be defined as 10 m inland from the Regional Storm floodplain, including a vertical freeboard of 0.5 meters that can be achieved as a result of natural grades within the 10 m buffer and/or grading associated with development at the edge of the 10 m buffer. Given the existing Greenfield land base associated with the secondary plan area, this is the City of Brampton and TRCA's preferred proposed NHS option.

During the MESP Phase 2 process the Area 47 Landowners Group proposed to alter/modify the Rainbow Creek corridor through grading works in the Regional Storm floodplain that could result in opportunities to achieve significant land use efficiencies while restoring and enhancing ecological features and functions to create a healthier, ecologically and structurally diverse and better-defined stream corridor system.

Through extensive discussions with City staff, TRCA staff and the Landowners Group, it was recognized that the proposed grading works to create a more well-defined stream (floodplain) corridor would result in a significant loss in the corridor (NHS) land base area. The analysis provided in **Table 6.7** quantifies that 30.84 ha of corridor land base/area will be lost, and also identifies the overall quality of the habitat and riparian vegetation will be improved through the proposed works.

The land base of the NHS is the most critical element to the overall health of the subwatershed in the long-term. Although the corridor can be improved as part of a restoration strategy, it is recognized that over the long-term, the Rainbow Creek Tributary corridor natural heritage values and functions could improve naturally. The long-term function of the corridor is tied to the protection of the land base and can be improved through stewardship that is not dependent on a restoration strategy for the modification works.

The alteration and interference of valley and stream corridors, including modifications to watercourses, flood hazards, and lands within valley and stream corridors to create additional area to accommodate or facilitate new development is generally not permitted by City and/or TRCA policies. Alterations and modifications may be supported where it can be demonstrated to the satisfaction of City of Brampton and TRCA, through appropriate technical reports and assessments (i.e., MESP/EIR/EIS) that modifications will result in:

- Permanent remediation and reduction of risk to existing development (i.e., the existing industrial development on Cadetta Road);
- Serve to improve public safety; and
- Demonstrate no negative impacts to the natural features and their ecological functions while also significantly and comprehensively improving ecological conditions.

For the City and TRCA to even entertain such an approach a number of ecological goals were agreed to, including but not limited:

- Minimal loss of NHS land base by establishing a consistent corridor width (100 m), which is necessary to ensure enhanced north-south connectivity long-term;
- Significant terrestrial and aquatic habitat enhancement and restoration;
- East-West ecological linkages between all corridors;
- Realignment and restoration of two reaches of Rainbow Creek (Cadetta Road and Clarkway Road);
- Application of 10 m environmental buffers (both sides); and
- Conveyance of Regional Storm flows.

Additionally, the modifications to the Rainbow Creek stream corridor must demonstrate to the satisfaction of City of Brampton and TRCA that:

- The modifications have been evaluated on a valley or stream corridor reach basis (i.e., Castlemore Road to Mayfield Road);
- Acceptable justification has been provided at a subwatershed scale through the completion of a comprehensive environmental study (i.e., MESP/EIR/EIS); and
- The modifications confirm that the control of flooding, erosion, pollution or conservation of land will not be affected.

The traditional approach of protecting the existing corridor, as defined by the wide shallow floodplain, was assessed against other opportunities to create a healthier and better-defined stream and valley corridor system. Following extensive planning and engineering discussions with City staff, TRCA staff and landowner representatives, a more pro-active and innovative approach to NHS planning is recommended, consisting of combined restoration works and adjacent grading works to create a much healthier corridor system. Such works will offer multiple ecological and engineering benefits to the City, TRCA, and the landowners, including:

- Flood remediation including the removal of Cadetta Road properties from the floodplain;
- Targeted and strategic restoration creating a more robust and resilient ecosystem than would be expected through gradual long-term regeneration of the floodplain;
- Ensure enhanced connectivity long-term within the Rainbow Creek valley corridor, which also provides for additional ecological connectivity through east-west linkages to Clarkway and Gore Road Tributaries;
- Increase in development lands within the plan area;
- Improved opportunities for stormwater servicing.

Presented below is a synopsis of the proposed Rainbow Creek corridor restoration and enhancement design concepts that have been developed. It is expected that further planning, modelling, preliminary design, and detailed design will be undertaken at the next planning stage to carry out the improvements and meet the targets, as part of future EIR and/or interdisciplinary EIS studies.

Permission to undertake the proposed modifications to the Rainbow Creek corridor will be contingent on:

- agreement on the Rainbow Creek corridor restoration concept amongst the entire landowners group; and

- the achievement of multiple ecological and engineering benefits as presented in this MESP, to the satisfaction of the City and TRCA.

Should there be no agreement amongst all landowners, or should it be determined by the City of Brampton and TRCA as part of future studies that the proposed modifications do not offer multiple ecological and engineering benefits as presented in this section, the existing NHS (as defined by the Regulatory Floodplain and 10m buffers) will be used to define the future development limits.

6.1 Valley Corridor Concept, Ecological Targets and Benefits

Restoration efforts within and outside the corridor are intended to meet the following environmental and engineering objectives:

- A net increase in aquatic and terrestrial habitat structure and quality (i.e. ecological form and function);
- Increase of available habitat for target species in the Humber River watershed and those recorded in the study area during field work as part of this study;
- Minimize the loss of land base from the existing conditions NHS;

- Mitigate the loss of extant wetlands within the Rainbow Creek NHS and the greater subwatershed study area though the widespread restoration of wetlands throughout the proposed corridor;
- Provide enhanced connectivity long-term within the Rainbow Creek valley corridor, which also provides for additional ecological connectivity through east-west linkages to the Clarkway and Gore Road Tributaries;
- Provide east-west linkages between Gore and Clarkway Tributaries and Clarkway and Rainbow Tributaries;
- Protection and improvement of contributing habitat for an Endangered species (i.e. Redside Dace in the lower reaches near Castlemore Road) and potential habitat for locally rare species (e.g. Chimney Crayfish); Invasive species (e.g. reed canary grass, narrow-leaved cattail) removal;
- Preservation of existing hydraulic characteristics, such as flood conveyance and flood storage to the greatest extent possible; and
- Reduction in flood-prone property and flood-susceptible roadways.

To meet the above objectives, a corridor width of 100 metres is required. The proposed corridor includes:

- A sufficient valley floor width to allow for future long-term channel migration and maintenance;
- A design to minimize the loss of land base from the existing conditions NHS, and implement targeted enhancement of ecological functions;
- Provide enhanced connectivity long-term within the Rainbow Creek valley corridor;
- Allow for the safe conveyance of the Regional Storm;
- Valley wall height of approximately 2m to allow for future adjacent SWM pond outlets;
- Stable side slopes (City's design preference of 5:1); and
- Valley corridor buffer/setback = 10 metres (both sides).

At select locations along the lower reaches of proposed corridor, an additional 5 m allowance will be required to accommodate a future city trail that is planned on the west side of the corridor, south of the TransCanada Pipeline (TCPL). The additional 5 m allowance will be required where the trail is to be located adjacent to proposed woody forest vegetation within the valley, bringing the total corridor width to 105 m along this reach. Where the proposed city trail is located adjacent to proposed meadow/marsh vegetation within the valley, the trial may be located within the standard corridor buffer allowance of 10 m. The City's trails plan does not require a trail along the Rainbow Creek corridor north of Arterial Road A2 through the employment lands.

In order for the overall engineering and environmental targets to be met, it is expected that all of the Rainbow Creek restoration/enhancement works will ultimately be implemented over the entire study area from Castlemore Road to Mayfield Road. However, given the extensive length of Rainbow Creek over this reach (i.e. approximately 4.9km) it is proposed that the design and implementation of the corridor restoration/enhancement works be undertaken in up to three smaller, more manageable segments:

- Segment 1 – Castlemore Road to proposed future Arterial Road A2 (north of TCPL)
- Segment 2 – Arterial Road A2 to Countryside Drive
- Segment 3 – Countryside Drive to Mayfield Road

These segment reaches recognize that there are land ownership and development timing/phasing considerations, but are sufficiently large enough to ensure that the works are implemented on a more holistic basis, avoiding a "piecemeal" approach.

The existing environmental characteristics, constraints and opportunities, together with proposed design elements and environmental targets are summarized in **Table 6.1** to **Table 6.3** for each of the above corridor segments. Based on the outlined targets, preliminary corridor planform and cross-section concepts are illustrated in **Figure 6.1**: to **Figure 6.3**.

Based on the proposed corridor, the potential future NHS coverage over the Rainbow Creek Tributary would be reduced from 76.40 ha (represented by the extent of the existing floodplain excluding the Cadetta Road development), to 45.42 ha. Therefore, the proposed corridor width allows for 30.98 ha of additional developable lands that would otherwise be included in the Rainbow Creek Tributary floodplain. In order to mitigate this significant loss of potential NHS coverage, it is necessary to implement the criteria outlined above, which includes but is not limited to extensive restoration plantings to create approximately 45.42 ha of natural cover within the corridor. The conceptual vegetation coverage within the new corridor is illustrated in **Figure 6.1**: to **Figure 6.3** and includes targets for:

- Woodlands covering the valley, slopes and buffers within all reaches – 30.30 ha;
- Meadow coverage focussed in the lower reach (R1) – 6.71 ha; and
- Wetland coverage consisting of marsh (3.57 ha) and swamp (4.12 ha) over the main channel and at storm pond outfalls within all reaches.

Swamp Restoration

The study team recognises that there may be some difficulty in restoring swamp communities due to challenges in creating a suitable hydrologic regime. As such, it is recommended that the species assemblage of created swamps within the proposed Rainbow Creek corridor contain a 50-30-20 proportion of obligate wetland, facultative wetland, and facultative species to ensure that if the hydrology is not conducive to a swamp, the community will still be forested and contribute to the overall forested cover in the subwatershed.

In addition to the above corridor restoration efforts, the loss of NHS land base is to be partially mitigated through establishing east-west linkages between the Rainbow Creek, Gore Road and Clarkway Tributary. These linkages, as well as additional tableland areas will be incorporated into the future NHS, as appropriate. Strategic orientation of "soft" land uses can be used to complement natural feature creation to establish linkages (i.e., parks, school blocks, etc.). Additionally, north-south connectivity must not be compromised through the refinement of the Rainbow Creek Tributary corridor design. East-west linkages are a significant ecological benefit and are a critical component in mitigating the loss of land base from the proposed realignment / modification of the Rainbow Creek corridor.

On an overall study area basis, the restoration efforts in the Rainbow Creek corridor amount to a net increase of roughly 32.76 ha (2.70%) in natural vegetation cover compared to pre/post development conditions, bringing the total natural vegetation cover in the MESP study area from 6.92% to 9.62%. On a segment-by-segment basis and overall, proposed natural heritage cover impacts and creation in the Rainbow Creek corridor are as follows:

- Segment 1 – 1.54 ha impacted, 16.90 ha restored.
- Segment 2 – 5.46 ha impacted, 14.99 ha restored.
- Segment 3 – 4.21 ha impacted, 13.53 ha restored.
- Total – 11.21 ha impacted, 45.42 ha restored.

It is important to understand that a single consistent corridor allowance has been specified over the entire reach (i.e. from Castlemore Road to Mayfield Road) so that the MESP targets, particularly the NHS coverage targets, are distributed on an equitable basis throughout the corridor. Although planning and design might take place over the three specified reaches individually, the design targets were developed so that there is an overall net improvement in Rainbow Creek Tributary corridor and which also contributes to the whole MESP study area.

Although some minor refinements may be necessary within the corridor for the purposes of addressing site-specific design challenges within each of the three reach segments (e.g. matching inverts, slopes adjacent to stormwater outfalls, etc.), it is important that targets be met within each segment and consistently implemented so that the greater MESP study area targets are also met and existing NHS floodplain land base losses within Rainbow Creek Tributary are mitigated.

It is also important to understand that the design and construction works within each of the three reach segments will need to ensure that the works tie-in seamlessly to the upstream and downstream reach segments if they are to be completed in separate timeframes. At the north end of the secondary plan area, planning and design for Segment 3 will also need to be co-ordinated with the proposed channel alignment within the Town of Caledon, north of Mayfield Road.

Once ultimately implemented, the proactive approach to establishing the Rainbow Creek Tributary corridor through the restoration and grading improvements described above is expected to provide significant overall ecological, engineering, and economic benefits, including:

- Early establishment of healthy diverse ecosystem, while minimizing the loss of land base to the existing conditions NHS;
- Significant increase to the vegetation coverage both within the Rainbow Creek Tributary corridor and within the secondary plan area as a whole;
- Aquatic and terrestrial habitat improvement;
- Improved terrestrial connectivity;
- Reduced flood hazards;
- Increase in development lands;
- Improved stormwater servicing; and
- Minimizes the requirements for long-term stewardship and maintenance of the Rainbow Creek valley corridor.

Table 6.1: Rainbow Creek Enhancement/Restoration Targets for Segment 1 – Castlemore Road to Future Arterial Road A2 (North of TCPL)

<table>
<tr><th>Design Elements</th><th>Existing Characteristics / Constraints / Opportunities</th><th>Design Targets</th></tr>
<tr><td>Aquatic Habitat</td><td>- Classified as Small Riverine Warmwater Habitat
- lack of specialized fish species and piscivores
-creek chub
- no mussels</td><td>- opportunities for fish and mussel habitat enhancement through re-alignment works adjacent to Cadetta Road (see geomorphology targets above)
- wetland and overhanging vegetation features to provide cooling and further water quality treatment at SWM pond outfalls before discharge into main channel
- fully vegetated channel will increase aquatic habitat structure and quality for aquatic wildlife, including potential habitat for the Endangered Redside Dace.</td></tr>
<tr><td>Terrestrial Features</td><td>- adjacent to field where Eastern Meadowlark was found
- adjacent to fields where Bobolink was found
- existing connectivity limited by narrow corridor through Cadetta Road industrial development
- riparian wetlands:
- dominant type: cattail mineral shallow marsh
- other types: reed-canary grass mineral marsh and mineral shallow marsh
- approx. total wetland area affected: 4.21 ha
- chimney crayfish found at one location downstream of HDF Rainbow 4.</td><td>- NHS vegetation cover target of 16.90 ha within corridor of varying width between 100 and 105 m, including:
- Woodland = 5.43 ha
- Wetland = 4.04 ha
o Swamp = 0.65 ha
o Marsh = 3.39 ha
- Mid-successional (open thicket) = 0.72
- Meadow = 6.71 ha

- realignment of Cadetta Road channel reach to new valley corridor the west to enhance terrestrial corridor connectivity
- opportunities for most extant wetlands to be incorporated into the design, though that may not be advisable due to prevalence of invasive species
- opportunity for enhancement of species composition and habitat structure
- creation of habitat for target species</td></tr>
<tr><td rowspan="2">Hydrology / Hydraulics</td><td>- shallow floodplain, approximately 80m to 300m wide, conveys existing flood flows*:
- 2-yr = 3.8 m^3/s
- 5-yr = 7.6 m^3/s
- 10-yr = 11.1 m^3/s
- 25-yr = 15.7 m^3/s
- 50-yr = 20.0 m^3/s
- 100-yr = 23.4 m^3/s
- Regional = 52.3 m^3/s</td><td>- new corridor width and depth sized to convey of a full range of flood flows</td></tr>
<tr><td>Existing flood levels*:</td><td>- match existing upstream & downstream flood elevations for range of storms
- valley depth selected to allow min. 0.3m freeboard above Regional flood elevation</td></tr>
</table>

Design Elements	Existing Characteristics / Constraints / Opportunities		Design Targets
	Downstream limit (HEC-RAS X-Sect 24.24): - 2-yr = 202.31 m - 5-yr = 202.86 m - 10-yr = 203.42 m - 25-yr = 203.66 m - 50-yr = 203.78 m - 100-yr = 203.83 m - Regional = 204.09 m	Upstream limit (HEC-RAS X-Sect 24.34): - 2-yr = 209.20 m - 5-yr = 209.40 m - 10-yr = 209.52 m - 25-yr = 209.64 m - 50-yr = 209.73 m - 100-yr = 209.85 m - Regional = 210.35 m	
	Existing flood storage volumes (HEC-RAS X-Sect 24.24 to 24.34)*: - 2-yr = 8,400 m^3 - 5-yr = 21,900 m^3 - 10-yr = 37,600 m^3 - 25-yr = 55,200 m^3 - 50-yr = 66,300 m^3 - 100-yr = 76,900 m^3 - Regional = 163,100 m^3		- corridor sized to prevent significant loss to existing flood storage volumes - understood that some storage volume may be lost simply due to a reduction in backwater behind undersized culverts when those structures are replaced in the hydraulic model (i.e. to reflect larger crossings in the future)
Geomorphology	Estimated meander belt width = 58m		- minimum valley floor / floodplain width equal to the meander belt width to allow for future long-term channel migration
	Existing profile: - downstream elevation = 201.3m (HEC-RAS X-Sect 24.24) - upstream elevation = 208.5m (HEC-RAS X-Sect 24.34) - length along centreline = 1,905m - average slope = 0.38%		- match existing upstream & downstream creek invert elevations - open bottom culverts used to facilitate road crossings, spanning bankfull width and potential erosion extents, with natural substrate and low flow channel throughout.
	Planform / Alignment: - typically broad, straightened agricultural swale - confined to narrow trapezoidal channel through Cadetta Road industrial development - length along centreline = 1,905m		- realign reach that currently traverses Cadetta Road development to the west in order to remove existing industrial properties from the floodplain - remainder of reach expected to generally maintain current lowflow channel alignment - for any re-alignment works (e.g. adjacent to Cadetta Road): - creation of riffle-pool type morphology consistent with low-order streams in Southern Ontario. Adjacent Clarkway and Gore tributaries used as reference reaches for meander planforn, sinuosity, stable cross section form and riffle-pool morphology. - slope of riffles ~1%, with extended pool lengths to reduce erosion potential and provide refuge for fish. - use of gravels and cobbles as bed material to provide stable grade control as well as enhance benthic and target fish spawning. - channel length expected to increase with meandering planform, resulting in increased levels of fish habitat, spawing, etc.
SWM			- valley corridor depth to allow for future SWM pond outlets – generally 2-3m - wetland and overhanging vegetation features to provide cooling and further water quality treatment at SWM pond outfalls before discharge into main channel
Slope Stability	- n/a – general lack of valley features		- valley wall sideslopes = max. 5:1 (City design preference)

Design Elements	Existing Characteristics / Constraints / Opportunities	Design Targets
Buffer	none	- minimum 10m stream/valley corridor buffer from top of valley slope (both sides) - buffer width increased to 15m on west side south of TCPL where future city trail is to be located adjacent to proposed sensitive vegetation. Where proposed city trail is located adjacent to proposed valley meadow/marsh vegetation (i.e. adjacent to the Cadetta Road development) the trial may be located within the standard corridor buffer allowance of 10 metres.

* Note - Flood targets based on flood flow rates from 2002 Humber River Hydrology. Targets to be refined based on on-going 2014 TRCA update study.

MASTER ENVIRONMENTAL SERVICING PLAN
BRAM EAST AREA 47

(CASTLEMORE ROAD - MAYFIELD ROAD / THE GORE ROAD - REGIONAL ROAD 50)

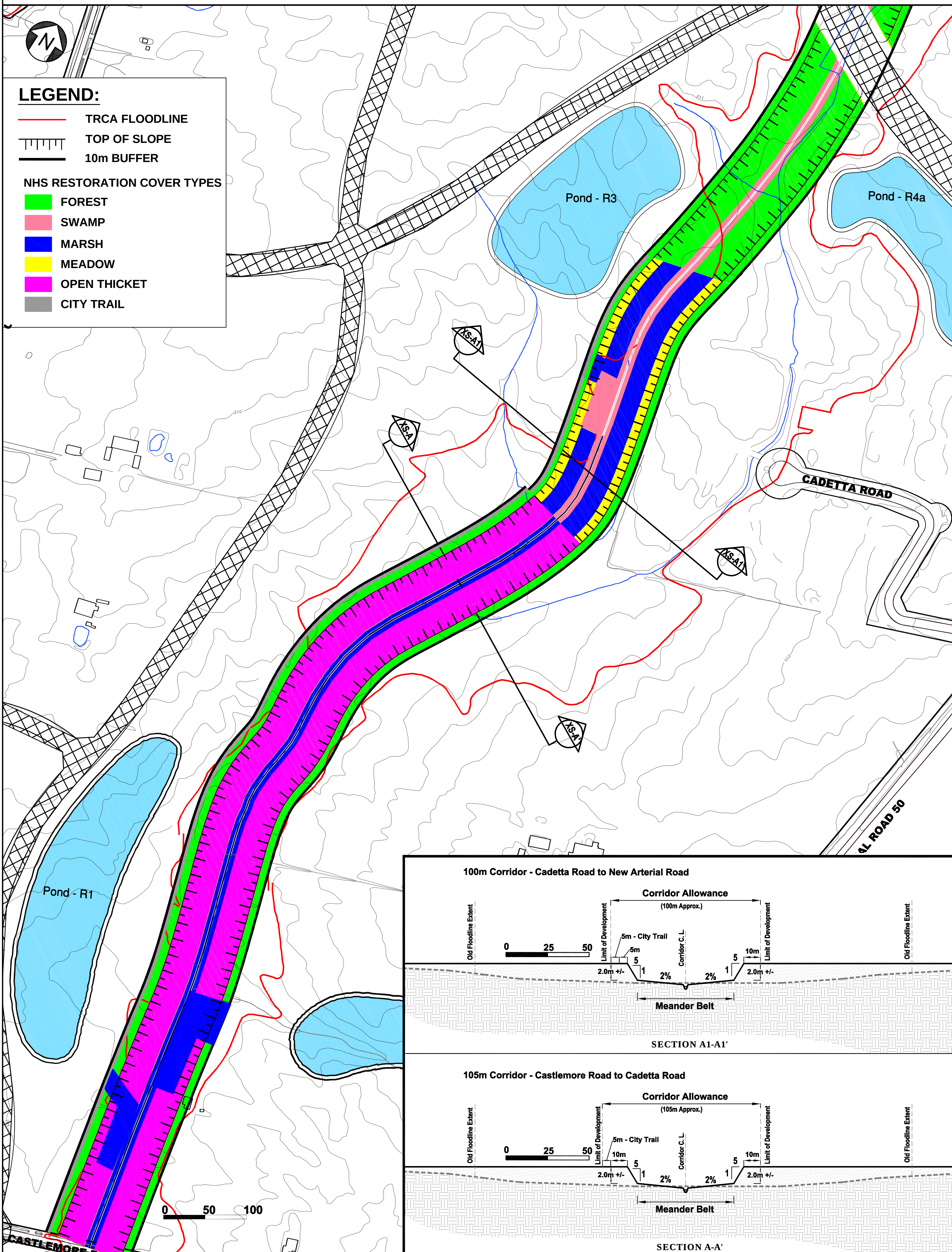

FIGURE - 6.1
RAINBOW CREEK ENHANCEMENT/RESTORATION CONCEPT
SEGMENT 1 - CASTLEMORE ROAD TO FUTURE ARTERIAL ROAD A2

AquafoBeech Limited

Table 6.2: Rainbow Creek Enhancement/Restoration Targets for Segment 2 – Future Arterial Road A2 to Countryside Drive

<table>
<tr><th>Design Elements</th><th colspan="2">Existing Characteristics / Constraints / Opportunities</th><th>Design Targets</th></tr>
<tr><td>Aquatic Habitat</td><td colspan="2">- Classified as Small Riverine Warmwater Habitat
- lack of specialized fish species and piscivores
- no mussels</td><td>- opportunities for fish and mussel habitat enhancement through re-alignment works, if any (see geomorphology targets above)
- wetland and overhanging vegetation features to provide cooling and further water quality treatment at SWM pond outfalls before discharge into main channel
- fully vegetated channel will increase aquatic habitat structure and quality for aquatic wildlife</td></tr>
<tr><td>Terrestrial Features</td><td colspan="2">- woodland #14 (not significant) in lower reaches (little - no impact)
- riparian wetlands:
  - dominant type: reed-canary grass mineral marsh
  - other types: duckweed floating-leaved aquatic (Ag pond #103) and mineral meadow marsh
  - approx. total wetland area affected: 5.46 ha
- Agricultural pond (#103) contains regionally rare flora (dotted watermeal, L3)
- adjacent to fields where Bobolink was recorded
- dotted watermeal, a floating aquatic plant and species of local conservation concern, is easily transplanted and spreads quickly</td><td>- NHS vegetation cover target of 14.99 ha within 100m corridor, including:
  - Woodland = 12.93 ha
  - Wetland = 2.06 ha
    o Swamp = 1.94 ha
    o Marsh = 0.12 ha
- focus on tree planting to increase size of extant significant woodland
- opportunities for most extant wetlands to be incorporated into the design, though that may not be advisable due to prevalence of invasive species
- opportunity for enhancement of species composition and habitat structure
- creation of habitat for target species
- opportunity for transplanting dotted watermeal</td></tr>
<tr><td rowspan="3">Hydrology / Hydraulics</td><td colspan="2">- shallow floodplain, approximately 60m to 175m wide, conveys existing flood flows*:
- 2-yr = 3.2 m^3/s
- 5-yr = 6.2 m^3/s
- 10-yr = 8.8 m^3/s
- 25-yr = 12.0 m^3/s
- 50-yr = 14.5 m^3/s
- 100-yr = 171 m^3/s
- Regional = 46.8 m^3/s</td><td>- new corridor width and depth sized to convey of a full range of flood flows</td></tr>
<tr><td colspan="2">Existing flood levels*:</td><td rowspan="2">- match existing upstream & downstream flood elevations for range of storms
- valley depth selected to allow min. 0.3m freeboard above Regional flood elevation</td></tr>
<tr><td>Downstream limit (HEC-RAS X-Sect 24.34)::
- 2-yr = 209.20 m
- 5-yr = 209.40 m
- 10-yr = 209.52 m
- 25-yr = 209.64 m
- 50-yr = 209.73 m
- 100-yr = 209.81 m
- Regional = 210.35 m</td><td>Upstream limit (HEC-RAS X-Sect 24.43):
- 2-yr = 219.39 m
- 5-yr = 219.83 m
- 10-yr = 220.27 m
- 25-yr = 220.56 m
- 50-yr = 220.68 m
- 100-yr = 220.77 m
- Regional = 220.98 m</td></tr>
</table>

Design Elements	Existing Characteristics / Constraints / Opportunities	Design Targets
	Existing flood storage volumes (HEC-RAS X-Sect 24.34 to 24.43)*: - 2-yr = 7,800 m^3 - 5-yr = 15,500 m^3 - 10-yr = 22,100 m^3 - 25-yr = 29,700 m^3 - 50-yr = 35,000 m^3 - 100-yr = 40,300 m^3 - Regional = 92,000 m^3	- corridor sized to prevent significant loss to existing flood storage volumes - understood that some storage volume may be lost simply due to a reduction in backwater behind undersized culverts when those structures are replaced in the hydraulic model (i.e. to reflect larger crossings in the future)
Geomorphology	Estimated meander belt width = 58m	- minimum valley floor / floodplain width equal to the meander belt width to allow for future long-term channel migration
	Existing profile: - downstream elevation = 208.5m (HEC-RAS X-Sect 24.34) - upstream elevation = 218.5m (HEC-RAS X-Sect 24.43) - length along centreline = 1,626m - average slope = 0.62%	- match existing upstream & downstream creek invert elevations - open bottom culverts used to facilitate road crossings, spanning bankfull width and potential erosion extents, with natural substrate and low flow channel throughout.
	Planform / Alignment: - typically broad, straightened agricultural swale - length along centreline = 1,626m	- most of reach expected to generally maintain current lowflow channel alignment - for any proposed re-alignment works: - creation of riffle-pool type morphology consistent with low-order streams in Southern Ontario. Adjacent Clarkway and Gore tributaries used as reference reaches for meander planforn, sinuosity, stable cross section form and riffle-pool morphology. - slope of riffles ~1%, with extended pool lengths to reduce erosion potential and provide refuge for fish. - use of gravels and cobbles as bed material to provide stable grade control as well as enhance benthic and target fish spawning. - channel length expected to increase with meandering planform, resulting in increased levels of fish habitat, spawing, etc.
SWM		- valley corridor depth to allow for future SWM pond outlets – generally 2-3m - wetland and overhanging vegetation features to provide cooling and further water quality treatment at SWM pond outfalls before discharge into main channel
Slope Stability	- n/a – general lack of valley features	- valley wall side slopes = max. 5:1 (City design preference)
Buffer	none	- minimum 10m stream/valley corridor buffer from top of valley slope (both sides) - no city trails planned within this reach – therefore no additional setback due to trails required.

* Note - Flood targets based on flood flow rates from 2002 Humber River Hydrology. Targets to be refined based on on-going 2014 TRCA update study.

MASTER ENVIRONMENTAL SERVICING PLAN
BRAM EAST AREA 47
(CASTLEMORE ROAD - MAYFIELD ROAD / THE GORE ROAD - REGIONAL ROAD 50)

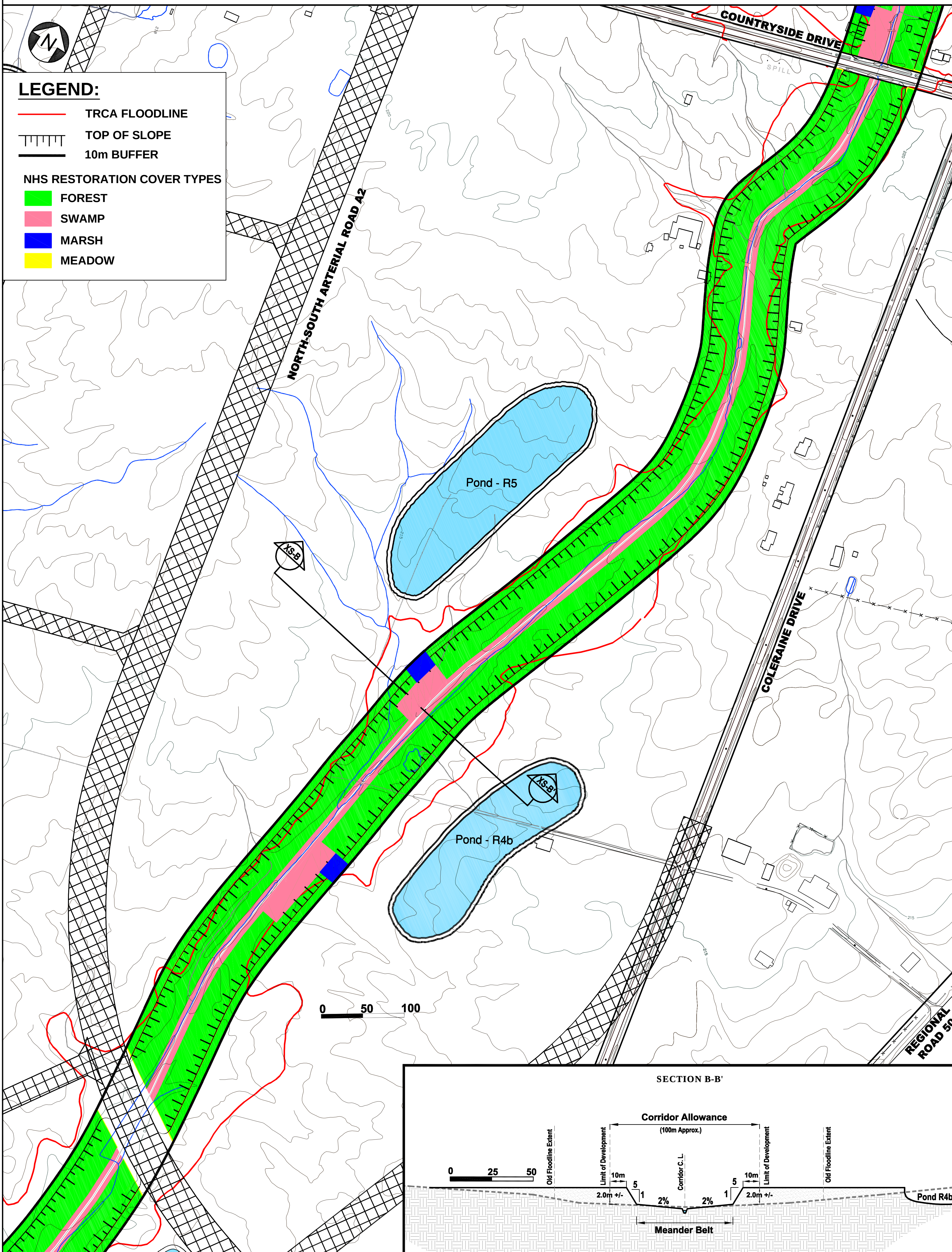

FIGURE - 6.2
RAINBOW CREEK ENHANCEMENT/RESTORATION CONCEPT
SEGMENT 2 - TO FUTURE ARTERIAL ROAD A2 TO COUNTRYSIDE DRIVE

AquafoRBeech Limited
2177 TORBRAM ROAD, BRAMPTON, ONTARIO, L6T 5C5
PHONE: (905) 790-3885, FAX: (905) 790-4090
WEB: www.aquaforbeech.com

Table 6.3: Rainbow Creek Enhancement/Restoration Targets for Segment 3 – Countryside Drive to Mayfield Road

<table>
<tr><th>Design Elements</th><th colspan="2">Existing Characteristics / Constraints / Opportunities</th><th>Design Targets</th></tr>
<tr><td>Aquatic Habitat</td><td colspan="2">- Classified as Small Riverine Warmwater Habitat
- lack of specialized fish species and piscivores
- no mussels
- 2 online agricultural ponds</td><td>- opportunities for fish and mussel habitat enhancement through re-alignment works adjacent to Colerain Drive (see geomorphology targets above)
- wetland and overhanging vegetation features to provide cooling and further water quality treatment at SWM pond outfalls before discharge into main channel
- fully vegetated channel will increase aquatic habitat structure and quality for aquatic wildlife, including target species such as Redside Dace and chimney crayfish.</td></tr>
<tr><td>Terrestrial Features</td><td colspan="2">- adjacent to fields where Bobolink and Eastern Meadowlark were found
- riparian wetlands:
-dominant type: reed-canary grass mineral marsh
- other types: cattail mineral shallow marsh and mineral shallow marsh
- approx. total wetland area affected: 1.54 ha</td><td>- NHS vegetation cover target of 13.53 ha within 100m corridor, including:
- Woodland = 11.94 ha
- Wetland = 1.59 ha
o Swamp = 1.53 ha
o Marsh = 0.06 ha
- any realignment of channel adjacent to Colerain Drive to enhance terrestrial corridor connectivity
- opportunity for enhancement of wetland species composition and habitat structure. Existing wetlands contain exotic invasive species (reed canary grass, narrow-leaved cattail);
- creation of habitat for target species</td></tr>
<tr><td rowspan="3">Hydrology / Hydraulics</td><td colspan="2">- shallow floodplain, approximately 50m to 150m wide, conveys existing flood flows*:
- 2-yr = 3.2 m^3/s
- 5-yr = 6.2 m^3/s
- 10-yr = 8.8 m^3/s
- 25-yr = 12.0 m^3/s
- 50-yr = 14.5 m^3/s
- 100-yr = 171 m^3/s
- Regional = 46.8 m^3/s</td><td>- new corridor width and depth sized to convey of a full range of flood flows</td></tr>
<tr><td colspan="2">Existing flood levels*:</td><td rowspan="2">- match existing upstream & downstream flood elevations for range of storms
- valley depth selected to allow min. 0.3m freeboard above Regional flood elevation</td></tr>
<tr><td>Downstream limit (HEC-RAS X-Sect 24.43):
- 2-yr = 219.39 m
- 5-yr = 219.83 m
- 10-yr = 220.27 m
- 25-yr = 220.56 m
- 50-yr = 220.68 m
- 100-yr = 220.77 m
- Regional = 220.98 m</td><td>Upstream limit (HEC-RAS X-Sect 24.52):
- 2-yr = 228.07 m
- 5-yr = 228.25 m
- 10-yr = 228.36 m
- 25-yr = 228.45 m
- 50-yr = 228.51 m
- 100-yr = 228.57 m
- Regional = 228.99 m</td></tr>
</table>

Design Elements	Existing Characteristics / Constraints / Opportunities	Design Targets
	Existing flood storage volumes (HEC-RAS X-Sect 24.43 to 24.52)*: - 2-yr = 7,300 m^3 - 5-yr = 17,700 m^3 - 10-yr = 23,000 m^3 - 25-yr = 34,900 m^3 - 50-yr = 41,900 m^3 - 100-yr = 46,900 m^3 - Regional = 92,100 m^3	- corridor sized to prevent significant loss to existing flood storage volumes - understood that some storage volume may be lost simply due to a reduction in backwater behind undersized culverts when those structures are replaced in the hydraulic model (i.e. to reflect larger crossings in the future)
Geomorphology	Estimated meander belt width = 58m	- minimum valley floor / floodplain width equal to the meander belt width to allow for future long-term channel migration
	Existing profile: - downstream elevation = 218.5m (HEC-RAS X-Sect 24.43) - upstream elevation = 227.5m (HEC-RAS X-Sect 24.52) - length along centreline = 1,358m - average slope = 0.66%	- match existing upstream & downstream creek invert elevations - open bottom culverts used to facilitate road crossings, spanning bankfull width and potential erosion extents, with natural substrate and low flow channel throughout.

	Planform / Alignment:
	- typically broad, straightened agricultural swale
	- recently re-aligned and confined to roadside ditch along east side of Coleraine Drive.
	- length along centreline = 1,358m
		- Ultimate alignment and crossing location at Coleraine Drive to be determined through future road improvement EA.
		- remainder of reach expected to generally maintain current lowflow channel alignment
		- for any re-alignment works (e.g. adjacent to Coleraine Drive):
		  - creation of riffle-pool type morphology consistent with low-order streams in Southern Ontario. Adjacent Clarkway and Gore tributaries used as reference reaches for meander planforn, sinuosity, stable cross section form and riffle-pool morphology.
		  - slope of riffles ~1%, with extended pool lengths to reduce erosion potential and provide refuge for fish.
		  - use of gravels and cobbles as bed material to provide stable grade control as well as enhance benthic and target fish spawning.
		  - channel length expected to increase with meandering planform, resulting in increased levels of fish habitat, spawing, etc.

SWM		- valley corridor depth to allow for future SWM pond outlets – generally 2-3m - wetland and overhanging vegetation features to provide cooling and further water quality treatment at SWM pond outfalls before discharge into main channel
Slope Stability	- n/a – general lack of valley features	- valley wall sideslopes = max. 5:1 (City design preference)
Buffer	None. The nearby flat land is currently in agriculture.	- minimum 10m stream/valley corridor buffer from top of valley slope (both sides) - no city trails planned within this reach, therefore no additional setback due to trails required.

* Note - Flood targets based on flood flow rates from 2002 Humber River Hydrology. Targets to be refined based on on-going 2014/15 TRCA update study.

MASTER ENVIRONMENTAL SERVICING PLAN
BRAM EAST AREA 47
(CASTLEMORE ROAD - MAYFIELD ROAD / THE GORE ROAD - REGIONAL ROAD 50)

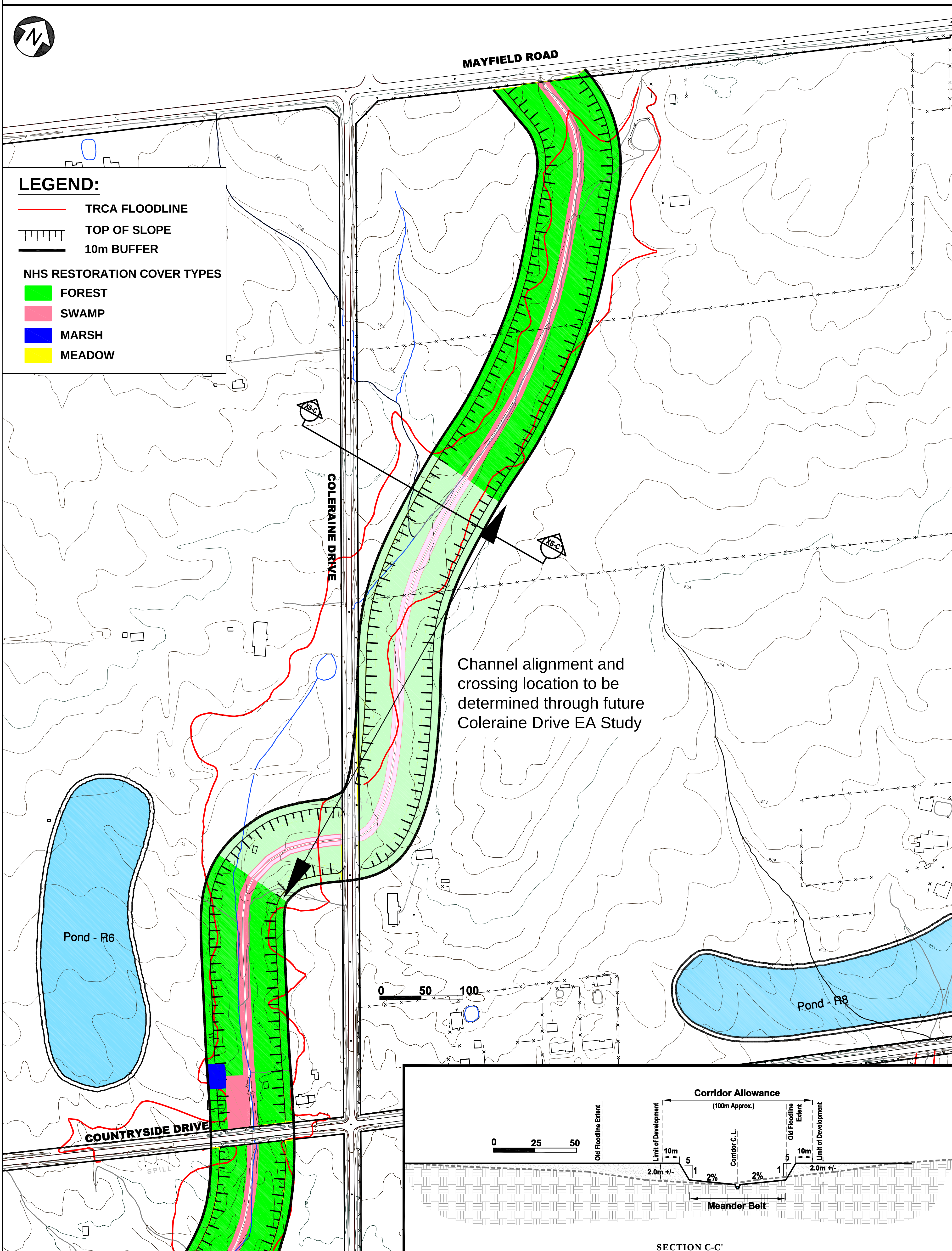

FIGURE - 6.3
RAINBOW CREEK ENHANCEMENT/RESTORATION CONCEPT
SEGMENT 3 - COUNTRYSIDE DRIVE TO MAYFIELD ROAD

AquafoBeech Limited
8177 TORBRAM ROAD, BRAMPTON, ONTARIO, L6T 5C5
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WEB: www.aquaforbeech.com

6.2 Hydraulic Modelling Assessment

A preliminary assessment of the proposed Rainbow Creek Tributary modification works was undertaken in order to confirm that the proposed 100m corridor width would be sufficient to convey the Regulatory flood flows and to assess the impacts of the proposed modifications on flood storage within the corridor.

The HEC-RAS hydraulic model for Rainbow Creek Tributary was modified to reflect the proposed corridor configuration and valley dimensions over the study area from Castlemore Road to Mayfield Road. Model results are provided in **Appendix L**, and summarized in **Table 6.4** and **Table 6.5**. As shown, the modelling indicates that the proposed corridor would have sufficient capacity to convey the Regional Storm flow with freeboard ranging from roughly 0.5m to 1.5m.

In terms of flood storage, the proposed corridor configuration would preserve or moderately increase flood storage volumes for the 2-year through 100-year flood events. Model results indicate that some flood storage may be lost for the Regional Storm event. This is attributed primarily to the existing wide floodplain near Cadetta Road in the lower reach (Segment 1), and the fact that the modified stream length is moderately lower due to creek / corridor re-alignment at this location to remove Cadetta Road and the industrial properties from the floodplain.

It should also be noted that, due to existing undersized culverts at Old Castlemore Road and Countryside Drive, storage volumes are "artificially" inflated somewhat within the existing floodplain due to backwater caused by these crossing structures. This storage will be lost when these culverts are ultimately replaced. As such, the modelling included a scenario in which the existing structures were removed in order to provide a better comparison to the future corridor condition.

6.2.1 Implementation

The conceptual sizing identified through the MESP will need to be confirmed and/or refined through preliminary and detailed design during the future planning stages. For example, further hydraulic modelling, grading plans, and technical analyses will need to be completed to ensure that the proposed corridor will convey the complete range of flood flows, and preserve existing flood storage volumes. Further details would be co-ordinated with the stormwater management and grading plans for the adjacent development lands. Restoration, grading, planting and landscaping plans will also need to confirm that the overall NHS coverage targets are met, including woodland, meadow and wetland targets. Further detailed implementation recommendations are provided in **Section 8.1.6.**

Table 6.4

Rainbow Creek Enhancement / Restoration Concept
Proposed Flood Levels & Freeboard

Proposed corridor:
- 2m low flow channel width
- 60m floodplain at 2%
- 2m valley walls at 5:1 slope
- 80m total valley width (100m with additional 10m buffer on either side)
- new bridge openings approx. 12m W x 2.25m H

Cross-section	Existing Invert (m)	Proposed Invert (m)	Proposed Top of Valley (m)	Regional Water Level (m)	Freeborad (m)
25.52	227.5	227.5	230.78	229.07	1.71
24.51	225.5	225.5	228.78	227.24	1.54
24.5	224.5	224.5	227.78	226.4	1.38
24.49	222.7	223.5	226.78	225.34	1.44
24.48	222				
24.475	Coleraine Drive				
24.47	222				
24.46	221.5	222.6	225.88	224.16	1.72
24.45	221	221	224.28	223.82	0.46
24.443		220.8	224.08	223.42	0.66
24.4425		Coleraine Drive			
24.442		220.8	224.08	222.89	1.19
24.441		220	223.28	222.07	1.21
24.44	219.5	219.5	222.78	221.91	0.87
24.43	218.5	218.5	221.78	221.12	0.66
24.425	Countryside Drive	Countryside Drive			
24.42	218.5	218.5	221.78	220.59	1.19
24.41	216.5	216.5	219.78	218.31	1.47
24.4	215.5	215.5	218.78	217.15	1.63
24.39	214.5	214.5	217.78	216.46	1.32
24.38	213.5	213.5	216.78	215.06	1.72
24.37	211.5	211.5	214.78	213.53	1.25
24.36	210.5	210.5	213.78	212.28	1.5
24.35	209.5	209.5	212.78	211.58	1.2
24.345		208	211.28	210.48	0.8
24.342		Future Arterial Road			
24.34	208.5	208	211.28	210.38	0.9
24.33	208	208	211.28	210.08	1.2
24.32	207.5	207.5	210.78	209.38	1.4
24.31	207	207	210.28	209.07	1.21
	Cadetta Drive				
24.3	207	207	210.28	208.61	1.67
24.29	206	206	209.28	207.91	1.37
24.28	205	205	208.28	207.03	1.25
24.27	204	204	207.28	205.98	1.3
24.26	203	203	206.28	205.03	1.25
24.25	202	202	205.28	204.74	0.54
24.24	201.3	201.3	204.58	204.11	0.47
	Old Castlemore Road	Old Castlemore Road			

Table 6.5

Rainbow Creek Enhancement / Restoration Concept
Comparison of Flood Storage Volumes

Proposed corridor:
- 2m low flow channel width
- 60m floodplain at 2%
- 2m valley walls at 5:1 slope
- 80m total valley width (100m with additional 10m buffer on either side)
- new bridge openings approx. 12m W x 2.25m H

		Segment 1 (Castlemore Rd to new Arterial A2)			
Flood Storage Volume		Existing	Existing w/out roads*	Proposed	Change
2-year	(1000 m3)	8.4	8.2	16.6	8.3
5-year	(1000 m3)	21.9	21.1	33.1	12.1
10-year	(1000 m3)	37.6	33.6	44.8	11.2
25-year	(1000 m3)	55.2	50.2	56.9	6.8
50-year	(1000 m3)	66.3	60.3	66.1	5.8
100-year	(1000 m3)	76.9	70.2	74.3	4.0
Regional	(1000 m3)	163.1	163.7	135.4	-28.2

		Segment 2 (new Arterial A2 to Countryside Dr)			
Flood Storage Volume		Existing	Existing w/out roads*	Proposed	Change
2-year	(1000 m3)	7.8	7.7	10.9	3.2
5-year	(1000 m3)	15.5	15.3	21.1	5.8
10-year	(1000 m3)	22.1	21.7	28.6	7.0
25-year	(1000 m3)	29.7	29.0	36.4	7.4
50-year	(1000 m3)	34.9	34.3	42.2	7.9
100-year	(1000 m3)	40.3	39.7	47.3	7.6
Regional	(1000 m3)	92.0	90.7	91.0	0.3

		Segment 3 (Countryside Dr to Mayfield Rd)			
Flood Storage Volume		Existing	Existing w/out roads*	Proposed	Change
2-year	(1000 m3)	7.3	5.2	8.7	3.6
5-year	(1000 m3)	17.7	11.7	18.4	6.7
10-year	(1000 m3)	23.0	17.3	25.8	8.6
25-year	(1000 m3)	34.9	23.5	33.8	10.3
50-year	(1000 m3)	41.9	28.1	39.9	11.8
100-year	(1000 m3)	46.9	33.5	45.2	11.7
Regional	(1000 m3)	92.1	79.5	95.4	15.9

		All Segments 1, 2, 3 (Castlemore Rd to Mayfield Rd)			
Flood Storage Volume		Existing	Existing w/out roads*	Proposed	Change
2-year	(1000 m3)	23.4	21.1	36.2	15.1
5-year	(1000 m3)	55.1	48.0	72.6	24.6
10-year	(1000 m3)	82.7	72.5	99.3	26.8
25-year	(1000 m3)	119.7	102.6	127.2	24.5
50-year	(1000 m3)	143.2	122.7	148.1	25.5
100-year	(1000 m3)	164.1	143.5	166.8	23.4
Regional	(1000 m3)	347.2	333.8	321.8	-12.0

* removes the storage due to backwater behind existing undersized road culverts

6.3 Natural Heritage

Currently, natural heritage features associated with Rainbow Creek consist of meadow marsh communities dominated by invasive species (i.e. *Phalaris arundinacea*, reed canary grass), cultural meadows, and a cultural woodland community. With the exception of hedgerow 62, adjacent hedgerows are dominated by non-native and in some cases, invasive woody species (i.e. European Buckthorn). It is known that Redside Dace (a species at risk) has been recorded downstream of the study site, but has not been recorded in the portion of Rainbow Creek within the Area 47 SPA. Other species at risk; including Barn Swallow, Bobolink, and Eastern Meadowlark; have been recorded within the vicinity.

The restoration of the Rainbow Creek corridor represents an opportunity to increase the amount of natural cover in the Rainbow Creek Tributary corridor and in the Area 47 SPA as well as the ecological function of the NHS. As previously mentioned, the Rainbow Creek corridor will be restored from Mayfield Road to Castlemore Road. Active restoration of the corridor associated with the floodplain modifications presents multiple benefits over passive naturalization, namely that the ecological quality of the restored area will be greater than what could reasonably be anticipated under a passive naturalization scenario. For example, the restoration of the Rainbow Creek corridor will involve the removal of invasive species, creation of diverse vegetation communities and habitats, monitoring (see **Sections 0** and **9.5**), and potential increase of habitat available to Redside Dace, a species that has been confirmed downstream of Castlemore Road. Under a passive naturalization scenario, it is probable that natural succession in the area within the Rainbow Creek floodplain would include the spread of invasive exotic species (without active management), as nearby seed sources for other/more desirable species are limited.

Natural cover (which is different from overall NHS land base) within the Area 47 SPA currently amounts to 76.49 ha, representing 6.30% of total study area land base; under the post-development scenario, with the proposed restoration works in the Rainbow Creek corridor, natural cover within the Area 47 SPA would total 109.25 ha, representing a 2.70% increase in total land area under natural cover (see **Table 6.7**).. Vegetation community types proposed within the Rainbow Creek corridor were selected to address the vegetative cover shortcomings identified in the Humber River Watershed Plan (TRCA, 2008) and the *How Much Habitat is Enough?* guidelines (Canadian Wildlife Service, 2013). Analysis of extant natural cover against the recommendations in the aforementioned publications resulted in the identification of two natural cover types of priority for the Area 47 SPA: wetlands and woodlands. To address these priorities, it was decided that a significant portion of the Rainbow Creek corridor should be restored to swamp and forest/woodland communities. It is critical to note that the proposed restoration measures within the Realigned Rainbow Creek corridor are not intended to mitigate losses of natural heritage features elsewhere in the study area. Losses of other natural heritage features outside of the Rainbow Creek corridor will be addressed through natural feature creation/restoration primarily along the Gore Road Tributary and Clarkway Tributary corridors, and to a lesser extent in the West Humber and Robinson Creek corridors (see **Section 5**).

While the amount of land base within the Rainbow Creek corridor (which includes hazard lands) is reduced by 26.46 ha, the quality of natural cover within the subwatershed is increased through restoration efforts within the corridor and the adjacent east-west wildlife corridor/linkage. A summary of natural cover in the study area, including the existing and proposed Rainbow Creek corridor, is provided below in **Table 6.7**, with a summary of each natural cover type in each of the three segments of the Rainbow Creek corridor provided in **Table 6.6**. The total area occupied by the Natural Heritage System; which includes lands occupied by natural cover, restoration areas for mitigating the loss of tableland vegetation, hazard lands, and associated minimum buffers; is summarized in **Table 6.8** according to tributary catchment (existing tributary catchments are illustrated in **Appendix K1**). In **Tables 6.7** and **6.8**, statistics include mitigation for natural features proposed for removal (detailed in **Section 5.1.1**). Statistics do not include lands within proposed east-west wildlife corridors outside of the above listed land use types.

Table 6.6: Summary of Proposed Natural Cover Types in the Rainbow Creek Corridor

Natural Cover Type	Area (hectares)			
	Segment 1	Segment 2	Segment 3	Total
Forest	5.43	12.93	11.94	30.30
Swamp	0.65	1.94	1.53	4.12
Marsh	3.39	0.12	0.06	3.57
Meadow	0.72	0.00	0.00	0.72
Mid-Successional Communities†	6.71	0.00	0.00	6.71
Total:	*16.90*	*14.99*	*13.53*	***45.42***

†Open thicket

Table 6.7: Summary of Natural Cover Statistics Under Two Development Scenarios Related to the Proposed Realignment of the Rainbow Creek Corridor

Vegetation Community Type	Area 47 study area post-development, no restoration in proposed Rainbow Creek Corridor		Extant natural cover lost or affected by the realignment of Rainbow Creek	Natural Cover in Restored Rainbow Creek		Area 47 study area post development, with restoration in all tributaries	
	Area of natural cover (ha)	% Coverage in Study Area	Area of natural cover (ha)	Area of natural cover (ha)	% Cover in Rainbow Creek corridor	Area of natural cover (ha)	% Coverage in Study Area
Woodland/forest/plantation	8.79	0.72%	0.11	30.30	64.97%	38.98	3.21%
Wetland, swamp †	3.85	0.32%	0.00	4.12	8.83%	7.97	0.66%
Wetland, marsh and shallow aquatic	17.54	1.44%	10.70	3.57	7.65%	10.41	0.86%
Mid-successional Communities	15.73	1.30%	0.00	6.71	14.39%	22.44	1.85%
Cultural Meadow ‡	34.23	2.82%	1.85	0.72	1.54%	33.10	2.73%
Total natural cover:	*80.14*	*6.60%*	*12.66*	*45.42*	97.38%*	112.90	*9.30%*
					*missing percentage = road crossings (2.62)	**+32.76**	**+2.70%**

Difference in natural cover compared to "Post-Development, no restoration in proposed Rainbow Creek corridor"

† includes both deciduous treed swamp and deciduous thicket swamp.

‡ cultural meadow outside of the valley lands are excluded from the calculation of total pre-development cultural meadow cover (tableland meadow cover is a function of farming practice and thus fluctuates from year to year). It follows that the area would be unchanged post-development without NHS mitigation/restoration.

Table 6.8: Summary of Land Area within the Area 47 SPA Natural Heritage System

	Robinson Creek	Rainbow Creek	Clarkway Tributary	Gore Road Tributary	West Humber River	Area 47 SPA Natural Heritage System	
						Area	% of Total Study Area
Total area (ha) without proposed Rainbow Creek corridor Restoration	3.33	75.24*	79.71	62.98	1.81	223.06	18.37%
Total area (ha) within proposed Rainbow Creek Corridor restoration	3.33	48.78	79.71	62.98	1.81	195.59	16.19%
					Difference	26.66	2.18%

*excludes the area of floodplain currently occupied by the Cadetta Road development

6.3.1 Implementation

To address natural cover targets for the Area 47 SPA, high-level conceptual maps (Figure 6.1: to Figure 6.3) were created of the extent and types of natural cover that is recommended within the proposed Rainbow Creek corridor. The specifics of the restoration plans; e.g. construction, planting, and monitoring; are to be undertaken as part of future EIR and/or interdisciplinary EIS studies. In order to meet the natural cover targets within the Area 47 SPA and Rainbow Creek corridor, the high-level conceptual maps presented in this report must be followed to the extent possible. The study team recognises that there may be some circumstances where slight non-adherence to the plan proposed in this document may be warranted. Monitoring recommendations are outlined in **Section 9**.

As mentioned above, the Rainbow Creek corridor has been divided into three reaches. The proposed restoration plan is intended to be implemented holistically along each reach. Accordingly, early and ongoing coordination amongst landowners is strongly recommended. It is also recommended that restoration plantings consist of locally native species, in accordance with the TRCA's guidelines.

Trails

The Community Design Framework (Figure 5.4) illustrates a pathway along the Rainbow Creek Tributary from Castlemore Road to Mayfield Road. However, the majority of lands east and west of the corridor are employment lands, with residential development limited to west of the corridor, adjacent to Segment 1, from just north of Arterial Road A2 south to Castlemore Road. The pedestrian trail will likely only be developed adjacent to this reach.

As previously mentioned, the ecological objectives for the Rainbow Creek Tributary corridor include mitigating the loss of NHS land base through achieving significant terrestrial and aquatic habitat enhancement and restoration. The buffer width along Rainbow Creek, from Castlemore Road to the TCPL corridor, will be variable from the minimum 10 m (in areas of meadow restoration) to 15 m in order to accommodate the proposed pedestrian trail.

East-West Corridor/Linkages

A key component in the restoration and enhancement strategy for the Rainbow Creek Tributary corridor is the provision of strengthened north-south linkages within the corridor as well as east-west linkages between the Gore Road, Clarkway and Rainbow Creek Tributary systems. As part of the provision of ecological benefit to the Rainbow Creek corridor and the greater SWS study area, a wildlife corridor is proposed between the Gore Road Tributary, Clarkway Tributary, and the Rainbow Creek tributary corridor on the Trans Canada Pipeline (TCPL) lands. As detailed in **Section 8.2.6**, the goal of the east-west corridor is to facilitate the movement of wildlife between the aforementioned tributaries, and to compensate for the loss of land base to the existing Rainbow Creek NHS. To achieve this goal, several parameters should be considered, e.g. the creation of a structurally diverse corridor and adjacent land uses.

Design considerations, including but not limited to landscaping, restoration, traffic calming, ecopassages, etc., will be addressed at future planning stages. Provided effective design principles are followed and wildlife species are similar to those presently known to occur in the study area, the recommended minimum width for the east-west corridor between the Clarkway and Rainbow Creek tributaries is 30 metres (Fernandez-Juricic et al., 2001; Fischer and Fischenich, 2000).

Locally Rare Species

Several locally rare species were recorded within the extant Rainbow Creek and in the Rainbow Creek HDFs. With so little natural heritage features within the Area 47 SPA, the protection of rare species is important to the overall ecological function of the subwatershed and to the greater natural heritage system within the West Humber River watershed, the City of Brampton, and beyond. Accordingly, it is recommended that locally rare species (i.e. Switchgrass, Dotted Watermeal, Freeman's Maple, Amethyst Aster) be transplanted into suitable habitat within the restored Rainbow Creek corridor as appropriate (see **Figure 2.18**, **Figure 2.19**, and **Figure 2.21** for species locations). In cases where the size of the individual precludes transplant, as could be the case with Freeman's Maple, it is suggested that seed be collected and grown for future plantings within the Rainbow Creek corridor or nursery stock grown from seed collected from Tree Seed Zone 34. It is further recommended that opportunities for transplanting the locally rare Long-leaved Pondweed, present in ELC Polygon 93 and Great Duckweed in ELC Polygon 92, as well as moving Leopard Frog and Chimney Crayfish to suitable areas within the Rainbow Creek corridor be explored. Note that that best time to identify and transplant Flat-leaved Pondweed is during the spring when the plant is visibly out of its winter dormancy.

7 SUMMARY: AREA 47 MASTER ENVIRONMENTAL SERVICING PLAN

Sections 4 to **6** of the report reviewed the potential environmental impacts from future development within the Area 47 study area and formulated a comprehensive set of stormwater/drainage and natural heritage recommendations to mitigate these impacts. Collectively these stormwater management and natural heritage strategies comprise the recommended Master Environmental Servicing Plan to protect and enhance the Area 47 natural resources as the future land use changes take place. A summary of the key components of the plan is provided below and illustrated in **Figure 7.1**.

7.1 Stormwater Management

A "treatment train" approach to stormwater management is recommended for the Area 47 study area consisting of both state-of-the art LID controls and traditional end of pipe stormwater ponds. The stormwater controls will be supplemented through further downstream drainage and corridor improvement works. In summary, the main components of the MESP associated with stormwater management include:

- 5mm of rainfall for all impervious surfaces is to be retained on-site and treated using LID source and conveyance control measures to mitigate water balance impacts, and to provide water quality, erosion control and environmental benefits;
- Design of LID swales (rear/side lot bioswales or valley slope swales) connected to the natural heritage system to mitigate the loss of small HDFs that are to be removed (i.e. "Mitigation 1" or "Mitigation 2" classifications); and
- End-of-pipe stormwater management ponds with permanent pool and extended detention storage for water quality, erosion control, and flood (quantity) control.

Additional recommended downstream drainage and environmental improvements to be implemented include:

- Combined stream restoration/enhancement and grading works on the Rainbow Creek Tributary to improve aquatic and terrestrial habitat, enhance the ecosystem diversity of the corridor, reduce existing flood impacts, and to improve the ability to outlet adjacent stormwater facilities; and
- Adequately sized future roadway crossing structures to allow for flood conveyance and improved fish and wildlife passage.

7.1.1 Stormwater Management Facilities

A suite of LID source and conveyance control measures is available to meet the 5mm retention target and to replicate the conveyance and water quality function of small HDFs to be removed as part of future urban development:

- Options for residential land uses may include rainwater harvesting, soakaway pits, downspouts directed to enhanced topsoil areas, bioretention (rain gardens), permeable pavement and grass/bio swales;
- Options for employment land uses may include rainwater harvesting, green roofs, soakaway pits, downspouts directed to enhanced topsoil areas, bioretention units, permeable pavement, filter strips and grass/bio swales.

It should be noted that the large rooftop and parking areas associated with employment landuses represent opportunities to implement some LID measures on a larger more intense scale than on residential lands, such as rainwater harvesting and permeable pavement.

Target lengths of HDF features to be replicated within each of the Area 47 stormwater catchments are listed in **Table 4.4**. Selection and future design of the appropriate LIDs will begin at the block planning stage, and should be undertaken using the guidance from the 2010 TRCA Low Impact Development Planning and Design Guidelines as well as applicable City of Brampton stormwater management design standards.

As shown in Figure 7.1, the MESP includes 27 stormwater management ponds to service the Area 47 development lands. Conceptual sizing of the ponds was undertaken in **Section 4.2.1** to estimate storage volumes and land requirements. The conceptual sizing includes the following:

- For Level 1 (Enhanced) water quality control, approximately 90 m^3/ha to 210 m^3/ha of permanent pool storage, depending on land uses;
- For erosion control, approximately 125 m^3/ha to 200 m^3/ha of extended detention storage, depending on land use, for capture and gradual release of a 25 mm event over 48 hours (main tributaries) or 120 hours (HDF's);
- For flood (quantity) control, extended detention storage of approximately 450 m^3/ha, on average, for residential lands to approximately 600 m^3/ha, on average, for employment lands, in order to provide post-to-pre runoff control;

Based on the above storage requirements, land requirements are estimated to occupy between roughly 4% to 11% of the development area. The ultimate sizing and land requirements for the ponds will vary depending on a number of design factors such as grading, storage depths, outlet depths, shape and general configuration of the facilities.

7.1.2 Drainage and Environmental Enhancements

The proposed Rainbow Creek Tributary realignment offers a significant opportunity to combine stream restoration and enhancement works with adjacent grading works to create a much healthier, ecologically diverse, and better-defined stream and valley corridor system than exists today, while also providing additional flood hazard and stormwater benefits. The existing stream corridor lacks a valley feature over most of its reach, has poor channel definition and very little riparian cover other than meadow grasses. The recommended stream restoration and grading improvements include:

- Creation of a well-defined 100-105 m stream and valley corridor to meet the flood conveyance, natural heritage, and stormwater servicing design objectives;

- Re-alignment works to eliminate floodplain impacts near the existing Cadetta Road industrial subdivision, and at Coleraine Drive where recent modifications have diverted the creek into the roadside ditch;

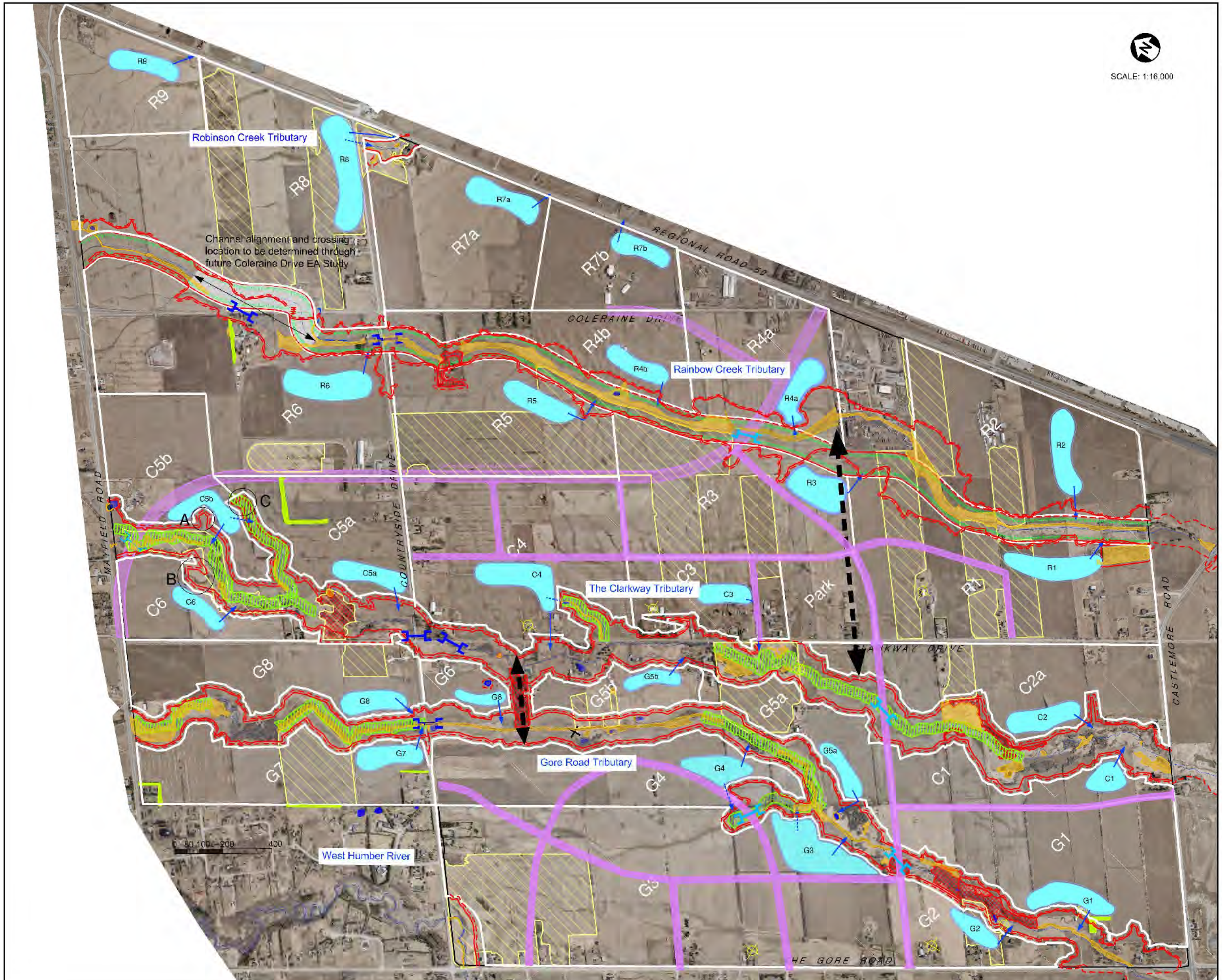
- Mitigation of the loss of NHS floodplain coverage through extensive restoration plantings to create 45.42 ha of diverse natural cover, consisting of targeted woodland, meadow, and wetland species.

The recommended corridor restoration/enhancement and grading improvements are illustrated conceptually in **Figure 7.1**. Such works will offer multiple ecological, economic and engineering benefits to the City, TRCA, and the landowners, including:

- Reduction in flood hazards;
- Significant increase in development lands;
- Improved stormwater servicing and water quality treatment;
- More robust and resilient ecosystem than would be expected through gradual long-term regeneration of the existing poorly-defined floodplain;
- A net increase in the natural vegetation cover over the MESP study area;
- Improved east-west terrestrial linkage between the Rainbow Creek valley corridor and the Clarkway Tributary corridor; and,
- Improved north-south terrestrial and aquatic linkage within the valley corridor.

Further drainage recommendations and environmental improvements within Area 47 focus on the bridge/culvert structures associated with the existing and proposed future roadways. The locations of anticipated new watercourse crossing structures are illustrated in **Figure 7.1**. Design recommendations for these structures include:

- Hydraulic design to meet capacity and frequency of flooding criteria for the roadway;
- Prevention of any increases to existing flood levels on adjacent lands;
- Elimination of existing floodplain spills on Rainbow Creek at Coleraine Drive and Countryside Drive;
- Erosion/scour protection;
- Provision of open bottom structures with a defined low-flow channel for fish passage; and,
- Use of TRCA's draft Road Crossing Guidelines document to establish opening spans that consider ecological factors. As a minimum, openings should span twice the bankfull width to allow for small wildlife passage.



MASTER ENVIRONMENTAL SERVICING PLAN AREA 47

LEGEND:

- STUDY AREA
- WATERCOURSE
- PROPOSED ROAD
- A SPECIAL POLICY AREAS

NATURAL HERITAGE STRATEGY

NO DEVELOPMENT

Protect Natural Heritage System:

- STREAM/VALLEY CORRIDOR
- SIGNITICANT WOODLANDS/WOODLOTS
- WETLAND FEATURES TO BE RETAINED
- AGRICULTURAL POND TO BE PROTECTED
- NATURAL FEATURE BUFFERS

FUTURE STUDY TO ASSESS DEVELOPMENT/ PROTECTION STATUS

- SAR HABITAT/NESTS - MNR consultation

ECOSYSTEM PROTECTION/ENHANCEMENT

- PROOSED 100m - 105m RAINBOW CREEK CORRIDOR RESTORATION AND ENHANCEMENT
- HEDGEROWS TO PROTECT, WHERE FEASIBLE
- RIPARIAN PLANTINGS
- FISH BARRIER REMOVAL
- WILDLIFE CORRIDORS

Note: A minimum of 3.3 ha of a tableland vegetation losses must be accounted for through tableand restoration in additional to NHS areas shown on this map

STORMWATER MANAGEMENT AND DRAINAGE

STORMWATER MANAGEMENT FACILITIES

- STORMWATER MANAGEMENT POND
  - -Level 1 water quality control
  - -Erosion Control (25mm/48hrs)
  - -Post-to-Pre flood control
- CATCHMENT BOUNDARY

LID Source and Conveyance Controls:
- 5mm retention over all development lands
- LID swales to mitigate loss of HDFs

DRAINAGE/ECOSYSTEM ENHANCEMENT

WATERCOURSE CROSSINGS IMPROVEMENTS
- -- NEW
- -- REPLACEMENT

MASTER ENVIRONMENTAL MANAGEMENT PLAN

FIGURE 7.1

AQUAFOR PROJECT NO.: 64608

AquaforBeech Limited

BRAMPTON Flower City

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7.2 Natural Heritage Summary

The key elements of the Natural Heritage Strategy for Area 47 are illustrated in **Figure 7.1** and include the following:

- Protection of natural features from development, including stream and valley corridors, significant woodlands, woodlots, wetlands, and specific agricultural ponds;
- Identification of three (3) Special Policy Areas (SPAs) in the Clarkway Tributary that recognize opportunities to improve corridor functions through future grading modifications, subject to future study (see Section 8);
- Provision of appropriate buffers to these natural features;
- Identification of wetland feature locations where further consultation with TRCA is recommended to confirm the protection or removal and mitigation status. It is understood that wetland features within the limits of the stream and valley corridor will be protected;
- Strengthening of the east-west woodland corridor connection (ELC polygon 58) between the Gore Road Tributary and Clarkway Tributary;
- Creation of an east-west linkage between the Rainbow Creek Tributary and the Clarkway Tributary corridors.

Additional environmental protection and enhancement recommendations include:

- Preservation of five healthy hedgerow features within the future Area 47 urban landscape, along with elimination of invasive vegetation within these features;
- Potential preservation of existing hedgerows located on the estate residential lots;
- Riparian plantings to improve aquatic habitat and shading over targeted reaches of the Gore Road Tributary and Clarkway Tributary;
- Native plantings within the Natural Heritage System buffers;
- Removal of a fish barrier on the Gore Road Tributary and Clarkway Tributary;
- Future trails shall be planned and designed to conserve the natural heritage system. Where trails are proposed within the NHS that will impact significant natural features, they will be relocated to an enhanced buffer area to avoid impacts to the natural heritage features and function.

Further environmental enhancements related to recommended drainage improvements were also discussed in **Section 7.1** above, and include stream restoration and grading works on the Rainbow Creek Tributary as well as fish and wildlife passage considerations for the design of future stream crossing structures. **Table 7.1**, below, provides a summary of the land base of the NHS under the two development scenarios described in **Sections 3.1** and **6**. Like **Table 6.8**, statistics in this table include the land base occupied by:

- Tableland and valleyland vegetation communities to be retained as part of the NHS
- Tableland vegetation communities removed as part of development, to be mitigated through restoration efforts;
- Hazard lands; and,
- Associated minimum buffers.

As previously discussed, the realignment of the Rainbow Creek Corridor results in a total NHS land base loss of 26.46 ha, which amounts to 2.10% of the total land area in Area 47. However, it is anticipated that the ecological function of the corridor will be increased as a result of the proposed restoration efforts.

Table 7.1: Summary of Land Area within the Area 47 SPA Natural Heritage System

	Robinson Creek	Rainbow Creek	Clarkway Tributary	Gore Road Tributary	West Humber River	Area 47 SPA Natural Heritage System	
						Area (ha)	% of Total Study Area
NHS without proposed Rainbow Creek Corridor							
Total land area (ha) without proposed Rainbow Creek corridor Restoration	2.56	74.44*	79.08	61.18	1.71	218.96	17.40%
Total area (ha) of natural heritage features proposed for removal and mitigation	0.77	0.80	0.63	1.00	0.10	3.30	0.26%
Total (ha):	*3.33*	*75.24*	*79.71*	*62.18*	*1.81*	*222.26*	*17.67%*
NHS with proposed Rainbow Creek Corridor							
Total land area (ha) with proposed Rainbow Creek Corridor restoration	3.33	48.78	79.71	62.98	1.81	195.79	15.56%
Difference in area under the two above scenarios:						-26.46	-2.10%

*excludes the area of floodplain currently occupied by the Cadetta Road development (5.10 ha).

8 IMPLEMENTATION

The preceding chapters have summarized the investigations, inventories and analyses used to define existing environmental conditions, future impacts, and recommended management measures which comprise the MESP for the Area 47 study area. The recommended measures include actions to address stormwater management requirements, trails, protection of the natural heritage system and associated ecological features, as well as significant restoration and enhancement works for the Rainbow Creek Tributary corridor.

In terms of the land development and environmental planning process, the role of the MESP is to provide a framework and broad-scale guidance to the next level of planning and design study as urban development proceeds. As such, the focus of this chapter is to provide guidance for the future work required to implement the MESP recommendations. This includes direction with respect to future studies, timing/phasing of the works, policy/design guidance, and approvals.

With respect to the Rainbow Creek Tributary corridor, the proposed restoration works and the implementation recommendations contained herein are contingent on agreement to a comprehensive plan over the entire study reach, Should there be no agreement amongst all landowners, or should it be determined by the City of Brampton and TRCA as part of future studies that the proposed modifications do not offer multiple ecological and engineering benefits as presented in this report, the existing NHS (as defined by the Regulatory Floodplain and 10 m buffers) will be used to define the future development limits.

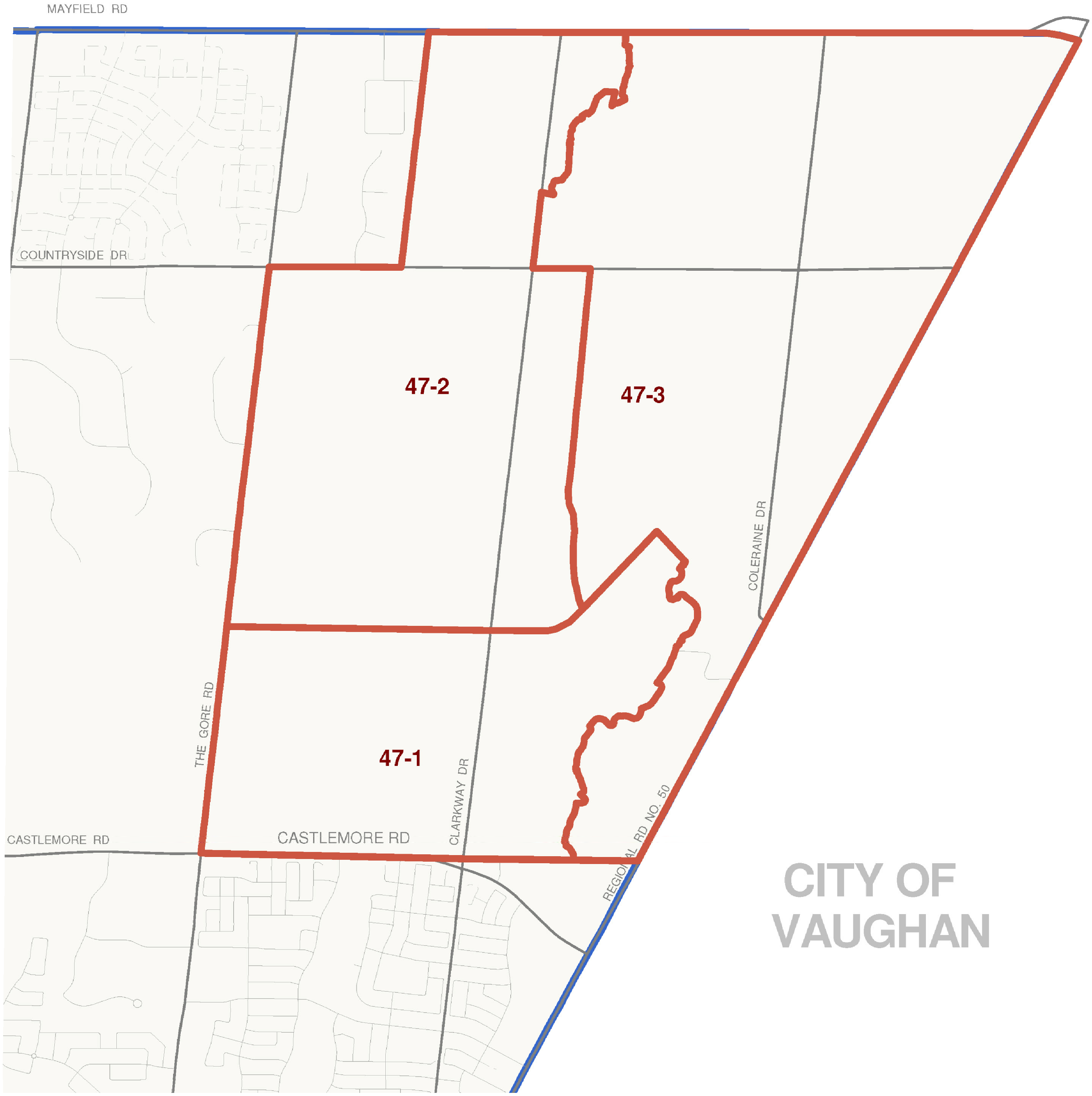
Block Planning Approval Process and Future Study Requirements

<u>Block Plan Areas</u>

The Area 47 Secondary Plan identifies three areas for subsequent Community Block Planning. The Block Plan areas are illustrated below in **Figure 8.1**. Block Plan Areas 47-1 and 47-2 cover lands generally designated for residential development and associated supporting land uses, while Block Plan Area 47-3 covers employment land uses. Through discussions with City planning staff, it is understood that land use planning and design for the residential neighbourhoods of Areas 47-1 and 47-2 will be subject to a traditional Block Planning approach, including development and approval of Draft Plans of Subdivision. However, this step in the planning process may not be required for the larger industrial development properties within Area 47-3. Instead, it is understood that the larger developments in this area may proceed on a Site Plan basis.

Regardless of the planning process to be applied, two levels of additional study will be required to implement the MESP recommendations:

- Functional Design; and
- Detailed Design.



EXTRACT FROM SCHEDULE H - COMMUNITY BLOCK PLAN AREAS, 2006 OFFICIAL PLAN

FIGURE 8.1 SECONDARY PLAN AREA 47 BLOCK PLANNING AREAS

Block Plan Areas 47-1 and 47-2

As noted above, Block Plan Areas 47-1 and 47-2 will be subject to a traditional Block Planning approach, including development and approval of Draft Plans of Subdivision. At this level of study, functional designs and associated analyses will be completed as part of a comprehensive Environmental Implementation Report (EIR). In general, these types of studies lay out the stormwater management, trail and natural heritage recommendations at a preliminary level of design in order to demonstrate how the MESP targets and criteria are met. They are generally undertaken on a block plan or prior to draft plan of subdivision approval basis.

For example, the comprehensive EIR provides preliminary design of the storm drainage system elements serving the block plan, including the major-minor drainage patterns, headwater drainage features to be protected, and the location and storage/sizing requirements for all stormwater management facilities. The EIR also includes conceptual restoration and enhancement plans, site-wide and feature-based water balances, tableland vegetation assessments, trail network, and a monitoring framework. For Area 47, the functional design level of study would also be the appropriate point in the process to complete the preliminary designs for the Rainbow Creek Tributary corridor restoration works and demonstrate how the design meets all of the targets identified in the MESP.

A Terms of Reference (TOR) for a comprehensive EIR must be completed based on the approved MESP and approved to the satisfaction of the City of Brampton and TRCA prior to initiating the comprehensive EIR process. The TOR must identify outstanding deficiencies from the approved MESP, which are to be completed as part of a comprehensive EIR. Development proponents must arrange a meeting with the City of Brampton and TRCA staff to discuss the TOR requirements.

Detailed designs would then rely on the findings and preliminary designs completed at the functional design stage in the EIR. For example, the final designs would include stormwater pond details such as grading, depths, and outlet configuration to meet the storage and release rate targets.

Special Policy Areas (SPAs)

Three (3) Special Policy Areas (SPAs) have been identified for the Clarkway Tributary that recognize opportunities to improve corridor functions through future grading modifications. The boundariesof the Clarkway Tributary Natural Heritage System as illustrated on Figure 7.1 will be finalized through the Block Plan 47-2 EIR to the satisfaction of the City in consultation with the TRCA. The EIR will address grading opportunities and constraints to improve the ecological features of the Clarkway Tributary and its associated headwater drainage features (HDFs). The areas are illustrated in Figure 7.1 and are discussed below:

- Area A – The area has an ill-defined surveyed top-of-bank and therefore the limits of the Clarkway Tributary valley corridor in this location will be refined.

- Area B – The norther limits of the landform associated with the Clarkway Tributary HDF 16-1 Is identified as an "Area of Grading Opportunity and Constraint". The surveyed top-of-bank within this area (Figure 2.17) may be refined subject to compensation for any change to the extent of the Natural Heritage System in this area. Compensation will be based on a minimum 1:1 ha of tableland area in a location and configuration that improves ecological features and functions. The mitigation/compensation must also include restoration planting.

- Area C – The northern limits of the Clarkway Tributary HDF 15-2 may be refined but must address the maintenance of contributing flows and ecological functions to the downstream portion of HDF 15-1 and the Clarkway Tributary.

Block Plan Area 47-3

For Area 47-3, it is understood that the larger employment based developments in the area may proceed by way of Site Plan Applications. At this level of study, functional design and detailed design will be undertaken together as part of an interdisciplinary EIS. It is critical that further analysis is completed at a Block Plan level and must be done comprehensively for the entire Block Plan area, prior to the consideration of individual site plan applications.

The interdisciplinary EIS must include functional servicing either for the Block Plan area as a whole, or, at a minimum, for the areas draining to each of the three proposed Rainbow Creek corridor design segments prior to completing any site-specific planning or detailed design. Without this work being completed comprehensively, environmental planning decisions cannot be made in accordance with an ecosystem approach to ensure compliance with the relevant higher order studies such as the Humber Watershed Plan, the West Humber River Subwatershed Plan, the Humber River Fisheries Management Plan (HRFMP), TRCA's Terrestrial Natural Heritage System Strategy (TNHSS) and the environmental and engineering targets noted in **Section 6**. These studies require a detailed implementation strategy in terms of compliance with the higher order plans, restoration and mitigation measures, phasing, interim measures, participating landowners, etc. This is to ensure the form and layout of new development is viewed in a broad context, rather than as individual properties considered in isolation of the larger natural system. The first streamlined planning application (i.e. Site Plan Application) will be required to complete the functional design for the entire reach as a whole, or at a minimum, the applicable segment.

In general, the detailed design would rely on the findings and preliminary designs completed at functional design stage. For example, the final design would include stormwater pond details such as grading, depths, and outlet configuration to meet the storage and release rate targets. Similarly, the detailed design of the Rainbow Creek corridor will require detailed grading plans, construction staging plans, planting plans and monitoring plans that build upon and finalize the preliminary designs developed at the EIR/EIS level.

A Terms of Reference (TOR) for an interdisciplinary EIS must be completed based on the approved MESP and approved to the satisfaction of the City of Brampton and TRCA prior to initiating the Site Plan Application process for any site plans within the Block Plan area. The TOR must identify outstanding deficiencies from the approved MESP, which are to be completed as part of a comprehensive EIR. Development proponents must arrange a meeting with the City of Brampton and TRCA staff to discuss the TOR requirements.

Priority / Phasing

Some components of the MESP Strategy will require other components to be in place before they can proceed. For example, the design of stormwater pond outfall structures to Rainbow Creek will require that the grading works for the channel be defined. Coordination of other components of the MESP Strategy (e.g. drainage and infrastructure improvements) may present opportunities to minimize in-stream disturbance and achieve cost savings. Therefore, this Chapter identifies phasing considerations associated with the implementation of recommended works, particularly those that may be inter-related.

Design Guidance and Policy Considerations

The implementation of the elements which comprise the MESP Strategy will be guided by a number of planning and design documents, as well as municipal and TRCA policies. The relevant documents and policies which may apply to each of the MESP components are listed in this Chapter.

Approvals

Prior to the construction or implementation of many of the MESP components (e.g. stream works, stormwater management facilities), approvals and/or permits may be required from one or more of the following agencies:

- City of Brampton;
- Toronto and Region Conservation Authority (TRCA);
- Ministry of the Environment (MOE);
- Ministry of Natural Resources and Forestry (MNRF);
- Department of Fisheries and Oceans (DFO); and
- Ministry of Transportation (MTO).

Table 8.1 summarizes the implementation considerations with further description for each of the recommended MESP elements provided below.

Table 8.1: MESP Implementation - Drainage and Stormwater Management Works

Subwatershed Strategy Components	Targets / Objectives / Benefits	Future Study Requirements	Priority / Phasing Considerations	Policy Considerations	Approvals
1. Hydraulics and Regulatory Floodplain Mapping – Refer to Report Section 8.1.1					
Update HEC-RAS hydraulic models and Regulatory Floodplain Mapping to reflect proposed bridge/culvert works and grading modifications	- Updated hydraulic modelling and regulatory floodplain mapping	- update HEC-RAS hydraulic models to reflect bridge/culvert replacement works to be completed as part of road improvements/widening - update HEC-RAS hydraulic models to include new road crossings, confirm hydraulic capacity requirements, and confirm no negative impacts to upstream and downstream flood levels - hydraulic modelling as part of comprehensive impact analyses for any proposed grading works within the floodplain (e.g. Rainbow Creek corridor improvements).		TRCA – Ontario Regulation 166/06	- TRCA
2. Stormwater Management Ponds – Refer to Report Section 8.1.2					
End-of-pipe Stormwater Management Ponds	- Level 1 water quality control (all ponds) - extended detention for erosion control – 25mm/48hrs (target for main tributaries, and 25mm/120hrs (interim target for HDFs); - flood control – post-to-pre control for 2-yr through 100-yr storm events. Pre-development peak flows defined based on existing drainage areas and unit flow rates for Humber River sub-basin #36 (Equation F).	<u>Functional Design Stage</u> - EIRs/interdisciplinary EISs to address planning and preliminary design of drainage systems and centralized SWM facilities: • Consultation with TRCA Planning Ecology staff to confirm appropriateness and targets for directing SWM discharges to HDF`s. • Demonstrate how pond locations/outfalls and/or LID swales will maintain flows to any HDF's that are to be protected; • Hydrologic modelling to confirm/refine storage requirements based on updated drainage areas and development densities; • Preliminary design of SWM Ponds (grading, inlet/outlet, rating curves); • Geotechnical investigations at any proposed pond locations not already covered by AME investigation (Appendix A). • coordinate outlet designs for Rainbow Creek SWM ponds with the grading and restoration plans for that corridor <u>Detailed Design Stage</u> - Detailed Stormwater Management Reports for individual subdivisions/sites - Detailed design of ponds (grading, operating levels, inlet/outlet design, forebay, maintenance access, emergency overflow, etc.) - Landscape plans for SWM ponds - Erosion and Sediment controls - Operations and Maintenance Manuals for SWM ponds	- locations and design for several stormwater ponds will need to be coordinated with designs for downstream receiving streams which may be subject to future grading modifications and/or relocation: • the Rainbow Creek Corridor; • HDFs with "Conservation" classification: o Gore 2-2; o Clarkway 7-1; o Robinson 1-1.	- MOE 2003 Stormwater Management Planning and Design Manual - TRCA 2012 Stormwater Criteria Document - City of Brampton 2008 Subdivision Design Manual	- City - TRCA - MOE

3. Low Impact Development (LID) Controls – Refer to Report Section 8.1.3					
Low Impact Development (LID) – source and conveyance controls	- 5mm of rainfall for impervious surfaces to be retained on-site and treated using LID measures to minimize water budget impacts - water quality and erosion control benefits in the form of reduced stormwater runoff volumes - potential to mitigate loss of HDFs through use of LID swales designs	Functional Design Stage - define the types of LID measures to be used - define the quantity/length of LID measures to replicate loss of small HDF's - preliminary design of LIDs Detailed Design Stage - soils permeability testing to define infiltration rates - SWM Report: • Sizing / modelling for LIDs • Site grading • Design drawings - Landscape designs - Erosion and Sediment controls - Operations and Maintenance Manuals		- TRCA 2010 LID Stormwater Management Planning and Design Guide - TRCA 2012 Stormwater Criteria Document - City of Brampton 2008 Subdivision Design Manual - City of Brampton 2011 Site Plan Approval Manual	- City - TRCA
4. Headwater Drainage Features (HDFs) – Refer to Report Section 8.1.4					
"Protection" classification: - Gore HDF2-1 - Clarkway HDF15-1	- preservation of hydrologic and environmental functions	Functional Design Stage - upstream stormwater drainage network to demonstrate how flows are to be maintained - consultation with TRCA Planning Ecology staff to confirm appropriateness and targets for directing SWM discharges to HDF`s - update HEC-RAS hydraulic model and floodlines using new TRCA flood flow rates and more detailed topographic mapping / survey information as it becomes available through Block Planning work Detailed Design Stage - Erosion and Sediment Control Plans		- TRCA's Evaluation, Classification and Management of Headwater Drainage Features Guidelines, January 2013 - TRCA 2012 Stormwater Criteria Document - TRCA – Ontario Regulation 166/06	- TRCA

"Conservation" classification: - Gore HDF2-2 - Clarkway HDF7-1 - Robinson Tributary HDF1-1	- conservation of hydrologic and environmental functions	<u>Functional Design Stage</u> - upstream stormwater drainage network to demonstrate how flows are to be maintained - consultation with TRCA Planning Ecology staff to confirm appropriateness and targets for directing SWM discharges to HDF`s - for any proposed channel modifications: • Preliminary grading/design • Hydraulic analyses for flood levels and volumes (new TRCA flood flow rates to be applied) • Restoration / planting targets <u>Detailed Design Stage</u> - for any proposed channel modifications • Detailed design / grading plans • Restoration and Planting Plans • Erosion and Sediment Control Plans • Construction Staging Plans including flow diversion	- minimize disturbance by coordinating channel modifications with construction of contributing SWM facilities and outfalls - instream construction works timed to account for warmwater fish habitat	- TRCA's Evaluation, Classification and Management of Headwater Drainage Features Guidelines, January 2013 - TRCA 2012 Stormwater Criteria Document - TRCA – Ontario Regulation 166/06 - City of Brampton 2008 Subdivision Design Manual	- TRCA - City - MNR - DFO
"Mitigation" classification	- replicate hydrologic and environmental functions for any features to be eliminated	<u>Functional Design Stage</u> - define the quantity/length/location of LID swales to mitigate loss of small HDF's. - locations within public lands are preferred <u>Detailed Design Stage</u> - design, grading of LID rear/side lot bioswales - design, grading, and restoration designs for LID valley swales and any receiving pocket wetlands		- TRCA's Evaluation, Classification and Management of Headwater Drainage Features Guidelines, January 2013	- TRCA - City
5. Road Crossings and Bridges - Refer to Report Section 8.1.5					
Bridge/culvert replacements as part of road widening/improvement works	- Regional Storm flood conveyance - flood relief - prevent scouring - span 2 times bankfull channel width for fish/wildlife passage - span erosion and meander hazards	<u>Environmental Assessment / Functional Design Stage</u> - define bridge location, sizing, alignment per: • hydraulic modelling • geomorphologic input • aquatic and terrestrial design input <u>Detailed Design Stage</u> - detailed design / grading plans - Erosion and Sediment Control Plans - Restoration Plans - Construction Staging Plans including flow diversion	- instream construction works timed to account for warmwater fish habitat - For Rainbow Creek: • co-ordinate hydraulic designs for bridges and channel • co-ordinate bridge construction with stream restoration works	- TRCA draft Road Crossing Guidelines - City of Brampton 2008 Subdivision Design Manual	- TRCA - City - MNR - DFO

<table>
<tr><th colspan="6">6. Rainbow Creek Stream Corridor Restoration and Grading Works – Refer to Report Section 8.1.6</th></tr>
<tr>
<td>Stream restoration and grading works from Castlemore Road to Mayfield Road
(up to three reach phases)</td>
<td>100- 105 m corridor to provide:
- Regional Storm flood conveyance
- flood relief (Cadetta subdivision)
- sufficient depth for stormwater outfalls
- increase in aquatic & terrestrial habitat structure and quality
- min. 46 ha NHS coverage, including extensive restoration plantings:
woodlands – 31.6 ha
meadow – 2.6 ha
marsh – 7.0 ha
swamp – 4.2 ha
Note: additional 5 m width required where city trail is to be located along west side of valley adjacent to woody forest vegetation in southern reach (resulting in 105 m corridor width).</td>
<td>Note: prior to proceeding with design and implementation of the proposed restoration works, agreement amongst all landowners is required.

- develop Terms of Reference for EIRs to address functional design stage for Areas 47-1 and 47-2.
- develop Terms of Reference for interdisciplinary EISs to address both functional and detailed design stages for Area 47-3.

<u>Functional Design Stage</u>
- preliminary design / grading plans
- alignment to account for recommendations from Coleraine Drive EA.
- alignment to remove Cadetta Road subdivision from Regulatory floodplain.
- hydraulic modelling to confirm flood conveyance capacity and flood volumes. Updated flood flows from TRCA Humber River modelling to be applied.
- grading and hydraulic designs to demonstrate how proposed works tie-into upstream and downstream reach segments
- preliminary designs to confirm HNS coverage targets

<u>Detailed Design Stage</u>
- Detailed design / grading plans
- Restoration and Planting Plans
- Erosion and Sediment Control Plans
- Construction Staging Plans including flow diversion</td>
<td>- studies, design, and construction to be completed prior to, or in conjunction with adjacent urban development
- ideally, planning, design and construction to be completed over entire reach. Considering land ownership and development timing, consideration may be given to breaking works into up to 3 phases:
Castlemore Rd. to Future Arterial Road A2
Future Arterial Road A2 to Countryside Dr.
Coutryside Dr. to Mayfield Rd.
- alignment in northern reaches may need to consider MTO recommendations for Highway 427 corridor.
- coordinate design/grading with SWM ponds/outfalls
- coordinate hydraulic design of channel with bridge improvements at road crossings
- instream construction works timed to account for warmwater fish habitat
- construction phasing plan to identify location and timing of flow diversion plans</td>
<td>- TRCA – Ontario Regulation 166/06
- City of Brampton 2008 Subdivision Design Manual</td>
<td>- TRCA
- City
- MNR
- DFO
- MTO (Hwy 427 corridor)</td>
</tr>
</table>

8.1 Drainage and Stormwater Management Controls

8.1.1 Hydraulics and Regulatory Floodplains

Floodplain hazard lands were defined over the Area 47 study area streams using existing TRCA Regulatory floodline information together with hydraulic model extensions, as outlined in **Section 2.2.3.** These constraints are based on flood flows from TRCA's 2002 Humber River Hydrology Update Study.

Future Study Requirements

Hydraulic model updates will also be required in support of the proposed future bridge/culvert works within Area 47, including:

- bridge/culvert replacement works to be completed as part of road improvements/ widening; and
- new arterial road crossings.

The modelling will be used to define the hydraulic capacity requirements for the structures, and confirm no negative impacts to upstream and downstream flood levels. Further discussion is provided in **Section 8.1.5**.

Any proposed grading works within the Regulatory floodplain will also require further hydraulic modelling as part of a comprehensive impact analysis to support the proposed modifications. This would include the proposed modifications to the Rainbow Creek corridor, or any other proposed grading changes within the regulatory floodplains. The hydraulic analyses would also require an accompanying cut/fill balance analysis to demonstrate that flood storage is maintained.

It should be noted that TRCA has recently updated the hydrologic modeling for the Humber River watershed. Based on the updated flood flow rates, TRCA will also be updating the hydraulic modelling and Regulatory Floodplain mapping within the watershed. As such, any future studies that are undertaken in support of proposed future bridge/culvert or grading works within the floodplain should be cognisant of the updated TRCA information.

At the EIR / EIS planning stage, future Block Plans / Site Plans should demonstrate that the development limits are consistent with both the 10 m horizontal and 0.5 m vertical setbacks from the Regulatory Floodplain. Any proposed site-specific grading solutions to address the 0.5 m vertical buffer requirement will be evaluated in accordance with Secondary Plan Policy 5.4.1.2 and implemented through detailed design.

As development planning progresses and more detailed topographic mapping becomes available through site surveys, the floodplain mapping may also be updated through revisions to the hydraulic model cross-sections which reflect the detailed topography.

Approvals

TRCA is the primary approval agency for floodplain mapping under Ontario Regulation 166/06.

8.1.2 End-of-Pipe Stormwater Management Ponds

End-of-pipe wet pond facilities are recommended for water quality, erosion and flood control for future development lands. Storage and release rate targets were defined in **Table 4.3** and include:

- Level 1 or “Enhanced” water quality control;
- Extended detention storage for erosion control, consisting of capture and release of runoff from the 25mm storm over 48 hours for ponds discharging to the main watercourses. For ponds discharging to HDF features, an interim erosion control target of 25mm over 120 hours was identified; and
- Post-to-pre flood control for 2-year to 100-year storms based on the existing drainage areas and TRCA unit release rate targets for Humber River sub-basin #36 (Equation F).

Conceptual stormwater pond locations and associated drainage areas were illustrated in **Figure 4.4**.

Future Studies

As noted earlier, it is anticipated that two progressively more detailed levels of study will be required as development and stormwater management planning and design progresses:

Functional Design Stage

This stage of planning should include efforts to refine the conceptual pond locations identified in the MESP. Location planning and design of future stormwater management ponds should take into account adjacent developments within a catchment, rather than on a site-by-site basis, in order to identify opportunities to minimize the overall number of facilities by providing larger, more efficient centralized ponds which are shared by more than one development site. The centralized ponds would provide benefits to both the development proponent and the City through savings in land and lower future maintenance requirements.

From a land use perspective ponds are ‘green infrastructure’ that contributes to the urban fabric and can contribute as a connective element in the overall pathways system.

The preliminary planning and design of the overall drainage and stormwater pond networks should be completed as part of a future EIRs (Areas 47-1 and 47-2) or interdisciplinary EISs (Area 47-3). These studies would include:

- Consultation with TRCA Planning Ecology staff to confirm the appropriateness of directing any SWM pond discharges to HDF`s. If the approach is acceptable, then further erosion assessments would be required, consistent with the methodology identified in TRCA`s Stormwater Management Criteria document;
- Hydrologic modelling to confirm/refine SWM pond storage requirements based on updated drainage areas and development densities;
- Preliminary design of SWM Ponds, including preliminary grading, inlet/outlet locations and elevations, and stage-storage-discharge rating curves;
- Review of the supporting geotechnical investigations completed as part of this MESP to confirm soils and groundwater conditions at proposed pond locations, and/or determine if a clay liner is warranted. Additional geotechnical investigations may be required for SWM ponds whose revised locations are significantly different than those assumed in the MESP and are therefore not covered by the geotechnical investigations in Appendix A;
- Coordination of the outlet designs with plans to preserve flows to headwater drainage features (HDFs) which are to be protected (refer to **Table 4.1**); and
- Coordination of the outlet designs for SWM ponds discharging to Rainbow Creek with the grading and restoration plans for the corridor (see also **Section 8.1.6**).

Detailed Design Stage

This stage of planning builds upon the preliminary work at the functional design level in order to finalize the drainage and stormwater pond designs. The following studies and analyses will be required:

- Preparation of Detailed Stormwater Management Reports for individual subdivisions or sites to demonstrate how the proposed systems conform to the targets identified in the overall MESP and EIR/EIS findings. This includes:
    - Site grading;
    - Calculations and/or modelling for sizing and detailed design of the contributing major/minor drainage systems;
    - Detailed design for end-of-pipe stormwater ponds, including grades, operating levels, inlet/outlet designs, forebay, maintenance access, sediment drying areas, emergency overflows, etc.;

    - Detailed designs for outfalls to the receiving stream or HDF, including restoration plans and/or connecting channels if required;
- Operations and Maintenance plans;
- Landscaping plans; and
- Erosion and Sediment Control Plans.

Phasing

The planning and design for several stormwater ponds will need to account for potential future grading modifications and/or relocation of downstream receiving channels, including:

- Grading and restoration works on the Rainbow Creek Corridor; and
- Possible modifications to HDF features classified as "Conservation", including HDF Gore 2-2, Clarkway 7-1, and Robinson 1-1.

The hydrologic/hydraulic modelling and floodplain mapping for the above channel works may impact the outfall design and/or location of the stormwater ponds draining into the affected watercourses. Therefore, the design of the SWM ponds and outlets from these facilities should be coordinated with the designs for the downstream receiving channel works.

Design Guidance and Policy Considerations

Design of future stormwater management ponds should be guided by the criteria and recommendations in the MOE 2003 Stormwater Management Planning and Design Manual, TRCA 2012 Stormwater Criteria Document, and the City of Brampton's 2008 Subdivision Design Manual.

Approvals

The City of Brampton and TRCA are primarily responsible for the review and approval of the proposed stormwater management ponds designs. A Certificate of Approval from MOE will also be required.

8.1.3 Low Impact Development (LID) Controls

The MESP recommends that LID source and conveyance control measures be applied over the study area. A 5mm retention target is recommended to mitigate water balance impacts. An appropriate quantity/length of LID measures is also recommended to replicate the water quality, erosion control and environmental functions of any small HDFs that are to be removed. Table 4.4 summarizes the length of potential HDF removals throughout the study area which may be mitigated through the use of an equivalent length of conveyance control LIDs such as LID swales, including rear/side lot bioswales or valley slope swales.

Future Studies

Functional Design Stage

Future EIR/interdisciplinary EIS studies will need to:

- Define the types of LID techniques that are to be incorporated into the future urban landscape to meet the 5mm retention target over the respective study areas;
- Determine the length of any HDF channels that are to be removed and identify the locations of an equivalent length of LID swales to be incorporated into the future urban drainage network; and
- Complete the preliminary sizing/design for these measures, including layout of the LID swales that will form part of the drainage network, including:
    - rear/side lot bioswale designs, demonstrating how stormwater flows are conveyed to downstream storm sewers and/or SWM ponds;
    - valley slope swale designs, demonstrating the capture of rear lot drainage from properties backing onto the valley systems, and safe conveyance via the valley slope area to the floodplain. Designs may also include pocket wetlands at the slope toe; and
    - any other LID swale features intended to maintain flows to HDFs which are to be preserved.

Planning for these measures should recognize a preference for locating the LIDs within public lands or rights-of-way.

Detailed Design Stage

The following studies and analyses will be required at the Detailed Design stage for the use of LID controls within proposed development sites/subdivisions:

- In-situ soil permeability testing to define the infiltration rates to be used in the design of the LID measures;
- Preparation of detailed Stormwater Management Reports for individual sites to demonstrate how the proposed LID controls conform to the 5mm water balance and HDF replication targets identified in the MESP and EIR. This includes:
    - Calculations and/or modelling for sizing of the LID measures;
    - Site grading for overland flow routes, including LID swales;

    - Drawings illustrating the location and design details for all LID controls, including grades, operating levels, inlet/outlet designs, pre-treatment areas, underdrains, maintenance access, and emergency overflow, etc.;
- An Operations and Maintenance Manual, where appropriate;
- Landscaping plans for naturalized LID stormwater treatment areas; and
- Erosion and Sediment Control Plans.

Design Guidance and Policy Considerations

The design of LID measures should follow the recommendations and guidelines contained in TRCA's 2010 Low Impact Development Stormwater Management Planning and Design Guidelines document. Additional design requirements may be found in the City of Brampton's 2008 Subdivision Design Manual and 2011 Site Plan Approval Manual.

Approvals

As many of the LID controls are expected to be incorporated into individual lots, as well as road rights-of-way, the City of Brampton will be the primary approval agency for design of the LID measures. Additional review and approval will also be provided by TRCA to confirm that the stormwater and environmental targets identified in the MESP are achieved, as well as any LID swale designs located within the regulated stream valley corridors.

8.1.4 Headwater Drainage Features (HDFs)

The MESP strategy recommends that several headwater drainage features be maintained as open watercourses (**Section 2.2.2**) so that their hydrologic and environmental functions are maintained. Management recommendations include:

Protection (no alteration):

- Gore HDF 2-1
- Clarkway HDF 15-1

Conservation (channel modification may be considered):

- Gore HDF 2-2
- Clarkway HDF 7-1
- Robinson HDF 1-1

In addition to the above, several other small headwater features were classified as "mitigation". These features can either remain as open watercourses as development proceeds, or can be replaced and replicated through appropriate lot-level and conveyance control LID swale measures.

Future Studies

Functional Design Stage

At the functional design stage, EIR or interdisciplinary EIS studies will need to confirm the length of any HDF channels that are to be removed and identify the locations of an equivalent length of LID swales to be incorporated into the future urban drainage network. Additional field investigations may be required to confirm that no additional HDFs are present within the subject block planning area. If additional HDFs are present, an analysis using the TRCA's Evaluation, Classification and Management of HDFs document will be required.

At the functional design stage, future studies will also need to complete feature-based water balance assessments to demonstrate how the proposed upstream urban drainage network will be configured such that flows are maintained to those HDF's designated for "protection" and "conservation". This may include:

- Directing a portion of the stormwater facility outfalls to these HDFs;
- Foundation drain collection systems which outlet to these HDFs; and
- Lot-level and conveyance LID measures (bioswales, etc.) to direct clean rooftop and overland runoff to these features.

As noted in **Section 8.1.2**, for ponds discharging to HDF features, an interim erosion control target of 25 mm over 120 hours was identified. However, further consultation with TRCA Planning Ecology staff is required at the functional planning stage to confirm appropriateness and targets for directing SWM discharges to HDF`s.

Subdivision planning at the functional design level should also reflect development limits which include appropriate allowances for those HDF's which are to be maintained as open watercourses. In doing so, hydraulic modelling and Regulatory floodlines for the HDF corridors should be confirmed / updated using new TRCA flood flow rates (see **Section 8.1.1** above) and more detailed topographic mapping and survey information as it becomes available through the Block Planning process

Regarding those HDF's identified for "conservation", if modification to any these features are proposed, the EIR studies should include preliminary designs for these features. The designs should be in accordance with guidelines for man-made watercourses and channels as outlined in the City of Brampton Subdivision Design Standards document, and would include:

- Preliminary plan / profile / grading plans;
- Hydraulic analysis to demonstrate that flood levels are contained with appropriate freeboard and flood storage volumes maintained for a complete range of design storms (i.e. 2-year through 100-year and Regional Storm); and
- Planting / restoration targets.

For those HDF features classified as "mitigation" (**Section 2.2.2**), the functional studies should include drainage plans which demonstrate that any HDF reaches to be removed will be replicated though the use of an equivalent quantity/length of LID swales connected to the natural heritage system. Planning for these measures should recognize a preference for locating the LIDs within public lands or rights-of-way.

Detailed Design Stage

Following the preliminary planning and design works above for any HDFs to be modified (i.e. "conservation" classification), detailed natural channel design would be completed. For this step, the preliminary design drawings would be refined to include specific details including:

- Detailed specifications for channel features such as side slopes, riffle-pool locations and dimensions;
- Detailed grading plans including plan, profile and cross-section design drawings;
- Design for any stormwater outfalls and connecting channels;
- Detailed restoration, landscaping and planting plans;
- Construction staging plans, including temporary flow diversion measures; and
- Erosion and sediment control plans.

Detailed designs, grading and restoration plans will also be required for any LID swales that are to mitigate the loss of small HDFs.

<u>Priority / Phasing</u>

Ideally, to minimize disturbance, construction of any HDF channel modifications would be timed to correspond with the construction of upstream contributing stormwater management facilities and/or drainage system. Instream construction works should be timed to account for warmwater fish habitat.

<u>Design Guidance and Policy Considerations</u>

Protection, conservation and mitigation of HDFs should be in accordance with TRCA's Evaluation, Classification and Management of Headwater Drainage Features Guidelines, January 2013. Discharges from stormwater management facilities to any HDFs should be in consistent with the methodology identified in TRCA's Stormwater Management Criteria document. Design of any HDF channel modifications should be in accordance with guidelines for man-made watercourses and channels as outlined in the City of Brampton 2008 Subdivision Design Standards document.

Approvals

TRCA would be the approval agency responsible for hydraulic modelling and flood hazard mapping updates associated with any proposed HDF modifications. Pursuant to Ontario Regulation 166/06 - Development, Interference with Wetlands, Alterations to Shorelines and Watercourses, TRCA would also be the primary approval agency for any stream works, with additional input from the City of Brampton. Additional permits may be required from MNR. Should the proposed works involve a fish rescue, a permit would be required under the Fish and Wildlife Conservation Act (1997). DFO authorization may also be required.

8.1.5 Roadway Crossings and Bridge Structures

The MESP strategy recommends improvements to stream crossing structures associated with future road widenings at existing crossing locations. In addition, new road crossings are also planned at select locations for new arterial roads.

The design of future road crossings should consider TRCA's draft Road Crossing Guidelines document. Design requirements to be considered include the following:

- Flood conveyance – per the City's 2008 Subdivision Design Manual, structure openings under arterial roads should be sized to prevent overtopping during all storm conditions including the Regional Storm.
- Floodplain impacts – the proposed crossing designs should not result in any increases to flood levels on adjacent lands. Further, future bridge improvements on Rainbow Creek at Coleraine Drive and Countryside Drive should be designed to eliminate the spill of floodwaters that currently exist at these locations. Future EA studies in support of the road improvements will require modelling to define the minimum hydraulic sizes required to prevent any increases in upstream or downstream flood levels.
- Stream morphology – the bridge designs should be sized to allow for ongoing morphologic processes and include natural stone sized to prevent scouring where necessary.
- Fish and wildlife passage – the crossings should consist of open-bottom structures with defined low-flow channels. A minimum crossing width of two times the bankfull channel width is suggested to also allow small wildlife passage in the overbank areas.

Future Studies

Environmental Assessments

The preliminary design of new bridge structures and/or bridge replacements should be defined through future Class Environmental Assessment (EA) studies to be undertaken by the City for arterial road improvements and widenings through the Area 47 study area. At this stage of the planning and design process, the focus should be on defining an appropriate opening size, location, alignment and configuration for the bridge structures in order to meet the objectives and recommendations of the MESP as listed above. As such, the EA studies should include input from qualified engineers, fluvial geomorphologists, and biologists.

For the Rainbow Creek crossing at Coleraine Drive which has recently been altered, the EA study should provide specific recommendations with respect to re-location of the crossing as well as re-alignment of the creek upstream and downstream of the road. For the other road crossings of Rainbow Creek (i.e. Castlemore Road, new Arterial Road A2, Countryside Drive), the EA studies should be coordinated with the preliminary designs for the corridor restoration works (**Section 8.1.6**) to ensure that the bridge designs agree with the proposed creek profile.

Detailed Design

Following the preliminary planning and design work for the EA studies, detailed design of the bridge structures should be completed in association with the road designs. For this step, preliminary designs would be refined to include specific details including:

- Detailed specifications for the bridge such as structural details, headwalls, wingwalls, grading, and channel details for open bottom structures, etc.
- Construction phasing plans that address fisheries timing windows, temporary diversions, pumping, and re-connection of flows, etc.
- Landscaping and restoration plans; and
- Erosion and sediment control plans

Priority / Phasing

The timing of the recommended bridge improvements on the Gore Road Tributary and Clarkway Tributary are generally not dependent on any other works or urban development. However, as noted above, planning and design of the bridge improvements on Rainbow Creek will need to be carefully coordinated with the proposed corridor restoration and grading works for this system.

Instream construction works associated with the bridge improvements should be timed to account for warmwater fish habitat. Co-ordination of bridge construction works with the stream restoration works on Rainbow Creek would also minimize instream disturbance and increase possible cost savings.

Design Guidance and Policy Considerations

Bridge designs should be in accordance with TRCA's draft Road Crossing Guidelines document as well as guidelines outlined in the City of Brampton 2008 Subdivision Design Standards document.

Approvals

TRCA is the approval agency responsible for review and approval of the hydraulic design of the bridges. Pursuant to Ontario Regulation 166/06 - Development, Interference with Wetlands, Alterations to Shorelines and Watercourses, TRCA would also be the primary approval agency for instream works, with additional input from the City of Brampton. Additional permits may be required from MNR. Should the proposed works involve a fish rescue, a permit would be required under the Fish and Wildlife Conservation Act (1997). DFO authorization may also be required.

8.1.6 Rainbow Creek Corridor – Proposed Restoration / Enhancement

The MESP presents an option to the traditional passive naturalization of the floodplain over the long term. If implemented, the plan will require extensive restoration/enhancement and grading works to create a 100 m wide stream and valley corridor for the Rainbow Creek Tributary over the Area 47 study area. An additional 5 m allowance (105m total width) is required in select locations to accommodate a future trail system within the southern reaches of the corridor. As noted earlier, prior to proceeding with design and implementation of the proposed restoration works, agreement on these optional works amongst all landowners is required. Without agreement, the existing NHS as defined by the Regulatory Floodplain and 10m buffer will be used to establish development limits.

The main goals of the proposed works include:

- Creation of a robust and resilient ecosystem in place of the poor channel and riparian conditions that exist today;
- Reduced flood hazards including property (i.e. Cadetta Road development) and flood-susceptible roadways;
- Significant increase in developable land; and

- Improved stormwater servicing and water quality treatment.

Key targets to be achieved through the corridor design are outlined in **Section 6**, and include:

- Regional storm flood conveyance;
- Creation of at least 45 ha of natural cover, consisting of woodlands, meadow, and wetland vegetation; and
- East/west connections between the three main valley corridors.

Further details with respect to objectives and design targets for the recommended restoration works are outlined in **Section 6**.

<u>Future Studies</u>

It is expected that all of the restoration/enhancement works will ultimately be implemented over the entire study reach from Castlemore Road to Mayfield Road. However, given the extensive length over this reach, it is proposed that the design and implementation be undertaken in up to three smaller, more manageable segments:

- Segment 1 – Castlemore Road to future Arterial Road A2 (Block Plan Area 47-1);
- Segment 2 – Arterial Road A2 to Countryside Drive (Block Plan Area 47-3); and
- Segment 3 – Countryside Drive to Mayfield Road (Block Plan Area 47-3).

Should planning and design for each of the segments be undertaken in separate timeframes, the designs will need to ensure that the works tie-in seamlessly to the upstream and downstream reach segments. Design of Segment 3 will also need to be coordinated with the proposed channel alignment within the Town of Caledon, north of Mayfield Road.

Cost Sharing Plans

Depending on land ownership, a cost-sharing plan may be necessary in order to allocate the costs of the works between benefitting owners. Costs to be shared would include:

- Earthworks to create the defined corridor;
- Plantings and restoration works;
- Diversion works (where required at Cadetta Road Industrial subdivision and Coleraine Drive);
- Related engineering and environmental studies; and

- Agency approvals.

Where re-alignment of the existing corridor is proposed (i.e. Cadetta Road development in Segment 1, or Coleraine Drive in Segment 3), land costs may also need to be considered. It is assumed that the City would bear a portion of the costs related to bridge replacements at road crossings and for the trails network to be incorporated into the corridor.

Environmental Assessments

As noted above, the planning and design for the Rainbow Creek corridor will need to be coordinated with Class EA studies for road improvements so that bridge crossing designs are consistent with the corridor design.

With respect to the Coleraine Drive crossing, the feasibility of realigning and/or modifying the cross-section of Rainbow Creek upstream and downstream of the roadway will be evaluated as part of the Class EA study to be completed by the City of Brampton. Any realignment and /or modifications should incorporate the ecological targets and hydraulic requirements as outlined in **Section 6** and shall also comply with the design criteria established by the City of Brampton for the reconstruction of Coleraine Drive.

Functional Design Stage

Preliminary design of the Rainbow Creek corridor restoration works should be completed at the functional design stage and should demonstrate how the proposed design will meet all of the targets identified in the MESP (**Section 6**). As noted, Terms of Reference for future EIR and interdisciplinary EIS studies will need to be developed and approved, before the preliminary designs can be carried out.

Based on the Block Plan Areas illustrated in **Figure 8.1**, Segment 2 and 3 of Rainbow Creek corridor are within Block Plan Area 47-3. The southern portion of the corridor below Arterial Road A2, Segment 1 is located within Block Plan Area 47-1. Therefore, it would be most appropriate for the preliminary design of the works to be completed in support of coordinated development plans for these two Block Plan areas. It is suggested that the preliminary design be completed either for the corridor reach as a whole, or, at a minimum, based on the areas draining to each of the three Rainbow Creek design segments:

- Segment 1 – preliminary design completed in conjunction with functional design stage for Block Plan Area 47-1 and Block Plan Area 47-3 (south of Arterial Road A2); and

- Segment 2 and 3 - preliminary design completed in conjunction with functional design stage for Block Plan Area 47-3 (north of Arterial Road A2).

With respect to Area 47-3, it is understood that the traditional Block Planning approach, including development and approval of Draft Plans of Subdivision, may not be required due to the larger industrial properties within these lands. Instead, it is understood that the larger developments in this area may proceed on a Site Plan basis. However, in order to implement the Rainbow Creek corridor works, an "up-front" interdisciplinary EIS will be required at the functional design stage to ensure that the proposed designs are completed on a holistic basis and are compatible with the grading and servicing needs of all adjacent properties and segments. The functional level of study should include:

- Preliminary valley corridor grading plans that are coordinated with adjacent lands and tie-in to upstream and downstream creek reaches;
- Typical plan, profile and cross-section drawings for the new corridor using Natural Channel Design, including the planned alignment for those reaches that are to be relocated (i.e. adjacent to Cadetta Road and Colerain Drive);
- Hydraulic analyses to confirm Regional Storm flood conveyance with suitable freeboard, as well as preservation of flood storage volumes. This work should use updated flood flow values from the current TRCA Humber River Hydrology Study;
- Hydraulic impact assessment to evaluate the potential for upstream and downstream impacts of the proposed works on peak flows, floodlines and erosion potential;
- Proposed storm outfall locations from planned adjacent stormwater management ponds;
- Fluvial geomorphologic and aquatic biologist input to the preliminary design for the low-flow channel, where relocation is proposed;
- Aquatic and terrestrial biologist input for preliminary/conceptual landscape and restoration designs, demonstrating that the NHS coverage targets are met;
- Integration of municipal trails system; and
- Short, Medium and long term Adaptive Monitoring Framework.

Detailed Design

Following the preliminary planning and design works above, detailed corridor design would be completed. For this step, the preliminary designs would be refined to include specific details including:

- Detailed grading plans including plan, profile and cross-section design drawings;
- Design for any stormwater outfalls and connecting channels;

- Detailed specifications for channel features such as side slopes, riffle-pool locations and dimensions;
- Detailed restoration, landscaping and planting plans;
- Construction staging plans, including temporary flow diversion measures;
- Erosion and sediment control plans; and
- Detailed Adaptive Monitoring Plan.

Priority / Phasing

As noted above, ideally, all of the corridor works will be designed and implemented on a holistic basis over the entire study reach from Castlemore Road to Mayfield Road. However, given the extensive length over this reach, the works may be undertaken in up to three smaller, more manageable segments. Planning and design of the northern reach (Segment 3) will need to consider any information available with respect to the proposed MTO corridor route through this area, and will also need to be co-ordinated with the proposed channel alignment within the Town of Caledon, north of Mayfield Road.

The Rainbow Creek corridor is the ultimate receiving water body for much of the proposed employment lands on the east side of Area 47. As such, the functional design of the corridor will need to be completed in conjunction with the adjacent urban development in order to coordinate the location, grading and design of stormwater ponds and outfalls. Corridor construction will need to be completed prior to the stormwater ponds coming into service.

To minimize disturbance, construction works may also be timed to correspond with the construction of road improvements and associated bridge replacements.

Instream construction works should be timed to account for warmwater fish habitat.

Design Guidance and Policy Considerations

Design of the corridor restoration works should be in accordance with targets and objectives outlined above and in **Section 6**. General guidelines for man-made watercourses and channels are also outlined in the City of Brampton 2008 Subdivision Design Standards document. Applicable TRCA design guidelines should also be referenced.

Approvals

Prior to any works being completed on EIR or interdisciplinary EIS studies, the applicant will be required to submit a draft Terms of Reference for City and TRCA approval.

TRCA is the approval agency responsible for hydraulic design of the corridor. Pursuant to Ontario Regulation 166/06 - Development, Interference with Wetlands, Alterations to Shorelines and Watercourses, TRCA would also be the primary approval agency for the proposed stream works, with additional input from the City of Brampton. Additional permits may be required from MNR. Should the proposed works involve a fish rescue, a permit would be required under the Fish and Wildlife Conservation Act (1997). DFO authorization may also be required.

It is also noted that the proposed re-alignment works adjacent to Cadetta Road and at Coleraine Drive may affect lands identified as Bobolink habitat during the MESP field investigations. Therefore, further future investigations will be required prior to construction to confirm whether any species-at-risk habitat or nests are still present at that time. If so, further discussions with MNRF will be necessary regarding permit requirements.

8.2 Natural Heritage System Implementation and Management

The following subsections present direction for future studies as they relate to the natural heritage resources identified within the Area 47 SPA. The recommendations contained herein are summarized in **Table 8.2**. Monitoring plans are presented in **Section 9**.

8.2.1 Woodlands/Woodlots

Fifteen (15) woodland and eight (8) treed wetland communities were identified during vegetation community assessment performed as part of this MESP. The majority of these treed communities are located wholly or partially within the valley systems. Others, such as ELC Polygons 11 and 58, are located within the tablelands. All woodlands other than ELC Polygon 11; which is located on the corner of Mayfield Road and Regional Road 50, ha slow ecologic function, and is isolated from other NHS features; have been included within the Natural Heritage System.

Future Studies

In order to conserve woodlands over the long-term, it is recommended that woodlands that could be affected by adjacent development be the subject of a feature-based water balance as part of an EIR or EIS. It is further recommended that the EIR/EIS evaluate the potential impacts to woodlands resulting from the proposed development. Woodlands in Areas 41-1 and 47-2 will be subject to an EIR, while woodlands in Areas 47-3 will be subject to an EIS.

Where development is proposed adjacent to woodlands, proponents will be required to complete a Woodlands Management Plan.

Priority / Phasing

It is recommended that EISs, EIRs, Woodland Management Plans, and Tableland Vegetation Assessments be completed at the Block Plan (Area 47-1 and Area 47-2) or the Site Plan (Area 47-3) stage.

Design Guidance and Policy Considerations

The City of Brampton is mandated, through its Official Plan, to ensure that woodlands are protected, maintained, and enhanced. Development proposed adjacent to woodlands will require the submission of a Woodland Management Plan to the City of Brampton for approval prior to the issuance of a grading or development permit.

Woodlands are protected under the City of Brampton's Woodland Conservation By-law.

In some cases, a Tableland Vegetation Assessment will be required should trees greater than 15 cm diameter at breast height (DBH) be proposed for removal.

Where woodlands also qualify as wetlands, as is the case with treed swamps, development proposed within and adjacent to wooded wetlands is subject to the provisions of Ontario Regulation 166/06.

Approvals

The City of Brampton will review planning applications to ensure that woodlands are adequately protected, maintained and, where feasible, enhanced. Also, the City is the primary review agency for Tableland Vegetation Assessments. The City also enforces their Woodland Conservation By-law.

Where woodlands also qualify as wetlands, development proposed within and adjacent to wooded wetlands is subject to the provisions of Ontario Regulation 166/06, and approval and permits from the TRCA is required.

8.2.2 Wetlands

Multiple wetlands, which include ponds, were identified within and directly adjacent to the Area 47 SPA as part of field investigations. The majority of these wetlands are located within the valley systems and are thus protected from development. Other wetlands are located in the tablelands. Some tableland wetlands have not been included within the NHS while others, namely ELC Polygons 87 and 96, have been included within the NHS.

Future Studies

In order to preserve the identified wetlands over the long-term, a feature-based water balance assessment should be completed as part of an EIS/EIR for any such features that could be affected by adjacent development. The assessment would document the contributing drainage and sources of water including any groundwater or surface water contributions, as well as the methods of maintaining the contributions in the post-development environment. Similar feature-based water balance assessments will also be required for any newly constructed wetland features within the Rainbow Creek restoration works, for example.

Priority / Phasing

It is recommended that EIRs be completed at the Block Plan (Area 47-1 and Area 47-2), and EISs at the Site Plan (Area 47-3) stage.

Design Guidance and Policy Considerations

The terms of reference for the EIR/EIS should be developed in consultation with the City of Brampton and the TRCA. The EIR/EIS should follow the recommendations and protocols contained within the latest iteration of the TRCA's *Environmental Impact Statement Guidelines*.

Wetlands are regulated by the TRCA under Ontario Regulation 166/06. Under this regulation, development and interference within wetlands is prohibited.

The City of Brampton is mandated, through its Official Plan, to ensure that wetlands are protected and enhanced.

Approvals

Development proposed within and adjacent to wetlands is subject to the provisions of Ontario Regulation 166/06. As such, approval and permits from the TRCA is required.

The City of Brampton will review planning applications to ensure that wetlands are adequately protected and, where feasible, enhanced.

8.2.3 Hedgerows and other Tableland Trees

The majority of the hedgerows in the Area 47 SPA are dominated by exotic invasive species and are of poor ecological quality. The hedgerow assessment identified six (6) hedgerows that are recommended for retention based upon the quality of the vegetation identified within or, as was the case with H37, its potential hydrologic value (**Section 2.4.3**).

Other tableland trees include those associated with settlements, including heritage properties, as well as lone and scattered trees. City policy requires three (3) trees as compensation for the removal of one (1) healthy tree at or above 15 cm diameter-at-breast-height (dbh).

Future Studies

Future studies are to assess the feasibility of retaining hedgerows H14, H37, H39, H43, H54, and H62.

Significant tableland trees associated with cultural heritage resources need to be specifically identified by the proponent.

A Tableland Vegetation Assessment will be required should trees greater than 15 cm diameter at breast height (DBH) be proposed for removal. There will also be a requirement for a compensation planting assessment and compensation planting plan to compensate for desirable vegetation removed during the development process (see **Section 3.9**).

Priority / Phasing

It is recommended that the assessment of tableland vegetation, including hedgerows and cultural heritage vegetation, occur at the Block Planning Stage and integrated in the EIR. For lands not subject to Block Plans (i.e. Area 47-3), it is recommended that the assessment occur at the Site Plan stage.

Design Guidance and Policy Considerations

Proponents are to follow the protocols of the City of Brampton's *Guidelines for the Assessment of Existing Tableland Vegetation updated 2015*.

Individual trees are subject to the provisions of the City of Brampton's Tree Preservation By-law.

Approvals

The City of Brampton is the approval agency for the assessment of upland vegetation and tree removals. The City also enforces its Tree Preservation Bylaw.

8.2.4 Species at Risk and other Species of Conservation Concern

A total of seven (7) provincially-listed Species at Risk (**Section 3.8.3**), and twenty eight (28) locally rare species (**Sections 2.4.4** to **2.4.6**) are known to occur within the Area 47 SPA.

Future Studies

As species become up-listed or added to the Federal and/or Provincial lists of species at risk or locally rare species lists, it will be necessary to investigate both the presence of these species and their habitat requirements. Future studies such as EIRs/EISs should also investigate the direct, indirect, and cumulative effects of the proposed development on species and their habitat. As a preliminary exercise it is recommended that upon the onset of a study, study proponents use available background information and consult with the MNRF (Endangered and Threatened species at risk) and the TRCA (Nationally Endangered, Threatened or Special Concern species, Provincially-listed species of Special Concern, Nationally and Provincially rare species, and locally rare species).

Bobolink and Eastern Meadowlark

The MNRF has recommended that additional Bobolink and Eastern Meadowlark surveys be completed within all areas of the Area 47 SPA that offer suitable habitat for either species at that point in time (to account for annual crop rotation). Survey methodology should adhere to the MNRF's draft Bobolink survey protocol, *Survey Methodology under the Endangered Species Act, 2007 – Dolichonyx oryzivorus (Bobolink)*, available from the local MNRF district office.

Barn Swallow

It is recommended that future studies confirm active Barn Swallow nesting sites identified in this report and screen for possible active nesting sites not identified in this report.

Properties not Accessed During MESP Field Studies

It is recommended that properties not accessed during field surveys in support of the Area 47 MESP be subject to 3-season botanical surveys and surveys for Species at Risk. These properties include the properties containing the following ELC Polygons: 102, 107, 108, 109, and 110.

Priority / Phasing

It is recommended that surveys for Species at Risk and other species of conservation concern occur at the next planning stage. For Area 47-1 and Area 47-2, this would be the Block Plan stage. For Area 47-3, surveys would occur at the site plan stage.

Design Guidance and Policy Considerations

Provincially-listed Endangered and Threatened species at risk and their habitat are protected under the Endangered Species Act (2007). As mentioned previously, the Area 47 Landowners' Group is currently in negotiations with the MNRF regarding options for habitat retention/compensation for SAR known to occur within the study area. As such, a SAR strategy has not been included in this report. However, this report does include a recommendation regarding the preferred approach for the protection/compensation of SAR habitat. The preferred hierarchy of SAR habitat protection/compensation is listed below from most preferred (1) to least preferred (4):

1. Conservation of habitat in place (i.e. protection);
2. Compensation elsewhere within the study area;
3. Compensation elsewhere within the watershed; or
4. Compensation off-site.

See also **Section** Error! Reference source not found. for additional policy considerations related to SAR habitat located between the Gore and Clarkway Tributaries near the tableland woodland (ELC Polygon 58).

Nationally Endangered, Threatened or Special Concern species; Provincially-listed species of Special Concern; Nationally and Provincially rare species; and locally rare species and their habitat are protected under the Provincial Policy statement and, ergo, the City of Brampton's Official Plan.

Approvals

The MNRF is the approval agency for provincially-listed species at risk. Any proposal which could kill, harass, harm, capture, or take a living member of a species that is listed as Endangered or Threatened in Ontario will require a permit from the MNRF. Similarly, proposed works which destroy or damage the habitat of a species that is listed as Endangered or Threatened in Ontario.

The City of Brampton and the TRCA are the approval agencies for proposed works which have the potential to impact locally Nationally Endangered, Threatened or Special Concern species; Provincially-listed species of Special Concern; Nationally and Provincially rare species; and locally rare species.

8.2.5 Environmental Buffers

Recommendations for minimum buffer widths have been made as part of this MESP report (**Section 4.2.1.1**).

Future Studies

It is recommended that planting specifications presented in this report be revisited as part of a comprehensive EIR or EIS. In addition, minimum buffer widths specified in this study may be increased subject to the completion of an EIR or EIS. The EIR/EIS will provide a detailed account of the natural heritage features and functions within and adjacent to the proposed development, describe the proposed development, and describe the potential impacts to natural heritage features and functions resulting from the proposed development.

Future development plans should demonstrate that the development limits are consistent with both the 10 m horizontal and 0.5 m vertical setbacks from the Regulatory Floodplain. Any proposed site-specific grading solutions to address the 0.5 m vertical buffer requirement will be evaluated in accordance with Secondary Plan Policy 5.4.1.2 and implemented through detailed design.

Priority / Phasing

For Area 47-1 and Area 47-2, EIRs shall be undertaken at the Block Plan stage. For Area 47-3, EISs shall be undertaken at the Site Plan stage.

Design Guidance and Policy Considerations

The terms of reference for the EIR/EIS should be developed in consultation with the City of Brampton and the TRCA. The EIR/EIS should follow the recommendations and protocols contained within the latest iteration of the TRCA's *Environmental Impact Statement Guidelines*.

Buffers should be fully vegetated with woody plantings, and soil stabilized with an appropriate herbaceous seed mix. It is recommended that herbaceous species selection follow the guidelines contained within the latest iteration of the *TRCA Seedmix Guidelines*, available from the TRCA.

Approvals

In general, buffers are reviewed and approved by the City of Brampton. Where buffers are located within areas regulated by the TRCA, TRCA staff will also review buffer recommendations. Buffers specific to and/or affecting Species at Risk may be reviewed by the MNRF as part of a mitigation plan.

8.2.6 East-West Corridors/Linkages

Two east-west corridors/linkages have been identified in through the MESP process. An existing east-west linkage between the Gore Road and Clarkway Tributaries consists of a tableland woodland approximately 370 metres south of Countryside Drive (inset photo). Second, a future wildlife corridor associated with the TCPL lands connecting the Clarkway Tributary and the Rainbow Creek Tributary/corridor has also been identified (**Section 6.3.1**). The MESP recommends expansion and restoration measures to enhance the ecological form and function of these corridors/linkages.

Furthermore, to protect the function of the woodland linkage, it is recommended that future road access to lands adjacent to the restored linkage be accommodated through an appropriate crossing over the Gore Tributary or Clarkway Tributary.

Future Studies

It is recommended that opportunities to create natural features and to orient passive and low-impact land uses to the north and south of both of the two east-west corridors/linkages be thoroughly investigated at the Block Plan stage through the Community Design Study and EIR (Area 47-1 and 47-2) or at the Site Plan stage through an EIS (Area 47-3).

In order to conserve the woodland linkage over the long-term, it is recommended that the woodland be the subject of a feature-based water balance as part of an EIR. It is also recommended that the EIR include raptor surveys among the suite of biophysical investigations required for the woodland (see **Section** Error! Reference source not found.).

It is also recommended that the location of future road crossings of the Gore Tributary and Clarkway Tributary provide due regard for the ecological structure and function of the woodland east-west linkage.

Furthermore, it is recommended that as part of the EIR/EIS opportunities to locate recommended mitigation/compensation areas for the removal of existing natural heritage features be evaluated along with the detailed design of the restoration plan for the woodland linkage. It is recommended that site conditions and the potential effects of adjacent development be thoroughly investigated in order to develop a suitable site-specific restoration plan that will benefit local wildlife in the long-term and improve the ecological form and function of the site.

Priority / Phasing

In regards to the woodland linkage; land use planning considerations (including and not limited to roads, land uses, etc.), corridor design, woodland management plan, the feature-based water balance and EIR/EIS are to occur at the Block Plan stage; as applicable.

Due to its location, the TCPL corridor will be subject to both EISs and EIRs. For Area 47-1 and Area 47-2, EIRs shall be undertaken at the Block Plan stage. For Area 47-3, EISs shall be undertaken at the Site Plan stage.

Design Guidance and Policy Considerations

The terms of reference for the EIR/EIS should be developed in consultation with the City of Brampton and the TRCA. The EIR/EIS should follow the recommendations and protocols contained within the latest iteration of the TRCA's *Environmental Impact Statement Guidelines*. Furthermore, development proposed adjacent to the woodland will require the submission of a Woodland Management Plan to the City of Brampton for approval prior to the issuance of a grading or development permit.

The goal of the east-west corridors/linkages is to facilitate the movement of wildlife between major tributaries, and to compensate for the loss of land base to the existing Rainbow Creek NHS. To achieve this goal, several parameters should be considered:

- Corridor design and width must be conducive to use by target wildlife known or expected to inhabit the area.

- The structural diversity of corridors/linkages has been demonstrated to be positive correlated to wildlife benefits (Bentrup, 2008; Fleury and Brown, 1997). It is thus recommended that naturalized landscaping (e.g. native shrubs and herbaceous plants, vernal pools, woody debris, etc.) along the corridor and, to the extent possible, adjacent lands be incorporated into the design in order to make the corridor more attractive to wildlife, provide cover and feeding opportunities, and to prevent wildlife desiccation.

- Placement of "soft" land uses such as open space, parks, SWM facilities, LID measures, etc. adjacent to the wildlife corridor as a means of increasing the corridor's ecological function (Beier et al., 2008).

- Road mortality and other undesirable wildlife-human interactions should be reduced to the extent possible. One way to achieve this is to ensure that the design of the corridor/linkage along the TCPL lands aims for rapid movement of wildlife through the corridor, rather than the provision of primary wildlife habitat within the corridor.

- Integration of the east-west wildlife corridor with natural areas within the Rainbow Creek corridor and the Clarkway Tributary valley.

Design considerations, including but not limited to landscaping, restoration, traffic calming, ecopassages, etc., will be addressed at future planning stages. Provided effective design principles are followed and wildlife species are similar to those presently known to occur in the study area, the recommended minimum width for the east-west corridor between the Clarkway and Rainbow Creek tributaries is 30 metres (Bentrup, 2008; Fernandez-Juricic et al., 2001; Fischer and Fischenich, 2000).

Approvals

Approvals for both linkages/corridors will be required from the City of Brampton, as well as the TRCA. Owing to the location of the woodland linkage between two tributaries, the woodland is located within lands regulated by the TRCA under Ontario Regulation 166/06. As such, a permit from the TRCA will be required for any development works within the regulated area. Portions of the recommended wildlife corridor/linkage along the TCPL lands are also regulated by the TRCA.

The City of Brampton will review future EIRs/EISs and Woodland Management Plan(s). The TRCA will also review EIRs/EISs.

8.2.7 Trails

The City of Brampton has developed a conceptual trail network for the Area 47 SPA as illustrated in Figure 1.3. Three types of trails are proposed: Class 1 and Class 3 trails will be located within or adjacent to existing and planned roads. In general, Class 2 trails will be located within the Natural Heritage System and / or buffer. Further details on trails are contained within **Section 5.2.1**.

As stated in **Section 5.2.1**, the proposed 5 m wide trail adjacent to the revised Rainbow Creek Corridor, which extends from Castlemore Road to the TCPL location, will avoid sensitive restoration areas. As such, the proposed trail is permitted within the 10 m buffer at the lower reach of the 100 m corridor, while near the more sensitive wooded areas upstream the trail will be located outside of the buffer for a total corridor width of 105 m.

Future Studies

This MESP has identified areas within the NHS that contain ecologically sensitive features. In cases where trails are located adjacent to ecologically sensitive features as identified in this plan or through future studies, or where trails are located within or adjacent to natural heritage features, the potential impact(s) of proposed trails should be assessed as part of an EIR and mitigated as appropriate. As recommended in this MESP, additional buffering may be required in order to locate the trail to minimize potential impacts to significant natural heritage features in six strategic locations along the watercourse corridors.

Priority / Phasing

The most ecologically appropriate location of cross-valley connections should be investigated as part of an EIR at the Block Plan stage (for Area 47-1 and Area 47-2) or as part of an EIS at Site Plan stage (Area 47-3).

Design Guidance and Policy Considerations

According to the City of Brampton’s Official Plan (Section 4.5.6.4), new pathways/trails through valley or watercourse corridors will protect, restore, and enhance environmental features. In addition, the Official Plan also states that pathways/trails “should be sited to avoid sensitive natural features…” (Section 4.5.6.2 (ii)). Accordingly, cross-valley connections proposed as part of the trail network will have to give due regard to the natural heritage features and functions of the Natural Heritage System. In order for that to occur, it is recommended that an EIS be completed in accordance with the latest iteration of the TRCA’s *Environmental Impact Statement Guidelines*.

In some cases, trails are proposed within and/or adjacent to habitat for species at risk. In these cases it is recommended that as a first step, the possibility of avoidance be investigated. Should avoidance of species at risk habitat not be possible, it is recommended that the proponent enter in to consultations with the MNRF regarding acceptable mitigation measures and, if applicable, to obtain the necessary permits.

Approvals

The City of Brampton is the primary approval agency for trails within the Area 47 SPA.

The construction of trails is considered a type of development. In areas where trails are proposed within lands regulated by the TRCA, a permit from the TRCA will be required.

In some cases, trails are proposed within and/or adjacent to habitat for species at risk. If trails could potentially impact species at risk and/or their habitat, a permit from the MNRF will be required.

Table 8.2: MESP Implementation - Natural Heritage System Components

Subwatershed Strategy Components	Targets / Objectives / Benefits	Future Study Requirements	Priority / Phasing Considerations	Policy Considerations	Approvals
1. Woodlands / Woodlots – Refer to Report Section 8.2.1					
Ensure that woodlands are not negatively impacted by development.	Protect, maintain, and enhance woodlands.	Retained tableland woodlands are subject to a feature-based water balance as part of an EIR that will also assess the potential impacts to woodlands as a result of development. A Woodland Management Plan will need to be submitted in support of development applications located adjacent to woodlands. A Tableland Vegetation Assessment will be required should vegetation removals be proposed.	It is recommended that EIRs/EISs, Woodland Management Plans, and Tableland Vegetation Assessments be completed at the Block Plan or the Site Plan stage.	Woodland protection is mandated through the City of Brampton's Official Plan. Woodlands are also protected by the City's Woodland Conservation By-law. Treed wetlands are regulated by the TRCA.	City of Brampton TRCA
2. Wetlands – Refer to Report Section 8.2.2					
Ensure that wetlands are not negatively impacted by development.	Protect and enhance wetlands and provide adequate compensation for those which cannot be retained.	Retained tableland wetlands are subject to a feature-based water balance as part of an EIR that will also assess the potential impacts to wetlands as a result of development.	It is recommended that EIRs be completed at the Block Plan (Area 47-1 and Area 47-2) and EISs at the Site Plan (Area 47-3) stage.	Wetland protection is mandated through the City of Brampton's Official Plan. Wetlands are regulated by the TRCA.	City of Brampton TRCA
3. Hedgerows and other Tableland Trees – Refer to Report Section 8.2.3					
Hedgerows and tableland trees should be retained where possible.	Trees have both natural and cultural heritage value.	Assess the feasibility of retaining hedgerows H14, H37, H43, H54, and H62 at the Block Plan or Site Plan stage. A Tableland Vegetation Assessment will be required should vegetation removals be proposed. Compensation Planting Assessment and Compensation Planting Plan to compensate for desirable vegetation removed in the development process. Such plans could include provisions for transplanting and/or propagation as applicable. Significant trees associated with cultural heritage properties will be subject to assessment.	It is recommended that the assessment of tableland vegetation be completed at the Block Plan (Area 47-1 and Area 47-2) or the Site Plan (Area 47-3) stage as part of an EIR or EIS, respectively.	The City of Brampton is the primary approval agency for Tableland Vegetation Assessments and the assessment of vegetation on cultural heritage properties. City policies requires 3 trees as compensation for the removal one healthy tree at or above 15 cm dbh. The protection of individual trees is subject to the provisions of the City of Brampton's Tree Preservation Bylaw.	City of Brampton

Subwatershed Strategy Components	Targets / Objectives / Benefits	Future Study Requirements	Priority / Phasing Considerations	Policy Considerations	Approvals
4. Species at Risk and other Species of Conservation Concern– Refer to Report Section 0					
Surveys for species at risk and other species of conservation concern are required.	Conservation and preservation of the natural heritage system.	As species become up-listed or added to the Federal and/or Provincial lists of species at risk or locally rare species lists, it will be necessary to investigate both the presence of these species and their habitat requirements. Specific studies are required for Bobolink, Eastern Meadowlark, and Barn Swallow, and any other SAR determined to be present within the study area. Properties not surveyed comprehensively during MESP field investigations will be subject to 3-season botanical surveys and surveys for Species at Risk	It is recommended that surveys be completed at the Block Plan (Area 47-1 and Area 47-2) or the Site Plan (Area 47-3) stage as part of an EIR or EIS, respectively.	Provincially-listed Endangered and Threatened species at risk and their habitat are protected under the Endangered Species Act (2007). A hierarchy of preferred habitat protection/compensation options is provided above in **Section 0**. Nationally Endangered, Threatened or Special Concern species; Provincially-listed species of Special Concern; Nationally and Provincially rare species; and locally rare species and their habitat are protected under the Provincial Policy statement and, ergo, the City of Brampton's Official Plan.	MNRF City of Brampton TRCA
5. Significant Wildlife Habitat – Refer to Report Section Error! Reference source not found.					
Investigation of potentially significant Raptor Feeding and Roosting Areas	Conservation of Significant Wildlife Habitat as a component of the NHS.	Future study will determine if a significant raptor feeding and roosting area is present between the Gore and Clarkway Tributaries. Survey methodology is to be confirmed with the applicable agencies.	It is recommended that surveys be completed at the Block Plan stage as part of an EIR.	Significant wildlife habitat is protected under the Provincial Policy statement and, ergo, the City of Brampton's Official Plan.	City of Brampton TRCA
6. Environmental Buffers– Refer to Report Section Error! Reference source not found.					
Confirmation of minimum buffer requirements.	Protection of the natural heritage system and mitigation of potential negative effects of development. Buffers to the NHS will be fully vegetated with woody vegetation.	The minimum buffer widths recommended in this MESP are intended to be implemented as outlined in the MESP. The minimum buffers recommended in the MESP may be subject to expansion following the completion of a comprehensive EIR.	It is recommended that future studies be completed at the Block Plan (Area 47-1 and Area 47-2) or the Site Plan (Area 47-3) stage as part of an EIR or EIS, respectively.	The EIS should follow the recommendations and protocols contained within the latest iteration of the TRCA's *Environmental Impact Statement Guidelines*. Buffers should be fully vegetated with woody plantings.	City of Brampton TRCA MNRF

Subwatershed Strategy Components	Targets / Objectives / Benefits	Future Study Requirements	Priority / Phasing Considerations	Policy Considerations	Approvals
7. East-West Linkages– Refer to Report Sections 6.3.1 and 8.2.6					
Creation of a wildlife corridor associated with the TCPL lands between the Clarkway Tributary and the Rainbow Creek Tributary.	Corridor will allow for wildlife movement between the two tributaries. Overall net ecological benefit to the NHS.	Opportunities to locate passive and low-impact land uses adjacent to the corridor should be considered. Future comprehensive studies (e.g. an EIS or EIR) will determine corridor design considerations.	It is recommended that EIRs be completed at the Block Plan (Area 47-1 and Area 47-2) and EISs at the Site Plan (Area 47-3) stage.	The EIR/EIS should follow the recommendations and protocols contained within the latest iteration of the TRCA's *Environmental Impact Statement Guidelines*.	City of Brampton TRCA
Enhancement of the linkage function performed by a tableland woodland located between the Gore and Clarkway Tributaries.	Enhance the woodland's function as a wildlife linkage. Avoid impacts to the NHS.	Opportunities to locate passive and low-impact land uses adjacent to the woodland should be considered. Bisection of the woodland linkage by transportation infrastructure is not recommended. Future studies should investigate road crossing options over the Gore and Clarkway Tributaries which do not inhibit the ecological form and function of the linkage. An EIR should include biophysical surveys as well as a feature-based water balance, impact assessment, and restoration plan for the woodland. A Woodland Management Plan will need to be submitted in support of development applications located adjacent to woodlands.	Land use planning considerations, the feature-based water balance, EIR, and Woodland Management Plan are to occur at the Block Plan stage.	The EIR should follow the recommendations and protocols contained within the latest iteration of the TRCA's *Environmental Impact Statement Guidelines*.	City of Brampton TRCA
8. Trails– Refer to Report Section 8.2.7					
Determine ecologically appropriate locations for trails for Gore Road and Clarkway Tributary corridors.	Avoid impacts to the NHS. Guide trail users through their neighbourhood while avoiding sensitive natural heritage features. Aid in fostering nature appreciation.	An EIR should determine the most ecologically appropriate locations for trails within and/or adjacent to the natural heritage system.	The EIR should be completed at the Block Plan (Area 47-1 and Area 47-2) or Site Plan (Area 47-3) stage.	According to the City of Brampton's Official Plan, trails should be sited to avoid sensitive natural heritage features and will protect, restore, and enhance environmental features within valleys and watercourses. Trails should not negatively impact species at risk or their habitat.	City of Brampton TRCA MNRF
Rainbow Creek Tributary	Preservation of modified corridor – trail to be located within additional 5m buffer except in areas south of the TCPL lands slated for meadow restoration.	The EIR should be completed at the Block Plan (Area 47-1 and Area 47-2) or Site Plan (Area 47-3) stage.	Minimize disturbance by coordinating construction with the modification of Rainbow Creek corridor.	The preferred trail alignment has been determined through stakeholder meetings. The proposed trail, which extends from Castlemore Road to the TCPL location, will avoid sensitive restoration areas.	TRCA City

9 MONITORING

The following sections outline recommendations with respect to future environmental monitoring activities. Detailed monitoring plans will be developed as part of future EIRs and will be designed in such a way that impacts can be distinguished from natural trends at an early stage. Monitoring program implementation will be the responsibility of the developer.

The EIRs will include an outline of an integrated environmental monitoring plan for the Study Area that is based on principles of Adaptive Environmental Management. The goal of Adaptive Environmental Management is to monitor the environmental features and functions of the Natural Heritage System (i.e. existing woodlots, new restoration areas) to observe the success of NHS, site design and mitigation measures (e.g. buffers, LIDs, etc.) in protection of these environmental features and functions (e.g.. fish habitat, wetland creation and water quality), and where unforeseen negative impacts are observed, to take action by instituting appropriate follow-up adaptive management measures, as appropriate.

Short, medium and long term monitoring needs to be considered for functions including those related to:

- Water quality;
- Fisheries;
- Hydrology (LID measures);
- Groundwater quality and quantity;
- Stream morphology;
- Terrestrial resources – woodlots, wetlands, wildlife, Environmentally Sensitive Areas; and
- West Humber Tributaries as per TRCA's Natural Channel Monitoring Guidelines.

If negative impacts are detected, a more intense monitoring program may be necessary to determine where, why and how fast the change is occurring, including, but not limited to:

- Proposing alternative, appropriate adaptive mitigation measures, if necessary; and
- Focusing on evaluating ongoing or proposed management practices.

In general, monitoring activities should take place:

- Prior to development to established baseline conditions;
- During construction prior to detect any changes or trends; and
- After construction in order to confirm that the environmental targets and objectives have been met.

Monitoring plans are to be vetted through the relevant review agencies (e.g. City of Brampton, TRCA) prior to implementation. Recommended minimum monitoring components are discussed below. Future studies (e.g. EIRs) and/or consultation with review agencies may result in additional monitoring requirements.

Data sharing between developers/proponents, where applicable, is encouraged.

9.1 Groundwater Monitoring

Groundwater monitoring should include water level and water quality measurements at one or more of the monitoring wells used in the characterization phase of the MESP study (see **Section** 2.1.2). Geotechnical investigation sites throughout the study area represent other candidate locations. Sites should be selected based on anticipated accessibility and availability during the course of the area's development and would ideally include:

- At least one site located upgradient and another downgradient of the groundwater direction (i.e. at the north and south ends of Area 47, respectively) to monitor impacts within the study area;
- A site on the west side of Area 47 to monitor impacts of the residential development planned for this area; and
- A site on the east side of Area 47 to monitor impacts of the industrial/commercial development planned for this area.

The primary objectives of the monitoring program would include:

- Assessment of the performance of the LID measures in maintaining the pre-development water balance; and
- Detection of potential groundwater level impacts and quality impacts to private wells in the area during construction. Note that, once the area is fully developed, it is assumed that the use of private wells in the area will have ceased.

The recommended monitoring should span:

- Minimum of 1-2 years prior to construction. Depending on the sites chosen, the past monitoring completed as part of this MESP could also be used to supplement the pre-development data;
- During construction; and
- Minimum of 2-3 years post-construction.

Monitoring would include:

- Continuous groundwater level measurements; and
- Three water quality sampling events in spring, summer and fall. Laboratory parameters should include TSS/turbidity, bacteria, nutrients, metals, and chlorides.

Reports should be submitted annually to the City and TRCA. Funding for the program would be the responsibility of the development community.

9.2 Surface Water Monitoring

Two groups of surface water monitoring activities are recommended to evaluate the impacts of the future land use changes and the effectiveness of the MESP management strategies:

- Instream monitoring of receiving streams; and
- Stormwater management facility monitoring.

Instream Monitoring

The cumulative impacts of future development coupled with implementation of the various upstream stormwater management and restoration/enhancement works over time is best measured through long-term monitoring in the downstream receiving watercourses. Therefore, it is recommended that the city develop a long-term monitoring program that focusses on instream water quality, temperature, and flow conditions. To do so, the City should work closely with TRCA who have on-going instream flow and water quality monitoring programs that the City of Brampton could utilize and/or build upon to measure the effectiveness of the recommended MESP strategy as it is implemented. Development of the monitoring program should answer the following questions:

- What should be monitored?
- Where to monitor?
- When to monitor?
- Who will run the program?

Recommendations with respect to the above are provided.

What should be monitored? The instream monitoring program should include:

- Streamflow gauges – to be used to assess runoff rates and volumes and to detect trends which may occur as the area is developed over the long-term.
- Temperature gauges – to be used to assess the thermal impacts associated with the upstream development. This would be of particular interest on Rainbow Creek where one of the objectives of the extensive planting works that are proposed within the restored corridor is to control or reduce instream temperatures.

- Water chemistry sampling – would consist of five (5) dry weather and five (5) wet weather events annually. Laboratory parameters should include representative pollutants such as TSS/turbidity, bacteria, nutrients, metals, and chlorides.

Where? There are currently no stream monitoring sites on the Area 47 study area tributaries. The nearest existing gauge site is located on the West Humber River Main Branch at Regional Road 7. However, this site is located upstream of the confluence with the Area 47 tributaries, and therefore would not be appropriate.

Two new stream monitoring sites are recommended at the downstream end of the Area 47 study area:

- A site on Rainbow Creek near Castlemore Road. This site would be setup to monitor hydrologic, temperature and water quality changes associated with both upstream industrial/commercial development and the restoration/enhancement works for the Rainbow Creek corridor;

- A site on the Gore Road Tributary near the outlet north of the Gore Road-Castlemore Road intersection. This site would monitor hydrologic, temperature and water quality changes associated with the upstream residential development.

Consideration may also be given to a gauge site on the Clarkway Tributary. However, it is noted that external development within the Town of Caledon north of Mayfield Road is also planned within this watershed. Therefore, it may be difficult to "isolate" any observed impacts from within the Area 47 lands.

When? In order to effectively measure the impacts of the land use changes and MESP management works, reliable baseline conditions will need to be established. Therefore, the monitoring program should be developed and implemented in a timely manner *before* construction begins. The recommended monitoring should span:

- Minimum of 1-2 years prior to construction;
- During construction; and
- Minimum of 2-3 years post-construction.

Given that build-out of the area is expected to take several years, a significant amount of data is expected to be collected. TRCA may therefore wish to consider maintaining these monitoring sites even after the monitoring requirements for Area 47 are complete.

Who? The monitoring program, including equipment installations, day-to-day monitoring exercises, maintenance, and data compilation should be executed by a qualified engineering consultant on behalf of the City and development community. Development of the program should also include TRCA input to ensure consistency with their requirements should the program be assumed by the authority for long-term monitoring following construction. Reports should be submitted annually to the City and TRCA. Funding for the program would be the responsibility of the development community.

<u>Stormwater Management Facility Monitoring</u>

As part of future subdivision and site plan agreements, it is recommended that the City of Brampton include requirements for the monitoring of individual stormwater management facilities. The purpose of the monitoring programs would be to confirm that the facilities have been constructed and are functioning as designed prior to assumption by the city.

In terms of end-of-pipe stormwater ponds, all facilities will require a monitoring program. LID source and conveyance controls, on the other hand, may be widespread and distributed throughout the proposed subdivision with a multitude of outlets. Therefore, the City, in consultation with the development proponent, should develop a tailored monitoring program suited to the site specific characteristics of the treatment system. For example, if a network of dry swales or bioswales is to be used, monitoring of runoff volumes and water quality may be targeted at select strategic outfall locations.

Stormwater facility monitoring programs should generally include:

- Influent and effluent sampling obtained at the inlets and outlet locations in order to confirm the 80% TSS removal target per the “enhanced” water quality design criteria as specified in the MOE Stormwater Management Planning and Design Manual;
- Temperature measurements at the inlet and outlet locations to assess thermal impacts of the stormwater facilities; and
- Water level/flow measurements at both the inlet and outlet location to assess peak flow reductions, and runoff volume reductions (LID’s).

A minimum of 2 to 3 years of monitoring is recommended following construction so that the performance can be verified over several significant storm events. Reports should be submitted annually to the City. Funding for the program would be the responsibility of the development proponent.

9.3 Stream Geomorphology Monitoring

As development progresses and land uses change within the Area 47 lands, fluvial geomorphological monitoring is recommended to evaluate impacts and potential issues along the study area watercourses.

Monitoring Locations

At least one monitoring site should be established on each of the Gore Road Tributary, Clarkway Tributary and Rainbow Creek. The sites should be selected through consultation with a qualified fluvial geomorphologist but are generally expected to be located within the southern reaches of the study area so that upstream land use changes and stormwater impacts can be assessed. The precise location of the monitoring sites should also consider reach sensitivities and existing erosion / slope stability characteristics that were noted during the characterization phase of the MESP (see **Section 2.2.1**).

Phasing and Methodology

Once the monitoring sites are established, monitoring should occur during the pre-construction, construction, and post-construction periods. Pre-construction monitoring should be conducted at least one to two years prior to site development in order to establish a baseline for monitoring conditions.

For each site, the detailed monitoring plan should include surveys of six (6) channel cross-sections (three riffles and three pools as applicable), and the longitudinal profile along the channel thalweg from the downstream-most cross-section to the upstream-most cross-section. Both parameters should be surveyed *twice annually*. Pebble counts to determine substrate composition and particle size distribution should be conducted *once annually* along the riffles. Lateral migration of the watercourses will also be monitored to determine the rate of adjustment and to determine if excessive erosion is occurring. It is recognized that natural migration should be expected, and therefore multi-year erosion threshold targets are recommended (i.e. monitored annually but target thresholds based on cumulative erosion should be assessed over 3 to 5 years).

Photographs should be collected twice annually to confirm changes to the channels overtime. The photographs should document the following standard vantage points at each cross-section:

- Upstream;
- Downstream;
- Left bank;
- Right bank; and
- Bed.

It is expected that the following changes to selected parameters will not be exceeded. However, baseline data analyzed by a qualified fluvial geomorphologist shall be used to confirm and/or modify the proposed thresholds:

- Site-averaged cross-sectional area should not increase or decrease in excess of 20%;
- Site-averaged inter-pool gradients should not differ in excess of 20% between successive surveys;
- Site-averaged riffle gradients should not increase or decrease in slope by more than 20% between successive surveys;
- Site-averaged cross-sectional mean bed elevation should not vary within 20% of the average bankfull depth at each site; and
- Lateral migration target thresholds should be scaled to channel size as a percentage of the average bankfull width at each site, based on classifications of bed material and expected lateral migration activity, and assessed over multiple monitoring years (results of annual surveys compared over the entirety of the monitoring program).

Should the above thresholds (or those revised following the baseline monitoring) be exceeded, the results should be analysed by a qualified fluvial geomorphologist. Consultation with city, TRCA and stakeholders would then be recommended to determine if mitigation actions are required.

Post-construction monitoring of the above-noted cross-sectional and stream profile parameters should occur within the established sites during years 1, 2, and 5 post-construction, with pebble counts occurring once during each of these three monitoring years.

The monitoring program should be executed by a qualified fluvial geomorphologic consultant on behalf of the City and development community. Reports should be submitted annually to the City and TRCA. Funding for the program would be the responsibility of the development community.

9.4 Terrestrial Ecology Monitoring

This section presents a preliminary monitoring framework for monitoring the terrestrial resources of the Area 47 SPA; monitoring recommendations are presented below in Table 9.1. Exact monitoring locations are to be determined as land use planning is finalized. Generally, it is recommended that monitoring locations include habitats sensitive in hydrological regime, areas of high ecological quality/function, and serious infestations of invasive non-indigenous species targeted for control. It is highly recommended that monitoring locations include the locations of conservative or sensitive species and habitats, as these species and habitats are important components of the local and Regional Natural Heritage System and may serve as bioindicators.

It is also recommended that terrestrial monitoring be completed annually during pre-construction, semi-annually during construction; and annually in years 1, 3, 5 and 10 post-construction unless a subsequent study such as an EIS have determined otherwise. The extent/duration of post-construction monitoring can be adapted from the recommended 1, 3, 5, and 10 year post-construction terrestrial monitoring specified above should the results of previous monitoring indicate such a necessity.

Table 9.1 also lists suggested unacceptable monitoring results and related contingency measures for each category of terrestrial monitoring. Future studies may add to the thresholds and triggers, especially as new and more detailed information becomes available. At the first sign of unacceptable monitoring results, the monitoring agent (i.e. the developer) is to review the monitoring results from all potentially relevant disciplines along with land use changes in order to ascertain a reasonable cause for the observed result. Following that, the monitoring agent is to employ measures to manage (i.e. halt or reverse) the unacceptable monitoring result. Contingency measures could include, and are not limited to: restoration and enhancement measures, augmentation of recreational trails, installation of fencing, redesign of SWMF outlets, minor changes to the adjacent land uses (e.g. park lighting), and stewardship measures.

As mentioned above, the Terms of Reference for any monitoring plan(s) must be approved by the relevant review agencies (e.g. TRCA, MNRF, City of Brampton). The development community/proponent is responsible for implementing the monitoring.

Table 9.1: Terrestrial Ecological Monitoring

Monitoring Parameter	Pre-Construction Monitoring	During Construction Monitoring	Post-Construction Monitoring	Triggers/Thresholds & Contingency Measures
Vegetation Monitoring	• Vegetation monitoring comprised of quantitative monitoring at permanent plots, as well as qualitative monitoring of occupancy-related effects along buffers and within natural areas. Locations will be finalized when the preferred land use us established. Surveys are to be completed during the peak growing season (June –August), preferably during the same time each monitoring year. • Quantitative Monitoring: Permanently marked transects will be established in natural areas (buffers, wetlands, riparian corridors and forests). Quadrats will be established along the transect and inventoried for plant species and photographed. Additional measurements/observations along the transect will be made including dominant trees/shrubs/herbaceous vegetation, depth and location of standing water, community health, site disturbance. Inventoried plant species will be characterized by abundance, CC and CW, FQAI, and, if applicable, presence of indicator species. • Qualitative Monitoring: Items to be monitored include encroachment into natural areas and buffers (fence removal, dumping of leaf litter, grass clippings, soil and garbage and construction debris), creation of pedestrian or vehicular trails, vandalism, presence and extent of invasive species infestations, etc. Locations of impacts will be recorded and photographed. Could include Floristic Quality Analysis. It is recommended that encroachments be reported to the landowner, the City of Brampton, and the TRCA. • Monitoring of invasive species should be included in all vegetation monitoring plans.	• During construction monitoring commences with the onset of any development activities in any development parcel. • Continue monitoring at stations established during Pre-construction Monitoring, to be completed during the growing season (late May/Early June – late August)	• Continue monitoring at stations established during Pre-construction Monitoring, to be completed during the growing season (late May/Early June – late August) • Monitoring is to take place during years 1, 3, 5 and 10 post-construction.	• Unacceptable monitoring results could include, but are not limited to, the following: mass die-off of species; loss of sensitive and/or target species and/or species of conservation concern; significant change in CC, CW, and/or FQI values; infestation of invasive species; and anthropogenic encroachments. • Contingency measures could include, and are not limited to, one or more of the following: restoration, augmentation of site hydrology, invasive species removal, trail augmentation, fencing, and stewardship.
Amphibian Calling Surveys	• Breeding amphibians in the study area will be monitored using calling surveys conducted at locations throughout Area 47 SPA, and in some cases, areas adjacent to the SPA (i.e. Ponds GP-10 and GP-11). • Date selection, survey methodology and data recording will follow the Marsh Monitoring Protocol (MMP) (3 visits per year). • Amphibian calling survey locations will be decided when the preferred land use is established, using air photos and previous monitoring results.	• During construction monitoring commences with the onset of any development activities in any development parcel. • Continue amphibian calling surveys at stations established during Pre-construction Monitoring, per MMP (3 times per year)	• Continue amphibian calling surveys at stations established during Pre-construction Monitoring, per MMP (3 times per year). • Monitoring is to take place during years 1, 3, 5 and 10 post-construction.	• Unacceptable monitoring results could include, but are not limited to, the following: a decline in overall species numbers, calling intensity, or a decline or loss of a species (especially development-sensitive species or species of conservation concern such as leopard frog). • Contingency measures could include, and are not limited to, one or more of the following: augmentation of site hydrology, restoration of extant wetlands and/or adjacent lands, creation of wetlands and foraging habitat, identification and mitigation of possible biological sinks, mitigation of ambient nighttime light, fencing, and stewardship.

Monitoring Parameter	Pre-Construction Monitoring	During Construction Monitoring	Post-Construction Monitoring	Triggers/Thresholds & Contingency Measures
Breeding Bird Surveys	• Breeding bird surveys will be completed using OBBA protocols during appropriate times of year (June – July). • Surveys for Species at Risk are to follow MNRF-specified protocols. • Survey locations will be finalized when the preferred land use is established.	• During construction monitoring commences with the onset of any development activities in any development parcel. • Continue surveys established during Pre-construction Monitoring, in June and July	• Continue surveys established during Pre-construction Monitoring, in June and July. • Monitoring is to take place during years 1, 3, 5 and 10 post-construction.	• Unacceptable monitoring results could include, but are not limited to, the following: overall decline in species diversity, declines of species of conservation concern, declining breeding evidence, and/or an increase in edge-tolerant species (e.g. brown-headed cowbird). • Contingency measures could include, and are not limited to, one or more of the following: habitat restoration and/or enhancement, mitigation of ambient noise and/or nighttime light, augmentation of human activities (e.g. encroachment, trails), fencing, and stewardship.
Road Mortality Surveys	• These surveys will focus on resident reptile (e.g. snake and turtle) species in the study area, but other taxa will also be recorded. Monitoring should include Countryside Drive, Castlemore Road, Clarkway Drive, Coleraine Drive, and The Gore Road; however the road survey segments will be finalized when the preferred land use is decided upon. • Any new roads should be considered for road mortality surveys, depending on their proximity to possible hibernacula. • Surveys should be carried out three times in the spring and three times in the summer.	• During construction monitoring commences with the onset of any development activities in any development parcel. • Continue surveys established during Pre-construction Monitoring (three times in the spring and three times in the summer)	• Continue surveys established during Pre-construction Monitoring (three times in the spring and three times in the summer) • Monitoring is to take place during years 1, 3, 5 and 10 post-construction.	• Unacceptable monitoring results could include, but are not limited to, the following: mortality of species of conservation concern, and/or identification of mortality “hot spots” and associated sinks. • Contingency measures could include, and are not limited to, one or more of the following: the installation of wildlife crossings/ecopassages, fencing, signage, and traffic calming.
Chimney Crayfish Surveys	• Chimney Crayfish have been identified in several areas throughout the study area. Suitable habitat for this species includes wetlands, floodplains, HDFs, and watercourses. Surveys should occur during summer in suitable habitat. • Crayfish burrows should be recording using a GPS system. • Number and location of burrows should be compared temporally and spatially. • Note: It is recommended that Chimney Crayfish monitoring results be considered in association with groundwater and surface water monitoring results.	• During construction monitoring commences with the onset of any development activities in any development parcel. • Continue surveys established during Pre-construction Monitoring.	• Continue crayfish surveys at stations established during Pre-construction Monitoring, • Monitoring is to take place during years 1, 3, 5 and 10 post-construction.	• Unacceptable monitoring results could include, but are not limited to, the following: decrease in species or burrow observations, or a significant change in occupancy/location of crayfish territories. • Contingency measures could include, and are not limited to, one or more of the following: augmentation of SWMF outlet flows, and augmentation of habitat (including but not limited to hydrology and soils) through restoration efforts.

Rainbow Creek Corridor Restoration

The efficacy of the restoration works in the to-be-constructed 100-105 m wide Rainbow Creek corridor is to be monitored. The primary ecological goal of said restoration works is to provide enhanced ecological function within the corridor. Accordingly, monitoring parameters for the corridor are to include restoration efficacy in addition to the other monitoring parameters specified in **Table 9.1** and **Table 9.2**. Monitoring is to occur within the constructed valley and in adjacent natural heritage features as applicable in years 1, 2, 3, 5, 10, and 15 post-restoration, but could be extended should the monitoring results indicate such a necessity.

It is recommended that efficacy monitoring of restoration efforts should, at a minimum, include planting survivorship, establishment of the target community, and use of the area as a corridor by terrestrial and aquatic wildlife (including target species). Unacceptable monitoring results could include, but are not limited to, the following: anthropogenic encroachment, erosion, failed establishment of planted material, failed establishment of target community, poor plant health, lack of demonstrable use by wildlife, and infestations of invasive species. Contingency measures could include, and are not limited to, one or more of the following: replanting, further restoration, assisted species introduction, augmentation of site hydrology, augmentation of site topography, soil amendments, fencing, and stewardship.

Linkage Restoration/Enhancement

It is recommended that the efficacy of the restoration works to be implemented in and adjacent to the east-west woodland linkage between the Gore and Clarkway Tributaries and the linkage be subject to terrestrial monitoring. As with the proposed Rainbow Creek corridor discussed above, monitoring parameters include restoration planting survivorship, establishment of the target community, and use of the area as a corridor by wildlife (including target species) in addition to the other monitoring parameters specified in Table 9.1. Monitoring is to occur within each of the east-west linkages and in adjacent natural heritage features as applicable in years 1, 2, 5, and 10 post-restoration, but could be extended should the monitoring results indicate such a necessity.

In addition to breeding bird surveys listed above in **Table 9.1**, it is recommended that owl surveys occur within the woodland linkage.

Buffers

It is recommended that the efficacy of buffer plantings be subject to terrestrial monitoring. Monitoring parameters are to include buffer planting survivorship, including such parameters as % coverage, % survivorship, and species assemblage. As part of this monitoring, it is recommended that quantitative photo plot monitoring occur within buffer areas twice annually. Buffer efficacy monitoring could occur in conjunction with other monitoring activities. Unacceptable monitoring results could include, but are not limited to, the following: anthropogenic encroachment, erosion, failed establishment of planted material, failed establishment of target plant community, poor plant health, and infestations of invasive species. Contingency measures could include, and are not limited to, one or more of the following: replanting, further restoration, augmentation of site hydrology or topography, soil amendments, fencing, and stewardship.

It is recommended that buffer monitoring occur in years 1, 2, 5, and 10 post-planting, but could be extended should the monitoring results indicate such a necessity.

9.5 Aquatic Ecology Monitoring

This section presents a monitoring framework for the aquatic resources of the Area 47 SPA. In recognition of the usefulness and availability of multiple years of background data, it is recommended that the fish survey locations shown in **Figure 2.24** and mussel survey locations shown in **Figure 2.25** continue to be monitored. The location(s) of additional monitoring sites will be determined on a case-by-case basis as development proceeds within the Area 47 SPA. Data sharing between developers, where applicable, is encouraged.

Monitoring should be completed annually in the spring when water levels are conducive to fish passage. In the Clarkway and Gore Tributaries, it is recommended that monitoring be conducted annually during pre-construction, annually during construction, and in years 1, 3, and 5 post-construction. In the Rainbow Creek Tributary, once the creek has been realigned/restored, it is recommended that monitoring occur annually for a minimum of 7 years (unless relevant agencies such as the MNRF, TRCA, and/or City of Brampton require otherwise). Specific monitoring parameters are outlined below in **Table 9.2**

During construction, monitoring commences with the onset of any development activities within the Area 47 SPA and continues until construction is 90% complete. Post-construction monitoring immediately follows the aforementioned construction monitoring. The extent/duration of post-construction monitoring can be adapted from the recommended 1, 3, and 5 year (and for Rainbow Creek, include year 7) post-construction aquatic ecology monitoring specified above should the results of previous monitoring indicate such necessity.

As previously mentioned, the Terms of Reference for any monitoring plan(s) must be approved by the relevant review agencies (e.g. TRCA, MNRF, City of Brampton). The development community is responsible for implementing the monitoring.

Table 9.2: Aquatic Ecology Monitoring

Monitoring Parameter	Pre-Construction Monitoring	During Construction Monitoring	Post-Construction Monitoring	Triggers/Thresholds & Contingency Measures
Fish Community	• It is recommended that fish community sampling follow Section 3: Module 1 of the Ontario Stream Assessment Protocol (OSAP), unless the sensitivity of the fish community (i.e. if Redside Dace were to be found) precludes electrofishing surveys. • It is recommended that mussel surveys be completed in accordance with the Protocol for the Detection and Relocation of Freshwater Mussel Species at Risk in Ontario Great Lakes Area (Mackie et al., 2008).	• During construction monitoring commences with the onset of any development activities in any development parcel. • Continue surveys established during Pre-construction Monitoring.	• Continue surveys established during Pre-construction Monitoring. • Monitoring is to take place during years 1, 3, and 5 post-construction.	• Unacceptable monitoring results could include, but are not limited to, the following: a significant change in fish community composition, reduction in sensitive species (i.e. if Redside Dace were to be found). • Contingency measures could include, and are not limited to, one or more of the following: augmentation of SWMF outlet flows (water quality and quantity) and/or temperature, and augmentation of habitat (including but not limited to hydrology) through restoration efforts.
Benthic Invertebrates	• In addition to other relevant sites that may be identified through site-specific monitoring plans, in order to assess the potential impacts of stormwater management on the aquatic community, it is recommended that benthic invertebrate monitoring occur upstream and downstream of stormwater pond outlets. • Benthic invertebrate monitoring should follow the methodology of the Ontario Benthos Biomonitoring Network (OBBN) (consistent with; Section 2: Module 3 of the OSAP).	• During construction monitoring commences with the onset of any development activities in any development parcel. • Continue surveys established during Pre-construction Monitoring.	• Continue surveys established during Pre-construction Monitoring. • Monitoring is to take place during years 1, 3, and 5 post-construction.	• Unacceptable monitoring results could include a negative change in most benthic indices. • Contingency measures could include, and are not limited to, one or more of the following: augmentation of SWMF outlet flows (water quality and quantity) and/or temperature, and augmentation of habitat (including but not limited to hydrology) through restoration efforts.
Aquatic Habitat Monitoring	• It is recommended that OSAP Section 4: Modules 2 and 3 be used to assess features including general morphology, depth, hydraulic head, instream cover and type, substrate, bank morphology, and riparian vegetation. • Barriers to fish passage should be identified and assessed using the Ontario Stream Assessment Protocol (OSAP) Section 4: Module 9 - *Instream Crossing and Barrier Attribution*. • It is recommended that headwater drainage features (HDFs) be monitored using OSAP Module 10 - *Assessing Headwater Drainage Features*.	• During construction monitoring commences with the onset of any development activities in any development parcel. • Continue surveys established during Pre-construction Monitoring.	• Continue surveys established during Pre-construction Monitoring. • Monitoring is to take place during years 1, 3, and 5 post-construction.	• Unacceptable monitoring results could include, but are not limited to, the following: a significant change in OSAP results indicating channel widening, erosion, an increase in fine sediment, a decrease in riparian vegetation, a decrease in fish cover, a decrease or increase in aquatic vegetation, and/or the presence of barriers to fish passage. • Contingency measures could include, and are not limited to, one or more of the following: augmentation of SWMF outlet flow volume, augmentation of habitat (including but not limited to hydrology) through restoration efforts, and/or removal of barriers to fish passage.

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ATTATCHMENT 1:

- Area 47 Landowners Group Letter (September 20, 2016)
- TRCA Letter (July 22, 2016)

Area 47 Landowners Group Inc.

c/o Suite 200
7501 Keele Street
Vaughan, Ontario
L4K 1Y2
(905) 760-2700

September 20, 2016

DELIVERED VIA E-MAIL (amiller@trca.on.ca)

Toronto Region Conservation
101 Exchange Avenue
Vaughan, Ontario
L4K 5R6

Attention: Mr. Adam Miller, Acting Senior Planner, Planning and Development

Dear Sir:

RE: Master Environmental Servicing Plan (MESP)
Area 47 Secondary Plan
City of Brampton

With reference to your letter dated July 22, 2016 (a copy of which is attached hereto), addressed to the City of Brampton concerning the subject MESP report dated May 9, 2016, this is to advise you that the undersigned has been appointed to act as trustee of the landowners group in respect of the Area 47 Secondary Plan.

As requested, the undersigned trustee hereby confirms the acknowledgment and commitment of its landowners group to address the Review Comments as outlined in your letter dated July 22, 2016, through the Block Plan process.

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

Yours very truly,

AREA 47 LANDOWNERS GROUP INC.

Helen A. Mihailidi
HAM:jk
Encl.

Toronto and Region **Conservation** *for* The Living City

July 22, 2016

CFN 41230

BY EMAIL: malik.majeed@brampton.ca

Mr. Malik Majeed, Policy Planner
Planning & Infrastructure Services Department
City of Brampton
2 Wellington Street West
Brampton, ON
L6Y 4R2

Dear Mr. Majeed:

Re: Master Environmental Servicing Plan (MESP) – Revised dated May 9, 2016
Highway 427 Industrial Secondary Plan Area (Area 47)
Ontario Municipal Board (OMB) File #PL141189
City of Brampton

Thank you for the opportunity to review and provide comments on the recent resubmission (received May 10, 2016), which includes the following documents:

- Response Letter, dated May 9, 2016, prepared by Aquafor Beech Limited;
- Final Report: MESP – Highway 427 Industrial Secondary Plan Area (Area 47), dated May 9, 2016, prepared by Aquafor Beech Limited;
- Technical Appendix: MESP – Highway 437 Industrial Secondary Plan Area (Area 47), dated May 9, 2016, prepared by Aquafor Beech Limited.

Further to our letter dated March 8, 2016, and as per the "Living City Policies for Planning and Development within the Watersheds of the Toronto and Region Conservation Authority (TRCA)" (LCP), staff provides the following comments as part of TRCA's commenting role under the *Planning Act*, the Authority's delegated responsibility of representing the provincial interest on natural hazards encompassed by Section 3.1 of the Provincial Policy Statement (PPS, 2014); TRCA's Regulatory Authority under the *Conservation Authorities Act* and O. Reg. 166/06, *Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses (as amended)*; and our Memorandum of Understanding (MOU) with the Region of Peel, wherein we provide technical environmental advice.

Purpose of the Application

The purpose of the Area 47 Secondary Plan Official Plan Amendment (OP2006-105) is to implement the policies of the Official Plan (OP) for the City of Brampton Planning Area, by establishing in accordance with Section 5.4 of the OP and the City's Growth Management Program, a policy framework to guide the development of a new Secondary Plan area in the City of Brampton, referred to as Area 47.

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In TRCA's jurisdiction, large scale urban development has included the preparation of Master Environmental Servicing Plans (MESPs). The purpose and role of the MESP in this context defines how the new Area 47 community will affect the natural environment, including natural hazards, and what specific servicing needs and constraints exist. A water management perspective is taken at this level, and includes an adaptive management strategy.

Background
On September 10, 2014, we understand City Council approved the OPA (2006-105) to implement the Area 47 Secondary Plan, which has since been appealed to the Ontario Municipal Board (OMB) by the Ministry of Municipal Affairs and Housing (MMAH), Ministry of Transportation (MTO), Region of Peel and others. The OMB has held several Prehearing Conferences (PHC) on June 9, 2015, October 16, 2015, March 4, 2016, and June 6, 2016. As part of the OMB's recent Notice of Decision (#21060018), dated January 18, 2016, a Consolidated Issues List (Exhibit #3) to be read in conjunction with a Matrix of Appeals (Exhibit #4) has been approved.

Recommendation
As previously recommended in our letter dated March 8, 2016, we advised the consulting team to make specific revisions to the various pages in the MESP, dated December 7, 2015, and return these sections of the report only. Once received, it was intended that these revised sections would be inserted into the existing document to replace the revised sections of the report, which would allow for the final approval of the MESP document.

The recent resubmission included updated copies of the main body for insert into the binders previously provided. Also, copies of select Appendix pages which were revised were also provided. With this fourth submission, TRCA staff **supports in-principle** the revised MESP subject to this letter being attached to the final MESP document, with a separate acknowledgement and commitment from the landowners group that the comments identified below will be addressed to the satisfaction of TRCA staff through the Block Plan review. The letter of commitment should also be attached to the final MESP document.

Review Comments

1. Section 3.10 identifies the 1 to 2 m grading restriction. However, Section 8 – Implementation should also provide reference to this grading restriction.

2. Gore 2-2 does not appear to be protected through the Block Plan. While this will be addressed through TRCA's review of the Block Plan, please note that any changes to the recommendations set out in the MESP will need to be analyzed within the context of the current policy regime, in this case, the updated TRCA Evaluation, Classification and Management of Headwater Drainage Features (HDFs) Guideline (dated July, 2013).

3. The Response Letter indicates that future study requirements are outlined in Section 8.3.5. This section does not appear to be included in the MESP document.

4. The updated report notes in Section 8.2.5 that the 0.5 m vertical buffer requirement from the Regulatory Floodplain will be evaluated in accordance with Secondary Plan Policy 5.4.1.2 and implemented through detailed design. Please note that Section 5.4.1.2 of OPA 2006-105 was intended to allow for grading in the environmental buffers to address significant changes to the Regulatory Floodplain resulting from the updated flood flow rates. Recognizing that the finalized flood flow rates within the study area have resulted in insignificant changes to the extent of the Regulatory Floodplain, it would seem unlikely that site-specific grading solutions within the buffer area would be required to achieve the 0.5 m vertical buffer requirement.

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5. While it may be reasonable to consider pond removals as part of the ongoing process, the specific need along with opportunities for replication/compensation of ecological function will need to be addressed during the Block Plan phase.

6. It is noted that the watercourse features that receive stormwater from SWM Pond R7a, R7b, R8 and R9 are located within the City of Vaughan and these watercourses traverse private lands. Previously, TRCA staff required the completion of an erosion assessment for these receiving watercourses to determine the level of control needed to avoid stream erosion of the receiving watercourse features. However, the landowners group indicated that these ponds will detain 25mm of rain for 120 hour to prevent any stream erosion on the receiving watercourses. Due to the fact that there is modification of catchment areas draining to these watercourses under proposed conditions, TRCA staff is of the opinion that during the Block Plan stage, proper erosion and flood assessments must be conducted on these receiving watercourses to determine the level of control needed to be provided by these stormwater management ponds to prevent stream erosion and flooding impact.

Conclusion

We thank you for the submission and trust these comments are of assistance in finalizing and approving the MESP. Should you have any further questions or comments, please do not hesitate to contact the undersigned.

Yours truly,

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