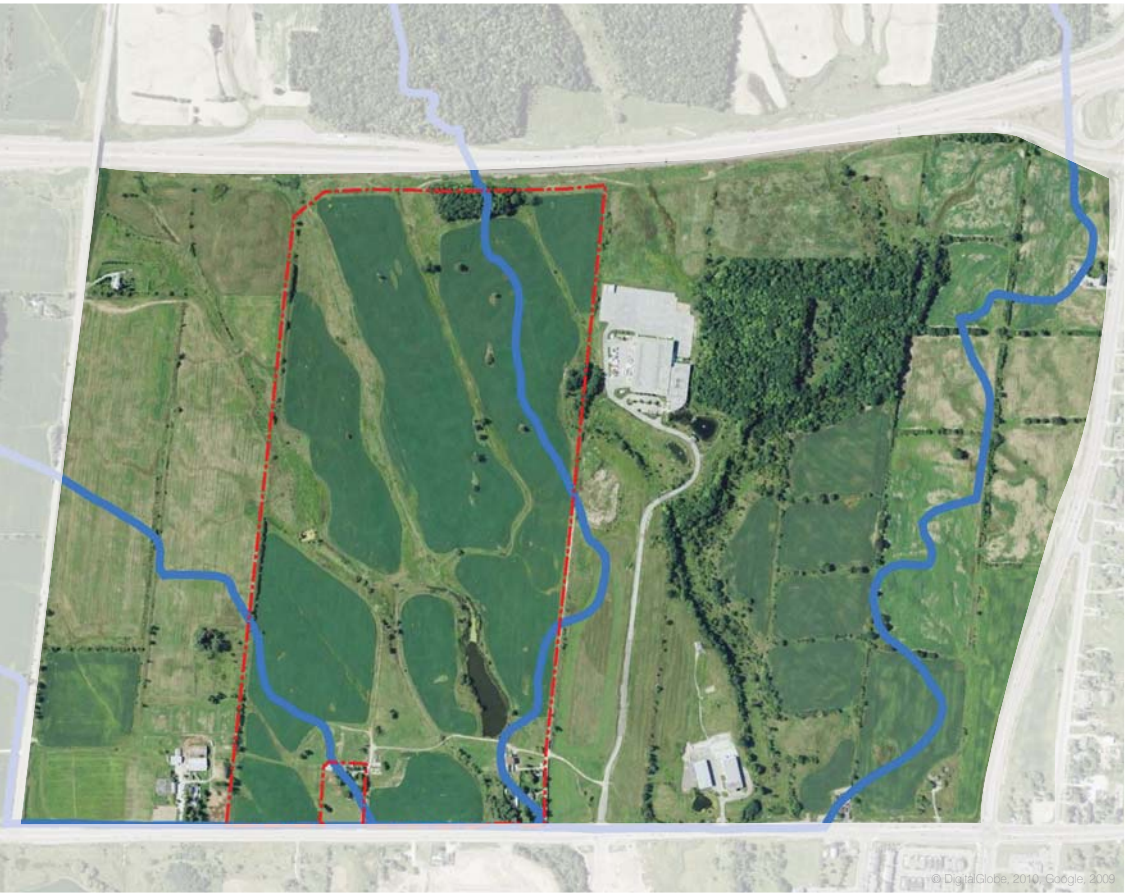

ENVIRONMENTAL IMPLEMENTATION REPORT / FUNCTIONAL SERVICING STUDY – MAIN REPORT (SUBMISSION)

May 2011

14 Mile Creek West and the Lazy Pat Farm Property
(3269 Dundas Street West), North Oakville West

PREPARED FOR:

Bentall Kennedy

PREPARED BY:

MMM GROUP

D14-011-18

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May 18, 2011

bcIMC Realty Corp.
c/o Bentall Kennedy (Canada) LP
55 University Avenue, Suite 300
Toronto, Ontario M5J 2H7

Attention: Mr. Michael Reel, Vice President, Investment Management

Dear Mr. Reel,

Subject: **Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farms Property, North Oakville West**

MMM Group Limited is pleased to submit our Environmental Implementation Report / Functional Servicing Study (EIR/FSS) for 14 Mile Creek West and the Lazy Pat Farms Property, North Oakville West. The EIR/FSS has been prepared in accordance with the approved Terms of Reference for EIR/FSS studies for North Oakville, in support of a Draft Plan of Subdivision and Zoning By-law Amendment application for the Subject Property.

The purpose of the EIR is to characterize and analyze the natural heritage features and functions and to determine and address the potential impacts of a proposed development application, including servicing requirements, on the Natural Heritage System (NHS). The purpose of the FSS is to identify servicing requirements related to sanitary, water, stormwater, roads, and site grading.

We thank you for the opportunity to undertake this Study. Please call should you have any questions or require clarification on any matters discussed.

Yours truly,

MMM GROUP LIMITED

Chris Tyrrell, MCIP, RPP
Manager, Planning & Environmental Design
Partner

Joe Sframeli, P.Eng.
Vice President
Infrastructure & Environmental Engineering

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Executive Summary

Executive Summary

This Environmental Implementation Report and Functional Servicing Study (EIR and FSS) has been prepared for a portion of lands within the 14 Mile Creek West catchment area (FM1001) and the bcIMC Realty Corp. lands, managed by Bentall Kennedy (Canada) LP and commonly known as the "Lazy Pat Farms" property (Subject Property). A range of environmental and municipal servicing matters are addressed in this EIR/FSS as required by the approved Terms of Reference for EIR/FSS studies for North Oakville.

The Subject Property is located within the western portion of North Oakville West Secondary Plan (NOWSP) area, which has been defined as the 407 West Employment Area. The Subject Property is located on the north side of Dundas Street West (Highway 5), generally mid-block between Tremaine Road and Bronte Road (Highway 25), in the Town of Oakville. The property encompasses an area of approximately 185 acres (75 hectares).

The purpose of the EIR is to characterize and analyze the natural heritage features and functions and to determine and address the potential impacts of a proposed development application, including servicing requirements, on the Natural Heritage System (NHS). The purpose of the FSS is to identify servicing requirements related to sanitary, water, stormwater, roads, and site grading. Further, the purpose of both the EIR and FSS is to provide a link between the Town's North Oakville Creeks Subwatershed Study (NOCSS) Management Report and Implementation Report, the NOWSP (OPA 289) and the Draft Plan of Subdivision submissions for development applications and identification of environmental and engineering draft plan conditions of approval for the Subject Property.

The following summarizes the major findings and recommendations of the EIR/FSS.

1.1 EIR Subcatchment Area and FSS Study Area

The Subject Lands are located primarily within the FM1001 subcatchment area, and smaller portions lie within the FM1102 and FM1109 subcatchment areas. The EIR subcatchment boundaries were refined using 2002 Town of Oakville topographic mapping. A comparison of updated existing drainage areas was made with drainage areas reported in the NOCSS Study. There are differences in drainage boundary interpretation resulting in approximately a 14 ha decrease in subcatchment FM1102, a 36 ha decrease in subcatchment FM1001 and a 3 ha increase in subcatchment FM1109.

EIR Subcatchment Area is defined to be the FM1001 subcatchment, focusing on the area south of Highway 407. Environmental and engineering requirements for the small portions of FM1102 and FM1109 subcatchment areas have been addressed without the need to prepare an EIR for these subcatchment areas, in accordance with the Terms of Reference.

The FSS Study Area is defined to be the lands within the 407 West Employment Area (lands bounded by Dundas Street West, Tremaine Road, Highway 407 and Regional Road 25 (Bronte Road)), to ensure servicing requirements for the areas external to the Draft Plan are adequate.

1.2 Natural Heritage System Framework

With respect to the Subject Property and the EIR Subcatchment Area, OPA 289, NOCSS and NOCSS Addendum identify various environmental features to be protected and/or studied further during the preparation of the EIR/FSS. As illustrated on Figure NOW3 from OPA 289 (Figure 2.1), the components of the Natural Heritage System (NHS) that are located within the EIR Subcatchment Area, and related subcatchment areas on the Subject Property include the 'High Constraint Stream Corridor Area' and 'Medium Constraint Stream Corridor Area', and features designated as 'Other Hydrological Features', which includes Low Constraint Stream Corridors, Hydrologic Features "A" and Hydrologic Features "B" and topographic depressions. These natural heritage components are further addressed through Section 2.0 and Section 5.0 of the EIR/FSS.

1.3 Land Use

The proposed land uses for the Subject Property consist of a range of employment uses and associated natural heritage and open space uses, in accordance with the Region's and Town's land use and planning directions for the 407 West Employment Area. The development concept envisions the creation of an office and business park with prestige employment uses adjacent to Highway 407, due to increased visibility along this major Highway. Limited commercial and service/retail uses are envisioned at the major road intersections along the Dundas Street corridor to serve the employment area. It is proposed that more general industrial uses, such as mixed warehousing and office uses may be accommodated internal to the business park. The Development Concept Plan (Figure 3.1) and proposed Draft Plan of Subdivision (Figure 3.2) are further addressed in Section 3.0.

The NOWSP, Figure NOW4 conceptually identifies a Major Trail System along the Burnhamthorpe Road extension, west of Bronte Road, extending to Tremaine Road, in addition to a Major Trail System within the NHS, along the main stream corridor which traverses the Subject Property. Design considerations are provided to guide further trail design at later stages in the development process where the trail system interfaces with the NHS.

The Planning Rationale Report, prepared by MMM Group Limited, in support of the Draft Plan of Subdivision and Zoning By-law Amendment applications, concludes that the development proposal is consistent with the Provincial Policy Statement, the Region of Halton Official Plan and the NOWSP.

1.4 Hydrogeology and Geology

The Subject Property and the three subwatersheds that traverse the property are located in a hydrogeological environment that is not particularly favourable towards mitigation of infiltration losses. The surficial fine-grained deposits of Halton Till found throughout the study area serves to limit infiltration to the groundwater system (65 mm/year) and as a result, the local stream systems receive a little over two-thirds of their total water from surface runoff (145 mm/year). Based upon the results of the water balance analysis, almost all of the groundwater base flow into the watercourses occurs over the period of November to May, when the entire shallow system, including upgradient reaches of the channel are saturated and contributing water to the streams. The watercourses are observed in a dry to ponded condition during the summer months as identified by the water balance, and the comparisons of measured stream flows to estimates from the water balance methodology are reasonable.

The lower reaches of the FM1001 tributaries (generally to the south of Highway 407) are interpreted as receiving minor groundwater contributions from the Queenston Shale bedrock but these contributions are insufficient to provide enough water to maintain flow in these watercourses during the summer months as the watercourses have been observed in dry to pooled conditions during these periods.

The section of the FM1109 tributary (14W-11/14W-11A) passing through the northeast corner of the Subject Property is interpreted from collected site data to be losing water to the ground, due to the nearby influence of a buried bedrock valley to the east, as is the large human-made pond at the central portion of the Subject Property.

The upper weathered zone of the surficial till deposits found throughout the subwatershed provides the bulk of the groundwater inputs to the local streams, but on a seasonal basis over about seven months of the year. The enhanced permeability of this upper zone permits infiltrating groundwater to travel through the shallow zone towards the watercourses and it is these conditions that provide the most promising potential mitigation opportunities at this site.

The greatest opportunity for mitigating against infiltration losses at the Subject Property is along the edge of the existing valley lands where the naturally weathered and fractured surficial till soils will remain undisturbed by construction and will retain their ability to convey water laterally towards the watercourses. It is along these lands that infiltration swales receiving clean roof runoff are proposed, and such infiltration measures are calculated to reduce the post-development on-site infiltration deficits from approximately 70% (with no mitigation proposed) to about 50%. On a total subwatershed basis, post-development base flow during the period between November and May is predicted to remain within 78% to 92% of the existing base flow contributions, whereas in dry periods, a slight increase in infiltration is provided to the groundwater system from the proposed mitigation measures.

The following recommendations as outlined in Section 4.0 are summarized as follows:

- Construct infiltration swales along the edges of the natural environment areas (tributary valleys) and direct clean roof runoff into these swales and allow it to infiltrate into the ground. Construction of these swales should only be done in dry weather to avoid remoulding the soil and effectively lining the swale sides and base with an impervious smeared layer. Manual scraping and removal of smeared soils from the sidewalls and base of the swales to expose the natural fracturing should be contemplated;

- Percolation testing at the proposed infiltration swale locations should be carried out during detailed design to confirm the infiltration rates of the surficial soils along the alignment of the proposed swales, and this information be used in refining the sizing of the swales. It is further recommended that a short length of swale be installed during the detailed design stage and tested to confirm its suitability for its intended purpose;

- Grading at the Subject Property should be, if possible, designed to moderate runoff and enhance recharge characteristics subject to the Town's standards for lot grading;

- Grade the rear/side yard landscaped grounds on lots adjacent to the natural features (tributary valleys) towards these features. This recommendation is also applicable to the Stormwater

Management Pond Blocks, where as much of the block area as feasible should be graded towards the valleys rather than back into the ponds;

- Steps to minimize post-development reduction in the infiltrative capacity of the low permeability till soils should be implemented where feasible. These steps are more pertinent to the parts of the Subject Property where minimal site grading is anticipated. These include: scheduling site grading and heavy construction activities during the drier summer months; designating areas that should see a minimum of construction traffic, particularly the areas where infiltration swales are proposed, and, scarifying and tilling the upper 0.5 m of soil within the proposed channel realignments to amend these soils with organic matter and/or placement of thicker topsoil cover to provide for water storage;

- Construct trench plugs at intervals along sewers and buried service trenches to prevent high permeability conduits from intercepting and redirecting groundwater away from discharge areas across the Subject Property;

- Construction of the watercourse crossings should be scheduled if possible during late summer to take advantage of the typically lower groundwater elevations during this season, and will reduce groundwater seepage into the pit excavations required for the jack and bore technique envisioned. The watercourses at the Subject Property have been observed to be in a generally dry condition during the summer and scheduling this work at this time will minimize potential for localized impacts to aquatic life;

- The service crossing proposed at the realigned channel should be completed at the time of construction of the new channel (before it comes into service) and in such case can be constructed using standard trenching methods;

- Dewatering volumes are not anticipated to exceed 50,000 litres/day. However, dewatering potential is dependent upon a number of factors such as the proposed depth and size of excavations, the time of year and groundwater elevations at the work areas. It may be later determined that a Permit to Take Water (PTTW) from the Ministry of Environment may be required for some aspects of construction;

- Off-site monitoring wells alongside the road allowances are recommended for decommissioning. These monitors will need to be decommissioned as per the requirements of O.Reg. 903 (as amended);

- Continued baseline monitoring of water levels at the on-site and remaining off-site wells is recommended. Monitors presently constructed on the Subject Property and other adjacent lands are recommended to remain in place for future monitoring in support of these developments until such time as they are no longer needed, in which case they will also need to be decommissioned as per the requirements of O.Reg. 903 (as amended). Monitors completed to shallow depth that will be completely removed by site grading will not require decommissioning since following site grading there will be no potential contaminant pathway left in place at such locations; and,

- Groundwater monitors presently constructed within natural environment areas may be retained for long-term, post development monitoring. Additional monitors (within the valley corridors) may be required to replace nearby existing monitors to be removed by development.

1.5 Natural Environment

The Subject Property and surrounding lands consists principally of agricultural lands that are actively farmed intermixed with recreation and rural residential uses that are dissected by a local and regional road network. The notable natural features within the catchments areas of the Subject Property include the Oakville-Milton Wetlands & Uplands Candidate Life Science Area of Natural and Scientific Interest (ANSI), North Oakville – Milton Wetlands – West Provincially Significant Wetland (PSW) Complex, Trafalgar Moraine Candidate Provincially Significant Earth Science ANSI, Halton Region Significant Woodlands as well as features identified in NOCSS including Core #1 and Linkage to Core #2 and Stream Corridors associated with Fourteen Mile Creek including watercourses supporting Redside Dace and Hydrological Features. With the exception of the Stream Corridors and Hydrological Features the remaining features are located beyond the boundary of the Subject Property. Within the boundaries of the Subject Property the main natural features consist of tributaries of Fourteen Mile Creek including Redside Dace habitat as well as their associated riparian habitat.

Detailed field investigations were undertaken in 2009 and 2010 to supplement background data from the NOCSS and previous field investigations undertaken on site by MMM Group (formerly Marshall Macklin Monaghan Limited). This data was used to verify the NOCSS classification of habitat as well as assess potential impacts to the natural features associated with the proposed concept plan. With the exception of a section of Reach 14W-12, generally the field data supported the NOCSS classification of form and function and associated constraints.

Potential effects to the natural heritage system associated with the proposed concept plan were also examined, taking into consideration the habitat present as well as mitigation measures, to determine potential residual impacts. These residual impacts include the requirement for possible *Fisheries Act* Authorization to permit the realignment of Medium Constraint watercourses including Reaches 14W-11A and 14W-14 as well as the stabilization of Reach 14W-16. The proposed realignments will provide suitable opportunities to undertake restoration works in watercourses that have been altered by agricultural activities including the incorporation of greater habitat diversity (i.e. riffles, pools) and improved riparian cover as identified in the compensation strategies. These restoration works will be implemented to address potential adverse effects to fish and fish habitat associated with the proposed realignments and stabilization works. The development concept plan also proposes to remove the existing by-pass pond (Reach 14W-14A) and incorporate it into the proposed stormwater management plan. This will result in the removal a constructed agricultural pond feature that, due to its current form, has adverse thermal and water quality effects to downstream Redside Dace habitat; its removal is anticipated to benefit fish and fish habitat. The natural heritage components are further addressed in Section 5.0.

1.6 Water Resources

The refinement of corridor width for high and medium constraint streams have been completed based on the guidance provided in the NOCSS. A medium constraint stream 14W-14 and a low constraint stream 14W-13 of the Fourteen Mile Creek West within the Subject Property are proposed to be diverted to tributary 14W-16 to accommodate the development. The proposed diversions of 14W-21 along Highway

407 will intercept flows from reaches 14W-13 and 14W-14 just downstream of Highway 407 and divert them to reach 14W-16 via another proposed diversion 14W-22 along the southwest limits of the Subject Property. Another medium constraint stream 14W-11A of the Fourteen Mile Creek East will be realigned along the Highway 407 and northeast limits of the Subject Property.

The existing medium constraint tributary 14W-16 between the southwest property limit and the main branch 14W-12 will be rehabilitated to accommodate the increased discharges due to the diversion of reaches 14W-13 and 14W-14 and to enhance its form and function. Conceptual natural channel designs have been developed for streams to be realigned and rehabilitated based on the principles of "Natural Channel Design" and NOCSS requirements.

The requirement for the maintenance of discharge-storage is achieved for a range of peak flows from a 10 year event to a Regional Storm assuming the new natural valley channel design for the proposed diversions. There is a 9% and 3% reduction in the volume of existing riparian storage for the 2 and 5 year events respectively. This is not significant in the context of the entire watershed and is estimated to have an insignificant effect on downstream flows. The elimination of tributaries 14W-13 and 14W-14 provides challenges to the maintenance of the existing volume of riparian storage for the 2 and 5 year events.

1.7 Stormwater Management

In accordance with NOCSS, the NOCSS unit flow rates have been used along with the updated existing drainage areas to calculate pre-development peak flow rates at the EIR nodes.

As required by NOCSS and the EIR/FSS Terms of Reference, alternative Stormwater Management Practices are described and evaluated for application in the EIR Subcatchment Area, and a stormwater management plan was selected to satisfy NOCSS SWM goals, objectives and targets.

The soils within the Subject Property have been characterized as clay loams that have a relatively low infiltration potential and the proposed employment land uses have a high imperviousness to accommodate viable employment development blocks. Therefore, minimal opportunities to implement infiltration techniques are anticipated, other than the potential for proposed infiltration swales alongside the valley corridors. However, the opportunities to integrate low impact development measures at lot level and conveyance stormwater management ponds will be considered in detailed design stage.

A stormwater management plan has been developed for the Subject Property based on the guidance provided in the NOCSS. Two stormwater ponds are recommended within the Subject Property to meet water quantity control, quality control, phosphorus control, and erosion control requirements set out in the NOCSS. The stormwater ponds are sized to control post-development flow rates from the Subject Property to pre-development levels for the 2-year to 100-year return period and to provide an enhanced level of water quality protection. The post-development peak flows are similar to pre-development levels at EIR nodes except for Regional Storm. A hydraulic assessment of Fourteen Mile Creek West south of Dundas Street indicated that increased flood risk due to Regional Storm is minimal and Regional Storm control for the Subject Property is not required.

A fluvial geomorphological and erosion threshold assessment has been completed for Fourteen Mile Creek West tributaries south of Dundas Street and the results from this assessment were used to provide the erosion control requirements for the proposed stormwater pond 3 (area of existing human-made pond).

Post-development catchment areas at the EIR nodes have been generally maintained to pre-development areas. However, subcatchment boundaries have been adjusted to meet grading and drainage objectives. Approximately 15ha of EIR catchment FM1102 (Figure 7.1) will become part of the culvert FM-D1 catchment area in the future according to the 2009 Tremaine and Dundas Secondary Plan Subwatershed Study, City of Burlington.

The Subject Property will be serviced by a conventional storm sewer system designed in accordance with Town of Oakville standards. The storm sewers will be sized for 5 year event. A continuous overland flow route has been provided throughout the Subject Property in order to safely convey major storm system flows in excess of the minor system up to the 100 year event.

1.8 Municipal Servicing

Section 8.0 outlines the municipal services for the 407 West Employment Area and Subject Property based on the proposed development concept plan. This includes proposed wastewater servicing, water distribution, stormwater servicing and management, and conceptual road and lot grading. The servicing design was developed using the information and guidelines provided by the Region of Halton's Water and Wastewater Master Plan, The North Oakville Creek Sub-Watershed Study and the 407 West Employment Area – Area Servicing Plan, May 2011, prepared by MMM Group.

Wastewater servicing design consists of a gravity flow system which drains north to south and connects to the proposed trunk sewer on Dundas Street West, ultimately discharging to the existing Colonel William Parkway wastewater system. The conceptual wastewater servicing design is described in detail in Section 8.2 and illustrated in Figure 8.2.

The water distribution system will be serviced from the Oakville pressure district Zone 3 supply, connecting at Dundas Street West and Bronte Road. Water will be supplied through a system of trunk and local mains within the proposed road network in accordance with the Regional Master Plan. Sizing of watermains was determined using the water model outlined in Section 8.3 and illustrated in Figure 8.4 and Appendix 8.2.

Stormwater servicing will consist of gravity sewers within the conceptual road network that will discharge to stormwater management facilities for treatment based on the catchment areas indicated in Section 7.0. The major storm system will convey the major storm flows via an overland flow route along the road rights-of-way to the designated stormwater management facility. The conceptual minor and major storm system designs are illustrated on Figure 8.5.

The conceptual road and lot grading was designed with the intention of matching existing grades as closely as possible while still maintaining necessary elements of the Stormwater Management Plan detailed in Section 7.0. The conceptual grading plan is illustrated on Figure 8.6.

1.0 Introduction

1.0 Introduction

1.1 Study Purpose

This Environmental Implementation Report and Functional Servicing Study (EIR/FSS) has been prepared in accordance with the requirements of the Town of Oakville North Oakville Environmental Implementation Report and Functional Servicing Study Terms of Reference (ToR), August 2, 2007, for a portion of lands within the 14 Mile Creek West catchment area, commonly known as the "Lazy Pat Farms" property, as shown on Figure 1.1. This parcel of land is owned by bcIMC Realty Corp. and managed by Bentall Kennedy (Canada) LP and is herein referred to as the "Subject Property".

The Subject Property is located within the western portion of North Oakville West Secondary Plan (NOWSP) area, which has been defined as the 407 West Employment Area. The Subject Property is located on the north side of Dundas Street West (Highway 5), generally mid-block between Tremaine Road and Bronte Road (Highway 25), in the Town of Oakville. The municipal address is 3269 Dundas Street West, Oakville and is legally described as Part of Lots 33 and 34, Concession 1, North of Dundas Street, Township of Trafalgar, now in the Town of Oakville, Regional Municipality of Halton. The property encompasses an area of approximately 185 acres (75 hectares).

This EIR/FSS has been prepared to address the NOWSP policy requirements in support of the approval of a Draft Plan of Subdivision and Zoning By-law Amendment application for the Subject Property. The NOWSP was adopted by Council on May 25, 2009. On December 4, 2009, the OMB approved the majority of the NOWSP, save and except for lands shown as Appeal Area on Attachment A of the decision which generally includes the lands bound by 14 Mile Creek on the west; Highway 407 on the north; Bronte Road to the east (including certain lands fronting on the east side of Bronte Road); and Dundas Street to the south. These lands remain under appeal, until such time as an OMB decision is rendered. The balance of the area, which includes the Subject Property is subject to the NOWSP which came into force and effect as of December 4, 2009.

OPA 289 establishes the North Oakville West Secondary Plan for the lands generally bounded by Dundas Street, Tremaine Road, Highway 407 and the Sixteen Mile Creek. The NOWSP includes land use designations and detailed policies establishing general development objectives to guide the future development of this area.

The NOWSP also sets out the requirements which must be met before any development can proceed. This included the preparation of an EIR/FSS:

- Policy 8.8.3 a) requires that an Environmental Implementation Report (EIR) be prepared for each subcatchment area, in accordance with the directions established in the North Oakville Creeks Subwatershed Study (NOCSS) Implementation Report for each subcatchment area identified in Appendix 8.2. The EIR must demonstrate how the submissions address the overall North Oakville Creeks Subwatershed Management Report. Policy 8.8.3 a) iii) requires that Environmental Implementation Reports be prepared in accordance with Terms of Reference approved by the Town of Oakville (the "Town"), the Region of Halton (the "Region") and the applicant(s), in consultation with Conservation Halton ("CH").

- Policy 8.8.3.b) requires that a Functional Servicing Report (FSS) be prepared for each plan of subdivision or major development application. The FSS must include a preferred servicing plan based on an analysis of servicing requirements, in accordance with any approved Class Environmental Assessment Studies, Halton Transportation Master Plan and the Master Servicing Plan for the North Oakville West Planning Area and including:
    i. servicing design requirements;
    ii. preliminary sizing of water and wastewater infrastructure;
    iii. layout for roads and other transportation systems including transit and trails; and,
    iv. preliminary sizing and location of stormwater management facilities and
    v. integration with environmental features and development areas.

  An Area Servicing Plan (ASP) has been prepared by MMM Group Limited for the 407 West Employment Area (area bound by Dundas Street West, Tremaine Road, Highway 407, and Regional Road 25 (Bronte Road)), based on the Area Servicing Plan Terms of Reference provided by the Region.

The work completed as part of this EIR/FSS and documented in this report was guided by requirements set out in the EIR/FSS Terms of Reference (August 2, 2007) approved by the Town and Conservation Halton, and is intended to satisfy the policy requirements of OPA 289. A copy of the approved Terms of Reference (ToR) is provided in Appendix 1.1.

As identified in the ToR, the purpose of the EIR is to characterize and analyze the natural heritage features and functions and to determine and address the potential impacts of a proposed development application, including servicing requirements, on the Natural Heritage System (NHS). The purpose of the FSS is to identify servicing requirements related to sanitary, water, stormwater, roads, and site grading. Further, the purpose of both the EIR and FSS is to provide a link between the Town's *North Oakville Creeks Subwatershed Study* (NOCSS) Management Report and Implementation Report, the NOWSP and the Draft Plan submissions for development applications.

The objectives to be fulfilled by the EIR/FSS are set out in the approved Terms of Reference, and include:

- Demonstrate how the subwatershed requirements set out in the NOCSS Management Report (including targets), the Implementation Report, and Secondary Plan are being fulfilled in all proposed Draft Plans;
- Provide sufficient level of conceptual design to ensure that the various components of the NHS and infrastructure can be implemented as envisaged in the NOCSS and Secondary Plan and to ensure that the Draft Plans are consistent with this conceptual design;
- Ensure servicing requirements as determined in the FSS for the areas external to the Draft Plan are adequate;
- Identify details regarding any potential development constraints or conflicts and how they are to be resolved;
- Provide any further implementation details as needed;
- Streamline the Draft Plan approval process; and,
- Facilitate the preparation of Draft Plan conditions.

As set out in the Terms of Reference, the EIR/FSS for the Subject Property has been prepared as a joint report to fully integrate environmental and engineering recommendations to protect the function of the NHS and service the Subject Property.

1.2 EIR Subcatchment Area and FSS Study Area

The Subject Property is located primarily within the FM1001 subcatchment area; and smaller portions lie within the FM1102 and FM1109 subcatchment areas. The limits of these subcatchments within the Subject Lands are shown on Figure 1.2 and have been refined from the subcatchment areas identified in the NOCSS based on further analysis undertaken through the preparation of this EIR/FSS as provided in Section 7.0. Table 1.1 notes the subcatchments draining the Subject Property and the areas/percentages of the Subject Property lying within each subcatchment area.

Table 1.1 – Subwatershed Areas

Subwatershed	Subwatershed Area (ha)	Subwatershed Area within Subject Property (ha)	Proportion of Subwatershed within Subject Property (%)	Proportion of Subject Property within the Subwatershed (%)
FM1102	44.6	4.8	11%	7%
FM1001	395.4	60.6	15%	80%
FM1109	365.1	10.0	3%	13%
Subject Property		**75.4**	**9.5%**	**100%**

The EIR/FSS Terms of Reference differentiate between the study area for the FSS and the subcatchment study area for the EIR. The EIR is to be completed on a subcatchment basis, while the FSS will address specific servicing requirements in support of draft plans of subdivision.

The NOCSS provides direction to the preparation of EIRs including the delineation of EIR subcatchments. Figure 7.4.2 from the NOCSS Addendum illustrates the EIR subcatchment areas. With reference to this figure (included at the end of this section) and direction from the Terms of Reference, the appropriate study areas for this EIR/FSS are:

- EIR Subcatchment Area is defined to be the FM1001 subcatchment, focusing on the area south of Highway 407; and,
- FSS Study Area is defined to be the lands within the 407 West Employment Area (lands bounded by Dundas Street West, Tremaine Road, Highway 407 and Regional Road 25 (Bronte Road)).

The EIR Subcatchment Areas and the FSS Study Area for the Subject Property are shown on Figure 1.2.

The ToR recognizes that ownership or draft plan boundaries will not follow subcatchment boundaries and allow for the assessment of portions of subcatchments where reasonable. The ToR recognizes that where the proposed development is within the majority of the EIR subcatchment with minor portions outside:

- Consideration will be given to minor adjustments in subcatchment boundaries with the conditions that the adjustments would not put undue restrictions on the servicing of adjacent subcatchments and demonstrate no negative impacts to flooding, erosion and the NHS; and
- If no change in subcatchment boundary is proposed, consideration is to be given to how development in the adjacent subcatchment is to be serviced. Conceptual drainage patterns are to be developed and profiles generated to ensure that the area can be serviced.

This EIR/FSS has addressed the subcatchment and draft plan requirements for the small portions of the Subject Property located within the FM1102 and the FM1109 subcatchment areas, without preparing complete EIRs for these subcatchment areas. With respect to the FM1102 subcatchment area, the portion of the Subject Property within this subcatchment is relatively small (4.8ha), comprising approximately 10.8% of the entire subcatchment area. With respect to FM1109 subcatchment area, the portion of the Subject Property within this subcatchment is relatively small (10.0ha), comprising approximately 2.7% of the entire subcatchment area. This EIR/FSS focuses on the FM1001 subcatchment and provides discussion of subcatchments FM 1109 and FM 1102 to the extent required.

This EIR/FSS consistently uses the following terms when referring to various land areas:

- the "Subject Property" referring to the bcIMC Realty Corp. land holdings managed by Bentall Kennedy (Canada) LP;
- the "FSS Study Area" referring to the 407 West Employment Area ((lands bounded by Dundas Street West, Tremaine Road, Highway 407 and Regional Road 25 (Bronte Road));
- the "EIR Subcatchment Area" referring to the FM1001 subcatchment area; and
- the "Study Areas", referring to both the EIR Subcatchment Area and the FSS Study Area.

As required by the EIR/FSS Terms of Reference, land uses as proposed by the Town's NOWSP for lands adjacent to the FSS Study Area are recognized and considered in planning and servicing analyses. The adjacent lands are designated Employment District and Natural Heritage and Open Space in the NOWSP.

1.3 Study Team

A multidisciplinary study team lead by MMM Group Limited has studied the environment and servicing of the Study Areas. The team and their responsibilities include:

MMM Group Limited:

- lead EIR consultant addressing limits of development, study integration, team/study management and coordination of EIR/FSS report preparation;
- lead FSS consultant addressing municipal servicing, stormwater management and site grading;
- aquatic habitats;
- terrestrial ecology
- geology and hydrogeology;
- hydrology and fluvial geomorphology; and,
- municipal planning matters and preparing the draft plan of subdivision.

Waters Edge:

- fluvial geomorphological and erosion threshold assessment.

1.4 References

Included in Appendix A1.2 is a complete list of references, studies, guidelines and documents which have been reviewed in preparation of this EIR/FSS.

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Study Areas

LEGEND

- Subject Property
- Subcatchment Area Boundaries
- EIR Subcatchment Area (FM1001)
- FSS Study Area

Scale: 1 : 15,000

0m 100 200 300 400 500 1km

Client: Bentall Kennedy

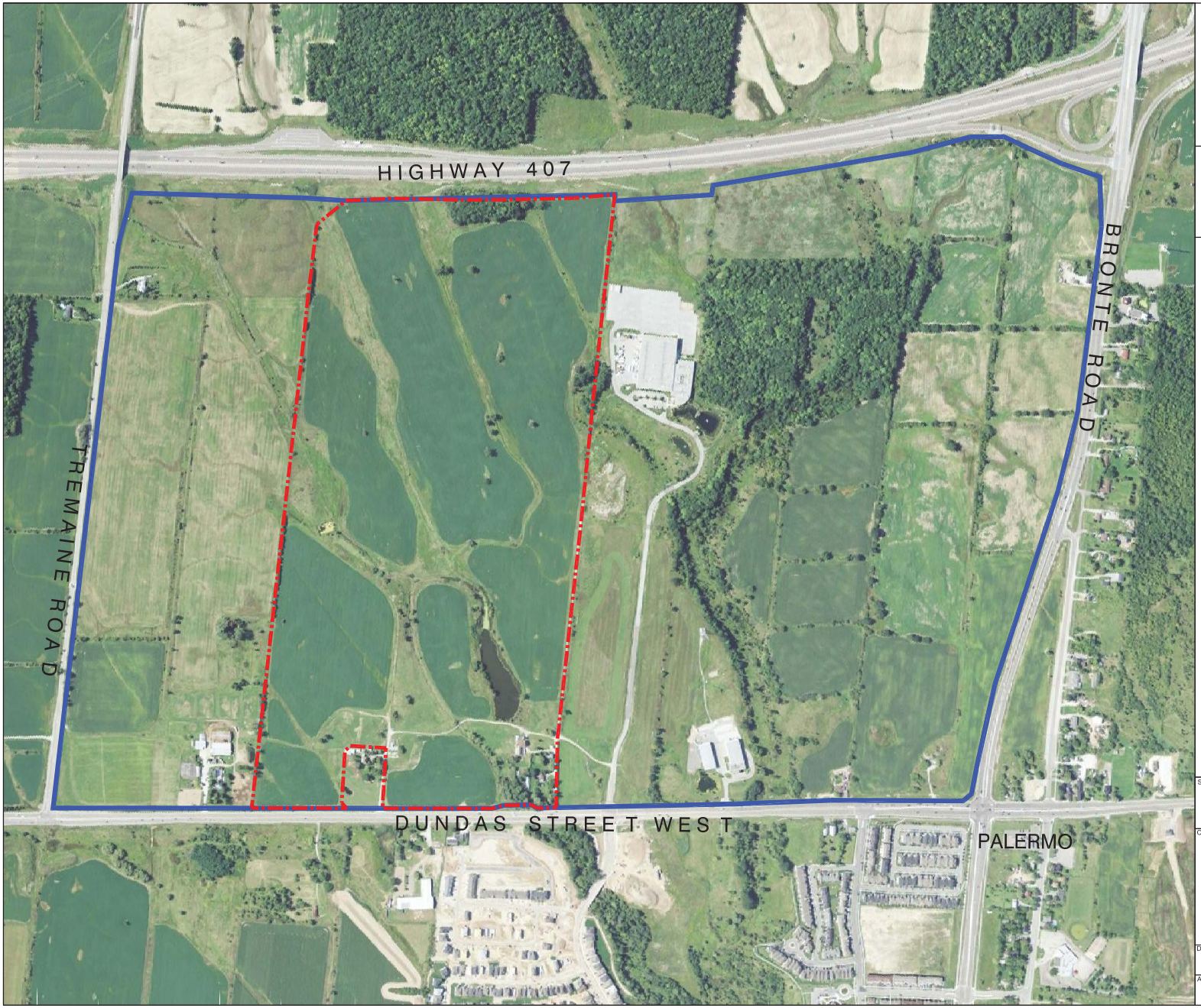
Prepared by: MMM GROUP

Date: March 3, 2011

Project No.: 1409222.001

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 1.2



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm property

Subject Property
with Aerial Photography

LEGEND

- Subject property
- 407 West Employment Area

Scale
1 : 7500
0m 50 100 150 200 250 500m

Client
Bentall Kennedy

Prepared by
MMM GROUP

Date
March 2, 2011

Project No.
1409222.001

Aerial Photo

Figure 1.1

2.0 Natural Heritage System Framework

2.0 Natural Heritage System Framework

2.1 Natural Heritage System Components

The 'Natural Heritage System Area' designation of the NOWSP reflects the components of the Natural Heritage and Open Space System and is intended to protect, preserve, and where appropriate, enhance the natural environment. OPA 289, the Town of Oakville North Oakville Creeks Subwatershed Study (NOCSS) and the North Oakville Creeks Subwatershed Study Addendum (NOCSS Addendum) provide policies and/or directions with respect to the protection and management of the North Oakville West Natural Heritage/Open Space System. The NOCSS is divided into four sections, which follow the four phases of a subwatershed management approach, they include Characterization, Analysis, Management Strategy and Implementation.

The Management Strategy outlines requirements with regard to lands restricted from development, lands with development limitations or constraints, stormwater management, input to land use policies and servicing requirements. The Implementation Plan outlines the implementation requirements for the recommended management strategy, studies needed in subsequent stages of the development process, environmental reporting requirements, agency responsibilities, and the approval process with the Town of Oakville, Halton Region and Conservation Halton, and, where applicable, the MNR and DFO.

With respect to the Subject Property and the EIR Subcatchment Area, OPA 289, NOCSS and NOCSS Addendum identify various environmental features to be protected and/or studied further during the preparation of the EIR/FSS. As illustrated on Figure NOW3 from OPA 289 (Figure 2.1), the components of the Natural Heritage System (NHS) that are located within the EIR Subcatchment Area, and related subcatchment areas on the Subject Property include the 'High Constraint Stream Corridor Area' and 'Medium Constraint Stream Corridor Area', and features designated as 'Other Hydrological Features', which includes Low Constraint Stream Corridors, Hydrologic Features "A" and Hydrologic Features "B" and topographic depressions.

These natural heritage components are further addressed through Section 5.0 of the EIR/FSS.

- ***High Constraint Stream Corridor Areas (Red Streams)*** – include certain watercourses and associated riparian lands, including buffers measured from stable top-of-bank and meander belts. They must be protected in their existing locations for hydrological and ecological reasons in accordance with the North Oakville Creeks Subwatershed Study (NOCSS). High Constraint Stream Corridor Areas located on the Subject Property, as identified in the NOCSS include reach 14W-12 and 14W-12A located north of Dundas Street to the confluence with 14W-16, and 14W-11A along the eastern property boundary. The High Constraint Stream Corridor reaches and associated riparian lands will be protected and enhanced.

  Section 5.0 of the EIR/FSS addresses the character, designations, management and protection of these High Constraint Steam Corridors within the EIR Subcatchment Area.

- ***Medium Constraint Stream Corridor Areas (Blue Streams)*** – include certain watercourses and associated riparian lands, including buffers measured from stable top-of-bank and meander belts. They must be protected for hydrological and ecological reasons, but may be deepened and/or

relocated and consolidated with other watercourses provided the watercourse feature and function of the watercourse is maintained in accordance with the NOCSS, and Federal, Provincial and Conservation Authority regulations, and natural channel design is used.

The Medium Constraint Stream Corridor Areas include reaches 14W-16, 14W-14 and 14W-11A. The Development Concept proposes the relocation of Medium Constraint Stream Corridor 14W-14 and Low Constraint Stream Corridor 14W-13 to align with the western property boundary and existing alignment of 14W-16, as supported by the EIR/FSS. The proposed removal of the by-pass pond, realignment of Reach 14W-14 and removal of Reach 14W-13 will result in the partial redirection of flow away from Reach 14W-12A with similar flow continuing to Reach 14W-12. This redirection of flow has the potential to alter the function of this short reach; however, due to the minimal flows, the homogeneous habitat present through most of the reach accessible to fish, the constructed nature of the watercourse and continued flow that will be directed to this reach by the proposed SWM pond, it is unlikely to have an adverse effect on the fish community. Considering the function of Reach 14W-12A, it is anticipated that potential adverse effects to fish habitat associated with the realignment of Reach 14W-14 and removal of Reach 14W-13 and the by-pass pond can be addressed through the enhancements proposed for Reaches 14W-16 and 14W-14.

Furthermore, the EIR proposes the relocation of Medium Constraint Stream Corridor 14W-11A, along the north-eastern corner of the Subject Property.

These stream relocations are consistent with the NOWSP policies for Medium Constraint Stream Corridor Areas.

Section 5.0 of the EIR/FSS addresses the character, designations, management, alteration and protection of these Medium Constraint Steam Corridors within the EIR Subcatchment Area.

The boundaries of the High Constraint Stream Corridor Areas and Medium Constraint Stream Corridor Areas are to be maintained as generally shown on Figure NOW 3 and the NOCSS, however, minor modifications have been considered to reflect differences in scale and levels of detail during the preparation of the EIR.

There are no Core Preserve Areas or Linkage Preserve Areas located on the Subject Property. The protection and management of these Core Preserve Areas and Linkage Preserve Areas within the 407 West Employment Area are subject to the NOWSP and NOCSS and are to be further evaluated through EIR/FSS for these respective subcatchment areas.

In addition to the High and Medium Constraint Stream Corridor Areas, there are a number of other hydrological features that also form part of the Natural Heritage and Open Space System to the extent that they are maintained after development occurs. These features include Low Constraint Stream Corridors, Hydrologic Features A and Hydrologic Features B, as described below:

- ***Low Constraint Stream Corridors (Green Streams)*** – while the streams do not need to be maintained, the function of the watercourse must be maintained in accordance with the NOCSS, and Federal, Provincial and Conservation Authority regulations. Low Constraint Steam Corridor Area (14W-13) is removed, however, the function of the watercourse is maintained within the

relocated channel. This creek removal is consistent with the NOWSP policies for Low Constraint Stream Corridor Areas.

- ***Hydrologic Features "A"*** – where a Hydrologic Features "A" is located within a Medium Constraint Stream Corridor which is to be moved or rehabilitated, it is intended that the Hydrologic Features "A" will be reconstructed in the relocated/rehabilitated stream corridor such that the form and function is retained or enhanced. There are three Hydrologic Features "A" located on the Subject Property, including features within reach 14W-14, 14W-16 and the existing human-made pond. These features have been considered through the detailed hydrological and hydrogeological assessment as part of the EIR/FSS.

- ***Hydrologic Features "B"*** – are not associated with the NHS, and may be relocated and consolidated with other wet features, wetlands or stormwater management ponds, provided the hydrologic function of the feature is maintained. There are three Hydrologic Features "B" located on the Subject Property. These features have been considered through the detailed hydrological and hydrogeological assessment as part of the EIR/FSS.

- ***Topographic Depressions*** – Topographic depressions do not form part of the NHS, however, NOCSS (Figure 6.3.15) identifies topographic depressions, ponds and pits that must be addressed as part of the stormwater management system design. Constructed ponds do not have to be included in the assessment of depression storage. These topographic depressions have been considered through the drainage and stormwater management assessment as part of the EIR/FSS, and the analysis has demonstrated that the SWM pond volumes compensate for the hydrologic influence of the existing depression areas.

2.2 Permitted Uses in the Natural Heritage System

Section 8.4.7.3 of the NOWSP identifies the potential permitted uses within the NHS. Permitted uses within the Natural Heritage System Area designation shall include only legally existing uses, buildngs and structures, and fish, wildlife and conservation management. Development or land disturbances shall generally be prohibited. In accordance with S. 8.4.7.3 b), exceptions are permitted subject to the satisfaction of the Town, in consultation with the Region of Halton and Conservation Halton, to accommodate such uses as: required flood and stream bank erosion controls; fish, wildlife and conservation management; to accommodate stormwater outfalls; the relocation of deepening of Medium Constraint Stream Corridor Areas; roads and related utilities; expansion of existing water and wastewater services; trails, interpretive signage or similar passive recreation uses; and stormwater management facilities, subject to S. 8.4.7.3 c) v), and in accordance with the directions of the NOCCS and any related EIR, and Federal, Provincial and Conservation Authority regulations.

Stormwater management facilities established in accordance with the directions of the NOCSS may be permitted within the Natural Heritage System Area, as outlined in Section 8.4.7.3 c) v), provided, the number, location and size of the stormwater management facilities have been identified through the EIR/FSS, and provided that generally such facilities:

"be limited where located in or adjacent to High and Medium Constraint Stream Corridor Areas, which are not located within Linkage Preserve Areas as designated conceptually on Figure NOW3, to areas:

- *outside the 100 year floodline;*

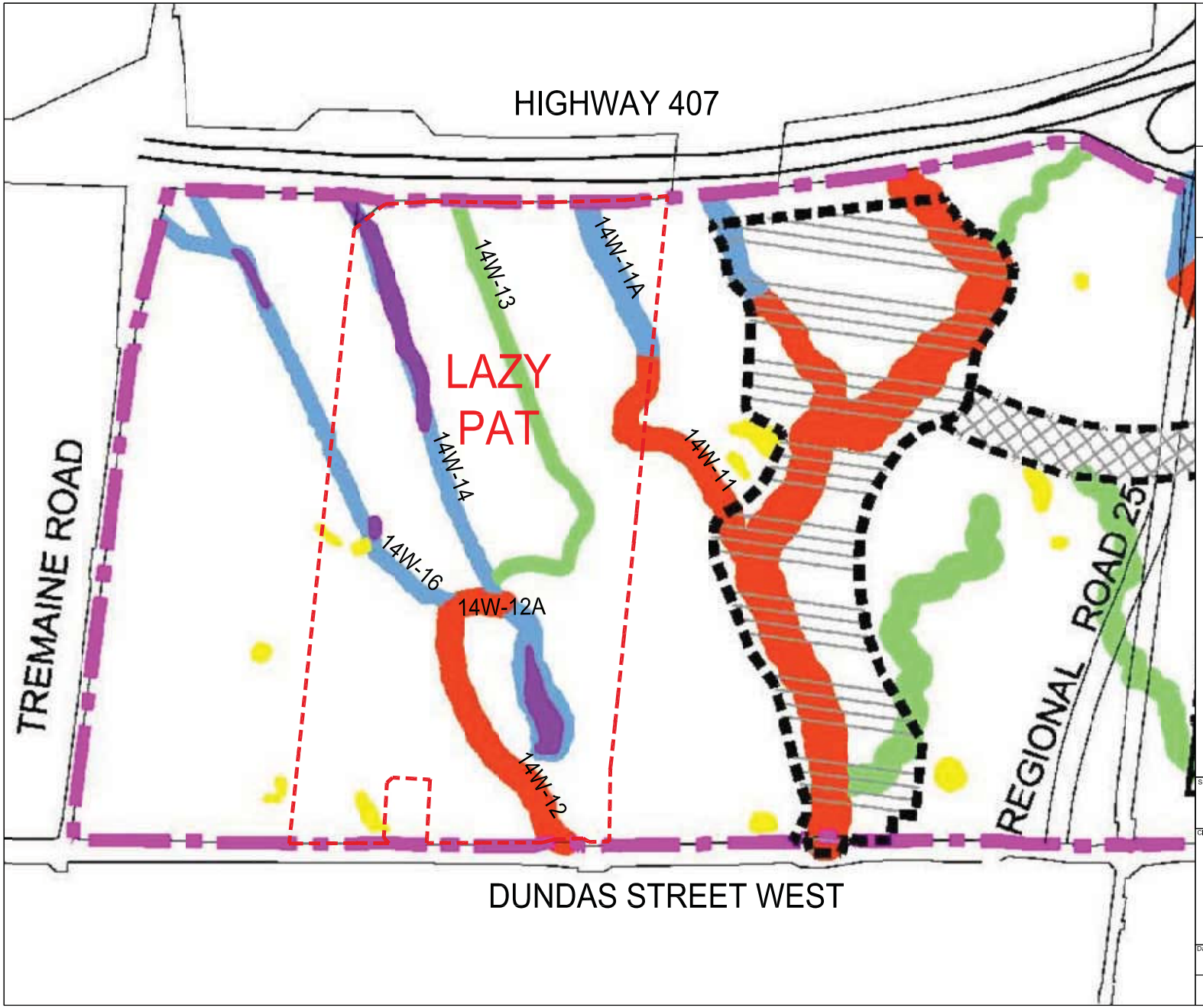
- *outside the meanderbelt allowance which is the meanderbelt plus the factor of safety;*
- *outside the erosion/access allowance measured from the meander belt or stable top-of-bank, except that some overlap of the access required for the stormwater management facility and the erosion/access allowance may be permitted in accordance with the directions established in the NOCSS, and to the satisfaction of the Town and Conservation Halton;*
- *outside the confined valley; and*

provided that there is no loss of flood storage or conveyance"

The NHS designation on the Subject Property does not comprise Core Preserve or Linkage Preserve Areas. Stream Corridor 14W-12 is identified on NOW3 as High Constraint Stream Corridor, and the human-made pond is identified as a Medium Constraint Stream Corridor and Hydrologic Feature 'A'. Therefore, stormwater management ponds may be permitted in or adjacent to High and Medium Constraint Stream Corridor Areas, subject to the criteria outlined in the NOWSP.

The EIR/FSS has determined the size and configuration of the stormwater management ponds and supports the use of the existing human-made pond as a stormwater management facility. The stormwater management ponds are proposed to be located outside of the 100 year floodline; outside the meanderbelt allowance which is the meanderbelt plus the factor of safety; outside the erosion/access allowance; and outside the confined valley. The EIR/FSS demonstrates that there is no loss of flood storage or conveyance.

The NOWSP provides opportunity to accommodate stormwater management facilities within the environmental setback associated with the High Constraint Stream Corridor Areas, as proposed in the development concept plan, and discussed in the EIR/FSS. The encroachment of the stormwater management ponds within the 30 metre environmental setback will be limited by incorporating the existing human-made pond into the active storage volume. This will accommodate a pond retention berm with minimal encroachment into the 30 metre environmental setback. The Draft Plan of Subdivision delineates the stormwater management blocks to ensure sufficient area for the detailed design of the stormwater management facilities and all of the ancillary features such as sediment dewatering areas, and maintenance access. Furthermore, as outlined in the EIR/FSS, from a fisheries perspective the existing pond appears to have a negative effect on downstream aquatic habitat and its removal and reconfiguration as a stormwater management facility would provide aquatic benefits.



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Figure NOW 3: Natural Heritage Components of Natural Heritage and Open Space System including Other Hydrological Feaures

LEGEND

- Subject Property
- Secondary Plan Area Boundary
- Core Preserve Area
- Core Preserve Area
- Linkage Preserve Area
- High Constraint Stream Corridor
- Medium Constraint Stream Corridor

Other Hydrological Features

- Low Constraint Stream Corridor
- Hydrologic Features "A"
- Hydrologic Features "B"

Scale: 1 : 7500 (0m 50 100 150 200 250 500m)

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: March 9, 2011

Project No.: 1409222.001

Figure 2.1

3.0 Land Use

3.0 Land Use

3.1 Development Concept Plan

The proposed land uses for the Subject Property consist of a range of employment uses and associated natural heritage and open space uses, in accordance with the Region's and Town's land use and planning directions for the 407 West Employment Area. The development concept envisions the creation of an office and business park with prestige employment uses adjacent to Highway 407, due to increased visibility along these major roads. Limited employment-related commercial and service/retail uses are envisioned at the major road intersections along the Dundas Street corridor to serve the employment area. It is proposed that more general industrial uses, such as mixed warehousing and office uses may be accommodated internal to the business park.

Figure 3.1 illustrates the Concept Plan for the Study Area based on the direction of the Town's NOWSP. The Concept Plan for the Study Area is generally consistent with the Town's NOWSP and Master Plan and incorporates modest revisions to the proposed road network based on further study. The road pattern follows a modified grid pattern which responds to the existing environmental and site conditions while encouraging accessibility and a viable transit network throughout the 407 West Employment area.

The concept plan accommodates three intersection locations with Dundas Street West, including the existing intersections with Valleyridge Drive and Colonel Williams Parkway. A new intersection with Dundas Street is proposed approximately equal distance between Tremaine Road and the Colonel Williams Parkway intersection. Two major east/west road corridors are proposed as identified in the NOWSP to accommodate access from Tremaine Road to Regional Road 25 (Bronte Road). The southern east/west road aligns with the proposed New North Oakville Transportation Corridor proposed on the east side of Bronte Road. The spacing and locations of these intersections is consistent with the NOWSP and aligns with the planning work being undertaken for the Dundas/Tremaine Secondary Plan area in the City of Burlington.

The development proposal outlines the proposed natural heritage and open space system based on the Town's NOWSP and NOCSS, which has been further refined for the Subject Property based upon the recommendations of the EIR/FSS. The central open space system and adjacent stormwater management will provide a primary focus for the business park, and accommodate pedestrian trails and passive recreational uses, integrated with the adjacent employment development. The stormwater management facilities will accommodate stormwater runoff within their respective subcatchment areas.

Figure 3.2 illustrates the Draft Plan of Subdivision for the Subject Property.

The Planning Rationale Report, May 2011, prepared by MMM Group Limited, concludes that the Draft Plan represents good and sound community planning and conforms to and implements the goals, objectives and policies of the Provincial Policy Statement, the Growth Plan for the Greater Golden Horseshoe, the Regional Official Plan, and the North Oakville West Secondary Plan.

3.2 Trail Planning

The NOWSP (S. 8.5.5.10) states that: "An extensive system of recreational trails will be developed related to the Natural Heritage and Open Space System as well as along certain public road rights of way. A conceptual major trail system which will form the basis for the development of this more extensive system is identified on Figure NOW4. However, any proposed trail development within the Natural Heritage and Open Space System shall be subject to further study as part of the Implementation Strategy to the satisfaction of the Town, in consultation with the Region of Halton and Conservation Halton. The system may be refined through the preparation of an EIR in accordance with the provisions of Section 8.8.3 a) of this Plan."

The NOWSP, Figure NOW4 conceptually identifies a Major Trail System along the Burnhamthorpe Road extension, west of Bronte Road, extending to Tremaine Road, in addition to a Major Trail System within the NHS, along the main stream corridor which traverses the Subject Property.

Section 8.4.7.3 of the NOWSP notes that one of the potential permitted uses in the NHS is:

iv) Trails, interpretative displays or signage or other similar passive recreation uses consistent with the purpose of the applicable designation and provided that:

- *for lands in the Linkage Preserve Area designation on Figure NOW3, such uses shall generally be located in the Linkage Preserve Area, but adjacent to the boundary of the linkage;*
- *trails shall be permitted within the setback from the edge of the Sixteen Mile Creek Valley, and may be permitted within the Valley subject to the review of their impact on any environmentally sensitive features;*
- *trails in stream corridors other than the Sixteen Mile Creek shall be permitted adjacent to the valley in the buffer; and,*
- *trails in the Natural Heritage System Area designation be designed and located to minimize any impact on the natural environment.*

Section 6.3.5.2 of the NOCSS states that,

"*Recreational trails for pedestrian and bicycle use will require special consideration and evaluation when planning their location within the NHS. A designated trail system associated with the NHS will be the best strategy to discourage informal trail creation (i.e., trail blazing) for the public wishing to gain access to the NHS.*

The following should be considered when planning the location of future trail systems:

- *Trails should cross the NHS (cores, linkages and stream corridors) within existing and proposed road crossings;*
- *Locations where roads are flanking core areas, trails should be substituted for sidewalks provided winter maintenance is feasible;*
- *Where trail systems are proposed to cross the NHS at locations other than where a road crossing is proposed, an impact assessment will be required to ensure no negative impacts to the NHS (i.e., species migration, impacts to drainage);*

- *Trail systems requiring winter maintenance will need to be located outside the NHS to minimize disturbance (i.e., ploughing, sand and salt); and*
- *Trail systems are not permitted in stream valleys.*

The NOCSS further notes that the Ministry of Natural Resources and Conservation Halton will need to be consulted as part of the evaluation of placement of trails within the NHS.

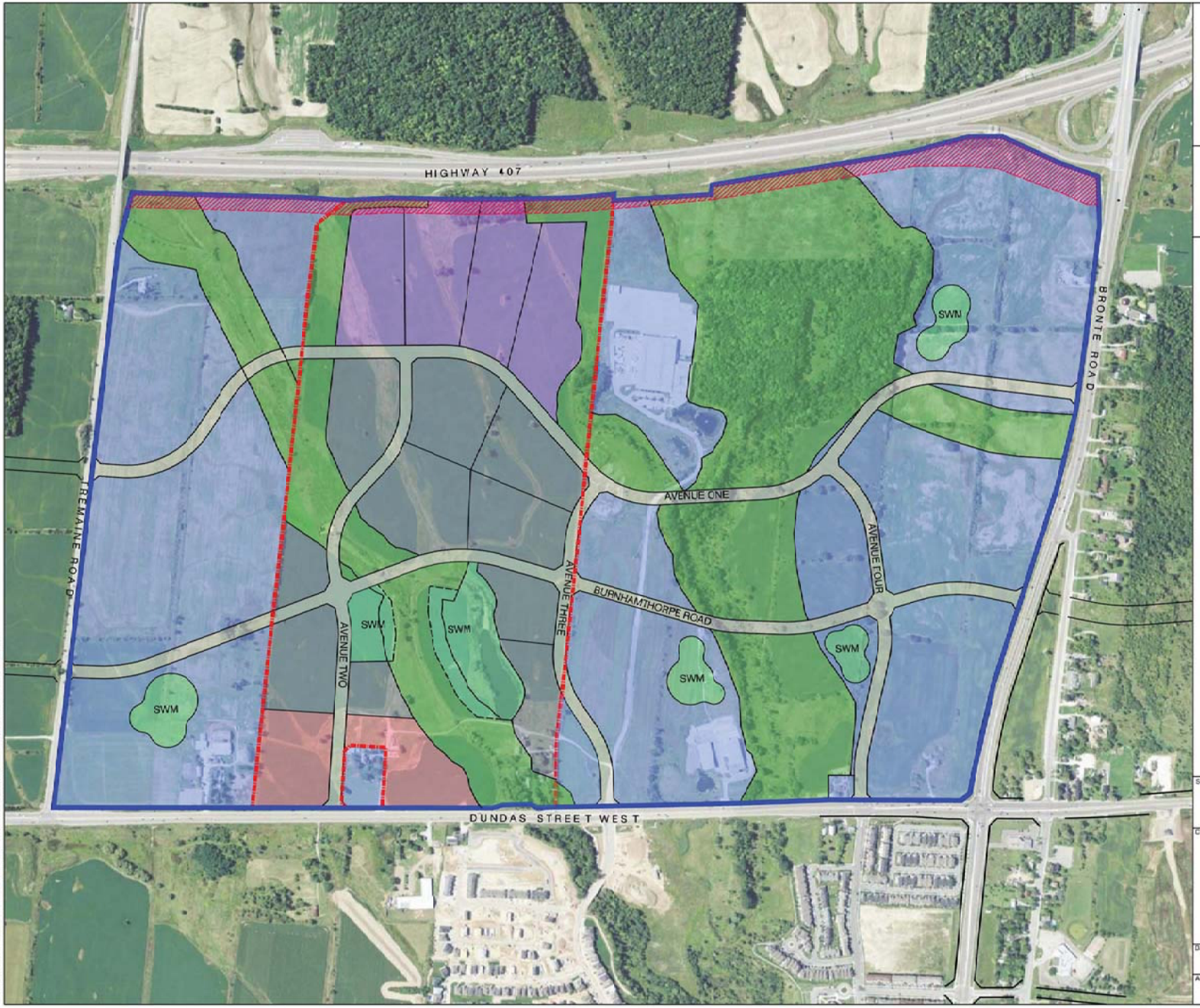
In the absence of a North Oakville West Trails Plan, the NOWSP provides the framework for trail planning within the 407 West Employment Areas and the Subject Property.

The Major Trail System along the Burnhamthorpe Road extension is intended to consist of a multi-use trail facility, constructed to Town standards.

The NOWSP permits trails within stream corridors, other than Sixteen Mile Creek, which are adjacent to the valley and located within the buffer. Trails in the NHS designation are to be designed and located to minimize any impact on the natural environment. The following provides general guidance where the proposed trail system interfaces with the NHS:

- The trail will only cross the stream corridors along a proposed road crossing.
- The trail will be aligned through the NHS to avoid sensitive natural features and habitats.
- Where trails are proposed in the vicinity of the stream, they will be located outside of the valleys in the stream corridor setbacks.
- Walking access should be restricted to a properly sited and established trail.
- The trail alignment through the NHS should be delineated in the field with specific consideration to vegetation cover, slope, and drainage, taking advantage of openings and avoiding sensitive natural features and habitats;
- Boardwalks or viewpoints adjacent to sensitive features or stormwater management facilities may be appropriate.
- The trail should avoid areas where there are trees that have a tendency to drop excessive debris, to droop or to break under heavy snow loads or wind.
- Where vegetation is dense, access can be provided by thinning the lower branches, but maintaining the stem and root structures.
- If there are sloping areas, the trails should not result in a concentration of surface runoff down the slope in order to avoid erosion. Trails along steep sloping areas should be avoided.
- The trails should not be lit where they traverse natural communities. Where walkways/trails approach or skirt natural areas, they could be lit strategically, and of a parks scale with fixtures low to the ground (e.g., bollard height). The lighting should be focused on the trail. There should be little or no sky-lighting effect due to the environment-friendly design (cutoff refractors).
- Fencing should be avoided around the trails. If bolstering of the trail alignment is required, it should occur through plantings of appropriate native indigenous vegetation, comprising species that produce dense growth and 'unfriendly' characteristics, such as thorns. As well, the plantings should be designed and implemented to promote natural succession, help control invasive species, provide for wildlife habitat and be native to the area.
- Over the long term, the establishment of unauthorized trails that may develop through excursions from the built trails, should be addressed through dense plantings and physical barriers, if necessary.

- Prior to construction, the limits of construction activity need to be established. Rutting and compaction of the terrain and scarring of the vegetation beyond the limits of construction should not occur.
- During construction, the smallest size of equipment should be used (specialty narrow width loader/backhoe) to avoid compaction and damage of the existing root zone.
- In most locations, it would be appropriate to prepare a hard surface, to minimize 'wearing' and widening of the modified area. The tread width needs to be a minimum of 1.2 m (3 m if maintenance vehicles are to utilize it) and the surface should be a lasting, stable material (i.e., crushed stone of similar pH to surrounding soils, asphalt, concrete pavers, or boardwalk) over an engineered base.
- A minimum vertical height clearance of 2.5 m over pathways should be maintained.
- A regular program of inspection and maintenance should be detailed.



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm property

407 West Employment Area Concept Plan

LEGEND		Area Hectares	*Acres*
Land use on Lazy Pat Property	Employment (Specific land use to be determined)	101.4	*251*
	Service Area (Service/Retail/Office)	6.4	*16*
	Light Employment	14.6	*36*
	General Employment	25.6	*63*
	Open Space	65.2	*161*
	Stormwater Management	14.8	*36*
	407 Transitway (Conceptual)	6.8	*17*
	Roads	17.7	*44*
		252.5 ha	*624 ac*

407 West Employment Area

Subject Property

Notes:

- For the purposes of our analysis we have made land use assumptions for the entire 407 West Employment Area
- Right-of-way requirements for future 407 Transitway to be determined

Scale: 1 : 7500 (0m 50 100 150 200 250 500m)

Client: Bentall Kennedy

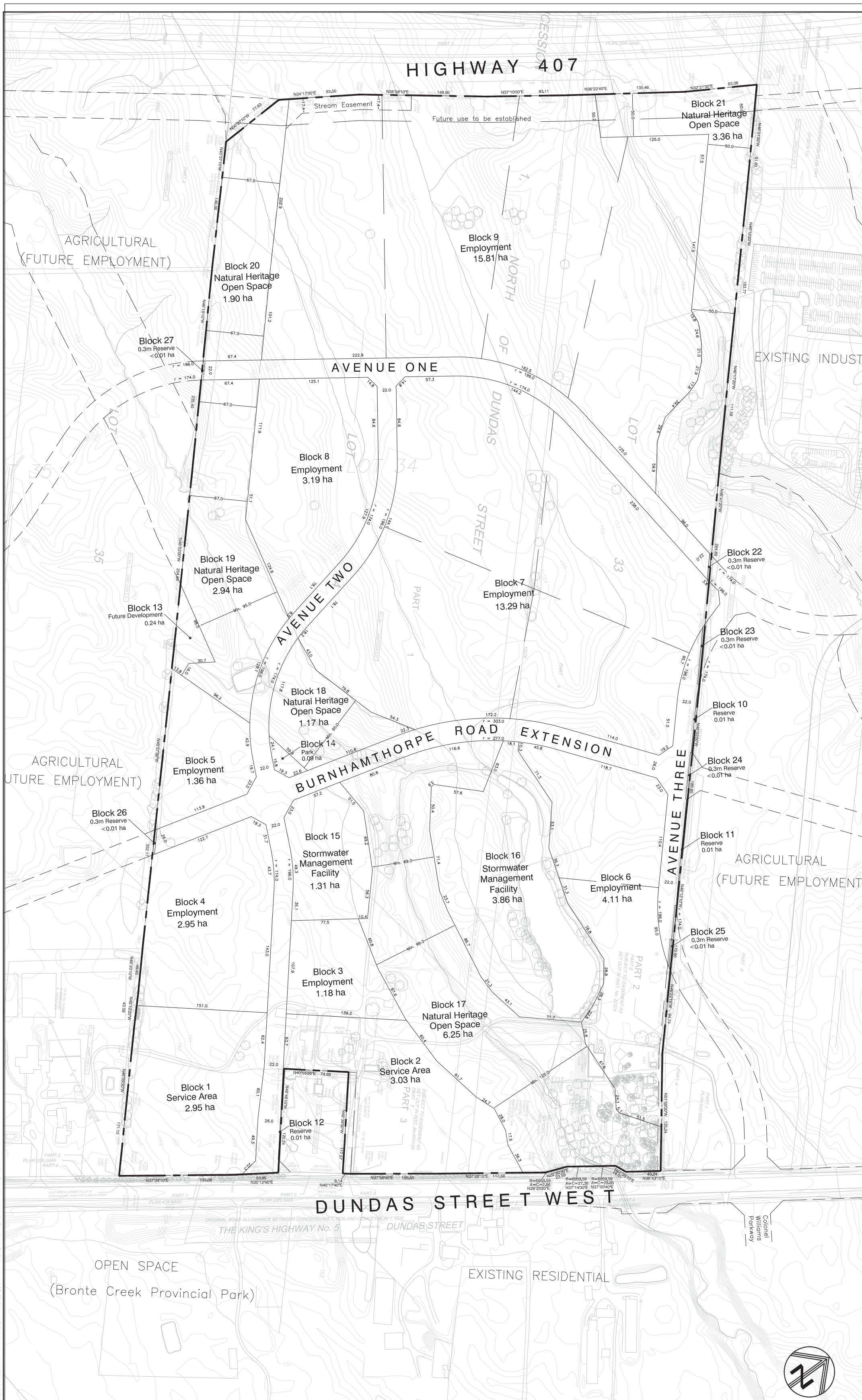
Prepared by: MMM GROUP

Date: May 6, 2011

Project No.: 1409222.001

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 3.1



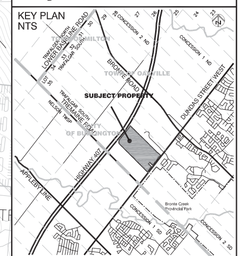
DRAFT PLAN OF SUBDIVISION

PART OF LOTS 33 AND 34, CONCESSION 1
NORTH OF DUNDAS STREET
GEOGRAPHIC TOWNSHIP OF TRAFALGAR
NOW IN THE TOWN OF OAKVILLE
REGIONAL MUNICIPALITY OF HALTON

XXX-X.XXX
XXXXX.XXX
24T-XXXXX

May 16, 2011

KEY PLAN
NTS



ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51 (17) OF THE PLANNING ACT, R.S.O., 1990

(a) AS SHOWN ON DRAFT PLAN
(b) AS SHOWN ON DRAFT AND KEY PLANS
(c) NO ADJACENT LANDS OWNED BY THE APPLICANT
(d) THE LAND IS TO BE USED ACCORDING TO THE SCHEDULE OF LAND USE
(e) AS SHOWN ON DRAFT AND KEY PLANS
(f) AS SHOWN ON DRAFT PLAN
(g) AS SHOWN ON DRAFT AND KEY PLANS
(h) MUNICIPAL WATER SUPPLY TO BE MADE AVAILABLE
(i) SOIL IS CLAYEY SILT TILL
(j) AS SHOWN ON DRAFT PLAN
(k) FULL MUNICIPAL SERVICES TO BE MADE AVAILABLE
(l) SUBJECT TO EASEMENTS AS IN INST. No. 645159 AND 735214 RELATED TO ACCESS, AS SHOWN ON THE DRAFT PLAN

SCHEDULE OF LAND USE

LAND USE	BLOCKS	AREA (ha)	(ac)
SERVICE COMMERCIAL	1 & 2	5.98	14.8
EMPLOYMENT	3 to 9	41.89	103.5
RESERVES	10 to 12	0.03	0.1
FUTURE DEVELOPMENT	13	0.24	0.6
PARK	14	0.09	0.2
STORMWATER MANAGEMENT	15 & 16	5.17	12.8
NATURAL HERITAGE /OPEN SPACE*	17 to 21	15.62	38.6
0.3m RESERVES	22 to 27	<0.01	<0.1
ROADS (LINEAR: 2,600.6m)	BURNHAMTHORPE ROAD, AVENUE ONE, AVENUE TWO and AVENUE THREE	6.10	15.1
TOTAL		75.13	185.7

* Limits of Natural Heritage/Open Space Blocks – The boundaries of the Natural Heritage/Open Space Blocks have been determined based on the corridor width delineation recommendations of the EIR/FSS, which considers the: fluvial geomorphologic requirements; regulatory floodplain; stable slope top of bank; fish and fish habitat protection requirements; preservation of hydrologic functions; and setback requirements. The limits of the Natural Heritage/Open Space blocks will be confirmed through field survey.

All internal distance dimensions on curves are chord length unless otherwise stated.

Dashed linework outside of subject property is conceptual only

Scale 1 : 1500

OWNER'S AUTHORIZATION

I AUTHORIZE MMM GROUP LIMITED TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION TO THE TOWN OF OAKVILLE FOR APPROVAL.

MIKE REEL, VICE-PRESIDENT INVESTMENT MANAGEMENT
BENTALL KENNEDY (CANADA) LP
c/o bcIMC REALTY CORP.

DATE

PLANNER'S CERTIFICATE

PLAN PREPARED BY MMM GROUP LIMITED.

CHRIS TYRRELL, MCIP, RPP
MMM GROUP LIMITED

DATE

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED AS SHOWN ON THIS PLAN AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

Fernando De Luca O.L.S.
MMM GROUP LIMITED – MMM GEOMATICS ONTARIO LIMITED

DATE

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Planning and Environmental Design
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Drawn NRH | Checked RR | Date MAY 16, 2011
Revisions –
No. | Date | By | App'd
Job No. 14 09222 001 P01

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm property

407 West Employment Area Draft Plan of Subdivision

Scale
1 : 4500
0m 50 100 150 200m

Client

Prepared by
MMM GROUP

Date
May 18, 2011

Project No.
1409222.001

Figure 3.2

4.0 Hydrogeology and Geology

4.0 Hydrogeology and Geology

4.1 Introduction

The Subject Property is approximately 75 ha in area, of which approximately 60.4 hectares is proposed for development. The ground at the Subject Property generally slopes from the northwest to the southeast from a topographic high of about 160 masl at the north boundary to approximately 142 masl in the main watercourse (FM-1001/14W-12) where it passes under Dundas Street West. In general, the lands at the Subject Property are gently undulated, with elevation changes between the crests of the rises down to the watercourses of the order of 5 to 8 m.

The property is bordered by the following existing land uses as illustrated on Figure 4.1:

- agricultural lands to the southwest, with Bronte Creek located approximately 1 km to the southwest of the western property line;
- Highway 407 and agricultural/forested lands to the northwest;
- An industrial facility (General Electric) and vacant/agricultural and forested lands to the northeast; and,
- Residential development (under construction) to the southeast.

A new quarry owned by Hanson Brick Ltd. is located approximately 1 km to the northwest of the Subject Property. The quarry is located to the north of Highway 407 and west of Tremaine Road.

Three subwatersheds cross the Subject Property, identified as subwatersheds FM1109, FM1001 and FM1102 in the North Oakville Creeks Subwatershed Study (NOCSS). Subwatershed FM1001 (also identified as the West Branch of Fourteen Mile Creek) drains the majority (approximately 80%) of the Subject Property (approximately 60.6 ha of the total 75.4 ha site area), contains three tributaries (14W-13, 14W-14, 14W-16) and a small and large pond (14W-14A), all of which eventually converge and exit the Subject Property at the southeast through a single main channel (14W-12).

A tributary of FM1109 (Central Branch of Fourteen Mile Creek, 14W-11/14W-11A) drains about 10.0 ha of the Subject Property area along the eastern and north-eastern portions of the Subject Property, and the watercourse flows across the northeast corner of the property.

The smallest of the three subwatersheds, FM1102 drains about 4.8 ha of the total property area at the extreme southwest corner. There is no defined channel through the Subject Property within this subwatershed but two shallow “swales” were observed in a moist to standing water condition in early May 2009 and in a dry condition in April 2010. No evidence of flowing water was observed in this subwatershed during the course of our investigation. A small pond is located on a farm property that is not part of the Subject Property and water from this pond drains under Dundas Street West through a culvert located to the west.

The present land use over the table lands on the Subject Property and adjoining lands is primarily agricultural. The farm in the past had been used to raise pigs but this use was discontinued 22 years ago. Within the watercourse valleys vegetation is generally comprised of tall grasses, weeds and shrubs.

The future development on the Subject Property will be fully serviced with municipal water and sewers. The development lands are designated for employment uses and will consist of industrial and commercial uses. Two stormwater management ponds will be constructed on the Subject Property, which will treat, approximately 60% and 20% of the total property area following development. The remaining 20% area is green space.

A hydrogeological evaluation of the Subject Property was carried out by MMM according to the Town of Oakville's Terms of Reference for Environmental Implementation Reports (EIR) and Functional Servicing Studies (FSS) carried out in North Oakville. The stated purpose of the EIR is to characterize and analyze the natural heritage features and functions, and to determine and address the potential impacts of a proposed development application, including servicing requirements on the natural heritage system. The Terms of Reference further indicate that the EIR be carried out on a subwatershed basis and that only one EIR will be permitted per subwatershed even if multiple property owners (developers) be proposing development within the same subwatershed. The expectation was that investigative works were not only to be carried out directly on the Subject Property, but also within the subwatershed catchment as a whole to characterize the entire natural heritage system.

The hydrogeological evaluation included interpreting regional geology and site-specific geology and hydrogeology, based on field work carried out by MMM at both on-site and off-site locations between May 2009 and February 2011. A detailed breakdown of field work activities is provided in Section 4.1.2.

4.1.1 Subwatersheds

The Subject Property is located within three subwatershed catchments identified in the NOCSS (Figure 4.1). The upper reaches of all three subwatersheds are defined by the crest of the Trafalgar Moraine that forms the topographic high ground to the northwest of the Subject Property. In Table 4.1 below, it is clear that the majority of the Subject Property are currently drained by the central subwatershed (FM1001) and that the Subject Property contains about 15% of the total overall area of this subwatershed. Conversely, the Subject Property only comprise about 3% of subwatershed FM1109, and about 11% of subwatershed FM1102. With further regard to FM1102, the small proportion (4.8 ha) of the Subject Property contained within this subwatershed also makes up only a very small proportion of the total area of the future employment lands to the west of the Subject Property. This hydrogeological investigation therefore focuses on subwatershed FM1001 although some discussion of subwatersheds FM 1109 and FM1102 is provided.

Table 4.1 – Subwatershed Areas

Subwatershed	Subwatershed Area (ha)	Subwatershed Area within Subject Property (ha)	Proportion of Subwatershed within Subject Property (%)	Proportion of Subject Property within the Subwatershed (%)
FM1102	44.6	4.8	11%	7%
FM1001	395.4	60.6	15%	80%
FM1109	365.1	10.0	3%	13%
Subject Property		**75.4**		**100%**

4.1.1.1 Subwatershed FM1001

As discussed above, Subwatershed FM1001 is the main subwatershed found at the Subject Property, draining approximately 80% of the Subject Property. This subwatershed is identified as the West Branch of Fourteen Mile Creek, and in the study, area is comprised of a main tributary (14W-16, 14W-12) with two smaller tributaries (14W-14, 14W-13) that all join on the Subject Property. The topography within the overall subwatershed slopes from northwest to southeast from a topographic high of about 185 masl at Number Two Sideroad to approximately 142 masl where the watercourse crosses under Dundas Street West. The land cover of the subwatershed area is mostly open or agricultural (90%), with about 8% of the total subwatershed area covered in forest (Figure 4.2). The remaining 2% area is considered impervious, comprised mainly of the Highway 407 pavement and the existing extent of the Hanson Brick quarry, which will expand over time as operations continue.

4.1.1.2 Subwatershed FM1109

Subwatershed 1109 is located east of Subwatershed FM1001 and this subwatershed is known as the Central Branch of Fourteen Mile Creek. This subwatershed drains a small portion of the Subject Property, primarily via a defined channel at the northeast corner (14W-11, 14W-11A) and through a swale, that drains a portion of the Subject Property near its east property line (Figure 4.2). The topographic relief of this entire subwatershed ranges from approximately 190 masl along the crest of the moraine to the northwest to about 150 masl along Dundas Street West. Approximately 23% of the overall subwatershed area is presently forested, 74% is interpreted as agricultural/open ground cover, and the remaining 3% is considered impervious (Highway 407 and the GE facility make up most of this).

4.1.1.3 Subwatershed FM1102

Subwatershed FM1102 is located to the west of Subwatershed FM1001 and is the smallest of three subwatersheds passing through the Subject Property. No defined channels were observed in this subwatershed on-site, other than two wide, gentle swales affected by agricultural activities (e.g., furrowing through cropping). These swales were found to contain pockets of stagnant/ponded water at the times of all site visits beginning from May 2009. The topography of this small subwatershed ranges from about 170 masl at the western limit of the subwatershed to about 152 masl along Dundas Street West. The current land use of the area is predominantly agricultural (90%) and forested (9%) with only a minor percentage (1%) imperviousness.

4.1.2 Work Program

The work program for the hydrogeological investigation was designed to address the requirements outlined in the Terms of Reference (TOR), including:

- Review of background information pertinent to the subwatersheds, including areas beyond the Subject Property limits;

- Field investigations, including:
    - Site visits, initial site inspection and quarterly visits;
    - Drilling boreholes and installing monitoring wells. Streambed mini-piezometers and staff gauges were also installed at on-site locations;
    - Soil sampling and grain size analyses of selected samples;
    - Quarterly groundwater level monitoring, including "continuous" monitoring using data loggers at selected monitoring wells located at both on-site and off-site locations;
    - Estimating watercourse flows at the time of the quarterly site visits;
    - Groundwater and surface water sampling; and,
    - Single well hydraulic conductivity testing and shallow percolation testing.

- Assessing site conditions, including:
    - Characterizing the local geologic and hydrogeologic conditions;
    - Identifying groundwater discharge areas and evaluating surface water base-flows;
    - Establishing surface water-groundwater interactions;
    - Preparing pre-development and post-development water balance analyses at the Subject Property and the overall subwatersheds;

- Analyzing and assessing the potential impacts of the development; and,

- Providing recommendations for the mitigation of any potential impacts.

4.2 Regional Physiography and Geological Setting

4.2.1 Regional Geology and Hydrostratigraphy

The Subject Property and surrounding area are situated in the South Slope physiographic region identified by Chapman and Putnam (1984). The Trafalgar Moraine, a subtle topographic ridge that was formed during the retreat of the Lake Ontario ice lobe 12-13,000 years ago, extends from western Mississauga across the northern part of Oakville and is found to the north and west of the property marking the boundary between the South Slope and the Peel Plain physiographic region to the north. The till plain on which the subject property lies is comprised of reddish coloured Clay-Silt Halton Till which is locally derived from the underlying bedrock.

The underlying bedrock in the area is Upper Ordovician red Shale and interbedded Limestone of the Queenston Formation. It is encountered at shallow depth and is reported in the MOE water well records as red shale with limestone, at depths between 3 to 27 metres below ground surface (mbgs). It is exposed at

surface along the steep valley walls of Bronte Creek to the west, and is exposed at surface at the lower reach of the central watercourse (14W-12) passing through the Subject Property alongside Dundas Street West. On a regional basis the bedrock surface is interpreted to be dipping from the northwest to southeast, generally following the regionally topographic slope, mapped with a surface elevation of approximately 165 to 170 masl in the vicinity of the Trafalgar Moraine to approximately 145 to 150 masl along Dundas Street (Ontario Department of Mines, 1964).

An infilled bedrock valley is identified through interpretation of the water well record logging at wells located east of the subject property, generally below the main tributary draining FM1109 (Central Branch of 14 Mile Creek, (Figure 4.2)). Bedrock elevations in this "valley" are interpreted between 120 to 130 masl to the east and south of the Subject Property and buried sand and gravel deposits are logged between the surficial tills and the bedrock in this section (water well records are found in Appendix 4-1). Farther north, by Burnhamthorpe Road, the valley bottom elevations are interpreted at about 140 to 145 masl, and low permeability till and/or clay deposits are logged from surface to rock.

Drawing 4.1 (appended to this report) presents the hydrogeological cross-sections A-A', B-B' and C-C' identified on Figure 4.2. These cross-sections were prepared from geological information recorded in the MOE water well records, supplemented with borehole data from MMM investigations in 2009 and data from the Hanson Brick Quarry studies.

Figure 4.3 presents the interpreted bedrock and shallow (till) based groundwater contours. The bedrock contours are based on both water well records and on and off-site borehole data, while the shallow contours are based primarily on borehole monitoring data. On this figure, groundwater in the bedrock is seen to generally flow from northwest to southeast with deflections created by the Bronte Creek valley to the west, and the infilled bedrock valley to the east, which leads to a west to east bedrock groundwater flow at the Subject Property. The regional horizontal gradient within the bedrock is approximately 0.009, increasing locally to 0.013 to 0.015 where the flow is being deflected towards the infilled bedrock valley.

The shallow groundwater system is controlled by the topography of the land declining from roughly 180 masl at the upper limits of Watershed FM1001 (at Number 2 Sideroad) down to approximately 145 masl at the point where the main FM1001 channel passes under Dundas Street West. On a watershed basis, the horizontal gradients in the shallow system are on the order of 0.01 to the southeast. Further discussion on groundwater levels is provided in Section 4.3.2.3.

The Halton Till and the Queenston Shale are poor aquifers due to their fine-grained nature and low permeability and are capable of providing only limited quantities of groundwater to water wells. In terms of existing groundwater usage, within the jurisdiction of the Halton Region Conservation Authority, approximately 75% of all wells are completed into the bedrock, which indicates that the surficial overburden deposits of Halton Till are not a significant source of groundwater in the area (Singer et al, 2003). Most wells in the study area are completed into the bedrock, except for wells in the bedrock valley. Wells drilled into the bedrock valley, south of Highway 407, are completed in the buried sand and gravel deposits above the shale bedrock.

The bedrock in the area is also described as a poor aquifer due to poor pore space interconnections in the shale. The Queenston Formation shale does not fracture easily or dissolve, which limits its effective porosity. The upper 3 to 5 m of the bedrock is weathered, and is where most of the available yield is

observed. The reported geometric mean averages of the specific capacity and Transmissivity for this formation are 1.5 l/min/m and 2.7 m^2/day, respectively (Singer et al, 2003). The bedrock is therefore considered a poor aquifer with yield capacities barely enough to satisfy individual domestic water needs.

As reported in Singer et al (2003), 92% of all wells completed within the Queenston Shale (across Southern Ontario, not only Halton Region) are reported as providing "fresh" water. Salty water is reported at 5% of these wells and the remaining 3% of wells are reported with either mineralized or sulphurous water. Water quality from the shale is considered highly variable, ranging from good to poor. Water quality from 12 samples were presented in the Singer report, and indicated the water is hard (mean hardness of 472 mg/L), has high levels of sodium and chloride (averages of 88 and 123 mg/L respectively), and an average concentration for sulphate of 251 mg/L.

4.2.2 Topography and Drainage

The Subject Property and surrounding area has moderate relief (between 190 to 130 masl on a regional basis, 160 to 142 masl relief across the Subject Property) with the ground generally falling from the west-northwest to east-southeast. The area is referred to as part of the South Slope physiographic region by Chapman and Putnam (1984). The Trafalgar Moraine, a subtle topographic ridge that extends from western Mississauga across the northern part of Oakville, lies to the north and northwest of the property.

The local drainage network is generally oriented in a west-northwest to east-southeast direction The Subject Property is predominantly drained by subwatershed FM1001, which has three tributary channels. Subwatersheds FM1109 and FM1102 drain the eastern portion and the extreme south-western corner of the Subject Property, respectively. These three subwatersheds are located in what can be described as a bevelled till plain with local relief provided by creek valleys, which are locally incised in the order of 5 to 10 m. Significant watercourses, such as Bronte Creek to the west are incised deeply into the underlying bedrock (bedrock exposed), with steep side slopes and relief in the order of 20 to 30 m relative to the table lands.

4.3 Hydrogeological Evaluation

4.3.1 On-Site and Off-Site Investigations

MMM carried out hydrogeological field investigations across the Subject Property and at off-site locations to the north and west of the Subject Property commencing in the late spring of 2009. Off-site field work was carried out within subwatershed FM1001, the focus of this EIR.

MMM's initial hydrogeological site visit took place on May 5, 2009. During this visit, hydrogeologists from MMM staked out the 12 on-site borehole locations (MMM-09-1 to MMM-09-12), installed 7 mini-piezometers (MP-01 to MP-07) within two of the sub-watercourse systems that cross the Subject Property (FM1001 and FM1109) and measured water levels at three of four monitoring wells MW-1 to MW-3 (MW-4 was reported by the farmer on the Subject Property to have been destroyed) installed on the Subject Property by Trow Associates Inc. (Trow, see Section 4.3.1.1). Estimates of stream flows and field parameters such as pH, temperature, electric conductivity and concentration of total dissolved solids were measured in the watercourses at each of the mini-piezometer locations. Monitoring wells associated with

the Hanson Brick Quarry site to the northwest of the Subject Property were observed following this site visit during a drive by of the local area.

A total of 16 boreholes were drilled at 12 locations within the Subject Property to depths of between 2.3 and 16.6 mbgs (metres below ground surface) in June 2009 (MMM-09-01 to MMM-09-12). Eleven (11) additional boreholes were drilled at eight off-site locations in November 2009 to depths ranging from 3.6 to 15.6 mbgs. Off-site property access was obtained from the Diocese of Hamilton (MMM-09-13 to MMM-09-15) and from the local municipalities and the Region of Halton (MMM-09-16 to MMM-09-20) for drilling within the road allowances. Borehole and monitoring well locations are presented on Figure 4.3 and Figure 4.4.

Soil samples from the overburden were collected using continuous sampling techniques. At selected intervals, split spoon samples were obtained from the upper portion of the continuous sample intervals. The sampling technique was changed to bedrock coring upon auger refusal at borehole locations where a greater depth was required. Water levels in the boreholes on the completion of drilling were recorded and monitoring wells were installed at each borehole.

The monitoring wells were constructed with 51 mm diameter Schedule 40 PVC screen and riser, equipped with O-rings at the threaded joints. Screens were between 0.5 to 3.0 m in length and a sand pack was installed around the screen, extending 0.3 m above the top of the screen. A bentonite seal was placed from the top of the sand pack to about 0.3 m below grade. A protective lockable steel casing and 0.3 m of concrete at surface completed the installations. Seven of these monitoring locations were constructed as nested wells with both a shallow and deeper monitoring well to ascertain vertical groundwater gradients.

Borehole logs for all boreholes, including stratigraphic descriptions, sampling intervals and monitoring well details, are contained in Appendix 4-2. Grain size analysis results from these boreholes are presented in Appendix 4-3.

Quarterly site visits were scheduled to monitor the Subject Property and off-site monitoring locations over spring, summer, fall and winter conditions. During such visits, manual water level readings were taken at the monitoring wells and mini-piezometers, data loggers were downloaded and when there was flowing water present (and not frozen), flow estimates were obtained in the watercourses at staked locations identified as FMP-1 to FMP-6. These site visits were ideally scheduled to follow periods of dry weather (greater than 3 to 5 days following a rain event), although this was not always possible. Flow measurements were supplemented with stream water levels at staff gauges locations SG-1 and SG-2.

Additional investigative work carried out by MMM at the time of the regularly scheduled monitoring visits included water quality sampling and hydraulic conductivity testing at selected monitors.

4.3.1.1 Investigations by Others

An earlier study was carried out on the Subject Property and additional lands to the north of Highway 407 in 2001, and three of the four monitoring wells installed from this program were still available for use from 2009 to present. This earlier field work was carried out on behalf of Beutel Goodman Real Estate Group and was undertaken at the property by Trow to document the geotechnical and environmental conditions at these lands. The report examined two parcels of land separated by Highway 407 and identified as Parcels

A and B. Parcel A coincides with the Subject Property currently under consideration for development. Parcel B was located north of Highway 407 extending north to Burnhamthorpe Road, with an area of about 23 ha. No work was carried out by MMM for this work program on the lands identified as Parcel B in the 2001 Trow reports.

Trow's prior on-site investigations consisted of the following:

- Drilled forty-five (45) geotechnical boreholes (MW-1 through MW-4, and BH-1 through BH-41) to depths ranging between 1.6 to 6.1 m below grade (39 borehole logs are available; six logs were missing from the report copy on file). Four groundwater monitoring wells were installed at the locations identified as MW-1 to MW-4 (MW-4 could not be located in 2009 and was reported by the previous owner as destroyed years ago). Shale bedrock was reported at 16 of the 39 locations with available borehole logs, generally those boreholes located along the south and west portions of Parcel A (the Subject Property under current investigation);

- Excavated forty-eight (48) shallow test pits to depths ranging 1.0 to 2.3 m. None of these test pits was reported having encountered the shale bedrock;

- One aspect of the Trow work plan was to investigate the potential for contamination near three USTs (Underground Storage Tanks) that had contained pig manure and one UST used for fuel storage. Soil and groundwater samples from the boreholes, monitoring wells and private wells located on the property were submitted for analysis and all met the relevant criteria of the time for the proposed commercial/industrial land use with full municipal servicing.

Copies of the available borehole logs, test pit logs and location plan from the Trow report are also included in Appendix 4-2.

Several hydrogeological investigations were carried out by Golder Associates Ltd. (Golder) on behalf of Hanson Brick in support of their Tremaine Quarry, located to the northwest of the Subject Property. Information from these investigations relevant to the hydrogeological interpretation of the Subject Property was examined. Copies of these reports, including annual monitoring reports up to November 2009 were obtained from those on file at the Regional Municipality of Halton.

The off-site field investigation programs carried out for Hanson Brick by Golder since 2002 consisted of the following:

- Construction of 11 on-site monitoring well nests (MW-1 to MW-11), with a minimum of a shallow monitor completed in the overburden till, and a deep monitor screened deep within the shale bedrock. Six nest locations also include a monitor screened within the upper shale, and 4 nest locations include a monitor screened across the till/shale bedrock interface;

- Construction of three off-site 150 mm diameter drilled test wells, located within the road allowances for Number 1 Side Road/Burnhamthorpe Road West and Tremaine Road. These wells were drilled and tested as part of a Class Environmental Assessment to determine the feasibility of providing a source of water communal water supply system for local residents;

- Static water level monitoring collected on a quarterly basis between 2002 and 2008, and monthly thereafter. The 2008 water level monitoring program included 11 private wells and monitoring of the 11 on-site monitoring well nests and the three test wells located on the road allowances. Most of the on-site monitors and all of the 11 private wells were equipped with data-loggers;

- In-situ hydraulic conductivity testing of the overburden and bedrock was carried out at most of the monitors at the 11 monitoring well nests, with the exception of two of the shallow overburden wells;

- Groundwater sampling at the 11 on-site monitoring well nests and at 10 private wells.

MMM staff did not access nor monitor any of the Hanson Brick wells during this study and used the publicly accessible reported data for those wells.

4.3.2 Site Geology

MMM's drilling programs confirm the surficial soils encountered within the Subject Property and the EIR Sub-catchment Study Area (FM1001) are comprised of Halton Till, underlain by Queenston Shale.

Topsoil generally ranged from 0.1 to 0.3 m thickness at most borehole locations. Thicker topsoil was noted at on-site boreholes MMM-09-4 and MMM-09-10, on the order of 0.5 to 0.6 m thickness. Both of these locations are near to existing watercourses (e.g., valley bottoms).

Generally, the soils at ground surface below the topsoil layer were classified as a brown to reddish brown stiff to very hard Clayey Silt Till, some sand, occasionally classified as Sandy Silt Till, with shale fragments. At six of the borehole locations[1], thin deposits of differing soils were logged between the topsoil and till. These deposits were generally similar in composition as the underlying till (e.g., Clayey Silt, to Silt with some sand and with till-like appearance, extending to depths between 0.5 to 1.4 m below grade) and are possibly representative of soils disturbed by farming activities. At MMM-09-4, located near to the tributary for sub-watershed FM1109, a deposit of Silty Sand to Sandy Silt (to 1.4 m depth) overlays the till.

Fracturing within the till was evident at most boreholes, with the shallower depths being highly fractured and weathered, and with fracture frequency noted to decrease with depth. Fractures were observed up to extend downward to between 4 to 6 m depth from the logging of the soil samples. Fractures near surface were observed to have a greyish white infilling of a Silt-Clay composition, or were identifiable through rusty to black oxidation staining.

The till deposits were logged to the underlying shale bedrock at the boreholes where the bedrock, or weathered bedrock was encountered or assumed through auger refusal. At many of the boreholes, the transition from shale/weathered shale to till was quite gradual.

The geological stratigraphy at the off-site drilling locations (MMM-09-13 to MMM-09-20) was similar though as locations progressed northward and the ground elevation increased the shale bedrock was less likely to be encountered.

[1] MMM-09-2 to MMM-09-5 inclusive, MMM-09-9, and MMM-09-12

The shale bedrock was identified as red Queenston Shale, with zones of green banding or green inclusions visible within the cores. The upper surface of the bedrock was weathered, with the weathered depth of the shale bedrock at the on-site boreholes generally extending beyond the lower completion depths of the boreholes. At three locations, the weathered depth of shale was logged to between 0.6 to 1.7 m from the top of the bedrock surface[2]. At MMM-09-15D (off-site location) the shale bedrock was still identified as weathered to 12.3 m depth (bottom of hole), with a highly weathered zone at approximately 5 to 6 m depth reported at this location. The RQD (Rock Quality Designation) of the shale bedrock was generally found to range from 29% at (poor rock mass quality) to 89% (good rock mass quality).

At the Subject Property, the surface of the bedrock was noted to decline in elevation from the southwest to the north-northeast[3]. Bedrock along the western property line was encountered at approximately 150 masl elevation. Towards the southeast corner of the Subject Property, where the main watercourse exits the property and passes under Dundas Street West, the bedrock surface is encountered at around 145 masl, and is in fact exposed at surface within the main stream channel alongside Dundas Street. The shale bedrock is located close to the watercourse channel bottoms up to the west-central parts of the Subject Property, being identified within 0.8 m of the channel at MMM-09-10, and approximately 1.6 m from the channel bottom in the vicinity of MMM-09-9 and MP-07.

At the northeast corner of the Subject Property, the bedrock was not encountered at either MMM-09-4 (borehole terminated at 146.3 masl) or at MMM-09-5D (borehole terminated at 142.8 masl). These on-site boreholes are the ones located in closest proximity to the buried bedrock valley identified in mapping and water well records.

4.3.2.1 Grain Size Analyses

Following installation of MMM-09-1 to MMM-09-20 monitoring wells, ten soil samples were submitted to Thurber Engineering Ltd. (Thurber) for a grain size analyses. The results of these grain size analyses were reviewed and used to provide estimates of hydraulic conductivity and soil classification for use in the water balance analysis. The grain size curves are found in Appendix 4-3.

Table 4.2 presents the location and depth of soil samples that were tested for grain size distribution and the estimated hydraulic conductivity. The estimates of hydraulic conductivity presented in Table 4.2 were obtained based on grain size results using the Hazen approximation:

[2]MMM-09-1 (1.5 m), MMM-09-6 (1.7 m), and MMM-09-10 (0.6 m)

[3] This includes information from the borehole logs prepared by Trow in their 2001 work on the property.

$K = 0.01 \times Cd_{10}^2$ (m/sec)

Where:

K = bulk hydraulic conductivity (m/sec);
d_{10} = grain size at which point 10% of the soil passes the sieve (mm); and
C = a constant generally set at 1 for these units.

Table 4.2 – Hazen Estimates of Hydraulic Conductivity

BH ID	Sample ID	Depth (mbgs)	Soil Description	d_{10} (mm)	Hazen $K \sim 0.01 \times d_{10}^2$ (m/sec)
MMM-09-01D	S2	1.5 – 1.7	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-05D	S3	2.7 – 2.8	Clayey Sandy Silt (TILL)	<0.001	$< 1.0X10^{-8}$
MMM-09-08	S1	0.9 – 1.1	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-09	S1	1.0 – 1.1	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-11	S1	1.0 – 1.2	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-12	S3	2.5 – 2.7	Clayey Silt (TILL), trace sand	<0.001	$< 1.0X10^{-8}$
MMM-09-13	S1	0 – 1.2	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-17	S4	5.5 – 5.6	Sandy Silt (TILL), some clay	<0.001	$< 1.0X10^{-8}$
MMM-09-18D	S1	0.9 – 1.2	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$
MMM-09-19D	S4	3.7 – 3.9	Clayey Silt (TILL), some sand	<0.001	$< 1.0X10^{-8}$

From Table 4.2, the Till deposits are estimated by the Hazen approximation to have hydraulic conductivities less than $1x10^{-8}$ m/sec. These are reasonable estimates for unweathered till soils, but will underestimate the apparent (or bulk) permeability of the surficial zone for these soils. The bulk hydraulic conductivities for the shallow soils are expected to be greater as the preferential horizontal movement of water will be through the fractures found in the upper, weathered zones of these soils, and alongside creek valleys where erosion of the original deposit also provides some additional fracturing caused by stress relief.

Table 4.3 – Tri-Linear Soil Classification

BH/SA	Description	Percent			Soil Classification
		Sand	Silt	Clay	
MMM-09-01D	Clayey Silt (TILL), some sand	26	45	28	Clay Loam
MMM-09-05D	Clayey Sandy Silt (TILL)	29	42	28	Clay Loam
MMM-09-08	Clayey Silt (TILL), some sand	26	43	31	Clay Loam
MMM-09-09	Clayey Silt (TILL), some sand	22	52	26	Silty Loam
MMM-09-11	Clayey Silt (TILL), some sand	27	44	29	Clay Loam
MMM-09-12	Clayey Silt (TILL), trace sand	12	60	28	Silty Clay Loam
MMM-09-13	Clayey Silt (TILL), some sand	27	44	29	Clay Loam
MMM-09-17	Sandy Silt (TILL), some clay	28	52	20	Silty Loam
MMM-09-18D	Clayey Silt (TILL), some sand	24	45	31	Clay Loam
MMM-09-19D	Clayey Silt (TILL), some sand	29	47	23	Medium Loam

Note: Percentages expressed in the table above are based on the proportions of Clay, Silt and Sand sized particles, excluding Gravel content

The grain size analyses were also used to derive the soil classification for estimating infiltration input into the water balance analysis. The percentage composition of soils was categorized as percentages of sand, silt, and clay and compared against classifications in a tri-linear soil classification chart. The results are presented on Table 4.3. The predominant soils found at shallow depth are Clayey Silt Till (and typically classified as Clay Loam). The tri-linear soil classifications range between Silty Clay to Medium Loams. On average, Clay Loam was considered representative of the soils found near surface for input into the water balance.

4.3.2.2 In-Situ Permeability Testing

Hydraulic conductivity testing was carried out at nine MMM monitoring well locations in December 2009, January 2010 and October 2010[4] to provide estimates of the in situ hydraulic conductivity of the deposits across the Subject Property and the FM1001 subwatershed. The monitoring well locations were selected on the basis of providing data from locations across the subwatershed, and for representative soil types, and at both shallow and deeper depths.

At six of the nine tested monitors, the hydraulic conductivity was anticipated to be quite low, and recovery was monitored using data loggers installed at those locations (see Section 4.3.2.3 for details of the loggers)[5]. Manual measurements were taken at MMM-09-9 and both wells at the two monitors at location MMM-09-10 as these wells recovered fairly quickly (less than 10 minutes each).

The hydraulic conductivity testing was generally carried out by extracting a volume of water in the monitoring well using either a polyethylene bailer or dedicated *Watterra* tubing and foot-valves, In the case

[4] MMM-09-04, MMM-09-09, MMM-09-15S, and MMM-09-17 (December 2009); MMM-09-19S, MMM-09-19D, and MMM-09-20 (January 2010); MMM-09-10S and MMM-09-10D (October 2010).

[5] Rising head recovery monitoring using data loggers at these locations indicated that recovery of the water levels in these wells over several hours (MMM-09-04, MMM-09-15S) to several days (MMM-09-17, MMM-09-19S, MMM-09-20). The recovery at monitor MMM-09-19D continued on the order of one month.

of testing carried out at MMM-09-10, a slug with a known volume was used to displace the water and a falling and rising head test was carried out. In all cases, the recovery of the water levels in the well was measured over time until they had recovered to within approximately 80% of the original water level.

Table 4.4 – In-Situ Permeability Testing Summary

Monitoring Well	Screen Interval (mbgs)	Description	Hydraulic Conductivity (m/sec)
MMM-09-09	1.8 – 2.3	Clayey Silt Till	9.0×10^{-6}
MMM-09-10S	1.6 – 2.1	Weathered Shale	6.4×10^{-6}
MMM-09-10D	6.2 – 7.7	Weathered Shale	4.4×10^{-6}
MMM-09-15S	1.5 – 4.4	Shaley Till to Weathered Shale	1.8×10^{-7}
MMM-09-04	3.0 – 6.0	Sandy Silt to Silty Sand Till, Clayey Silt Till and Sandy Silt Till	4.4×10^{-9}
MMM-09-17	2.9 – 5.9	Clayey Silt Till and Sandy Silt Till	3.9×10^{-9}
MMM-09-19S	3.2 – 5.9	Clayey Silt Till	4.8×10^{-10}
MMM-09-20	4.2 – 7.2	Clayey Silt Till	3.0×10^{-9}
MMM-09-19D	13.6 – 15.1	Clayey Silt Till	9.8×10^{-11}

Notes:

The calculated horizontal hydraulic conductivity may be underestimated due to effects such as smearing of the borehole wall during drilling. This can reduce the ability of water to be transmitted across the perimeter of the borehole and so may result an underestimate of the hydraulic conductivity.

The geometric mean horizontal hydraulic conductivity of the upper till/weathered shale is calculated at about 3×10^{-6} m/sec (using the first four results in the table above).

The geometric mean horizontal hydraulic conductivity for the deeper till deposits is calculated to range from 3.7×10^{-9} m/sec (MMM-09-04, MMM-09-17, and MMM-09-20) to 2.2×10^{-10} m/sec (data from MMM-09-19 nest only). Vertical hydraulic conductivity is further assumed to be $1/10^{th}$ the horizontal hydraulic conductivity.

The recovery data was analysed with Aquifer Test Pro (Version 4.2) using the Hvorslev (1951) approach and the results of the hydraulic conductivity testing are presented in Table 4.4[6]. These values are considered representative of horizontal hydraulic conductivity in the immediate vicinity of the well. It is anticipated that the vertical hydraulic conductivities with depth will be an order of magnitude lower than these values.

The measured hydraulic conductivities within the shallow zones of the Till deposits (i.e., 1.5 to 4.5 m depth) were generally one to two orders of magnitude greater than the conductivities estimated using the Hazen approximation from grain size analyses for the Till (see Section 4.3.2.1). The horizontal hydraulic conductivities in the weathered shale were measured on the order of 10^{-6} m/sec, and are expected to decrease with depth as the effects of weathering and fracturing becomes less pronounced[7].

[6] The Hvorslev analyses are presented in Appendix 4-4.

[7] Hydraulic conductivity measurements from the Hanson Brick monitors (Golder Associates. November 2009) show the hydraulic conductivity (geometric means) of the shale bedrock decreasing with depth, from an order of magnitude of 10^{-7} m/sec at the overburden/bedrock interface to 10^{-9} m/sec at depths greater than 30 mbgs – see summary table and plot in Appendix 4-4.

4.3.2.2.1 Percolation Testing

Two percolation tests were performed at locations identified as PT-1 and PT-2 on October 18, 2010. Percolation Test PT-1 was located nearby to the monitoring well nest at MMM-09-10 and PT-2 was carried out in the vicinity to mini-piezometer location MP-04.

The percolation test holes were between 160 to 300 mm diameters and were dug out to a minimum depth of 0.2 m into the till below the base of the overlying topsoil. Each hole was pre-soaked by filling it with water and allowing the water to infiltrate completely prior to the start of the test. If necessary following pre-soaking, silt and sediment were removed from the bottom of the hole and the hole was cleaned to its original depth. Water was then poured into the hole until the water level was approximately 0.15 m above the base of the hole. A small board was placed across the top of the hole and a reference point was marked on the board over the center of the hole. All the measurements were taken from that reference point with a measuring tape. The distance from the top of the board to the surface of the water was measured and recorded at consistent time intervals.

Plotted results of the percolation tests at PT-1 and PT-2 are presented in Appendix 4-4. Percolation testing yielded T-times of 2 to 4.4 min/cm in the Clayey Silt Till at the these two locations. These T-times correlate to hydraulic conductivities in the upper weathered zone of the Till at locations PT-1 and PT-2 on the order of 10^{-3} to 10^{-5} m/sec, or to an infiltration rate equivalent (used in the MOE Storm Water Design Manual, 2003) of between 135 to 300 mm/hour. These results, while higher than would be anticipated for a clay-rich Till, illustrate the effects of weathering and fracturing in increasing the bulk hydraulic conductivity of these types of soils at shallow depth.

4.3.2.3 Groundwater Level Monitoring

Groundwater level measurements at the monitoring wells and mini-piezometers have been carried out on a quarterly schedule since the installation of the on-site monitors in June 2009. On-site and off-site quarterly monitoring has been typically scheduled to occur roughly during the months of January, April, July and October. The complete results of groundwater level monitoring at the Subject Property are tabulated on Tables SWL-1 through SWL-3 found in Appendix 4-5. This table also includes water levels from the previously installed Trow monitors MW-1, MW-2 and MW-3, which are included in the MMM monitoring program.

Groundwater levels were also continuously monitored at selected wells using pressure transducers (data loggers). MMM staff installed *Schlumberger* Mini-Diver DI501 data-loggers at five on-site monitoring wells in June 2009 (MMM-09-1S, MMM-09-4, MMM-09-9, MMM-09-10S and MMM-09-10D). Additional units were installed at five off-site locations in November 2009 (MMM-09-15, MMM-09-17, MMM-09-19S, MMM-09-19D and MMM-09-20) following completion of the off-site drilling program. A *Schlumberger* Mini Baro-Diver DI500 was also installed at the Subject Property to provide barometric compensation of the data. The loggers were suspended from the tops of the monitors by steel cables and were set to record water level fluctuations at hourly intervals.

The data from each data logger and the baro-logger were downloaded during the quarterly monitoring visits[8]. Figures SWL-1 through to Figure SWL-14 in Appendix 4-5 present plots of the spot level and continuous water level measurements. The data logger plots (Figures SWL-7 through SWL-14 inclusive) include the spot water level measurements and generalized stratigraphy and well construction details at the boreholes, and where available nearby stream channel invert elevations and mini-piezometer spot data measurements.

Groundwater levels exhibit a seasonal pattern from the spring time highs of late March/early April to late season lows at the end of the growing season (late September/early October). On the basis of the quarterly spot measurements at all on and off site monitors, the annual fluctuation in static water levels varied from 0.4 to 1.8 m (average of 1.0 m) at monitors located some distance from the watercourses. This seasonal range was less at the monitors located in the low lying lands next to the watercourses, from about 0.1 to 0.6 m declines observed between the spring and fall (average of about 0.4 m)[9]. The lower seasonal fluctuation observed at monitors located next to watercourses is not unexpected as watercourse valleys act as a boundary to the shallow groundwater system. Figure 4.5 and Figure 4.6 present interpreted groundwater levels at the Subject Property for spring and summer conditions.

The range in seasonal groundwater fluctuations was also examined at nine of the ten data-logger equipped wells[10]. The seasonal range at these wells, with their continuous data sets, when compared to the corresponding ranges obtained from spot measurements at these same wells, was found to be about 0.5 to 0.7 m higher (average 0.6 m). It is therefore not considered unreasonable based on these observations to conclude that the seasonal groundwater level fluctuations observed from 2009 to 2011 can range in average from between approximately 1.0 and 1.7 m (low ground and higher ground).

Vertical gradients are available from the seven monitoring well nests. At five of the nests consistent downward hydraulic gradients were recorded[11]. At monitoring well nest MMM-09-01 downward gradients ranged from 0.01 and 0.21, with downward gradients greater than 0.10 occurring when the shallow water levels at this location rose in response to rain or snow melt events. At the other four monitors, the measured downward gradients were more pronounced, less variable, and ranged from 0.34 to 0.38 (MMM-09-18), up to 1.07 to 1.16 (MMM-09-05)[12].

Upward vertical gradients from between 0.004 to 0.08[13] are present at well nests MMM-09-6 and MMM-09-10. These two nests are located on the Subject Property next to the central watercourse (14W-14) and are screened in the shale bedrock. In addition, at monitoring well MMM-09-09 (also screened in the upper

[8] The data loggers at the off-site wells north of Highway 407 were removed in February 2011. Two of these data loggers were then installed at MMM-09-02, and at MMM-09-06-D.

[9] Monitoring wells MMM09-04, MMM-09-06S, MMM-09-06D, MMM-09-07, MMM-09-09, MMM-09-10S, MMM-09-10D, MMM-09-14 and MMM-09-17 are located nearby to the watercourses. The remaining wells were considered to be included in the other category described above.

[10] MMM-09-19D that experienced very slow recovery of water levels is excluded from this discussion.

[11] Monitoring Well Nests MMM-09-01, MMM-09-05, MMM-09-15, MMM-09-18 and MMM-09-19

[12] Early data at some of these monitors is not included in these summaries because the calculated vertical gradients were not accurate (as one or both of the nested wells were still recovering).

[13] A springtime reversal in gradient was noted at MMM-09-06 when elevated shallow groundwater levels following the spring melt resulted in a temporary downward gradient of 0.21 at this location.

shale) which is located close to the main branch of the FM1009 watercourse, the groundwater levels are also seen to be above the stream channel bed elevation at mini-piezometer MP-07 (located about 40 m away). The data logger plots for MMM-09-09 and the MMM-09-10 nest indicate the groundwater levels at these locations are above the stream bed elevation over much of the year, declining at or below the channel during the summer season in particular (refer to Figures SWL-9 and SWL-10 in Appendix 4-5).

These findings imply that minor groundwater discharge from the bedrock aquifer is occurring at the Subject Property across both the main channel and central watercourse channel (14W-14) over much of the year. The volume of bedrock groundwater discharge over 14W-14 (central tributary to FM1001) is insufficient to maintain base flow during the summer months as witnessed by the dry channel conditions during the summer season.

Data collected from groundwater monitors and mini-piezometers alongside the eastern tributary to FM1009 (14W-13) and the tributary to FM1109 at the eastern part of the Subject Property do not indicate bedrock groundwater contributions into these channels, and the interpreted bedrock groundwater contours (see Figure 4.5 or Figure 4.6) are below the channel bed elevations (14W-14 channel bed declines from 153.9 to 148.5 masl, the tributary to FM1109 declines from 154.9 to 151.3 masl on the Subject Property). The tributary to FM1109 is considered to be losing water into the ground over most of the year (refer to Figure SWL-8 in Appendix 4-5).

The data logger plots also illustrate rapid rises in the shallow groundwater following notable precipitation events and snow-melts, followed by a decline towards pre-event water levels over a two to three week length of time. These observations are consistent with an environment comprised of generally low hydraulic conductivity materials (till and/or clayey silt soils in the overburden and shale in the bedrock). Weathering of the surficial zone (approximately the upper 3-5 m) results in an enhanced bulk permeability of these soils due to the presence of fractures and other openings. This allows the upper zone to more readily receive, and transmit water, with rapid increases in water level due to events such as snow melts (clearly visible in the data logger equipped wells (Figures SWL-7 to SWL-14 in Appendix 4-5), which is then followed by a lowering of the water table as the upper zone drains. With depth, the effects of weathering and the frequency of fractures decreases and the permeability of these till and clayey silt soils becomes lower.

4.3.2.4 Stream Base Flow Measurements

Estimates of the flows within the watercourses traversing the Subject Property were carried out by MMM staff during site visits between May 2009 and February 2011. Measurements were taken at consistent locations at each tributary, generally at the mini-piezometers and flow monitoring points (MP-1 to MP-7 and FMP-1 to FMP-4, refer to Figure 4.4 for these locations[14]). The flow estimates were generally carried out if possible following 5 days of dry weather, with some exceptions when precipitation events conflicted with staff scheduling.

The measurements were carried out by visually identifying a consistent length of channel and measuring the time for a small floating object to travel from the upstream end to downstream end of the measured

[14] FMP-3 is located at the central tributary of the FM1001 watercourse at the southeast corner of Tremaine Road and Number 1 Sideroad.

length of this reach. A minimum of five to six timed runs were obtained (using the stop-watch function on a GPS) and an average flow velocity was calculated. Runs where the floating object were caught on an obstruction or otherwise prevented from travelling down channel unhindered were ignored and the run was repeated. Saturated channel cross-sectional areas were obtained at the upstream and downstream ends of the length under consideration and an average area was calculated. This allowed for an estimate of total flow at the watercourse. Frictional losses along the channel sidewalls and along the substrate were ignored and thus the calculated flow volumes are recognized to be potentially over-estimated.

Stream flow measurements pertinent to each watercourse are summarized in Table 4.5 below. Flow estimate calculations are also provided in Appendix 4-5. Table 4.5 also presents estimated base flow contributions from groundwater based upon the monthly water balances carried out for this study[15].

The watercourses within the Subject Property and EIR Sub-catchment Study Area were generally observed in flowing conditions during the late fall through to the late spring, although wintertime observations often found the watercourses as completely frozen, or frozen with some flow observed below the ice. In the summer months, the watercourses, particularly the central and eastern tributaries to FM1001 and the tributary for FM1109. The main tributary for FM1001 was observed on the Subject Property during the summer and late summer months with little to no flow, and pooled or standing water. These summertime pockets of water along the lower stretches of the watercourse are likely from a combination of minor groundwater discharge from the bedrock system, and remnants of storm flows collected in depressions along the stream channel.

It is also noted that, based on interpretation of aerial photography, that ditching along both sides of Highway 407 appears to be conveyed directly into the tributaries passing through the Subject Property, without benefit of stormwater management ponds. One other source of water within the main tributary of FM1001 is from quarry discharge at the Hanson Brick operation to the north of Highway 407. Groundwater and precipitation entering the quarry is reported to be intermittently pumped into a settling pond and discharged into this watercourse. In 2008, a total volume of approximately 44,500,000 litres was pumped from the quarry into this watercourse, at an average rate of 1,078 litres/minute. This is equivalent to an average of about 13 hours discharge per week into this watercourse, which would not be noticeable during fall to spring conditions, but which would lead to additional water to this stream during the summer period when the watercourses are intermittent.

[15] The monthly water balance methodology and pre-development infiltration estimates are presented beginning in Section 4.4.2 of this report.

Table 4.5: Summary of Stream Flow Observations

Monitoring Location	Easting	Northing	5-May-09	29-May-09	19-Jun-09	24-Sep-09	9-Nov-09	18-Nov-09 and 20-Nov-09
5-Day Preceding Weather Description			20 to 25 mm rainfall recorded at Pearson and Oakville Weather Stations on April 30, and additional 1 mm combined over May 1 and 2. May 2 to 5 no precipitation.	Wet weather. May 27-28, 30 mm combined recorded at Pearson, 15 mm combined recorded at Oakville. An additional 3 - 4 mm of rain recoded at both stations on May 29	Rain Event June 16, 12 to 15 mm recorded at Pearson and Oakville over June 16 to 17, bulk falling on the 16th.	3 to 4 mm rain recorded at Pearson and Oakville combined on September 21 and 23 (Pearson only). Previous to these minor events, there was no precipitation recorded after August 28-29 at either station.	3 to 4 mm precipitation recorded at each weather station over November 4 and 5.	Zero precipitation recorded at Pearson or Oakville from November 4-5. Significant Precipitation Event beginning approx. 0500 hours at Oakville/Pearson on the morning of November 19, precipitation ending at 0300 hours on the 20th - 14 mm at Pearson
Subwatershed FM1001	Est'd Base Flow Rates from Water Balance -->		**1,060 to 430 LPM (April and May)**	**430 to 25 LPM (May and June)**	**25 LPM (June)**	**0 to 49 LPM (Sept and Oct)**	**49 to 173 LPM (Oct and Nov)**	**173 LPM (Nov)**
Easternmost Tributary (14W-13)								
FMP-4	597523	4809561				Downstream of FMP-4 standing water in pockets - no flow	Standing water in channel, no flow	
Central Tributary (14W-14)								
FMP-3 (Corner of Burnhamthorpe and Tremaine)								No defined channel - water observed flowing in rivulets from concrete bridge/culvert. Water was bright green with algae Some flow from west through culvert that crosses Tremaine Road
MP-06	597348	4809417.944	Mini-piezometer is situated in water but area is spread out with Reed Canary Grass, flow is present but spread out over wide area - no flow estimate possible. Temperature = 14.8C (Air Temp = 22.5C @ 2:00 PM) Conductivity = 873 uS, pH = 7.81					
MP-03/FMP-5	597808	4809266.198	Watercourse flowing. Flow estimated at approx.**365 LPM**	Flow estimated at **43 LPM**		Channel dry		
Main (Westernmost) Tributary (14W-16/14W-12)								
MP-07	597541	4809149.703	Watercourse flowing but no suitable location for flow estimate found during first visit. Temperature = 16.9C (Air Temp = 16.0C @ 2:20 PM) Conductivity = 1,050 uS, pH = 7.95	Watercourse flowing. Flow estimated at**445 LPM**.				
FMP-1 (upstream of SG-1)	597618	4809131						
Staff Gauge #1 (Upstream of small (West) Pond)	597677	4809113.09	Flow estimate downstream of MP-07 immediately upstream of small pond outlet (flowing) into main channel (roughly where SG-1 was later installed). Flow estimated at approx**450 LPM.** Temperature = 20.1C (@ 2:40 PM) Conductivity = 404 uS, pH = 8.5!			No flow, standing water observed. Temperature = 20.0C (Air Temp = 26.2C) Conductivity = 862 uS, pH = 7.05	Flow estimated at**106 LPM**	
MP-04/FMP-06	597972	4809088.192	Watercourse flowing. No suitable reach for flow estimate Temperature = 14.3C (Air Temp = 16.0C @ 10:55 AM) Conductivity = 710 uS, pH = 8.78	Water flowing, flow estimated at **268 LPM**.	Water flowing, flow estimated at **645 LPM** - precipitation event recorded 2-3 days prior	Channel dry at MP-04. At farm bridge downstream of MP-04, no flow also observed in channel, standing water only in pools.		
Staff Gauge #2 (by Dundas Street)	598345	4809063.452	Flow in Main Channel by Dundas Street - channel is in bedrock so no opportunity to install mini-piezometer. Flow estimated at approx. **1,020 LPM** - same order of magnitude as water balance estimate. Temperature = 18.9C (time approx. 3:00 PM) Conductivity = 853 uS, pH = 8.45			Standing water - no discernible flow		Nov. 18 - Ponded water observed in main channel with no discernible flow. Nov. 20 - Flow measured in channel, estimated at approximately **1,635 LPM** (after rainfall)
Subwatershed FM1109 (14W-11A/14W-11)	Est'd Base Flow Rates from Water Balance -->		**102 to 42 LPM (April and May)**	**42 to 3 LPM (May and June)**	**3 LPM (June)**	**0 to 6 LPM (Sept and Oct)**	**5 to 17 LPM (Oct and Nov)**	**17 LPM (Nov)**
MP-01	597409	4809839.704	Watercourse flowing. Not an ideal location for an estimate but estimated flow rate was approx. **220 LPM** - same order of magnitude as water balance estimate Temperature = 15.8C (@ 1:05 PM) Conductivity = 700 uS, pH = 8.1!	Flow estimated at **128 LPM**.		Channel dry at mini-piezometer - standing water observed in low spots - no flow. Temperature = 20.1C (Air Temp = 26.1C) Conductivity = 2987 uS, pH = 6.07	No flow, pooled water in places	
FMP-2 (located between MP-01 and MP-02)	597608	4809788					Channel approximately 1.0m wide intermittent damp to wet areas approx. 0.02m depth. No measureable flow.	
MP-02	597769	4809665.798	Minor/slow/diffuse flow observed - could not be estimated. Temperature = 19.2C (Air Temp = 18.2C @ 12:30 PM) Conductivity = 745 uS, pH = 8.04	Watercourse flowing. Flow estimated at**247 LPM**.		Channel dry	No flow, pooled water in places	
Subwatershed FM1102								
Tributary FM1102 (Tributary passing through SW part of Site)	597989	4808801	No defined channel (ploughed field) and no culvert passing under farm lane to direct flows. Stagnant/ponded water in furrows. Temperature = 21.4C Conductivity = 460 uS, pH = 7.97					
Other Water Features								
Large Pond (21 m to the west of MMM-09-2)			Temperature = 18.9C Conductivity = 630 uS, pH = 8.11					
MP-05 (Small ponded area on hill-top)	597514	4809671.167	Ponded area on crest of hill. Temperature = 21.4C (@ 1:30 PM) Conductivity = 185 uS, pH = 7.98			Dry	Channel dry at mini-piezometer - standing water observed in low spots - no flow. Pooled water 2.5 m west of MP location	
Comments regarding FM1001/FM1109			Flow estimates at the downstream end of FM1001 (14W-12) by SG-2 (1,020 LPM) is of the same order of magnitude order of magnitude estimated by water balance (between 430 to 1,060 LPM). Flow estimates at MP-01 (FM1109/14W-11A) are also the same order of magnitude (though a bit higher) as estimated by the water balance	Measurements obtained at the end of the month, so flow as would be predicted by the water balance is anticipated somewhere between the average rate for May and June. Estimated flows within FM1001 are of the same order of magnitude but higher than the average for May and June. At FM1109, at least an order of magnitude higher than predicted. Weather was wet however so measured flows should be higher than predicted by water balance.	Flows measured at FM1001 an order of magnitude higher than would be predicted by water balance, but measurement was obtained about three days after rain event. These higher flows may also coincide with a discharge event at the Hanson Brick Quarry located upstream of the site.	Both FM1001 and FM1109 were dry or pooled with no flow which is inline with September estimates of the water balance which predicts no flow.	FM1001 (14W-16) entering site flow estimated at 106 LPM, on the same order of magnitude as predicted by the water balance. FM1109 - no discernible flows, pooled water, but water balance estimates low flows of 5 to 17 LPM	At downstream end of FM1001 (by Dundas Street), no discernible flow was observed on Nov. 18, but two days later after approximately 1-day rainfall event, flow at the same station was estimated at 1,635 LPM.

Notes:
5-day Preceding Weather observations, focussed on precipitation are presented at the top of the table for Oakville and Pearson Airport weather stations. The Pearson data is complete, the Oakville data, while closer to the site does have missing data.
The 5-day weather observations are also colour coded (shaded) per the following:

Stream flow estimates were made by measuring the time for a floating object to traverse a measured length of watercourse, of generally consistent cross-sectional profile and straight alignment. An average time was calculated using between 3 to 6 measurements. As flow velocity was thus obtained.
The area of this typical cross-sectional saturated profile (or a weighted average of multiple profiles along the length of run) was calculated and this, combined with the flow velocity were used to arrive at an estimated flow rate in the channel.
The calculated flow is considered an overestimation as it does not account for lower flows due to friction along the water/channel bed interfaces.

For the purposes of checking the water balance model against estimated stream flows (described above), the monthly water balance volumes of groundwater infiltration was assumed to be converted fully stream base flow.
Estimates (presented in LPM) for the entire subwatershed FM1001, and a portion of the tributary to FM1109 that passes through the northeast corner of the site area from the water balance calculations are identified**bold blue** text.
Where estimates were obtained towards the beginning or end of a month, a range of the calculated average monthly base flows is presented. Measurements made towards the middle of the month are correlated against the estimated base flow calculated for the month.
The water balance calculations are based on long-term averages and variations in actual precipitation from these averages will affect results. Furthermore a portion of infiltrating water will be directed to the deeper system, though this is estimated at less than 10%.
Most of the infiltrating groundwater is anticipated to flow horizontally through the upper weathered/fractured zone, discharging as this layer drains into watercourses within a 1 to 2 month timeframe.

Considered dry preceding 5-days and suitable for base flow estimates | Precipitation recorded within 5 days | Significant precipitation on the day of or within 1 to 2 days before visit

Table 4.5: Summary of Stream Flow Observations

Monitoring Location	Easting	Northing	18-Dec-09	21-Jan-10	13-Apr-10	5-Aug-10	18-Oct-10 and 19-Oct-10	17-Feb-11 and 18-Feb-11
5-Day Preceding Weather Description			4.5 mm of precipitation recorded at Pearson over December 13 to 16. 2.5 mm of this on December 14. Incomplete data at Oakville.	0.2 mm precipitation at Pearson on January 19, zero at Oakville over preceding 5-days.	32 mm precipitation at Pearson Over April 6 to 8 (5-7 days prior), and at Oakville, 12 mm between the 4th to the 6th, 25 mm on the 7th, and 5 mm on the 8th. No precipitation at either station April 9 to 13.	0.2 mm recorded at Pearson (July 31) and 1 mm recorded at Oakville (July 31) otherwise no precipitation at either station in the previous 5 days.	Oakville Data incomplete over 5-day interval. Pearson Airport data indicates 12.4 mm rainfall Oct 14 (and 4.2 mm Oct. 13). MMM staffe visited site late afternoon Oct. 14 to view conditions at main tributary following rain event - main channels were in flood. Quarterly site visit was 4-5 days later with no additional precipitation recorded. Flows observed over Oct 18-19 were continuing to decline from Oct. 14 rates	Minor precipitation recorded at Pearson Airport (1.4 mm) or Oakville (2.6 mm) in preceding 5 days. However, temperatures were generall above 0C in the preceding 5 days with snow cover melting. The maximum daily temperatures on the two days on-site at both weather stations were recorded between 10 and 11C.
Subwatershed FM1001	Est'd Base Flow Rates from Water Balance -->		338 LPM (Dec)	518 (Jan)	1,060 LPM (April)	0 LPM (July and August)	49 LPM (Oct)	1,087 LPM (Feb)
Easternmost Tributary (14W-13)								
FMP-4	597523	4809561		Watercourse was frozen, no visible flow	Flow estimated at **88 LPM**.	Dry	No flow estimates made	
Central Tributary (14W-14)								
FMP-3 (Corner of Burnhamthorpe and Tremaine)				(Jan 22) Frozen, ice clear with pockets of trapped air. No flow observed.	Flow estimated at **235 LPM**.		No suitable location to measure flow was available this visit, some flow was observed.	
MP-06	597348	4809417.944		Frozen.		Dry	No flow estimates made	
MP-03/FMP-5	597808	4809266.198		Frozen. No flow observed	Flow estimated at **183 LPM**.	Dry	Flow estimated at **83 LPM**	
Main (Westernmost) Tributary (14W-16/14W-12)								
MP-07	597541	4809149.703		Frozen, no flow observed. Clear ice.		Dry	No flow estimates made	
FMP-1 (upstream of SG-1)	597618	4809131	Flow estimated at **592 LPM**.	Frozen, crunchy ice over a denser ice. No flow observed.	Flow estimated at **381 LPM**.	Dry	No flow estimates made	
Staff Gauge #1 (Upstream of small (West) Pond)	597677	4809113.09		Frozen. Crunchy ice over a clear denser ice. Flow observed downstream at culvert crossing.		No flow, some pooled water.	No flow estimates made	
MP-04/FMP-06	597972	4809088.192	At farm bridge downstream of MP-04, flow observed in channel - ice along edges.	Some flow observed north of concrete farm bridge, but frozen at bridge and to the south. MP-04 has been destroyed by ice. Flow estimated at **63 LPM**.	Flow estimated at **871 LPM**.	Dry	No flow estimates made	
Staff Gauge #2 (by Dundas Street)	598345	4809063.452		Frozen, some flow under ice.	Flow observed.	No flow, some pooled water.	No flow estimates made	
Subwatershed FM1109 (14W-11A/14W-11)	Est'd Base Flow Rates from Water Balance -->		34 LPM (Dec)	46 (Jan)	102 LPM (April)	0 LPM (July and August)	5 LPM (Oct)	94 LPM (Feb)
MP-01	597409	4809839.704		Frozen. No flow observed.		Dry		
FMP-2 (located between MP-01 and MP-02)	597608	4809788	Frozen - water flowing under ice. Ice at least 2 cm thick. Clear and dense ice.	Frozen, dense ice covered with snow	Flow estimated at **100 LPM**	Dry	Flow estimated at **32 LPM**	
MP-02	597769	4809665.798	Frozen. Broke through ice - about 0.1 m of water. No measureable flow.	Frozen. Surface water in area frozen. Wet under ice.		Dry		
Subwatershed FM1102								
Tributary FM1102 (Tributary passing through SW part of Site)	597989	4808801						
Other Water Features								
Large Pond (21 m to the west of MMM-09-2)								
MP-05 (Small ponded area on hill-top)	597514	4809671.167		Frozen. Surface water in area frozen.				
Comments regarding FM1001/FM1109			Flow in FM1001 (14W-16) at same order of magnitude (but higher) than predicted by the water balance but also within about 3 days of a rainfall event. At FM1109, low flows are predicted by the water balance, and low flows seen but channels also ice-covered frozen.	All watercourses frozen at time of visit - water balance infiltration estimates suggest flow potential but very little opportunity to measure flow - one measurement obtained at FM1001 is an order of magnitude lower than predicted).	FM1001, flows estimated at about 870 LPM just upstream of Dundas Street, which is in line with water balance estimate of 1,060 LPM. FM1109 estimates of flow at 100 LPM, vs. 102 LPM estimated by water balance.	All watercourses dry (or pooled water in low areas) which agrees with water balance estimate (no flow)	Flows where measured are a bit higher than (but same order of magnitude) as flows predicted by water balance. Rates were noted to be declining still following a significant rain event on Oct 13-14.	Channels were in flood and flow measurements were not attempted by field staff.

Notes:
5-day Preceding Weather observations, focussed on precipitation are presented at the top of the table for Oakville and Pearson Airport weather stations. The Pearson data is complete, the Oakville data, while closer to the site does have missing data.
The 5-day weather observations are also colour coded (shaded) per the following:

Stream flow estimates were made by measuring the time for a floating object to traverse a measured length of watercourse, of generally consistent cross-sectional profile and straight alignment. An average time was calculated using between 3 to 6 measurements. As flow velocity was thus obtained.
The area of this typical cross-sectional saturated profile (or a weighted average of multiple profiles along the length of run) was calculated and this, combined with the flow velocity were used to arrive at an estimated flow rate in the channel.
The calculated flow is considered an overestimation as it does not account for lower flows due to friction along the water/channel bed interfaces.

For the purposes of checking the water balance model against estimated stream flows (described above), the monthly water balance volumes of groundwater infiltration was assumed to be converted fully stream base flow.
Estimates (presented in LPM) for the entire subwatershed FM1001, and a portion of the tributary to FM1109 that passes through the northeast corner of the site area from the water balance calculations are identified in bold blue text.
Where estimates were obtained towards the beginning or end of a month, a range of the calculated average monthly base flows is presented. Measurements made towards the middle of the month are correlated against the estimated base flow calculated for the month.
The water balance calculations are based on long-term averages and variations in actual precipitation from these averages will affect results. Furthermore a portion of infiltrating water will be directed to the deeper system, though this is estimated at less than 10%.
Most of the infiltrating groundwater is anticipated to flow horizontally through the upper weathered/fractured zone, discharging as this layer drains into watercourses within a 1 to 2 month timeframe.

Considered dry preceding 5-days and suitable for base flow estimates | Precipitation recorded within 5 days | Significant precipitation on the day of or within 1 to 2 days before visit

4.3.2.5 Groundwater and Surface Water Quality

Groundwater samples were collected by MMM staff at selected locations on September 24, 2009 and January 21, 2010 for background general chemistry. The samples were obtained from nine monitoring wells (MMM-09-4, MMM-09-10S, MMM-09-10D, MMM-09-11, MMM-09-15S, MMM-09-15D, MMM-09-17, MMM-09-19S, MMM-09-19D). One surface water sample was collected from a water stream, where a staff gauge SG-1 was installed (see Figure 4.4). Dedicated polyethylene bailers were used for the purging and sampling of the groundwater into laboratory prepared sample bottles. The samples were then placed in a cooler with ice and transported to the laboratory (*Maxxam Analytics*) under standard Chain of Custody procedures.

Water quality sample results are provided in Tables WQ-1 and WQ-2 found in Appendix 4-6. Selected inorganic and metal parameter concentrations are plotted in Figure WQ-1 to facilitate the water quality characterization discussion. A graphical representation of cation and anion water chemistry is depicted in a Piper/Trilinear diagram, as shown in Figure WQ-2 (Figures WQ-1 and WQ-2 are also presented in Appendix 4-6). Water quality results were compared to the Ontario Drinking Water Standards (ODWS) and the Provincial Water Quality Objectives (PWQO)[16]. For comparative purposes, the groundwater sample results were also grouped according to the geological unit in which the wells are screened. The groupings include monitoring well sample results screened in Halton Till, the till/bedrock interface, Queenston Shale (deep/shallow), and surface water.

As shown in Tables WQ-1 and WQ-2 and Figure WQ-1 several parameters exceed the ODWS, PWQO, or both comparative standards, from at least one location, including boron, cobalt, iron, manganese, silver, sodium, uranium, zinc, hardness, total dissolved solids (TDS), dissolved organic carbon (DOC), sulphate, chloride, and nitrate.

Water quality results were generally indicative of rural land uses, with no widespread evidence of inorganic parameter impacts at the Subject Property. Dissolved metals sample concentrations (cobalt, sulphate, magnesium, molybdenum, DOC and manganese), were higher in wells screened within the Halton Till as compared to samples collected from wells screened in the Queenston Shale. Samples collected from bedrock monitors indicated relatively higher boron concentrations as compared to collected till water quality samples.

Surface water quality samples indicate higher concentrations of conductivity, manganese and lower concentrations of DOC and sulphate as compared to the collected groundwater sample concentrations.

With the exception of MMM-09-15S, there is no marked variance in water chemistry between wells screened within the same geological unit. MMM-09-15S exhibited elevated concentrations of conductivity, sodium, chloride, and iron in comparison to other bedrock wells, indicating it may be affected by road de-icing salt from Tremaine Road.

[16] ODWS are from Table 2 (Chemical Standards) and Table 4 (Chemical/Physical Objectives and Guidelines) of Technical Support Document for Ontario Drinking Water; Standards, Objectives and Guidelines (MOE), June 2003, revised June 2006.

PWQO are from Table 2 (Table of PWQOs and Interim PWQOs) of Water Management, Policies, Guidelines, Provincial Water Quality Objectives (MOE), July 1994, revised February 1999.

The Piper/Trilinear diagram (Figure WQ-2) shows good segregation between the till, bedrock, and surface water samples, with each grouping occupying a close-knit area within the diagram. Therefore, water from the different aquifers have a unique 'geochemical fingerprint', and can be characterized within a defined area of the Piper diagram. It is apparent from these distinct groupings that there was limited groundwater - surface water mixing at the time of sampling.

4.3.3 Local Hydrogeological Setting

The following discussion of the local hydrogeology is based on the information gathered during this investigation and from previous studies conducted on the property and elsewhere within the watersheds.

The surficial fine-grained deposit of Halton Till found throughout the study area serves to limit infiltration to the groundwater system and as a result, the local stream systems receive a little over two-thirds of their total water from surface runoff. As will be demonstrated in the water balance discussion, average infiltration in this environment is approximately 65 mm/year. Of this 65 mm/year of infiltration, on the order of 0.3 to 5 mm/year is estimated to recharge the deeper bedrock system[17], with the majority of the groundwater inputs to the local watercourses considered to flow laterally through the upper, weathered zone of the till. Almost 100% of this contribution occurs primarily in the period of November to May when the entire shallow system, including upgradient reaches of the channel are saturated and contributing water to the streams.

The upper weathered zone of the till is estimated to have a bulk horizontal hydraulic conductivity on the order of $3x10^{-6}$ m/sec. This enhanced permeability permit infiltrating groundwater to travel somewhat quickly through the shallow zone towards the watercourses. During the late fall to late spring seasons, the streams are generally observed to be in flow, which is predicted by the water balance (groundwater infiltration is predicted during these periods). The higher bulk conductivity in the shallow system can also be observed through the rapid rise and subsequent steady declines in shallow groundwater elevations following precipitation and snow melt events visible in the data logger plots (Appendix 4-5).

Because of this enhanced conductivity, most (approximately 90%) of the infiltrating groundwater moves horizontally through the shallow system, and provides a source of base flow to the local streams during the late fall to late spring. During the growing season groundwater infiltration ceases (there is a water deficit and plants are active and using up water),the shallow system drains, and the watercourses become dry. Figure 4.5 and Figure 4.6 illustrate this decline in the shallow groundwater levels that leads to the reduction in base flow contribution from the spring into the summer seasons.

Towards the lower (southern) reaches of watershed FM1001 the watercourse valleys approach the underlying Queenston Shale bedrock, which is exposed at surface at the extreme southern limits of FM1001 (at the southern end of 14W-12), just before it passes under Dundas Street. Minor groundwater inputs from the bedrock discharging into the main watercourse and the central tributary (14W-14) across the entire Subject Property is interpreted from the monitoring well data. Bedrock discharge into the main

[17] These estimates are based upon an average downward vertical gradient through the till of approximately 0.4, and vertical hydraulic conductivity ranging between $3.8x10^{-10}$ to $2.2x10^{-11}$ m/sec (see notes from Table 4.4). The greater vertical recharge (approx. 5 mm/year) is considered the more representative value for this system.

watercourse is anticipated to continue up to a point roughly where this watercourse passes under Highway 407, and in the central tributary (14W-14) up to a point somewhere between the Highway and Number 1 Sideroad. The extent of the length of these reaches with potential bedrock discharge may become reduced somewhat by ongoing and future activities at the recently constructed Hanson Brick quarry, which is being excavated into the shale, and thus will lead to a localized lowering of the groundwater within the bedrock around the perimeter of the pit over time.

The seasonal groundwater elevation changes within the bedrock are not as highly variable as in the surficial tills, and thus its contribution of groundwater towards these two watercourse channels is considered to continue throughout the year. However, the volumetric rate of water moving towards these watercourses is low, and during the summer months, is insufficient to provide enough water to maintain flow in these watercourses, particularly in the reaches from about the mid-point of the Subject Property and to the north, where the channels have been observed in a dry state during the summer period. Over the lower reaches of the main channel there may be greater opportunity for groundwater to maintain pools in the channel as the bedrock is exposed in the channel and the watercourse is shaded somewhat by large trees.

The surface water elevation of the large human-made pond at the centre of the Subject Property was surveyed by MMM surveyors on February 10, 2011 and was measured at 148.57 masl. This places the water elevation in the pond well above the interpreted bedrock groundwater contours, and as well above the groundwater elevations recorded at MMM-09-02 since June 2009 (ranged between 146.34 to 148.40 masl). Based on these records and interpretations this pond is being maintained from primarily surface runoff rather than groundwater contributions. Some shallow groundwater contribution may be directed into the pond near its northern extent during springtime conditions, although at that time of the year, there is a surplus of water available to the entire natural system. Aerial photography from 1935 shows no evidence of ponding at this location but rather the continuation of tributary 14W-14 passing through this spot before joining with the main channel to the south.

4.4 Impacts of the Proposed Development

For the purposes of this study, the employment lands development for the Subject Property and adjacent lands to be developed was considered to be 90% future imperviousness within the development limits. Lands designated to remain in their natural state, or to be reconstructed in a natural state were assumed to be 100% pervious after development.

Under existing conditions, four watercourses currently enter the Subject Property from the west and northwest. The three tributaries associated with watercourse FM1001 converge into one main channel at about the middle of the Subject Property, and one tributary (14W-11/14W-11A) to watercourse FM1109 cuts across the northeast corner of the Subject Property.

It is proposed to re-align the central and eastern tributaries (14W-14 and 14W-13) of the main watercourse (FM1001) at the north boundary of the Subject Property, to the west and then southerly along the western property line to the main channel (14W-16). The tributary to FM1109 that enters the property at the northeast (14W-11A) is also proposed for re-alignment along the northern and eastern property lines up to the point where it currently exits on the Subject Property (14W-11).

The main focus of the following impact assessment will be on the effects of the proposed development on the overall water balance, more specifically on changes to infiltration to the groundwater system. In addition to the water balance analysis, the potential impacts related to the proposed stream channel realignments will also be examined (14W-14, 14W-11A).

4.4.1 Water Balance Methodology

The MOE Stormwater Planning and Design Manual (2003) offers a method to estimate the infiltration on the site, based on a local infiltration factor "i", which is applied to the available water surplus to determine the groundwater recharge for a given area with pervious cover. The methodology considers factors such as the soil type, topography, and vegetation to arrive at the infiltration factor that is then applied against the water surplus to provide an estimate of the amount of water infiltrating into the ground. The remaining water surplus is considered runoff.

Under the post-development conditions the infiltration factor is recalculated to account for changes in soil types, vegetation and topography after development, and the infiltration and runoff at the pervious land areas are recalculated. As the land after development will have impervious surfaces that prevent infiltration, such as building footprints, roads and parking areas, the pervious area available for infiltration is reduced. Furthermore, there is limited opportunity for evapotranspiration on these impervious surfaces, other than evaporative losses from wetting and ponding of water in shallow depressions (estimated at 10% of total precipitation), and so total precipitation is applied to these surfaces instead of the water surplus.

The discussions that follow focus on subwatershed FM1001 only, which is the main system passing through the Subject Property and is the subwatershed for which this EIR is specifically addressing. The adjoining subwatersheds FM1102 and FM1109 will behave in a similar manner though the magnitude of change under post-development conditions will depend in part on the proportion of development area in North Oakville compared to the total subwatershed area in these other subwatersheds.

4.4.2 Climate and Water Surplus

The inputs used for the water balance calculations are based on information provided by Environment Canada using climate data from the Gerard meteorological station (43°26'-N 79°42'-W), for the period 1990 to 2006. Environment Canada inputted their climate data into a computer model to provide actual evapotranspiration and water surplus inputs for soils with different water holding capacities (WHCs). Under existing conditions the WHC of the soils at the Subject Property and surrounding areas are estimated to be 200 and 400 mm (see Section 4.4.3.1). The Environment Canada data is presented in Appendix 4-7 and is also found on Table WB-1 within this same Appendix.

The Subject Property is located in an area of temperate climate with a mean annual temperature of 9.0 C and a mean annual precipitation of 819 mm. The potential evapotranspiration estimate that was provided by Environment Canada based on the Thornthwaite approach is 656 mm per year. The mean actual evapotranspiration in the vicinity of the Subject Property (pervious areas excluding existing imperviousness runoff contributions) is 607 and 644 mm respectively for soils with WHCs of 200 mm and 400 mm (see below) reflecting periods of soil moisture deficiency. The pre-development water surplus, the water available for infiltration and runoff, is estimated to be 198 mm per year under existing conditions across the

entire subwatershed (FM1001) and 209 mm per year on the portion of the Subject Property found within this subwatershed.

4.4.3 Inputs to Water Balance

Site specific inputs used in the water balance analysis are summarized in Table 4.6 and the inputs under the post-development case are explained below. The rationale for the pre-development and post-development inputs is discussed in Sections 4.4.3.1 and 4.4.3.2.

Table 4.6 – Watershed Specific Inputs Used in the Water Balance – FM1001

Infiltration Factor Based on Land Conditions	**Pre-Development**	**Post-Development**
Topography	0.11	0.11 to 0.13
Soils	0.10	0.10
Vegetation	0.11	0.11
Sum	**0.32**	**0.32 to 0.34**
Water Holding Capacity of Soils (mm)	**Pre-Development**	**Post-Development**
	200 and 400	100, 200 and 400

Site Areas for Use in Calculations (ha) **Subject Property Only (within FM1001)**	**Pre-Development**	**Post-Development**
Pervious	60.6	16.6
Impervious	0.0	44.0
Total Area	**60.6**	**60.6**
Entire Subwatershed, including Subject Property	**Pre-Development**	**Post-Development**
Pervious	379.5	289.7
Impervious	15.9	105.7
Total Area	**395.4**	**395.4**

Notes:
The individual infiltration factors presented in this table are **weighted averages** across the entire subwatershed (bcIMC and other developer owned lands south of Highway 407 as well as the lands north of 407).
Post-development areas are based on the conceptual development plan (dated February 4, 2011) which is subject to revision. Because site grading is expected to reduce slopes in developed lands to the order of 2%, the infiltration factor for topography increases from 0.11 to 0.13 within the developable lands only. This also includes an assumption pertaining to increased future imperviousness at the Hanson Brick Quarry lands as that operation expands.
Water Holding Capacity of Soils is based values presented on Table 3 from the MOE Stormwater Management Manual (2003).

The infiltration factors and WHCs presented in Table 4.6 are considered to be the same across all subwatersheds for the purposes of this analysis. The increase in imperviousness across the entire

subwatershed also includes increased imperviousness at developable lands owned by others in North Oakville as well as increased imperviousness at the Hanson Brick quarry north of Highway 407, which will expand over time.

4.4.3.1 Pre-Development Conditions

The surficial soils at the Subject Property and surrounding area within the subwatersheds, as described previously, are generally comprised of Clayey Silt Till, underlain by Shale Bedrock (exposed at surface in watercourses near to Dundas Street). As described in Section 4.3.2.1, the surficial soils are best classified as Clay Loam. The existing vegetation at the Subject Property is predominantly agricultural with soy beans having been planted on site in 2010. Corn is also a major local crop grown within the subwatershed areas. The soil and vegetation conditions at the Subject Property lead to a soil water holding capacity of 200 mm and 400 mm as defined on Table 3 of the MOE Stormwater Planning and Design Manual.

The pre-development infiltration factor for the Subject Property and the main subwatershed (FM1001), "i", is calculated at 0.32 based on the following:

- Topography is considered to be hilly, i_{topo} = 0.11 (average slopes across the three subwatersheds is approximately 3.0%)
- Soils are considered to be a clay loam from grain size analysis, i_{soils} = 0.10
- Cover is predominantly cultivated land with some forest cover, i_{cover} = 0.11

The pervious surface area of the Subject Property within FM1001 under existing conditions is approximately 60.6 ha. Approximately 48.9 ha of this area is situated within future developable lands and will be changed following development, the remaining 11.7 ha will not be developed. Most of this 11.7 ha area (approximately 9.8 ha) will essentially remain untouched, other than from works such as road crossings and sewer outfalls. It is proposed to realign the watercourse tributaries entering the Subject Property along the north (Highway 407) property line. The central and eastern tributaries to FM1001 (14W-14 and 14W-13) are proposed to be diverted to the west and then southerly along the property line with the Arch-Diocese lands and into the main FM1001 tributary where it enters the Subject Property. The tributary to FM1109 is proposed to be diverted easterly along the north property line and then to the south back to the point where it currently exits the Subject Property. The proposed channel realignments are shown on Figure 4.7. The approximate area of the FM1001 channel realignments (within FM1001) is 1.8 ha[18].

4.4.3.2 Post-Development Conditions

Future development of the Subject Property and adjacent development lands from agricultural to employment land use will change the evapotranspiration, runoff and infiltration conditions of these lands by adding hard surfaces such as roads, driveways, parking lots, sidewalks and roofs that are effectively impervious. For the purposes of the water balance analyses, the total area covered by impervious surfaces for this type of development is estimated at about 90% over the 48.9 ha of developable area. This is equivalent to about 73% imperviousness over the full 60.6 ha of site area (within Subwatershed FM1001) with the 11.7 ha of "natural" area with 0% imperviousness included.

[18] The 1.8 ha is the approximate area of the proposed channel where cuts below existing grade will be required, necessitating the removal of the upper weathered soils within this area.

Post development conditions on lands northwest of Highway 407 are anticipated to remain essentially the same as the pre-development situation. These lands are currently designated Protected Countryside (Greenbelt Plan, 2005) and Agricultural in the local and Regional Official Plans. The post-development water balance on a subwatershed basis (FM1001) includes allowance for a minor increase in imperviousness in the lands northwest of the 407 that reflect a projected increase in size of the Hanson Brick Tremaine Quarry over time.

It is also noted however, that runoff from pervious areas surrounded by streets within the developed lands will eventually be directed to the stormwater management system, as it will drain onto the road network and from there into the storm sewer system. The exception would be the runoff from pervious areas abutting and draining to natural features or runoff conveyed to these features by means of mitigation such as infiltration swales.

Under the post development condition, the soil composition is expected to remain classified as a Clay Loam after site grading, as soils used for fill are expected to be obtained from the Subject Property, and the soils exposed by cutting activities are anticipated to be similar to the existing surficial soils. The vegetation following development is anticipated to be comprised predominantly of short-rooted vegetation such as grassed lawn in landscaped areas, with natural vegetation remaining as-is elsewhere where these areas are to remain undisturbed or with new plantings in areas to be created through the proposed channel realignments.

Based on Table 3 from the MOE Stormwater Management Manual (2003), Clay Loams with short rooted vegetation such as lawns are shown to have a WHC on the order of 100 mm. Therefore, under the post-development scenarios, the local climate data provided by Environment Canada for soils with a WHC of 100 mm was used to estimate the future water surplus for the developed areas of the Subject Property and surrounding development lands. With a WHC of 100 mm, the Actual ETR is reduced from 607 to 640 mm/year (pre-development conditions) to 536 mm/year at areas to be landscaped. The reduction in Actual ETR across pervious areas of the developed lands results in an estimated water surplus of about 231 mm/year compared to the pre-development surplus of 209 mm/year, over pervious areas of the property. These changes apply to the future landscaped grounds within the development lands only, or to about 4.9 ha of the total 48.9 ha of lands to be developed within the 60.6 ha total area within FM1001. On a subwatershed basis, the estimated water surplus (pervious area) rises from 198 mm/year to about 208 mm/year.

4.4.4 Water Balance

Water balance analyses were performed for the entire Subject Property area, and for the three subwatersheds that are partially located within the Subject Property. As noted earlier, discussions will be focussed upon subwatershed FM1001. Water balance analyses for the other two subwatersheds FM1109 and FM1102 are also presented in Appendix 4-7 for completeness. In addition, a pre-development water balance analysis was carried out for a portion of the FM1109 subwatershed that passes through the east corner of the Subject Property to compare observed watercourse base flows against predicted base flows from these analyses (identified on Figure 4.2). This is discussed in Section 4.4.4.1.1.

4.4.4.1 Pre-Development Water Balance

Under pre-development (existing) conditions the Subject Property is considered pervious over its full area (e.g., 60.6 ha within FM1001). The water surplus under these conditions was calculated as 209.4 mm/year (see Section 4.4.2) and the infiltration factor was calculated to be 0.32. Therefore, pre-development infiltration across the full property area and leading towards the tributaries of FM1001 is estimated at about 65.1 mm per year (39,474 m^3/year), which is consistent with the reported infiltration values for these types of soils. Most groundwater recharge occurs during the spring melt period when soil moisture content is high. The remaining 144.3 mm per year (87,434 m^3/year) would be available for surface run-off, most of which occurs during the spring melt period.

On a subwatershed basis, the predevelopment water balance indicates that FM1001 will receive 247,940 m^3/year of infiltration (62.7 mm/year equivalent) and 653,053 m^3/year (165.2 mm/year) of runoff. The subwatershed volumes reflect pre-existing imperviousness within the entire subwatershed (e.g., Highway 407, Hanson Brick quarry).

The major contribution of water to the subwatershed occurs, as expected, in the late winter and spring. Water surpluses during the majority of the growing season (June through October) are essentially zero as the ETR remains high and the soil moisture goes into a deficit. Soil moisture starts to become replenished in September/October.

The pre-development water balances for the Subject Property and the overall subwatershed are summarized on Table 4.7 and Table 4.8 (in Section 4.4.4.2), with the detailed, monthly water balance calculations presented in Appendix 4-7 on Table WB-2-FM1001.

4.4.4.1.1 Base Flow Comparisons to Pre-Development Water Balance

During the course of the site investigations, estimates of surface water flows were made at selected locations in the watercourses/tributaries of FM1001 and FM1109 that passed through the Subject Property. No flow estimates were attempted at FM1102, as there was no defined channel or any measurable flow at this part of the Subject Property.

One of the requirements of the EIR and FSS TOR is to validate the pre-development water balance where possible. The water balance analyses provide monthly estimates of infiltration and runoff. For purposes of this comparison, we have assumed that monthly infiltration calculated by the water balance is representative of base flow conditions in the watercourses less 10% to allow for recharge of the deeper shale bedrock aquifer, leaving 90% of the infiltration calculated by the water balance available for base flow to the creeks.

Table 4.5 presents the watercourse base flow estimates against the water balance calculated infiltration volumes (90% as noted above), converted to equivalent flow rates at the downstream edges of the watercourses. For FM1001 (West Branch of Fourteen Mile Creek) this is at SG-2 by Dundas Street (bottom end of reach 14W-12). For FM1109, (Central Branch of Fourteen Mile Creek) only a portion of a contributing tributary passes through the Subject Property (14W-11A). The upgradient portion of this tributary was identified on Figure 4.2 and a pre-development water balance analysis was carried out for this small portion of FM1109 (see Table WB-2-14W-11A in Appendix 4-7).

The water balance is based upon averages from a 16-year weather record and the calculated monthly average infiltration is being treated as a proxy for base flows to the watercourses. These monthly averages were then compared to measured estimates of channel flows (with inherent inaccuracies) that are a function of real (non long-term averaged) weather patterns. Notwithstanding the above, as can be seen from Table 4.5, the predicted stream flows and measured stream flows are in good agreement when measurements were possible without influence from rainfall or snow-melt events (e.g., February 17-18, 2011), and generally of the same order of magnitude. Thus it can be concluded that the water balance methodology used in this study is a simple, yet valid, model of the hydrogeological system in which the Subject Property is situated.

4.4.4.2 Post-Development Water Balances

In addition to the pre-development water balance, two post-development water balance scenarios were examined. The first of these scenarios examined the worst case situation with no mitigation measures applied at the Subject Property and the second scenario examined the improvements from the worst case scenario with mitigation measures employed. The post-development scenarios were compared against the pre-development case. The results for the water balance calculations are described below and summarized on Table 4.7 and Table 4.8. The detailed calculations are presented on Tables WB-2-FM1001 through WB-4-FM1001 located in Appendix 4-7.

The following assumptions have also been made to estimate the post-development water balance including recharge mitigation measures:

- Total imperviousness within the developable areas of the properties is assumed to be 90%, which is a conservative percentage, likely higher than will be the case at final build out;

- There is no infiltration occurring on hard surface areas and evapotranspiration is significantly lower than that under pre-development conditions (10% as evaporation only), due to rapid runoff of precipitation;

- Runoff from the road network, as well as roof areas not directed to mitigation is discharged directly into the storm sewer network;

- The characteristics of the native soils and bedrock limit the choices of suitable measures to infiltrate water into the ground at both the Subject Property and the surrounding areas. The data collected over the course of this investigation indicates the upper, weathered zone of the till soils has enhanced (secondary) permeability from fracturing. The most promising locations for infiltration-promoting mitigation measures will therefore be within areas where the native soils are to be left undisturbed by construction activities;

- The imperviousness of the Subject Property after development is calculated at about 73% (44.0 ha) of the total 60.6 ha site area found within subwatershed FM1001. Of this 44.0 ha, roofs are assumed to account for approximately 40% of the total imperviousness or about 17.6 ha. Runoff from the roof areas may be suitable for use in mitigation measures depending upon the nature of the businesses that eventually are developed (e.g., businesses with zero to low emissions versus

heavy industries with the potential to release particulate matter that collects on roofs). For the purpose of this analysis the runoff collected on the roofs has been considered usable for mitigation measures, though as noted above the opportunities to mitigate in this hydrogeological environment are limited;

- Infiltration works such as infiltration swales constructed along the periphery of areas retained in their natural state are considered viable. By carefully constructing these measures within the undisturbed natural environment areas, they are anticipated to be capable of recharging a portion of the relatively clean roof runoff that can be directed to these swales, provided the existing surficial fractured and weathered zone of the native till soils remains intact. This will require using specified construction techniques to minimize smearing of the walls and bases of these swales, which would dramatically reduce the potential effectiveness of these measures. Constructing infiltration swales within portions of the Subject Property with engineered fill or deep cuts into unweathered and relatively unfractured soils will not be effective for mitigating infiltration, but, will, if connected to infiltration swales along the perimeter of the natural features will provide temperature moderation to the roof runoff;

- Construction of artificial wetlands within the proposed valley re-alignment that will convey the central and eastern tributaries (14-W-14 and 14W-13) to the main FM1001 tributary channel will provide for some measure of additional infiltration, though this will be limited somewhat by the fact that such wetlands will be constructed within newly exposed (unweathered) soils in cut areas, with much lower infiltration potential than the weathered soils; and,

- Additional mitigation measures, such as vegetative swales at parking areas, landscaped infiltration ponds/wetlands, green roofs, cistern systems for grey-water use and/or landscape irrigation, etc. are specific to lot configurations, intended use, building design and so forth and should be examined during later stages of detailed design or at the time of building permit applications. For example, construction of landscaped ponds/wetlands would not appear feasible on a lot with a large warehousing facility and extensive parking facilities, but may be feasible at a lot housing a corporate headquarters facility. As such specific measures on a lot by lot basis are not identified at this time and they have not been included in the post-development water balances.

4.4.4.3 Post-Development Water Balance with No Mitigation

This first scenario, examines the worst-case condition, where there will be no mitigation measures incorporated. This assumes that all impervious area runoff (less impervious surface losses to evaporation), including roof runoff, is conveyed directly into the stormwater management system. This scenario considers that groundwater infiltration is supplied only by precipitation that falls upon pervious areas. The potential maximum loss of infiltration from the proposed development was calculated to provide a worst-case estimate of the potential impacts on infiltration due to the introduction of hard surfaces. Detailed monthly water balance calculations may be found on Table WB-3-FM1001 in Appendix 4-7.

Table 4.7 – Pre and Post Development Water Balance – No Mitigation

Parameters	Pre-Development		Post-Development		Change	
	mm/year	m^3/year	mm/year	m^3/year	m^3/year	%
Subject Property Only (within FM1001)						
Precipitation	819.0	496,314	819.0	496,314	0	0.0%
Total AET	607.5	368,138	160.4	97,229	(270,909)	-73.6%
Evaporative Losses at 10% Precipitation	0.0	0	59.5	36,044	36,044	N/A
Infiltration (MOE Methodology)	65.1	39,474	20.0	12,135	(27,339)	-69.3%
Runoff (MOE Methodology)	144.3	87,434	578.4	350,525	263,091	300.9%
Entire Subwatershed, incl. Subject Property						
Precipitation	819.0	3,238,326	819.0	3,238,326	0	0.0%
Total AET	585.4	2,314,628	445.7	1,762,294	(552,334)	-23.9%
Evaporative Losses at 10% Precipitation	3.3	13,022	21.9	86,552	73,530	564.7%
Infiltration (MOE Methodology)	62.7	247,940	48.5	191,845	(56,095)	-22.6%
Runoff (MOE Methodology)	165.2	653,053	300.9	1,189,854	536,801	82.2%

Notes:
Evaporative losses are losses of precipitation though simple evaporation on impervious surfaces (such as from ponding at puddles).

As indicated in Table 4.7 under this worst case scenario, the water balance method estimates a 69% reduction in groundwater infiltration from the Subject Property falling within subwatershed FM1001 while on a total subwatershed basis the reduction in infiltration is estimated at about 23%[19]. On-site runoff contribution to the watercourse system is calculated to increase on the order of 300%, or by 82% on a subwatershed basis. The change to the local groundwater recharge function assumes that all runoff from hard surfaces is conveyed to the storm sewer network. Some additional loss of groundwater flow may occur due to foundation drains and permeable backfill surrounding services, however, most of recharge loss is anticipated to be due to rapid runoff from impervious surfaces.

4.4.4.4 Post-Development Water Balance with Mitigation

A post-development water balance analysis was carried out with mitigation measures. The choice of mitigation measures was constrained by site conditions (e.g., site soils, location and orientation of natural

[19] The overall subwatershed calculations includes, in addition, to the effects identified at the Subject Property, effects from development on lands owned by others, and from the proposed expansion of the Hanson Brick Quarry lands to the north of Highway 407.

features) and design constraints (e.g., site grading, requirements for connections to adjacent future developments). The locations of the proposed mitigation measures examined under this scenario are shown on the conceptual plan of development (dated February 4, 2011) presented on Figure 4.7.

The improvements to recharge and runoff contributions of the following mitigation measures were examined:

- A portion of the roof runoff is collected and directed into infiltration swales preferentially located at the edge of the buffers to the natural features. Locating these swales in the natural buffer will ensure that the functionality of these swales will not be compromised as a result of site grading activities on the Subject Property. These swales could also be constructed within the "natural" areas that are to be created as a result of the proposed watercourse diversions. However, as the surficial soils in those areas are expected to be deeper, less fractured soils exposed by cutting the grades they have not been assumed to provide any appreciable infiltration capacity (and are not included in the water balance calculations), although there will be some infiltration potential. The locations of infiltration swales will need to be confirmed at detailed design as other factors such as final site grades must be considered in the siting of these facilities. Figure 4.8 presents a conceptual design of one of these infiltration swales. As these swales are not designed for stormwater management, they do not have to adhere strictly to the criteria specified by the MOE Stormwater Planning and Design Manual (2003) in particular a requirement that they drain in 24 to 48 hours, and in fact are assumed for the purposes of the calculations to convey one void-space volume of runoff water per month into the shallow groundwater system as explained earlier. This is somewhat conservative as the information collected at the monitors equipped with data-loggers indicates that the upper soils drain (following rainfall events) within a 2 to 3 week period.

Artificial wetlands are proposed within the valley of the westernmost of the two proposed channel realignments (14W-13 and 14W-14) to make up for the post-development loss of the small, unclassified wetland located within the existing Tributary 14W-14. Clean roof runoff could be directed to these wetlands to provide the potential additional infiltration to the shallow system. However, the post-development water balance does not account for any infiltration benefits from these artificial wetland(s) for two main reasons:

1. These wetlands will be constructed within the limits of the proposed channel realignments that will be excavated under an existing hillock, and the underlying soils will be unweathered till with a lower hydraulic conductivity on the order of 10^{-7} to 10^{-8} m/sec compared to the hydraulic conductivity of the weathered zone of $3x10^{-6}$ m/sec. This is approximately 3% and less of the transmissive capacity of the upper weathered soils and will not add a significant volume of water back into the shallow groundwater system.
    a. Scarifying and amending the upper 0.5 m of the newly exposed soils within the re-aligned valleys with organic material would however enhance the infiltrative capacity of these newly exposed soils; and,

2. The static water level within the underlying bedrock ranges from about 155 to 152.5 masl along the proposed channel realignment, and the invert of the realigned channel profile will range from about 154 to 151 masl. In order for there to be potential for vertical infiltration through the bottom of these constructed wetlands, the design water levels in these wetlands will need to be higher than

that of the bedrock. The layout of these artificial wetlands is a detailed design issue at which time the elevations of these ponds would be identified.

Notwithstanding the above, these wetlands can be expected to provide some level of infiltration enhancements during the drier summer season when shallow groundwater levels in the valleys have declined somewhat due to the effects of evapotranspiration. Contributions to groundwater infiltration from these measures are not however included in the water balance calculations as a conservative assumption and the potential volumes of infiltration will also be relative to the final design sizing of these features.

Additional enhancements to the post-development infiltration at these development lands may be realized through the promotion of additional infiltration measures within the development such as wet (landscaped) ponds, bio-retention facilities, vegetated swales, etc. The feasibility of such measures is however a function of the individual lot configurations, proposed lot uses and site design opportunities. The infiltration contributions from these potential opportunities, are anticipated to be minor because these features will likely be constructed on disturbed soils (cut or engineered fill). Infiltration from these undetermined mitigation measures are therefore not accounted for in the water balance calculations.

Table 4.8 summarizes the results of the water balance assessment for the Subject Property including pre-development and the post-development conditions with the implementation of mitigation measures described above. The detailed calculations are found on Table WB-4-FM1001 in Appendix 4-7.

Table 4.8 – Pre and Post Development Water Balance – With Mitigation

Parameters	Pre-Development		Post-Development		Change	
	mm/year	m^3/year	mm/year	m^3/year	m^3/year	%
Subject Property Only (within FM1001)						
Precipitation	819.0	496,314	819.0	496,314	0	0.0%
Total AET	607.5	368,138	160.4	97,229	(270,909)	-73.6%
Evaporative Losses at 10% Precipitation	0.0	0	59.5	36,044	36,044	N/A
Infiltration (MOE Methodology)	65.1	39,474	32.9	19,959	(19,515)	-49.4%
Runoff (MOE Methodology)	144.3	87,434	565.5	342,701	255,267	292.0%
Entire Subwatershed, incl. Subject Property						
Precipitation	819.0	3,238,326	819.0	3,238,326	0	0.0%
Total AET	585.4	2,314,628	445.7	1,762,294	(552,334)	-23.9%
Evaporative Losses at 10% Precipitation	3.3	13,022	21.9	86,552	73,530	564.7%
Infiltration (MOE Methodology)	62.7	247,940	51.7	204,349	(43,591)	-17.6%
Runoff (MOE Methodology)	165.2	653,053	297.8	1,177,350	524,297	80.3%

Notes:
Evaporative losses are losses of precipitation though simple evaporation on impervious surfaces (such as from ponding at puddles).

With mitigation, the water balance method estimates a 49% reduction in groundwater infiltration at the Subject Property within FM1001, which is an improvement from the 69% loss calculated under the worst case scenario. The increase in post-development runoff generated at the Subject Property for the mitigated scenario is reduced from about 300% to 292%. Volumetrically, approximately 7,825 m^3/year of potential runoff is redirected into infiltration through these proposed mitigation opportunities compared to the unmitigated scenario.

On a total subwatershed basis (FM1001 only), and where opportunities are present, using similar mitigation measures on development lands owned by others, about 12,500 m^3/year of runoff may be redirected into the ground as infiltration. Mitigation at the Subject Property and development lands owned by others is calculated to reduce overall infiltration losses by about 25% of the unmitigated totals[20].

4.4.4.5 Discussion of Water Balance Results

The preceding tables and discussion present the potential impacts and results of mitigation measures on the post-development water balance for the Subject Property within subwatershed FM1001. From the tables it can be seen that with the proposed mitigation measures it can be anticipated that impacts to recharge across the Subject Property will be reduced but not eliminated. This is not unexpected for this type of urban development, situated within a setting where the predominant surficial soil is low permeability clayey silt till. The geological conditions present at the Subject Property limit the types of mitigation measures that can be employed with reasonable expectation of success.

The potential for effective mitigation measures at the Subject Property is also affected by the proposed site coverage where a conservative 90% imperviousness ratio has been assumed on the developable portions of the Subject Property. This constraint leads to reduced lot level perviousness and infiltration potential as there is simply much less available area in which to infiltrate a large volume of water in order to reach a balance.

Enhanced infiltration measures that attempt to recharge water directly to the subsurface have the potential to recover a larger proportion of the lost recharge function. Enhanced recharge however, is more expensive to construct, requires favourable hydrogeological conditions including a relatively permeable subsurface, simple geological conditions and a relatively deep water table. Conceptually these occur where the water table is deeper than 3 m from finished grade either naturally or due to the introduction of suitable fill, and the local soil is sufficiently permeable (>15 mm/hour infiltration rates) to allow a relatively rapid transfer of the infiltrating water.

[20] On a subwatershed basis, the total infiltration reduction across the development lands south of the 407 is calculated at approximately 49,600 m^3/year without any mitigation and with mitigation, at about 37,100 m^3/year, which is a 25% improvement in the total calculated infiltration losses from the redevelopment of these future employment lands (Subject Property and lands owned by others). These volumes exclude infiltration reductions assumed and accounted for in the water balance from the future expansion of the Hanson Brick Quarry lands to the northwest.

As noted from the results of site investigations, the surficial soils found across the Subject Property are made up of clayey silt till which is not considered an ideal soil for constructing infiltration measures. Construction activities at the Subject Property as well as placement of compacted earth fill will serve to reduce the native infiltration capacities of this clayey silt till soil.

Infiltration swales may be constructed along the edges of the watercourse valleys where weathering and stress relief of the low permeability deposits has resulted in a highly fractured upper soil zone conducive to recharge and are considered to be the most opportune locations for installing mitigation measures for infiltration. These areas will not be affected by site grading which would lead to scraping and compaction and which would degrade or remove the ability of these low permeability soils to transmit water through the weathered zone (e.g., fractures)[21]. Specific construction limitations will also be required for these measures to be successful. Construction of the swales can only be done in dry weather to avoid remoulding the soil and effectively lining the swale sides and base with an impervious smeared layer. Manual scraping and removal of smeared soils from the sidewalls and base of the swales to expose the natural fracturing should be contemplated.

4.4.4.6 Discussion of the Potential for Base Flow Reductions to Watercourses

The surficial soils across the entire watershed system are comprised of low permeability Halton Till and as a result, the local stream systems receive a little over two-thirds of their total water from surface runoff (based on the water balance) with the balance derived from groundwater.

The majority of the groundwater inputs to these watercourses is derived from the shallow till zone, and almost 100% of this contribution occurs primarily in the period of November to May when the entire shallow system, including upgradient reaches of the channel are saturated and contributing water to the streams. The proposed development, with the incorporation of mitigation measures will result in approximately a 49% reduction in infiltration across the Subject Property area. However, the watercourses will continue to receive contributions from the upgradient areas (north of Highway 407), which are not planned for urban development and are not expected to undergo major land use changes, with the exception of the expansion of quarrying at the Hanson Brick property to the northwest. These upgradient areas are on the order of 2.6 times the catchment area of the future development lands south of Highway 407[22].

Figure 4.9 graphically presents the monthly and cumulative infiltration calculated using the water balance methodology for the pre-development and post-development with mitigation scenarios. As discussed in Section 4.3.3 of this report, approximately 90% of this infiltration is considered to flow laterally towards the watercourses providing base flow, the balance recharging the shale bedrock. The figure shows that the calculated monthly infiltration under post-development conditions ranges between 78 to 92% of the pre-development values between November and May, and for the period between June and October is slightly greater than the pre-development conditions. The net effect is that additional infiltration will be directed towards the on-site tributaries during the late summer months than currently is the case. During the wetter winter and spring periods, although the calculated post-development infiltration is reduced from the existing condition, this also occurs during the time of the year when the area is expected to be fully saturated from

[21] Excluding the proposed re-alignments that are to be constructed within unweathered till soils exposed through cuts.

[22] Future development lands to the south of Highway 407 total approximately 110.1 ha (28%) of the total FM1001 subwatershed area.

snow melt and other runoff. The net effect to the lower reaches of FM1001 is considered positive given the potential for additional water during the late summer months.

As identified earlier in this report, the existing channel reaches for the main and central tributaries of FM1001 (14W-16, 14W-14, and 14W-12) are below the interpreted bedrock groundwater levels and so there is minor upward flow of groundwater from the underlying bedrock and intervening till soils towards these channels[23]. These bedrock contributions are small and insufficient to maintain flow in this watercourse during the summer months (watercourses were observed in dry to pooled conditions during both the 2009 and 2010 summer seasons), but are expected to remain consistent in the post-development.

4.4.4.7 Dewatering Potential

Extensive construction dewatering is not anticipated across the majority of the Subject Property other than for removal of minor seepage into excavations. Dewatering related to building construction will be in large part a function of the proposed building designs. Minimal dewatering would be expected for buildings with slab-on-grade foundations whereas buildings constructed with basements and/or underground parking may require more extensive groundwater removal.

The excavations of the stormwater management ponds are expected to be fully completed within the Clayey Silt Till found at surface across the entire subwatershed. Because the ponds are expected to be constructed fully within low permeability deposits, no significant dewatering during construction is anticipated. Localized sand seams within the till may be encountered that are expected to be managed through passive drainage. Sump pumping at a limited rate may be required to address minor water seepage encountered during excavation. The need for clay liners at these ponds is also not anticipated, though if required, the native soils are likely suitable for this purpose[24].

The development will be serviced with municipal water and sewers. The sewer services are expected to be mainly located in the till soils and as such, no dewatering other than local sump pumping for construction of sewer services, is anticipated. Granular pipe bedding backfill material used for buried services may become a preferential flow path for percolated surface water and groundwater. Anti-seepage collars should be installed at regular intervals to prevent continuous groundwater flow along the backfill. The frequency of collar installation will depend on final grade elevation, slope of services and thickness of granular pipe bedding.

Based on the proposed concept plan (refer to Figure 4.7) four watercourse crossings, with buried services (e.g., water, sewer) are proposed within FM1001, with three of these crossings located on the Subject Property. It is understood that the crossings will be carried out using jack-and-bore techniques that will preclude the need for trenching across the watercourses. Access pits would need to be constructed at each side of the watercourse and removal of minor groundwater seepage from these pits may be required.

Scheduling excavations for the late summer, if practical, will further serve to reduce groundwater seepage into excavations as this is the time of year when groundwater levels are typically at their lowest. In particular, scheduling the channel crossing works for the late summer when these channels are observed in

[23] The proposed channel realignment will be below the bedrock groundwater table so this will remain similar.

[24] Subject to confirmation by a geotechnical engineer.

dry condition is recommended as this will minimize potential for localized impacts to aquatic life. It is further recommended that the service crossing of the proposed realigned channel be completed at the time of construction of the new channel. In this one location, simple trenching can be used, provided the work is carried out before the realigned channels become operational.

Dewatering volumes are not anticipated to exceed 50,000 litres/day. However, dewatering potential is dependent upon a number of factors such as the proposed depth and size of excavations, the time of year and groundwater elevation. It may be later determined that a Permit to Take Water (PTTW) from the Ministry of Environment will be required. The need for this permit would be identified at detailed design. The application requirements for a PTTW requires the applicant to address how much water will be withdrawn, over what time period, where it will be discharged to, the expected zones of influence and effects on natural features and other users, among other things. Monitoring and mitigation measures would also be required and would be identified in the application. Permit to Take Water applications are submitted after detailed design and in advance of the construction works.

4.5 Conclusions and Recommendations

The Subject Property and the three subwatersheds that traverse the property are located in a hydrogeological environment that is not particularly favourable towards mitigation of infiltration losses. The surficial fine-grained deposits of Halton Till found throughout the study area serves to limit infiltration to the groundwater system (65 mm/year) and as a result, the local stream systems receive a little over two-thirds of their total water from surface runoff (145 mm/year). Almost all of the groundwater base flow into the watercourses occurs over the period of November to May, when the entire shallow system, including upgradient reaches of the channel are saturated and contributing water to the streams. The watercourses are observed in a dry to ponded condition during the summer months as predicted by the water balance, and the comparisons of measured stream flows to estimates from the water balance methodology are reasonable.

The lower reaches of the FM1001 tributaries (generally to the south of Highway 407) are interpreted as receiving minor groundwater contributions from the Queenston Shale bedrock based on water level monitoring carried out at the Subject Property over the past two years. However, the rate of influx of bedrock groundwater is low, and during the summer months, is insufficient to provide enough water to maintain flow in these watercourses, observed in the summer months as dry to pooled condition. Over the lower reaches of the main channel there may be greater opportunity for bedrock-based groundwater to maintain pools in the stream channel as the bedrock is exposed in the channel and the watercourse is shaded somewhat by large trees.

The section of the FM1109 tributary (14W-11/14W-11A) passing through the northeast corner of the Subject Property is interpreted from collected site data to be losing water to the ground, due to the nearby influence of a buried bedrock valley to the east.

The large human-made pond at the central portion of the Subject Property is also losing water to the groundwater system on the basis of measured surface water levels at the pond (148.57 masl) compared to the interpreted bedrock water levels (145 to 147 masl) and to water level measurements obtained at monitor MMM-09-02 (146.34 to 148.40 masl), screened in the surficial till soils approximately 40 m to the east of the pond.

The upper weathered zone of the till, with an estimated bulk horizontal hydraulic conductivity on the order of $3x10^{-6}$ m/sec therefore provides the bulk of the groundwater inputs to the local streams, but on a seasonal basis over about seven months of the year. The enhanced permeability of this upper zone permits infiltrating groundwater to travel somewhat rapidly through the shallow zone towards the watercourses and it is these conditions that provide the most promising potential mitigation opportunities at this site.

However, these opportunities are of limited extent as:

- 90% of the lands proposed for actual development are currently assumed to be covered with impervious surfaces, either asphalt/concrete or building envelope, leaving very little pervious area within the developable parts of the Subject Property;

- Significant site grading is proposed within the developable lands, where the tops of the gentle ridges at the Subject Property will be removed by cut and these material will be placed and compacted in the lower lying lands to raise grades. This will lead to most of the surficial soils within the developable zone consisting of deeper unweathered deposits and reworked and compacted layers of the clayey silt till. These soils will therefore have significantly less transmissive ability to convey large quantities of water at any mitigation devices proposed within the developable lands.

Therefore the most promising opportunity for mitigating against infiltration losses at the Subject Property is along the edge of the existing valley lands where the naturally weathered and fractured surficial till soils will remain undisturbed by construction and will retain their ability to convey water laterally towards the watercourses. It is along these lands that infiltration swales receiving clean roof runoff are proposed, and such infiltration measures are calculated to reduce the on-site infiltration deficits from approximately 70% to about 50%. On a total subwatershed basis, post-development base flow during the period between November and May is predicted to remain within 78 to 92% of the existing base flow contributions, whereas in dry periods, a slight increase in infiltration is provided to the groundwater system from the proposed mitigation measures.

The following recommendations are provided:

- Construct infiltration swales along the edges of the natural environment areas (tributary valleys) and direct clean roof runoff into these swales and allow it to infiltrate into the ground;

- Construction of the swales should only be done in dry weather to avoid remoulding the soil and effectively lining the swale sides and base with an impervious smeared layer. Manual scraping and removal of smeared soils from the sidewalls and base of the swales to expose the natural fracturing should be contemplated;

- Percolation testing at the proposed infiltration swale locations should be carried out during detailed design to confirm the infiltration rates of the surficial soils along the alignment of the proposed swales, and this information be used in refining the sizing of the swales. It is further recommended that a short length of swale be installed during the detailed design stage and tested to confirm its suitability for its intended purpose;

- Grading at the Subject Property should be, if possible, designed to moderate runoff and enhance recharge characteristics subject to the Town's standards for lot grading;

- Grade the rear/side yard-landscaped grounds on lots adjacent to the natural features (tributary valleys) towards these features. This recommendation is also applicable to the Stormwater Management Pond Blocks, where as much of the block area as feasible should be graded towards the valleys rather than back into the ponds;

- Steps to minimize post-development reduction in the infiltrative capacity of the low permeability till soils should be implemented where feasible. These steps are more pertinent to the parts of the Subject Property where minimal site grading is anticipated and they include:

- Scheduling site grading and heavy construction activities during the drier summer months to reduce the potential of lowering the permeability of these materials while they are in a wet state;

- Where possible, designating areas that should see a minimum of construction traffic. In particular heavy construction equipment must be kept away from the crests of the slopes by the valley lands (along the rear lot lines of the abutting lots), where infiltration swales are proposed;

- Scarify and till the upper 0.5 m of soil within the proposed channel realignments to amend these soils with organic matter and/or placement of thicker topsoil cover to provide for water storage. There will be a substantial volume of topsoil at the property after grading and this material can be re-used at the site;

- Construct trench plugs at intervals along sewers and buried service trenches to prevent high permeability conduits from intercepting and redirecting groundwater away from discharge areas across the Subject Property;

- Construction of the watercourse crossings should be scheduled if possible during late summer to take advantage of the typically lower groundwater elevations during this season, and will reduce groundwater seepage into the pit excavations required for the jack and bore technique envisioned. The watercourses at the Subject Property have been observed to be in a generally dry condition during the summer and scheduling this work at this time will minimize potential for localized impacts to aquatic life;

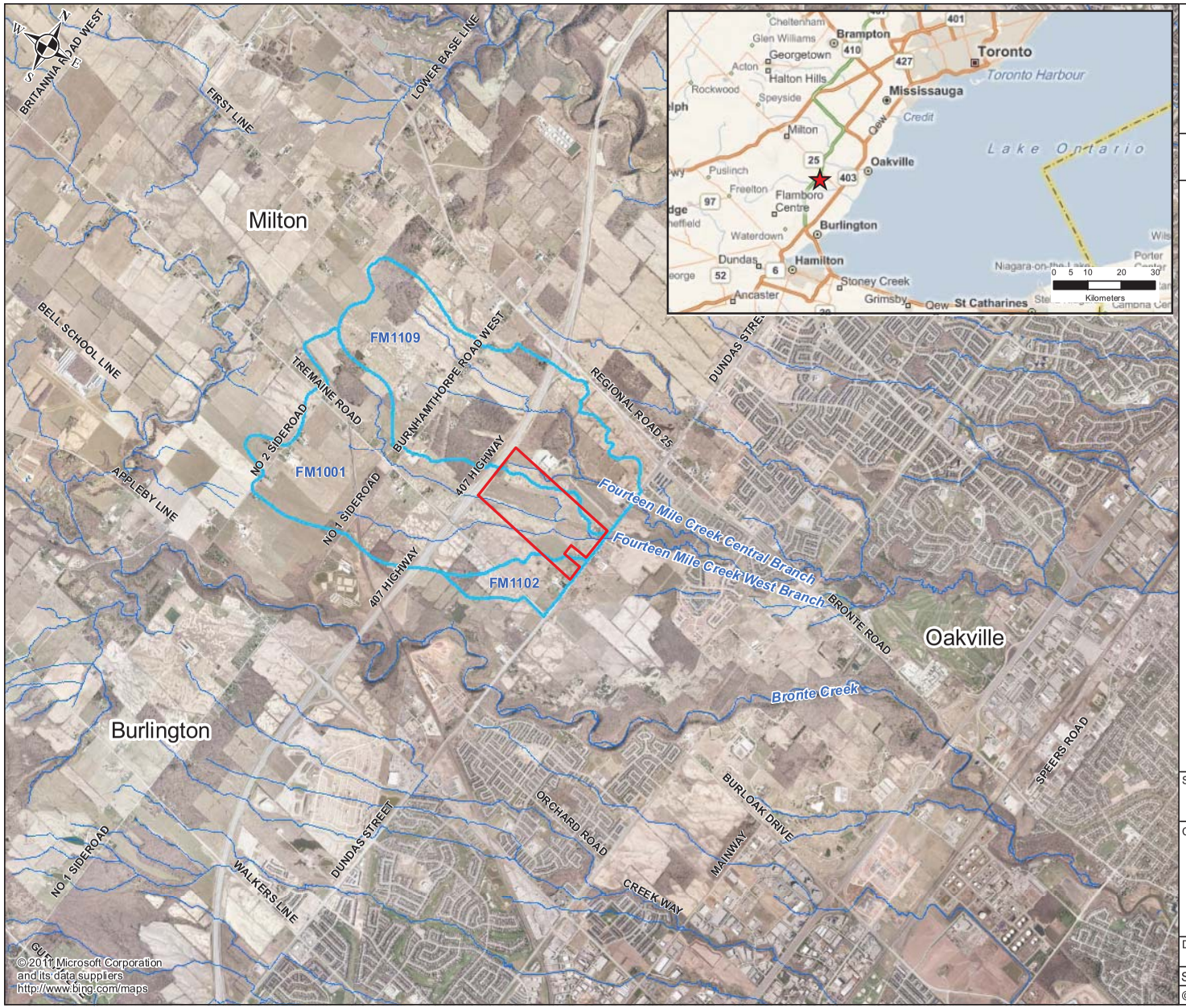
- The service crossing proposed at the realigned channel should be completed at the time of construction of the new channel (before it comes into service) and in such case can be constructed using standard trenching methods;

- Dewatering volumes are not anticipated to exceed 50,000 litres/day. However, dewatering potential is dependent upon a number of factors such as the proposed depth and size of excavations, the time of year and groundwater elevation. It may be later determined that a Permit to Take Water (PTTW) from the Ministry of Environment will be required;

- Off-site monitoring wells alongside the road allowances are recommended for decommissioning. These monitors will need to be decommissioned as per the requirements of O.Reg. 903 (as amended);

- Continued baseline monitoring of water levels at the on-site and remaining off-site wells is recommended. Monitors presently constructed on the Bentall property and other adjacent developer owned lands are recommended to remain in place for future monitoring in support of these developments until such time as they are no longer needed, in which case they will also need to be decommissioned as per the requirements of O.Reg. 903 (as amended). Monitors completed to shallow depth that will be completely removed by site grading will not require decommissioning since following site grading there will be no potential contaminant pathway left in place at such locations; and,

- Groundwater monitors presently constructed within natural environment areas may be retained for long-term, post development monitoring. Additional monitors may be required to replace existing monitors to be removed by development (e.g., MMM-09-6, MMM-09-1).



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Site Location

Legend

- Municipal Boundaries
- Subject Property
- Subcatchment Areas
- Watercourse

Scale: 0 0.5 1 2 3 Kilometers

Client: Bentall Kennedy

Prepared by: MMM GROUP

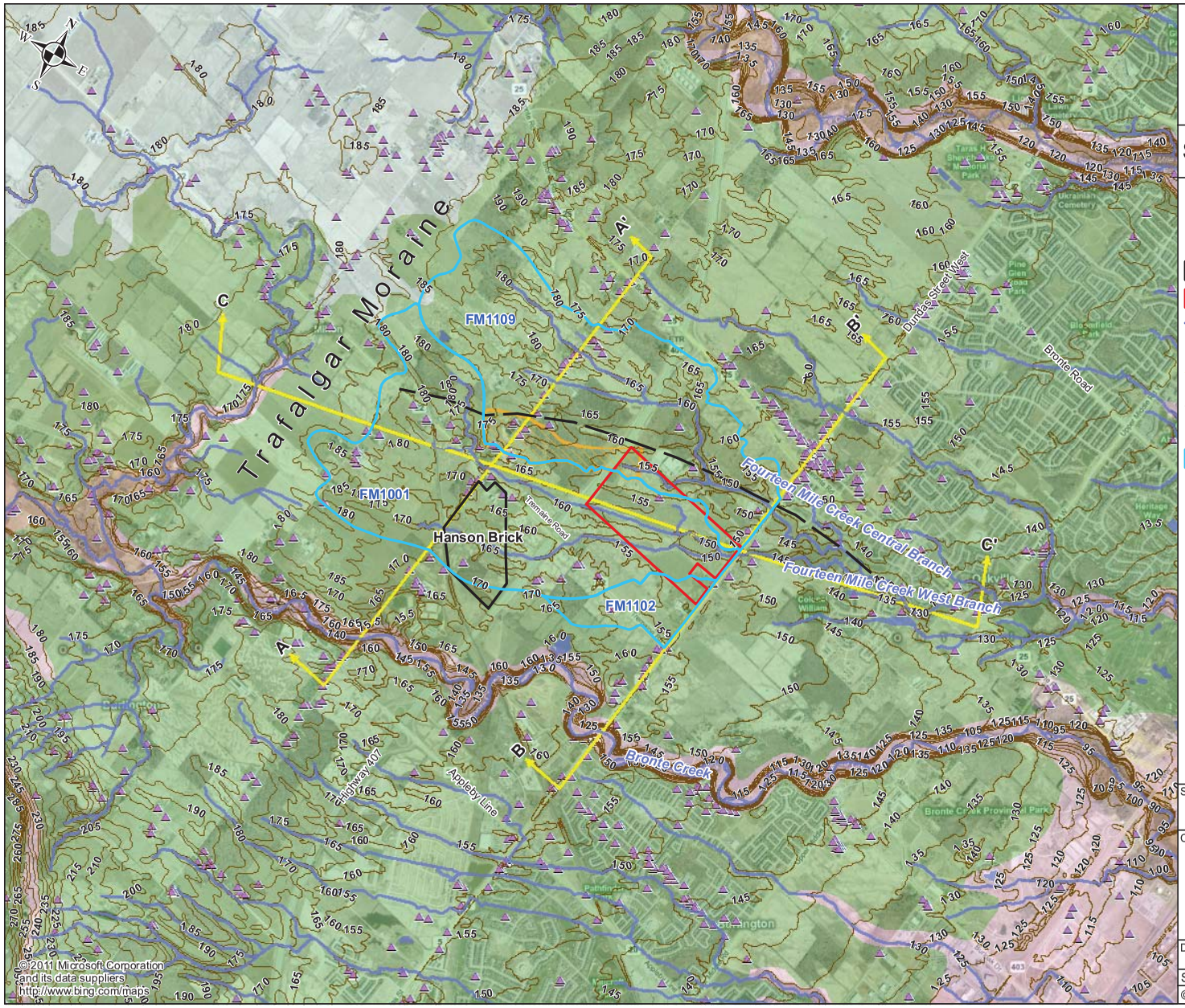
Date: May 6, 2011

Project No.: 14-09222-001-HG1

Scale as Shown

Figure: 4.1

J:\14442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\ Figure 4.1 Site Location.mxd



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Surficial Geology

Legend

- Buried Bedrock Valley (Inferred from Water Well Records)
- Approximate Extent of Hanson Brick Tremaine Quarry Lands
- Subject Property
- Watercourse
- Waterbody
- Cross-Section
- Topographic Contour (5m Interval) (Based on OBM mapping)
- MOE Water Well Locations
- Subcatchment Areas
- (See text in section 4.4.4.1.1 of the report for explanation)

Surficial Geology

- Queenston Formation (Shale Limestone)
- Halton Till
- Peel Pond Glaciolacustrine Silt and Clay Deposits
- Modern Alluvial Deposits

Scale: 0 0.5 1 2 Kilometers

Client: Bentall Kennedy	Prepared by: MMM GROUP
Date: May 6, 2011	Project No.: 14-09222-001-HG1
Scale as Shown	Figure: 4.2

J:\14442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.2 Surficial Geology.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Interpreted Shallow and Bedrock Groundwater Contours

Legend

- Interpreted Shallow Groundwater Contours
- Interpreted Bedrock Static Water Levels
- Buried Bedrock Valley

Monitoring Locations

- MMM Monitoring Well
- TROW Monitoring Well
- Lazy Pat Farm Well
- Approximate Extent of Hanson Brick Tremaine Quarry Lands
- Subject Property
- Waterbody
- Subcatchment Areas
- Watercourse
- MOE Water Well Locations

Locations Not Monitored by MMM

- Hanson Brick Monitoring Well
- Hanson Brick Test Wells

Note: Interpreted bedrock groundwater contours are based on the MOE water well record data along with upper levels from MMM and Hanson Brick monitors.

Scale
0 0.25 0.5 1 1.5
Kilometers

Client	Prepared by
Bentall Kennedy	MMM GROUP
Date: May 6, 2011	Project No.: 14-09222-001-HG1
Scale as Shown	**Figure: 4.3**
© Queen's Printer for Ontario	

J:\1442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.3 Interpreted Shallow and Bedrock Groundwater Contours.mxd

J:\1442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.4 On-site Monitoring Locations.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

On-site Monitoring Locations

Legend

- Subject Property
- Watercourse

Monitoring Locations

- MMM Monitoring Well (2009)
- Mini-Piezometer
- TROW Monitoring Well (2001)
- Lazy Pat Farm Well
- Flow Monitoring Points
- Staff Gauge

Contours

- 5m interval
- 0.5m interval

Note: FMP-3 is located offsite at the southeast corner of Tremaine Road and Number 1 Sideroad

Scale 0 100 200 400 Metres

Client: Bentall Kennedy

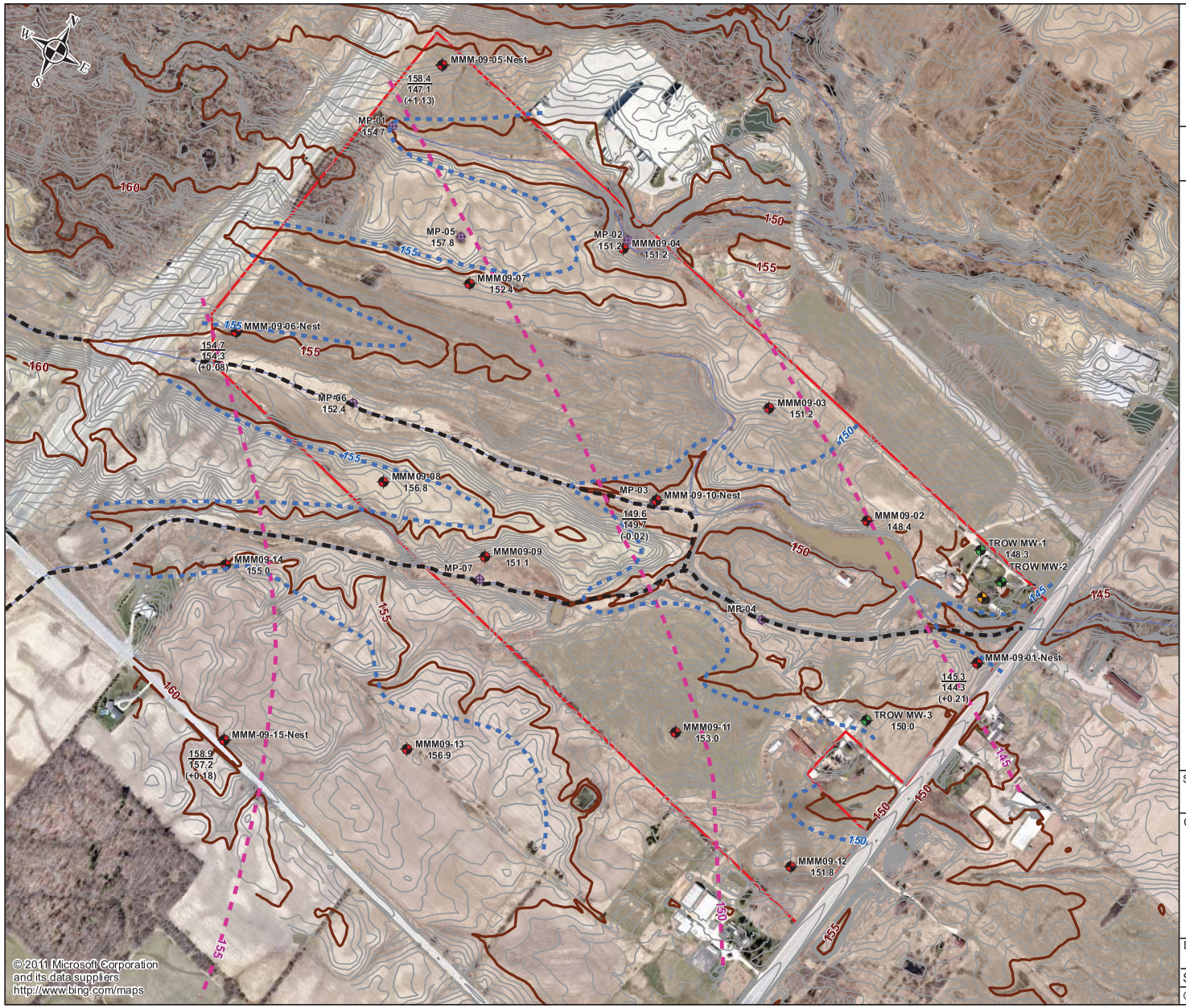
Prepared by: MMM GROUP

Date: May 6, 2011

Project No. 14-09222-001-HG1

Scale as Shown

Figure: 4.4



J:\1442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.5 Static Water Levels - Spring.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Static Water Levels - Spring

Legend

- Interpreted Shallow Groundwater Contours
- Interpreted Bedrock Groundwater Contours
- Interpreted Zone For Potential Bedrock Groundwater Contribution to Watercourses
- Watercourse
- Subject Property

Monitoring Locations

- MMM Monitoring Well
- Mini-Piezometer
- TROW Monitoring Well
- Lazy Pat Farm Well

Contours

- 5m interval
- 0.5m interval

For the nested wells: The upper value represents the shallow monitor and the lower value represents the deep monitor. The value in brackets represents the vertical gradient at the nest. Positive (+) values indicate downward flow, negative (-) values indicate upward flow.

Data for MMM 09-15D is based upon Jan. 2010 levels as April 2010 values were depressed and not fully recovered from groundwater sampling in Feb. 2010.

Scale 0 100 200 400 Metres

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: May 6, 2011

Project No. 14-09222-001-HG1

Scale as Shown

Figure: 4.5

J:\1442 Projects by Job Number\2009\14-09222-001-HG1 Bentall Lands\050 Mapping\MXD\Report\Figure 4.6 Static Water Levels - Summer.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Static Water Levels - Summer

Legend

- Interpreted Shallow Groundwater Contours
- Interpreted Bedrock Groundwater Contours
- Interpreted Zone For Potential Bedrock Groundwater Contribution to Watercourses
- Watercourse
- Subject Property

Monitoring Locations

- MMM Monitoring Well
- Mini-Piezometer
- TROW Monitoring Well
- Lazy Pat Farm Well

Contours

- 5m interval
- 0.5m interval

Notes:

CNL - Could Not Locate

For the nested wells: The upper value represents the shallow monitor and the lower value represents the deep monitor. The value in brackets represents the vertical gradient at the nest. Positive (+) values indicate downward flow, negative (-) values indicate upward flow.

Scale 0 100 200 400 Metres

Client: Bentall Kennedy

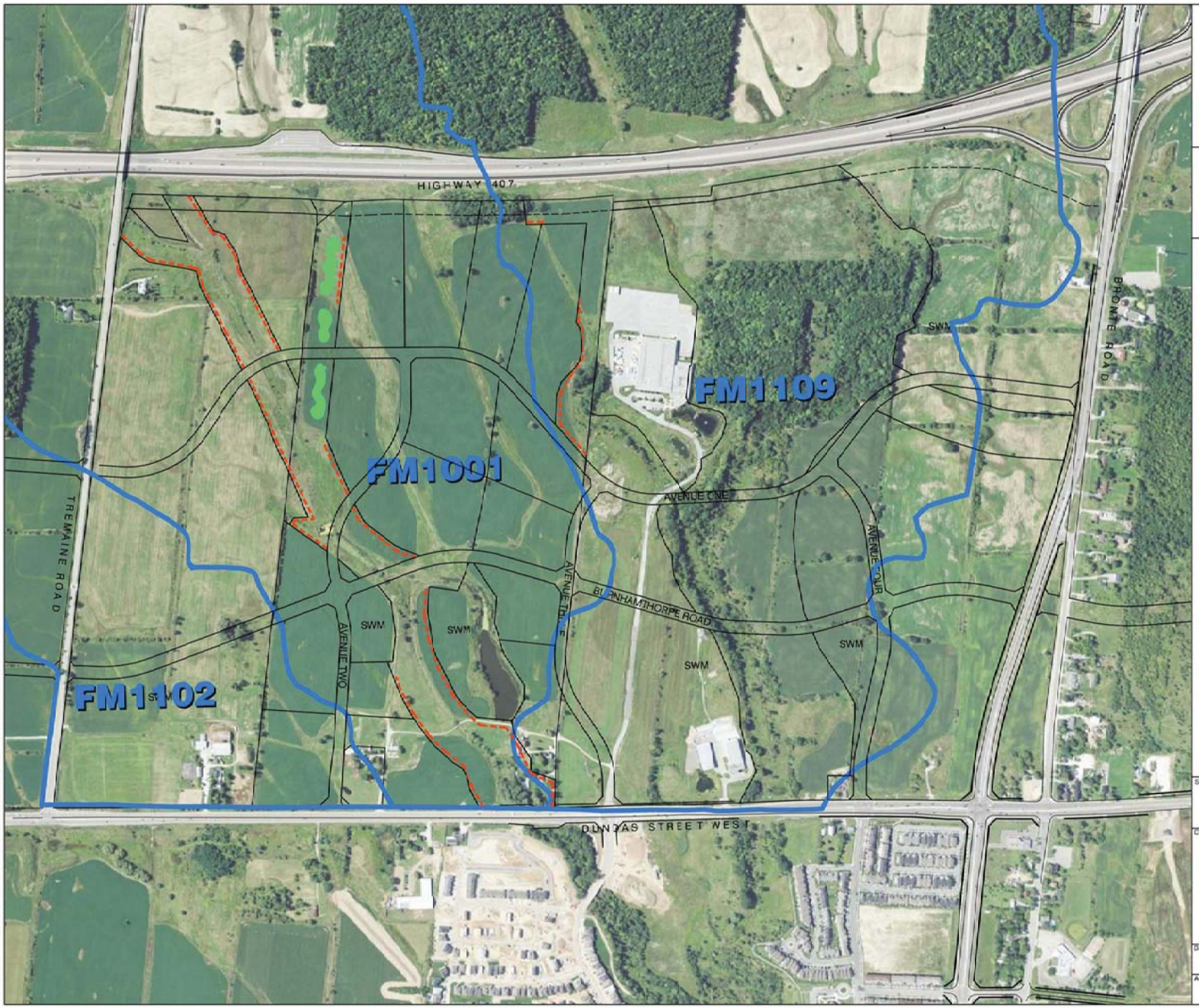
Prepared by: MMM GROUP

Date: May 6, 2011

Project No. 14-09222-001-HG1

Scale as Shown

Figure: 4.6



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm property

Concept Plan and Mitigation Opportunities

LEGEND

- Potential Infiltration Swales (Undisturbed Soils)
- Conceptual Artificial Wetlands
- Sub-catchment Areas

Note: Potential mitigation opportunities are indentified on Bentall lands (FM1001 and FM1109) and land owned by others in FM1001 only.

Scale: 1 : 7500 (0m 50 100 150 200 250 500m)

Client: Bentall Kennedy

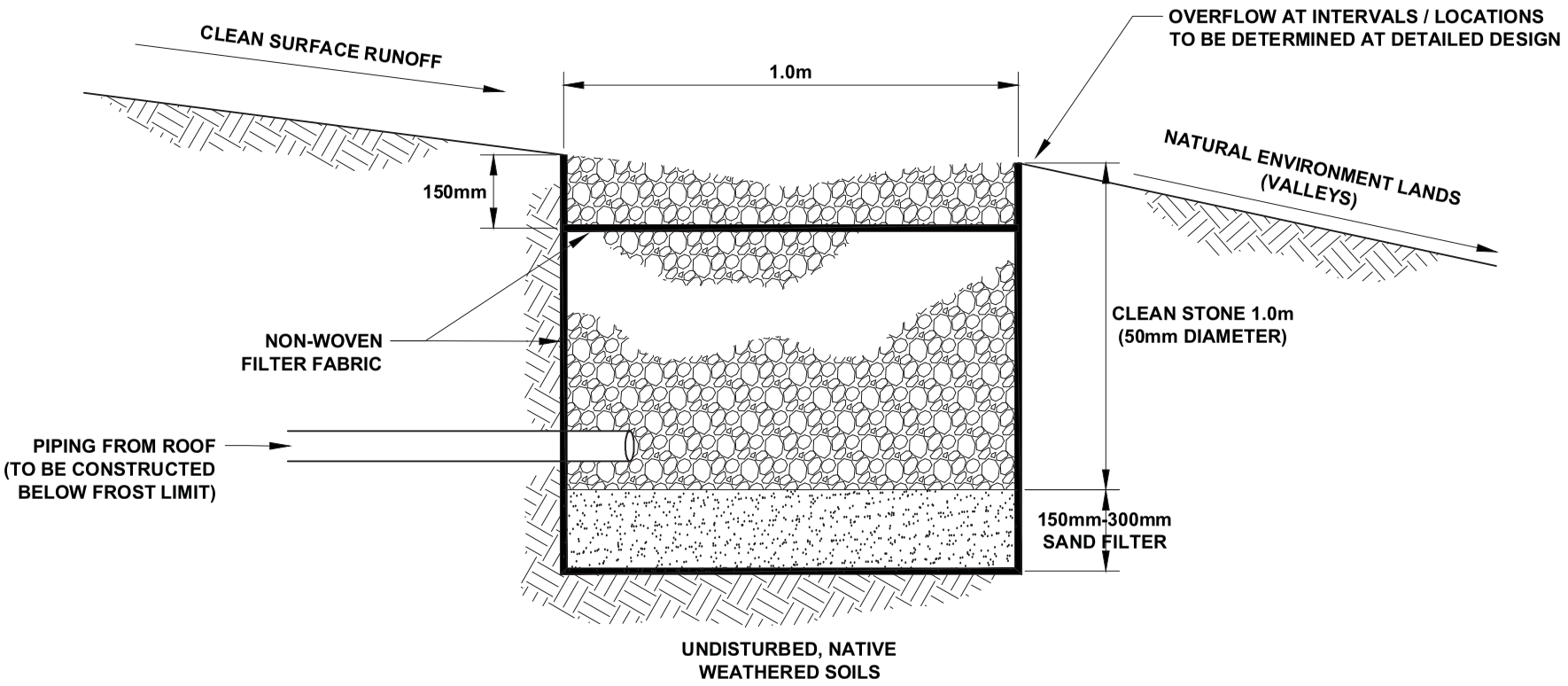
Prepared by: MMM GROUP

Date: May 6, 2011

Project No.: 1409222.001

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 4.7



NOTE:
CONFIRMATION OF LOCATION AND SIZING OF THESE FACILITIES TO BE CARRIED OUT AT DETAILED DESIGN THROUGH ADDITIONAL FIELD INVESTIGATIONS AND PERCOLATION TESTING.

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Infiltration Swale

Scale: N.T.S.

Client: Bentall Kennedy

Prepared by: MMM GROUP

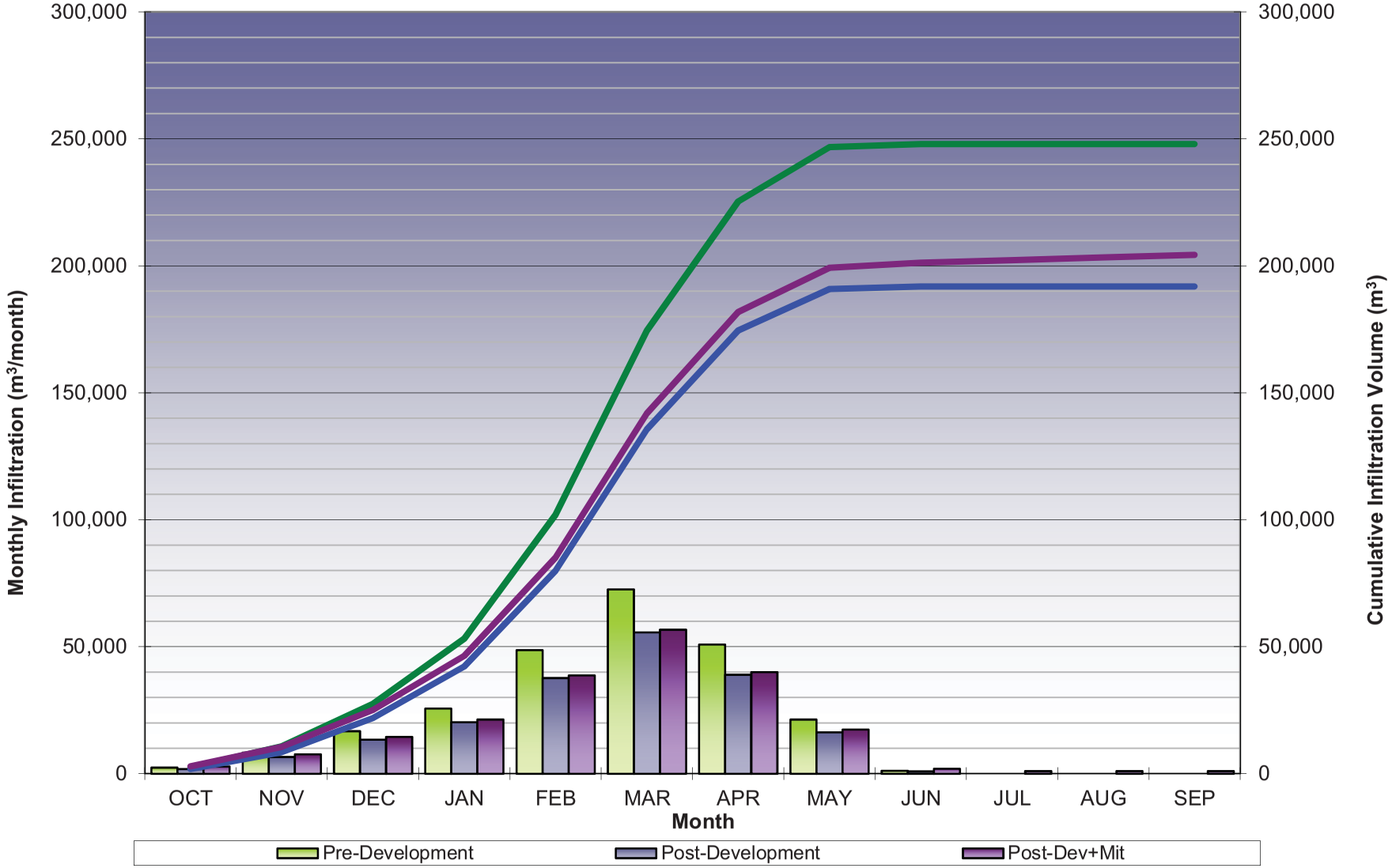
Date: March 2011

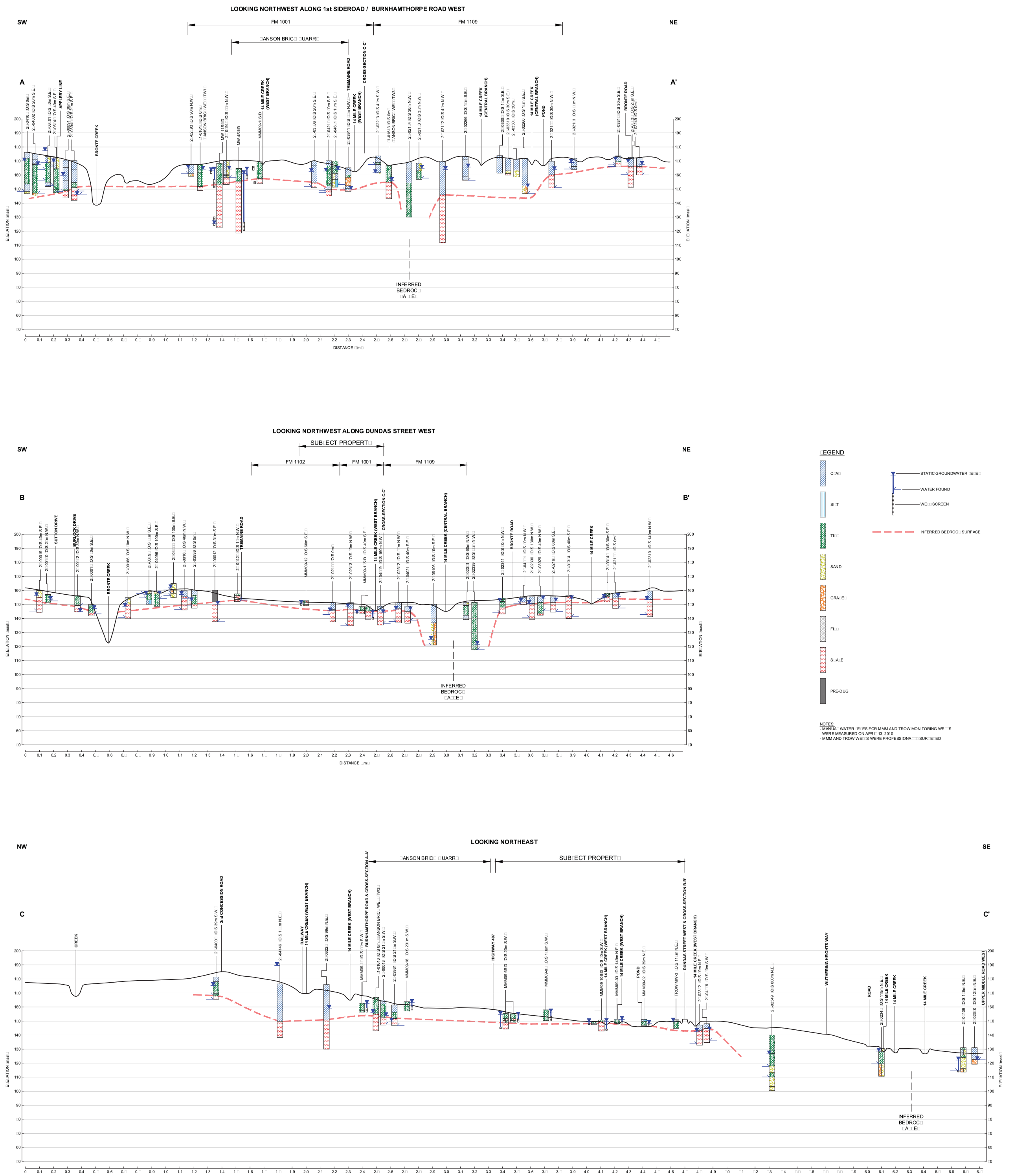
Project No.: 14-09222-001-HG1

Aerial Photo: .

Figure 4.8

Figure 4.9: Monthly and Cumulative Infiltration - FM1001 Subwatershed Pre-Development and Post-Development





Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Hydrogeologic Cross-Sections A-A', B-B' and C-C'

Horizontal 1 : 10000 Vertical 1 : 1000

Bentall Kennedy

MMM GROUP

March 2011

14-09222-001-HG1

Drawing 4.1

5.0 Natural Environment

5.0 Natural Environment

5.1 Introduction

5.1.1 Study and Site Overview

The North Oakville Secondary Planning Areas includes a number of watercourses that drain to the south, outletting to Sixteen Mile Creek or directly to Lake Ontario. These watercourses include Joshua's Creek, Morrison Creek, Munn's Creek, Shannon Creek, Osenego Creek, Fourteen Mile Creek, Taplow Creek, Glenn Oak Creek, and Sixteen Mile Creek. Generally, the existing land use in the North Oakville Secondary Planning Areas are a mixture of agriculture, recreation (golf course and riding stable) and rural residential uses that are dissected by a local and regional road network. The North Oakville Secondary Plans designate the lands for a variety of residential, employment, commercial, institutional, recreational and natural heritage, and open space uses. The Subject Property is located within the North Oakville West Secondary Planning Area and more specifically, the 407 West Employment Area, which is planned to accommodate a variety of employment uses.

Within the catchment areas associated with the Subject Property the land use consists principally of active agriculture. The agricultural areas are intermixed with a variety of natural features of varying sizes and sensitivities. Generally the notable natural features include the Oakville-Milton Wetlands & Uplands Candidate Life Science Area of Natural and Scientific Interest (ANSI), North Oakville – Milton Wetlands – West Provincially Significant Wetland (PSW) Complex, Trafalgar Moraine Candidate Provincially Significant Earth Science ANSI, Halton Region Significant Woodlands as well as features identified in NOCSS including Core #1 and Linkage to Core #2, Stream Corridors associated with Fourteen Mile Creek including watercourses supporting Redside Dace and Hydrological Features. These catchment areas and often the natural features are traversed by a series of roads including Burnhanthorpe Road, Regional Road 25 (Bronte Road), Highway 407, Dundas Street and Tremaine Road.

5.1.2 Study Objectives and Scope of Work

The objective of this study is to satisfy the requirements for an Environmental Implementation Report and Functional Servicing Study (EIR/FSS) for the Bentall Lazy Pat Lands located north of Dundas Street, East of Regional Road 25 (Bronte Road), South of Highway 407 and west of Tremaine Road, in the Town of Oakville hereafter referred to as the "Subject Property" (Figure 1.1).

The North Oakville West Secondary Plan (NOWSP) and the North Oakville Creeks Subwatershed Study (NOCSS, TSH et al 2006) identify the requirement to prepare an EIR to "…characterize and analyze the natural heritage features and functions (of the Subject Property) and to determine and address the potential impacts of the proposed development application, including servicing requirements, on the Natural Heritage System" as defined in the NOCSS. The North Oakville Environmental Implementation Report and Functional Servicing Study Terms of Reference (Town of Oakville, 2007) defines the scope of work required for completion of an EIR.

Table 5.1 summarizes the EIR requirements identified in the terms of reference, and how this report addresses the requirements.

In this report, we also review and assess: natural heritage provisions of the Provincial Policy Statement, *PPS* (2005); Ontario's *Endangered Species Act*, *ESA* (2007); Ontario Regulation 162/06 (Conservation Halton's Development, Interference with Wetlands and Alterations to Shorelines and Watercourse Regulation); and the associated Policies, Procedures and Guidelines for the Administration of Ontario Regulation 162/06 and Land Use Planning Policy Document (Conservation Halton 2006), to demonstrate how the proposed development conforms to the requirements of these policies/legislation.

Table 5.1 - Summary of applicable EIR study requirements identified in the North Oakville EIR and FSS Terms of Reference (Town of Oakville 2007)

NHS Component	EIR Study Requirements according to Terms of Reference	How Requirement is addressed
Cores and Linkages located in off-site portions of EIR subcatchments	Delineate boundaries and Linkage areas based on NOCSS and present the boundaries on recent aerial photographs	Core and Linkage boundaries from NOCSS are presented on 2009 aerial photographs on Figure 5.1 of this report. Core and Linkage boundaries have not been field confirmed or surveyed.
	Assemble background information on natural environment features and functions within the Core(s) and Linkage(s) from the NOCSS and other secondary sources. For Cores, include features, functions and management recommendations.	Designated natural environment features occurring within the overlapping EIR subcatchments are presented on Figure 5.1. A summary of natural environment features, functions and management recommendations for Core #1[1] is presented in Section 5.3.5.5.
	Conduct preliminary field review of features to confirm limits and character of vegetation communities within Cores and Linkages (e.g. roadside review or similar using recent aerial photographs).	Roadside review of Core #1 and the Linkage to Core #2 (located in off-site portion of overlapping subcatchment FM1109) was completed on August 18th and September 11th 2009. A summary of field observations is presented in Section 5.3.5.5.
	Identify any effect of other works (i.e. road crossings, servicing, SWM etc.) and associated requirements related to Cores and Linkages.	Effects and associated requirements of road and servicing crossings of Core #1 and the Linkage to Core #2 are discussed in Table 5.10 to 5.12.
	For Linkages, review stream corridor assessment to ensure that any proposed proponent modifications to stream corridors (locations, widths, etc.) that may influence Linkages are identified.	Proposed watercourse modifications do not affect stream corridors associated with Linkages. See Figure 5.6 for an overview of proposed watercourse modifications.

[1] Core #1 is a component of the proposed Natural Heritage System for North Oakville and is associated with the Fourteen Mile Creek valley. Core #1 is located off-site to the west.

NHS Component	EIR Study Requirements according to Terms of Reference	How Requirement is addressed
Stream Corridors	Identify any relevant fish habitat setbacks, on a reach basis based on the fisheries buffers recommended in the NOCSS Management Report, and as confirmed through the studies.	Fisheries setbacks as recommended by NOCSS have been applied on a reach basis and combined with the stream corridor width delineation to obtain the development limit/open space area.
	With respect to Species at Risk, fish habitat setbacks will be identified on a reach basis with reference to NOCSS, and through discussions with relevant agencies.	The setback associated with the High Constraint reach supporting Redside Dace consists of meander belt plus 30 m, consistent with the requirements of the MNR. Consultation with MNR has been initiated.
Fish and Fish Habitat	Prepare detailed habitat mapping for all streams that contain fish habitat, which potentially may be impacted by the proposed development.	Habitat within the Subject Property was documented during multi-season field investigations and described in Section 5.3.4.4.
	Additional fish sampling may be necessary to fill information gaps.	Additional fish community sampling was undertaken in the upstream reaches of the watercourses to document potential seasonal habitat. This information is presented in Section 5.3.4.1.
	Detail proposed works (e.g., stormwater management facilities, road crossings, grading) adjacent to the fish habitats and assess/predict the impacts of construction and operation of the works, considering channel length and form, riparian buffers, flow volume and duration, water quality and water temperature.	Potential impacts to aquatic habitat associated with the proposed development are detailed in Section 5.9.2 and 5.10.
	Detail mitigation measures and assess potential residual impacts of any works in or adjacent to fish habitats.	Potential mitigation measures and an assessment of residual effects to aquatic habitat associated with the proposed development are detailed in Section 5.9.3 and Table 5.10.
Stream Modification or Rehabilitation	Conduct a detailed field investigation of the reach requiring modification or an appropriate reference reach (channel relocation) in order to determine existing aquatic habitat features.	Habitat within the Subject Property was documented during multi-season field investigations and described in Section 5.3.4.4. This information was obtained in suitable detail to guide modification/relocation works.

NHS Component	EIR Study Requirements according to Terms of Reference	How Requirement is addressed
	Prepare a fish habitat compensation plan that clearly demonstrates how modified reaches will achieve a net gain in fish habitat and meet the 'no net loss in fish habitat productivity' as required by Section 35(2) of the *Fisheries Act*.	A fish habitat compensation concept is presented in Section 5.9.2. This concept will form the basis for the preparation of the fish habitat compensation plan once commented on by the regulatory agencies.
	Illustrate the extent of any features supporting critical life stages of fish or other aquatic biota and clearly demonstrate how the proposed compensation will replace the form and function of this habitat.	Due to the type of habitat present within the reaches to be modified/relocated, critical habitat was not identified. The compensation concept takes into account limiting habitat within the Subject Property with an objective to enhance the habitat present.
Forested Stands within Stream Corridors	Use a combination of aerial photographs, ground truthing, and ELC mapping to determine the extent of forested cover within potential stream corridor(s).	Two (2) forested stand within a stream corridor are present on the Subject Property. ELC mapping of these communities are presented on Figure 5.2 (Vegetation Units 3A and 5A).
	Identify the characteristics of forested stands and their relationship to the stream corridor (including potential implications, if any, on stream corridor width/location.	A summary of vegetation community characteristics is presented in Table 5.6.
	Identify forested stands within the stream corridor(s) and measures to be used to protect and/or manage them as appropriate.	Feature will be protected with setbacks as discussed in Table 5.11 and presented on Figure 5.5 and in Section 6.0, Figures 6.4a-e & 6.5.
Hydrologic Features 'A' and 'B'	Use a combination of aerial photographs, ground truthing, and ELC mapping to determine the extent of wetland cover for each Hydrologic Feature 'A'.	The Location of Hydrologic Features 'A' on the Subject Property is presented on Figure 5.1. ELC mapping showing the extent of wetland cover is presented on Table 5.6.
	Identify the form and function of each Hydrologic Feature 'A' and document its ecological and hydrologic relationship to the watercourse (e.g., does the feature represent an online pond or wetland).	A summary of form and function of each Hydrologic Feature 'A' wetland community, including its ecological and hydrologic relationship to the watercourse, is presented in Table 5.6.
	Identify how the ecological and hydrological relationships of the Hydrologic Feature 'A' is considered in the proposed stream modification.	The form and function of Hydrologic Features 'A' will be recreated within realigned stream corridors, as described in Table 5.6.

5.1.3 Agency Consultation

Consultation with Conservation Halton (CH) and the Ministry of Natural Resources (MNR) were undertaken during the preparation of the EIR to verify the classification of the natural environment features on-site. Selected agency communications are provided in Appendix 5.8.

Conservation Halton

- August 17, 2010 – CH confirmed the classification of on-site wetlands identified as provincially significant on *Provincially Significant North Oakville – Milton West Wetland Complex* mapping (MNR, 2006). According to Ms. Brenda Axon the MNR indicated that they would amend the North Oakville-Milton West wetland complex to remove the wetlands as part of the complex.

- October 5, 2010 - On-site meeting with CH representatives Ms. Leah Smith and Ms. Samantha Mason to discuss on-site fish and fish habitat resources in an effort to confirm the reach classifications, setback requirements and development constraints.

- November 15, 2010 - North Oakville Agency Review Meeting where MMM Group presented the proposed concept plan including channel realignments, development setbacks, incorporation of the on-site pond into the stormwater management plan and constraint classification of watercourse reaches based on habitat types.

- January 20, 2011 - CH issued comments based on material presented on November 15, 2010. MMM Group responded to the comments on March 1, 2011.

- April 19, 2011 – On-site meeting with CH representatives Ms. Leah Smith and Ms. Samantha Mason as well as representatives from the MNR, Town of Oakville and Halton Region to discuss the proposed concept plans.

Ministry of Natural Resources

- May 5, 2009 - A permit was obtained from the MNR (Aurora District) for a Licence to Collect Fish for Scientific Purposes in order to conduct fish community sampling within the Subject Property (Licence # 1052019).

- January 25, 2011 - Consultation with the MNR to discuss the proposed concept plan on two species; Redside Dace and Bobolink, protected under the *Endangered Species Act* (*ESA*).

- April 19, 2011 – On-site meeting with MNR representative Mr. John Pisapio as well as representatives from the CH, Town of Oakville and Halton Region to discuss the proposed concept plans.

5.1.4 Field Investigations

Field investigations for aquatic, vegetation, wildlife resources was undertaken in 2002, 2009 and 2010. During these years, the surveys and monitoring efforts covered multiple seasons and are summarized in Table 5-1.1 Field Work Chronology in Appendix 5.1.

5.2 Natural Heritage Planning Policy

In this section, we provide an overview of Natural heritage planning policy and relevance to the Subject Property.

5.2.1 North Oakville Creeks Subwatershed Study

The North Oakville Creeks Subwatershed Study is the main natural heritage policy document guiding the development process in North Oakville. The North Oakville Creeks Subwatershed Study (NOCSS, Town of Oakville 2004), adopts a Core Areas approach to planning of the Natural Heritage System in North Oakville. Utilizing the Core Area approach, clusters of habitats (i.e. Cores) were identified within the planning area based on a number of criteria (discussed below), and "Linkages" between Cores were identified. This network of Cores and Linkages, combined with identified High and Medium Constraint Stream Corridors, comprise the proposed Natural Heritage System in North Oakville.

As stated in the NOCSS Management Report for terrestrial features – "Using this approach, the terrestrial features which are outside the boundaries of the Cores and Linkages may be removed" (Page 6-35). While for the stream corridors, NOCSS stated the following management options:

- **High Constraint -** the corridor is left in its present condition with development occurring outside of its boundaries where it is anticipated that development is not likely to affect the watercourse. Alternatively, if the watercourse is anticipated to be affected, the recommendation is that the reach is to be maintained in the present location and undertake enhancement of the geomorphic and aquatic habitat conditions within the affected watercourse.

- **High Constraint Requiring Rehabilitation -** Maintain the watercourse in its current location however; provide enhancement opportunities for effective protection while maintaining function.

- **Medium Constraint -** Similar to High Constraint, with an additional option to undertake stream relocation with enhancement of the existing conditions. Medium Constraint reaches typically have been straightened or modified for agricultural drainage purposes, which suggests they have a reduced sensitivity to relocation; therefore, enhancement efforts would provide benefits to the overall form and function of the system.

- **Low Constraint -** Where the watercourse will not be affected, it is recommended that the corridor be left in its present condition, leaving the channel/swale in the existing condition. If the watercourse will be affected, it is first recommended that designs combine stormwater management/surface drainage systems and if this cannot be accommodated replicate the affected reach through a system of surface water conveyance techniques (i.e. backyard swales).

5.2.1.1 Core(s) and Linkage(s)

Core areas described in the NOCSS were established according to a set of specific criteria, such that when the Cores are linked together, they create the basis for a Natural Heritage System in North Oakville. The criteria are: diversity of habitat, size, contiguous, connectivity, significance, representativeness and overall watershed functionality. The intent was to identify large and sustainable units consisting of a diversity of continuous habitats and adjacent areas that are considered to be integral to the function of the habitat captured by the Core area. Management of Core areas is based on the function of the area with respect to the ecological "theme". These themes include: Forest Interior, Open Country and Habitat Connectivity within Cores. Special Considerations for Redside Dace habitat and Buttonbush swamp influence the management of the Core area where these habitats occur.

Cores are connected to each other via Linkages. Locations of Linkages were generally selected to follow natural features whenever possible and are intended to be of sufficient size and character to ensure the functionality and sustainability of the Natural Heritage System.

No Cores or Linkages are identified on the Subject Property.

Core #1 (Fourteen Mile Creek [Main]) and the Linkage between Core #1 and Core #2 are identified within EIR subcatchment FM1109 which extends on to the north corner of the Subject Property. A summary of background information describing natural environment features and functions within Core #1 and the Linkage to Core #2 from the NOCSS and other secondary sources and coarse level field review is provided in Section 5.3.5.5 and mapped on Figure 5.1.

5.2.1.2 Stream Corridors

Streams require riparian setbacks to protect them from the impacts of urban development and associated human activity. Typically these setbacks widths range from 15 to 30 m to maintain the biological components of many wetlands and streams. There are occasions when the need for larger setbacks increases in some situations. For the Redside Dace streams, the setbacks required by MNR due to its classification as an Endangered Species under the *ESA* consist of 30m on either side of the meander belt width. According to NOCSS Reach 14W-12 requires the meander belt plus 30 m setback with the non-Redside Dace reaches requiring a minimum width of 15m. Redside Dace habitat associated with Reach 14W-12 will be retained in full with the exception of minor encroachments associated with the SWM ponds and a section of the Burnhamthorpe Road Extension that runs parallel to the northern section of Reach 14W-12. The upper reach has been informally identified as 14W-12A and is shown in Figure 5.4.

A detailed assessment of the appropriate stream corridor width is presented in Section 6.3. The stream corridors for Reaches 14W-11A, 14 and 16 setbacks exceed the recommended 15 m fisheries setback. However, due to the classification of Reach 14W-12 as Redside Dace habitat and correspondingly a High Constraint reach, the recommended fisheries setbacks exceed these floodplain and fluvial corridors and form the development limit.

5.2.1.3 Other Features

Woodlots

Woodlots are not specifically identified and afforded management strategies in the NOCSS; however, woodlands larger than 0.5 ha are considered to be an important natural heritage feature and are candidates for assessment as *Significant Woodlands* under the Halton Region *Official Plan* (2006)*, Section 130(1)e*.

There is one woodlot (Vegetation Unit 4, Figure 5.2) that was previously identified as regionally significant based on proximity (< 50 m) to a medium constraint stream (NOCSS, p 6-48). This woodlot was excluded from the Natural Heritage System based on the "Core Area Approach" adopted by NOCSS (see section 1.4.1 for discussion). According to this approach "the terrestrial features which are outside the boundaries of the Cores and Linkages may be removed" (NOCSS p. 6-35). NOCSS provides additional justification for removal of this feature due to its location within the proposed Highway 407 Transitway right-of-way. If Transitway development proceeds, it is likely that the woodlot would fall below the area threshold required to be considered for evaluation as a woodland (i.e. 0.5 ha).

The Regional Official Plan (2006) allows local municipalities to substitute a 'Systems Approach' to identifying and protecting the Greenlands System within a Secondary Plan area and permits use of criteria other than those identified in the Regional Official Plan, provided that certain criteria are met, including that the alternative Greenlands System is introduced in an appropriate Local Official Plan amendment and is approved by the Region. Because the Natural Heritage System approach proposed in the NOCSS and in the NOWSP, which has received OMB approval in part, December, 2009.

The NOWSP (Official Plan Amendment No. 289) was adopted by Council on May 25, 2009, which resulted in an amendment to the existing Town's Official Plan to include the NOWSP. Through the amendment, the Significant Woodland/Greenland B designation in the original Towns Official Plan would be revised as it relates to the North Woodlot (Vegetation Unit 4), based on the inclusion of the Natural Heritage System approach identified in the NOWSP. The woodlot would therefore not be considered a constraint to development of the Subject Property.

5.2.1.4 Forested Stands within Stream Corridors

The NOCSS Terms of Reference states that "preservation of forested stands within stream corridors is generally preferred, and recommendations were provided in the NOCSS for forest preservation within stream corridors". Two forested stands within a stream corridor is present within the study area (Vegetation Units 3A and 5A, Figure 5.2). These features will be retained in full and protected with setbacks.

5.2.1.5 Hydrologic Features 'A' and 'B'

Hydrologic features A and B are pond or wetland features that have hydrologic function. Type 'A' features are associated with the Natural Heritage System and are located inside the corridor of a High or Medium Constraint Stream. Type 'B' features are not associated with the Natural Heritage System. EIR study requirements for Hydrologic Features 'A' within the proposed modified stream corridors are summarized in Table 5.1.

The NOCSS identifies 3 type 'A' features and 2 type 'B' features within the Subject Property (Figure 5.1). The type 'A' features are associated with stream reach 14W-14, 14W-16 and the large pond connected to stream reach 14W-12. The type 'B' features are both located to the west of stream reach 14W-16.[2] In addition to the Hydrologic Features 'A' identified during the NOCSS, we have identified additional wetland features located within high or medium constraint stream corridors through field studies in 2009 and 2010; given their context, these wetlands meet criteria for classification as Hydrologic Features 'A'. Additional wetland features located within high or medium constraint stream corridors are associated with stream reaches 14W-11A and 14W-16.

The development concept proposes the relocation of reach 14W-14, 14W-13, 14W-11A and modification of reach 14W-16, therefore impacts to Hydrologic Features 'A' located within these reaches is anticipated. A description of the form, function and ecological relationship of Hydrologic Features 'A' is presented in Table 5.6. Hydrologic Features 'A' will be recreated within the proposed modified stream corridors, as illustrated on Figure 6.4 a-e & 6.5 and discussed further in Table 5.6. No ecological study requirements for Hydrologic Features 'B' are identified within the EIR ToR, and therefore these features are not considered constraints to development from an ecological perspective under the NOCSS policy framework.

5.2.2 Provincial Policy Statement (MMAH 2005)

The Provincial Policy Statement (PPS) is issued under Section 3 of the *Planning Act*. The current PPS came into effect March 1 2005. According to the natural heritage provisions of the PPS (Section 2.1), development and site alteration shall not be permitted in:

1. Significant habitat of endangered species and threatened species
2. (Provincially) Significant Wetlands (PSW)
3. Significant woodlands
4. Significant valleylands
5. Significant wildlife habitat
6. (Provincially) Significant Areas of Natural and Scientific Interest (ANSI)
7. Adjacent lands to the above-noted natural heritage features

For features 3 through 6, development and site alteration may be permitted if it can be demonstrated that there will be no negative impacts on the natural features or their ecological functions.

Based on field work conducted to date, available background information and subsequent analysis, the following information describes the natural heritage provisions for sensitive species, PSWs and significant woodlots on the Subject Property:

- **Endangered / Threatened Species**: Two Endangered / Threatened species are known to occur on the Subject Property: Redside Dace and Bobolink. Based on consultation with Melinda Thompson-Black of the Aurora District MNR (November 22, 2010), no additional endangered or threatened species are known to occur on the Subject Property.
    - Redside Dace habitat associated with Reach 14W-12 will be retained in full with the exception of minor encroachments associated with the SWM ponds and a section of the Burnhamthorpe Road Extension that runs parallel to the northern section of Reach 14W-12 (12W-12A). The proposed setbacks identified were developed in accordance with the policies of the NOCSS.

[2] Note: these are small topographic depressions that were ploughed in 2009/2010, with no associated wetland vegetation.

- Field Studies in 2005 and 2010 identified Bobolink (Threatened provincially) on the Subject Property. Consultation with MNR to identify potential habitat / planning implications is ongoing and additional breeding bird surveys will be undertaken in spring 2011 to supplement previous work.

- **PSWs**: There are no PSWs on the Subject Property[3]. Portions of the Subject Property are located on 'adjacent lands' to the North Oakville – Milton West PSW as defined within the PPS (i.e. within 120 m of proposed development lands on the Subject Property). Portions of the Oakville-Milton wetland complex are identified within overlapping EIR subcatchments, outside of the Subject Property boundaries, as indicated on Figure 5.1. An overview of this feature is provided in section 5.3.2.

- **Significant Woodlands**: The woodland present on the Subject Property (Vegetation Unit 4, Figure 5.2) was assessed as regionally significant during the NOCSS based on size >0.5 ha and proximity (within 50 m of) a medium constraint watercourse. However, this feature was excluded from the proposed Natural Heritage System (NHS) based on the Core Area NHS planning approach adopted by the NOCSS. The Valley Forest (Unit 5, Figure 5.2) may be considered significant under the PPS due to the uncommon status of this community (S3S4 per NHIC S-ranks). No evaluation of the significance of this feature is presented here because it will be retained in full with setbacks as required under the policies of the NOCSS.

- **Area of Natural Scientific Interest (ANSI):** There are no provincially significant ANSI's on the Subject Property. A portion of the Subject Property is located on 'adjacent lands' to one of the woodlands designated as part of the Oakville – Milton Wetlands & Uplands Candidate Life Science ANSI (i.e. within 120 m of proposed development lands on the Subject Property, (Figure 5.1). No impacts to the candidate ANSI associated with the proposed development are anticipated because the feature is functionally isolated from the Subject Property by Highway 407.

5.2.3 Conservation Halton Regulation 162/06 and Wetland Policy (2006)

Conservation Halton regulates wetlands within the study area under Ontario Regulation 162/06 and the associated policy document "Policies, Procedures and Guidelines for the Administration of Ontario Regulation 162/06 and Land Use Planning Policy Document" (Conservation Halton, 2006). Several wetland areas were identified on the Subject Property through background information review and through the vegetation community mapping undertaken in 2009 and 2010. The location of wetlands on the Subject Property is mapped on Figure 5.2.

5.3 Existing Conditions

5.3.1 Physiography, Drainage and Soils

The Subject Property lies within the South Slope physiographic region, a strip of land between the former Lake Iroquois Shoreline to the south and the Peel Plain to the north (Chapman and Putnam, 1984). The EIR/FSS study area lies just south of the Trafalgar Moraine, which is located north of Highway 407. The

[3] Portions of the North Oakville-Milton West PSW complex were previously identified on the subject lands, but this designation was rescinded within the Subject Property to comply with NOCSS (personal communication with Conservation Halton, August 2010).

region is characterized by low relief drumlinized topography. Detailed descriptions of the physiography, drainage and soils are presented in Section 4.

In general, the surface drainage features include a series of four (4) un-named agricultural swales that function as tributaries to Fourteen Mile Creek. These swales generally flow from northwest to southeast across the Subject Property. Three of the swales merge near the centre of the property and continue southeast to the culvert at Dundas Street West. The fourth swale transects the northeast corner of the property. The swales are generally poorly defined features that convey surface runoff from lands north of Highway 407.

According to The Soils of Halton County (Gillespie et al., 1971), soils on the Subject Property consist primarily of Oneida clay loam. The Oneida clay loam soils are well drained, with gentle to moderate slopes and are slightly stony to stone free. Soils within the network of agricultural swales are classified as Jeddo clay loam and are poorly drained, with gentle slopes and slight stoniness.

5.3.2 Environmental Designations

Environmental designations have been assigned to several features located on the Subject Property or off-site portions of EIR subcatchments that partially overlap the Subject Property, as described below:

- **Oakville-Milton Wetlands & Uplands *Candidate* Life Science Area of Natural and Scientific Interest** (ANSI), (MNR 2006). The candidate ANSI consists of 11 woodlots units comprising approximately 290 ha in total area. This candidate ANSI has been selected for its representation of kettle and headwater wetlands and drier tableland forests in Site District 7E4. Three (3) of the woodlots are located within the off-site portions of overlapping EIR subcatchments north of Highway 407 (Figure 5.1). A portion of the Subject Property would be considered "adjacent lands" as defined in the PPS (i.e. within 120 m of the ANSI).

- **North Oakville – Milton Wetlands – West Provincially Significant Wetland (PSW) Complex** (MNR 2006a). The PSW complex includes 147 individual wetlands with a combined area of 20.29 ha comprised of 70% marsh and 30% swamp. The wetlands occur on and around the western portion of the Trafalgar Moraine, and are primarily situated in headwater areas of tributaries of Sixteen Mile Creek, Fourteen Mile Creek and Taplow Creek and in adjacent internally draining areas. Portions of this PSW complex had previously been identified on the Subject Property; however these portions were removed from the complex to conform with NOCSS watercourse classifications (personal communication with Brenda Axon, Conservation Halton 2010). Although a portion of this PSW complex is present within EIR subcatchments that extend onto the property, none of the mapped PSW's are found on the Subject Property (Figure 5.1). A portion of the Subject Property would be considered "adjacent lands" as defined in the PPS (i.e. within 120 m of the PSW).

- **Trafalgar Moraine *Candidate* Provincially Significant Earth Science ANSI (MNR 2006b).** The Trafalgar Moraine is a broad high ridge of glacial till, approximately 20 km long x 30 m high. It is considered an "excellent example of the last standstill of the Lake Ontario ice lobe…(supported) glacial Lake Peel, and deflect(ed) the path of East Sixteen Mile Creek, creating the most dramatic

landscape of Oakville". This candidate ANSI is located immediately north of the Subject Property, north of Highway 407.

- **Halton Region Significant Woodland/Greenlands B**. The North Woodlot on the Subject Property (Unit 4, Figure 5.2) was determined to be a *Significant Woodland* according to the criteria defined in the Halton Region Official Plan (2006) through analysis completed during the NOCSS. According to policy 130 (1) of the Halton Region Official Plan, *Significant Woodlands* are considered *Greenlands B*, a component of the regional *Greenlands System*. The Regional Official Plan allows local municipalities to adopt a 'Systems Approach' to identifying and protecting the Greenlands System within a Secondary Plan area by using criteria other than those identified in the regional Official Plan, provided that certain criteria are met, including that the alternative Natural Heritage System approach to *Greenlands B* are introduced in an appropriate Local Official Plan amendment and are approved by the Region.

  Through the NOCSS, the north woodlot was identified as significant but was not included in the proposed Natural Heritage System. Because the Natural Heritage System approach identified in the NOCSS and in the NOWSP has not been adopted through a Town of Oakville Official Plan amendment, it is assumed that the Significant Woodland/Greenlands B designation in the Regional Official Plan would apply to the North Woodlot until the Town's Official Plan is amended.

- **NOCSS Core #1 and Linkage to Core #2.** The NOCSS identified Cores and Linkages within the North Oakville planning area. These features, combined with medium and high constraint streams, form the proposed Natural Heritage System in North Oakville. No Cores or Linkages are located on the Subject Property. Core #1 and Linkage to Core #2 are located off-site in EIR subcatchment FM1109, a small portion of which extends onto the northeast edge of the Subject Property.

- **Stream Corridors.** NOCSS identifies stream corridors according to the characteristics and processes that affect the health of a stream system within a watershed, which is detailed in the NOCSS and summarized here. These characteristics and processes include: Environmental, Geomorphologic, Hydrologic and Hydrogeologic. The interaction of the four components, their sensitivities and the ability of the system to respond to development pressures, provided the basis for developing appropriate management strategies. These different levels of management are identified according to the associated constraints to development or alterations permitted within these systems. The following describes the areas of constraints, the management and where these occur within the Subject Property.

  High Constraint Stream Corridor (Red Stream)
  High Constrain Reaches are considered to be a high quality resource and in the case with Reach 14W-12 results from the presence of Redside Dace (*Clinostomus elongatus*) a species classified as Endangered in Ontario and is subject to protection under the *ESA*. There is one High Constraint reach within the limits of the Subject Property; 14W-12 within subcatchment FM1001.

  High Constraint Stream Corridor Requiring Rehabilitation (Red Hatched Stream)
  Reach 14W-11 in the northeast portion of the site, located within subcatchment FM1109, is classified as a High Constraint Reach Requiring Rehabilitation.

Medium Constraint Stream Corridor (Blue Stream)
Streams identified as Medium Constraint are considered to have the potential for rehabilitation as they may or may not have a well-defined morphology but do maintain a geomorphic function. There are four Medium Constraint streams within the Subject Property including Reaches 14W-14, 14W-14A and 14W-16 that discharge into Reach 14W-12 (High Constraint) within subcatchment FM1001. The remaining Medium Constraint reach is located in the northeast corner of the Subject Property identified as Stream 14W-11A within subcatchment FM1109 that flows into Reach 14W-11 a High Constraint stream requiring rehabilitation.

Low Constraint Stream Corridor (Green Stream)
Watercourses identified as green are considered to be ephemeral headwater swales that lack definition and function to convey flow and sediments within a system. Reach 14W-13 is the only Low Constraint reach within the Subject Property. It discharges into Reach 14W-12 (High Constraint).

- **Hydrological Features.** Hydrological features are defined by their association with other Natural Heritage Systems including stream corridors. Type 'A' features are associated with the Natural Heritage System located inside the corridor of a High or Medium Constraint Stream.

  A Hydraulic Feature B is not associated with the Natural Heritage System and may be relocated and consolidated with other wetlands, water features or SWM facilities, provided the hydrologic function of the feature is maintained.

  There are three type 'A' features and two type 'B' features within the Subject Property. The type 'A' features are associated with Reaches 14W-14, Reach 14W-14A and Reach 14W-16. The type 'B' features are located within the Reach 14W-16 corridor as well as in the southwest corner of the property (Figure 5.1).

5.3.3 Species of Conservation Concern

5.3.3.1 Species At Risk

Redside Dace

Redside Dace (*Clinostomus elongatus*) was previously recorded in a lower section of Reach 14W-12 immediately upstream of Dundas Street (Figure 5.3). The following points summarize the status of Redside Dace and habitat potential on the Subject Property:

Status
- Designated "Threatened" by the Committee On the Status of Species At Risk in Ontario (COSSARO) and listed as "Endangered" on the Species at Risk in Ontario (SARO) list (Ontario Regulation 230/08, updated regularly);
- Designated "Endangered" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), No Schedule and No Status under the Federal *Species at Risk Act* (*SARA*);
- Redside Dace has a provincial S-Rank of S2 (Imperiled); and,
- This species receives automatic general habitat protection under the *ESA* 2007;

- No species-specific habitat regulation is in force at this time.

Habitat and Field Observations

- Redside Dace were captured in a refuge pool immediately upstream of Dundas Street culvert inlet in September 2001;
- Suitable habitat existing in the lower section of Reach 14W-12 to support this species; and,
- The project team met with MNR on January 25, 2011 to discuss ESA issues and consultation is ongoing with MNR to determine general and/or species-specific habitat protection for this species on the Subject Property per the ESA 2007.

Eastern Milksnake

Eastern Milksnake (*Lampropeltis triangulum*) was previously recorded in the general vicinity of the Subject Property (MNR personal communication, 2010). The following points summarize the status of Eastern Milksnake and habitat potential on the Subject Property:

Status

- Designated "Special Concern" by COSSARO and listed as "Special Concern" on the Species at Risk in Ontario (SARO) list (Ontario Regulation 230/08, updated regularly);
- Designated "Special Concern" by COSEWIC, and listed as "Special Concern" on Schedule 1 of SARA (SARA Public Registry, updated periodically);
- Eastern Milksnake has a provincial S-Rank of S3 (Vulnerable in Ontario); and,
- Habitat for Eastern Milksnake is not specifically protected by the ESA or SARA.

Habitat and Field Observations

- Eastern Milksnake is a habitat generalist that occupies a wide variety of habitats including field, swamp, open woodlot and culturally influenced habitats. In Ontario, this snake is more common in heavily forested areas (deciduous, evergreen and mixed) than in areas of low forest cover but is also common in rural pastures and hayfields, as well as in and around barns, sheds and houses (COSEWIC 2002);
- Suitable habitat for this species is present on the Subject Property (i.e. within agricultural fields, North Woodlot, Valley Forest, swale network, around barns, etc.);
- No Eastern Milksnake have been observed on the Subject Property to date, although no targeted surveys for this species were conducted; and,
- Suitable habitat for Eastern Milksnake will persist post-development within retained natural environment features including Vegetation Units 3, 4, 5 and retained portions of Vegetation Unit 2. In addition, the realigned watercourse sections will be restored to natural vegetation cover that will provide potential habitat for habitat generalists including Eastern Milksnake.

Snapping Turtle

Snapping Turtle (*Chelydra sepentina*) was previously recorded in the general vicinity of the Subject Property (MNR personal communication, 2010). The following points summarize the status of Snapping Turtle and habitat potential on the Subject Property:

Status

- Designated "Special Concern" by COSSARO and listed as "Special Concern" on the SARO list (Ontario Regulation 230/08, updated regularly);
- Designated "Special Concern" by COSEWIC, No Schedule and No Status under SARA;
- Snapping Turtle has a provincial S-Rank of S3 (Vulnerable in Ontario); and,
- Habitat for Snapping Turtle is not specifically protected by the ESA or SARA.

Habitat and Field Observations

- According to COSEWIC Status Report (2008), the preferred habitat for the Snapping Turtle is characterized by slow-moving water with a soft mud bottom and aquatic vegetation. Established populations are most often located in ponds, sloughs, shallow bays or river edges and slow streams;
- Suitable habitat is found within the large pond feature. Marginal habitat may be present along wetter portions of the swales, but this habitat is somewhat ephemeral; and
- No Snapping Turtles have been observed on the Subject Property to date, although no targeted surveys for this species were completed.

Monarch Butterfly

Monarch Butterfly (*Danaus plexippus*) was previously recorded in the general vicinity of the Subject Property (MNR personal communication, 2010) and was observed on the Subject Property during field surveys in 2009 and 2010. The following points summarize the status of Monarch Butterfly and habitat potential on the Subject Property:

Status

- Designated "Special Concern" by COSSARO and listed as "Special Concern" on the SARO list (Ontario Regulation 230/08, updated regularly);
- Designated "Special Concern" by COSEWIC and listed on Schedule 1 of SARA;
- Monarch has a provincial S-Rank of S4 (Apparently secure in Ontario); and,
- Habitat for Monarch is not specifically protected by the ESA or SARA.
- Based on the draft Significant Wildlife Habitat Ecoregion Criteria Schedules and Addendum to Significant Wildlife Habitat Technical Guide" (OMNR Working Draft, January 2009), no significant habitat for Monarch is present on-site (i.e. no butterfly migratory route/stopover areas - field and forest 10 ha or greater within 5 km of lake Ontario).

Habitat and Field Observations

- The Subject Property contains suitable breeding and feeding habitat for this species within cultural meadow/meadow marsh areas. Habitat suitability is defined by the presence of milkweed species (Asclepias sp., the only plant on which Monarch caterpillars feed) and the presence of nectar producing plants (which provide a food source for adult Monarchs). The cultural meadow and meadow marsh habitats throughout the Subject Property support occasional stands of Common Milkweed (although no notable stands were observed) and abundant nectar producing plants including asters, goldenrods, thistle, etc.; and,
- It is expected that suitable habitat for this species will persist post-development within retained portions of Vegetation Unit 2. In addition, the realigned watercourse sections will be restored to open meadow/meadow marsh vegetation cover and Asclepias sp. and nectar producing plants will

be included in revegetation seed mixes to enhance habitat potential for Monarch (Section 6; Figure 6.4(a-e) and 6.5).

Bobolink

Bobolink (*Dolichonyx oryzivorus*) was recorded on the Subject Property during breeding bird surveys conducted in 2005, and again through incidental observations during the breeding bird season in 2010. Bobolink recently received protection under the *ESA* 2007 due to continued severe population declines, especially within its core range in Eastern Canada. The following points summarize the status of Bobolink and habitat potential on the Subject Property:

Status

- Designated "Threatened" by COSSARO and listed as "Threatened" on the SARO list (Ontario Regulation 230/08, Endangered Species Act, 2007).
- Because this species was listed as Threatened after June 30, 2008, it receives automatic general habitat protection under the ESA 2007;
- No species-specific habitat regulation is in force at this time.
- Designated "Threatened" by COSEWIC, No Schedule and No Status under SARA; and,
- Bobolink has a provincial S-Rank of S4 (Apparently secure in Ontario).

Habitat and Field Observations

- Bobolink originally nested in tall-grass prairie, but has adapted to nest in forage crops (e.g., hayfields) and open grassland habitats following the conversion of the vast majority of prairie ecosystems to agricultural uses;
- Suitable grassland/agricultural habitat is present on the Subject Property within the drainage channel network and cultivated fields (although habitat suitability of cultivated fields varies between years depending on the type of crop under cultivation);
- During breeding bird surveys in 2005, 40 Bobolink were recorded at Station # 7 (BB7, Figure 5.4). In addition, approximately 40 Bobolink were recorded in the riparian meadow between Station #6 and Station #7. Based on habitat suitability and the fairly large number of individuals recorded, breeding is likely;
- In 2010, a total of 16 Bobolink were observed over the course of 2 consecutive days (July 13th and 14th) within the drainage channel network as indicated on Figure 5.4. Breeding evidence in 2010 was based on males singing on territory in suitable nesting habitat;
- Two (2) Bobolink were observed in 2010 north of Station #1 during water quality monitoring surveys; and,
- The project team met with MNR on January 21, 2011 to discuss ESA issues and consultation is ongoing with MNR to determine general and/or species-specific habitat protection for this species on the Subject Property per the ESA 2007. Avifaunal field work is scheduled for spring 2011 to provide additional information regarding Bobolink.

5.3.3.2 Provincially Significant Species

One provincially significant bird species, Black-crowned Night-heron (*Nycticorax nycticorax, S3B – Vulnerable*), was observed on the Subject Property on August 20, 2009. One adult and one juvenile were

flushed from the shallows of the large pond (Vegetation Unit 1, Figure 5.2). This observation occurred outside of the breeding bird season and does not suggest breeding activity on the Subject Property.

5.3.3.3 Regionally Rare/Uncommon Species

A total of 11 vegetation species considered rare or uncommon in Halton Region and/or the Greater Toronto Area and/or Site District 7E-4 (per Varga et al 2000) were observed on the Subject Property: Panicled Aster (*Aster lanceolatus ssp lanceolatus*), Fringed Sedge (*Carex crinita*), Shagbark Hickory (*Carya ovata var ovata*), Turtlehead (*Chelone glabra*), Torrey's Rush (*Juncus torreyi*), Eastern Red Cedar (*Juniperus virginiana*), Rice Cutgrass (*Leersia oryzoides*), Sandbar Willow (*Salix exigua*), Carolina Rose (*Rosa carolina*), Northern Wild-raisin (*Viburnum cassinoides*) and Winterberry (*Ilex verticillata*). The location of regionally rare/uncommon species is noted in Table 5.6 and Table 5.7. All eleven regionally rare/uncommon species observed have provincial S-ranks of S4 or S5 and are considered common in Ontario.

Nine (9) bird species (both breeding and non-breeding) considered uncommon in Halton Region (Dwyer 2006) were observed on the Subject Property: Gadwall (*Anas strepera*), Blue-wing Teal (*Anas discors*), Black-crowned Night-heron, Northern Harrier (*Nycticorax nycticorax*), Wilson's Snipe (*Gallinago delicata*), Willow Flycatcher (*Empidonax traillii*), Horned Lark (*Eremophila alpestris*), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*) and Eastern Towhee (*Pipilo erythrophthalmus*). All of these have provincial S-ranks of S4 or S5, except Black-crowned Night-Heron which has an S-rank of S3B (discussed in Section 5.3.3.2). Observation locations are noted in Table 5.8 in Section 5.3.6.2.

5.3.4 Aquatic Resources

Aquatic community and habitat investigations were undertaken through the spring, summer and fall of 2009 as well as the winter of 2010 by MMM Group aquatic biologists to supplement the existing information within NOCSS (2006) and field investigations undertaken in 2002. Sampling and habitat documentation was undertaken in each reach to assist with the characterization of the habitat present across the Subject Property.

For the purposes of this Report, Reach 14W-12 has been informally divided into two reaches; Reach 14W-12A that originates at the farm pond (Reach 14W-14) and flows westerly to its confluence with Reach 14W-16 and Reach 14W-12 that continues downstream to Dundas Street. This division is proposed to assist with the description of the habitat as these two sections differ considerably from one another in terms of form and function and as a result warrant separate classifications.

These investigations included fish community sampling, benthic macroinvertebrate community sampling, aquatic habitat mapping, and water quality monitoring. Fish community sampling in 2009 was not undertaken in Reach 14W-12 in order to minimize potential adverse effects to Redside Dace.

Fish Community Approach

Fish community sampling in 2009 was primarily undertaken in May. Fish sampling sites were located in association with Ontario Stream Assessment Protocol (OSAP) sites, thereby relying on the site to have suitable conditions (i.e. sufficient water) to carry out OSAP. The timing of fish community sampling was selected based on the previous field investigations carried out in 2002 identifying a number of tributaries as

intermittent/ephemeral flow regimes. Sampling was conducted using a HT-2000 Halltech Battery Backpack Electrofisher. A single pass method was used in the tributaries where water was observed and in the wadeable nearshore areas of the two ponds. All fish were processed (i.e. identification, measurement & tally) on-site and returned promptly to the approximate capture site.

Subsequent field investigations identified additional potential locations of fish habitat that did not meet the OSAP conditions. These areas principally consisted of Highway 407 culvert outlets where refuge pools had been scoured. These areas were spot sampled using the backpack electroshocker where sufficient water was present in July, 2009.

Benthic Macroinvertebrate Community Approach

Benthic macroinvertebrate sampling was conducted at each of the OSAP sites using the compatible Ontario Benthos Biomonitoring Network (OBBN) protocol. Benthos collection was completed using the traveling kick and sweep method covering a 10 m distance over three minutes in both pool and riffle habitats. Benthic macroinvertebrate samples were preserved in the field and taken back to the lab for processing according to OBBN. Samples were rinsed and randomly sorted into sub-samples using the bucket method, and the sub-samples were picked until at least 100 organisms were collected. The picked organisms were tallied and identified according to the OBBN coarse 27 group mix of Phyla, Orders, Classes and Families.

Water Quality Approach

The Ontario Municipal Board (OMB) *Mediation Item: Stormwater Management – Temperature and Dissolved Oxygen Targets* (July 12, 2007) indicates that specific target levels are recommended for water temperature and dissolved oxygen for the purposes of fisheries protection. A conservative target maximum daily water temperature of 20ºC is achieved for fisheries protection and applied in the stormwater management for lands draining to Fourteen Mile Creek. Based on the Provincial Water Quality Objective (MOE, 1994) for coldwater fisheries associated with the target water temperature, a conservative DO target of 6mg/l is to be applied. The OMB decision recommended that a temperature and DO monitoring program be established prior to development to establish a baseline against which target levels can be assessed and modified. This would provide a baseline condition in the intermittent watercourses that may not meet the previously mentioned targets. Conservation Halton (CH) was contacted to determine the best location and procedure to monitor the water quality (specifically DO and temperature) as per the requirements of the mediation (Kim Barrett, Conservation Halton; Pers. Comm. March 30, 2009).

Water quality parameters were recorded at each station on a bi-weekly basis beginning May 12, 2009 and ending October 30, 2009, including water temperature, total dissolved solids (TDS), conductivity, pH and dissolved oxygen (DO). Water temperature, TDS, conductivity and pH were measured using a Hanna Instruments HI98129 multimeter and DO was measured using an Extech Instruments Waterproof Exstik II Dissolved Oxygen Meter. Temperature monitoring was undertaken using temperature sensors that were installed in the tributaries where sufficient water was believed to persist throughout the monitoring period to keep the sensor submerged. For consistency, water quality sampling was conducted at the water temperature monitoring stations on a bi-monthly basis between May 12, 2009 and October 30, 2009. Water quality parameters were recorded around the same time of day whenever possible, following data retrieval/download of the temperature sensor. Additional water quality data was recorded at benthic and fish community sampling locations in 2009.

Aquatic Habitat Approach

Field investigations undertaken in 2009 and 2010 were developed using the EIR/FSS Terms of Reference (Town of Oakville, August 2, 2007). Beyond the limits of the Subject Property, existing conditions were documented at the subcatchment level of detail to characterize stream reaches. These observations were generally made from road crossings beyond the Subject Property including Highway 407 (ETR), Tremaine Road, GE Company laneway, and downstream of Dundas Street (main channel crossing). This information is used to compare the current conditions with previous findings reported in the NOCSS Characterization Report and to provide context for on-site aquatic habitat documented at a greater level of detail. Within the Subject Property, field staff detailed the existing conditions and drainage characteristics including aquatic habitat features. Specific focus was placed on habitat potential and effects related to Redside Dace, which is considered to inhabit Reach 14W-12.

On-site habitat characterization was detailed using Ontario Stream Assessment Protocol (OSAP) mapping, detailed photographs and notes during multiple site visits during the spring, summer and fall of 2009. The OSAP protocol requires that the sampling site should represent at least one riffle-pool sequence, be at least 40 m long, and begining and ending at a crossover point. In channelized or modified streams, such as those occurring within the Subject Property, a site can be selected based on a 40 m length of stream with similar bank heights and relative uniformity of depth profile across the channel. Due to the limited amount of flow within the watercourses, only three potential locations met the above criteria during spring field investigations.

5.3.4.1 Fish Community

The majority of the fish community for Fourteen Mile Creek consists of generalist species, which are tolerant of warmwater temperatures with moderate amounts of organic enrichment. The exception to this is Redside Dace recorded in the lower section of Reach 14W-12 as this species requires cool, clear flowing water with riffle-pool sequences and overhanging bank vegetation (NOCSS Characterization Report, 2006).

Fish community data presented below summarizes previous field investigations undertaken in 2002, information available in NOCSS as well as supplemental field investigations undertaken in 2009 in support of this EIR. Fish community sampling undertaken in 2002 was undertaken during the low flow period (July and September) and used a combination of methods including electrofishing, minnow traps and incidental observations within the main channel and the associated ponds (MMM, 2003). Fish community sampling in 2002 was limited to Reaches 14W-12, 14W-16 and 14W-14A due to the lack of water in the remaining tributaries. The location of each sampling site is identified in Figure 5.6

Recognizing the intermittent/ephemeral nature of the other watercourses on-site, the 2009 field investigations were undertaken in both the spring (May) and summer (July) to document seasonal fish habitat use and the connectivity of the watercourses during this high flow period.

The results of the fish community sampling are summarized in Table 5.2, on the following page.

Reach 14W-11

Fish community within this tributary consists of three species including Brook Stickleback, Fathead Minnow and Creek Chub (Table 5.2). Based on the results of sampling efforts, this tributary provides spawning opportunities for both Brook Stickleback (*Culaea inconstans*) and Fathead Minnow (*Pimephales promelas)*, as young of the year were observed. Due to the minor flow observed later in the season it is anticipated that these specimens originate from downstream fish habitat and use this reach seasonally.

Table 5.2 – Fish Community Data (MESP 2003, MMM, 2003 & MMM, 2009)

Fish Species		Reach Identification						
Fish Species	Scientific Name	14W-11A Site 1	14W-11A Site 2	14W-12 Site 1*	14W-12 Site 2*	14W-14	14W-14A (Large Pond)	14W-16 - Small Pond
Blacknose Dace	*Rhinichthys atratulus*			*66*	17			3
Bluntnose Minnow	*Pimephales notatus*	2	8		17			
Brook Stickleback	*Culaea inconstans*		2	*24*	4	8	2	
Brown Bullhead	*Ictalurus nebulosus*			*2*	5		1	
Creek Chub	*Semotilus atromaculatus*	4	15	*82*	67		*37**	
Fathead Minnow	*Pimephales promelas*	9	9	*14*	12	2		
Largemouth Bass (YoY)	*Micropterus salmoides*						*3**	2
Redside Dace	*Clinostomus elongatus*			*2*				
White Sucker	*Catostomus commersoni*			*6*	2		*7**	

**2002 Fish Community Sampling Results*

Reach 14W-12

The fish community sampling was not undertaken in 2009 due to the classification of this reach as providing Redside Dace habitat (MNR, 2009). Historic fish community sampling in September 2002 resulted in the capture of eight warmwater and coolwater species including Redside Dace. Fish community sampling sites in this reach included a refuge pool located immediately upstream of the Dundas Street culvert inlet as well as a second refuge pool located approximately 200 m upstream of Dundas Street at an existing farm road crossing of the watercourse. Fish were only sampled in these areas as the remainder of the watercourses had insufficient flow/water. Redside Dace were only captured at the downstream refuge pool during sampling. During 2009 field investigations fish continued to be observed schooling in the downstream refuge section.

The continued presence of fish indicates that this reach continues to directly support what is presumed to be a self-sustaining fish population as the Dundas Street culvert likely functions as a barrier to fish movement due to the perched outlet (approximately 0.15 m), a second vertical drop within the culvert (approximately 0.15 m) and the base of the culvert that creates shallow sheet flow over smooth concrete with little cover/velocity breaks.

Reach 14W-12A

Fish community sampling was not undertaken in this tributary as there was insufficient flowing water during spring field investigations and fish were not observed in pooled habitat during subsequent water quality monitoring investigations. Reach14W-12A may provide seasonal fish habitat during periods of flow for fish located within the pond (Reach 14W-14A) and perhaps fish originating from Reach 14W-12 however, due to its channel form and the habitat present it would likely only support generalist species for the relatively short duration of flow.

Reach 14W-13

Fish community sampling was conducted within this reach in July downstream of the Highway 407 culvert outlet. Due to the limited amount of water present, this section was selectively sampled using the backpack electroshocker however, did not result in the capture of any fish. This and historic field observations of a dry channel confirms the NOCSS classification of this system as not functioning as aquatic habitat.

Reach 14W-14

Fish community sampling was also undertaken in this reach during July in response to the observation of pooled water in the vicinity of the Highway 407 culvert outlet. Similar to sampling in Reach 14W-13 this section was selectively sampled using the backpack electroshocker due to the limited amount of water present. Sampling resulted in the capture of Brook Stickleback and Fathead Minnow. Both are considered warmwater species that are tolerant of a variety of habitat conditions with the substrate and emergent vegetation in pool habitat providing suitable habitat. The absence of other species with more specialized habitat requirements (i.e. coarse substrate, thermal regimes, etc.) indicates that this area provides marginal direct fish habitat. These species may have originated from upstream/downstream habitat during the spring freshet and been unable to migrate downstream due to receding water levels later in the season as field investigations through the year indicate that the channel connecting this refuge pool to permanent habitat (Reaches 14W-14A and 14W-12) appeared to remain dry for the summer months.

Reach 14W-14A

Fish community sampling was undertaken in 2002 and 2009 by MMM Group aquatic biologists as well as by the authors of the NOCSS (2006) documents in support of their study. The pond supports a warmwater and coolwater baitfish and warmwater sportfish (Largemouth Bass) community. The presence of Largemouth Bass (*Micropterus salmoides*) indicates that the pond is productive as they are a top level predator species that require a substantive forage base. It is likely that the Largemouth Bass have been stocked as the pond is a constructed feature and similar habitat that would have provided a source population is absent in the area. This pond is intermittently connected to adjacent watercourses by a single inlet and outlet (Reach 14-12A) at the north end of the pond, providing seasonal access for fish.

Reach 14W-16

Fish community sampling undertaken immediately upstream of the confluence with Reach 14W-12 did not result in the capture of fish; however, one dead Brook Stickleback (*Culaea inconstans*) was observed at the abandoned field crossing located at the upstream limit of the site. Spot shocking was also undertaken in areas where a small amount of water was present between the two OSAP sites yet did not have sufficient water to be used as an OSAP site. This spot sampling did not result in the capture of fish. The 2002 sampling program also intended to sample Reach 14W-16 upstream of its confluence with Reach 14W-12 however, flows were also insufficient at that time. Although, fish were not captured in this reach, they were observed during benthic macroinvertebrate sampling in 2009. The species in this reach included Blacknose Dace *(Rhinichthys atratulus)* and Brook Stickleback upstream of the confluence with Reach 14W-12. These species were also previously recorded in 2002 downstream in the Reach 14W-12, (MMM, 2003).

The small pond adjacent to this reach has a low diversity fish community consisting of Blacknose Dace and Largemouth Bass (Table 5.2). Although fish sampling resulted in the capture of 2 Largemouth Bass, more specimens including adult, juvenile and young of year were observed during field investigations. It appears that the Largemouth Bass are present as a result of pond stocking due to poor connectivity to downstream fish communities and similar habitat that would have provided a source population is absent in the area.

Connectivity to adjacent watercourses is limited to periods when high water levels in the pond discharge down a relatively steeply sloped, moderately defined narrow channel into Reach 14W-16. Due to the pond's origin as a constructed feature, the poor connection to downstream fish habitat, the apparent stocking of the pond and the absence of its identification in the NOCSS or other documents this pond is not considered to function as direct fish habitat regulated under the federal *Fisheries Act*.

5.3.4.2 Benthic Macroinvertebrate Community

Benthic macroinvertebrates are small, aquatic organisms that exist in the substrate of a watercourse or water body and are excellent indicators of environmental conditions including habitat diversity and water quality (i.e. organic pollutants). They form a crucial component of the aquatic ecosystem by breaking up leaves and other organic debris, feeding on algae and other plants in the watercourse, and are food for many fish species. An assessment of water quality can be conducted using benthic macroinvertebrate communities that will place the watercourse into one of seven categories; excellent, very good, good, fair, fairly poor, poor and very poor.

Benthic macroinvertebrate community sampling was completed at three sites where sufficient water was present to follow the OBBN protocol. The sites were sampled using a transect kick and sweep method to sample both riffle and pool habitat. In the event that there were no significant habitat differences within the site, three random locations were selected for sampling. This sampling provides a representative sample of the benthos within the watercourse. Benthic macroinvertebrate samples were preserved in the field and taken back to the lab for processing according to the OBBN protocol. Samples were rinsed and randomly sorted into sub-samples using the bucket method, and the sub-samples were picked until at least 100 organisms were collected. The picked organisms were tallied and identified according to the OBBN coarse 27 group mix of Phyla, Orders, Classes and Families. Results of the benthic macroinvertebrate community investigations were analyzed using the following metrics typically employed by agencies to assess water quality, with the results of the analysis presented in Table 5.3.

- **Hilsenhoff biotic Index (HBI):** These picked samples were entered into the OSAP *HabProgs* database program to calculate the Hilsonhoff Biotic Index (HBI) for the watercourse. This value then correlates to one of the seven water quality categories. HBI is calculated using scores based on the benthic macroinvertebrates tolerance to organic and toxic pollutants. A lower score indicates a lower tolerance to organic pollution and a higher score indicates increased tolerance to organic pollution (Clayton, et al, 2004; Mandaville, 2002; Moring, 2001; Ourso, 2001).
    - HBI and the corresponding water quality conditions are described as:
        - 0.00-3.50 Excellent: No apparent organic pollution
        - 3.51-4.50 Very Good: Possible slight organic pollution
        - 4.51-5.50 Good: Some organic pollution
        - 5.51-6.50 Fair: Fairly significant organic pollution
        - 6.51-7.50 Fairly Poor: Significant organic pollution
        - 7.51-8.50 Poor: Very significant organic pollution
        - 8.51-10.00 Very poor: Severe organic pollution

- **Percent Tolerant Taxa:** A greater abundance of taxa tolerant to impacts typically indicates poor water quality conditions.

- **Percent EPT**: Species that belong to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) (EPT) are considered sensitive to pollution and will have higher percentages in healthier streams.

- **Percent Dominant Taxa:** A benthic macroinvertebrate community that is largely dominated by a single species (>20%) indicates poor water quality as a stream that is under environmental stress will have a benthic macroinvertebrate community that is less diverse.

- **Percent Chironomidae:** Benthic macroinvertebrates that belong to the Chironomidae (midge) family are generally considered to have increased tolerance to pollution and will therefore have increased abundance in streams with poor water quality and a high abundance indicates degraded conditions.

- **Simpson's Diversity Index:** A community dominated by one or two species is considered to be less diverse than one in which several different species have a similar abundance. Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so does diversity. The value ranges between 0 and 1, with 1 representing infinite diversity and 0 representing no diversity.

Table 5.3 – 2009 Benthic Macroinvertebrate Community Assessment Results

Metric	14W-11A	14W-16A	14W-16
HBI	6.70 – Fairly Poor	7.36 – Fairly Poor	7.86 – Poor
% Tolerant Taxa	88.5%	97.1%	98.8%
% EPT	1.9%	0.0%	0.0%
% Dominant Taxa	51.0%	42.6%	92.0%
% Chironomidae	51.0%	37.3%	2.8%
Simpson's Diversity Index	0.70	0.67	0.15

Results of the benthic macroinvertebrate community analysis indicate Fairly Poor to Poor water quality throughout the study reach according to the HBI. All of the sites had high proportions of taxa tolerant to human impacts (i.e. Chironomidae, Isopoda), and relatively no representatives of sensitive taxa Ephemeroptera, Plecoptera or Trichoptera (EPT). The Simpson's Diversity Index ranged from 0.15 to 0.70 throughout the study sites, as a good proportion of each community was composed by one or two taxa. The benthic macroinvertebrate community suggests aquatic habitat influence by the adjacent land use including impacts to habitat (i.e. homogeneous altered habitat) and water quality.

5.3.4.3 Water Quality Parameters

Water Quality parameters within the Fourteen Mile Creek tributaries were documented during fish community and benthic macroinvertebrate community sampling as a component of the protocols used (OSAP, OBBN). Additional monitoring was also undertaken to comply with the conditions set forth by the Mediation for the North Oakville Subwatershed Study (NOCSS, 2004) to establish baseline targets for future monitoring of water temperature and dissolved oxygen. Water quality parameters sampled included hourly temperature monitoring using water temperature loggers that were left in place from May to October 2009 and bi-weekly monitoring of temperature, dissolved oxygen, conductivity, total dissolved solids and pH using hand held units. The data obtained was analyzed to determine thermal regime, thermal stability and average levels of dissolved oxygen.

Water Temperature

Water temperature monitoring was undertaken from late spring (May 2009), through to early fall (October 2009) in order to identify baseline levels for future monitoring requirements. The data recorded was used to determine the existing thermal regime and stability within the watercourses. Temperature data was obtained through the use of temperature sensors set to record water temperature every hour. These temperature sensors were downloaded every two weeks to ensure that the site maintained sufficient water to completely submerge the sensor and to allow staff to record water quality data at the same location. The temperature logger placed in the section of Reach 14W-12A located to the north of the pond (Reach 14W-14A) was removed on June 10, 2009 due to a lack of water in the channel. The logger was not reinstalled as water levels did not reach sufficient levels within the channel to submerge the device. As such, water temperature was only recorded when water was present during bi-monthly site visits.

A summary of the water temperature data recorded in the tributaries are present in Table 5.4, with monthly temperature data and graphing presented in greater detail in Appendix 5.6. The temperature data was assessed using the protocol set forth in the *Ontario Stream Assessment Protocol* (OSAP) (Stanfield, 2005)

and *A Thermal Habitat Classification for Lower Michigan Rivers* (Wehrly et al, 1999). The average weekly maximum and minimum water temperature was calculated for each of the first three weeks in July. This data was then used to calculate the average weekly temperature fluctuation for the watercourse. The watercourses were placed into one of three thermal regimes described by the MNR; coldwater (average maximum summer water temperature from 10°C to 18°C), coolwater (18°C to 25°C) or warmwater (25°C or warmer). Based upon water temperature fluctuations described in Wehrly et al (1999), the watercourses were then placed into one of three thermal categories; stable (<5°C), moderately stable (5°C to 10°C) and extreme (> 10°C) (MNR, 2004; Stanfield, 2005; Wehrly et al, 1999).

Table 5.4 – Summary of Water Temperature Data July

Tributary	July Weekly Max	July Weekly Min	July Weekly Average Fluctuation	Thermal Category	Thermal Stability
14W-11[4]	25.1	11.6	13.5	Warmwater	Extreme
14W-12A Pond outlet[5]	*23.7*	*8.3*	*15.3*	*Coolwater*	*Extreme*
14W-12 Downstream limit	27.2	12.5	14.7	Warmwater	Extreme
14W-16	24.3	14.8	9.5	Coolwater	Moderately Stable

Analysis of the temperature fluctuations for the sampling period between May 12, 2009 and October 30, 2009 suggests that the water temperature within the tributaries fluctuates greatly in response to elevated air temperatures and rain events (*Appendix 5.6*). In most cases water is not retained within the tributaries throughout the summer. These factors suggest that the watercourse receive insufficient groundwater inputs to maintain base flow let alone a stable coolwater/coldwater thermal regime.

Dissolved Oxygen

Dissolved Oxygen (DO) levels in each of the watercourses were recorded bi-monthly at the termperature logger location when water was present in the channel as shown in Figure 5.3. Below are the summarized results (Table 5.5)

[4] The logger was imbedded in saturated fine substrate material on July 8, 2009.

[5] This location dried out between May 28 and June 11, 2009. The temperature logger was removed on June 11, 2009. Thermal category and stability was conducted for the month of May, as such the thermal category and stability cannot be analyzed according to the Wehrly et. al., 1999 method.

Table 5.5 - Dissolved Oxygen Monitoring Summary (mg/L)

Date 2009	Reach			
	14W-11A	14W-16	14W-12A	14W-12
May 12	10.31	14.0	-	-
May 28	7.28	8.62	3.38	7.57
June 11	4.58	10.82	-	5.67
June 26	5.3	8.58	-	5.2
July 8	-	6.35	-	5.4
July 30	7.65	7.89	-	7.77
August 28	5.98	7.95	-	7.28
September 10	-	7.5	-	4.88
September 30	8.4	8.89	-	7.25
October 19	6.14	9.95	-	8.93
October 30	7.11	9.35	6.7	8.43
Average	6.97	9.08	5.04	6.84
Max	10.31	14.00	6.70	8.93
Min	4.58	6.35	3.38	4.88

The OMB set specific targets for DO based on current in-stream conditions, keeping in mind that current conditions may exceed the target levels. For Fourteen Mile Creek, the conservative DO target is 6 mg/l, which is the Provincial Water Quality Objective for coldwater fisheries associated with a water temperature of 20ºC.

Based on the average recorded DO levels in four tributaries within the Subject Property, three out of four watercourses exceed the DO target under current conditions. Flow conditions in Reach 14W-12A was limited the number of sampling opportunities; therefore, average DO levels may not be representative of conditions when flow is present in this tributary.

5.3.4.4 Aquatic Habitat

The tributaries to this branch of Fourteen Mile Creek originate north of Highway 407 in areas dominated by agricultural fields and large forest blocks. According to NOCSS (2006) as these headwater systems flow through the Subject Property they flow through agricultural fields (Reaches 14W-13, 14, 16) and consists of primarily terrestrial vegetation and isolated pools with the majority demonstrating signs of straightening and agricultural influences. The channel substrate consists of silt and muck without a defined channel, little meander and little to no buffer (i.e., 1 metre or less grassed riparian buffer). The only reach within this branch of Fourteen Mile Creek West to have extended sections with a defined channel are Reach 14W-12 and Reach 14W-16. In the lower section of Reach 14W-12 near Dundas Street, the aquatic habitat substantially improves with the presence of riffle, pool, boulder, undercut banks and woody debris providing shelter and food for a diverse fish community. Redside Dace were sampled at this location (NOCSS Characterization Report, 2006).

Two constructed ponds are also located within the Subject Property, identified as Reach 14W-14A and an offline pond associated with 14W-16. Based on historic aerial photography and information presented in

NOCSS (2006), both ponds appear to have been constructed between 1954 and 1960 and have some form of seasonal connection/contribution to adjacent tributaries (Section 6).

The flow regime of the watercourses within the Subject Property is principally intermittent with habitat restricted to areas of pool refuge habitat during summer months. The flow contributions to these watercourses consist principally of surface water contributions associated with precipitation events and the spring freshet. Generally the surficial till found throughout the study area serves to limit infiltration to both the shallow and deep groundwater systems with the local stream systems receiving a little over two-thirds of their total water from surface runoff.

Groundwater contributions also support flow in these watercourses to a lesser extent however, due to the poor permeability of the soil this contribution is limited. The majority of the groundwater inputs to the local watercourses considered to flow laterally through the upper, weathered zone of the till resulting in almost 100% of this contribution primarily from November to May. This enhanced permeability of this weathered till layer permits the shallow groundwater to travel somewhat quickly through the weathered zone towards the watercourses. Because of this enhanced conductivity, approximately 90% of the infiltrating groundwater moves horizontally through the shallow system, and provides a source of flow to the local streams during the late fall to late spring. During the growing season this shallow groundwater infiltration ceases (there is a water deficit and plants are active and using up water) and the shallow system drains and the watercourses become dry (Section 4).

Towards the southern portion of watershed FM1001, the watercourse valleys approach the underlying Queenstown Shale bedrock, which is exposed at surface just before it passes under Dundas Street. Minor groundwater inputs from the deeper bedrock groundwater in Reaches 14W-12 and 14W-14 continuing up to a point roughly where this watercourse passes under Highway 407. The extent of the length of these reaches with potential bedrock discharge may have been reduced somewhat by ongoing activities at the recently constructed Hanson Brick quarry which is being excavated into the shale, and thus will lead to a localized lowering of the groundwater within the bedrock around the perimeter of the hole. The seasonal groundwater elevation changes within the bedrock are not as highly variable as in the surficial tills, and thus its contribution of groundwater towards these two watercourse channels is considered to continue throughout the year. However, the volumetric rate of water moving towards these watercourses is low, and during the summer months, is insufficient to provide enough water to maintain flow in these watercourses, particularly in the reaches from about the mid-point of the Subject Property and to the north, where the channels have been observed in a dry state during the summer period. Over the lower reaches of the main channel there may be greater opportunity for groundwater to maintain refuge pools due to these minor contributions and shade provided by the adjacent large trees/culvert. These refuge pools were observed in Reach 14W-12 at the Dundas Street culvert inlet and upstream at a farm road culvert crossing.

Below is a brief description of the aquatic habitat found on the Subject Property that was documented during field investigations (Appendix 5.7). The data obtained for aquatic habitat on the Subject Property during detailed field investigations is supplemented with site reconnaissance data for the aquatic habitat beyond the limits of the Subject Property documented at the “subcatchment level of detail” identified in the EIR ToR. This supplemental data was generally limited to observations from road crossings and a review of available aerial photography due to landowner access. This information is presented below in association with the detailed data to provide context to the aquatic habitat found on-site. For contextual purposes the following description of aquatic habitat presents the information in an upstream to downstream orientation rather than following the numerical nomenclature of the reaches.

Reach 14W-11A

This watercourse associated with this reach appears to originate north of Burnhamthorpe Road as an online pond. Flow discharging from the pond to the south flows under Burnhamthorpe Road and continues as Reach 14W-20A downstream through a large woodlot considered a component of the Candidate Oakville-Milton Wetlands and Uplands ANSI (Figure 5.3). The channel through this reach appears to consist of a combination of wetland habitat (i.e. meadow marsh), an online pond associated with residences fronting onto Burnhamthorpe Road and a defined channel through the forested habitat. Approximately 425 m south of Burnhamthorpe Road Reach 14W-20A transitions into Reach 14W-19 and consists of a channel with greater meandering. Reach 14W-19 continues in this meandering form until it approaches Highway 407. A 35 m section of this reach immediately adjacent to the highway has been realigned parallel to Highway 407 prior to flowing into the highway culvert that is approximately 100 m long. Fish observed downstream of the Highway 407 crossing are unlikely to access habitat upstream due to the lack of permanent flow and barriers to fish movement created by a rock apron at the culvert inlet and a vertical drop of approximately 0.50 m located within the realigned section of the channel.

As the watercourse enters the Subject Property it is considered Reach 14W-11A and is considered a Medium Constraint Corridor that discharges into a High-Constraint Corridor–Requiring Rehabilitation as identified in Figure 5.3. The watercourse enters the property as it discharges from the Highway 407 culvert located in a small remnant stand of trees that were historically linked to the wooded area north of the highway. Immediately downstream of the culvert the channel is poorly defined with isolated areas of standing water and diffuse flow through a densely vegetated straightened channel. The stream morphology is uniform throughout the straightened channel with primarily silt and clay substrates. Pooled water was observed approximately 225 m downstream of the Highway 407 culvert in an area where farm equipment traverse the watercourse creating rutting and resulting in a wide shallow pooled area.

Reach 14W-11

This reach is considered High-Constraint Corridor–Requiring Rehabilitation, eventually discharging into reach 14W-1A, a High Constraint Corridor. Habitat diversity improves slightly within the wooded area due to the localized presence of woody debris, potentially providing cover and altering flow paths to create pools. This reach is a poorly defined feature with saturated soils and surface water in isolated pools during field investigations. Downstream of the wooded area, Reach 14W-11 offers poor habitat diversity, lacking a defined channel or pools, as the tributary flows beyond the property limits.

Reach 14W-13

The headwaters of Reach 14W-13 appear to originate west of Highway 407 within subcatchment FM1004. Flow upstream of Highway 407 appear to principally consist of highway drainage and surface runoff from the westbound Truck Inspection Station and land immediately adjacent that is conveyed under Highway 407 via a culvert approximately 115 m in length onto the Subject Property. Due to the rock material at the culvert inlet, lack of a defined natural channel and the absence of fish habitat downstream of Highway 407 on the Subject Property the headwaters of Reach 14W-13 is considered to provide surface water flow contributions.

According to NOCSS Reach 14W-13 is not considered to provide aquatic habitat (NOCSS, 2006). Field investigations confirm that this reach does not appear to provide direct fish habitat with contributions to downstream fish habitat principally associated with flow contributions. Downstream of the Highway 407 culvert outlet the watercourse flows through a straightened channel with earthen berms that define the banks. Where water was observed during the spring field investigations it was in isolated pockets over saturated soils that were heavily vegetated, as well as areas of pooled water in tire ruts associated with farm equipment crossings. Fine substrate materials, composed of clay, sand and organic material provides limited diversity within the channel. The limited canopy cover consisted of individual trees at two locations along the observed flow path. These observations of the type of habitat present were consistent with those made in 2001.

Reach 14W-14

This watercourse originates north of Highway 407 at Burnhamthorpe Road West as a series of agricultural swales. As it flows south of Burnhamthorpe Road it is identified as Reach 14W-15 and is considered to be a swale conveying flow easterly through active agricultural fields within subcatchment FM 1003b (NOCSS, 2006). The stream is characterized as a poorly defined braided channel that flows through a 7 m wide naturally vegetated riparian corridor, bounded by active crop fields on both sides. The stream enters the truck inspection station ROW at the southwestern end as a series of small braided channels that range in width from 0.15 m to 0.30 m. Within the ROW, water has collected in a pool approximately 0.25 m deep and 0.88 m wide, which receives input from the roadside drainage associated with the truck inspection station and Highway 407. The combined flow is conveyed through three parallel corrugated steel pipe (CSP) culverts approximately 135 m long that cross Highway 407 and discharge flow to stream Reach 14W-14 upstream of the Subject Property. The stream appears to be intermittent as there was no observed flow within the braided channels at the time of field investigations in August 2009. When flow is present, Reach 14W-15 has the potential to provide direct fish habitat to fish documented downstream in stream reach 14W-14 however, this habitat is likely limited to the culvert, the inlet and outlet due to the absence of channel form and structure.

As the channel enters the Subject Property it is identified as Reach 14W-14. The watercourse immediately downstream of the highway culverts consists of an area of open water with silt substrates as observed in May 2009. This pooled habitat likely originated by the scouring of water discharging from the culvert. The most significant feature of this reach is this culvert outlet pool which functions as refuge habitat for fish species where fish were observed during spring sampling and habitat mapping events. Connection with downstream habitat is seasonally limited to the spring freshet and rain events. It is during these periods that sufficient water may permit temporary access for fish to this refuge habitat. Although the presence of collected water at the culvert outlet may provide periodic refuge habitat during periods of low flow, it is anticipated that the shallow pool would go dry during extended periods without precipitation.

The reach through the Subject Property flows between two active agricultural fields. Approximately half of Reach 14W-14 consists of a combination of defined and undefined flow through meadow marsh habitat. The remainder of the channel to its confluence with Reach 14W-13 is a narrow and shallow defined channel through dense meadow marsh and cultural meadow vegetation. During field investigations in early May 2009, the channel consisted of saturated soils with dense vegetation that would create pockets of water. This type of habitat was also observed in 2001. The watercourse is considered to be intermittent as the channel was predominantly dry throughout the 2009 water quality monitoring period and in 2001. There is no canopy cover along the entire watercourse between Highway 407 and the confluence with Reach

14W-13. The only trees are located along the sparse hedgerow at the upper limit of the reach, south of the highway.

Reach 14W-14A

Reach 14W-14A consists of an excavated pond that appears to have been constructed between 1954 and 1960, likely for irrigation purposes. The construction of the pond appears to have resulted in the reconfiguration of the drainage channels on-site to allow for the pond to receive/discharge flow and divert the main channel around the new pond feature. The pond appears to have been originally constructed in a low lying area in Reach 14W-14. Based on water surface elevations and groundwater elevation data, this pond appears to be maintained from surface runoff rather than groundwater contributions. Flow from this low area would continue downstream and join with a tributary associated with Reach 14W-16 prior to flowing as a single channel under Dundas Street.

Following the construction of this pond flow from Reaches 14W-13 and 14W-14 were directed to the pond. Currently flow enters and discharges from the pond at the same location with discharge only occurring when water levels reach a certain elevation. This pond is approximately 9600 m^2 (240 m long x 40 m wide on average) with shoreline habitat of this pond consists of cattails, stumps and woody debris with an area of cobbles/concrete debris along the southern shore along the farm road. The substrate within the pond is primarily composed of fine silts, sand and muck. This pond supports Largemouth Bass, a top level predator species requiring a substantive forage base. Water temperature data recorded on July 8, 2009 was 26°C within the warmwater thermal regime discharging into coolwater habitat supporting Redside Dace, which prefers water temperatures below 25°C.

Reach 14W-16

This watercourse originates north of Burnhamthorpe Road, west of Tremaine Road and receives drainage from a combination of agricultural lands, railway and roadway runoff. This watercourse also receives pumped water from the Hanson Brick Quarry located north of Highway 407. According to Golder Associates (2000) during 2008, approximately 400,000 to 1,800,000 litres of water per week was pumped out and discharged into the watercourse over a period of 8 to 24 hours per week (Golder Associates, 2009). As a result of these contributions, the flow within this watercourse including Reaches 14W-16 and 14W-12 on the Subject Property may be prolonged and at a greater rate than if it relied solely upon the natural seasonal shallow groundwater contributions and precipitation.

This upstream reach located from the northeast quadrant of the Highway 407/Tremaine Road intersection is identified as Reach 14W-17 and generally consists of field drainage within subcatchment FM1002. This reach has been modified by planting of crop through the apparent flow path and likely functions primarily as an agricultural swale. Downstream of Highway 407, flow is conveyed through old field meadow to Reach 14W-16. In the absence of barriers to fish passage upstream of the limits of the Subject Property to Tremaine Road, this stream reach potentially functions as intermittent direct fish habitat.

Approximately 225 m downstream of Highway 407, Reach 14W-17 ends and is identified as Reach 14W-16 prior to entering the Subject Property. Reach 14W-16 at the western limits of the Subject Property flows intermittently through dense vegetation within a moderately defined channel with a substrate consisting predominately of clay, with silt, interspersed with gravel and sand. The width of the active channel is 1.4 m and the average depth of water is 0.18 m as observed during OSAP investigations. Although this section of

the watercourse lacks canopy cover, this reach retains shallow isolated pools that are well shaded by dense overhanging vegetation.

As the channel continues downstream it becomes more defined in the vicinity of the small pond associated with this reach. The substrate consisting of coarser material including gravel, cobble and boulders set in clay and overtopped with silt. The width of the active channel is 0.88 m with an average water depth of 0.20 m as observed during OSAP investigations. The habitat diversity also improves downstream consisting of riffle and pool sequences with deeper pool habitat located at two existing creek crossings. The active channel is well defined and during periods of low flow water is contained within the channel; however, during periods of moderate to high flows (i.e. spring and heavy rains), water overtops the banks and flows through braided channels located adjacent to the main channel and separated by vegetated hummocks. The floodplain is defined in the downstream section by a steeply sloped valley. This section receives overflow from the small agricultural pond that discharges into the upper part of this reach. Algae growth within this reach was observed to initiate in late spring and increase through the summer with dense growth that would cover the entire channel. This growth is may be due to the nutrient contributions associated with active agriculture upstream and on-site. This channel did not have flow during field investigations on June 11 2009 with habitat limited to isolated pools. Flow was only observed in response to precipitation events during subsequent field investigations.

The associated small pond located to the west of this reach is approximately 700 m^2 (35 m long x 20 m wide). As previously indicated, historic aerial photography and information presented in NOCSS (2006) indicates that the pond is a constructed feature excavated between 1954 and 1960. This is supported by the relatively uniform habitat present in the pond consisting of steeply sloped banks and rectangular shape. The main in-water cover habitat feature associated with the pond consists of dense algae growth. During field investigations the Largemouth Bass were observed in areas of open water not occupied by the algae mats. Water temperature data recorded during July 8, 2009 field investigations was 26°C, indicating warmwater habitat.

The pond receives flow inputs from a shallow agricultural swale from the agricultural lands to the west that is ploughed through during the growing season and is not identified on mapping. Flow discharges from the east end of the pond to Reach 14W-16 as an intermittent channel. This channel appears to have been created naturally by the ponds overflow as indicated by its meandering and heterogeneous form as it flows over a relatively steeply sloped channel that in combination with intermittent flows would likely restrict fish passage seasonally. As previously indicated, this pond is not considered to function as direct fish habitat regulated under the federal *Fisheries Act* as it is a constructed feature with a poor connection to downstream fish habitat, consisting largely of stocked fish and the lack of reference to this feature in the NOCSS or other documents.

Reach 14W-12

This reach is classified as a High Constraint Stream, likely due to its direct support of Redside Dace. According to NOCSS (2006) the upstream limit of Reach 14W-12 consists of a poorly defined swale that transitions to a defined channel immediately upstream of Dundas Street with channel disturbances consisting of the Dundas Street crossing, concrete revetments and farm crossings. The surrounding land use consists of agricultural and livestock with livestock noted as having access to the stream. The primary geomorphic processes influencing this reach were aggradation and widening. Fallen and leaning trees,

exposed tree roots, poorly formed bars, siltation in pools and riffles and accretion on point bars were noted at the site.

Field investigations confirm the presence of the swale component of the reach described in NOCSS (2006) with its location along a section of the channel located to the north of reach 14W-14A (pond). As the channel continues downstream and turns to the south joining with Reach 14W-16 a distinct change from a swale to a defined channel is noted. The section of Reach 14W-12 downstream of this connection point is very different in form and function and as a result for the purposes of this report the section of Reach 14W-12 located to the north of Reach 14W-14A (pond) has informally been identified as Reach 14W-12A and described below separately from the remainder of Reach 14A-12.

Reach 14W-12A

Reach 14W-12A is approximately 125 m long and conveys flow from Reaches 14W-13, 14W-14 and 14W-14A. Background data indicates that the drainage network underwent a significant alteration between 1954 and 1960 resulting most notably in the construction of Reach 14W-14A (pond) and the reconfiguration of the existing network to convey flows around the newly constructed pond. This reconfiguration resulted in the construction of Reach 14W-12A a channel that was not previously part of the drainage network to direct flow to Reach 14W-12.

Reach 14W-12A consists of diffuse flow through cattails at the outlet of the pond (Reach 14W-14A) and extends for approximately 75 m followed by a poorly defined channel downstream within a constructed valley feature. During December 2010 site reconnaissance the poorly defined channel section was observed to have flow with a wetted width of 0.60 m and a maximum depth of 0.09 m with a small pooled area (0.23 m deep) located at the confluence of 14W-12 & 14W-12A, this localized increase in depth and habitat appeared to be more of a function of flow from Reach 14W-12 rather than 14W-12A. During field investigations in June 2009, there was insufficient water to maintain flow with available aquatic habitat consisting of shallow areas of standing water. A temperature logger installed in May, 2009 to record water temperature in this Reach was removed on June 11, 2009 due to a lack of water. Although the dense substrate remained damp, there is insufficient surface water and ground water contributions to maintain base flow in this reach. Due to the intermittent/ephemeral flows, marginal habitat present and the artificial nature of this channel (constructed to convey flow from the by-pass pond), it appears to provide negligible direct fish habitat.

Reach 14W-12

The upstream limits of this tributary are morphologically similar to 14W-16 with a defined low-flow channel and sections with braided channels through vegetated hummocks. The habitat is provided by pools connected by short shallow riffle segments. The riffle habitat is characterized by gravel and cobble over clay and a wetted width of approximately 0.80 m and depth ranging from 0.10 m and 0.28 m, when water was observed. The pool substrate consists of clay overtopped by silt with the water depth ranging from 0.23 cm to 0.31 m during low flow conditions. Dense algae growth observed in 14W-16 extends downstream through the upper section of this reach.

A pool approximately 0.60m deep has formed at a field crossing located approximately 200 m upstream of Dundas Street. In 2001 this feature was observed to function as refuge fish habitat during low flow as the channel immediately upstream and downstream were dry and fish were sampled in this pool. Downstream

of the field crossing the stream flows within a single defined channel characterized by riffle and pool sequences. The substrate associated with riffle habitat consists of exposed shale bed, fragmented shale and till with substrate in pool habitat consisting of silt overtop of the same substrate. The in-water cover habitat is similar to upstream sections with an increase in woody material associated with the adjacent willow trees in the riparian zone. This section lacks the algae growth that characterizes the upstream section of Reaches 14W-12 and in 14W-16.

The final 50 m of this reach prior to flowing under Dundas Street has been altered though the lining of the watercourse banks with concrete retaining walls. This in combination with the substrate consisting largely of exposed shale bedrock results in a hardened channel with little morphological diversity. As the channel approaches the culvert a pool has formed at the inlet, perhaps due to the continued scouring of the area as flow is directed into the channel at a right angle. Similar to the refuge pool identified upstream during previous field investigations, this pool as well as the remainder of this hardened reach extending upstream provides refuge habitat in the summer and was the location of Redside Dace capture in 2001. As previously indicated the substrate in this reach consists largely of exposed bedrock however, due to the collapse of the decorative façade of the retaining wall into the creek there are large cobble/boulder size blocks present.

The culvert is concrete lined and appears to consist of a series of extensions that were installed to accommodate road widening as indicated by the zigzag structure and difference in elevations between extensions. During periods of low flow, water is directed to the edges of the culvert as the middle of the culvert is slightly elevated. The culvert does not appear to provide fish passage as its base consists of exposed concrete that results in sheet flow over a smooth surface. Furthermore there were two vertical drops observed within the culvert including an approximate 0.15 m drop within the culvert associated with a culvert extension and the culvert outlet, which is perched approximately 0.15 m based on observations during Spring 2009 field investigations.

5.3.5 Vegetation Resources

5.3.5.1 Vegetation Approach

A three (3) season botanical inventory and assessment of the Subject Property was conducted between 2009 and 2010. In 2009, surveys on the Subject Property were completed on August 20th and 21st and off-site subcatchment surveys (as described below) were completed on August 18th and September 11th. In 2010, surveys on the Subject Property were completed on April 22nd and July 13th and 14th.

The scope of vegetation field work and analysis included the following:

- Classification, mapping and evaluation of vegetation communities within the Subject Property using a modified version of *the Ecological Land Classification* (ELC) *System for Southern Ontario* (Lee et al. 1998). Field datasheets are provided in Appendix 5.5.

- Evaluation of community significance according to Bakowsky (1996) and the NHIC Biodiversity Explorer database (updated regularly).

- Review of location and condition of hedgerows and tree clusters.

- Three season botanical inventory and preparation of a vascular plant list (Appendix 5.3).
    - Plant species status was evaluated using the NHIC website for provincial rarity ranks (i.e. S-Ranks); the Species At Risk in Ontario List (updated regularly) for provincial status designations; and the Canadian Species At Risk list (updated regularly) for national status designations; and Varga et al (2000) for regional status in Halton Region and Hill's Site Region 7E4.
    - Nomenclature generally follows the Ontario Plant List (1998).

- As required by the North Oakville EIR Terms of Reference (Town of Oakville, 2007), coarse level surveys of Cores and Linkages occurring in off-site portions of EIR subcatchments that overlap with the Subject Property were completed. These consisted of drive-by surveys with binoculars, supplemented by aerial photograph review.

- Though no Cores or Linkages are present on the Subject Property, Core #1 and the Linkage to Core #2 are present within off-site portions of Subcatchment FM1109, which extends onto the Subject Property.

Vegetation communities, hedgerows and tree clusters located on the Subject Property are mapped on Figure 5.2 and discussed in detail in section 5.3.5.2, section 5.3.5.3, Table 5.6 and Table 5.7. Vegetation communities associated with Core #1 and the Linkage to Core #2 were previously mapped and classified using ELC during the NOCSS; that mapping is presented in Appendix 5.4. These vegetation communities are described in Section 5.3.5.5.

5.3.5.2 Vegetation Overview

The majority of the Subject Property is under active agricultural production. Additional anthropogenic land uses are located along the north side of Dundas Street West; these include 2 residential properties, associated farm buildings, and a small pasture area Figure 5.2).

Natural and semi-natural vegetation communities are predominantly associated with a network of drainage features that generally flow from northwest to southeast across the Subject Property, but also include a small (1.27 ha) tableland woodlot. Additional vegetation features include isolated hedgerows and tree clusters. North of Dundas Street, the existing land use is predominantly rural residential/agricultural. South of Dundas, agricultural land uses are currently undergoing conversion to primarily urban residential uses.

Key findings of the floral inventory include:

- In total, 120 vascular plant species were identified on the Subject Property during field surveys, not including 3 records identified to the genus level only (Appendix 5.3). Of the 120 species identified, 40 (33%) are not native to Ontario (per NHIC SE ranks).
- No federally or provincially designated species at risk or provincially rare (S1-S3 rank) plant species were recorded.

5.3.5.3 Vegetation Communities

A total of 13 vegetation community types in 5 vegetation units were identified on the Subject Property including cultural meadow, meadow marsh, shallow marsh, shallow aquatic, open aquatic, swamp thicket, deciduous swamp and deciduous forest. Hedgerows and tree-clusters are summarized in section 1.3.5.4 of this report.

One vegetation community (Unit 5a, Dry-Fresh Oak-Hickory Deciduous Forest, FOD2-2) is provincially uncommon (S3S4, Bakowsky 1996/NHIC 2010). This unit is located outside of the development envelope and will be retained in full and protected with setbacks. All other vegetation communities identified on the Subject Property are considered common in Ontario.

Terrestrial and wetland vegetation communities were identified on the Subject Property. They are mapped on Figure 5.2 and described in Table 5.6 on the following page.

Table 5.6 – Terrestrial and Wetland Vegetation Community Summary

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
1: Pond	• Feature identified as 'Hydrologic Feature A' within NOCSS • 34 species observed. • Notable species: Crested Sedge. • Feature is an online pond with a fringe of wetland vegetation	1A: Cattail Mineral Shallow Marsh (MAS2-1)	• Cattail dominated fringe along periphery of large pond feature. • Narrow-leaved Cattail dominates, with Purple Loosestrife, Reed Canary Grass, Broad Leaf Cattail, American Bugleweed, and Climbing Nightshade. • Overall sensitivity and botanical quality are low (low diversity, common and tolerant wetland species). • Surrounds shallow aquatic and open aquatic communities.
		1B: Duckweed Floating-leaved Shallow Aquatic (SAF1-3)	• A 2 m to 3 m wide band of duckweed surrounding the open central portion of large pond feature. • Dominated by Lesser Duckweed. • Community boundary likely variable within and between years due to floating nature of duckweed.
		1C: Open Aquatic (OAO)	• Central portion of large pond feature is an open water community lacking vegetation cover.
2: Old field and riparian wetlands	• Communities 2B, 2C, 2D, 2F and 2G qualify as "Hydrologic Feature 'A'" per NOCSS because they are wetlands associated with watercourses. The area and extent of these features is greater than indicated by the NOCSS Hydrologic Features 'A' mapping (as indicated on Figure 5.1) • 63 species observed. • Notable species include Panicled Aster, Sandbar	2A: Dry-Moist Old Field Meadow (CUM1-1)	• Open old field meadow, dominated by tolerant grasses and forbs (e.g. Smooth Brome, Redtop, Common Teasel, goldenrod and aster species, Queen Anne's Lace) with some scattered clusters of tree and shrub regeneration (predominantly Shagbark Hickory, American Basswood and hawthorn). • Occasional clumps of facultative and obligate wetland species occur within drainage channels. Wetland species observed within Unit 2A include Reed Canary Grass, Woolgrass Bulrush, Torrey's Rush, Purple Loosestrife, Narrow-leaved Cattail, and Soft Rush. • Notable species: Shagbark Hickory, Torrey's Rush • Comprises the majority of the land area within the Vegetation Unit 2 drainage feature network. Forms the matrix within which other unit 2 communities are found. Occupies slopes of shallow

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
	Willow, Torrey's Rush, Rice Cutgrass, Crested Sedge and Shagbark Hickory. Notable species generally associated with wetland subunits with exception of Shagbark Hickory. • Presence of Watercress (Nasturtium officinale) observed occasionally within drainage features may indicate groundwater influence.		valleys within drainage feature network. • Anthropogenic disturbance: adjacent active agricultural use likely results in periodic disturbance (e.g. chemical spraying / vegetation dieback) and wetland boundaries likely shift from year to year depending on extent of ploughing. • Low botanical quality and health (dominated by non-native grasses and disturbance tolerant species, disturbed by adjacent agricultural activities); Low sensitivity.
		2B: Reed-canary Grass Mineral Meadow Marsh (MAM2-2)	• Open meadow marsh community dominated by Reed Canary Grass. Common associates include Purple Loosestrife, Panicled Aster, Carex spp., Redtop and Great-hairy Willow-herb. • Occurs as several relatively large pockets on bottomlands within the drainage channel network. • Some disturbance noted: soil compaction and wheel ruts at farm equipment crossings, presence of non-native species (including invasive species). • Low to moderate botanical quality and health (relatively low species diversity, dominated by tolerant wetland species, but presence of some regionally significant species); moderate sensitivity (due to wetland classification and presence of regionally significant species).
		2C: Willow Mineral Thicket Swamp (SWT2-2)	• Occurs as a small inclusion within the drainage feature network. • Dominated by a dense cover of Sandbar Willow, with cattail and Reed Canary Grass dominating the understory. • Low to moderate quality and health (relatively low species diversity, dominated by tolerant wetland species, with some regionally significant species); moderate sensitivity (due to wetland characteristics and presence of regionally significant species).
		2D: Cattail Mineral	• Cattail dominated pockets within drainage feature network.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
		Shallow Marsh (MAS2-1)	• Narrow-leaved Cattail dominates, typical associates include Purple Loosestrife, Reed Canary Grass, Broad Leaf Cattail, American Bugleweed, and Climbing Nightshade. • Overall sensitivity and botanical quality are low (low diversity, common and tolerant wetland species).
		2F: Broad-leaved Sedge Mineral Meadow Marsh (MAM2-6)	• Open meadow marsh community dominated by sedges, including Carex vulpinodea, Carex cristatella and Carex lupulina. Common associates include Soft Rush, Panicled Aster, Woolgrass Bulrush and Torrey's Rush. • Occurs within the channel in portions of the drainage channel network. • Moderate quality and health (relatively low species diversity, dominated by tolerant wetland species, but presence of some regionally significant species); moderate sensitivity (due to wetland classification and presence of regionally significant species).
		2G: Forb Mineral Meadow Marsh (MAM2-10)	• Open meadow marsh community dominated by wetland asters (Panicled Aster and Purple-stemmed Aster. • Occurs as several relatively large pockets on bottomlands within the drainage channel network. • Low to moderate quality and health (relatively low species diversity, dominated by tolerant wetland species, but presence of regionally significant species); moderate sensitivity (due to wetland classification and presence of regionally significant species).
		3A: Fresh-Moist Willow Lowland Deciduous Forest (FOD7-3)	• A young to mid-aged Crack willow dominated deciduous forest with sparse canopy cover. Moderate understory cover of Riverbank Grape, Thicket Creeper, Gray Dogwood, Buckthorn and Tartarian Honeysuckle. The ground layer is characterized by a mix of disturbance and sun-tolerant species, along with typical

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
			riparian species. • Drainage feature transitions to a cement bottom channel adjacent to Dundas Street, and in stream vegetation is largely absent from this portion of the reach. • Disturbance: non-native, invasive plant species are widespread and locally abundant; road noise from Dundas Street. • Moderate botanical sensitivity (several regionally significant species present) with low to moderate ecological quality and health (due to high percentage of non-native species).
3: Lowland deciduous forest	• 26 species observed. • Notable Species include Torrey's Rush, Rice Cutgrass, Panicled Aster.	3B: Mosaic of Mineral Cultural Meadow (CUM1) and Forb Mineral Meadow Marsh (MAM2-10)	• Small, moderately sloped mosaic of Cultural Meadow and Forb Meadow Marsh adjacent to barn. • Dominant species include Smooth Brome, Purple Loosestrife, Reed Canary Grass and goldenrod. • Low botanical sensitivity with low ecological quality and health.
		4: Dry-Fresh Sugar Maple-Oak Deciduous Forest (FOD5-3) Inclusion: Mineral Thicket Swamp (SWT2)	• Mid-aged closed canopy tableland forest community. Canopy is dominated by Sugar Maple, with associates of Northern Red Oak, White Oak, Shagbark Hickory, American Basswood and American Beech. Sub-canopy is predominantly Eastern Hop-hornbeam with White Ash and American Basswood. Understory is relatively open and dominated by regenerating Sugar Maple, with occasional Choke Cherry and Buckthorn. Some hawthorn and Gray Dogwood present along edges of unit. Ground layer cover is approximately 20% and includes a mix of common woodland species and spring ephemerals. • East portion of unit adjacent to watercourse was previously cleared and is regenerating to forest– Bur Oak, White Ash and American Basswood more prevalent in this area. • Small swamp thicket inclusion present at south edge of Woodlot is dominated by Winterberry, with a dense ground layer of sedge (Carex crinita).

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
			• Evidence of disturbance: presence of non-native, invasive species (though not widespread or abundant)' noise from adjacent Highway 407, and relatively open understory possibly resulting from deer browse. Canopy (tree and branch) dieback noted at west end of unit, possibly as a result of salt spray from adjacent Highway 407 eastbound lanes. • Overall botanical quality is low to moderate. Ecological health and sensitivity is moderate (relatively low levels of disturbance, presence of swamp-thicket inclusion, presence of regionally significant plant species). • The NOCSS identified this as a 'Significant Woodland' per Halton Region criteria due to size greater than 0.5 ha and proximity (<50 m) to a medium constraint stream corridor (TSH et al, 2006).
4: North Woodlot	• 34 species observed. • Notable Species include Fringed Sedge, Shagbark Hickory and Winterberry.	5A: Dry-Fresh Oak-Hickory Deciduous Forest (FOD2-2)	• Provincially uncommon mature oak-hickory valley forest stand dominated by Northern Red Oak and Shagbark Hickory on steep valley slopes. Sub-canopy is dominated by Eastern Hop-hornbeam. Understory cover is moderately dense and includes Choke Cherry and Tartarian Honeysuckle with Gray Dogwood, young American Elm, and hawthorn along the edges. Ground layer is sparse and includes a mix of common woodland species including Kidney-leaved Buttercup, Yellow Trout-lily, and Narrow-leaved Spring Beauty. • Canopy trees average approximately 70-80 cm diameter at breast height. • Non-native, invasive plant species are present and locally abundant but not widespread. • Moderate botanical quality, health and moderate to high sensitivity (due to provincially uncommon status).

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
5: Valley Forest and floodplain marsh	• 31 species observed. • Notable species include Shagbark Hickory, Turtlehead, Torrey's Rush, Panicled Aster and Rice Cutgrass.	5B: Jewelweed Mineral Meadow Marsh (MAM2-9)	• Floodplain meadow marsh community dominated by Spotted Jewel-weed, with Reed Canary Grass, Panicled Aster, Rice Cutgrass, Blue Vervain, sedge and Turtlehead. • Frequent standing snags and deadfall logs in floodplain provide good wildlife habitat infrastructure. • Small vernal pool east of watercourse. • Continues east of property boundary. • Relatively low disturbance. Field ploughed in close proximity floodplain marsh at south end of the valley forest where valley slopes are more moderate. • Moderate botanical quality, health and sensitivity.

5.3.5.4 Hedgerows/Tree Clusters

Hedgerows and tree clusters are also found on the Subject Property. They are mapped on Figure 5.2, and described in Table 5.7 below.

Table 5.7 – Hedgerow/Tree Cluster Summary

Figure 5.2 Reference Code	Dominant Species (in decreasing order of abundance)	General Characteristics
TC1	Bur Oak, Shagbark Hickory, apple, hawthorn	• A series of isolated individual trees within active agricultural fields. • Trees range in size from approximately 40-70 cm dbh; 15 m tall. • Tree health is good overall.
TC2	Bur Oak, Buckthorn, Common Pear	• A small cluster containing several large Bur Oak. • Trees range in size from 60 to 90 cm dbh. • Dense regeneration of Bur Oak saplings, Buckthorn and pear in understory. • Tree health moderate to good.
HR1	Hawthorn, Buckthorn	• Broad (approximately 5 m wide) shrub hedgerow with frequent gaps approximately 200 m long. • Dominated by shrubs averaging approximately 2 to 3 m tall. • Moderate to good individual health, but overall botanical health lower due to presence of non-natives. • Some connectivity with Unit 2 / 5, but no connectivity to other natural areas to the north.
HR2	Shagbark Hickory, Bur Oak	• Short hedgerow (approximately 140 m) comprised of 7 large, well-spaced open grown trees within active agricultural field. • Trees range from 50 – 70 cm dbh, 15 m tall. • Trees generally in good health; one tree in poor condition. • Some connectivity with stream reach 14W-13 to north, but no connectivity to other natural areas to the south.
HR3	Hawthorn, Common Apple	• A shrub hedgerow with frequent large gaps along the west property boundary (total length approximately 470 m). • Hedgerow is 1 tree width, generally. Dominated by shrubs averaging approximately 3-4 m tall. • Moderate to good health. • Provides connectivity between stream reaches 14W-14 and 14W-16.

Figure 5.2 Reference Code	Dominant Species (in decreasing order of abundance)	General Characteristics
HR4	Hawthorn, Shagbark Hickory, Carolina Rose, Northern Wild-raisin, Buckthorn, Black Raspberry, Common Apple	• Continuous single tree width hedgerow along west boundary of property (approximate length 210 m). • Dominated by shrubs averaging approximately 3 m tall. • Good health. • Some connectivity with stream Reach 14W-16 to north, but no connectivity to other natural areas to the south.
HR5	American Basswood, hawthorn, Norway Spruce	• Very short (approximately 125 m) hedgerow along west property boundary. • Trees generally young, averaging approximately 15 cm dbh and up to 10 m tall. • Good health.
HR6	Shagbark Hickory, Bur Oak	• Very short (approximately 90 m) hedgerow along the west boundary of the Subject Property just north of Dundas Street. Trees average approximately 45 cm dbh and 10 to 15 m tall. • Moderate health. • Some connectivity with roadside hedgerow to the south.
HR7	Hawthorn, American Elm	• Very short (approximately 110 m) shrub hedgerow located along the east property boundary. • Composed of young trees and shrubs averaging approximately 10 cm dbh and up to 5 m tall. • Moderate health. • Isolated feature with no connectivity to other natural features.

5.3.5.5 Offsite Vegetation Communities associated with Core #1 and the Linkage to Core #2

Vegetation Overview

Core #1 and the Linkage to Core #2 are located within off-site portions of EIR subcatchment FM1109, which extends onto the north / east corner of the Subject Property. Core #1 is associated with the main branch of 14 Mile Creek between Tremaine Road and Bronte Road. Eleven distinct ELC vegetation communities types were mapped within Core #1 and the Linkage to Core #2 during surveys completed for the NOCSS:

- Dry-Moist Old Field Meadow (CUM1-1);
- Mineral Cultural Thicket (CUT1);
- Dry-Fresh Oak-Hardwood Deciduous Forest (FOD2-4);
- Sugar Maple-Oak Deciduous Forest (FOD5-3);
- Sugar Maple-Hickory Deciduous Forest (FOD5-5);
- Mineral Meadow Marsh (MAM2);
- Reed-canary Grass mineral Meadow Marsh (MAM2-2);
- Narrow-leaved Sedge Mineral Meadow Marsh (MAM2-5);
- Cattail Mineral Shallow Marsh (MAS2-1);

- Rice Cut-grass Mineral Shallow Marsh (MAS2-9); and
- Duckweed Floating-leaved Shallow Aquatic.

ELC community mapping from the NOCSS covering Core #1 and the Linkage to Core #2 is presented in Appendix 5.4 (Figure 6.3.4; Modified from NOCSS). Several of the wetland communities identified within Core #1 and the Linkage to Core #2 are included within the North Oakville-Milton West PSW complex. The location of PSW within Core #1, the Linkage to Core # 2, as well as adjacent lands is presented on Figure 5.1 and a description of the PSW complex is provided in Section 5.3.2. All of the ELC communities identified in Core #1 and the Linkage to Core #2 through the NOCSS are considered common in Ontario (NHIC S-ranks of S4 or S5).

Reconnaissance Level Field Review and Aerial Photograph Interpretation

A reconnaissance level roadside survey completed on August 18th and September 11th, 2009, combined with recent (2009) aerial photograph interpretation of vegetation within Core #1 and the Linkage to Core #2 generally confirmed the character and extent of vegetation communities as reported in the NOCSS with the following exceptions (as noted in Appendix 5.4):

- The NOCSS identifies 2 CUM1-1 areas east of the Fourteen Mile Creek valley and south of the large forested area. These areas were partially planted to Soybean in 2009 and are thus smaller;
- The isolated field located between the north edge of the large forested area and Highway 407 was fallow in 2009 and would be classified as CUM1-1; and,
- The wetlands located within the proposed Linkage to Core #2 appeared to be under cultivation in 2009. The areas remain wet (per 2009 aerial photograph) and would likely revert to wetland plant species cover if left to fallow.

Overall, the character and extent of vegetation associated with Core #1 and the Linkage to Core #2 as identified in the NOCSS remains unchanged; relatively minor changes in vegetation cover within Core #1 and the Linkage to Core #2 are restricted to actively managed agricultural areas and are expected given the crop rotation farming practices employed on these lands.

Core #1 Management Themes and Recommendations

The NOCSS states that Core #1 includes a diversity of habitat types and themes, including;

- **Forest Interior:** associated with woodland in northern portion of core;
- **Linkage:** habitats provide a potential linkage to lands north of Highway 407 and south of Dundas Street;
- **Open Country:** open country habitats are found along the northern and eastern edges of this area; and,
- **Redside Dace:** Population of known Redside Dace in lower portions of the creek in this area.

Management recommendations for Core #1 identified in the NOCSS are:

- The existing woodlands and wetlands are recommended for retention;
- Linkages between the forested component of the Core and lands to the south should be connected with Linkages approximately 200 m in width. Significant gaps in these connections will be created by major roadways and highways in the area. As well, the connections should be wooded; and
- Balance is required between management of the open and wooded habitats. The configuration of the Core would allow for a block of open country habitat in the north of approximately 5.2 ha and a

block approximately 8.8 ha in area in the southeastern portion of the Core. The rest of the Core should be wooded.

5.3.6 Wildlife Resources

Wildlife resources were evaluated through field surveys. Specific survey methods are described and summary results are discussed below.

5.3.6.1 Wildlife Approach

Avifauna

Breeding bird surveys were conducted by qualified, experienced staff according to Ontario Breeding Bird Atlas (OBBA) protocols on June 7th and July 12th, 2005. Seven stations were selected for monitoring based on the habitats present on-site (Figure 5.4). Wind speed varied from none to light, and there was no precipitation. The surveys ran from 6:07 AM to 9:30 AM. Noise from Highway 407 hampered the detection of birds by sound at survey stations #4, #5 and #6. Incidental observations of bird species were also recorded during all natural environment field surveys, including August 20th and 21st, 2009 and April 22nd, July 13th and July 14th 2010. The results section (Section 5.3.6.2) includes a brief habitat description, location information using UTM (NAD 83) coordinates, time of survey, and a list of all bird species detected at each survey station.

Bird species status was evaluated using the NHIC Biodiversity Explorer website for provincial rarity ranks (i.e. S-Ranks); the Species At Risk in Ontario list (MNR website, updated periodically) for provincial status designations; the Canadian Species At Risk list (COSEWIC website, updated periodically) for national status designations; and the Halton Natural Areas Inventory (Dwyer 2006) for regional conservation status. A complete list of bird species observed on the Subject Property is provided in Appendix 5.2, Table 5-2.1.

Anurans

Amphibian use and habitat assessments were completed on the Subject Property using a combination of visual surveys and incidental observations (2005 and 2009) and amphibian `calling` surveys (2010). Calling amphibian surveys were conducted at eight (8) stations on three dates in 2010: April 21, June 7, and June 25.

Amphibian activity was assessed using the *Marsh Monitoring Program* amphibian calling survey protocol (Bird Studies Canada 2003). Calling surveys were conducted by qualified experienced staff under appropriate conditions (i.e. dusk/evening survey with suitable air temperatures). Following this protocol, calling activity was rated as Level 1 (individual calls can be counted – no overlap), Level 2 (some calls can be counted, some overlap) or Level 3 (calls continuous and overlapping, individuals not distinguishable).

Call survey stations are mapped on Figure 5.4. Calling survey results are summarized in Appendix 5.2 Table 5-2.2 and discussed in Section 5.3.6.2.

Other Wildlife

Supplemental wildlife observation of other fauna, including reptiles, mammals and butterflies, were recorded during field visits. All observations made during the field surveys were recorded, including sightings of species, as well as evidence of use (e.g. browse, tracks / trails, scat, burrows, and vocalizations).

5.3.6.2 Wildlife Survey Results

Avifauna

In total, 44 bird species were recorded during 2005 breeding bird surveys and through incidental observations made in 2005, 2009 and 2010 while conducting additional field surveys (Appendix 5.2, Table 5-2.1). Species observed are predominantly common, generalist and urban-adapted species, with some forest-associated species and wetland-associated species also recorded. The avifauna observed and exhibiting breeding evidence in the study area are expected for the disturbed site conditions. Of the total of 44 bird species observed:

- Most (40 species) showed some evidence of breeding (possible, probable or confirmed); a number showed no evidence of breeding and are considered unlikely breeders on the property (Ring-billed Gull, Herring Gull, Great Blue Heron, Black-crowned Night Heron).
- One (1) federally (COSEWIC) and provincially (COSSARO) designated Threatened species was recorded: Bobolink.
- No provincially rare species (i.e. S1 to S3 ranked by NHIC) were recorded.
- Two (2) species are considered *Area Sensitive* (species requiring large areas of suitable habitat in order to sustain population numbers) by MNR (2000)[6]: Northern Harrier and Savannah Sparrow.
- Nine (9) species considered to be "Uncommon" (found at 15-35 survey stations) in Halton Region (Dwyer 2006) were recorded (both breeding and non-breeding). They are listed in Table 5.8 below.

[6] **Area Sensitive** bird species require "a substantial area of suitable habitat for successful breeding and their populations decline when habitat becomes fragmented". This includes birds of various habitats, such as grassland or forest birds. In the case of forest birds, the "minimum forest habitat for area sensitive species is at least 100 metres from any edge habitat" (MNR 2000; pp 43).

Table 5.8 – Avifauna Species of Conservation Concern

Common Name	COSEWIC[3]	MNR[4]	SARA Status and Schedule [5]	Halton Region (1993) [6]	MNR Area Sensitive[7]	BB1	BB2	BB3	BB4	BB5	BB6	BB7	Incidental Observations
Black-crowned Night-heron (*Nycticorax nycticorax*)				U									X
Blue-winged Teal (*Anas discors*)				U									X
Bobolink (*Dolichonyx oryzivorus*)	THR	THR	No Status: No Schedule									X	X
Eastern Towhee (*Pipilo erythrophthalmus*)				U									X
Gadwall (*Anas strepera*)				U		FY							
Horned Lark (*Eremophila alpestris*)				U								X	
Northern Harrier (*Circus cyaneus*)	NAR	NAR		U	X								X
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)				U		X	X				X		X
Savannah Sparrow (*Passerculus sandwichensis*)					X	X	X				X	X	X
Willow Flycatcher (*Empidonax traillii*)				U								X	
Wilson's Snipe (*Gallinago delicata*)				U									X

Refer to Legend in Appendix 5.2

Anurans

Table 5.9 provides a composite list of amphibian survey results from 2005, 2009 and 2010. Table 5-2.2 (Appendix 5.2) provides a summary of 2010 amphibian calling survey results.

Table 5.9 – Anuran Survey Summary Results

Species	Amphibian Calling Station							
	1	2	3	4	5	6	7	8
	Vegetation Unit and Description							
	Unit 4 Forest	Unit 2B Marsh	TC1 Tree Cluster	Unit 2A Old Field	Unit 5B Meadow Marsh	Dug Pond	Unit 1 Pond	Resid.
American Bullfrog (*Rana catesbeiana*)						✓	✓	
American Toad (*Bufo americanus*)							✓	
Green Frog (*Rana clamitans*)							✓	
Gray Treefrog (*Hyla versicolor*)							✓	
Northern Leopard Frog (*Rana pipiens*)							✓	

In total, 5 herpetofaunal species were observed on the Subject Property during the 2005, 2009 and 2010 field surveys.

- No federally (COSEWIC) or provincially (COSSARO) significant herpetofaunal species were recorded.
- No provincially rare species (i.e. S1 to S3 ranked by NHIC) were recorded.

One (1) species considered "Uncommon" in Halton Region (Dwyer 2006) was recorded: American Bullfrog (*Rana catesbeiana)*.

- The remaining species recorded on the Subject Property are considered to be widespread and abundant within Ontario (S4-S5) (Natural Heritage Information Centre, 2011); and,
- Green Frogs and American Toads had the highest relative abundance. Other species were present in low or very low numbers.

On the Subject Property, evidence of anuran breeding was primarily restricted to the large pond approximately 200 m northwest of Dundas Street and at two locations in shallow isolated pools to the west of the pond (Station 7; Vegetation Unit 1). A small amount of breeding was recorded at the small pond (Station 6) near the southeast property limit. Refer to Figure 5.4 for locational information.

At Pond 1, 5 herpetofauna species were recorded:

- Green Frog (*Rana clamitans*) (2010 ~ 40 individuals recorded during calling surveys; 2005 – 4 adults observed);
- American Toad (*Bufo americanus*) (2010 – not recorded during calling surveys; 2005 ~100+ tadpoles observed);
- American Bullfrog (2010 – not recorded during calling surveys; 2005 – 1 tadpole observed during visual surveys);
- Northern Leopard Frog (*Rana pipiens*) (2010 – 1 individual during calling surveys); and,
- Gray Treefrog (*Hyla versicolor*) (2010 – 2 individuals during calling surveys).

Of these, American Bullfrog, Green Frog and Gray Treefrog are closely associated with the pond and its immediate vicinity, while American Toad and Northern Leopard may range into nearby riparian meadow habitats.

At Station 6, small numbers of American Toad were recorded during calling surveys. This species likely utilizes the ponded water during breeding and adjacent meadow habitats during other life cycle stages.

The remainder of the stations (Stations 1-5) which are located closer to Highway 407 had no anurans breeding within them. This lack of breeding includes the small ponded area where hundreds of tadpoles were noted May 5th, 2009 (A. Kulin Personal Comm.). The lack of anuran breeding is consistent with the unsuitable habitat present. Stations 1, 2, 4 and 5 lacked the aquatic habitat required for anuran breeding. Station 3 had a small and insufficient water volume and lacked aquatic vegetation used by tadpoles for concealment and foraging.

Results of the 2010 survey are similar to those collected in 2005 for the Natural Environment Survey (Marshall Macklin Monaghan, 2005). As in 2010, anuran breeding was largely confined to the large pond near Dundas Street and absent in remaining areas in 2005. There were some minor differences; Gray Treefrog and Northern Leopard Frog were present in 2010 but not observed in 2005. Based on habitat present it is likely that both species were present in 2005 but not recorded since calling surveys weren`t completed. American Bullfrog was recorded in 2005 (one individual). This species was not recorded in 2010 and may have become extirpated.

In summary, anuran breeding is primarily limited to the large pond located near Dundas Street. Within this pond, anurans are largely limited to Green Frog. A small number of Gray Treefrogs and Northern Leopard Frogs also breed within the pond. American Toad tadpoles were observed in the riparian areas immediately west of the pond and likely breed within the pond as well. During the non-breeding portion of their life cycle, anuran species are likely within the pond, its vicinity or meadow marsh along intermittent watercourses.

Other Wildlife

The following points summarize other wildlife (mammal and insect) observations made on the site during field work completed to date:

2005

- Sightings of White-tailed Deer (*Odocoileus virginianus*) or their tracks were made throughout the site;
- A deer bedding area was observed between breeding bird stations #6 and #7 in an upland meadow area between fields and consisted of approximately 20 well-worn spots;
- Raccoon (*Procyon lotor*) tracks were observed throughout the site;
- Coyote (*Canis latrans*) scat was found by survey station #1; and,
- Eastern Cottontail (*Sylvilaus floridanus*) was observed between stations #2 and #3.

2009 and 2010

- Several Monarch Butterfly adults and 1 Monarch caterpillar were observed within Unit 2 adjacent to the large pond (Reach 14W-14A). Monarch are discussed further in section 5.3.3;
- Evidence of White tailed Deer (tracks and browse) were observed in Unit 4 (North Woodlot); and,
- A Meadow Jumping Mouse (*Zapus hudsonius*) was observed at the edge of the cultivated field south of Unit 4 (North Woodlot).

Monarch is discussed further in section 5.3.3. All mammal species detected on the Subject Property are considered very common and secure in Ontario (per NHIC S-ranks), and are expected based on the site conditions.

5.3.7 Hydrogeology

The surficial fine-grained deposits of Halton Till found throughout the study area serves to limit infiltration to the groundwater system and as a result, the local stream systems receive a little over two-thirds of their total water from surface runoff. The upper weathered zone of the till, provides the bulk of the groundwater inputs to the local streams, but on a seasonal basis typically from November to May. During this period the entire shallow system, including upgradient reaches of the channel are saturated and contributing water to the streams. The watercourses are observed in a dry to ponded condition during the summer months.

The lower reaches of the FM1001 tributaries (generally to the south of Highway 407) are interpreted as receiving minor groundwater contributions from the Queenston Shale bedrock based on water level monitoring carried out at the Subject Property over the past two years. However, the rate of influx of bedrock groundwater is low, and during the summer months, is insufficient to provide enough water to maintain flow in these watercourses. Over the lower reaches of the main channel there may be greater opportunity for bedrock-based groundwater to maintain pools in the stream channel as the bedrock is exposed in the channel and the watercourse is shaded somewhat by large trees.

Reaches 14W-11 and 11A in the northeast corner of the Subject Property is interpreted to be losing water to the ground, due to the nearby influence of a buried bedrock valley to the east. Reach 14W-14A appears to be losing water to the groundwater system on the basis of measured surface water levels at the pond (148.57 masl) compared to the interpreted bedrock water levels (145 to 147 masl) and to water level measurements.

Overall, the relative contribution of groundwater to the maintenance of aquatic and wetland features on the Subject Property appears to be minor; rather, these features are all associated with the watercourse reaches that appear to be maintained largely by surface water inputs.

5.4 Description of the Proposed Development

The development proposal is to accommodate the creation of an office and business park in accordance with the Region's and Town's land use and planning directions for the 407 West Employment Area. The development concept consists of employment uses adjacent to Highway 407 and Bronte Road, due to increased visibility along these major roads with limited commercial and service/retail uses at the major road intersections along the Dundas Street to serve the employment area. It is recognized that more general industrial uses, such as mixed warehousing and office uses may be accommodated internal to the

business park. The concept plan is generally consistent with the Town's NOWSP incorporating modest revisions to the proposed road network based on more detailed study. The road pattern and resulting watercourse and buried services crossings follows a modified grid pattern which responds to the existing environmental and site conditions while encouraging accessibility and a viable transit network throughout the 407 West Employment Area as shown in Figure 5.5 and Figure 5.6.

5.5 Development of Setback Requirements

Feature limits, setbacks and environmental management requirements were reviewed from the EIR ToR and consideration of grading and servicing requirements. Primary focal areas included the stream corridors and consideration of natural environment features on surrounding lands. The collective review encompassed the following considerations and objectives:

- Consultation with the Town, HC and MNR;
- Anticipated preliminary grading and servicing requirements;
- Maintenance of groundwater interactions and input to natural areas and receiving watercourses;
- Protection of surface water quality in receiving watercourses through sediment/erosion control measures, including an approved Sediment and Erosion Control Plan;
- Setback requirements, based on a combination of: the nature and sensitivity of features to be protected and endeavoring to be consistent with buffers applied to natural features in the area; and,
- Tree protection measures.

5.6 Proposed Concept Plan

The proposed concept plan was developed to address the above environmental management recommendations. The general characteristics of the proposed plan are as follows:

- The proposed development will consist of an office and business park in accordance with the Region's and Town's land use and planning directions for the 407 West Employment Area.
- Elimination of Reach 14W-13 with upstream flows directed to realigned Reach 14W-14.
- Realignment of Reach 14W-14 to the west with discharge into Reach 14W-16 as it flows onto the Subject Property. Reach 14W-16 will require stabilization downstream of the Reach 14W-14 connection to accommodate the increased flows.
- Realignment of Reach 14W-11A.
- There are three proposed road crossings of two watercourse reaches, including: the Burnhamthorpe Road extension crossing of Reach 14W-16, an Avenue 2 crossing of Reach 14W-16 and the Avenue 1 crossing of the realigned section of Reach 14W-14. The Burnhamthorpe Road alignment differs from the alignment identified in the Secondary Plan due to the desire to minimize potential adverse effects to a High Constraint watercourse and reducing the number of watercourse crossings. The Burnhamthorpe Road alignment identified in the Secondary Plan was located to the south of the proposed alignment and would have crossed Reach 14W-12 and 14W-14A. The proposed alignment identified in the concept plan will instead cross Reach 14W-16, a Medium Constraint stream corridor and encroach into the upstream setback associated with the northernmost section of Reach 14W-12 (14W-12A).
- The lots will be serviced by municipal water, sanitary and stormwater services.
- Two SWM facilities are proposed on the Subject Property between the Burnhamthorpe Road extension and Dundas Street. The SWM pond to the east of Reach 14W-12 will incorporate the

existing by-pass pond into the design. Treated outflow from both SWM ponds will be discharged into Reach 14W-12.

A considerable amount of environmental work and project team review has been undertaken to evaluate natural features and to identify associated setbacks, and environmental enhancement opportunities. The plan development has been guided by this iterative process and coupled with the EIR ToR, has guided the preparation of this EIR. The intent of this EIR is to evaluate the sensitivity and significance of the features on the Subject Property and any other natural features that could be influenced by the development and to identify mitigation and environmental management measures to protect and enhance those features.

5.7 Stormwater Management

The proposed stormwater management plan recommends two SWM ponds to the east and west of Reach 14W-12 between Dundas Street and the Burnhanthorpe Road Extension. These SWM facilities have been sized to provide an E*nhanced* (Level 1) quality control, extended detention and quantity control for the subject lands. The SWM ponds will have bottom draw outlets through reversed slope pipes with discharge to shaded rock channels (in a French drain arrangement) prior to discharging into Reach 14W-12. Detailed information is provided in Section 4. Key objectives for stormwater management include:

- Controlling post-development flows to allowable flow rates;
- Maintaining hydrological inputs to Reach 14W-12;
- Preventing downstream erosion in Reach 14W-12;
- Providing Enhanced water quality treatment;
- Mitigating temperature increases (through native species plantings around the pond perimeter, implementing a 'bottom draw' outlet structure, discharge in a rock lined channel shaded by plantings); and,
- Monitoring the SWM for condition and performance.

5.8 Sanitary Servicing and Water Distribution

This section briefly outlines proposed servicing of the site. For additional details, refer to Section 8 of this EIR/FSS.

The Subject Property is proposed to be serviced via gravity sewers within the right-of-way of the proposed road network, including watercourse crossings, for both storm and sanitary servicing. All sewers will be sized appropriately to accommodate the proposed development using the Region of Halton's and Town of Oakville's design criteria. The storm sewers will discharge to the proposed stormwater management facility for treatment. The sanitary sewers will discharge to the existing sanitary sewer on Colonel William Parkway.

Water servicing will be provided to the Subject Property by a network of trunk and local watermains within the right-of-way of the proposed road network, including watercourse crossings. The watermains will be designed to provide adequate domestic supply and fire protection in accordance with the Region of Halton's design criteria.

5.9 Impact Review and Evaluation

5.9.1 Impact Overview

This section reviews potential impacts or condition changes to natural environmental features on or bordering the Subject Property. The primary impacts relate to the elimination of Reach 14W-13 with flow directed to Reach 14W-14, stabilization of a section of Reach 14W-16, the incorporation of Reach 14W-14A into the SWM pond (by-pass pond and Vegetation Unit 1), the proposed re-alignments of Reach 14W-14 and Reach 14W-11A (and the associated riparian areas) and the encroachment into Reach 14W-12 (and Reach 14W-12A) setbacks by the SWM ponds and Burnhamthorpe Road alignment. Additional impacts relate to retained natural environmental features on the Subject Property and/or surrounding lands (e.g. construction related impacts to woodlands or downstream effects on water quality).

Potential impacts related to proposed road and service crossings of Core #1, Linkage to Core #2 and watercourse crossings are discussed in Table 5.11, per requirements of the EIR/FSS ToR (Town of Oakville, 2007) for the EIR Subcatchment Area Level of Detail. However, these impacts do not result directly from works proposed on the Subject Property and will be addressed through future studies.

Three primary natural environment factors are discussed: aquatic resources; vegetation; and, wildlife. In Tables 5.10 to 5.12, we review each factor in terms of potential effects, proposed mitigation and residual effects. The identified mitigation measures will be incorporated with appropriate wording on construction drawings and the Lot Grading Plans that will be prepared prior to any site grading (following Draft Plan approval). The proposed concept plan is provided for reference in Figure 5.5 and Figure 5.6 for terrestrial and aquatic habitats.

5.9.2 Fish Habitat Compensation Concepts

Proposed development activities including channel realignment are anticipated to result in the Harmful Alteration, Disruption or Destruction (HADD) a contravention of Section 35(1) of the federal *Fisheries Act*. In order to obtain a *Fisheries Act Authorization* and permit the works to proceed, a fish habitat compensation plan to address to adverse effects to fish habitat is required to clearly demonstrate how modified reaches will achieve a net gain in fish habitat. This net gain will meet the 'no net loss in fish habitat productivity' as required by Section 35(2) of the *Fisheries Act*. A compensation concept has been prepared that will support critical life stages of fish or other aquatic biota and replace the form and function of the existing channels that will be realigned. These concepts have been prepared to address potential adverse effects associated with Reaches 14W-14, 14W-11A, 14W-16 and 14W-14A. According to NOCSS (2006), Reach 14W-13 is not considered to function as fish habitat. Provisions made within NOCSS to address its removal have been incorporated in the stormwater management section and as such is not described in this section.

The intent of the compensation concepts are to improve habitat diversity through the construction of riffle and pool habitat that is currently absent in the reaches that will be affected. The existing stream corridors are subject to intermittent disturbances to the creek and associated riparian habitat principally associated with the current agricultural land use. The compensation concepts are provided in Section 6 of the EIS/FSS, illustrated on Figures 6.4a-e and 6.5 and is described below for each specific reach, as well as additional enhancement opportunities. Please note that in order to maintain consistency with hydraulic analysis we have also included reach identifiers identified as Section 6 for cross referencing. Once these

concepts have been reviewed and accepted by DFO a Fish Habitat Compensation Plan will be prepared based on these concepts with supporting detail design drawings in order to obtain *Fisheries Act* Authorization for the works.

Measures to specifically address Redside Dace and their habitat as they relate to the review of the project under the *ESA* will be addressed through continued consultation with the MNR.

Reach 14W-14 Realignment (Reach 14W-22)

This reach will be realigned along the north and west boundaries of the Subject Property (Figure 6.4a,b,c). The proposed concept for Reach 14W-14 consists of creating a morphologically diverse channel with pools along the outside bend connected by riffle habitat. This alternating sequence of riffle/pool habitat will provide suitable habitat for the species present including Blacknose Dace, Creek Chub as well as Bluntnose and Fathead Minnows found within this reach as well as downstream within Reach 14W-12. The introduction of pool habitat will also provide greater areas of potential refuge habitat where resident fish can congregate during periods of low flow as evidenced in downstream reaches.

The proposed habitat diversity is also anticipated to improve the seasonal range of Redside Dace as well. In its current form, Reach 14W-14 is unlikely to support Redside Dace due to the existing conditions consisting of diffuse flows through dense aquatic vegetation. The realigned Reach 14W-14, consisting of a defined channel with morphological diversity will provide greater opportunity for Redside Dace to use these upstream reaches. Furthermore, the improvement to Creek Chub spawning habitat created by the introduction of more riffles is also anticipated to improve Redside Dace habitat. Although Creek Chub are a generalist species, Redside Dace have a reproductive association with Creek Chub using Creek Chub nests for spawning.

Floodplain wetlands consisting of a combination of meadow marsh habitat have also been incorporated into the design to recreate the function of the online wetlands within the existing floodplain of Reach 14W-14 (Figure 6.4a,b,c; Figure 6.5). The meadow marsh habitat has been designed through grading of the floodplain to create areas with greater frequency and duration of flooding. It is anticipated that this periodic flooding will create conditions suitable for brook stickleback spawning as they build nests in areas with flooded grasses.

Although the realigned reach (14W-14) may result in a shorter stream length than existing reach, the resulting corridor width is wider. This wider corridor will incorporate the principles identified in *Table 6.3.4 Aquatic and Riparian Management by Reach* through the planting and seeding of the valley with native species in a manner that takes into consideration the preferred riparian habitat for the *ESA* regulated species. As the majority of the watercourses on the Subject Property are devoid of canopy cover largely consisting of active agricultural fields, the planting of these riparian areas will provide an enhancement over the existing conditions.

These proposed measures including improved in-water habitat diversity, floodplain wetland habitat and riparian plantings are expected to result in a net gain to fish habitat through:

- Potential expansion in the range of the resident fish population;
- Potential improvement to spawning habitat for the resident fish species including Redside Dace;
- Incorporation of the existing online wetland habitat within the realigned floodplain; and,

- Improved canopy cover through the stream corridor currently consisting of a combination of disturbed riparian habitat and active agricultural fields.

Although it is anticipated that the resulting realigned reach will be shorter than the existing feature, the improvements these compensation concept measures are anticipated to be sufficient to address the requirements of Section 35(2) of the *Fisheries Act* as the productive capacity of this reach is expected to be improved over the existing agricultural swale.

Reach 14W-16 Stabilization

Due to the proposed increase in flows within the lower reaches associated with the realignment of Reach 14W-14, Reach 14W-16 will require stabilization. This requirement will provide the opportunity to enhance the existing habitat that has been adversely affected by agricultural practices. Similar to the Reach 14W-14 realignment this reach will also be designed with a meandering channel consisting of alternating riffle and pool habitat however, without creation of floodplain wetlands (Figure 6,4a,c,d; Figure 6.5). Similarly the stream corridor will be planted to improve riparian habitat and in time canopy cover.

The anticipated benefits associated with these works are again similar to Reach 14W-14 owing to the similarity in habitat that will be created. This reach will likely have a greater duration and frequency of flow due to the contribution of both realigned Reach 14W-14 and existing Reach 14W-16 upstream of the Subject Property. This, in combination with the proximity to an existing fish population in Reach 14W-12, will likely result in a greater potential for range expansion and Redside Dace use.

It is anticipated that these compensation concept measures will be sufficient to address the requirements of Section 35(2) of the *Fisheries Act* as the productive capacity of this reach is expected to be improved over the existing agricultural swale.

Reach 14W-11A Realignment

Similar to Reach 14W-14, Reach 14W-11A will be realigned along the north and east (Reach 14W-23) boundaries of the Subject Property (Figure 6.4a,e). This realignment will provide the opportunity to enhance the existing habitat that has been adversely affected by agricultural practices. This realigned reach will also be designed with a meandering channel consisting of alternating riffle and pool habitat, with the stream corridor planted to improve riparian habitat and in time canopy cover.

The anticipated benefits associated with these works are again similar to Reach 14W-14 owing to the similarity in habitat that will be created. Reach 14W-11A connects to Reach 14W-11, a reach considered to be High Constraint Requiring Rehabilitation. As a result if rehabilitation measures are undertaken in Reach 14W-11 the enhancements in Reach 14W-11A will provide greater continuity and opportunities for further upstream migration.

It is anticipated that these compensation concept measures will be sufficient to address the requirements of Section 35(2) of the *Fisheries Act* as the productive capacity of this reach is expected to be improved over the existing agricultural swale.

Removal of Reach 14W-14A (By-pass Pond)

Reach 14W-14A consists of a by-pass pond that receives flow from reaches 14W-13 and 14 when a certain elevation is reached flow is discharged into Reach 14W-12A then into 14W-12. During the summer months this water is often the warmest water in the pond due to the manner of discharge from the surface. Considering that the receiving watercourse supports Redside Dace, a coolwater species, the removal of this feature and its incorporation into the SWM pond will remove the potential adverse effects associated with water temperature and dissolved oxygen. According to the DFO's *Working Around Water? Factsheet Series (Ontario Edition)* by-pass ponds *"… are also prone to dissolved oxygen and water quality problems, increases in water temperature, and sediment accumulation problems. Proposals* ***for bypass ponds on coldwater streams are generally not approved*** *due to the potential that downstream water temperatures may increase beyond levels that coldwater fish need to survive".* The removal of pond habitat (i.e. by-pass, on-line) specifically those contributing to cool/coldwater habitats, is anticipated to improve water quality (i.e. water temperature) related to fish habitat. NOCSS (2006) states, that one of its broad level riparian corridor management recommendations to achieve certain targets on a system wide basis includes the removal online ponds. These types of features are considered detrimental from a temperature moderation perspective. Although the pond in question is not an online feature, its effects are similar and the removal of these adverse effects would be beneficial to the aquatic habitat of downstream reaches.

Considering the manner in which this pond functions and the presence of an *ESA* regulated species in the receiving watercourse that requires coolwater habitat, its removal would be a benefit to aquatic habitat and result in a net gain to fish habitat.

Redirection of flow from Reach 14W-12A

The proposed, realignment of Reach 14W-14 and removal of the by-pass pond and Reach 14W-13 will result in the partial redirection of flow away from Reach 14W-12A with similar flow continuing to Reach 14W-12. This redirection of flow has the potential to alter the function of this short reach; however, due to the minimal flows, the homogeneous habitat present through most of the reach accessible to fish, the constructed nature of the watercourse and continued flow that will be directed to this reach by the proposed SWM pond, it is unlikely to have an adverse effect on the fish community. Considering the function of reach 14w-12A, it is anticipated that potential adverse effects to fish habitat associated with the realignment of 14W-14 and the removal of reach 14W-13 and the by-pass pond can be addressed through the enhancements proposed for Reaches 14W-16 and 14W-14.

Removal of Existing Crossings

The proposed realignment and enhancement works will also provide the opportunity to remove existing functioning and/or abandoned farm crossings within Reach 14W-16. These crossings have the potential to function as barriers (seasonal/permanent) to fish passage and may be unstable due to their age. As a result their removal has the potential to result in a net gain to fish habitat. Prior to removing these features their influence on fish habitat will be examined in greater detail as the constriction of flow may have created deep pool habitat that function as refuge pool habitat. As necessary this function may be retained or recreated using other methods to maintain the form and function of these refuge pools.

5.9.3 Encroachment into Reach 14W-12 (12A) Stream Corridor Setback

The SWM ponds are anticipated to encroach into the stream corridor delineated by the meanderbelt width and 30 m setback to either side; however, the encroachment is limited to the setback rather than the meanderbelt. The area within the stream corridor that will be affected consists principally of active agricultural fields. It is anticipated that adverse effects associated with this encroachment will be minimal, resulting from the encroachment of the SWM pond berms, which can be enhance with native vegetation plantings.

The proposed Burnhamthorpe Road alignment identified in section 5.6 (Proposed Concept Plan) is located within an area of active agricultural fields and cultural meadow. The revised alignment is preferred over the original alignment, identified in the Secondary Plan, as it eliminates two watercourse crossings. Originally, the road alignment crossed Reach 14W-12, a High Constraint stream corridor, and 14W-14, the existing farm pond (Reach 14W-14A). The proposed concept plan results in a single watercourse crossing of Reach 14W-16, a Medium Constraint stream corridor, and encroachment into the Reach 14W-12A stream corridor, which is located where Reaches 14W-14 and 14W-13 occurred prior to realignment. It is anticipated that the proposed encroachment can be addressed through the planting of the areas adjacent to the proposed road alignment in order to enhance the existing riparian habitat and minimize potential adverse effects to the aquatic habitat.

5.9.4 Overview of Mitigation Measures

Specific mitigation measures are identified for each evaluation factor in Tables 5.10, 5.11, and 5.12. A number of mitigation measures are common to the three natural environment evaluation factors, including: Erosion and Sediment Control (ESC) plan; fencing; stewardship; spills management / best management practices during construction; and monitoring. Other measures are specific to certain factors. An overview of mitigation measures is provided below:

1. **Erosion & Sediment Control (ESC) Plan**. This strategy will mitigate impacts on vegetation, wildlife (habitat) and aquatic resources by implementing ESC fencing at grading limits, preventing sedimentation in adjacent natural features. The ESC Plan will be prepared as a condition of Draft Approval, and approved by Conservation Halton and the Town of Oakville. The framework of the Plan, including construction sequencing, performance monitoring and monthly reporting, will be detailed in an Erosion and Sediment Control Brief.

2. **SWM Strategy.** The proposed SWM strategy will mitigate impacts to vegetation, wildlife habitat and aquatic resources by: controlling post-development flows (to reduce sedimentation and erosion potential in adjacent vegetation blocks and watercourses); and, treating stormwater runoff (to reduce potential for degradation of water quality in Reach 14W-12 and receiving watercourses downstream of the Subject Property). Additional details are provided in Section 4.

3. **Hydrology / Infiltration**. Although the potential for at-source infiltration is limited given soil types, passive infiltration and utilization of at-source measures where local soils permit are recommended. These measures will contribute to local recharge. Additional details are provided in Section 4.

4. **Temporary and permanent fencing**. Temporary vegetation protection fencing (which may be combined with ESC measures) is recommended to prevent damage to adjacent retained vegetation areas. Permanent fencing at lot limits abutting the realigned/retained watercourse features is recommended to prevent uncontrolled access and dumping.

5. **Spills Management Plan and Best Management Practices (BMPs).** These during-construction measures will reduce potential for contamination of groundwater, receiving watercourses and adjacent vegetation. Guidelines for heavy equipment use reduce potential for damage to natural areas (e.g. stream disturbance, refueling, mechanical damage to trees, soils compaction etc.).

6. **Monitoring.** Monitoring is recommended during-construction (e.g. S/E fence and SWM facility inspection) to ensure mitigation measures are functioning as intended and whether adaptive mitigation is required to address potential deficiencies. A Biological Monitoring program will also be undertaken following construction including aquatic habitat/community vegetation and wildlife monitoring, focusing on retained and re-aligned portions of the stream corridor network. It is intended that the program would be developed as a condition of Draft Plan approval. This integrated monitoring approach will help to identify issues of concern and recommend strategies to address problems in a timely manner.

   This integrated monitoring approach will help to identify issues of concern and recommend strategies to address problems in a timely manner.

Table 5.12 – Summary of Potential Impacts to Wildlife

Wildlife			
Feature Significance and Sensitivity	**Natural Environment Impacts**	**Mitigation Measures**	**Residual Effects**
Subject Property • The cultivated fields, small woodlands and network of drainage swales supporting cultural meadow/meadow marsh vegetation provide habitat for common, urban-adapted, open-country, edge and generalist species and some habitat for wetland and woodland associated species. • Some specialized wildlife habitat is present – amphibian breeding habitat in the pond. • One (1) SAR species was recorded (Bobolink). • One (1) provincially significant species was recorded (Black-crowned Night-heron) but was recorded outside of the breeding season and is not thought to be breeding on the subject property. • Ten (10) regionally significant species were recorded (9 avifaunal spp. and 1 herpetofaunal sp. - Bullfrog). American Bullfrog was not recorded in 2010 and may be extirpated from the subject property. • Two (2) of the bird species observed are considered area sensitive • No woodland amphibian breeding habitat is present **Adjacent Lands** • Lands within EIR subcatchments that overlap with the subject property include much larger, more ecologically significant and sensitive wildlife habitat blocks. • Adjacent lands to the east include Core #1 and the Linkage to Core #2 as defined in the NOCSS. • The NOCSS states that; "the forested portion of (Core #1) was found to provide potential nesting habitat for a number of forest bird species of conservation concern. Most of these bird species are also considered to be area sensitive species, despite the limited amount of interior habitat beyond 100m of the edge (<1ha).	Potential impacts on wildlife habitat are similar to those discussed for vegetation (i.e. direct / indirect impacts to habitat – removals, fragmentation, occupancy related effects etc.). Some additional occupancy-related effects are specific to wildlife (e.g. influence of increased pedestrian activity adjacent to wildlife habitats). • **Direct impacts**. Loss of wildlife habitat is restricted to cultivated fields, meadow marsh/shallow marsh vegetation within realigned portions of the drainage swale network (Vegetation Unit 2) and the large pond (Vegetation Unit 1). Direct impacts to the large pond and drainage swale network are considered temporary as these features will be recreated within the proposed SWM ponds and realigned stream corridors, respectively. • **Movement opportunities** for wildlife will be maintained via the retained/realigned stream corridor(s). • **Habitat for Bobolink may be impacted.** Consultation with MNR is ongoing. • **Habitat for species of regional conservation concern will not be impacted over the long-term.** There will be a temporary disturbance to riparian meadow during relocation and restoration. The regionally significant bird species recorded are tolerant of cultural habitats. • **Anuran breeding habitat associated with the large pond (Vegetation Unit 1) will be removed.** Anuran species may re-colonize the SWM pond habitat following construction. Ephemeral pool/pond habitat will be recreated within realigned watercourse reaches, and will provide potential amphibian breeding habitat in the post-construction landscape. • **Indirect Impacts**. There is potential for indirect impacts to wildlife habitats on adjacent lands as the result of construction, changes to hydrology and occupancy related activities.	Retention and recreation of vegetation communities (as discussed above) will also protect wildlife habitat. Specific mitigation measures are as follows: • **Movement opportunities**. Open country movement opportunities will be maintained via the retained/realigned stream corridors. • **Habitat for Bobolink.** As noted, consultation with MNR is ongoing with regards to Bobolink, and the proposed development will conform to the requirements of the *ESA* 2007 legislation with regards to this species. • Habitat for wildlife species of conservation concern will be retained in situ, relocated or recreated. Additional measures are proposed to protect this habitat, including: S/E controls; maintenance of hydrological inputs; fencing / restricted access; and stewardship initiatives (e.g. signage, property owner/tenant brochures). • **Sediment / Erosion Controls** and **the SWM system** are designed to reduce the potential for sedimentation or contamination of receiving habitats. • **Maintenance of hydrology**. Direction and volume of surface flows to be maintained post-construction. • **Occupancy-related impacts**. Occupancy related impacts to wildlife and wildlife habitat will be mitigated by a combination of measures: **fencing** along retained/realigned stream corridors to restrict access; and **stewardship** initiatives (Natural Heritage System signage, property owner/tenant brochure). The intent is to restrict access to sensitive areas and inform local residents about the sensitivity of adjacent natural areas. • **Monitoring**. An avifaunal and anuran monitoring program will be developed in accordance with applicable directions in the NOCSS as a condition of Draft Plan approval. • **Restoration / rehabilitation.** As noted above, restoration measures will be implemented to recreate the form and function of meadow marsh/shallow marsh and ephemeral pond habitats within the realigned portions of stream	Residual impacts to wildlife and wildlife habitat resulting from subdivision development on the subject property are anticipated to be minor: • The proposed development is primarily restricted to cultivated fields that provide habitat for common, tolerant wildlife species. • There is no direct impact to significant or sensitive wildlife habitats.[1] • While there are direct impacts to amphibian breeding habitat, ephemeral pool/pond habitat suitable for amphibian breeding will be recreated within the buffers of realigned stream reaches. Amphibians may also re-colonize SWM ponds following construction. • Additional measures are proposed to reduce potential for indirect impacts to off-site wildlife habitat (i.e. S/E control, SWM treatment of contaminants, maintenance of hydrological inputs to dependent features, buffering of sensitive areas). • Stewardship measures are proposed to raise awareness of the sensitivity of adjacent natural areas and further reduce potential for indirect (occupancy-related) impacts. However, it is acknowledged that in any populated area there is potential for unauthorized intrusion and damage to natural areas, and less tangible but inferred effects of occupancy on breeding bird activity. Population changes in breeding birds are inevitably related to the approved transformation of the broader landscape in the Region. Changes can also be effected by factors outside the Region (such as alteration/loss of wintering habitat, severe climatic conditions during migration activity, and changes in migratory stopover habitat). Hence, it must be recognized that shifts in wildlife species composition may be inevitable in this area over time, and in fact have probably already occurred with changes in the regional

[1] Consultation with MNR in regards to Bobolink is ongoing.

Wildlife			
Feature Significance and Sensitivity	**Natural Environment Impacts**	**Mitigation Measures**	**Residual Effects**
• Other natural environment features that provide wildlife habitat on adjacent lands to the north, south, east and west include the Candidate Oakville-Milton Wetlands and Uplands Life Science ANSI, the Candidate Trafalgar Moraine Earth Science ANSI, Greenbelt Plan "Protected Countryside", portions of the North Oakville-Milton West Provincially Significant Wetland complex, Bronte Creek Provincial Park, and Bronte Creek provincially significant life science ANSI.	• **Construction-related impacts**. These are generally limited to temporary disturbances to the large pond (Vegetation Unit 1) and portions of Vegetation Unit 2 habitats during construction. Potential for sedimentation and contamination are addressed by S/E controls and SWM measures. • **Hydrology**. As above, retained off-site habitats may be impacted by changes to hydrological inputs. • **Occupancy-related impacts**. These may include: woodland edge effects; and other degradation of wildlife habitat. In addition, there will be an increased pedestrian presence adjacent to retained/recreated habitats.	reaches. The re-vegetation plant list will include *Asclepias* species and nectar producing plants to enhance habitat suitability for Monarch Butterfly.	landscape.

Table 5.11: Summary of Potential Impacts to Vegetation

Vegetation			
Feature Significance and Sensitivity	**Natural Environment Impacts**	**Mitigation Measures**	**Residual Effects**
Subject Property • The subject property is dominated by active agricultural land uses with a network of drainage swales supporting cultural meadow/meadow marsh vegetation. • A small deciduous woodland within the proposed Highway 407 transit way, abuts the existing Highway 407 ROW at the north end of the property. • A dug pond with a fringe of wetland vegetation is located approximately 200 m north of Dundas Street. • A small provincially uncommon deciduous forest community [Dry-Fresh Oak-Hickory Deciduous Forest (FOD2-2, S3S4] is located on the banks of Reach 14W-11 along the east property boundary. • Occasional hedgerows are present; hedgerow trees are in variable condition (poor, fair, good) • Overall, vegetation is dominated by disturbance tolerant and non-native species and has a low to moderate ecological significance and sensitivity • Twelve (12) regionally rare/uncommon species were identified on the subject property. Eight (8) are located within the drainage swale network, 3 are associated with hedgerows, and 1 is located in vegetation unit 4i. **Adjacent Lands** • Adjacent lands to the east include Core #1 and the Linkage to Core #2 as defined in the NOCSS. • Adjacent lands to the north, east and west include the Candidate Oakville-Milton Wetlands and Uplands Life Science ANSI, the Candidate Trafalgar Moraine Earth Science ANSI, Greenbelt Plan "Protected Countryside", and portions of the North Oakville-Milton West Provincially Significant Wetland complex. • Adjacent lands to the south include Bronte Creek Provincial Park.	**Direct impacts** Direct impacts to vegetation on the subject property are: • The removal of portions of Vegetation Unit 2 (a, d, & g) to accommodate the relocation of Reaches 14W-14, 14W-13, 14W-11A. • Temporary disturbance of vegetation within Reach 14W-16 for channel modification to handle increased flows from consolidated drainage features. • Removal of Vegetation Unit 1 and portions of Vegetation Unit 2A to accommodate construction of a SWM pond. • Removal of Hedgerows HR2, HR3, HR7 and portions of HR4, and removal of Tree Clusters TC1 and TC2 to accommodate site grading and road construction. Direct impacts to vegetation[1] adjacent to the subject property are: • Removal of cultural meadow, cultural thicket and oak dominated deciduous forest to accommodate 2 new road crossings of the Fourteen Mile Creek valley (part of Core #1). • Removal of hedgerows to accommodate new road construction. • Removal from the edge of a Sugar Maple dominated deciduous forest (part of Core #1) to accommodate road crossing of the Linkage between Core #1 and Core #2. • **Edge effects.** Vegetation removal and dieback at the forest edge is not desirable because this edge helps to moderate microclimate changes between the bordering open field and the more shaded forest interior. This can result in exposure of the less disturbed forest zone to additional sunlight and invasive plant species which can lead to trunk damage (sunscald), desiccation, and localized changes in ground flora (e.g. increase in	• **Vegetation Protection Fencing (temporary)**. Will be installed prior to any site grading to delineate the work zone and prevent direct damage to adjacent retained vegetation (i.e. mechanical damage, root damage, soil compaction). This fencing will remain until construction is complete. • **Permanent fencing**. To be installed along lot limits abutting retained/realigned watercourse features. This prevents intrusion and uncontrolled dumping into these features. • **Watercourse Buffer Management**. The NOCSS identifies buffer requirements for all Medium and High Constraint Reaches. The buffers identified for protection of retained watercourses on the subject property are considered sufficient to protect associated vegetation features including forested areas [Vegetation Unit 5A (Valley Forest) and Vegetation Unit 3A]. • **Sediment/Erosion Control Plan.** To prevent sedimentation of off-site retained vegetation; S/E fencing will be installed prior to any site grading. Steep slopes may be created as a result of grading requirements. In these cases erosion control blankets are recommended. • **Hydrology**. Surface and groundwater water inputs to drainage features to be maintained. . • **Stewardship**. An integrated stewardship approach is proposed, including: signage at the Natural Heritage System limit; and property owner/tenant brochures. • **Monitoring**. A vegetation monitoring program will be developed in accordance with applicable directions in the NOCSS as a condition of Draft Plan approval. • **Restoration / rehabilitation.** A landscape planting plan/restoration plan will be developed to guide restoration of meadow marsh and shallow marsh vegetation within realigned reach corridors on the subject property. The plan will include measures to re-establish regionally rare/uncommon species in addition to common and tolerant species that dominate the existing communities. These	Residual impacts to vegetation are assumed to be relatively minor, with proper implementation of recommended mitigation, stewardship and monitoring measures. • The edge of Vegetation Units 3A and 5A and on-site hedgerows have been 'pre-stressed' by a long history of plowing adjacent to or within the dripline. The recommended watercourse buffers identified in the NOCSS will provide good dripline and root zone protection for Units 3A, and 5A. • Edge effects are already present in the natural features on-site due to the anthropogenic land use history and small size and high edge ratio. Exotic and invasive species are prevalent at the cultivated field edge, and widespread but typically not abundant within Vegetation Units 3A and 5. Given the increased development in the broader landscape, some increase in exotic and invasive species is likely. The intent is to reduce this to the extent possible. • With the restoration/rehabilitation of meadow marsh/shallow marsh within realigned stream corridors, and the drainage design measures to maintain hydrology, no substantive changes in wetland vegetation diversity or function are anticipated. The restored meadow marsh/shallow marsh communities will likely undergo natural succession towards a greater percentage cover of woody species (trees and shrubs) over time, unless actively managed to prevent succession. • Residual impacts from construction are anticipated to be very minor, with implementation of recommended vegetation protection fencing, S/E fencing and spills management plan.

[1] Existing conditions information based on NOCSS, off-site vegetation was not classified during the present study.

Vegetation			
Feature Significance and Sensitivity	**Natural Environment Impacts**	**Mitigation Measures**	**Residual Effects**
• Other designated features are present in the general area, including the Bronte Creek provincially significant life science ANSI.	exotic and invasive species). Potential edge effects are restricted to portions of Core #1 where new crossings are proposed. • **Indirect Impacts**. There is potential for indirect impacts to vegetation as the result of construction, changes to hydrology and occupancy related activities. • **Construction-related impacts.** These include: damage to vegetation outside the work zone; sedimentation; spills of contaminants or fuels; root pruning; damage to limbs; and soil compaction. • **Hydrology**. Retained vegetation (including off-site habitats) might be impacted by changes to hydrology on the subject property. For example, wetland vegetation that receives hydrological inputs from the subject property can be stressed if those inputs are significantly changed (e.g. change to surface water volume / flow direction; reduced infiltration or changes to groundwater flow direction). • **Occupancy-related impacts**. These may include: woodland edge effects (e.g. invasive species proliferation); trail creation; vandalism; refuse/vegetation dumping; and, effects of salt spray from road maintenance.	measures may include seedbank salvage and/or salvage of sedge 'turf' from densely vegetated portions of relocated watercourses. The restored meadow marsh/shallow marsh communities will likely undergo natural succession towards a greater percentage cover of woody species (trees and shrubs) over time, unless actively managed to prevent succession. • **Core and Linkage Crossings.** The proponent(s) responsible for design and construction of roads/services that will cross Core #1 and the Linkage to Core #2 will be required to address the study requirements identified in the North Oakville EIR/FSS Terms of Reference. In addition, the following recommendations identified in the NOCSS should be incorporated into the design of Core and Linkage Crossings; • Use of plantings and wing-walls to direct wildlife using the linkage to culvert/bridge crossings; • Consideration of alternative road designs to minimize the width of the gap created by the roadway (in either Linkages or other natural areas); • Locating services under the roadway to minimize roadway right-of-way; and, • Road alignments through Core Areas should be selected to avoid woodland and wetland features.	

Table 5.10: Summary of Potential Impacts to Aquatic Resources

Aquatic Resources			
Feature Significance and Sensitivity	**Natural Environment Impacts**	**Mitigation Measures**	**Residual Effects**
Subject Property • West Fourteen Mile Creek tributaries flow through the subject property including Reaches 14W-11, 14W-11A, 13, 14, 14A, 16 and 12. • Reach 14W-13 is considered *Low Constraint* with the possibility of elimination/incorporation into SWM plan/surface drainage systems. • Reaches 14W-11, 14W-14 and 14W-16 are considered *Medium Constraint* for retention in current location or can be relocated with enhancement of the existing conditions. • Reach 14W-11A is considered *High Constraint Requiring Rehabilitation* for retention in its current location with enhancement opportunities for effective protection while maintaining function. • Reach 14W-12 is considered *High Constraint* and is to remain in its present condition with development occurring outside of its boundaries. Alternatively, if the watercourse is anticipated to be affected, the recommendation is that the reach is to be maintained in the present location and undertake enhancement of the geomorphic and aquatic habitat conditions within the affected watercourse. • Reach 14W-12A is also considered High Constraint however, due to its form, function and origin as drainage from a constructed by-pass pond its function as fish habitat is marginal. •	**Subject Property** • **Road crossings.** The construction of the Burnhamthorpe Road Extension crossing and Avenue 2 will result in crossings of existing watercourses with the Avenue 1 crossing over the realigned channel. Impacts to aquatic habitat associated with the channel under the structure and loss of riparian habitat under the road footprint. The use of an open bottom culvert will potentially result in fewer impacts and impacts of lesser severity when compared to a box culvert. Both types of crossings share similar impacts including the transport of deleterious substances (i.e. sediment, fuel, etc.) associated with construction activity, elimination of floodplain vegetation that could result in reduced productivity and shading of the watercourse at the crossing location and loss/alteration of habitat during construction due to in-water work. Typically there are more impacts to the aquatic habitat associated with a box culvert versus an open bottom precast culvert structure, as the natural channel bed is covered with a box culvert. The type of crossing will be determined in future studies. • **Encroachment of the Burnhamthorpe Road Extension into Reach 14W-12A stream corridor.** The construction of the Burnhamthorpe Road Extension has been realigned to the north of the alignment proposed Secondary Plan in order to minimize adverse effects to a downstream section of Reach 14W-12 where Redside Dace are known to inhabit. This has resulted in the alignment located parallel to Reach 14W-12A. Reach 14W-12A has marginal function as fish habitat. As a result the location of the Burnhamthorpe Road Extension is anticipated to have minimal effects to the aquatic habitat. • **Buried services watercourse crossings.** Potential impacts and their severity are directly related to the type of construction method used and the location of installation. In the absence of proper mitigation, impacts associated with service installation have the potential to contravene the	**Subject Property** • **Road crossing/alignment.** Road crossings/alignments will be designed in a manner that minimizes encroachment into the stream corridors (i.e. grading/fill). The preferred option for the road crossing consists of an open bottom structure to minimize impacts to the watercourse by minimizing the potential for in-water works. Where the Burnhamthorpe Road alignment is anticipated to encroach into the stream corridor (riparian zone), the area will be planted with native vegetation to enhance the existing disturbed riparian habitat thereby minimizing the potential adverse effects to aquatic habitat. • In the event that this type of crossing cannot be constructed (i.e. unsuitable soils), a box culvert will be used that will be designed to minimize the footprint within the valley and provide fish passage (i.e. low flow channel lined with appropriately sized riverstone). **Watermain construction.** The preferred construction method will be to install the watermains within the footprint of the roadbed thereby consolidating the servicing corridor and minimizing encroachments into the valley. In the event that there is insufficient cover between the road and the culvert to permit this, the watermain will be constructed within the road right-of-way using a trenchless method to minimize the potential for physical disturbance to aquatic habitat and associated	• **Road Crossing.** It is anticipated that with the construction of an open bottom precast structure that avoids in-water work (i.e. footing excavation, realignment, etc.) and the development and implementation of suitable mitigation measures (i.e. construction methods), a HADD will not occur. In the event that a box culvert is selected as the preferred crossing structure it is anticipated that impacts to fish habitat cannot be entirely mitigated and as a result the construction of this type of crossing may result in a HADD. If a HADD does occur, fish habitat compensation measures will be required to address these outstanding impacts and achieve a net gain to the productive capacity of fish habitat. • **Road Alignment.** It is anticipated that potential adverse effects associated with the encroachment of Burnhamthorpe Road alignment in the Reach 14W-12A will be minimized by the introduction of native tree and shrub species into the remaining riparian habitat to enhance this disturbed feature. • **Service Crossing.** It is anticipated that impacts to aquatic habitat associated with construction of the watercourse crossings can largely be mitigated. The use of a trenchless construction method is anticipated to potentially have less adverse effects than open cut construction. The effects of a standard open cut construction method in the tributaries can also likely be mitigated due to the relatively small size of the watercourses and its

Aquatic Resources			
Feature Significance and Sensitivity	**Natural Environment Impacts**	**Mitigation Measures**	**Residual Effects**
	Fisheries Act through the introduction of deleterious substances and/or result in a HADD. • Installing buried services using an open cut construction method will have the potential to result in impacts to the aquatic habitat through the alteration of the watercourse bed and banks, temporary access for construction, removal/compaction of vegetation/soils, transport of deleterious substances to the watercourse. • The use of a trenchless method (i.e. directional drilling) will minimize the potential for impacts to the aquatic habitat as it is anticipated that the area of disturbance will be confined to the margins of the floodplain/valley walls. The trenchless construction method will minimize the extent of activity immediately adjacent to the watercourse that has the potential to impact the aquatic habitat (i.e. in-water intrusions by equipment and personnel, sediment transport, etc.); provided construction activity is restricted to a delineated work area. Furthermore, the disturbance to the floodplain vegetation is minimized and the potential for sediment transport and erosion is reduced. • **Encroachment of SWM ponds into Reach 14W-12 development setback.** The proposed locations of the SWM ponds will result in a minor encroachment into the proposed setback. This encroachment will occur adjacent to Reach14W-12. Although an encroachment of this nature has the potential to adversely affect fish habitat through the removal of riparian habitat, the majority of the area to be encroached upon consists of active agricultural fields (actively tilled). As a result, impacts will be minimal considering minimal riparian vegetation will be disturbed. Furthermore the encroachment will consist generally of the pond berm (passive once constructed) that can be planted and seeded with native species. Encroachment into Redside Dace (riparian) habitat will continue to be discussed with MNR as it relates to the *ESA*. • **Incorporation of Reach 14W-14A (By-Pass Pond) into the SWM Pond.** The removal of the pond and its incorporation into the SWM pond will result in a benefit to the fisheries due to its warmwater contributions to Reach 14W-12 that supports the coolwater species	stream corridor. If trenchless construction is not feasible (i.e. bedrock) an open cut construction methods will be used to install the watermain. • **Sewer construction.** A sewer crossing to service the subject property will be installed along Avenue 1. The preferred method of construction will be constructed within the road right-of-way using a trenchless method (i.e. jack and bore) to minimize the potential for physical disturbance to aquatic habitat and associated stream corridor. If trenchless construction is not feasible (i.e. bedrock) an open cut construction methods will be used to install the watermain. • **Encroachments into watercourse setbacks.** The areas where there will be encroachment consist largely of active agricultural lands or disturbed riparian habitat. In these areas where watercourse setbacks will be encroached (i.e. SWM ponds-Reach 14W-12, the Burnhamthorpe Road Extension parallel to Reach 14W-12A, road and service watercourse crossings) they will be restored using native plantings and seeding. • **Timing of in-water construction (if required).** In the event that in-water works are required (i.e. footings, box culvert, open cut) works will adhere to the in-water timing window including permissible works from July 1 to September 15 for reach 14W-12 and July 1 to March 31 for all remaining watercourses. • **In-water construction method (if required):** If	intermittent flow regime. A review of the service crossing under the *Fisheries Act* crossing can likely be addressed through DFO's Operational Statements provided the proposed works meet the conditions. In the event that the proposed construction methods do not meet the conditions of the Operational Statements and/or the effects cannot be entirely mitigated this construction method has a greater likelihood of resulting in the HADD of fish habitat and may require fish habitat compensation measure. This assessment is dependent upon site specific impacts; the type of habitat affected and will be determined through consultation with HC/DFO once the construction method has been determined at the detail design stage. • **Encroachments into watercourse setbacks.** Residual effects associated with these encroachments are anticipated to be minor due to the limited habitat present (i.e. SWM pond-Reach 14W-12) of natural habitat and the disturbed nature of the natural habitat that will be affected. Furthermore, as the areas will be restored using native plantings and seeding the areas there is a potential to enhance these locations from their current form. • **Surface and groundwater quality.** The residual effects are anticipated to be minor given: the lack of direct disturbance to watercourses; improved treatment of surface water discharging from the subject property (via the SWM system); enhanced / larger buffer for nutrient filtering; and implementation

Aquatic Resources			
Feature Significance and Sensitivity	**Natural Environment Impacts**	**Mitigation Measures**	**Residual Effects**
	Redside Dace. Typically the removal of pond habitat (i.e. by-pass, on-line) specifically those contributing to cool/coldwater habitats, is considered an enhancement to fish and fish habitat due to the associated adverse effects to water quality (water temperature, dissolved oxygen). • **Removal of Reach 14W-13.** This Low Constraint reach will be eliminated with flow originating from north of Highway 407 directed to the realigned Reach 14W-14. • **Realignment of Reaches 14W-14, 14W-11A and Stabilization of Reach 14W-16.** These works are anticipated to result in the alteration and destruction of fish habitat. In the absence of other measures these works will contravene the *Fisheries Act*. • **Alteration of flow to Reach 14W-12A.** The alteration of flow to this reach is anticipated to have minimal adverse effects to fish habitat as flows from the proposed SWM pond will be directed through this reach to Reach 14W-12 • **Water quality impacts (long-term)**. Potential for increased sedimentation / erosion, contamination. • **Water quality impacts (temporary)**. Potential water quality impacts during construction activities (e.g. sedimentation, spills). • **Hydrology**. Potential changes to the hydrological regime resulting from increases in impervious surface and elevated flows or as the result of SWM discharge. • The majority of flow is made up of surface water contributions that will continue to be directed to the watercourses. On site surface runoff will be directed to the proposed SWM ponds resulting in a localized redirection of surface runoff in the Reach 14W-14 catchment area. Reach 14W-13 will be eliminated with flow directed to Reach 14W-14. These changes will result in a slight shift in the amount of surface water directed to Reach 14W-14 between Highway 407 and the SWM ponds.	in-water works are required, in-water construction measures will consist of isolating the work area and redirecting flow (i.e. dam and pump, dam and flume, diversion channel) downstream to minimize potential adverse effects. Standard mitigation measures including sediment and erosion control measures (i.e. sediment filter bag) and fish screens on pump intakes will be incorporated into the design to minimize potential adverse effects. Adherence to the permissible in-water timing window will not be required for the proposed Avenue 1 crossing over the realigned channel provided the realigned channel is not connected to the existing channels. This will permit the construction to occur throughout the year will low potential for adverse effects to fish habitat. • **Fish relocation (if required).** In the event that in-water works are required and the work area must be isolated, a fish relocation will be undertaken to remove fish from the isolated work area and relocate the fish downstream. This will be undertaken by qualified aquatic biologists with a Scientific Collectors Permit from the MNR. • **Surface water quality (long-term).** The SWM facility will provide Enhanced level of treatment of stormwater runoff prior to discharge to Reach 14W-12. The conversion of agricultural land to developed commercial and industrial uses is anticipated to reduce bacterial, nutrient, and total suspended sediment contamination due to cessation of tilling and fertilizing practices. Significant reductions to phosphorus loadings due to the switch from more heavily applied agriculture related fertilizers to maintenance related fertilizers	construction mitigation measures (i.e. S/E Plan, Spills Plan and BMPs). Potential changes to water quality (i.e. water temperature and dissolved oxygen) will be monitored during construction and post-construction as indicated in the OMB decision with Ontario Municipal Board (OMB) *Mediation Item: Stormwater Management – Temperature and Dissolved Oxygen Targets* (July 12, 2007). • **Sediment and erosion.** No adverse effects from construction generated sediment runoff are expected with the implementation and maintenance of an approved S/E Plan. • **Groundwater flow / volume.** Residual effects are anticipated to be minor – groundwater recharge is very limited on the site. The drainage design recommends passive infiltration (and at-source infiltration measures where local soils permit) • **Incorporation of Reach 14W-14A (By-Pass Pond) into the SWM Pond.** The removal of this warmwater contribution to downstream coolwater habitat will improve fish habitat. Although the footprint of this feature will be incorporated into the proposed SWM pond (another open water feature), the mitigation measures proposed (bottom draw, rock channel outlet) will assist in mitigating potential adverse effects to temperature from the existing condition. • **Realignment of Reaches 14W-14, 14W-11A, Alteration of flow to Reach 14W-12A and Stabilization of Reach 14W-16.** The

Aquatic Resources			
Feature Significance and Sensitivity	**Natural Environment Impacts**	**Mitigation Measures**	**Residual Effects**
	The potential impact is minimal as the remaining Reach 14W-14 catchment area north of Highway 407 will remain undisturbed and flow will be redirected from Reach 14W-13. As a result this short section of Reach 14W-14 upstream of the SWM ponds will continue to receive approximately 95% of the existing surface water contributions thereby minimizing potential adverse effects to fish habitat. • **Groundwater contributions.** Potential impacts to the groundwater regime and subsequent impacts to base flow in receiving watercourses is associated primarily with the removal/compaction of the upper weathered till layer. The weathered soil layer will be altered/removed by grading activities thereby reducing the amount of shallow groundwater moving laterally that comprises the majority of the groundwater inputs into the watercourses. Although this constitutes the majority of groundwater inputs into the watercourses on the subject property, the flow regime will continue to be influenced largely by surface water. It is anticipated that the deeper groundwater inputs will remain largely unaffected by the proposed development and will continue to provide similar inputs to the lower reaches of the watercourse where refuge pools supporting fish including Redside Dace have been observed.	are anticipated. While not of similar importance as phosphorus, other soluble and insoluble pollutants will see overall reductions in concentrations, subject to the treatment capacities of the water quality improvement features. The SWM facilities will also mitigate potential temperature increases from pond water warming by planting native shrubs around the pond perimeter and using a bottom-draw outlet structure and discharge through a rock lined trench shaded by plantings. • **Groundwater.** Groundwater quality protection will generally be addressed by the same measures in place for surface water quality protection (i.e. E&S Plan, SWM system). The potential for minor changes to localized groundwater recharge/discharge areas and corresponding base flow contribution to the watercourses is inferred to be minor given the low permeability of soils and remaining undisturbed catchment areas upstream. Mitigation measures consisting of the installation of infiltration galleries along the proposed stream corridors are anticipated to mitigate potential adverse effects. Clean water (i.e. roof runoff) will be directed to the galleries located along the edge of the corridor where the shallow weathered till remains intact promoting the existing lateral movement of shallow groundwater. • **Water quality (temporary).** S/E Control Plan, Spills Management Plan, Best Management Practices (BMPs) for heavy equipment use. • **Hydrology.** SWM / drainage design to retain, treat and control discharge to Reach 14W-12.	realignment of these reaches provides the opportunity to enhance the existing conditions of these altered watercourses. As identified in NOCSS, the concept plan has been developed to enhance existing habitat form and function. The proposed concept will result in an enhancement over the existing channels by including morphologically diverse habitat (i.e. riffles and pools) as well as floodplain wetlands that will extend the potential range of the fish community including Redside Dace further upstream into habitat currently not utilized. As a result, the proposed compensation concepts for the stream realignments are anticipated to result in a net gain in the productive capacity of fish habitat. This is anticipated to be sufficient to obtain *Fisheries Act* Authorization for these works.

Aquatic Resources			
Feature Significance and Sensitivity	**Natural Environment Impacts**	**Mitigation Measures**	**Residual Effects**
		• **Monitoring**. Potential impacts within the reaches will be assessed using the monitoring program discussed in Section 5.9.5 of this report. Requirements for monitoring of water temperatures and dissolved oxygen will be incorporated into the program in accordance with Ontario Municipal Board (OMB) *Mediation Item: Stormwater Management – Temperature and Dissolved Oxygen Targets* (July 12, 2007).	
Adjacent Lands • Reach 14W-12 flows downstream of Dundas Street in a meandering defined channel that is considered Redside Dace habitat. Reach 14W-11, 1A and 1 to the east of the subject property also support Redside Dace and are considered High Constraint.	**Adjacent Lands** Potential impacts to aquatic habitat on adjacent lands are similar to those identified on the subject property with varying levels of severity. Below is a list of potential impacts that would likely occur as a result of the development of those lands however site specific impacts will be addressed during future studies undertaken in support of the EIR/FSS pertaining to those subcatchments areas and the Draft Plan Level of Detail. Potential impacts include : • **Road and service crossings.** Fourteen Mile Creek will be crossed in three locations including Reaches 14W-11, 14W-2 and 14W-1A to the east and one location; Reach 14W-16 to the west. Potential impacts are similar to those identified above including type of road crossings, methods of construction and location of servicing installation. • **Groundwater contributions.** Impacts are anticipated to be similar potentially with differing levels of severity based on the type of development proposed, mitigation measures and the amount of undisturbed open space remaining. • **Water quality impacts to (temporary and permanent)**. These impacts are anticipated to be similar to those discussed above. • **Hydrology**. The changes in surface water contributions that make up the majority of the flow contributions due to increase imperviousness are based upon the development proposed. It is anticipated that it will	**Adjacent Lands** Mitigation measures will be developed through a greater detailed examination of potential impacts during future EIR/FSS studies specific to the draft plan areas.	**Adjacent Lands** Residual effects will be identified during future EIR/FSS studies specific to the draft plan areas

Aquatic Resources			
Feature Significance and Sensitivity	**Natural Environment Impacts**	**Mitigation Measures**	**Residual Effects**
	be similar in nature to the potential impacts identified for the Subject Property, with majority of these contributions maintained to the watercourses with minor redirection of surface runoff associated with SWM systems.		

5.9.5 Monitoring

A biological monitoring program will be developed as a condition of Draft Plan approval. It is anticipated that it will include aquatic, vegetation and wildlife components undertaken during and following substantial completion of construction. Additional monitoring may be required in association with other review agencies (DFO, MNR) and their respective permitting processes (*Fisheries Act*, *ESA*).

The main features within the Subject Property that will require monitoring include the stream corridors as these features include the aquatic and terrestrial features that will be retained. The modified channels will be examined to determine whether they are functioning as intended and whether the proposed works have resulted in the net gains anticipated. The following outlines the conceptual monitoring program that will be implemented with the final details of the monitoring plan detailed as a condition of Draft Plan Approval. The monitoring plan will generally follow the recommended components of a monitoring plan as outlined in Section 6.4 of the Management Strategy (NOCSS, 2006).

Aquatic Community: Due to the intermittent flow regimes of the watercourses aquatic community sampling (i.e. fish and benthic macroinvertebrates) will be undertaken in the spring. This information will provide an indication whether the range of the resident fish community has expanded due to the proposed works and whether the habitat changes and SWM measures have improved habitat conditions. These works will not include Reach 14W-12 due to the presence of Redside Dace and the desire to minimize potential adverse effects to this species.

Aquatic Habitat: Aquatic habitat investigations will also be undertaken in the spring to document seasonal habitat ranges. It is intended that future monitoring locations will in part be located at the same OSAP sites established during the preparation of this report to provide context and a pre- vs. post analysis of effects. Aquatic habitat monitoring will also consist of an analysis of the water temperature and dissolved oxygen that will also include results from hydraulic and hydrogeological monitoring.

Vegetation: Monitoring of the vegetation community composition and boundaries will assist in determining potential impacts resulting from development or perhaps natural succession. Monitoring will continue to use ELC as the vegetation protocol for consistency with existing inventories and its common use by regulatory agencies. The monitoring of vegetation will include establishing monitoring sites within woodlands and wetlands associated with both undisturbed and realigned/relocated stream corridors.

Wildlife: Wildlife monitoring will consist of breeding bird surveys and amphibian monitoring as a continuation of the works undertaken to date in order to assess the potential impacts or enhancements associated with the proposed development. The protocols that will be used consist of the Ontario Breeding Bird Atlas protocols at established monitoring locations on the Subject Property and Marsh Monitoring.

Protocol in the early spring with particular emphasis on the wetland habitat created within the realigned/relocated reaches to determine if the measures proposed are functioning as intended.

Additional monitoring for hydrogeology and SWM facilitates are presented in Sections 4 and 6.

5.10 Conclusions and Recommendations

Based on this review, we conclude that development of the Lazy Pat lands as proposed can be undertaken while protecting key environmental features. This conclusion reflects the following considerations:

- The 'big picture' has been considered in the following manner:
  - Fulfilling the requirements of NOCSS (2006) addresses the ecosystem features/functions and identifies opportunities, constraints and mitigation strategies.
  - The assessment of impacts, constraints and mitigation proposed recognize and anticipate that changes in the landscape matrix will occur. Most notably, this area is undergoing a shift in land use from agricultural to an office and business park.
  - The present work implements the objectives identified in NOCSS, providing a more detailed review and recommendations for the Subject Property and adjacent lands. This is consistent with the consideration of ecosystem function.

- Potential impacts to off-site features (i.e. Core Area 1, Linkage to Core Area 2, Stream Corridors) were examined on a subcatchment level of detail as identified in the EIR ToR. Potential impacts will be examined in greater detail during future EIR/FSS studies specific to those draft plan areas.

- Due to the dominant land use by active agriculture, the terrestrial habitat features are principally contained within the stream corridors identified by a combination of fluvial and aquatic habitat setbacks.

- The removal of Reach 14W-14A (by-pass pond) and its incorporation into the SWM pond will result in the enhancement of fish habitat. The pond in its current for contributes warmwater to the coolwater receiving watercourse supporting Redside Dace. Impacts associated with the removal of wetland and amphibian habitat are addressed through the incorporation of wetland habitat within the realigned Reach 14W-14.

- Reaches 14W-14 and 14W-11A will be realigned; habitat within Reach 14W-12A will be subject to a potential alteration due to the redirection of flow and Reach 14W-16 will be stabilized to accommodate increased flows associated with the Reach 14W-14 realignment. The realignment/stabilization works will provide an opportunity to enhance the existing habitat through the improvement of habitat diversity in both the channel and riparian habitat. These measures are anticipated to result in a net gain to the productive capacity of these systems thereby satisfying Section 35(2) of the *Fisheries Act*.

- Continued consultation with the MNR specifically related to Redside Dace and Bobolink and *ESA* requirements is required.

- The SWM drainage strategy implements an Enhanced Level of treatment for stormwater to ensure protection of the receiving watercourses. Additional measures to maximize cooling of water in and leaving the basin have been identified for further review/refinement in the detail design.

- Recommended design (i.e. open bottom culverts) and construction (i.e. trenchless construction) methods for servicing (i.e. road crossings, watermain and sanitary/storm sewer) will minimize the

potential for in-water works and as a result direct impacts to the active channel with reduced impacts to riparian habitat.

- Standard construction mitigation (i.e. in-water timing restrictions, spoils management, sediment and erosion control plans) will minimize the potential for potential impacts to the natural features.

- Incorporation infiltration galleries receiving clean water (i.e. roof runoff, rear lot drainage, etc.) along the margins of the development setback within the NHS in order to promote the lateral movement of shallow groundwater through the undisturbed stream corridor soils. This water will be directed to the watercourses and constructed floodplain wetland habitat in the realigned valleys.

- The recommended monitoring program will build on existing information, and assess the operation of the SWM, drainage measures and reach realignments.

- It is concluded that the concept plan, as well as environmental management and setback implementation, conform to the principles identified in the NOCSS.

To ensure that environmental protection and mitigation is properly managed during site development the following recommendations/actions are identified:

- An Erosion and Sediment Control Plan will be prepared as a pre-condition to Registration of the Draft Plan. The plan will be submitted to the HC and the Town of Oakville for review and approval prior to any grading and site alteration.

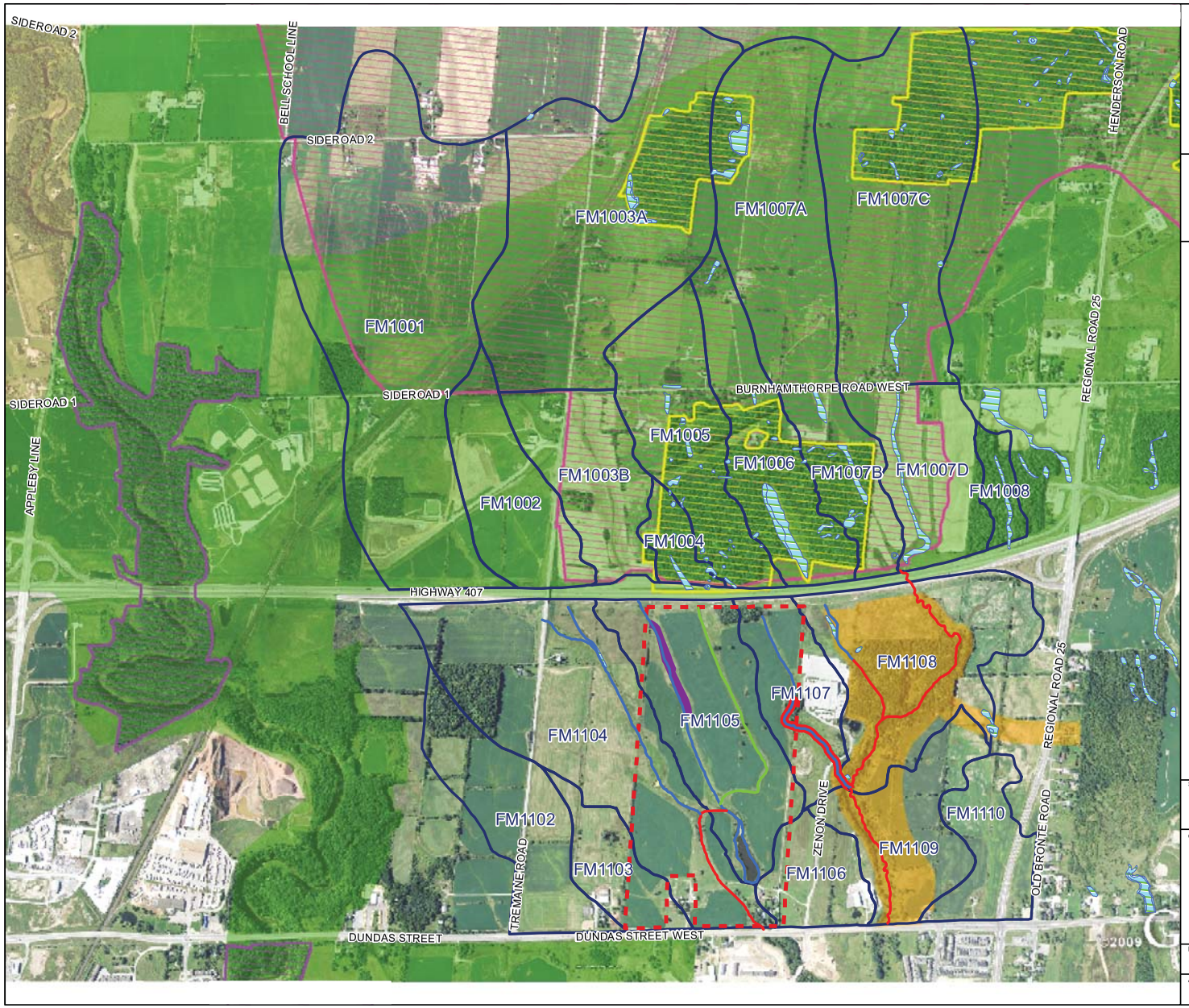
- Vegetation and silt protection measures will be implemented (i.e. diversion berms, temporary sediment control basins, temporary paige wire fencing and silt fencing) and maintained prior to and throughout construction.

- Permanent fencing is recommended along the interface between lots and the stream corridors to minimize encroachment and disturbance.

- Tree Management measures will include the preparation of an Arborist Report and a Tree Preservation Plan (TPP). The TPP will be developed through the preparation of Detailed Vegetation Plan that will be submitted in association with the Lot Grading Plan prior to registration.

- An environmental inspector should conduct site checks prior to and periodically during construction to ensure that protection and mitigation measures are properly implemented and to identify if any remedial measures are required.

- The monitoring approach is recommended to ensure that various mitigation and design measures are maintained and operating during construction. The post-construction monitoring is also recommended for a period of 2 years following construction.



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Natural Environment Features:
407 West Employment Area and Overlapping NOCSS EIR Subcatchments

LEGEND

- Subject Property
- Subcatchment Area Boundary
- Provincially Significant Wetlands
- ANSI, Life Science
- Candidate Oakville-Milton Wetlands & Uplands Life Science ANSI
- Candidate Trafalgar Moraine Earth Science ANSI
- NOCSS Core #1 and Linkage to Core #2
- Protected Countryside (Greenbelt Plan)
- Niagara Escarpment Plan Area
- Hydrologic Feature "A"

Watercourse Constraints

- High Constraint Stream Corridor
- High Constraint Stream Corridor - Requiring Rehabilitation
- Moderate Constraint Stream Corridor
- Low Constraint Stream Corridor

Scale: 0 125 250 500 750 1,000 m

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: May 6, 2011

Project No.: 1409222001

Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5.1

M:\Jobs\2009\14 092222 001 P01 - 407 West Employment Area\mapping\mxd\2011 05\Figure 5-1 - Natural Environment Features - 407 West Employment Area and Overlapping NOCSS EIR Subcatchments.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Vegetation Communities

LEGEND

- Subject Property
- VegCommunitiesSD
- Wetland Communities
- 407 Transitway

HR Hedgerow
TC Tree Cluster

Unit ELC Community

1A	Cattail Mineral Shallow Marsh (MAS2-1)
1B	Duckweed Floating-leaved Shallow Aquatic (SAF1-3)
1C	Open Aquatic (OAO)
2A	Dry-Moist Old Field Meadow (CUM1-1)
2B	Reed-canary Grass Mineral Meadow Marsh (MAM2-2)
2C	Willow Mineral Thicket Swamp (SWT2-2)
2D	Cattail Mineral Shallow Marsh (MAS2-1)
2E	Red-top Mineral Meadow Marsh (MAM2-3)
2F	Broad-leaved Sedge Mineral Meadow Marsh (MAM2-6)
2G	Forb Mineral Meadow Marsh (MAM2-10)
3A	Fresh-Moist Willow Lowland Deciduous Forest (FOD7-3)
3B	Mosaic of Mineral Cultural Meadow (CUM1) and Forb Mineral Meadow Marsh (MAM2-10)
4	Dry-Fresh Sugar Maple-Oak Deciduous Forest (FOD5-3)
4I	Mineral Thicket Swamp (SWT2) inclusion
5A	Dry-Fresh Oak-Hickory Deciduous Forest (FOD2-2)
5B	Jewelweed Mineral Meadow Marsh (MAM2-9)

Scale: 0 50 100 200 300 400 m

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: May 6, 2011

Project No.: 1409222001

Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5.2

M:\Jobs\2009\14 092222 001 P01 - 407 West Employment Area\mapping\mxd\2011 03\Figure 5-2 - Vegetation Communities.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Wildlife Sampling Locations

LEGEND

- Subject Property
- Bird Sampling Stations
- Anuran Sampling Locations
- Bobolink Observation Locations
- 407 Transitway

Scale: 0 50 100 200 300 400 m

Client: Bentall Kennedy

Prepared by: MMM GROUP

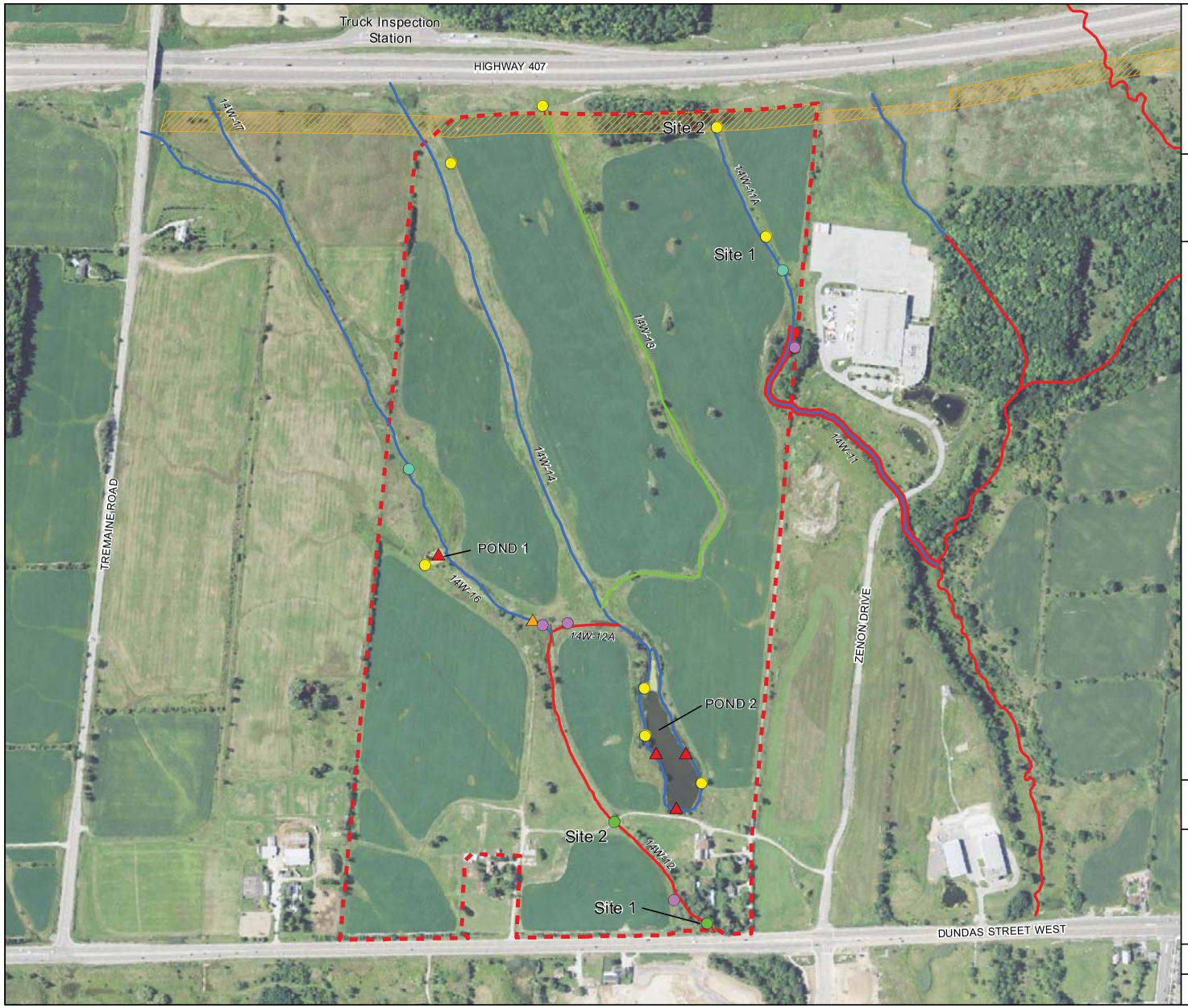
Date: May 6, 2011

Project No.: 1409222001

Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5.3

M:\Jobs\2009\14 09222 001 P01 - 407 West Employment Area\mapping\mxd\2011 05\Figure 5-3 - Wildlife Sampling Locations.mxd



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Aquatic Ecology: Field Investigations and Watercourse Constraints

LEGEND

- Subject Property
- Temp Logger Locations (2009)
- Benthic / OSAP (2009)
- Electroshocking Locations (2009)
- Benthic / OSAP and Electroshocking Location (2009)
- Minnow Trap Locations (2002)
- 407 Transitway

Watercourse Constraints

- High Constraint Stream Corridor
- High Constraint Stream Corridor - Requiring Rehabilitation
- Moderate Constraint Stream Corridor
- Low Constraint Stream Corridor

Scale: 0 50 100 200 300 400 m

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: May 6, 2011

Project No.: 1409222001

Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5-4

M:\Jobs\2009\14 09222 001 P01 - 407 West Employment Area\mapping\mxd\2011 05\Figure 5-4 - Aquatic Ecology - Field Investigations and Watercourse Constraints.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Vegetation Communities: Proposed Development Impact Review

LEGEND

- Subject Property
- VegCommunitiesSD
- Wetland Communities
- Open Space Area
- Interaction with Redside Dace Riparian Habitat
- 407 Transitway

HR Hedgerow
TC Tree Cluster

Unit ELC Community

1A	Cattail Mineral Shallow Marsh (MAS2-1)
1B	Duckweed Floating-leaved Shallow Aquatic (SAF1-3)
1C	Open Aquatic (OAO)
2A	Dry-Moist Old Field Meadow (CUM1-1)
2B	Reed-canary Grass Mineral Meadow Marsh (MAM2-2)
2C	Willow Mineral Thicket Swamp (SWT2-2)
2D	Cattail Mineral Shallow Marsh (MAS2-1)
2E	Red-top Mineral Meadow Marsh (MAM2-3)
2F	Broad-leaved Sedge Mineral Meadow Marsh (MAM2-6)
2G	Forb Mineral Meadow Marsh (MAM2-10)
3A	Fresh-Moist Willow Lowland Deciduous Forest (FOD7-3)
3B	Mosaic of Mineral Cultural Meadow (CUM1) and Forb Mineral Meadow Marsh (MAM2-10)
4	Dry-Fresh Sugar Maple-Oak Deciduous Forest (FOD5-3)
4I	Mineral Thicket Swamp (SWT2) inclusion
5A	Dry-Fresh Oak-Hickory Deciduous Forest (FOD2-2)
5B	Jewelweed Mineral Meadow Marsh (MAM2-9)

Scale: 0 50 100 200 300 400 m

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: May 6, 2011

Project No.: 1409222001

Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5-5

M:\Jobs\2009\14 09222 001 P01 - 407 West Employment Area\mapping\mxd\2011 05\Figure 5-5 - Vegetation Communities - Proposed Development Impact Review.mxd

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Aquatic Ecology: Proposed Development Impact Review

LEGEND

- Subject Property
- Open Space Area
- Interaction with Redside Dace Riparian Habitat
- Temp Logger Locations (2009)
- Benthic / OSAP (2009)
- Electroshocking Locations (2009)
- Benthic / OSAP and Electroshocking Location (2009)
- Minnow Trap Locations (2002)
- 407 Transitway

Watercourse Constraints

- High Constraint Stream Corridor
- High Constraint Stream Corridor - Requiring Rehabilitation
- Moderate Constraint Stream Corridor
- Low Constraint Stream Corridor

Scale: 0 50 100 200 300 400 m

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: May 6, 2011

Project No.: 1409222001

Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5-6

M:\Jobs\2009\14 092222 001 P01 - 407 West Employment Area\mapping\mxd\2011 05\Figure 5-6 - Aquatic Ecology - Field Investigations and Watercourse Constraints - Proposed Development Impact Review.mxd

6.0 Water Resources

6.0 Water Resources

6.1 Introduction

The proposed development area contains the headwater tributaries of Fourteen Mile Creek West which flow generally from west to east through the development area. The headwaters enter the development area via 5 culverts (FM1, FM2, FM3, FM4 and FM5) located under Highway 407 and exit the site through two culverts (FM-D4 and FM-D5) located under Dundas Street West as shown in Figure 6.1. Two tributaries of Fourteen Mile Creek West (14W-13 and 14W-14) will be diverted to tributary 14W-16 and an east tributary 14W-11A will be realigned to accommodate the proposed development.

According to the Terms of Reference (TOR) of the Environmental Implementation Report (EIR)/Functional Servicing Study (FSS) for North Oakville, the following requirements are to be satisfied:

- Refine corridor widths of medium and high constraint streams within the study area; and
- Develop preliminary design concepts based on the principles of "Natural Channel Design" for streams to be relocated and/or rehabilitated.

Therefore, the following tasks were completed to satisfy the requirements of the TOR of EIR/FSS and are presented in this report:

- Corridor width estimation; and
- Preliminary natural channel design for the proposed channel diversions.

6.2 Background

The following studies, technical guidelines and references were reviewed and used in the preparation of this study:

- North Oakville Creeks Subwatershed Study (NOCSS), 2006
- North Oakville Creeks Subwatershed Study Addendum, 2007
- Morphologic Relationships of Rural Watercourses in Southern Ontario and Selected Field Methods in Fluvial Geomorphology, Annable, 1996
- River & Systems: Flooding Hazard Limit, Technical Guide, Ontario Ministry of Natural Resources, 2002
- Belt Width Delineation Procedures, PARISH geomorphic, 2004

6.3 Corridor Width Delineation

The NOCSS and its related addendum set out the approach for the delineation of stream corridor widths. The corridor widths of the high and medium constraint streams and the end points of the reach delineations are required to be refined as part of the EIR/FSS study. High constraint streams are required to preserve the form and function, while medium constraint streams are required to preserve the current functions. Low constraint streams can be replaced through infrastructure or stormwater management practices. The factors to be considered in the refinement of the corridor widths include:

- Fluvial geomorphologic requirements;
- Regulatory floodplain;
- Stable slope top of bank;
- Fish and fish habitat protection requirements;
- Preservation of hydrologic function;
- Edge of any identified terrestrial features;
- Hydrologic features ”A”; and
- Setback and buffer requirements.

Hydrologic features “B” and topographic depressions do not contribute to the definition of corridor widths. Hydrological features associated with the Natural Heritage System and located inside the high and medium constraint stream are identified as Hydrologic features “A”. Hydrological features not associated with the Natural Heritage System are identified as Hydrologic features “B”. The factors considered in the refinement of the corridor width are discussed in Sections 6.3.1 to 6.3.7. These analyses have been completed for reaches 14W-11A (Medium Constraint), 14W-12 (High Constraint), 14W-13 (Low Constraint), 14W-14 (Medium Constraint) and 14W-16 (Medium Constraint) within the Subject property. Reaches 14W-11A, 14W-13 and 14W-14 will be eliminated and diverted to accommodate the proposed development. The estimated corridor widths for reaches 14W-11A, 14W-13 and 14W-14 will be applied to the corresponding diversion channels.

6.3.1 Fluvial Geomorphic Analysis

A historical evaluation of changes of channel alignment was conducted using air photos from 1934, 1960, 1969, 1988 and 2009 (Figure 6.2). It was determined that all watercourses within the study limit have been significantly altered, presumably to accommodate agricultural practices. The drainage courses have been repeatedly straightened, and a relatively short reach (14W-12) just upstream of Dundas Street remains in a natural condition.

14W-12 is the only reach observed to have a defined channel. This definition occurred immediately upstream of Dundas Street and evolves into a poorly defined swale at the upstream end of the reach. Channel disturbances consist of the Dundas Street crossing, concrete revetments and farm crossings. The primary geomorphic process influencing this reach is aggradation and widening. Fallen and leaning trees, exposed tree roots, poorly formed bars, siltation in pools and riffles and accretion on point bars were noted at the Subject Property.

The remaining reaches on Fourteen Mile Creek West are poorly defined vegetated swales. The majority of the reaches show signs of straightening and agricultural influences. Therefore, the fluvial geomorphic analysis is not applicable to these reaches since they are not in a natural condition.

6.3.1.1 Meander Belt Width

Since the meander belt widths of the existing streams cannot be determined from the historical movement, they were calculated using the following two empirical methods:

- PARISH Geomorphic Ltd., 2004
- Annable, 1996

The results of the calculation are presented in Table 6.1 which shows reasonable agreement between the two methods.

Table 6.1 – Estimated Belt Widths

Reach	Meander Belt Width (m)		
	PARISH Geomorphic Ltd	Annable (1996)	Selected Value
14W-11A	-[a]	15.5	16.0
14W-12	57.4[b]	54.8	57.0
14W-12A	32	27	32
14W-13	-[a]	1.6	2.0
14W-14	31.1	29.8	31.0
14W-16	52.2[b]	49.3	53.0

[a] This empirical relation is not applicable for reaches satisfying the following criteria: *2-Year Discharge (m^3/s) x Channel Slope (m/m) x Drainage Area (km^2) < 6 x 10^{-4}*

[b] Includes allowances for hydrologic regime change in post development conditions

6.3.1.2 100 Year Erosion Rate

According to the NOCSS (Figures 6.3.15a and 6.3.15b), the 100 Year erosion rate or 10% of the meander belt width to each side of the belt width is applied as a factor of safety. The 100 Year erosion rate cannot be estimated using historic air photos as all water courses within study area have been altered to accommodate agricultural practices. Therefore, 10% of the meander belt width is added to each side of meander belt width instead of 100 Year erosion rate.

6.3.2 Regulatory Floodplain

In accordance with NOCSS, the regulatory floodplain delineation is required for all high and medium constraint streams as identified in the Secondary Plan. The floodplain is to be delineated for the larger of the Regional Flood or the 100 year flood.

A medium constraint stream (14W-13) and a low constraint stream (14W-14) within the study area will be relocated along the southeast of Highway 407 and southwest of the property limits and a medium constraint stream (14W-11A) within the study area will be realigned along the southeast of Highway 407 and southeast of property limits to accommodate the proposed development (Figure 6.1). Therefore, the regulatory floodplain was delineated for the remaining watercourses, 14W-11A, 14W-12 and 14W-16, within the study area for pre-development conditions and is shown in Figure 6.3. The regulatory floodplain for post-development conditions was delineated for reach 14W-12 only as shown in Figure 6.3. The regulatory floodplain for the rehabilitation reach 14W-16, diversion reaches 14W-21, 14W-22 and 14W-23 will be delineated during the detailed design stage. The diversion channel and rehabilitation channels will be designed such that the regulatory floodplain is within the proposed corridor widths. Detailed hydraulic analysis is presented in Appendix 6-1.

6.3.3 Top of Bank

A field analysis was undertaken to delineate the top of bank for the stream to remain in an undisturbed condition. This analysis was performed for the Subject Property, but top of bank staking for the remaining portions of the watercourse inside the subcatchment boundary remains to be done as these areas are located on adjacent landholdings. A similar exercise to determine the stable top of bank delineation will be required as the development plans for these areas are advanced.

For the Subject Property, field staking was initially performed by MMM staff in 2009 according to professional experience based on similar watercourse forms. The staking was subsequently reviewed by Conservation Halton and Town of Oakville staff to arrive at a final position as shown in Figure 6.3, along with the required setbacks. Reservation on the final position of the top of bank lines for the areas indicated on Figure 6.3 was expressed to allow for internal discussions between the Town of Oakville and Conservation Halton on the watercourse and valleyland functions in these areas as they were not readily apparent in the field.

All watercourses inside the Subject Property are unconfined systems, and the delineated top of bank forms a general separation between the valley form and areas currently available for agricultural operations. As such, a geotechnical opinion on the stability of this line is not required (as shown by NOCSS, Figure 6.3.15b). Nevertheless, the negotiated final position of this line and a 7.5m setback from it are shown in Figure 6.3. Both the top of bank line and the 7.5 m offset are contained entirely within the overall environmental setback lines except relatively a small portion within reach 14W-16. This corresponding top of bank line is preliminary as discussed above and will be finalized after consultation with Conservation Halton and Town of Oakville.

6.3.4 Fisheries Setback Requirements

Buffer widths in the 15 to 30 m range are required to maintain the biological components of many wetlands and streams (Castelle et al., 1994). Environment Canada (2004) recommends a minimum buffer of 30 m for streams and recognizes that vegetating the riparian areas associated with lower order streams is critical. MNR (1994) *Fish Habitat Protection Guidelines for Developing Areas* recommends buffers of 15 m from important fisheries habitat.

For the redside dace habitat, the buffer requirements of the draft *Redside Dace Recovery Strategy* (Dextrase et al., 2005) are recommended. This would result in buffer widths of 30 m from top of bank for incised channels and 30 m on either side of meander belt width if a defined valley is not present. Therefore, redside dace habitat reach 14W-12 is provided with 30 m buffer width on either side of meander belt width.

6.3.5 Setback and Buffer Requirements

A 7.5 m setback allowance for minor streams and a 15 m setback for major streams are provided and setbacks for each reaches within the development area are presented in Table 6.2.

Table 6.2 – Setback Requirements

Reach	Setback (m)
14W-11A/14W-23	15
14W-12	30[a]
14W-16	15
14W-14/14W-22	15
14W-13/14W-21	7.5

[a] Based on redside dace habitat

6.3.6 Hydrologic Feature 'A'

There are three Hydrologic Features 'A' in the Fourteen Mile Creek reaches, 14W-14, 14W-12 and 14W-14A, within the Subject Property identified on Figure 7.3.1 of NOCSS and shown on Figure 5.1. Reach 14W-14 will be eliminated and replaced by diversion 14W-22. Hydrologic Feature 'A' in this area will be replaced by online wetlands and floodplain ponds along the proposed diversion 14W-22 as shown in Figure 6.4a. Hydrologic Feature 'A' in reach 14W-12 within the Subject Property will not be disturbed by the development. Therefore, the two Hydrologic Features 'A' will have various setbacks as discussed above. The Hydrologic Feature 'A' in the reach 14W-14A is a manmade pond and will be replaced by additional active storage volume in the SWM pond.

6.3.7 Corridor Widths

As previously discussed, the following factors were considered for the corridor width delineation:

- Fluvial geomorphologic requirements;
- Regulatory floodplain;
- Stable slope top of bank;
- Fish and fish habitat protection requirements;
- Preservation of hydrologic function;
- Edge of any identified terrestrial features;
- Hydrologic features "A"; and
- Setback and buffer requirements.

Each of these factors have been considered and calculated where appropriate. Figure 6.3 shows the corridor width for each of the reaches and are presented in Table 6.3.

Table 6.3 – Estimated Stream Corridor Width

Reach	Corridor Width Components			Corridor Width (m)
	Meander Belt Width (m)	Erosion Allowance (m)	Setback and Buffer (m)	
14W-11A	16.0	2.0	15.0	50.0
14W-12	57.0	6.0	30.0	129.0
14W-12A	32	3	30	98.0
14W-13	2.0	0.2	7.5	17.4
14W-14	31.0	3.0	15.0	67.0
14W-16	53.0	6.0	15.0	95.0

6.4 Conceptual Natural Channel Design

Stream rehabilitation opportunities have been identified in the Management Strategy of the NOCSS and recommends that:

- High Constraint Streams must be protected in their locations. The only modifications permitted would be through local enhancement or rehabilitation works.
- High Constraint Streams with Rehabilitation must be maintained in their current location but provide enhancement opportunity to provide for effective protection and their functional role.
- Medium Constraint Streams can be either relocated or deepened to improve the overall resiliency of the stream network and subwatershed.
- Low Constraint Streams can be replaced through infrastructure or SWM facilities.

A medium constraint stream (14W-14) and a low constraint stream (14W-13) of the Fourteen Mile Creek West within the development area are proposed to be eliminated to accommodate the development. New channels are therefore needed to intercept the flows from 14W-13 and 14W-14 just downstream of Highway 407 and to divert to tributary 14W-16. The proposed diversions 14W-21 along Highway 407 will intercept flows from the reaches 14W-13 and 14W-14 just downstream of Highway 407 and divert them to reach 14W-16 via another proposed diversion 14W-22 along the southwest property limits as shown in Figure 6.1. The existing medium constraint tributary 14W-16 between the southwest property limit and the main branch 14W-12 will be rehabilitated to accommodate the increased discharges due to the diversion of the Fourteen Mile Creek West tributaries 14W-13 and 14W-14. Another medium constraint stream 14W-11A will be realigned along the Highway 407 and southeast limits of the property limits (14W-23) to accommodate development.

6.4.1 Design Criteria

The design criteria for the natural channel design of diversions 14W-21, 14W-22 and 14W-23 and the rehabilitation of tributary 14W-16 are summarized as follows:

- Provide bankfull channel dimensions based on stream morphology;
- Convey the larger of 100-Year and Regional Storm floods with a minimum freeboard of 0.3 m;
- Keep the maximum channel velocity less than 1.7 m/s for the bankfull condition and 2.0 m/s for storms up to a 100-Year flood, to enable the use of vegetation for channel protection;
- Provide adequate hydraulic capacity through road crossings;

- Enable the passage of fish up to the culvert at Highway 407;
- A riffle/pool meandering sequence along the flatter channel reaches; and
- A step/pool system to enable the passage of fish up the steeper channel reaches.

6.4.2 Hydrology

The NOCSS and NOCSS Addendum recommend that unit area flows be used to calculate design flows for existing conditions. They are given in the NOCSS Addendum for the 2 year to 100 year events and Regional Storm and are presented in Table 7.2. Estimated peak flows corresponding to channel diversions and rehabilitation reach are summarized in Table 6.4.

Table 6.4 – Peak Flows (m^3/s)

Reach	Drainage Area (ha)	Frequency (Years)						
		2	5	10	25	50	100	RS[1]
14W-21	6.76	0.010	0.030	0.040	0.060	0.080	0.090	0.300
14W-22	129	0.739	1.20	1.48	1.90	2.19	2.46	6.41
14W-16	327	2.22	3.56	4.32	5.49	6.34	7.14	17.9
14W-11A	38.7	0.148	0.281	0.370	0.492	0.568	0.658	1.74

[1] Regional Storm

6.4.3 Proposed Channel Morphology

6.4.3.1 Tributary 14W-16

A bankfull discharge of 1.95 m^3/s was estimated for this reach based on a 1.5 year return period flow and a 1.25 m^3/s was estimated using the Annable empirical relationship for rural water courses in Southern Ontario. These two predictions are very close to each other and a bankfull discharge of 1.95 m^3/s was selected for the tributary 14W-16.

A bankfull width of 5.0 m and average bankfull depth of 0.36 m was selected to produce a bankfull velocity of less than 1.7 m/s (which allows vegetation to be used as erosion protection) and a width to depth ratio greater than 10. A meander length of 50 m was selected as 10 times the bankfull width.

The proposed channel morphology for this relatively flat reach of the watercourse (slope 0.53%) is a meandering watercourse with a riffle/pool sequence, where the riffle slope is approximately 2 times the average slope of the channel, has a bankfull width of 5 m, and bankfull depth of 0.36 m with side slopes of 2:1. The proposed alignment and plan form of reach 14W-16 is shown in Figures 6.4a, 6.4c and 6.4d. Typical riffle/pool cross sections for the 14W-16 channel are provided in Figure 6.5.

The pool cross-section consists of a pool with a depth twice the bankfull depth, and a point bar with a slope of ±10%. The maximum depth of the pool is located 2/3 of the length of the pool from the start of the pool. The morphological parameters for tributary 14W-16 are presented in Table 6.5.

6.4.3.2 14W-22 Diversion

The proposed morphology of the 14W-22 diversion is a meandering watercourse with riffle/pool sequence. The proposed cross-section is that of a moderately entrenched stream with an entrenchment ratio less than 2.2. The bankfull discharge of 0.64 m^3/s was estimated based on a 1.5 year return period flow and 0.63 m^3/s was estimated based on the Annable empirical relationship for rural watercourses in Southern Ontario. These two predictions are in excellent agreement and a bankfull discharge of 0.64 m^3/s was selected for 14W-22 diversion.

A bankfull width of 4.5 m with a bankfull depth of 0.28 m was selected to provide a bankfull velocity less than 1.7 m/s (to permit vegetative erosion protection) and a bankfull width to depth ratio greater than 10. The proposed alignment and plan form of reach 14W-16 is shown in Figures 6.4a, 6.4b and 6.4c. Typical riffle/pool cross sections for the 14W-22 channel are provided in Figure 6.5.

The proposed riffle slope is approximately twice the average slope of the reach, and the pool depth at low flow is equal to bankfull riffle depth, with twice the bankfull riffle depth at bankfull discharge. The morphological parameters for diversion 14W-22 are presented in Table 6.5.

6.4.3.3 14W-21 Diversion

The proposed morphology of the 14W-21 diversion is a relatively straight watercourse. Estimated bankfull discharge based on the Annable empirical relationship is 0.07 m^3/s which corresponds to a flow greater than the 25 year return period. Therefore, the bankfull discharge of 0.003 m^3/s was selected for 14W-21 diversion based on a 1.5 year return period flow. A bankfull width of 0.5 m with a bankfull depth of 0.10 m was selected. These dimensions will provide bankfull discharge greater than 0.003 m^3/s and were selected to accommodate construction. The morphological parameters for diversion 14W-21 are presented in Table 6.5. The proposed alignment and plan form of reach 14W-21 is shown in Figures 6.4a and 6.4b.

6.4.3.4 14W-11A Realignment (14W-23)

The proposed morphology of the 14W-11A realignment is a relatively straight watercourse. Estimated bankfull discharge based on the Annable empirical relationship is 0.26 m^3/s which corresponds to a 5 year return period. Therefore, a bankfull discharge of 0.012 m^3/s was selected for 14W-11A realignment based on a 1.5 year return period flow.

A bankfull width of 1.5 m and a bankfull depth of 0.20 m was selected to provide a bankfull velocity less than 1.7 m/s (to permit vegetative erosion protection). Typical riffle/pool cross sections for the 14W-23 channel are provided in Figure 6.5.

The proposed riffle slope is approximately twice the average slope of the reach, and the pool depth at low flow is equal to the bankfull riffle depth and twice the bankfull riffle depth at bankfull discharge. The morphological parameters for diversion 14W-23 are presented in Table 6.5. The proposed alignment and plan form of reach 14W-23 is shown in Figures 6.4a and 6.4e.

Table 6.5 – Morphological Parameters for Channel Diversion and Rehabilitation

	14W-16	14W-22	14W-21	14W-23
Drainage area	327 ha	129 ha	6.76 ha	38.7 ha
Bankfull Discharge	1.95 m^3/s	0.64 m^3/s	0.003 m^3/s	0.13 m^3/s
Bankfull Width	5 m	3.5 m	0.5 m	1.5 m
Bankfull Depth	0.36 m	0.28 m	0.10 m	0.20 m
Bankfull Width/Depth	14	13	5	6
Average Channel Slope	0.53%	0.32%	0.32%	0.40%
Riffle Slope	1.06%	0.64%	0.64%	0.80%
Meander Length	56 m	35	-	-
Riffle Length	13 m	9 m	6 m	6 m
Sinuosity	1.2	1.2	1.0	1.0
Entrenchment	>2.2	1.4 – 2.2	1.4 - 2.2	1.4 – 2.2

6.4.4 Road Crossings

Three road crossings are proposed as shown in Figure 6.4a, one at diversion channel 14W-22 and the other two at tributary 14W-16. These road crossings will be sized during preliminary design to have no adverse impacts on the watercourse. While the hydraulic opening dimensions of the crossing structures will be advanced at the detailed design stage, all crossings will be constructed with full span of the low flow channel. All structures will present open bottoms to facilitate the development of a healthy stream substrate and will avoid the installation of piers or other channel obstructions in the hydraulic cross-section where possible.

6.4.5 Hydraulic Analysis

A HEC-RAS analysis of tributary 14W-16, 14W-22, 14W-23 and 14W-21 diversions was carried out to determine the 2 to 100-year and the Regional Flood water profiles, and to confirm the adequacy of the channel capacity. The proposed three road crossings were not included in the model and will be considered during the detail design stages. At this conceptual design stage, riffle sections were considered for the proposed diversion channels and rehabilitation channel for the hydraulic analyses, and cross-section details including pool sections will be included at the detail design stage. Manning's roughness coefficients of 0.03 (channel) and 0.07 (bank) were used.

The predicted bankfull and 100-year velocities for the tributary 14W-16 and diversions 14W-21, 14W-22 and 14W-23 are less than 1.7 m/s and 2.0 m/s respectively, indicating that vegetation can be used for erosion protection of the watercourse.

6.4.6 Maintenance of Riparian Storage

The NOCSS and its related Addendum outline requirements to be addressed when proposing to lower and/or relocate a medium constraint stream. One such requirement includes maintenance of discharge-storage relationships for regulatory floodplains. In particular, any modifications to a stream or floodplain should address the maintenance of discharge-storage characteristics to prevent increases in peak flows in downstream areas. The NOCSS Addendum states that discharge-storage characteristics must be addressed for a range of design events including the 2 to 100-year and Regional Storm events.

To address this requirement and confirm channel size, a riparian storage analysis of Fourteen Mile Creek West was undertaken with the HEC-RAS model. As noted in Appendix 6-1, the existing HEC-RAS model sections were developed with OBM topographic mapping and field survey data. To evaluate the existing riparian volume within Fourteen Mile Creek West, and in order to eliminate backwater effects from manmade obstructions, an existing culvert within the Subject Property was temporarily removed from the model.

Under proposed conditions, the HEC-RAS cross-sections were modified to reflect the proposed channel cross sections shown in Figure 6.5. As with the evaluation of existing conditions, the riparian storage within the proposed system is completed without the effects of culverts.

To effectively evaluate and compare the riparian storage volumes for both existing and proposed conditions, HEC-RAS simulations were undertaken for various flow conditions. Results of the riparian storage analysis are summarized in Table 6.6 with detailed output provided in Appendix 6-2.

Table 6.6 – Comparison of Pre-Development and Post-Development Riparian Storage

Return Period (Year)	Floodplain Storage Volume (m^3)	
	Existing	Post Development
2	7,500	6,800
5	9,920	9,630
10	11,280	11,290
25	13,140	13,850
50	14,730	15,640
100	16,170	17,010
Regional Storm	35,310	35,930

Approximately 35,310 m^3 of floodplain storage is currently available in the Fourteen Mile Creek West system within the study area during a Regional Storm event, while approximately 35,930 m^3 of floodplain storage is provided under post development conditions. The requirement for the maintenance of discharge-storage is achieved for a range of peak flows from 10 year event to Regional Storm assuming the new natural valley channel design. There is a 9% and 3% reduction in the volume of existing riparian storage for 2 and 5 year events respectively. This is not significant in the context of the entire watershed and is estimated to have an insignificant effect on downstream flows. The elimination of tributaries 14W-13 and 14W-14 provides challenges to the maintenance of the existing volume of riparian storage for the 2 and 5 year events.

6.4.7 Stream Length Requirements

Medium constraint stream reaches 14W-14 and 14W-11A and a low constraint stream reach 14W-13 will be eliminated and replaced by proposed channels 14W-21, 14W-22 and 14-23. A medium constraint

stream reach 14W-16 will be rehabilitated to accommodate higher flows. Table 7.6 shows the existing stream lengths and the proposed stream lengths for the medium constraint streams. The proposed realignment and rehabilitation of medium constraint streams have more channel length than existing conditions through realignment and meandering of these channels. The existing medium constraint stream length of 1,328 m will be replaced with 1,550 m length of more defined channel with increased habitat diversity (i.e. riffles, pools, etc) improving the habitat, specifically for Redside Dace. The realignment provides an opportunity to improve fish habitat over the existing system that is periodically subject to disturbance associated with agricultural practices. The low constraint stream reach 14W-13 will be replaced through SWM facility as recommended in Management Strategy of the NOCSS.

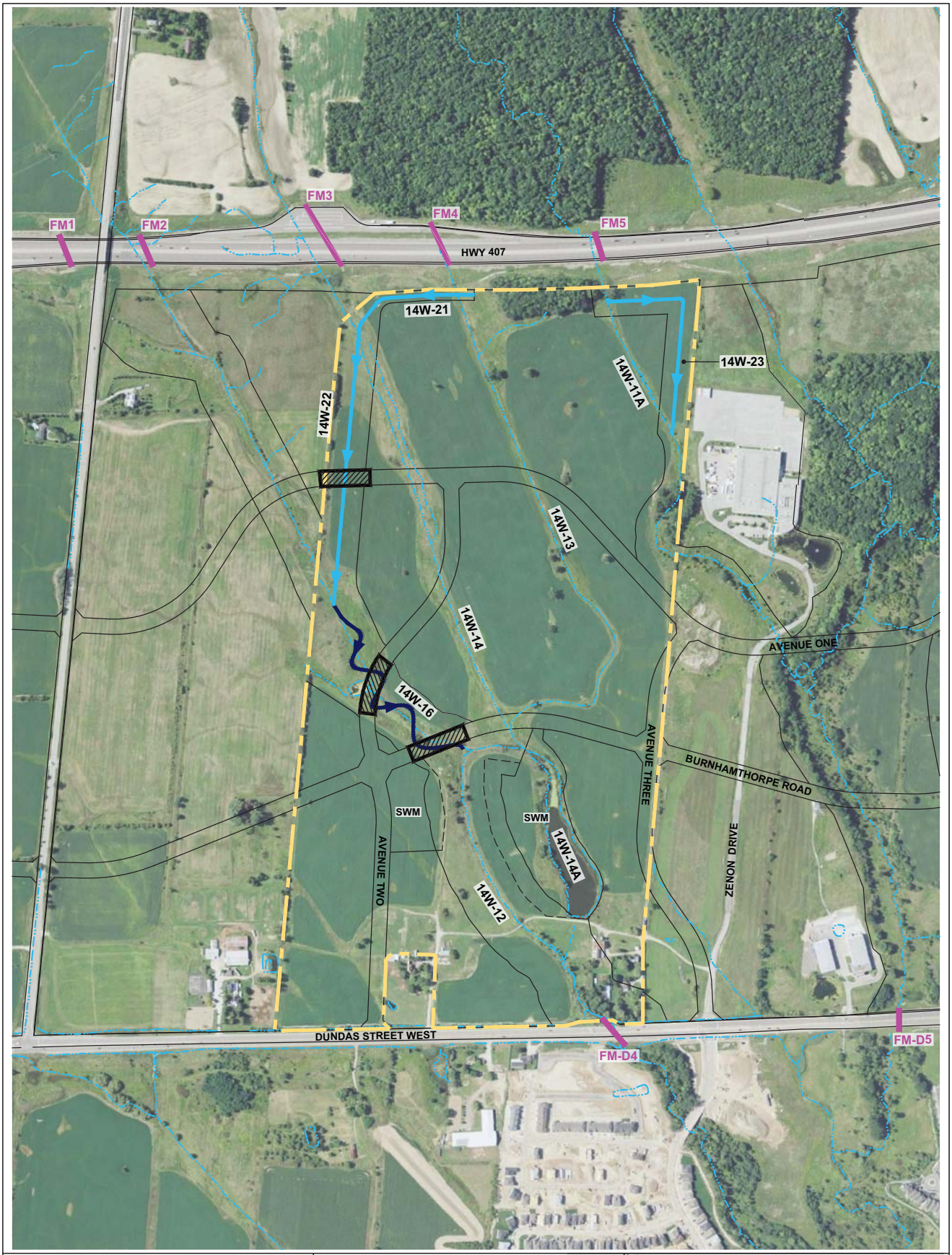
Table 6.7 – Existing and proposed Stream Lengths for Medium Constraint Streams

Channel ID	Existing Channel Length (m)	Proposed Channel Length (m)
14W-14	733	731 (14W22=521 m; 14W-21=210 m)
14W-16	370	459
14W-11A	225	360 (14W-23)
Total	**1,328**	**1,550**

6.5 Summary

Refinement of corridor width for high and medium constraint streams have been completed based on the guidance provided in the NOCSS. Two medium constraint tributaries of Fourteen Mile Creek West in the Subject Property are realigned and a low constraint tributary is eliminated to accommodate the proposed development. One medium constraint reach will be rehabilitated to enhance its form and function. Conceptual design has been developed for streams to be realigned and rehabilitated based on the principles of “Natural Channel Design” and NOCSS requirements.

FIGURE 6.1.dwg Existing Channel System & Proposed Channel Diversion & Rehabilitation S:\14-41\14\09222-001-WR1\REPORT 01 FEB 2011\ May 10, 2011 - 10:03am



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Existing Channel System, And Proposed Channel Diversion and Rehabilitation

LEGEND

- SUBJECT PROPERTY
- PROPOSED WATER CROSSING
- EXISTING CULVERT
- CHANNEL DIVERSION
- CHANNEL REHABILITATION

Scale: 1 : 6000 (0, 100, 200, 300m)

Client: Bentall Kennedy

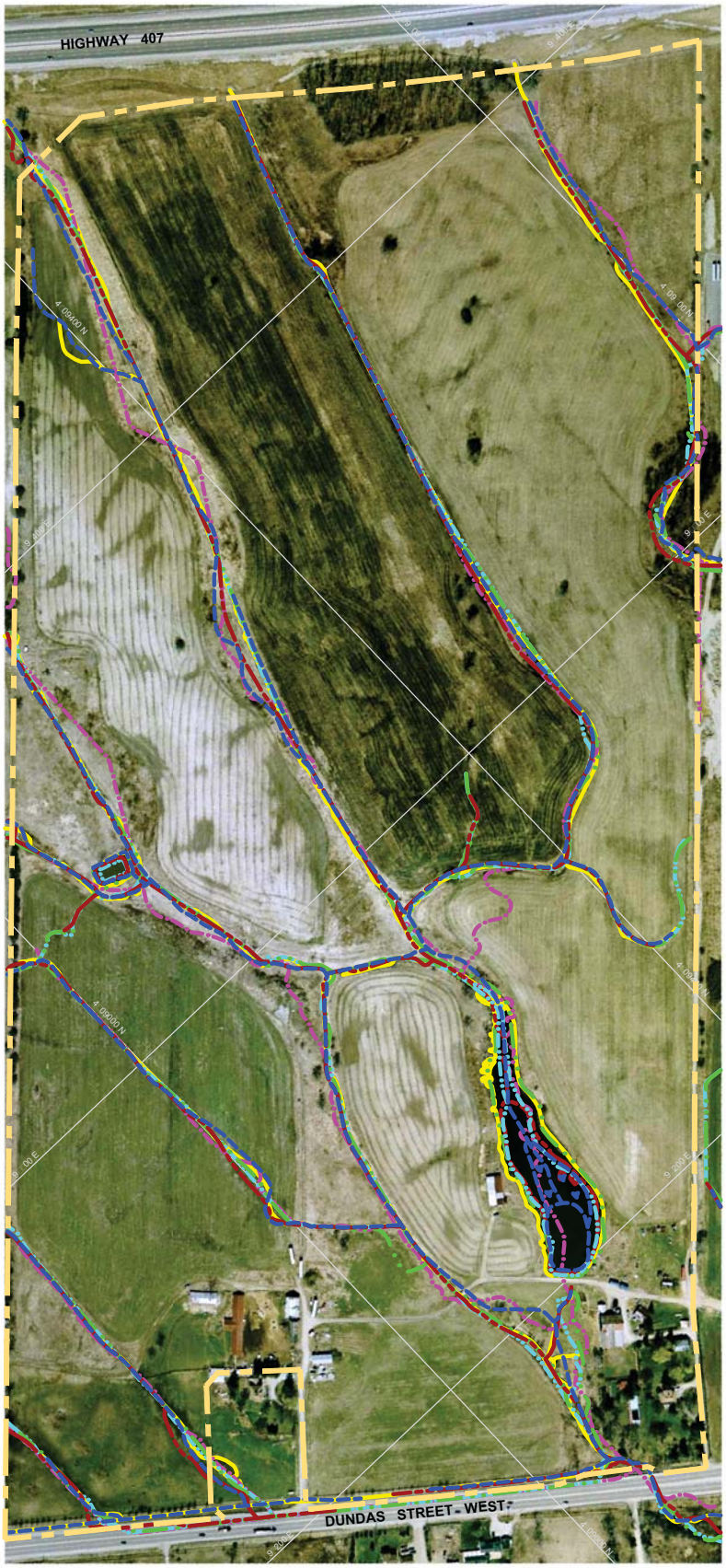
Prepared by: MMM GROUP

Date: May 2011

Project No.: 14-09222-001-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.1



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Historical Channel Planform

LEGEND

- SUBJECT PROPERTY
- 1934
- 1960
- 1969
- 1979
- 1988
- 2009

Scale: 1 : 4000 (0, 50, 100, 150, 200m)

Client: Bentall Kennedy

Prepared by: MMM GROUP

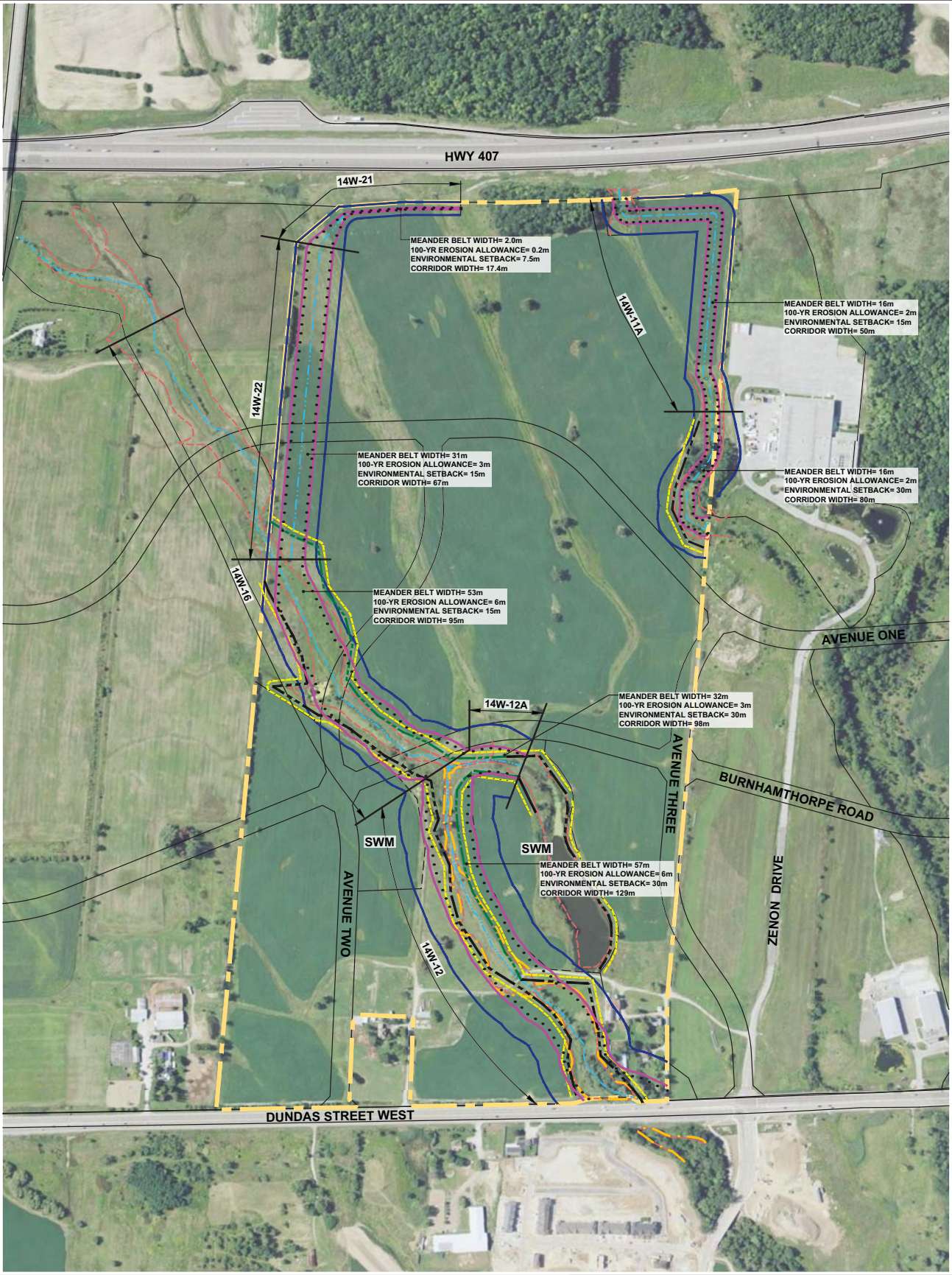
Date: May 2011

Project No.: 14-09222-001-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.2

FIGURE 6.3.dwg Corridor Delineation S:\14-41\14\09222-001-WR1\REPORT 01 FEB 2011\ May 10, 2011 - 10:06am



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Corridor Delineation

LEGEND

- SUBJECT PROPERTY
- EXISTING REGIONAL FLOODLINE
- POST-DEVELOPMENT REGIONAL FLOODLINE
- MEANDER BELT WIDTH
- 100-YR EROSION ALLOWANCE (10% OF MEANDER BELT WIDTH)
- ENVIRONMENTAL SETBACK
- TOP OF BANK
- PRELIMINARY TOP OF BANK
- TOP OF BANK 7.5m BUFFER

Scale: 1 : 5000 (0, 50, 100, 150, 200, 250m)

Client: Bentall Kennedy

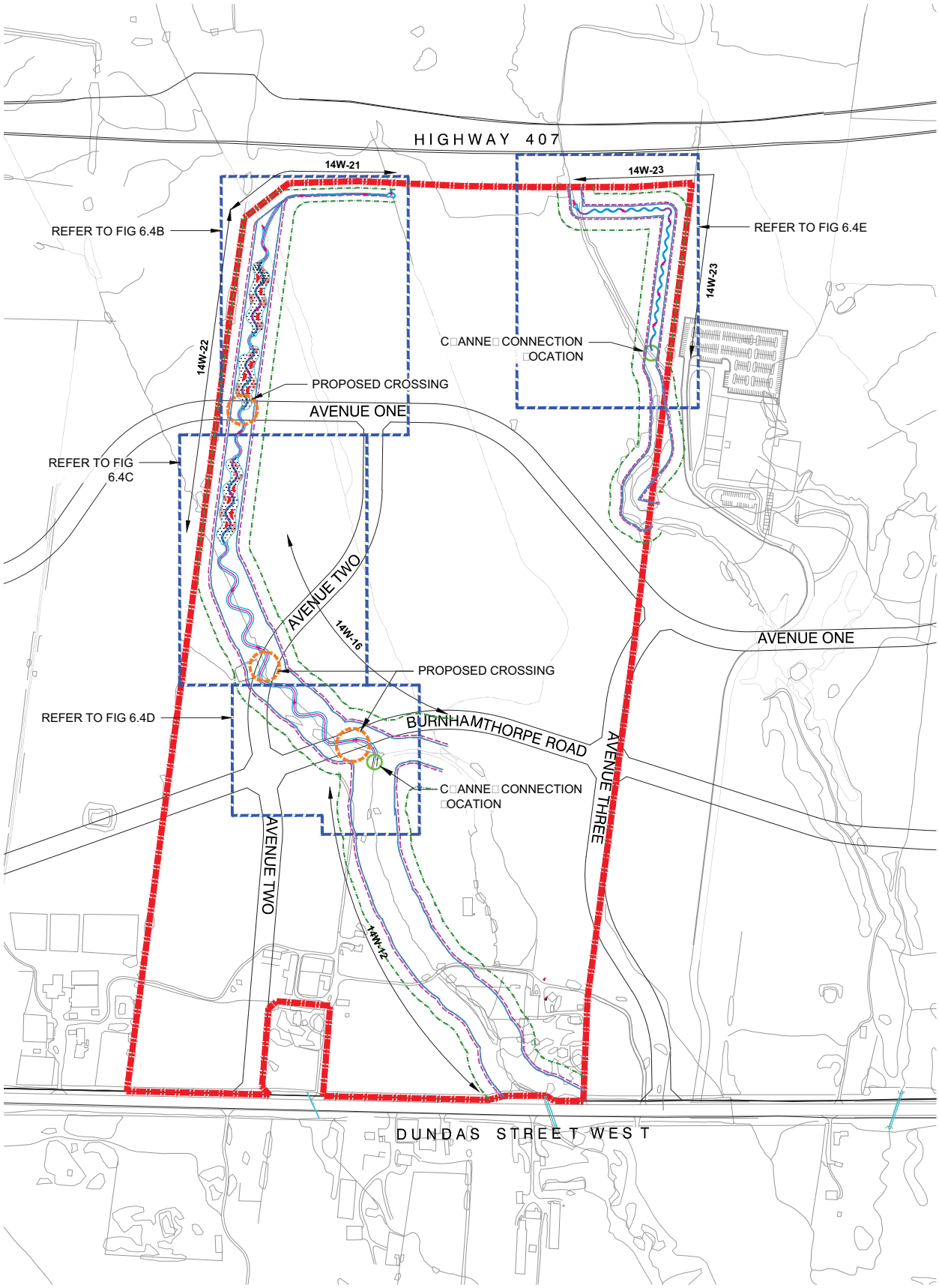
Prepared by: MMM GROUP

Date: May 2011

Project No.: 14-09222-001-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.3



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Fourteen Mile Creek Natural Channel Design Alignment And Planform Keyplan

LEGEND

- SUBJECT PROPERTY
- MEANDER BELT WIDTH
- 100-YR EROSION ALLOWANCE (10% OF MEANDER BELT WIDTH)
- ENVIRONMENTAL SETBACK
- CHANNEL DIVERSION / REHABILITATION

Scale: 1 : 5000 (0m 50 100 150 200 250m)

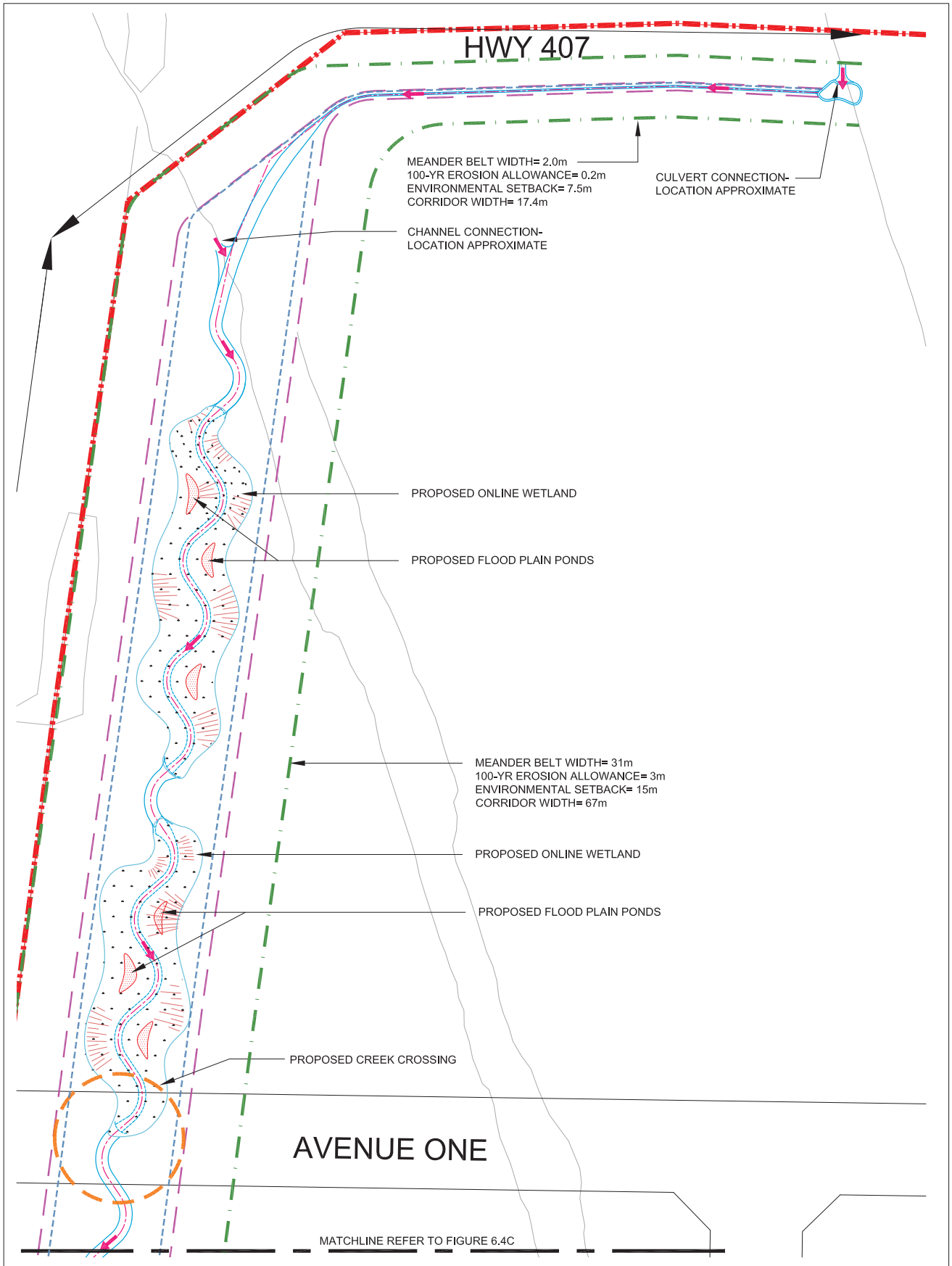
Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: May 2011

Project No.: 1409222.001

Figure 6.4A



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Diversion Channels 14w-21 And 14w-22
Alignment And Planform

LEGEND

- SUBJECT PROPERTY
- MEANDER BELT WIDTH
- 100-YR EROSION ALLOWANCE (10% OF MEANDER BELT WIDTH)
- ENVIRONMENTAL SETBACK
- CHANNEL DIVERSION / REHABILITATION

Scale: 1 : 1000

0m 100 200 300

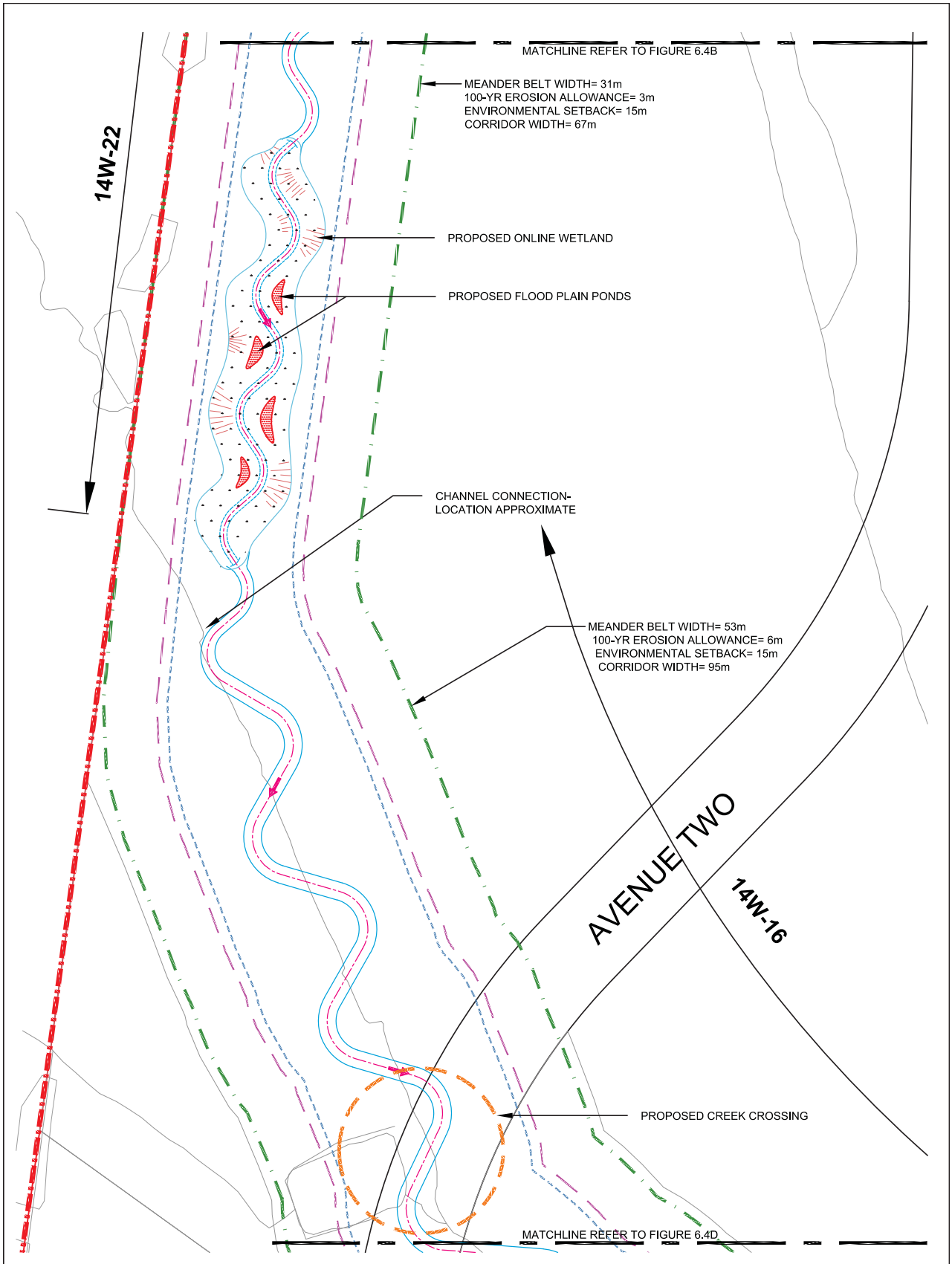
Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: May 2011

Project No.: 1409222.001

Figure 6.4B



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Diversion Channel 14w-22 And Reach 12w-16 Rehabilitation Alignment And Planform

LEGEND

- SUBJECT PROPERTY
- MEANDER BELT WIDTH
- 100-YR EROSION ALLOWANCE (10% OF MEANDER BELT WIDTH)
- ENVIRONMENTAL SETBACK
- CHANNEL DIVERSION / REHABILITATION

Scale: 1 : 1000

0m 100 200 300

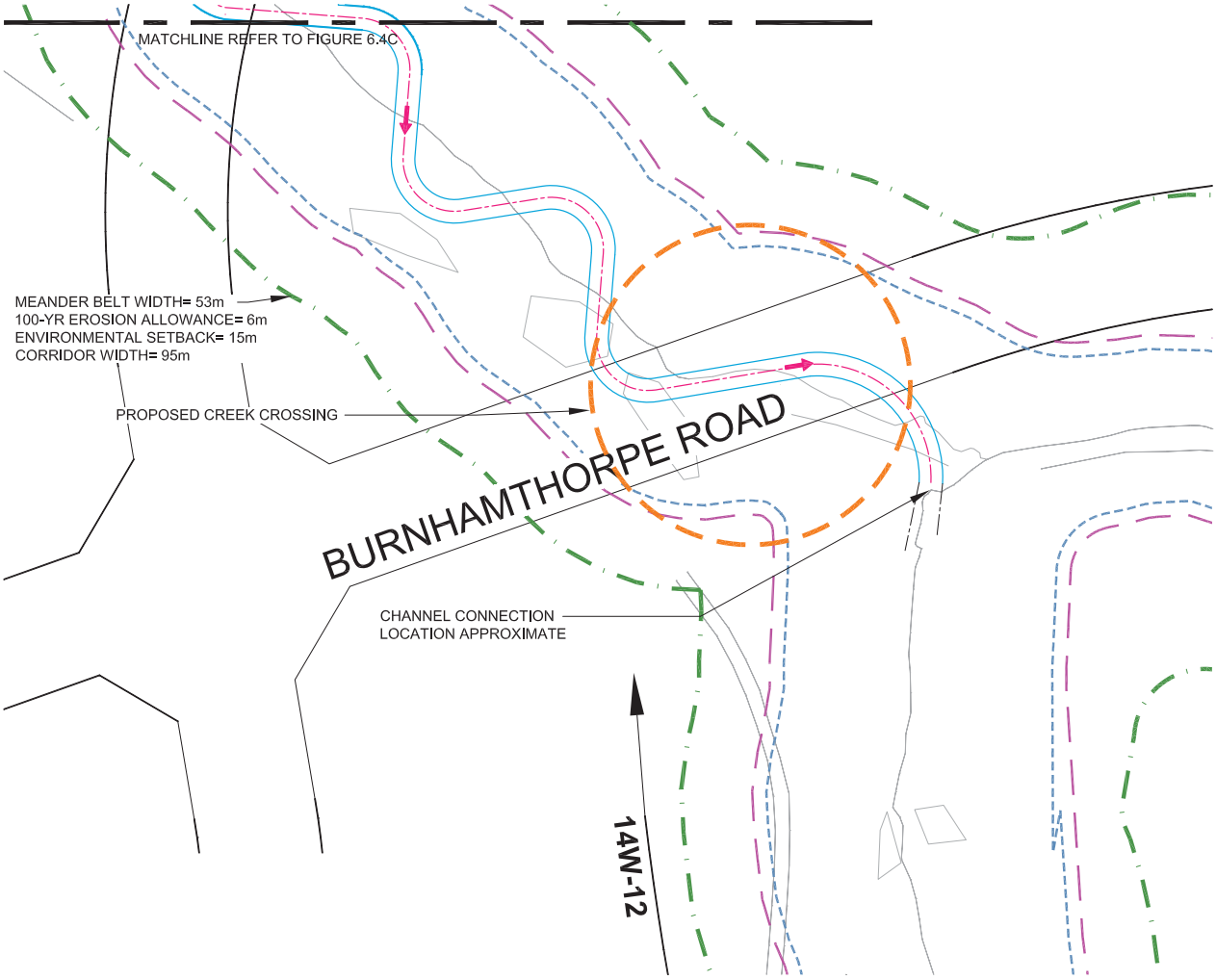
Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: February 2011

Project No.: 1409222.001

Figure 6.4C



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Reach 14-w16 Rehabilitation Alignment And Planform

LEGEND

- SUBJECT PROPERTY
- MEANDER BELT WIDTH
- 100-YR EROSION ALLOWANCE (10% OF MEANDER BELT WIDTH)
- ENVIRONMENTAL SETBACK
- CHANNEL DIVERSION / REHABILITATION

Scale: 1 : 1000

0m 100 200 300

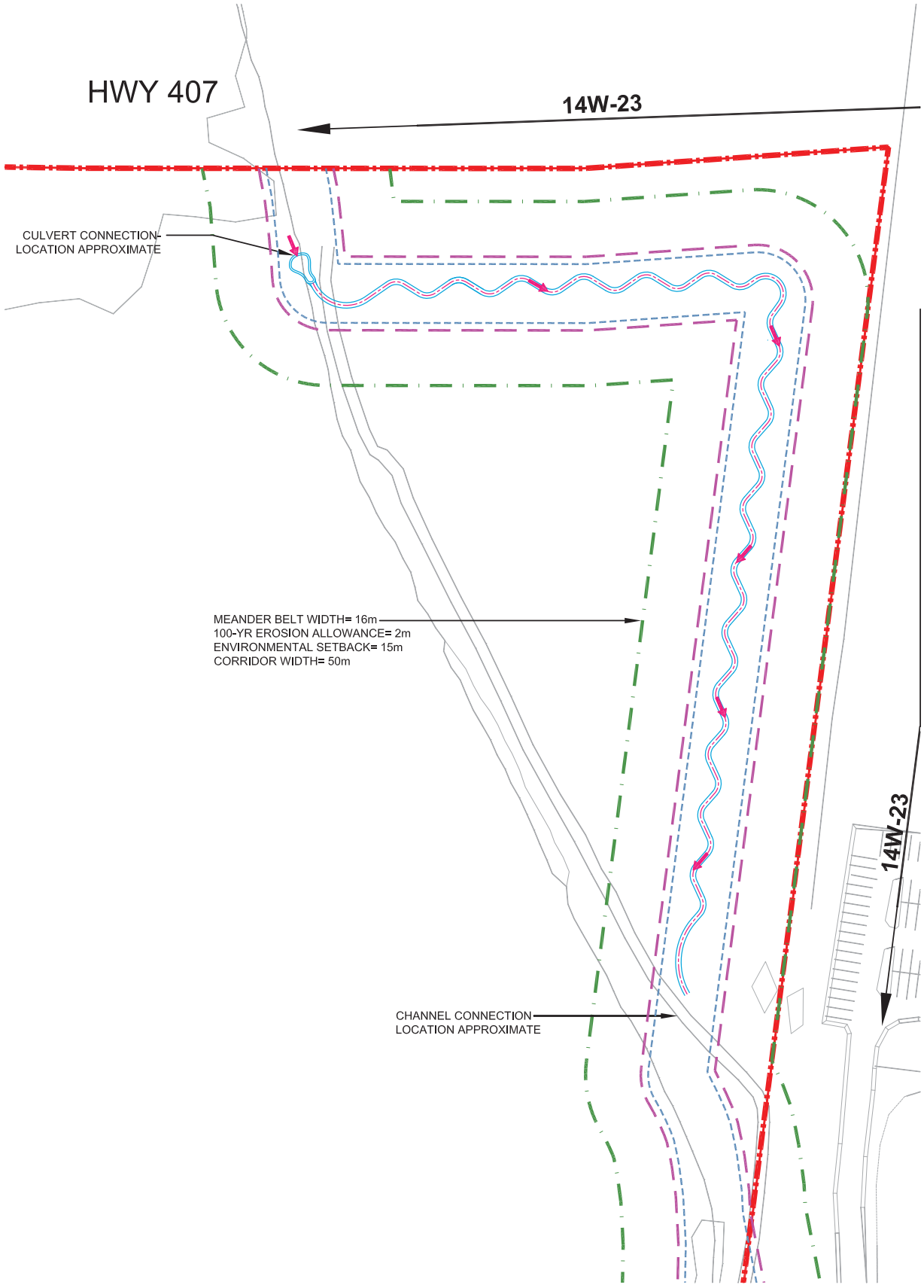
Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: May 2011

Project No.: 1409222.001

Figure 6.4D



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Diversion Channel 14w-23
Alignment And Planform

LEGEND

- SUBJECT PROPERTY
- MEANDER BELT WIDTH
- 100-YR EROSION ALLOWANCE (10% OF MEANDER BELT WIDTH)
- ENVIRONMENTAL SETBACK
- CHANNEL DIVERSION / REHABILITATION

Scale: 1 : 1000

0m 100 200 300

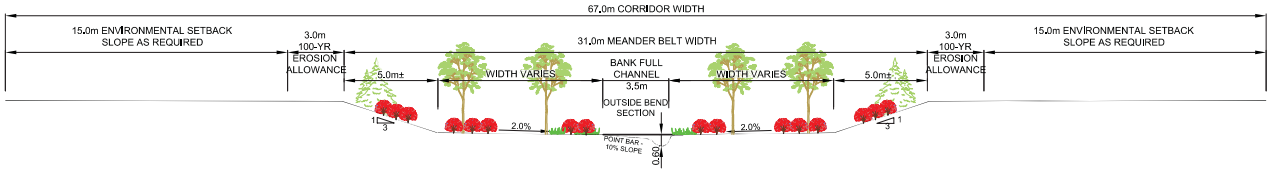
Client: Bentall Kennedy

Prepared by: MMM GROUP

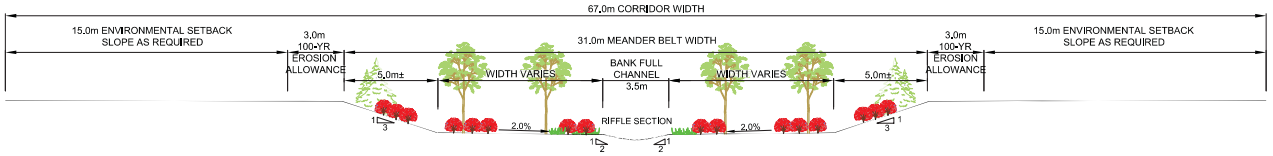
Date: May 2011

Project No.: 1409222.001

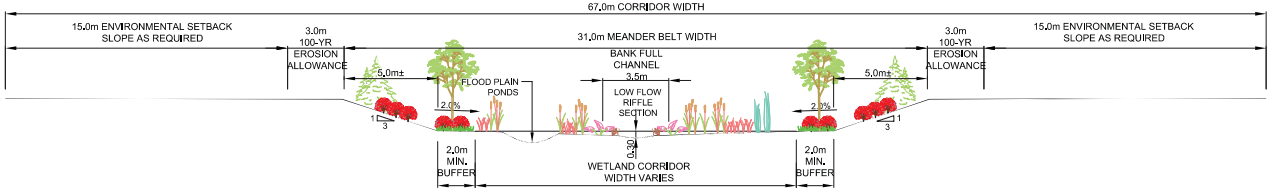
Figure 6.4E



CHANNEL CORRIDOR - CHANNEL OUTSIDE BEND



CHANNEL CORRIDOR - CHANNEL RIFFLE SECTION BEND



CHANNEL CORRIDOR - WETLAND LOCATION

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Channel Corridor Sections
Typical For 14w-22

Scale
1 : 250
0m 5m 10m 15m

Client
Bentall Kennedy

Prepared by
MMM GROUP

Date
February 2011

Project No.
1409222.001

Figure 6.5

7.0 Drainage and Stormwater Management

7.0 Drainage and Stormwater Management

7.1 Introduction

This section details the grading, drainage and stormwater management requirements for the Lazy Pats Lands of the North Oakville West Boundary Plan area.

OPA 289 policy 8.4.5 states that, "*The management of water resources within the North Oakville West Planning Area shall be undertaken in accordance with the directions established in the North Oakville Creeks Subwatershed Study (NOCSS). No amendments to the Secondary Plan shall be required to implement the recommendations of the Subwatershed Study or for changes to the number or location of stormwater management facilities in accordance with the policies of Section 8.6.2.2.a) of this Plan".*

Section 6.0 of the NOCSS presents the recommended Management Strategy for the North Oakville Creeks Subwatershed. It includes strategies for land use management, stormwater management, terrestrial and wetland resources management, riparian corridor management, rehabilitation, remediation and monitoring plans. The goals, objectives, and targets of the Management Strategy are set out in NOCSS Section 6.2.

The NOCSS Section 6.3.6 discusses the Stormwater Management component of the Management Strategy. It includes discussion on hydrology, peak flow control, hydrogeology, water quality, fisheries protection, low impact development, source pollution prevention and various types of SWM measures.

7.2 Stormwater Management Objectives

The overall stormwater management plan is intended to address multiple objectives including peak flow control, water quality, erosion control and maintaining existing hydrologic water balance. The recommended stormwater management approach detailed in NOCSS is as follows:

- **Water Quantity:** The NOCSS recommends that stormwater management targets include control of the peak flow to pre-development levels for the 2-year to 100-year return period events and the Regional Storm. The modeling of pre-development conditions to establish unit flow rate targets for quantity control purposes has been completed as part of NOCSS and presented in Table 7.2.

OPA 289 Policy 8.4.13.2 and the NOCSS Addendum identify that future land use development applications may carry out an investigation of the potential increases to flood risk in downstream areas to confirm if Regional Storm controls are necessary. If the study finds (and the Town and Conservation Halton concur), that no increase in risk occurs to downstream landowners or public uses, these agencies may conclude that control of the Regional Storm level is not required.

- **Infiltration:** The NOCSS recommends that infiltration levels be maintained as close to current levels as possible to reduce impacts on groundwater systems. The overall strategy is to provide as many opportunities for infiltration as possible in the developed areas. This can be achieved by various techniques that take advantage of physical settings (i.e. soil conditions and topography) as well as best available technology and management practices.

- **Water Quality:** The NOCSS recommends meeting MOE's Enhanced Level of water quality protection (Level 1) when sizing stormwater management facilities for phosphorus control and fisheries protection. The Town requires that there be no-net increase in phosphorus loadings as a result of development. This objective will be met with the use of enhanced Level SWM ponds and as a result, there is no requirement to further analyze phosphorus loadings during development approvals. Temperature controls at SWM facility outlets can be provided through bottom draw outlets and rock filtration measures combined with shading.

- **Erosion Control SWM Facility Sizing:** The NOCSS recommends that detailed erosion threshold analyses be required as part of an EIR/FSS so that existing channel erosion or aggradation is not exacerbated by development.

- **Topographic Depressions:** The NOCSS recommends that the storage within the topographic depressions be refined and checked against the storage within proposed SWM ponds in the EIR subcatchment area to verify that the SWM pond storage accounts for the depression storage.

- **Stormwater Management Applications:** The NOCSS recommends the use of a hierarchy of stormwater controls with preference for source control, followed by conveyance system control, with less reliance on end-of-pipe control. In addition, where feasible, the use of infiltration measures, including the diversion of drainage to pervious surfaces as well as designed infiltration facilities, surface retention, and storage is encouraged, to help maintain pre-development water balance conditions. NOCSS identifies the requirement for end-of-pipe SWM facilities for water quality and quantity control, it also recommends that consideration be given to alternative management measures to meet the SWM objectives and targets. In this regard, the NOCSS discusses alternative low impact development techniques, various source pollution protection programs and alternative SWM practices to be considered.

7.3 Assessment of Stormwater Management Alternatives

The stormwater management plan recommendations of the NOCSS which apply to the proposed development have been detailed in Section 3.4.2. NOCSS identifies the requirement for end-of-pipe SWM facilities for water quality and quantity control, it also recommends that consideration be given to alternative management measures to meet the SWM objectives and targets. In this regard, the NOCSS discusses alternative low impact development techniques, various source pollution protection programs and alternative SWM practices to be considered. As required by NOCSS and the EIR/FSS Terms of Reference, in this section the alternative Stormwater Management Practices described, evaluated for application in the development, and a preferred approach is selected to satisfy NOCSS SWM goals, objectives, and targets.

7.3.1 Stormwater Management Practices

Stormwater Management Practices (SWMPs) can be applied locally at the lot level, along conveyance systems, or as end-of-pipe facilities. Each SWMP varies in its effectiveness and utility to address different water quality and quantity concerns.

Lot level SWMPs include discharging roof leader to pervious surfaces or soakaway pits, rain gardens, pervious pavements, green roofs and reduced lot grading. These SWMPs encourage infiltration to

groundwater; help to reduce the volume of water travelling to the major and minor systems and help to preserve hydrologic regime. Infiltration techniques are also effective for reducing temperature effects and removing sediment, heavy metals and nutrients from stormwater. Generally, infiltration techniques are recommended in areas where the minimum infiltration rate is equal to or greater than 15 mm/hr. Where practical, this is a preferable SWMP.

Conveyance SWMPs include drainage swales, infiltration trenches, exfiltration/filtration system and filter strips. Drainage swales and filter strips rely on various forms of vegetation to enhance the pollutant removal, habitat value and aesthetics of a development. Without other SWMPs they can effectively treat the stormwater from small areas (< 2 ha).

End-of-pipe SWMPs, such as extended detention ponds, artificial wetlands and infiltration basins can remove moderate to high levels of sediment from stormwater. Extended detention wetlands are also efficient in removing nutrients from stormwater during the summer months. These facilities can be effective for a wide variety of land areas.

7.3.2 Evaluation

In reviewing these options for inclusion in the proposed Stormwater Management Plan, these alternatives were evaluated on the basis of capabilities, limitations and physical constraints associated with their implementation. This included the following factors:

- Their ability to meet SWM goals, objectives and targets;
- Suitability of soils and groundwater conditions;
- Site topography and size of contributing drainage areas;
- Compatibility with urban form and natural features; and
- Municipal servicing requirements.

The evaluation of alternative SWMPs has made use of guidelines in the *MOE Stormwater Management Planning and Design Manual, March 2003*, and *TRCA Low Impact Development Stormwater Management Planning and Design Guide, 2010.*

7.3.2.1 Lot Level SWMPs

The NOCSS recommends that the existing infiltration over the site be maintained but acknowledges that implementation is difficult (NOCSS analysis report Section 5.5.2, page 5-11). An approach to maintaining water balance can be attempted by implementing infiltration techniques within developed areas such as discharging roof runoff to soak away pits and pervious pavements where soils allow. These SWMPs are generally less feasible for the proposed industrial/commercial development within the Fourteen Mile Creek watershed (north of Dundas Street) as:

- The soils have been characterized as clay loams that have a relatively low infiltration potential; and
- Industrial/commercial development typically has a high imperviousness for viable site plans, therefore there would be minimal opportunity to implement infiltration techniques.

However, the following opportunities to integrate SWMPs at the lot level will be considered in detailed design stage. While they may be less effective at promoting pre-development rates of infiltration, they will assist in the conversion of rainfall to evapotranspiration rather than runoff:

- Harvesting of rainwater from rooftops for non-potable uses (e.g. irrigation, toilet flushing) using rain barrels or cisterns;
- Installation of green roofs;
- Integration of soakaways (e.g. infiltration trenches or chambers) below landscaped areas. Section 4.4.4.4 discusses infiltration swales proposed along the edge of the buffers to the natural features to infiltrate a portion of the roof runoff; and
- Incorporation of bioretention areas, rain gardens or biofilters into the landscape plans for the site.

7.3.2.2 Conveyance SWMPs

Conveyance SWMPs, such as pervious pipe systems and wide-bottom swales are not practical for the proposed industrial/commercial development within the Fourteen Mile Creek watershed (north of Dundas Street) as the soils have been characterized as clay loams that have a low infiltration potential and they may result in over wide rights of way or inefficient roadway longevity due to imperfect drainage.

Incorporation of vegetated filter strips and narrower open channel swales to intercept and treat parking lot and road runoff will be considered on the site where opportunities exist during the detailed design stage.

7.4 Proposed Stormwater Management Approach

The objective of the SWMP plan is to provide satisfactory storm drainage from the site and ensure the long term sustainability of the receiving watercourses. The primary factor from a water quality perspective is to remove sediment and associated pollutants from stormwater runoff preventing them from entering the receiving water courses. Based upon the considerations discussed in the previous section, two extended detention wet ponds are recommended for the proposed development area. An additional extended detention wet pond is recommended for the adjacent development areas to the west. The approximate locations of the extended detention wet ponds are shown on Figure 7.3. Additional details of the proposed wet ponds are provided later in the chapter. As discussed, lot level controls and conveyance controls will be used to a limited degree as initial means of control but as the level of implementation cannot be determined until further into the development process, the end of pipe SWM facilities have provided full redundancy to ensure the required level of treatment are provided. All of the proposed ponds will be designed to provide stormwater quality and quantity control in accordance with the criteria referred to in the NOCSS.

7.4.1 Existing Drainage Boundaries

The updated EIR subcatchment drainage boundaries for the Fourteen Mile Creek West are shown in Figure 7.1 based on 2002 Town of Oakville topographic mapping. The updated drainage areas at EIR Nodes (Dundas Street culverts) are shown in Table 7.1 along with drainage areas reported in the NOCSS study.

Table 7.1 – EIR Subcatchment Drainage Areas

EIR Subcatchment	EIR Nodes	Existing Drainage Area (ha)	
		NOCSS	MMM
FM1102	FM-D2	46.6	30.2
	FM-D3	11.7	14.4
FM1001	FM-D4	424	388
FM1109	FM-D4a	15.2	15.2
	FM-D5	340	343

7.4.2 Pre-Development Flows

The NOCSS recommends that flow rates per unit area be used to calculate existing condition rates. The rates are given in the NOCSS Addendum for the 2-year to 100-year storm events and the Regional Storm and are presented in Table 7.2. It is also noted in the NOCSS that further modeling of existing conditions target flows is not required at the EIR/FSS stage. In accordance with NOCSS recommendations, NOCSS unit flow rates have been used, along with the updated existing drainage areas to calculate existing peak flows at the EIR nodes. NOCSS unit flow rates and the resulting pre-development flows at Dundas Street culverts are summarized in Table 7.2.

Table 7.2 – NOCSS Unit Flow Rates and Pre-Development Flows at Dundas Street Culverts

EIR Node	Flow Type[1]	Return Period (Year)						
		2	5	10	25	50	100	RS[2]
FM-D2	UFR ($m^3/s/ha$)	0.007	0.011	0.013	0.017	0.020	0.022	0.054
	PFR (m^3/s)	0.211	0.332	0.393	0.513	0.604	0.664	1.631
FM-D3	UFR ($m^3/s/ha$)	0.010	0.016	0.020	0.024	0.027	0.031	0.065
	PFR (m^3/s)	0.144	0.230	0.288	0.346	0.389	0.446	0.936
FM-D4	UFR ($m^3/s/ha$)	0.006	0.010	0.012	0.015	0.018	0.020	0.049
	PFR (m^3/s)	2.33	3.88	4.65	5.82	6.98	7.75	19.0
FM-D4a[3]	UFR ($m^3/s/ha$)	0.006	0.010	0.013	0.017	0.019	0.022	0.055
	PFR (m^3/s)	0.091	0.152	0.198	0.258	0.289	0.334	0.836
FM-D5	UFR ($m^3/s/ha$)	0.006	0.010	0.013	0.017	0.019	0.022	0.055
	PFR (m^3/s)	2.06	3.43	4.46	5.84	6.52	7.55	18.9

[1] UFR = Unit Flow Rate, PFR = Peak Flow Rate; [2] RS = Regional Storm; [3] Unit flow rate at culvert FM-D5 is used

7.4.3 Preliminary Grading Plans and Post-Development Drainage Boundaries

A preliminary grading plan for the proposed development area was developed and is illustrated in Figure 8.6. The proposed grading was developed to ensure integration with neighbouring lands, cores, linkages and receiving watercourses. Post-development sub-catchment boundaries have been delineated based on this preliminary grading plan and are shown in Figure 7.2. It is not possible to maintain strict existing drainage boundaries; however, every attempt has been made to maintain them as closely as possible by varying roadway vertical and horizontal alignments which determine available grades. Table 7.3 provides a comparison of the drainage area for the existing and post-development conditions at existing culvert locations (EIR Nodes) under Dundas Street West.

Table 7.3 – Summary of Pre-Development and Post-Development Areas

EIR Subcatchment	Culvert ID	Pre-development Area (ha)	Post-development Area (ha)	Difference (ha)
FM1102	FM-D2	30.2	30.9	+0.7
	FM-D3	14.4	15.4	+1.0
FM1001	FM-D4	388	378	-10.0
FM1109	FM-D4a	15.2	11.7	-3.5
	FM-D5	343	340	-3.0
Total		**791**	**776**	**-14.8**

With the exception of culvert FM-D4a, drainage area diversions to each culvert outlet are generally less than 10% of available area. Total catchment area for EIR catchments FM1102, FM1001 and FM1109 is reduced to 776 ha in post-development condition from 791 ha in pre-development condition. Approximately 15 h of EIR catchment FM1102 (1102 in Figure 7.1) will become part of culvert FM-D1 catchment area in future according to the *2009 Tremaine and Dundas Secondary Plan Subwatershed Study*.

7.4.4 Conveyance of Minor System Flows

The Subject Property will be serviced by a conventional storm sewer system designed in accordance with Town of Oakville standards. The storm sewers will be sized using a 5 year return frequency and the current Town of Oakville IDF curves.

All runoff from the development areas will be conveyed to the proposed stormwater management facilities located in the Subject Property. The collected runoff will be treated for water quality, and quantity control with extended detention for erosion control. The conceptual storm servicing plan is shown in Figure 8.5.

7.4.5 Conveyance of Major Storm Flows

A continuous overland flow route has been provided throughout the FSS Study Area in order to safely convey major storm system flows in excess of the minor system up to the 100 year event. Excess flows will be contained within either the roadway right-of-way or by other lands such as flow easements under the Town's control. For all classes of roads, the product of depth of water at the gutter times the velocity of flow shall not exceed 0.65 m^2/s. All overland flow routes will be directed to two stormwater management ponds located in the Subject Property as shown in Figure 8.5. Should the major system flow exceed the conveyance capacity of any given road, the storm sewer will be sized to accommodate the excess flows such that the road capacity is not exceeded. The major system flows will be attenuated in the stormwater management ponds to achieve the allowable release rates as defined by the NOCSS. The conceptual major system is illustrated in Figure 8.5.

7.5 Post-Development Hydrologic Analysis

The GAWSER (Guelph All-Weather Sequential-Events Runoff) hydrologic model for Fourteen Mile Creek West, north of Dundas Street was developed as part of the NOCSS study and was obtained from Conservation Halton. In the model, each catchment is divided into impervious and pervious zones where the pervious zone can be further characterized by a maximum of four different soil types. Each soil type is then divided into two zones, which represent the proportionate contribution of that soil type to sub-surface

and groundwater flows. Runoff from the sub-catchments is routed using a form of the area/time versus time method. The Fourteen Mile Creek West catchments north of Dundas Street were further sub-divided into several subcatchments in the NOCSS study as shown in Figure 7.1. This model was updated to represent the post-development catchment boundaries as shown in Figure 7.3 and land use conditions north of Dundas Street. This was accomplished by changing GAWSER input parameters representing subcatchment impervious areas and hydrograph parameters. The hydrograph parameters include the main channel travel time (TMC), off channel travel time (TOC) and base time factor (FTB). The GAWSER parameters used in the post-development conditions are listed in Table 7.4.

Table 7.4 – GAWSER Sub-Catchment Parameters

Sub Catchment #	Drainage Area (km^2)	Impervious (%)	Main Channel Travel Time , TMC (hrs)	Off-Channel Travel Time, TOC (hrs)	Base Time Factor, FTB
FM 3000	0.3088	90	0.15	0.05	1.0
FM 3050	0.2105	20	0.25	0.15	1.0
FM 3070	0.1068	90	0.30	0.05	1.0
FM 3080	0.0573	90	0.25	0.05	1.0
FM3090	0.1545	90	0.15	0.05	1.0
FM 3100	0.4690	90	0.15	0.05	1.0
FM 4000	0.2193	1	0.40	0.15	2.0

GAWSER simulated post-development peak flows (with SWM ponds) are compared with pre-development peak flows at their respective EIR nodes along Dundas Street. Post-development peak flows are similar to pre-development levels at EIR nodes except for the Regional Storm.

Table 7.5 – Comparison of Pre-Development and Post-Development Peak Flows at EIR Nodes

Return Period (Year)	Peak Flows (m^3/s)									
	FM-D2		FM-D3		FM-D4		FM-D4a		FM-D5	
	Pre-Dev	Post-Dev	Pre-Dev	Post-Dev	Pre-Dev	Post-Dev	Pre-Dev	Post-Dev[1]	Pre-Dev	Post-Dev[1]
2	0.211	0.198	0.144	0.141	2.33	2.12	0.091	0.070	2.15	2.04
5	0.332	0.333	0.230	0.230	3.88	3.46	0.152	0.117	3.58	3.40
10	0.393	0.396	0.288	0.271	4.65	4.28	0.198	0.152	4.66	4.42
25	0.513	0.531	0.346	0.352	5.82	5.46	0.258	0.199	6.09	5.78
50	0.604	0.609	0.389	0.373	6.98	6.29	0.289	0.222	6.81	6.46
100	0.664	0.659	0.446	0.416	7.75	7.19	0.334	0.257	7.89	7.48
RS	1.63	3.51	0.936	1.76	19.0	22.4	0.836	0.644	19.7	18.7

[1] Post-development flows are due to changes in drainage areas only.

Post-development peak flows at EIR nodes are higher than pre-development levels for the Regional Storm event. Additional flood risks due to the higher regional storm peak flows are discussed in Section 7.9 and Appendix 7.2.

7.6 Stormwater Management Facilities

The recommended SWM pond locations are shown in Figure 7.3. The location and sizing of the SWM ponds are based upon the principle of maintaining existing drainage patterns to the undisturbed channel reaches. The locations are set to maintain current drainage outlets to existing watercourses so that the flow regime conditions will be maintained in them. Furthermore, Master Planning principles promote the consolidation. Pond 1 and Pond 2 will outlet to culverts FM-D2 and FM-D3 respectively. Pond 3 will incorporate the existing manmade pond feature 14W-14A and will outlet to reach 14W-12.

The Tremaine and Dundas Secondary Plan Subwatershed Study (2009) has recommended three SWM facilities for the Fourteen Mile Creek drainage areas west of Tremaine Road and south of Highway 407. The locations of proposed SWM ponds are also shown in Figure 7.3. The proposed pond locations in east of the Subject Property (EIR catchment FM1109) are shown in Figure 3.1. Sizing of these ponds is not considered in this study.

The proposed stormwater management facilities operating characteristics are presented in Tables 7.6 to 7.8.

Table 7.6 – Stormwater Pond 1 Storage Requirements

Return Period	Post-Development Flow without Control	Required Release Rate	Post-Development Flow with Control	Required Storage Volume
Year	m^3/s	m^3/s	m^3/s	m^3
2	1.75	0.211	0.198	9,000
5	2.46	0.331	0.333	11,000
10	2.89	0.391	0.396	12,500
25	3.45	0.512	0.531	14,500
50	3.87	0.602	0.609	16,000
100	4.28	0.662	0.659	18,000

Table 7.7 – Stormwater Pond 2 Storage Requirements

Return Period	Post-Development Flow without Control	Required Release Rate	Post-Development Flow with Control	Required Storage Volume
Year	m^3/s	m^3/s	m^3/s	m^3
2	0.875	0.144	0.141	3,900
5	1.23	0.230	0.230	5,000
10	1.45	0.288	0.271	6,000
25	1.73	0.346	0.352	6,500
50	1.94	0.389	0.373	8,000
100	2.14	0.446	0.416	8,500

Table 7.8 – Stormwater Pond 3 Storage Requirements

Return Period	Post-Development Flow without Control	Required Release Rate	Post-Development Flow with Control	Required Storage Volume
Year	m^3/s	m^3/s	m^3/s	m^3
2	3.25	0.380	0.371	18,000
5	4.56	0.633	0.621	23,000
10	5.37	0.760	0.756	26,000
25	6.38	0.950	0.928	31,500
50	7.15	1.14	1.14	33,500
100	7.91	1.27	1.22	38,500

Various storage requirements for the proposed stormwater management ponds are summarized in Table 7.9. The permanent pools have been sized to provide Enhanced Level protection (80% long-term suspended solids removal) in accordance with MOE SWMP Design Manual. The required active storage for water quality was estimated using 40 m^3/ha as recommended by MOE SWMP Design Manual. The required erosion control volume was estimated based on hydrologic simulations as discussed in Section 7.4.7. Quantity control volumes were estimated to control 100-year post-development peak flows to pre-development levels.

Table 7.9 – Stormwater Management Facility Characteristics

	Pond 1	Pond 2	Pond 3
Total contributing drainage area (ha)	30.9	15.5	63.3
Imperviousness (%)	90	90	90
Permanent pool volume (m^3)	6,742	3,373	13,823
Water quality volume (m^3)	1,235	618	2,532
Erosion control volume (m^3)	6,500	3,250	13,500
Quantity control volume (m^3)	18,000	8,500	38,500
Total pond volume (m^3)	24,742	11,873	52,323
SWM pond block area (ha)	1.6	0.9	2.9

The SWM pond block area was estimated based on the following considerations:

- SWM pond length to width ratio = 3:1
- Pond depth
    - Permanent pool = 2.0 m
    - Active volume = 2.0 m
    - Freeboard = 0.30 m
- Side slopes
    - 7 to 1 within 3 m horizontal zone above and below the PWL
    - 4 to 1 below the “7 to 1” zone to the pond bottom
    - 3 to 1 in all other transition zones above extended detention level
- Perimeter buffer of 7.5 m beyond HWL (100yr/regional)

Sufficient additional area inside the reserved SWM blocks is available to incorporate all preferred criteria for wet ponds according to MOE guidelines. Stormwater pond cross-section and profile including inlet and outlet will be provided once the pond locations are finalized after consultation with Town of Oakville, Conservation Halton and Ministry of Natural Resources.

7.7 Erosion Control Analysis

The NOCSS identifies the need to complete an erosion threshold and erosion control analyses as part of the EIR/FSS so that existing channel erosion or aggradation is not exacerbated by development.

Water's Edge has been engaged by MMM to conduct fluvial geomorphological and erosion threshold assessments of the Fourteen Mile Creek tributaries south of Dundas Street. Water's Edge staff have completed site inspections of the study area on November 25 and December 3, 2010. The tributaries south of the Dundas Street culverts FM-D2 and FM-D3 could not be found during the site visit. Therefore, the assessment was carried out to the west (south of culvert FM-D4) and east (south of culvert FM-D5) tributaries of Fourteen Mile Creek. Detailed fluvial geomorphological and erosion threshold assessments are provided in Appendix 7.1.

The purpose of a continuous model erosion analysis is to estimate the existing condition erosion index by examining the history of area rainfall and flow rates in the watercourses to develop a number representing an erosion index. Rather than by direct calculation with a continuous rainfall series, the erosion index may be estimated by an analysis of the site's rainfall history from an intensity duration frequency curve for the area. The 24-hour SCS Type 2 design storms with return periods of six months, nine months, one year and two year were developed to evaluate the performance of various stormwater management erosion control scenarios. Based on the IDF curve for the Town of Oakville, the 24-hour rainfall volumes were calculated using the relationship between the return periods of the annual maxima rainfall series (Tm) and the partial duration annual rainfall exceedance series (Tc) (Chow, 1964). Table 7.10 shows the 24 hour rainfall volumes for the selected return periods used.

Table 7.10 – Rainfall Volumes for 24 Hour SCS Type 2 Distribution

Return Period (Month)	Volume (mm)
6	37.3
9	41.2
12	44.7
24	50.9

The GAWSER hydrological model was used to predict the hydrographs for particular storm events at the erosion assessment sites with the various SWM Facility storage-discharge relationships that will provide various detention times for specific storm event (e.g. 25mm storm event). Erosion indices for each scenario were calculated using the following equation.

$$Ei = \sum (Q_i - Q_c)\Delta t \qquad \text{Eqn 1}$$

Where Ei = Erosion Index
Qi = Channel Flow at time, if Qi > Qc
Qc = Critical Flow (from excess shear stress table, Appendix 7.1)
Δt = Time Step

The total weighted index for a year for a given scenario was calculated according to:

Total EI = EI6 x 2 + EI9 x 1.33 + EI12 x 1 + EI24 x 0.5

EI# indicates the index value for a storm with a return period of # months.

The calculated erosion index for existing conditions has been compared to post-development conditions assuming various control schemes are in place for SWM pond 3. Table 7.11 summarizes the results.

As demonstrated in Table 7.11, the release of uncontrolled stormwater to the downstream watercourses results in a high erosion potential index when compared to existing conditions. 72 hour extended detention of the runoff from a 25 mm storm event is required for the proposed development, resulting in an erosion index below existing conditions. Therefore, 72 hour extended detention of the 25 mm storm event will be provided for erosion control for pond 3.

Table 7.11 – Existing, Uncontrolled and Controlled Erosion Index Comparison for Pond 3

Scenario	Erosion Index	% Increase from Existing
Existing	368,996	-
Uncontrolled	458,528	24
25mm/24 hour detention	439,852	19
25mm/48 hour detention	387,289	5
25mm/72 hour detention	367,218	-0.5
40mm/24 hour detention	455,199	23
40mm/48 hour detention	400,711	9
40mm/72 hour detention	359,334	-3

Erosion control analysis was not carried out for the SWM ponds 1 and 2 since fluvial geomorphic and erosion threshold assessment for channels downstream of the ponds 1 and 2 could not be carried out as discussed earlier. However, 72 hour extended detention of the 25 mm storm event will be provided for erosion control for ponds 1 and 2.

7.8 Topographic Depression Volumes

As discussed in Section 3.4.2, the NOCSS recommends that the surface storage volumes in area topographic depressions be identified and comparisons made to SWM pond storage. Further clarification was provided as part of a mediation agreement, which is outlined in Mediation Item: Depressional Storage, dated May 30, 2007. As outlined in this agreement the principle intent of evaluating the existing depression

storage was to ensure that the natural depression storage is maintained in the SWM system. Artificially created (manmade) storage was to be excluded from this evaluation. As also described in this agreement, in order to ensure that the storage volume of depression areas is maintained, the calculated depression volume was to be compared to the proposed SWM pond volume within same drainage area. If the depressional volume is determined to be less than or equal to the SWM facility volume then no additional analysis or change to SWM facility design would be required. The depressions identified in the NOCSS study within the development area are listed in Table 7.12.

Table 7.12 – Depression Areas (From NOCSS Study, Table 6.3.7)

ID	EIR Catchment	Subcatchment (Figure 7.1)	Depression Size (ha)
80	FM1102	1103	0.0923
81	FM1001	1105	0.0944
82	FM1001	1105	0.0727

Detailed topographic mapping has not been carried out for depressions identified in the NOCSS study. However, an analysis has been carried out to demonstrate that the proposed stormwater ponds have sufficient storage volumes to compensate the grading of depression areas in the study area.

An equivalent depression area is estimated based on the proposed SWM pond's freeboard volume and assumed depression depth of 0.5 m. The estimated depression areas are presented in Table 7.13 for the three catchment areas. These equivalent depression areas are much larger than that presented in Table 7.12.

Equivalent depression drainage areas that can generate runoff volume equivalent to the proposed SWM pond freeboard volume are presented in Table 7.14 for the 100-Year storm and Regional Storm. The equivalent depression drainage areas range from 8 % to 17% of catchment areas for the 100-year strom and 2% to 5% for the Regional Storm.

These analyses have demonstrated that the SWM pond volume compensate for the hydrologic influence of the existing depression areas.

Table 7.13 – Equivalent Depression Areas

EIR Catchment ID	Catchment ID (Figure 7.1)	Pre-Development Drainage Area (ha)	No. of SWM Ponds	Freeboard Storage (m^3)	Average Depression Depth (m)	Depression Area (ha)	% of Drainage Area
FM 1102	1102	30.2	1	3,173	0.50	0.63	2.10
FM 1102	1103	14.4	1	1,626	0.50	0.33	2.26
FM 1001	1104 & 1105	116	1	6,473	0.50	1.29	1.12

Table 7.14 – Equivalent Drainage Areas

EIR Catchment ID	Catchment ID (Figure 7.1)	Pre-Development Drainage Area (ha)	No. of SWM Ponds	Freeboard Storage (m^3)	100 Year Runoff Depth (mm)	Depression Drainage Area (ha)	% of Drainage Area	Regional Storm Runoff Depth (mm)	Depression Drainage Area (ha)	% of Drainage Area
FM 1102	1102	30.2	1	3,173	66	4.81	16	230	1.38	5
FM 1102	1103	14.4	1	1,626	66	2.46	17	230	0.71	5
FM 1001	1104 & 1105	116	1	6,473	66	9.81	8	230	2.81	2

7.9 Downstream Impacts for Regional Storm

Policy 8.4.13.2 of OPA 289 states, "The North Oakville Creeks Subwatershed study recommends that stormwater targets include control of the peak flow to predevelopment levels for various return periods, including the regional storm. Through the land development application process, an investigation of the potential increase to flood risk may be carried out to confirm if Regional Storm controls are necessary, in accordance with the directions established in the North Oakville Creeks Subwatershed Study."

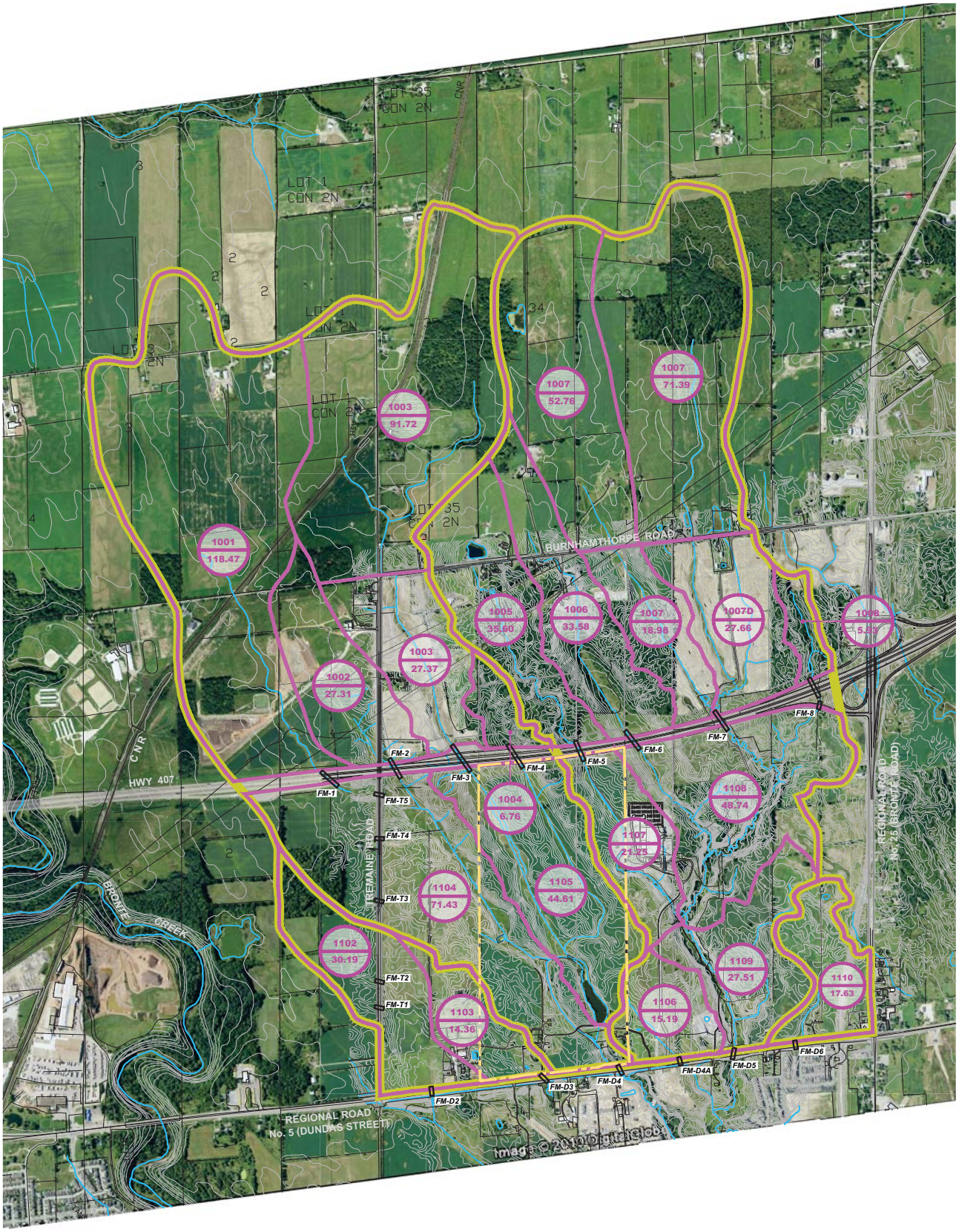
The NOCSS recommends that stormwater management targets include control of the peak flow to predevelopment levels for the 2-year to 100-year return period events and the Regional Storm. It also notes that future land use development applicants may carry out an investigation of the potential increase to flood risk to confirm if Regional Storm controls are necessary. This analysis is to include the increase in risk to life as well as the potential for flood risk to private, municipal, regional, provincial and federal property under Regional Storm conditions.

A hydraulic assessment was carried out to assess the post-development flood risk in the Fourteeen Mile Creek south of Dundas Street due to Regional Storm. The results from this analysis indicate that Regional Storm control for the Subject Property is not required. Details of this analysis are provided in Appendix 7.2.

7.10 Summary

A stormwater management plan has been developed for the Subject Property based on the guidance provided in the NOCSS. The stormwater ponds are sized to control post-development flow rates from the Subject Property to pre-development levels for the 2-year to 100-year return period and to provide an enhanced level of water quality protection. The post-development peak flows are similar to pre-development levels at EIR nodes except for Regional Storm. A hydraulic assessment of Fourteen Mile Creek West south of Dundas Street indicated that increased flood risk due to Regional Storm is minimal and Regional Storm control for the Subject Property is not required. A fluvial geomorphological and erosion threshold assessment has been completed for Fourteen Mile Creek West tributaries south of Dundas Street and the results from this assessment were used to provide the erosion control requirements for the proposed stormwater ponds.

FIG 7.1.dwg □ayo:1t S:\14-41\14\09222-001-SW1\ Mar 03, 2011 - 2:55pm



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Existing Drainage Boundaries

LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EIR SUB-CATCHMENT BOUNDARY
- CULVERTS (EIR NODES)
- 1001 / 118.47 — SUB-CATCHMENT No. / AREA (ha)

Scale: 1 : 15000 (0 0.1 0.25 0.5 0.75km)

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: March 2011

Project No.: 14-09222-001-SW1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 7.1

FIGURE 7.2.dwg Comparison □□E□isting □ Post-Development Catchment □o□ndaries S:\14-41\14\09222-001-SW1\ May 10, 2011 - 10:10am

EIR SUB-CATCHMENT	DRAINAGE AREAS (ha)	
	PRE-DEVELOPMENT	POST-DEVELOPMENT
FM-1102	44.6	46.3
FM-1001	388	378
FM-1109	358	352

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Comparison of Existing and Post-Development Catchment Boundaries

LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EIR SUB-CATCHMENT BOUNDARY
- CULVERTS (EIR NODES)

Scale: 1 : 15000 (0 0.1 0.25 0.5 0.75km)

Client: Bentall Kennedy

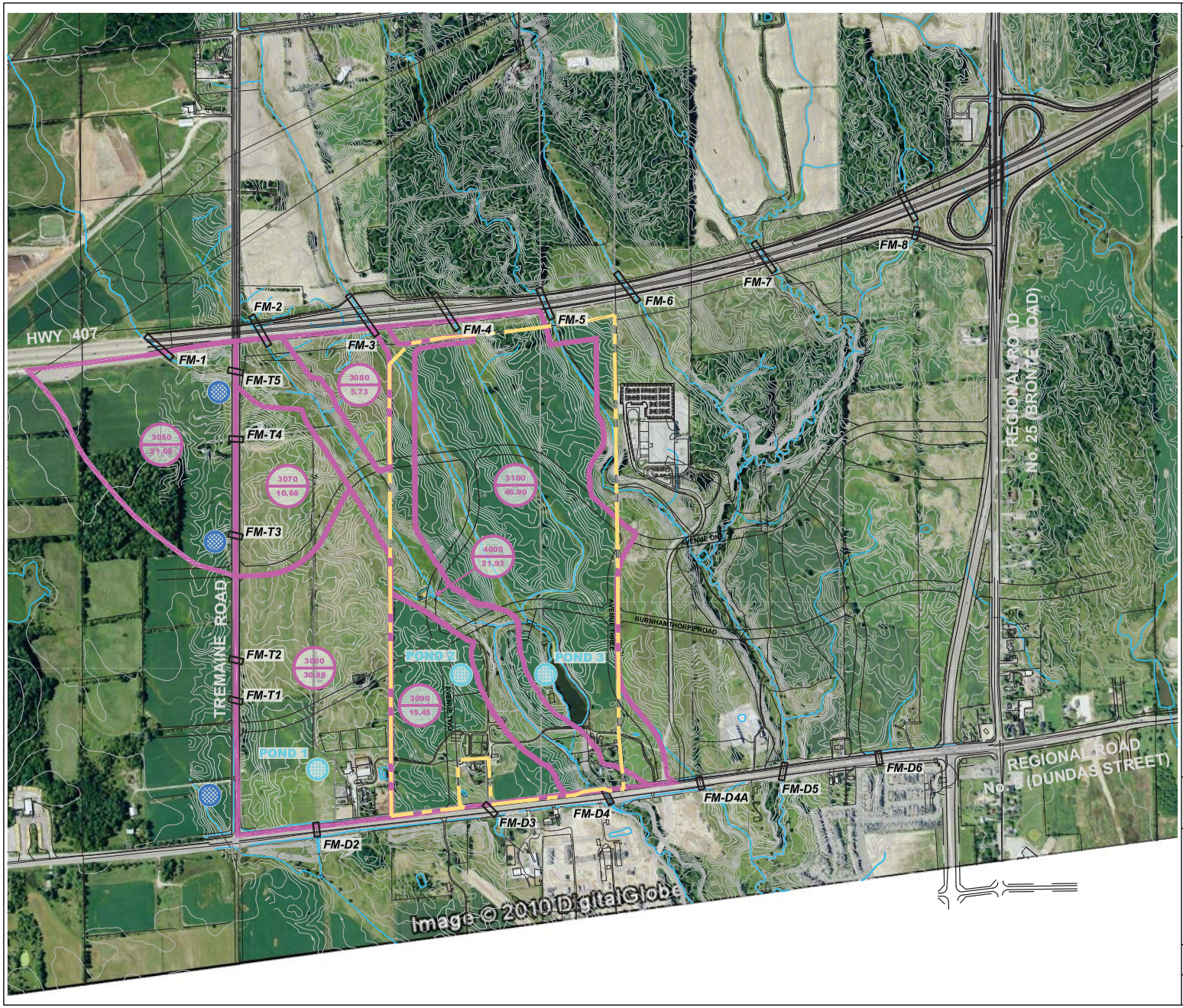
Prepared by: MMM GROUP

Date: May 2011

Project No.: 14-09222-001-SW1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 7.2



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Gawser Model Drainage Areas Post-Development

LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- CULVERTS (EIR NODES)
- 3100 — SUB-CATCHMENT No.
- 46.90 — AREA (ha)
- PROPOSED SWM POND
- PROPOSED SWM POND (TREMAINE AND DUNDAS SECONDARY PLAN SUBWATERSHED STUDY, 2009)

Scale: 1 : 10000 (0 0.1 0.2 0.3 0.4 0.5km)

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: May 2011

Project No.: 14-09222-001-SW1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 7.3

FIGURE 7.3.dwg Gawser Model Drainage Areas Post-Development S:\14-411\14\09222-001-SW1 May 10, 2011 - 9:35am

8.0 Municipal Services

8.0 Municipal Services

8.1 Introduction

The municipal services component of the Environmental Implementation Report/Functional Servicing Study (EIR/FSS) addresses the servicing (water, wastewater, and stormwater) and grading requirements to develop the FSS Study Area. The servicing design is intended to work in conjunction with the stormwater management plan and other considerations as detailed in Section 7.0.

The municipal servicing design for the EIR/FSS has been conceptually developed utilizing the land use concept plan as its basis. The land use concept plan illustrates natural features, the pattern of major roads and the land uses. The proposed municipal servicing design generally follows the proposed road layout while taking into account the natural features and topography of the site. This is appropriate at the EIR/FSS level.

To develop the municipal servicing design the Region of Halton's Water and Wastewater Master Plan (WWMP) and the Stormwater Management Plan (SMP) in Section 7.0 were reviewed and utilized. The design and documentation has been developed in conjunction with the 407 West Employment Lands – Area Servicing Plan prepared by MMM.

In the WWMP and the subsequent update, the Region considered a wide variety of possible strategies to service the expected growth throughout the entire Region for both water and wastewater servicing. The conclusions of the Region's work with respect to treatment and conveyance (including conveyance options) as it affects the FSS Study Area are summarized in the following Wastewater and Water Sections.
The Stormwater Management Plan for the 407 West Employment Area is generally consistent with the North Oakville Creek Sub-watershed Study (NOCSS). The NOCSS sets the standards and requirements for the treatment of stormwater throughout North Oakville.

8.2 Conceptual Wastewater Servicing Strategy

8.2.1 General

The Region of Halton provides the Town of Oakville with Wastewater Treatment, Sewage Pumping Stations and Wastewater Collection services. The wastewater infrastructure requirements are outlined below.

8.2.2 Treatment

Wastewater treatment for Oakville is provided at three Wastewater Treatment Plants (WWTP). These plants are Mid-Halton, Oakville South East, and Oakville South West. The recommended alternative in the Master Plan proposed that all wastewater treatment for growth in Oakville and Milton be at the Mid-Halton WWTP.

The first phase of Mid-Halton WWTP was constructed in 1991 with a rated capacity of 20,000 m^3/d. It was subsequently re-rated to 25,000m^3/d. The Region completed an expansion of the plant to 50,000 m^3/d in

2003 and has subsequently completed the next expansion to 75,000 m^3/d in order to service anticipated growth within Milton and Oakville.

The Region has planned the Mid-Halton Wastewater plant and has sufficient land to allow it to be expanded in an orderly and predictable fashion. These expansions would be timed so that the capacity is available when required. Expansion of capacity will trigger the need for various other changes or improvements such as biosolids handling and a new outfall (not required until growth beyond the Halton Urban Structure Plan (HUSP)).

8.2.3 Collection System

Figure 8.1 is a representation of the portion of the Region's proposed wastewater collection and pumping system that are intended to service the FSS Study Area, the lands to their east and a portion of the expected growth in Milton.

The FSS Study Area generally slope from north to south and towards the centre of the lands approximately 180m to the east of Colonel William Parkway at Dundas Street. The Master Plan provides for a series of local sewers that will drain from north to south connecting to a new Trunk Sewer System on Dundas Street. The Region does not show the sewers within the FSS Study Area. One of the purposes of this report is to apply the Master Plan concept to the Secondary Plan road and development scheme and recommend a specific plan for the sewer system.

At Dundas Street, a trunk system which directs the flows to the existing system at Colonel William Parkway is proposed. The existing system will intercept flow and divert it south towards the Mid-Halton Plant in a manner that minimizes impact to the existing residents of the Town of Oakville.

More specifically, the lands to the west of the 14 Mile Creek Natural Heritage Area (NHS) and east of Tremaine Road will be conveyed south by an internal wastewater sewer along an internal future street to the Trunk Sewer on Dundas Street which will then connect to the existing wastewater system at Colonel William Parkway. The external area from the lands west of Tremaine Road can connect to the system at an internal local road or on Dundas Street. The wastewater flows from the lands between the two natural heritage areas will be conveyed south along an internal street and discharged to the existing wastewater system on the south side of Dundas street at Colonel William Parkway. The lands east of the eastern natural heritage area and west of Bronte Road will be conveyed south along future internal street and will connect to the Trunk Sewer on Dundas Street which will then discharge to the existing system at the south side of Dundas Street at Colonel William Parkway. There is the possibility for the flows from a portion of these lands to discharge to the existing system at Valleyridge Drive; this would require extending the existing sewer to Dundas Street and further analysis to confirm that there would be no adverse effects on the existing residential units downstream.

The existing system eventually discharges to the Mid-Halton WWTP and Pumping Station (PS). No upgrades to the existing wastewater sewers are anticipated to accommodate future development. The need for a local or regional pumping station appears not to be required

8.2.4 Region's Timing of Required Wastewater Infrastructure

Regional project 3706 is required to service the FSS Study Area. This project can be completed as development requires. The connection point at Colonel William Parkway is in place with available capacity to service the FSS Study Area.

8.2.5 Expected Sewage Generation

In this Section sewage generated in the FSS Study Area has been assessed and compared to the Master Plan. The design criteria that the Region has utilized in the Master Plan are used in this analysis. To develop the estimated sewage generation, the system design criteria is first set out and then applied to the proposed development statistics from Figure 3.1.

The Region of Halton wastewater system criteria is as follows:

Table 8.1 – Average Day Wastewater Flow

Land Use	Unit	Collection System	Treatment
Residential	L/cap/d	275	365
Commercial	m^3/ha/d	24.75	17.5
Industrial	m^3/ha/d	34.375	25.8
Institutional	m^3/ha/d	11.00	11.0

The modified Harmon Peaking Factor (K) equation is used to determine the peak flows for the collection system. The average day wastewater flow criteria for wastewater treatment includes an allowance for infiltration. An infiltration allowance of 0.286 L/s/ha is added to the peak system flows for designing the collection system.

The treatment capacity flow generated by the FSS Study Area is:

Table 8.2 – Generated WWTP Flows: FSS Study Area Concept Plan Projections

	Residential ML/d	Commercial ML/d	Industrial ML/d	Institutional ML/d	Total ML/d
Average Daily Flow	0.0	0.7	3.4	0.0	4.1

Pumping stations and sewers are designed based upon peak flows. Flows will increase as various sub-catchment areas are connected to the Trunk Sewer. Table 8.3, estimates the peak flow to the existing wastewater sewer on Colonel William Parkway. This is the full flow from the FSS Study Area.

The difference in the peak flows between the Region's projections and from those generated from the FSS Study Area Concept Plan combined with the proposed increase in pipe slope in some instances will impact the sizing of the Dundas Street West trunk sewer by one pipe size in some locations.

Table 8.3 – Peak Generated Collection System @ Colonel William Parkway Trunk Sewer: FSS Study Area

	Residential L/s	Commercial L/s	Industrial L/s	Institutional L/s	Total L/s
Average Flow	0.0	8.6	39.0	0.0	69.6
Peaking Factor	4.3	3.358	2.867	4.3	
Harmon Peaking Factor (K)	0.80	0.80	0.80	0.80	0.80
Infiltration	0.0	8.6	28.0	0.0	36.6
Total	0.0	31.7	117.5	0.0	149.2

8.2.6 Region's Concept Plan Applied to the FSS Study Area

The proposed sewer system to service the FSS Study Area is described in this Section and as well as the proposed drainage boundaries as illustrated on Figure 8.2.

8.2.6.1 Dundas Street Wastewater Sewer

As discussed in the above Sections, the Region proposes that all wastewater flows from the FSS Study Area drain to a trunk wastewater sewer system along Dundas Street West. As plans were being developed for the FSS Study Area, alternative locations for this wastewater sewer were considered. At this stage it has been determined that Dundas Street West would be a feasible alignment for the wastewater sewer.
The Master Plan recommends that the Dundas Street West gravity wastewater sewer directing flows from the entire 407 West Employment Area to the gravity wastewater sewer on Dundas Street West and ultimately to the existing wastewater sewer on Colonel William Parkway. This study generally supports that conclusion.

A preliminary design has been undertaken for the trunk wastewater sewer on Dundas Street West, which is presented on the attached drawings, P1-P13.

8.2.6.2 Internal Collection Systems

In order to convey wastewater drainage from the Subject Property consistent capitalization with 8.3.2 to the Dundas Street West sewer collection system, various alternative system layouts were evaluated. The common elements of the system layouts were:

- All sewers are located on proposed road alignments; and
- All crossings of watercourses on natural features follow proposed road alignments.

A number of factors were considered that would influence the proposed alternatives. The factors include environmental features, existing topography, proposed road patterns, stormwater management facilities, and relative ease of sewer construction.

While Figure 8.2 shows the preferred alignment for the internal sewers, there is flexibility in the location of these sewers and the corresponding drainage boundaries. The sizing of the Dundas Street sewer has considered this flexibility and as such will allow the plan to evolve as it moves forward over time. The costs for local sewers are not considered to be DC recoverable.

A local or regional pumping station appears to be unnecessary.

8.2.6.3 External Drainage Areas

Two other tributary areas will connect to the Dundas Street trunk sewer at various locations. Due to their shorter lengths and smaller tributary areas they are considered to be local sewers. Together they service an approximate area of 69 hectares of developable lands with an estimated equivalent population of 3805 people. These local sewers allow the Dundas Street trunk to be kept at a nominal depth.

The adjacent Tremaine-Dundas Secondary Plan Area, City of Burlington will discharge wastewater flows to the Dundas Street Trunk system. A Secondary Plan is currently being prepared for the area to determine the preferred land use concept. At present there are 3 land use options proposed which includes approximately 56 hectares of developable land. For the purpose of this study the most conservative approach was assumed to evaluate the downstream wastewater sewer. It was assumed that the entire lands would develop as residential. The wastewater flows generated by the Tremaine-Dundas Community are shown in Table 8.4.

Table 8.4 – Peak Generated Collection System Flows to Dundas Trunk Sewer: Tremaine Dundas Community

	Residential L/S	Commercial L/S	Industrial L/S	Institutional L/S	Total L/S
Average Flow	6.9	0.0	0.0	0.0	6.9
Peaking Factor	3.560	3.560	3.560	3.560	3.560
Harmon Peaking Factor (K)	1.0	1.0	1.0	1.0	1.0
Infiltration	16.0	0.0	0.0	0.0	16.0
Total	40.6	0.0	40.6	0.0	40.6

The Sixteen Hollow Lands to the east of the 407 West Lands are zoned employment with a large component of open space. A large portion of the developable lands represent the future Oakville Hospital

located at approximately Dundas Street and Third Line. Due to the proximity of these lands to the existing wastewater trunk sewer on Third Line or Bronte Road, it is likely that the wastewater flows from the Sixteen Hollow Lands will not discharge to the Dundas Street wastewater sewer. However, there is available capacity within the system to accommodate these flows should these lands connect to this system. The wastewater flows generated by the Sixteen Hollow Lands are shown in Table 8.5.

Table 8.5 – Peak Generated Collection System Flows @ Dundas Street Trunk Sewer: Sixteen Hollow Lands Only

	Residential L/s	Commercial L/s	Industrial L/s	Institutional L/s	Total L/s
Average Flow	0.0	0.0	3.6	0.5	4.1
Peaking Factor	3.652	3.652	3.652	3.652	3.652
Harmon Peaking Factor (K)	0.80	0.80	0.80	0.80	0.80
Infiltration	0.0	0.0	2.6	1.1	3.7
Total	0.0	0.0	13.3	2.6	15.9

8.2.7 Sewer Sizing and Technical Analysis

Flows and sewer sizes were developed using Regional design criteria. Detailed design sheets are provided in Appendix 8.1.

The sewers were sized utilizing the modified Harmon Peaking Factor equation with offsetting peaks for residential and employment.

Conceptual Plan-Profiles of the Wastewater Sewer design are provided in Appendix 8.4.

8.3 Conceptual Water Servicing Strategy

The Region's Water and Wastewater Master Plan in 2002 set out a strategy for the long term and orderly development of the Region's infrastructure. The Region's 'South Halton Water and Wastewater Master Plan Update" dated June 2008 updated the strategy for the water supply and distribution system. In the case of water, this report addressed supply, pressure districts, storage and distribution. This report also addresses timing. The Master Plan provided conceptual information on the location of proposed infrastructure; however, this is subject to more detailed review when considering the servicing corridors available through the road network that is proposed as part of the Concept Plan for the FSS Study Area.

This EIR/FSS report has been prepared to develop on and complement the Region's plans by providing more specific information on how it can be implemented in the context of the specific plans for the FSS Study Area. Therefore, to provide appropriate context, the Region's Plan as it relates to the FSS Study Area is summarized in this Section.

8.3.1 Supply

Historically water supply for South Halton has come from three main sources, the Burlington Water Purification Plant, the Oakville Water Purification Plant, and wells within Milton (to service specific areas of Milton).

The 2002 Master Plan concluded that the long-term growth of Halton would require the construction in stages of a new water treatment plant that will have an ultimate capacity of 220 ML/d. The first stage of this new plant (Burloak) has been recently completed.

This new supply is critical to meet the Region's medium and long-term growth projections for both the 407 West Employment Area and the Region as a whole. For the purpose of the remainder of this report it is assumed that the first stage of this plant is on-line.

8.3.2 Pressure Districts

The Subject Property consistent with 8.2.6 is located within the Oakville pressure district identified as Zone 3 or O-3. Zone 3 in Oakville includes all lands with an elevation of 128 to 166m. The zone boundary is generally parallel to Sixteen Mile Creek on the east, along Highway 407 to the north, along Tremaine Road to the west, and generally in between Upper Middle Road and the Q.E.W. to the south as shown on Figure 8.3.

Supply for Zone 3 is currently via a booster pumping station at Eighth Line and Upper Middle Road and the Kitchen Reservoir and Pump Station at Regional Road 25 and Upper Middle Road. Storage is provided at the Moore Reservoir on Sixth Line north of Burnhamthorpe Road (north of Dundas Street).

In the future, the supply to Zone 3 will be augmented via a 1200mm watermain connection on Dundas Street from 400m east of Bronte Road to Neyagawa Boulevard. This supply will be connected to the existing Zone 3 water supply (Moore Reservoir on Sixth Line) via the existing 600mm watermain on Dundas Street connecting to the existing Sixth Line main which links the Eighth Line Water Booster Pumping Station (WBPS) with the Moore Reservoir.

8.3.3 Storage

Storage for Oakville Zone 3 is currently provided at the R.J. Moore Reservoir on Sixth Line. Until 2002, Zone 3 also provided the storage for Zone 4, where it was pumped to Zone 4 on an as required basis. In 2002, an elevated storage tank was constructed in Zone 4 on Trafalgar Road north of Burnhamthorpe Road.

To address increased demands in Oakville and Milton, the Region will also be constructing a new 30ML Zone 4 reservoir in Milton to service the North Oakville East Lands and existing Zone 4 lands.
The existing storage available in Oakville Zone 3 is sufficient for long term build-out of the FSS Study Area as well as all other lands serviced by Zone 3.

8.3.4 Distribution

Development in Oakville is currently serviced via a series of trunk watermains that connect sources of supply, pumping, and storage to a local distribution network.

To support growth, the Region proposes a series of new trunk watermains that interconnect with and expand the existing system and connect to the new proposed sources of supply, pumping and storage as described above. The FSS Study Area will connect to the existing Zone 3 system at Dundas Street and Bronte Road, looped along Tremaine Road and internally through the FSS Study Area to ultimately connect to the future watermain (Regional Project #5854) in the adjacent Sixteen Hollow Lands. Water service will be distributed to the local network from the Dundas Street and the internal regional watermains.

8.3.5 Region's Timing

The infrastructure described above will be constructed on an as-required basis for each phase of development. For example, the 600mm watermain on Tremaine Road from Dundas Street to the proposed new East-West Road, Avenue One, within the FSS Study Area will not be constructed until the proposed development plan proceeds. In many instances works such as the treatment plants, storage, and pumping stations will be constructed incrementally. In the case of linear infrastructure, it will be extended incrementally to provide local service connectivity and looping.

8.3.6 Expected Water Demand

In this Section, water demands under various conditions have been assessed using the design criteria that the Region has utilized in the Development Charge (DC) Update Report are used in this analysis. To develop the estimated demands, the system design criteria is first set out and then applied to the proposed development statistics from Figure 3.1.

The flow demand, storage volume requirements, and pumping station capacities are similar to those used by the Region in developing the Master Plan Update. Any difference in the demand estimated in the Master Plan or DC Update Report is due to an increase of undevelopable natural heritage areas throughout the FSS Study Area.

Table 8.6 sets out the system unit demands. Table 8.7 summarizes the Water System Design Criteria.

Table 8.6 – System Unit Demands

	Residential L/cap/day	**Commercial L/employee/day**	**Industrial L/employee/day**	**Institutional L/employee/day**
Average Day Demand	330	213	302	74
Maximum Day Peaking Factor	1.9	1.9	1.9	1.9
Peak Hour Peaking Factor	3.00	3.00	3.00	3.00

Table 8.7 – Water System Design Criteria

Component	Condition/Description	Criteria
Pumping Stations	With adequate zone storage available	Maximum day flow to zone and all subsequent zones
	Without adequate storage available	The greater of peak hour flow or maximum day plus fire to the zone and the maximum day flow to all subsequent higher zones
Storage	Balancing storage	25% of maximum day demand
	Fire storage	Largest expected fire zone (based on land use)
	Total	125% of Balancing + Fire (allows for 25% Emergency Storage)
Fire flow	Minimum flow (single family residential)	5,500 L/min for 2 hours @ minimum 140 kPa (20 psi)
	Minimum flow (industrial/commercial/institutional)	15,000 L/min for 3 hours @ minimum 140 Pa (20 psi)
System pressure	Normal operating conditions	280 kPa (40 psi) to 700 kPa (100 psi)

Table 8.8 summarizes the projected demands under various conditions for the FSS Study Area at build-out by applying the above criteria to the development statistics described in Figure 3.1.

Table 8.8 – Flow Demands: Linear Infrastructure: FSS Study Area Concept Plan Population Projections

	Residential (ML/d)	Commercial (ML/d)	Industrial (ML/d)	Institutional (ML/d)	Total (ML/d)
Average Day Demand	0.0	0.8	3.7	0.0	4.5
Maximum Day	0.0	1.5	7.0	0.0	8.5
Peak Hour	0.0	2.4	11.1	0.0	13.5

8.3.7 Region's Concept Plan Applied to the FSS Study Area

One of the important purposes of this report is to apply the Region's Master Plan Update water distribution concept to the approved Secondary Plan for the FSS Study Area. As stated at the outset of this Report, the Report's purpose is to adapt the Region's servicing concept to the approved Secondary Plan, not to modify it. As a result of this principle, and because the estimated demand based upon the approved Secondary Plan is similar to the demand assumed by the Region, no changes are recommended to the Region's proposed supply, pumping, or storage system network.

The development of a community plan has however created the opportunity, and in fact the need, for a 'plan specific' trunk water main distribution network to be developed to replace the generic one that the Region applied in the absence of a Secondary Plan.

The proposed ASP water distribution network is illustrated in Figure 8.4. To address environmental sensitivities and minimize impact, all mains are proposed to be located on existing or proposed road allowances.

The proposed ASP water distribution system is essentially the same as the distribution from the Region's Master Plan Update (MPU) with minor changes based on the outcome of land uses proposed by the approved Secondary Plan. The following key elements of the proposed distribution network that are the same as the Region's MPU water system include:

- The 1200mm PD3 supply main on Dundas Street from Bronte Road to Tremaine Road (Region Project # 5851); and
- The 600mm PD3 watermain on Tremaine Road from Dundas Street to the proposed East-West Collector through the FSS Study Area (Region Project #5853).

Changes to the network to respond to the proposed Secondary Plan and road pattern include the following minor changes to the Region's MPU.

- A slight relocation of the east-west 600mm watermain to better match the proposed road alignment (Region Project # 5627).

Finally, to maintain required fire flows and adequate pressure during all phases of development, the local north-south watermains should connect to the 1200mm diameter watermain on Dundas Street.
The proposed changes to the distribution system will have no change to the development charge projects.

8.3.8 Water Distribution Modeling Analysis

The Region of Halton provided a copy of the Region's Water Distribution Model dated August 12, 2008 to assist MMM in modeling the proposed Area Servicing Plan watermain system. The following recommendations are based on the update of the Region's model to include the proposed ASP watermain system shown in Figure 8.4.

8.3.9 Water Distribution Modeling Results for Peak Hour and Maximum Day

The proposed FSS Study Area system was incorporated into the Region of Halton's Water Distribution Model to determine if the proposed FSS Study Area water system would be adequate to service the FSS Study Area. Table 8.9 summarizes the results of the distribution modeling. Copies of the Peak Hour and Maximum Day model results have been included in Appendix 8.2.

Table 8.9 – Results of Water Distribution Modeling for Proposed ASP Water System

	Peak Hour	Maximum Day
Minimum HGL	193.71 m	197.39 m
Node for Minimum HGL	NO-228,229,236,237,238, 239,240,&241	NO-236,237, 238&239
Maximum HGL	193.80 m	197.43 m
Node for Maximum HGL	NO-246 ,252, WJ-1150-O, & WJ-3114-O	NO-245,246, 251, 252, WJ-150-O, WJ3114-O, & WJ-3116-O
Minimum System Pressure (psi)	49.39 psi	50.32 psi
Node for Minimum System Pressure	WJ-3046-O	NO-239
Maximum System Pressure (psi)	66.53 psi	71.69 psi
Node for Maximum System Pressure	NO-252	NO-252

The results of the distribution modeling show that the proposed ASP water system will provide adequate flow and pressure to all locations in the ultimate development condition. It should be noted that the maximum headloss in the proposed system is only 0.02m during a maximum day demand and 0.06m during a peak hour demand. The low headloss in the overall system indicates that the watermains are adequately sized and that increasing the watermain sizes from the proposed 1200/600mm trunk watermains and the 300mm distribution watermains is not required.

8.3.10 Water Distribution Modeling Results for Maximum Day plus Fire

The proposed system was also modeled to determine if the proposed water distribution system could meet the Region's fire requirements of 5,500 L/minute for residential development and 15,000 L/minute for commercial/institutional/industrial development.

The results of the maximum day plus fire modeling indicates that the fire flow of 15,000 L/minute at a residual pressure of 20 psi is available at all nodes within the FSS Study Area. Therefore, it can be concluded that the proposed ASP water system is adequately sized for the maximum day plus fire demands.

8.3.11 Additional Design Considerations

8.3.11.1Local Service Watermains

The FSS Study Area Concept Plan proposes developments that front onto external roads such as Dundas Street, Tremaine Road, and Bronte Road where Regional DC watermains are proposed. These proposed developments will require water services and in some cases may require local watermains to service these developments. The ASP primarily addresses the watermain sizes for the transmission and major

distribution watermains. Local distribution have been preliminarily sized in the study and this FSS supports the Draft Plan. All service connections will be in designed in accordance with the Region's published standards for water connections.

8.3.11.2Mitigation Measures for Single Feed Watermain Supplies

The ultimate water distribution is a well-designed network of interconnected watermains with multiple loops to ensure security and flexibility in servicing the full build out of the proposed Area Servicing Plan. While it is a priority to loop systems where possible and as soon as the opportunity is available, it will be necessary to service development areas with single feed watermains during various phases of development until the future watermain loops can be constructed. This includes the internal 600mm diameter watermain which will not looped until the adjacent Sixteen Hollow Lands are developed.be

8.4 Stormwater

8.4.1 General

There are currently no storm sewers or stormwater management facilities to service the FSS Study Area. The existing conditions currently drain overland primarily by sheet flow into the existing creeks onsite. These creeks then drain offsite to the south under Dundas Street West via 3 culverts. There is currently no treatment of the stormwater from the Subject Property.

Both the minor and major storm systems have been designed to conform to the Stormwater Management Plan presented in Section 7.

8.4.2 Minor Storm System (Sewers)

The conceptual minor storm system has been designed to convey up to the 1:5 year storm event to the appropriate stormwater management facility. The intention of the minor storm system is to match as closely as possible with the existing drainage boundaries of each of the existing culverts. The minor storm system will consist of gravity sewers that will discharge to a SWM facility for treatment. The majority of the storm sewers are within the conceptual road network with some of the sewers discharging to the SWM facility within an easement on a development block.

The conceptual minor storm system is shown on Figure 8.5. The proposed storm sewer system has been designed to the current Town of Oakville design criteria. The storm design sheets are available in Appendix 8.3. The Plan-Profiles of the storm design are available in Appendix 8.4.

8.4.3 Major Storm System (Overland Flow)

The proposed major storm system is in accordance with stormwater management plan as described in Section 7 of this report. The overland flow route will convey flows up to the 1:100 year storm event to the stormwater management facility containing the major flows within the road right-of-way. The overland flow route is shown on Figure 8.5.

8.5 Grading

The existing topography of the FSS Study Area generally slopes from north to south and towards the centre of the lands approximately 180m to the east of Colonel William Parkway at Dundas Street West. The general philosophy of the conceptual grading plan is to match existing grades as closely as possible while still maintaining necessary elements of the Stormwater Management Plan in Section 7.0. Due to the relatively shallow bedrock in some locations it may be advantageous to increase the height of fill in some areas to provide less complicated construction of the municipal servicing.

The preliminary road grades all meet the Town of Oakville criteria, all road grades fall between 0.5% and 3.5%. The preliminary lot grading will generally slope towards the right of way so that the stormwater can be treated in the stormwater management facilities. Both the preliminary road grades and lot grading will be further refined as the development goes through the subdivision and site plan process. Final road and lot grading will be completed in accordance with the Town of Oakville's grading criteria. As noted in Section 4.0, at the detailed design stage, landscaped areas adjacent to natural features will be graded towards these features wherever possible.

The conceptual grading plan is illustrated in Figure 8.6.

8.6 Summary

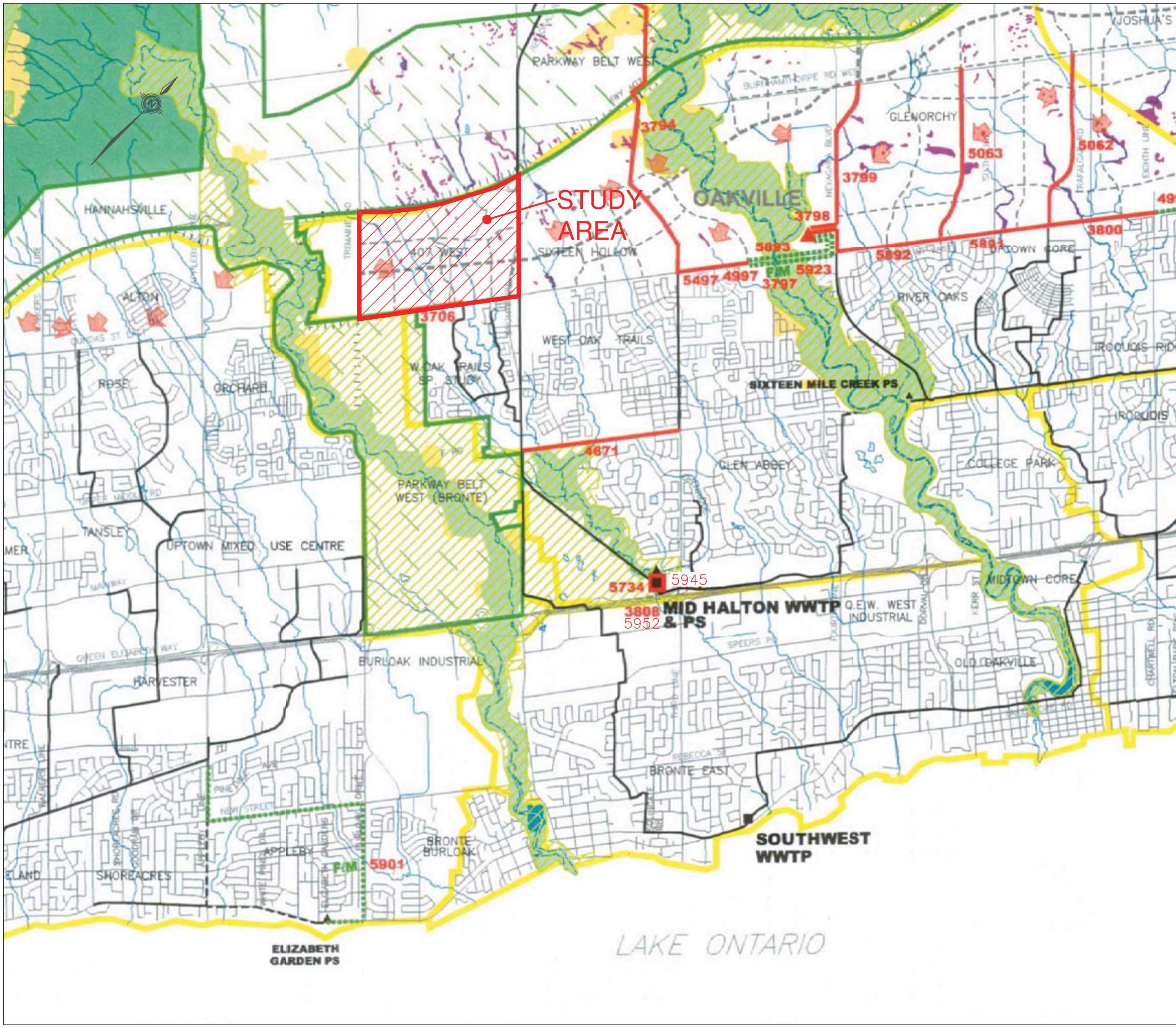
The Municipal Servicing Section of the EIR/FSS provides a conceptual design of the wastewater, water and storm servicing, the road and lot grading and the overland flow route associated with the development of the FSS Study Area.

The wastewater design will incorporate a gravity sewer system within the conceptual road network that generally drains north to south and outlets into the proposed Dundas Street Trunk Sewer which in turn discharges to the existing wastewater sewer on Colonel William Parkway. The Wastewater design sheets are available in Appendix 8.1. The conceptual wastewater servicing design is illustrated on Figure 8.2.

The water distribution system will consist of a network of local and trunk watermains within the conceptual road network. A water distribution model of the proposed watermain was completed to size the watermains within the FSS Study Area. The results of the water model for the FSS Study Area are available in Appendix 8.2. The conceptual water servicing design is illustrated on Figure 8.4.

The minor storm system will consist of gravity sewers within the conceptual road network that will discharge to a SWM facility for treatment based on the catchment areas indicated in Section 7.0. The major storm system will convey the major storm flows via an overland flow route along the road right-of-ways to the designated SWM facility. The storm design sheets are available in Appendix 8.3. The conceptual minor and major storm system design are illustrated on Figure 8.5.

The conceptual road and lot grading is designed with the intention of matching existing grades as closely as possible while still maintaining necessary elements of the Stormwater Management Plan detailed in Section 7.0. The conceptual grading plan is illustrated on Figure 8.6.



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

REGIONAL WASTEWATER PLAN

LEGEND:

- STUDY LIMIT
- WWTP DRAINAGE BOUNDARY
- EXISTING WASTEWATER PUMPING STATION
- EXISTING WASTEWATER TREATMENT PLANT
- PROPOSED/UPGRADE WASTEWATER PUMPING STATION
- PROPOSED WASTEWATER TREATMENT PLANT EXPANSION
- EXISTING WASTEWATER SEWER
- EXISTING WASTEWATER FORCEMAIN
- PROPOSED WASTEWATER SEWER
- FLOW DIRECTION
- PROPOSED WASTEWATER FORCEMAIN
- LAKES, RIVERS & CREEKS
- ANSI
- ESA
- PROVINCIALLY SIGNIFICANT WETLANDS
- REGIONAL WETLANDS
- NIAGARA ESCARPMENT
- GREENBELT
- GREENLANDS
- NINTH LINE CORRIDOR

**EXACT LOCATION OF PROPOSED WORKS TO BE DETERMINED IN THE SUBSEQUENT EA OR DETAILED DESIGN PHASE

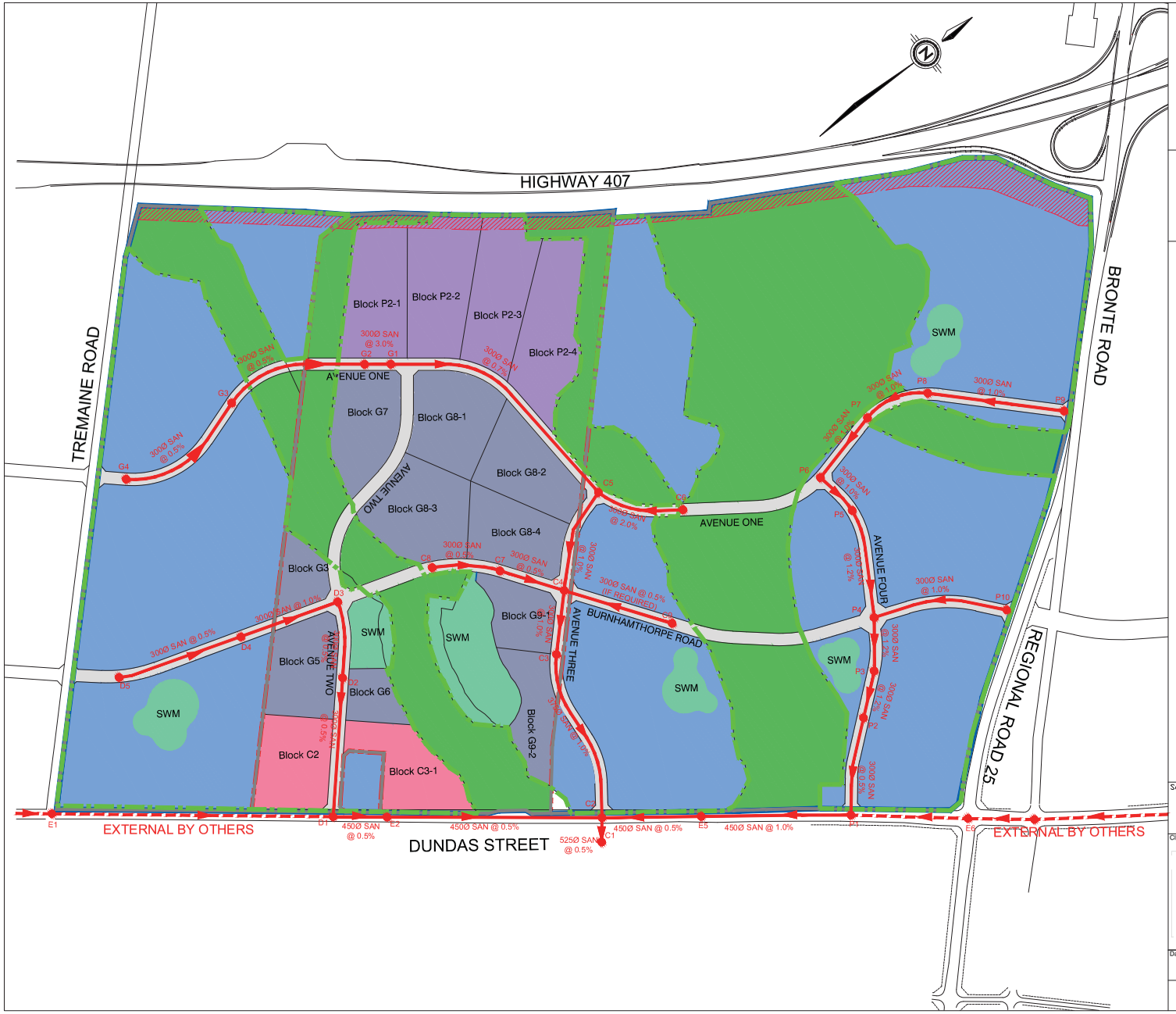
SOURCE: KMK CONSULTANTS LIMITED
SOUTH HALTON WATER AND WASTEWATER
MASTER PLAN UPDATE
JUNE 2008

Scale	
NTS	
Client: Bentall Kennedy	Prepared by: MMM GROUP
Date: MAY 2011	Project No.: 1409222.001
	FIGURE 8.1

PRINTED ON: FILE NAME: X:\DVIO\14-09222\MAIN\ASP-FSS Exhibits\EX3.1-FIG8.1_Regional Wastewater Plan.dwg_Fig 8.1

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

WASTEWATER DRAINAGE PLAN



LEGEND

- 407 WEST EMPLOYMENT AREA
- EXISTING PROPERTY LINE
- SUBJECT LANDS
- COMMERCIAL (SERVICE/RETAIL/OFFIC
- PRESTIGE EMPLOYMENT
- GENERAL EMPLOYMENT
- EMPLOYMENT (SPECIFIC USE TBD)
- NATURAL HERITAGE SYSTEM AREA
- STORMWATER MANAGEMENT AREA
- HIGHWAY 407 TRANSITWAY
- SANITARY SEWER
- SANITARY MANHOLE
- SANITARY DRAINAGE BOUNDARY
- EX. SANITARY SEWER (B.O.)

FOR THE PURPOSES OF OUR CONCEPTUAL SERVICING ANALYSIS, CONSERVATIVE LAND USE ASSUMPTIONS HAVE BEEN MADE FOR THE ENTIRE 407 WEST EMPLOYMENT AREA

Scale 0 100 200 300 400 500m

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: MAY 2011

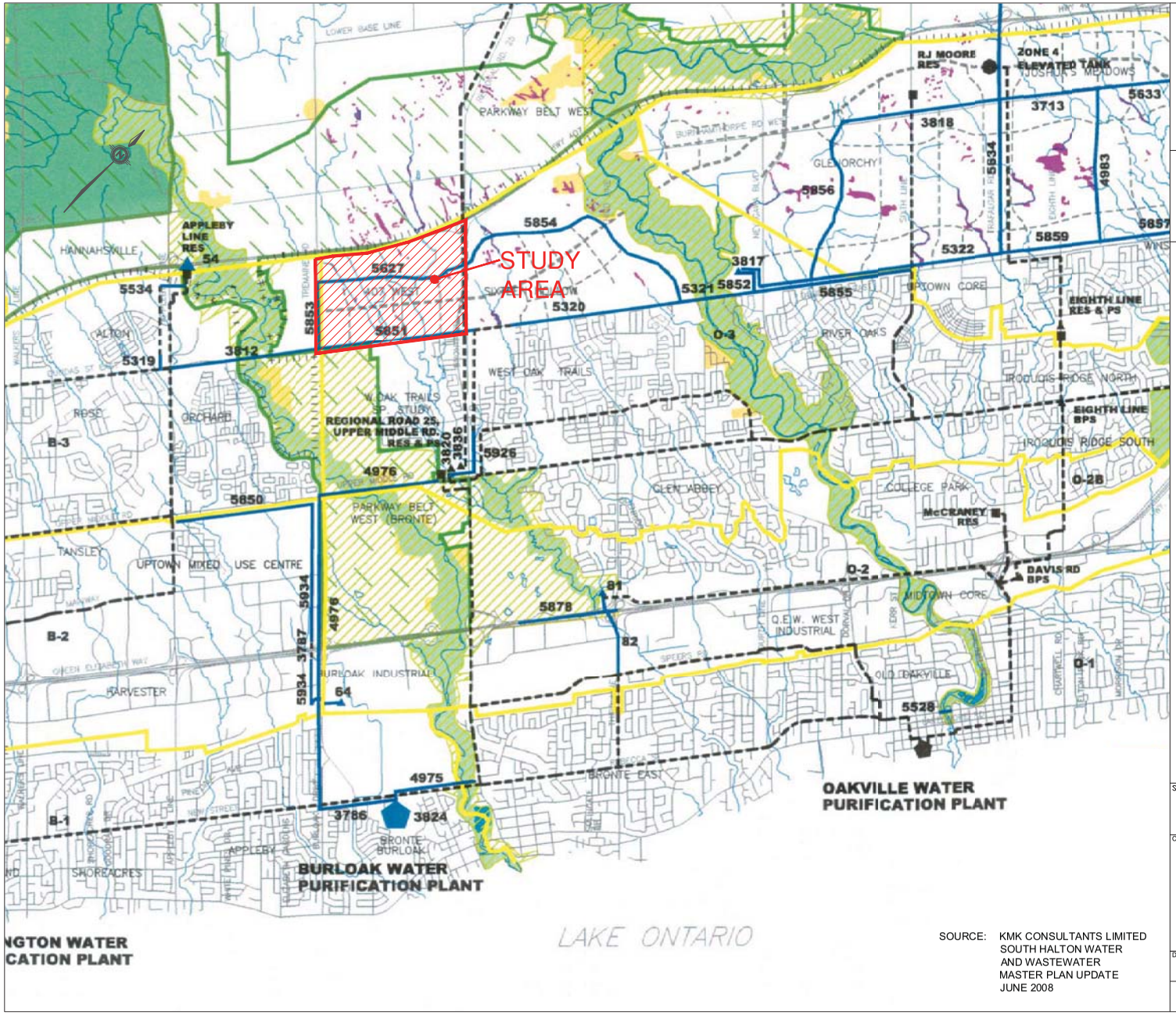
Project No.: 1409222.001

FIGURE 8.2

FILE NAME: x:\DIV10\14-09222\MUN\ASP-FSS Exhibits\EX3.6-FIG8.2_Wastewater Drainage Plan.dwg_Fig 8.2

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

REGIONAL WATER PLAN



LEGEND:

- STUDY LIMIT
- ZONE BOUNDARIES
- EXISTING BOOSTER PUMPING STATION
- EXISTING RESERVOIR
- EXISTING WATER TREATMENT PLANT
- EXISTING ELEVATED TANK
- EXISTING STANDPIPE
- EXISTING WELL
- PROPOSED BOOSTER PUMPING STATION
- PROPOSED RESERVOIR
- PROPOSED WATER TREATMENT PLANT
- EXISTING WATERMAIN
- PROPOSED WATERMAIN
- MILTON GROUND WATER
- LAKES, RIVERS & CREEKS
- ANSI
- ESA
- PROVINCIALLY SIGNIFICANT WETLANDS
- REGIONAL WETLANDS
- NIAGARA ESCARPMENT
- GREENBELT
- GREENLANDS
- NINTH LINE CORRIDOR

SOURCE: KMK CONSULTANTS LIMITED
SOUTH HALTON WATER
AND WASTEWATER
MASTER PLAN UPDATE
JUNE 2008

Scale: NTS

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: MAY 2011

Project No.: 1409222.001

FIGURE 8.3

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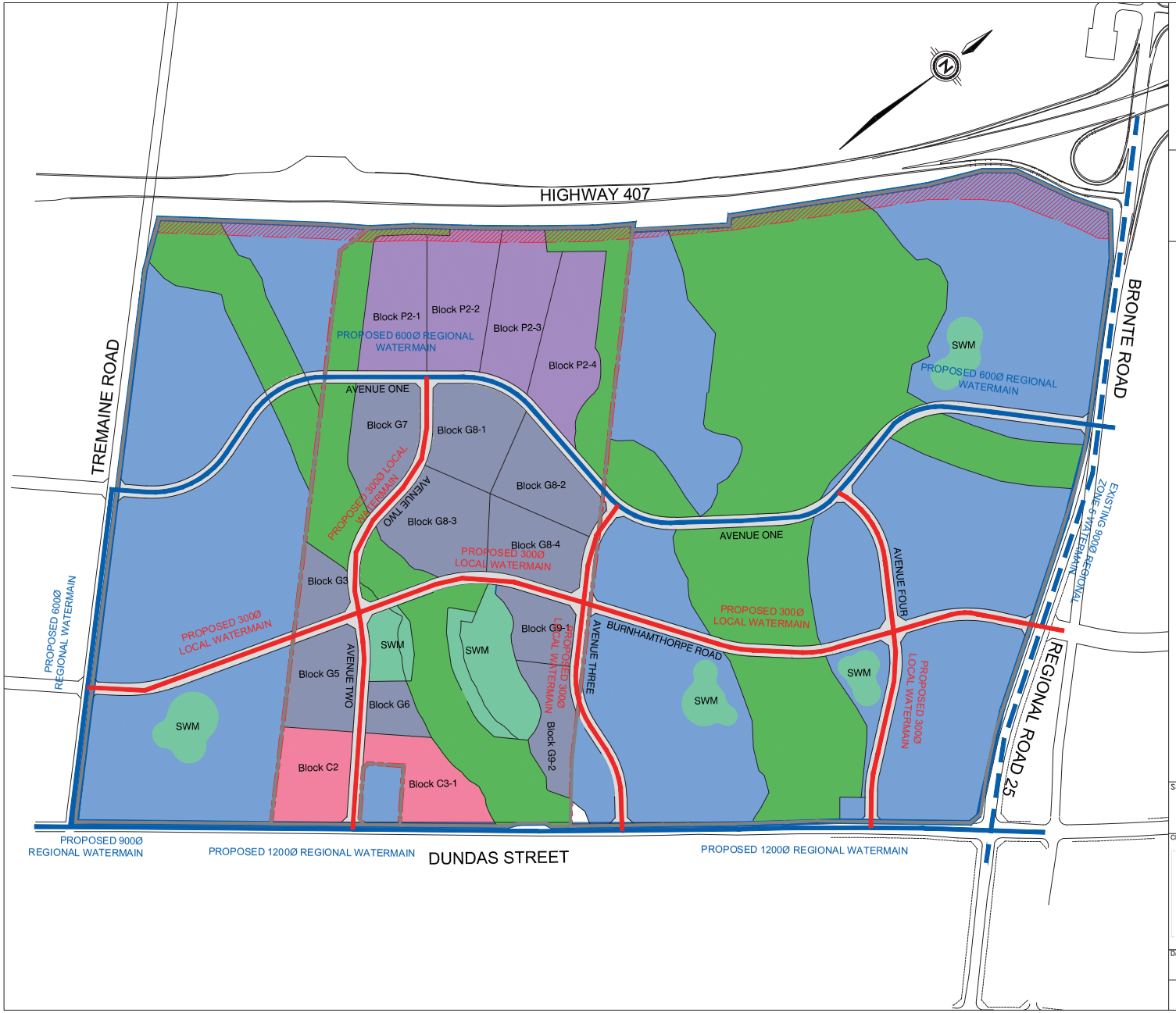
Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

WATER DISTRIBUTION PLAN



LEGEND

- 407 WEST EMPLOYMENT AREA
- EXISTING PROPERTY LINE
- SUBJECT LANDS
- COMMERCIAL (SERVICE/RETAIL/OFFICE)
- PRESTIGE EMPLOYMENT
- GENERAL EMPLOYMENT
- EMPLOYMENT (SPECIFIC USE TBD)
- NATURAL HERITAGE SYSTEM AREA
- STORMWATER MANAGEMENT AREA
- HIGHWAY 407 TRANSITWAY
- EXISTING REGIONAL WATERMAIN
- PROPOSED REGIONAL WATERMAIN
- PROPOSED LOCAL WATERMAIN

FOR THE PURPOSES OF OUR CONCEPTUAL SERVICING ANALYSIS, CONSERVATIVE LAND USE ASSUMPTIONS HAVE BEEN MADE FOR THE ENTIRE 407 WEST EMPLOYMENT AREA

Scale: 0 100 200 300 400 500m

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: MAY 2011

Project No.: 1409222.001

FIGURE 8.4

FILE NAME: X:\DIV\01\1+-09222\MUN\ASP-FSS Exhibits\EX2.6-FIG8.4_Water Distribution Plan.dwg_Fig 8.4

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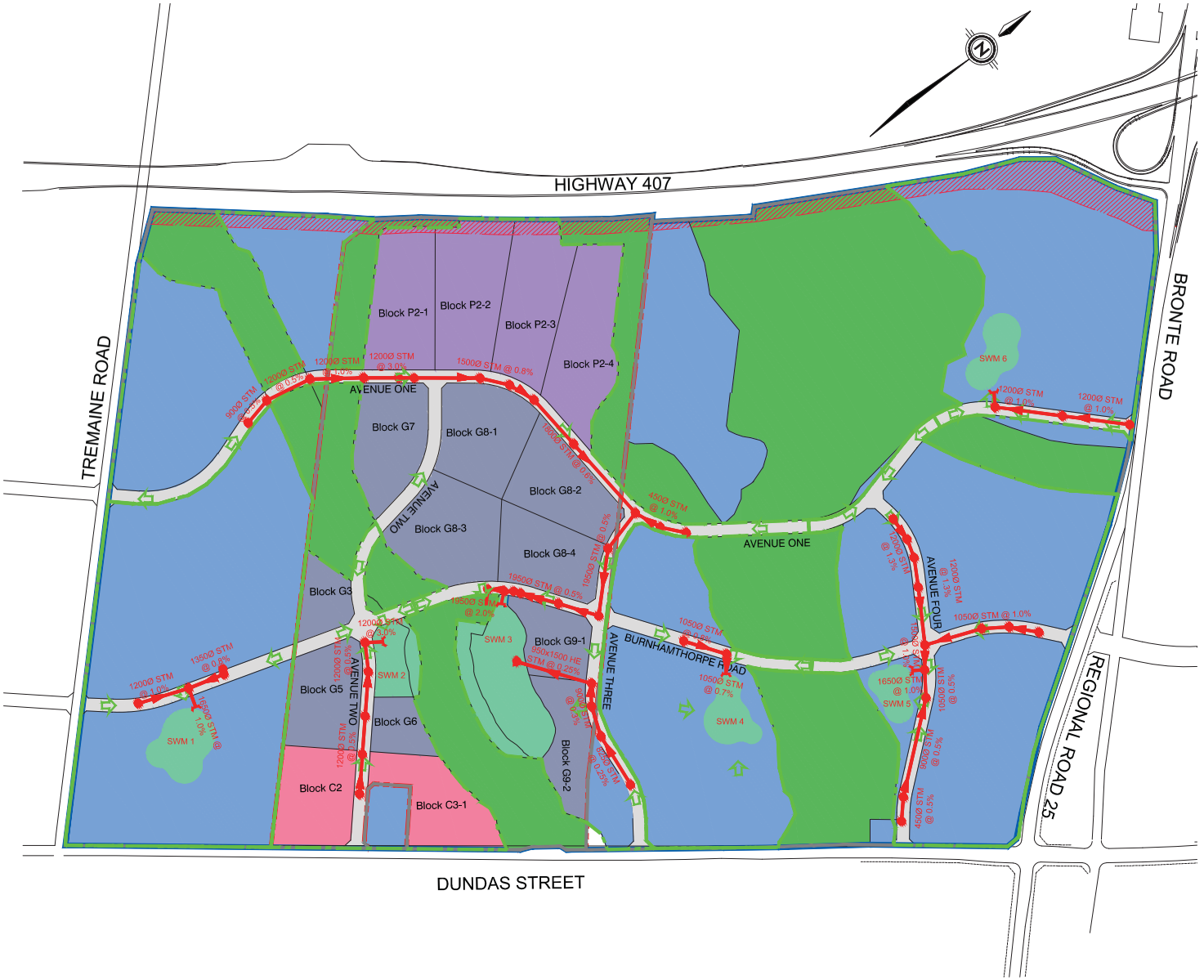
STORMWATER DRAINAGE PLAN



LEGEND

- 407 WEST EMPLOYMENT AREA
- EXISTING PROPERTY LINE
- SUBJECT LANDS
- COMMERCIAL (SERVICE/RETAIL/OFFI
- PRESTIGE EMPLOYMENT
- GENERAL EMPLOYMENT
- EMPLOYMENT (SPECIFIC USE TBD)
- NATURAL HERITAGE SYSTEM AREA
- STORMWATER MANAGEMENT AREA
- HIGHWAY 407 TRANSITWAY
- STORM SEWER
- STORM MANHOLE
- STORM DRAINAGE BOUNDARY
- OVERLAND FLOW ROUTE

FOR THE PURPOSES OF OUR CONCEPTUAL SERVICING ANALYSIS, CONSERVATIVE LAND USE ASSUMPTIONS HAVE BEEN MADE FOR THE ENTIRE 407 WEST EMPLOYMENT AREA

Scale: 0 100 200 300 400 500m

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: MAY 2011

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FIGURE 8.5

FILE NAME: X:\DIV10\14-09222\MUN\ASP-FSS Exhibits\FIG 8.5_Stormwater Drainage Plan.dwg_Fig 8.5

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

GRADING PLAN

LEGEND

- 407 WEST EMPLOYMENT AREA
- EXISTING PROPERTY LINE
- SUBJECT LANDS
- COMMERCIAL (SERVICE/RETAIL/OFFICE)
- PRESTIGE EMPLOYMENT
- GENERAL EMPLOYMENT
- EMPLOYMENT (SPECIFIC USE TBD)
- NATURAL HERITAGE SYSTEM AREA
- STORMWATER MANAGEMENT AREA
- HIGHWAY 407 TRANSITWAY
- 2.0% PROPOSED ROAD GRADE
- 240.70 PROPOSED ROAD ELEVATION

FOR THE PURPOSES OF OUR CONCEPTUAL SERVICING ANALYSIS, CONSERVATIVE LAND USE ASSUMPTIONS HAVE BEEN MADE FOR THE ENTIRE 407 WEST EMPLOYMENT AREA

Scale: 0 100 200 300 400 800m

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: MAY 2011

Project No.: 1409222.001

FIGURE 8.6

FILE NAME: X:\DIV10\14-09222\MUN\ASP-FSS Exhibits\Fig 8.6 - Conceptual Grading.dwg_Fig 8.6