Analysis of the temperature fluctuations for the sampling period between May 12, 2009 and October 30, 2009 using the Wehrly *et al.* (1999) method suggests that the water temperature within the reaches fluctuates greatly in response to elevated air temperatures and rain events (Appendix 5.6). In most cases, water is not retained within the reaches throughout the summer. These factors suggest that the reaches receive insufficient groundwater inputs to maintain base flow, let alone a stable coolwater/coldwater thermal regime. The results of the Wehrly *et al.* (1999) method for thermal categorization are supported by the results obtained using the Chu *et al.* (2009) method. Furthermore, both methods indicate that the water temperatures within the reaches are influenced by air temperature, such that: at cooler air temperatures habitat within the stream reaches is indicative of coolwater habitat, which then changes to resemble that of warmwater habitats at higher air temperatures.

Table 5.5 – Summary of Water Temperature Data Analysis (2009), Chu *et al.* Method

Tributary	Linear Trendline Equation @ 24 ºC	Linear Trendline Equation @ 36 ºC	Thermal Category
Reach 14W-11[7]	19.07	27.78	Coolwater to warmwater
Reach 14W-12 downstream limit	19.89	28.47	Coolwater to warmwater
Reach 14W-16	19.57	27.37	Coolwater to warmwater
Reach 14W-14A (Farm Pond) (2011) Summary Range (bottom to top)	21.79 to 25.28	20.38 to 30.13	Coolwater to warmwater

Water temperature monitoring in the Farm Pond (Reach 14W-14A) was carried out in 2011 and documented in the Technical Memorandum – NH#1 included in the Appendix 5.9. A summary of the temperature ranges is provided in Table 5.5 above. The water temperatures in the pond are consistently higher than stream reaches. An exception is noted with respect to temperatures recorded at the deepest portion of the pond. At first glance, the temperatures recorded at the deepest logger would seem to suggest that the water temperatures at the bottom of the pond have a negative correlation to air temperature and therefore could be influenced by groundwater. This is not the case for the following reason. The temperature data at the deepest logger conflicts with the hydrogeological data collected during the same time frame, which indicates that the pond levels were always higher than the groundwater levels recorded at the surrounding monitoring wells, thus meaning that water from the pond seeps into the ground and therefore cannot receive groundwater discharge at this location. The hydrogeological monitoring data also showed that the pond level declined by about 0.5 m from the beginning of July to the end of September 2011, the period in which the pond temperature monitoring took place.

[7] Given the condition of the logger upon retrieval on July 8, 2009, compared to others in the pond during the same time, it appears that it was imbedded in the substrate and was recording sediment temperature rather than collecting water temperature data.

Dissolved Oxygen

DO levels in each of the reaches were recorded bi-monthly, at the temperature logger location, when water was present in the channel as shown in Figure 5.4 with the data are summarized in Table 5.6 (below).

The OMB *Mediation Item: Stormwater Management – Temperature and Dissolved Oxygen Targets* (July 12, 2007) sets 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. During 2011 monitoring efforts in Reach 14W-14A, dissolved oxygen readings were collected at various depths in the Farm Pond in August. As expected and likely due to surface agitation, the DO levels in the pond at the surface meet or exceed the OMB target. As the depth increases, the DO levels continue to drop with DO levels at depths of 2.0 m or greater below the OMB target of 6 mg/l associated with recorded water temperatures between 20ºC and 24.3ºC. This distribution of DO is not unexpected considering the shallow depth of the Farm Pond and the likelihood of mixing. The reduced DO in the deeper area is likely attributed to less mixing and bacteria activity in the sediment. There may be periods throughout the year when dissolved oxygen levels may rise in the pond, when algae and/or aquatic plants in the pond receive sufficient exposure to sunlight to produce greater amounts of oxygen during photosynthesis.

Table 5.6 - Dissolved Oxygen Monitoring Summary (mg/l)

Date	Reach			
2009	14W-11A	14W-16	14W-12A	14W-12
May 12	10.31	14.00	-	-
May 28	7.28	8.62	3.38	7.57
June 11	4.58	10.82	-	5.67
June 26	5.30	8.58	-	5.20
July 8	-	6.35	-	5.40
July 30	7.65	7.89	-	7.77
August 28	5.98	7.95	-	7.28
September 10	-	7.50	-	4.88
September 30	8.40	8.89	-	7.25
October 19	6.14	9.95	-	8.93
October 30	7.11	9.35	6.70	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

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

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, as these headwater systems flow through the Subject Property, they flow through agricultural fields (Reach 14W-13, Reach 14W-14 and Reach 14W-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 within undefined sections while those scattered sections of defined channel consist of coarse substrate. In both conditions, the channels exhibit little meander and minimal to no buffer (i.e. 1 metre or less grassed riparian buffer). The only reaches within the West Branch of Fourteen Mile Creek 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 Farm Pond (Reach 14W-14A) and a seasonally offline pond associated with 14W-16 (Pond 1/Dug Pond). Based on historic aerial photography and information presented in NOCSS, both ponds appear to have been constructed between 1954 and 1960 and have some form of seasonal connection/contribution to adjacent reaches (Section 6.0). Anecdotal information from the current farmer indicated that the Farm Pond (Reach 14W-14A) had been constructed in 1954, just prior to Hurricane Hazel as the berm impounding water was washed away and had to be rebuilt.

The flow regime of the reaches within the Subject Property are principally intermittent with habitat during summer months restricted to areas of pool refuge. The flow contributions to these reaches 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 and, as a result, the local stream systems receive a little over two-thirds of their total water from surface runoff.

Groundwater contributions do contribute flow to these reaches to a lesser extent; however, due to the low permeability of the soil, this contribution is limited. The majority of the groundwater inputs to the local reaches are considered to flow laterally through the upper, weathered zone of the till resulting in almost 100% of the groundwater contribution occurring 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 reaches. Due to this enhanced conductivity, approximately 90% of the infiltrating groundwater moves horizontally through the shallow system, and provides a source of flow to the local reaches 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), the shallow system drains, and the reaches become dry (Section 4.0).

Towards the southern portion of watershed FM1001, the reach valleys approach the underlying Queenston Shale bedrock, which is exposed at surface just before it passes under Dundas Street. Minor groundwater inputs from the deeper bedrock groundwater are interpreted to take place in Reaches 14W-12 and Reach 14W-14. In the case of Reach 14W-14, these inputs are interpreted to continue up to a point roughly where this watercourse passes under Highway 407. 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 reaches is considered to continue throughout the year. However, the volumetric rate of water moving towards these two reaches is low, and during the summer months, is insufficient to provide enough water to maintain flow in these reaches, particularly, 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 sections 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 limitations. 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 this pond flows to the south under Burnhamthorpe Road and continues as Reach 14W-20A (reach not identified on figures) downstream through a large woodlot considered a component of the Candidate Oakville-Milton Wetlands and Uplands ANSI. 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 (reach not identified on figures) 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, as well as, 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 (Reach 14W-11) as identified in Figure 5.4. 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 traverses the watercourse creating rutting and resulting in a wide shallow pooled area. Along the channel the vegetation community is wetland and given its context, this wetland meets the criteria for classification as a Hydrologic Feature 'A'.

Reach 14W-11

This reach is considered High-Constraint Corridor–Requiring Rehabilitation, eventually discharging into Reach 14W-1A (reach not identified on figure), a High Constraint Corridor. It is an intermittent watercourse with flows observed during the spring and following precipitation events. 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 observed during field investigations. The isolated pools are likely associated with precipitation event or seasonal spring flows as the hydrogeology indicates that the watercourse is losing water to the ground. Downstream of the wooded area, Reach 14W-11 offers poor habitat diversity, lacking a defined channel or pools, as it continues 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 adjacent lands 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 principally provide surface water flow contributions.

According to NOCSS, Reach 14W-13 is not considered to provide aquatic habitat. Field investigations confirm that this reach does not appear to provide direct fish habitat with contributions to downstream fish habitat principally associated with intermittent flow contributions. Downstream of the Highway 407 culvert outlet, the reach 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, in areas of pooled water in tire ruts associated with farm equipment crossings. Similar to Reach 14W-11, the hydrogeology of this reach is interpreted to lose water to the ground and as a result, the pools are likely associated with surface water contributions. 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 background documentation.

Reach 14W-14

The headwaters of this reach 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 (reach not identified on figure) and is considered to be a swale conveying flow easterly through active agricultural fields within subcatchment FM 1003b as identified in NOCSS. Reach 14W-15 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. It 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 associated with the Subject Property. Reach 14W-15 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 of Highway 407 in stream Reach 14W-14: however, this habitat is likely limited to the culvert inlet pool due to the absence of channel form and structure located further upstream.

As the channel enters the Subject Property it is identified as Reach 14W-14. The reach 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 (Hydrologic Feature 'A') including its confluence with Reach 14W-13 and downstream to discharging into Reach 14W-12A. The wetland boundary as determine in NOCSS for Hydrologic Feature 'A' has increased in size as noted above. The defined section consists of 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 background documents. The reach is considered to be intermittent as the channel was predominantly dry throughout the 2009 water quality monitoring period and as documented in 2001 background reports. There is no canopy cover along the entire reach between Highway 407 and the confluence with Reach 14W-13. The only trees present are located along the sparse hedgerow at the upper limit of the reach, south of the highway.

Reach 14W-14A (Farm Pond)

Reach 14W-14A consists of an excavated Farm Pond (Hydrologic Feature 'A') 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 wetland boundary of the pond as determine in NOCSS for Hydrologic Feature 'A' has increased in size since its original assessment. The pond appears to have been originally constructed in a low-lying area in Reach 14W-14 in which flow from this low area would have likely continued downstream and join with Reach 14W-12 prior to flowing as a single channel under Dundas Street. Based on water surface elevations and groundwater elevation data, this pond appears to be maintained from surface runoff rather than groundwater contributions.

The construction of this pond resulted in flow from Reach 14W-13 and Reach 14W-14 being directed into the pond. Currently, flow enters and discharges from the pond at the same location with discharge only occurring when water levels in the pond reach a certain elevation. This pond is approximately 9,600 m^2 (240 m long x 40 m wide on average) with the shoreline habitat of the pond consisting 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. Additional surveys and monitoring of habitat in this pond was undertaken in 2011 to satisfy comments received from CH (September 6, 2011). The results

of this monitoring and additional documentation of this feature are detailed in the Technical Memorandum NH#1 (Appendix 5.9).

This pond supports Largemouth Bass, a top-level predator species requiring a substantive forage base. Detailed thermal datum was collected in 2011 to characterize the stratified thermal regime in the pond and to determine if the water temperatures are influenced through groundwater inputs. Detailed graphs and calculations are presented in the Technical Memorandum NH#1 (Appendix 5.9). The results of temperature monitoring when evaluated in conjunction with the hydrogeological monitoring results, indicate that the pond is not influenced by groundwater. The pond primarily functions as warmwater habitat, which discharges warmwater to downstream Reach 14W-12 via Reach 14W-12A during storm events.

Reach 14W-16

The headwaters of this reach originate north of Burnhamthorpe Road, west of Tremaine Road and receives drainage from a combination of agricultural lands, railway and roadway runoff. It also receives pumped water from the Hanson Brick Quarry located north of Highway 407. According to Golder Associates (2009), in the year 2008, approximately 44,500,000 litres of water was pumped from the quarry into the headwaters, via a settling pond, at an average rate of 1,078 litres/ minute. This is equivalent to an average of about 13 hours discharge per week, which would not be noticeable during fall to spring conditions, but which would lead to additional water to this reach during the summer period when flows are intermittent.

This upstream reach located from the northeast quadrant of the Highway 407/Tremaine Road intersection is identified as Reach 14W-17 (reach not identified on figures) and generally consists of field drainage within subcatchment FM1002. This reach has been modified by planting of crops through the apparent flow path and likely functions primarily as an agricultural swale. Downstream of Highway 407, flow is conveyed through an old field meadow where it becomes Reach 14W-16 prior to entering the Subject Property. 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 Pond 1 (Dug Pond) associated with this reach. With the substrate consisting of coarser material including gravel, cobbles and boulders set in clay and overtopped with silt in this area. 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 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 1 (Dug 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. Along the channel, there is an existing wetland classified as a Hydrologic Feature 'A' under NOCSS. However, since NOCSS's assessment, another wetland was noted during field investigations and given its context, this wetland meets the criteria for classification as a Hydrologic Feature 'A'.

Pond 1 (Dug 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 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.

Pond 1 (Dug Pond), which is not identified on mapping, receives flow inputs from a shallow agricultural swale from the agricultural lands to the west. These lands are ploughed during the growing season. Flow discharges from the east end of the pond to Reach 14W-16 via an intermittent channel. This channel appears to have been created naturally by the pond's overflow as indicated by its meandering and heterogeneous form. It continues as a relatively steeply sloped channel that in combination with intermittent flows would likely restrict fish passage seasonally. As previously indicated, this pond may function as direct fish habitat regulated under the federal FA (1985); however, as it is a constructed feature with a poor connection to downstream fish habitat and consisting largely of stocked fish, it likely functions primarily as a Hydrologic Feature 'B' within the floodplain based on mapping in the NOCSS.

Reach 14W-12

This reach is classified as a High Constraint Stream, likely due to its direct support of Redside Dace. According to Section 4W.8.5 of the NOCSS Characterization Report (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 grazing, 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 this reach (renamed Reach 14W-12A) described in NOCSS with its location along a section of the channel located to the north of Reach 14W-14A (Farm 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 (Farm Pond) has informally been identified as Reach 14W-12A and described below separately from the remainder of Reach 14A-12.

Reach 14W-12 is considered to be morphologically and functionally similar to the lower section of Reach 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 cobbles over clay and a wetted width of approximately 0.80 m and depth ranging from 0.10 m and 0.28 m, when flow 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 Reach 14W-16 extends downstream through the upper section of this reach.

A pool approximately 0.60 m deep has formed at an existing farm road crossing located approximately 200 m upstream of Dundas Street. During each site visit, this feature was observed to function as refuge habitat for fish 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 bedrock, 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.

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 captured in 2001 noted in background documentation. 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.

Reach 14W-12A

Reach 14W-12A is approximately 125 m long and conveys flow and surface runoff from Reach 14W-13, Reach 14W-14 and Reach 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 (Farm Pond) and the reconfiguration of the existing network to convey flows to the west of the newly constructed pond. As previously indicated, the individual currently farming the land has indicated that the Farm Pond was constructed in the fall of 1954. 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 is a constructed feature associated with the constructed Farm Pond (14W-14A). It flows through a trapezoidal valley that contains a short section (approximately 40 m long) of a narrow incised channel located between dense cattail growth originating at the Farm Pond (Reach 14W-14A) inlet/outlet and at the convergence of Reach 14W-12A with Reach 14W-112 and Reach 14W-16. The incised channel receives diffuse flow through cattails at the outlet of the Farm Pond (Reach 14W-14A) and extends for approximately 40 m. It has been noted in repeated site visits between 2009 and 2011 that the cattail community originating at the outlet of 14W-14A (Farm Pond) continues to expand, further encroaching downstream within Reach of 14W-12A. During December 2010 site reconnaissance, flow was observed within a wetted channel width of 0.60 m and depth of 0.09 m with a small pooled area (0.23 m deep). 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 groundwater contributions to maintain base flow in this reach.

This reach may provide direct seasonal fish habitat, when water is present and there is connectivity past the dense cattail growth at the confluence with Reach 14W-12/Reach 14W-16 and the Farm Pond (Reach 14W-14A). Notwithstanding the potential connectivity when there is water present, its constructed nature and limited habitat diversity would limit its function as fish habitat.

To obtain a greater understanding of the function of Reach 14W-12A as potential direct fish habitat and contributing habitat, a spring field investigation was undertaken on April 4, 2017. The timing of this investigation followed the *Evaluation, Classification and Management of Headwater Drainage Features Guidelines Approved July 2013* (CVC/TRCA, Finalized January 2014). During this site investigation, Reach 14W-12A had a wetted width of 2.05 m and an average water depth of 0.14 m within the section with the narrow incised channel with a narrower wetted width and deeper depths in the section with the dense cattails at the confluence with Reach 14W-12. Flow was present, but was minimal and was being conveyed from Reach 14W-13 and Reach 14W-14. No flow was observed flowing out of Reach 14W-14A. Fish community sampling was undertaken by dip netting within the incised channel, but did not result in the capture of any fish; potentially due to the dense cattails that would likely impede fish passage at the upstream and downstream limits of Reach 14W-12A.

However, a second spring field investigation on May 10, 2017 after period of wet weather was undertaken. During this visit, the water level in all reaches were elevated above the April observations with increased depths and wetted widths in Reach 14W-12A. Furthermore, flow was observed outleting into Reach 14W-12A from the Farm Pond. The flow from Reach 14W-12A into Reach 14W-12 was of a large enough (volume/depth), that fish passage from downstream into Reach 14W-12A through the dense cattails may have been possible. This observation confirms that a seasonal connection between Reach 14W-12 and Reach 14W-12A does occur, although is likely seasonally dependent on large precipitation events.

Although the function of Reach 14W-12A as seasonal direct fish habitat could not be confirmed, it does provide a function to convey flow along with drift materials/allochthonous inputs to downstream direct fish habitat consisting of Occupied Redside Dace habitat during a critical period in the fish's lifecycle.

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, with additional surveys completed for verification and soil auger samples in 2014. Soil augers were done in accordance with ELC methodology with reference to the Field Manual for Describing Soils (Ontario Centre for Soil Resource Evaluation, 1993). In 2009, surveys on the Subject Property were completed on August 20 and 21 and off-site subcatchment surveys (as described below) were completed on August 18 and September 11. In 2010, surveys on the Subject Property were completed on April 22 and July 13 and 14. In 2014, surveys were completed on September 24.

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

- Due to the vegetation mapping efforts documented in the NOCSS, lack of Cores or Linkages present on the Subject Property and the EIR ToR requires only a preliminary field review of features, the classification, mapping and evaluation of vegetation communities within the Subject Property was carried out 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.
    - The modified ELC approach facilitated the classification of vegetation communities smaller than 0.5 ha in order to capture the smaller natural features on the Subject Property.
    - This method uses additional feature names not specified in the ELC (i.e. tree cluster, pasture), which allows for a complete description of the cultural landscape features.
    - Soil auger samples were taken at representative locations in ELC communities in the proposed Open Space Area corridor (Figures 5.2, 5.5, 5.7).

- Evaluation of community significance according to Bakowsky (1996) and the NHIC database (Current July 30, 2014).

- 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 database provincial rarity ranks (i.e. S-Ranks) (current July 30, 2014); the Species At Risk in Ontario List (current October 31, 2014) for provincial status designations under the ESA (2007); the Rare Vascular Plants of Ontario (Oldham and Brinker, 2009) for provincially rare plants, the Canadian Species At Risk Act list (updated October 21, 2014) 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 (Newmaster *et al.,* 1998).

- As required by the North Oakville EIR ToR, 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 5.7 and Table 5.8. 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 rural residential properties, associated farm buildings, and pasture areas (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, and forested stream valley. 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 SAR 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 5.3.5.4 and Table 5.8 of this report.

One vegetation community (Unit 5a, Dry-Fresh Oak-Hickory Deciduous Forest, FOD2-2) is provincially uncommon (S3S4, Bakowsky 1996/NHIC 2014). 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 5.7 on the following page.

Table 5.7 – Terrestrial and Wetland Vegetation Community Summary

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
1: Farm Pond (Reach 14W-14A)	• Feature identified as Hydrologic Feature A' within NOCSS. • Reach 14W-14A • 34 species observed. • Notable species: Crested Sedge. • Feature is an online/bypass pond with a fringe of wetland vegetation. • Submerged vegetation in shallow water areas that becomes sparse as water depth increases. • The existing Hydrologic Feature 'A' portion of the Farm Pond is approximately 0.531 ha and consist of SAF1-3, OAO and SAS1-1 vegetation communities. • A new wetland has been noted surrounding the Farm Pond which has an approximate area of 0.767 ha and consist of MAS2-1 vegetation community. • All of the existing Hydrologic Feature 'A' (Farm Pond) and new wetland will be removed;	1A: Cattail Mineral Shallow Marsh (MAS2-1)	• Cattail dominated fringe along periphery of Farm Pond (Reach 14W-14A) feature. • Narrow-leaved Cattail dominates, with Purple Loosestrife, Reed Canary Grass, Broad Leaf Cattail, American Bugleweed, and Climbing Nightshade, • Interspersed with Water Plantain, Lance-leaved Aster, Queen Anne's Lace, Cutgrass, and Fox Sedge. • 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 Farm Pond (Reach 14W-14A) feature. • Dominated by Lesser Duckweed. • Community boundary likely variable within and between years due to floating nature of duckweed and the amount of algal growth in the pond throughout the year.
		1C: Open Aquatic (OAO)	• Central portion of Farm Pond (Reach 14W-14A) feature is an open water community lacking vegetation cover.
		1D: Pondweed Submerged Aquatic (SAS1-1)	• Submerged vegetation throughout the shallow areas, dominated by Pondweed (*Potamogeton sp*.) and Coontail (*Ceratophyllum sp*.) species.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
	however, CH confirmed on February 07, 2018, that the open water function of the Hydraulic Feature 'A' (Farm Pond) does not need to be replicated.		
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 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*)	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 valleys within drainage feature network. • Anthropogenic disturbance: adjacent active agricultural use likely results in periodic disturbance (e.g. chemical spraying/vegetation dieback, grazing) 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. • Hand augured soil samples (3) taken as part of ELC mapping in this community shows mineral soil types of Clay to Silty Loam

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
	observed occasionally within drainage features. • The existing Hydrologic Feature 'A' portion of Reach 14W-14 is approximately 1.343 ha and consist of MAM2-2 vegetation community. Approximately 0.94 ha will be removed. • New wetlands have been noted in Reach 14W-14 and consist of MAS2-1 (approximately 0.027 ha) and MAM2-2 (approximately 0.681 ha) vegetation communities. All MAS2-1 and most of MAM-2-2 (approximately 0.607 ha) will be removed.		over bedrock (Queenston shale and limestone). Organics were restricted to a very thin organic litter layer (<5 cm). Augers were consistently refused at 44-62 cm depth due to hitting rock.
		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). • A hand soil auger (associated with ELC) in this community shows mineral soil types of Silty Clay over Clay over bedrock (Queenston shale and limestone). Organics were restricted to a very thin organic litter layer (<1 cm), and thin organic fibric layer (5 cm). The auger was refused at 65 cm depth due to hitting rock.
		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

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
			wetland characteristics and presence of regionally significant species). • A hand soil auger (associated with ELC) was not taken in this unit due to feasibility reasons (too crowded to move auger effectively)
		2D: Cattail Mineral Shallow Marsh (MAS2-1)	• Cattail dominated pockets within drainage feature network. • 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). • A hand soil auger (associated with ELC) in this community shows mineral soil types of Silty Clay over Clay over bedrock (Queenston shale and limestone). Organics were present as a thin organic litter layer (5 cm), and thin organic humic layer (15 cm). This soil is a "mineral" soil. The auger was refused at 60 cm depth due to hitting rock.
		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). • No soil auger was taken in this unit.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
		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). • A hand soil auger (associated with ELC) in this community shows a mineral soil type of Silty Clay over bedrock (Queenston shale and limestone). Organics were restricted to an organic litter layer (10 cm). The auger was refused at 80 cm depth due to hitting rock.
3: Lowland deciduous forest	• 26 species observed. • Notable Species include Torrey's Rush, Rice Cutgrass, Panicled Aster.	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 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). • No hand soil auger (associated with ELC) was taken in this unit due to its proximity to the occupied residence.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
		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. • No hand soil auger (associated with ELC) was taken in this unit due to its proximity to the occupied residence.
4: North Woodlot	• 34 species observed. • Notable Species include Fringed Sedge, Shagbark Hickory and Winterberry.	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*). • 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.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
			• 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). • No hand soil auger (associated with ELC) was taken in this unit.
5: Valley Forest and floodplain marsh	• 31 species observed. • Notable species include Shagbark Hickory, Turtlehead, Torrey's Rush, Panicled Aster and Rice Cutgrass.	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 to 80 cm diameter at breast height (dbh). • 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). • A hand soil auger (associated with ELC) in this community shows a mineral soil type of very dry compacted Silty fine Sand. Hand auguring at long the watercourse banks. This may be attributed the alluvial deposits associated with the meandering watercourse as the auger could not be advanced beyond 20 cm.

Unit	Overview/Flora Summary	Vegetation Subunit and ELC Community	Community Description (attributes/functions)
		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 Reach 14W-11. • 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. • A hand soil auger (associated with ELC) in this community shows mineral soil types of medium Sandy Loam and medium Sandy Clay Loam. Organics were restricted to an organic litter layer (8 cm). Hand auguring could not be advanced beyond 45 cm.

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 5.8 below.

Table 5.8 – 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 to 70 m 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.
TC3	Trembling Aspen	• A small aspen stand in an area of active pasture. • Trees range in size from 10 to 30 cm dbh; 10 to15 m tall. • Tree health is good. However, many fallen branches were observed.
HR1	Hawthorn, Buckthorn, Oak	• Broad (approximately 5 m wide) shrub hedgerow with frequent gaps approximately 200 m long. • Dominated by shrubs averaging approximately 2 to 3 m tall. • Sparse small Bur Oak and White Oak less than 10 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 140m) comprised of 7 large, well-spaced open grown trees within active agricultural field. • Trees range from 50 to 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.

Figure 5.2 Reference Code	Dominant Species (in decreasing order of abundance)	General Characteristics
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 to 4 m tall. • Moderate to good health. • Provides connectivity between stream Reach 14W-14 and Reach 14W-16.
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 northeast corner of the Subject Property. Core #1 is associated with the main branch of Fourteen Mile Creek between Tremaine Road and Bronte Road. Eleven distinct ELC vegetation community types were mapped within Core #1 and the Linkage to Core #2 during surveys completed for the NOCSS and are listed below.

- 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)
- 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 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 18 and September 11, 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 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.
- 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 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

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 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.
- 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 7 and July 12, 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 environment field surveys, including August 20 and 21, 2009 and April 22, July 13 and July 14 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 (MNRF 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 5.3. Calling survey results are summarized in Appendix 5.2 Table 5-2.2 and discussed in Section 5.3.6.2.

Bats

Bat habitat in the form of maternity roosting habitat assessments was completed on the Subject Property in 2015. Exit surveys were undertaken using a combination of visual observations and acoustic monitoring. Given that the suitable vegetation communities that could potentially provide roosting habitat for bats are contained within the proposed Open Spaces designated areas and retained, exit surveys were only preformed on the existing structures with bat habitat potential. Two rounds of exit surveys were conducted on the existing structures on four dates in 2015: June 4, 11 and 16, and July 13. If no bats were noted exiting a structure during the first survey, a follow-up survey was not required.

Exit surveys followed MNRF guidance under appropriate conditions (i.e., dusk/evening survey with no rain) and were assessed by placing observers at pre-identified potential exit points with enough observers to achieve full visual coverage of the exits. Combined with the visual survey, acoustic monitoring also was undertaken. Prior to the beginning of each survey, SM3BAT (Wildlife Acoustics) detectors equipped with SMM-U1 omnidirectional ultrasonic microphones were deployed in order to record bat calls. One detector was used to record in stereo on two channels with two microphones extended on cables. Each microphone was positioned 3 to 3.5 m above the ground at each monitoring location and within 5 to 10 m of each building face in order to maximize bat detection and to capture quality sound files.

Detectors were programmed to begin recording at the start of the survey in triggered mode with settings recommended for recording bats. During the survey, observers noted any bats observed exiting the structure or flying in the general vicinity, along with the time of each observation. Additional notes on behavior and flight path were recorded.

The recorded audio files were played through Sonobat® software to determine species or group of bats. Exit survey results are summarized in Appendix 5.2 Table 5-2.3 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).
- Two (2) federally (COSEWIC) and provincially (COSSARO) designated Threatened species were recorded: Bobolink and Barn Swallow.
- One (1) provincially rare species, Black-crowned Night Heron (*Nycticorax nycticorax, S3B, S3N – Vulnerable – Breeding, Vulnerable – Non-Breeding*), was observed on the Subject Property. This observation does not suggest breeding activity on the Subject Property.
- Two (2) species are considered *Area Sensitive* (species requiring large areas of suitable habitat in order to sustain population numbers) by MNRF (2000)[8]: 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).

The avifauna species of conservation concern are listed in Table 5.9 below.

[8] 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; p. 43).

Table 5.9 – Avifauna Species of Conservation Concern

Common Name	COSEWIC[3]	MNRF[4]	SARA Status and Schedule [5]	Halton Region (1993) [6]	MNRF 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
Barn Swallow (*Hirunda rustica*)	THR	THR	No Status, No Schedule										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 5.10 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 5.10 – Anuran Survey Summary Results

Species	Amphibian Calling Station							
	A1	A2	A3	A4	A5	A6	A7	A8
	Vegetation Unit and Description							
	Unit 4 Forest	Unit 2B Marsh	TC1 Tree Cluster	Unit 2A Old Field	Unit 5B Meadow Marsh	Dug Pond/ Pond 1	Farm Pond /Reach 14W-14A	Residential
American Bullfrog (*Rana catesbeiana*)							✓	
American Toad (*Bufo americanus*)						✓	✓	
Green Frog (*Rana clamitans*)							✓	
Gray Treefrog (*Hyla versicolor*)							✓	
Northern Leopard Frog (*Rana pipiens*)							✓	

In total, five (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) (NHIC, 2011).
- Green Frogs and American Toads had the highest relative abundance with other species were present in low or very low numbers.

On the Subject Property, evidence of anuran breeding was primarily restricted to the Farm Pond (Reach 14W-14A) approximately 200 m northwest of Dundas Street and at two locations in shallow isolated pools to the west of the pond (Station A7; Vegetation Unit 1). A small amount of Bullfrog breeding was recorded at Pond 1 (Dug Pond) (Station A6) near the southeast property limit. Refer to Figures 5.3 for locational information.

At the Farm Pond (Reach 14W-14A), five (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).
- Gray Treefrog (*Hyla versicolor*) (2010 – 2 individuals during calling surveys).

Of these, American Bullfrog, Green Frog and Gray Treefrog are closely associated with the Farm Pond (14W-14A) and its immediate vicinity, while American Toad and Northern Leopard may range into nearby riparian meadow habitats.

At Station A6, 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 A1-A5) 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 5, 2009. The lack of anuran breeding is consistent with the unsuitable habitat present. Stations A1, A2, A4 and A5 lacked the aquatic habitat required for anuran breeding. Station A3 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 (MMM, 2005). As in 2010, anuran breeding was largely confined to the Farm Pond (Reach 14W-14A) 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 Farm Pond (Reach 14W-14A) 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 this pond. American Toad tadpoles were observed in the riparian areas immediately west of this pond and likely breed within this pond as well. During the non-breeding portion of their life cycle, anuran species are likely within this pond, its vicinity or meadow marsh along intermittent watercourses.

Bats

Bats were observed exiting from Building 1 (large barn) and Building 3 (small barn) during exit surveys while none were observed exiting from the remaining buildings. To identify exiting bats, call files from associated with the barns on both survey nights were analyzed with results presented below.

Call classifications were divided into three types for reporting:

- High-frequency calls belonging to Myotis are denoted as ‘Myo’;
- High-frequency calls of insufficient quality to make a confident species identification are denoted as ‘U-HiF’; and

- Calls identified as belonging to a non-myotid species, such as Big Brown Bat (*Eptesicus fuscus*), are denoted as "N-Myo".

Results are provided in Table 5.11.

Table 5.11 – Species Classifications of Exiting Bats

Survey No.	Date	Building	Observer Position	No. of Exiting Bats	Time of Observation	Call Classification
1	6/4/2015	Building 1	South	1	21:07	Myo
1	6/4/2015	Building 1	South	1	21:12	No recording
1	6/4/2015	Building 1	South	1	21:18	N-Myo
1	6/4/2015	Building 1	South	1	21:26	N-Myo
1	6/4/2015	Building 1	South	1	21:31	U-HiF
1	6/4/2015	Building 1	West	1	21:36	Myo
1	6/4/2015	Building 1	East	0	N/A	N/A
1	6/4/2015	Building 1	North	1	21:26	N-Myo
1	6/4/2015	Building 1	North	1	21:37	U-HiF
2	7/13/2015	Building 1	South	2	21:15	N-Myo
2	7/13/2015	Building 1	South	1	21:16	N-Myo
2	7/13/2015	Building 1	South	1	21:17	No recording
2	7/13/2015	Building 1	South	2	21:21	N-Myo
2	7/13/2015	Building 1	South	2	21:22	N-Myo
2	7/13/2015	Building 1	South	1	22:08	N-Myo
2	7/13/2015	Building 1	West	1	21:34	N-Myo
2	7/13/2015	Building 1	West	1	21:38	N-Myo
2	7/13/2015	Building 1	North	0	N/A	N/A
2	7/13/2015	Building 1	East	1	21:21	N-Myo
1	6/11/2015	Building 3	North	1	21:11	N-Myo
1	6/11/2015	Building 3	Southwest	0	N/A	N/A
1	6/11/2015	Building 3	East	0	N/A	N/A
2	7/13/2015	Building 3	North	0	N/A	N/A
2	7/13/2015	Building 3	East	1	21:25	N-Myo
2	7/13/2015	Building 3	East	0	N/A	N/A
2	7/13/2015	Building 3	Southwest	0	N/A	N/A

A total of 22 bats were observed exiting over the course of the surveys. Results are summarized as follows:

- The majority of exiting bats were observed at Building 1 (20 in total), with similar numbers observed exiting on each survey night (8 and 12 respectively);
- On both survey nights the majority of exiting bats exited from points at the south face of the building; and
- At Building 3, 1 bat was observed exiting on each survey night, from the east and the north faces, respectively.

Table 5.12 provides species classification results by building.

Table 5.12 – Summary of Results by Building and Date

Building	Date	No. of Exiting Bats	No. *Myotis spp.*	No. Non-Myotis	No. Unknown HiF	No. No Recording
Building 1	June 4, 2015	8	2	3	2	1
Building 1	July 13, 2015	12	0	11	0	1
Building 3	June 11, 2015	1	0	1	0	0
Building 3	July 13, 2015	1	0	1	0	0

Results are summarized as follows:

- The only bats observed exiting from Building 3 are non-Myotis species;
- Of the 20 bats observed exiting at Building 1;
    - at least 2 were Myotis spp.;
    - 14 were non-Myotis; and
    - 4 could not be assigned a species ID.

In summary, bats were only observed exiting Buildings 1 and 3 with the remaining buildings showing no evidence of bat use. The majority of bats observed were using Building 1. SAR bats (*Myotis spp*.) were observed exiting in low numbers at Building 1 only. The maximum number of bats observed exiting on any night was 12. The low numbers of exiting *Myotis spp.* (and other bat species) indicate usage of the buildings is likely restricted to either a very small maternal roost site or is a non-maternal roost, such as that used by males, who tend to roost individually or in low numbers.

Due to the recorded presence of *Myotis spp.* exiting a roost in Building 1, any modifications or disturbance to the structure will require an approval under the ESA (2007) which will be determined in consultation with the MECP during detail design.

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 (Figure 5.3) 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.
- 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 (Figure 5.2) adjacent to the Farm 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).
- A Meadow Jumping Mouse (*Zapus hudsonius*) was observed at the edge of the cultivated field south of Unit 4 (North Woodlot).
- Northern brown snake (*Storeria dekayi*) was observed swimming through Reach 14W-12 near Dundas Street. (2009)

2011

- A single Snapping Turtle (*Chelydra serpentina*) was observed in May, 2011.

Monarch and Snapping Turtle are discussed in Section 5.3.3. All mammal species, except for the *Myotis spp*., detected on the Subject Property are considered 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 Subject Property serves to limit infiltration to the groundwater system and as a result, the local reaches 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 reaches, but on a seasonal basis, typically from November to May. During this period the entire shallow system, including up gradient reaches of the channel are saturated and contributing water to the reaches. Generally, these same reaches are observed to be dry or with ponded water 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 since 2009. 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. In the lower (southern) reaches within the Subject Property, there may be greater opportunity for bedrock-based groundwater to maintain pools within the channel as the bedrock is exposed in the channel and the reaches are shaded somewhat by large trees.

Reach 14W-11 and Reach 14W-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 (Farm Pond) appears to be losing water to the groundwater system on the basis of measured surface water levels at the pond (148.7 masl on average) compared to the interpreted bedrock water levels at the three surrounding monitoring well locations (147.1 to 147.6 masl on average). Further studies undertaken in 2011 supported earlier findings that indicated Reach 14W-14A (Farm Pond) is not influenced by groundwater inputs, but is losing water to the ground and detailed information related to Reach 14W-14A (Farm Pond) was presented in Technical Memorandum HG#1-Hydrogeology. This memo was submitted to CH and the Town of Oakville, March 30, 2012. Additional work was carried out at the upstream end of the pond in 2013 at the request of CH with the installation of a mini-piezometer nest nearby to the inlet/outlet of the pond. The data collected by that end of the pond indicates that groundwater gradients vary between inward and outward relative to the pond levels and that the area where there is potential for groundwater seepage is located

beyond the western limit of the pond. Details of the groundwater monitoring and assessment for the Subject Property are described in Section 4.0 of this EIR.

Overall, the relative contribution of groundwater to the maintenance of aquatic and wetland features on the Subject Property appears to be minor with the reaches and wetlands generally appearing 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, Figure 5.6, and Figure 5.7.

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, CH and MNRF.
- Anticipated preliminary grading and servicing requirements.
- Maintenance of groundwater interactions and input to natural areas and receiving reaches.
- Protection of surface water quality in receiving reaches 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.
- Tree protection measures.

5.5.1 Determining Stream Corridor Widths

The determination of the stream corridor widths for the associated reaches within the Subject Property was undertaken to address the objectives listed above while adhering to the requirements associated with, NOCSS and the Recovery Strategy for Redside Dace (*Clinostomus elongatus*) in Ontario (2010) in association with the ESA (2007) Ontario Regulation 242/08. Given that the legislative requirements of the ESA (2007), supersedes NOCSS, consultation with the MNRF was undertaken to determine which reaches would be subjected to the ESA (2007) requirements. Based on that consultation, MNRF confirmed the following under Section 29.1 of the Ontario Regulation 242/08 (Jane Devlin, MNRF, pers. comm., December 20, 2013):

- For Reach 14W-12 and Reach 14W-16 – 29.1 Subsection i, ii, iii and iv apply (these subsections refer to Occupied Redside Dace Habitat as having a setback consisting of the meander belt plus 30 m on either side applied as defined in the regulation).
- For Reach 14W-11A, Reach 14W-12A, Reach 14W-13, Reach 14W-14 and Reach 14W-14A - 29.1 Subsection v applies (this subsection refers to Contributing Redside Dace habitat; however, there is no setback width defined in the regulation).

This confirms that Occupied Redside Dace habitat receives setback protection under the ESA (2007) Ontario Regulation 242/08 of MB + 30 m while Contributing habitat does not, and as such, is subjected to the setbacks as define by NOCSS. Within NOCSS, the stream corridor widths associated with each reach are to be determined based on the cumulative total of three factors, which are:

- the meander belt;
- the setback allowance for minor (7.5 m) or major (15 m) streams; and
- the factor of safety (also referred to as the erosion threshold).

To ensure the most stringent setbacks are applied to a stream corridor width, where applicable, both the Ontario Regulation 242/08 setback and the NOCSS setback were calculated, with the setback that resulted in the widest stream corridor width being selected. In addition, where specific features are located along a reach (i.e., wetland, woodland), the NOCSS define setback would also be included. As such, the outside limit of the widest setback will be referred to as the "Development Limit" within the EIR/FSS document.

During the determination of the Development Limit associated with each reach, there was one exception, Reach 14W-12A. Although this reach was not classified as Redside Dace Occupied habitat, this reach is classified as a High Constraint Stream Corridor in NOCSS. By providing the widest stream corridor setback, impacts to the existing form and function of Reach 14W-12A can be reduced by providing flow and allochthonous inputs downstream stream to Reach 14W-12 post-development through this wider stream corridor. In addition, when determining the NOCSS stream corridor, the minor stream setback of 7.5 m was applied to all reaches to further buffer the Natural Heritage features post-development. Refer to Appendix 6.4 in Section 6.0 for a breakdown of how each stream corridor setback was established for each reach under all development phases.

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.
- Reach 14W-11A will be realigned along the north and eastern Subject Property boundary via new Reach 14W-23.
- Realignment of Reach 14W-14 from where it enters the Subject Property to where it will discharge in existing Reach 14W-12A via new Reach 14W-22.
- Elimination of Reach 14W-13 with upstream flows being directed into Reach 14W-22 (realigned Reach 14W-14) via new Reach 14W-21.
- There are three proposed new road crossings of two reaches, including:

  - Burnhamthorpe Road Extension will cross both Reach 14W-16 and new Reach 14W-22 and
  - Avenue 1 will cross new Reach 14W-22.
- This proposed Burnhamthorpe Road Extension alignment differs from the alignment identified in the Secondary Plan, as well as, the previous concept plans submitted for the Subject Property due to the desire to minimize potential adverse effects to a High Constraint Stream Corridor 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 Reach 14W-14A (Farm Pond). The proposed alignment identified in the concept plan will instead cross Reach 14W-16, classified as a Medium Constraint Stream Corridor in NOCSS.
- In the Secondary Plan, Avenue 2 was originally proposed to cross Reach 14W-16 to connect Dundas Street, Avenue 1 and Burnhamthorpe Road Extension within the Subject Property. Changes to the road alignments through the Subject Property resulted in the removal of the original crossing of Reach 14W-16 by shifting the proposed alignment for Avenue 2 onto the lands west of the Subject Property. By undertaking this shift in the proposed Avenue 2 alignment, a crossing of Reach 14W-16 and the encroachment into Redside Dace setback associated the Reach 14W-12 can be eliminated.
- The lots will be serviced by municipal water, sanitary and stormwater services.
- Two stormwater management (SWM) facilities are proposed on the Subject Property between the Burnhamthorpe Road Extension and Dundas Street. The SWM facility to the east of Reach 14W-12 will incorporate the existing Farm Pond (Reach 14W-14A) into the design thereby removing this feature. The other facility will be constructed to the west of the Reach 14W-12. Treated outflow from both SWM facilities will be discharged into Reach 14W-12. Originally both facilities were proposed to encroach into the meander belt plus 30 m limit associated with Reach 14W-12. During the preliminary design of these SWM facilities, a major design consideration included minimizing this encroachment. To that effect, these facilities are no longer located within the meander belt plus 30 m setback. A temporary encroachment of up to 6 m will be required to complete the necessary grading for the facilities. Localized permanent encroachment and disturbances within the setback will be necessary to construct the SWM facility overflow outlets which will be further detailed. The disturbed vegetation in these areas will be restored.
- Recreational trails consisting of both On-Roads Trails and Major Trails through the NHS are proposed (see Section 3.0). The Major Trails within the Highway 407 West Employment Area (including the Subject Property) have principally been located along the margins of the NHS to minimize encroachments to the actual natural features and maintain the alignment within the existing disturbed areas (Figure 5.7). The siting of the trails within the NHS of the Lazy Pat Farm property will be undertaken once the stream corridor limits have been agreed upon and involve consultation with the MNRF/MECP and CH.

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 facilities to the east and west of Reach 14W-12 between Dundas Street and the Burnhamthorpe Road Extension. An additional SWM facility is proposed between Avenue 1 and the Burnhamthorpe Road Extension on the west side of Reach 14W-16. These SWM facilities have been sized to provide an *Enhanced* (Level 1) quality control, extended detention and quantity control for the Subject Property. Detailed information is provided in Section 7.0. 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.
- Monitoring the SWM for condition and performance, specifically related to temperature.

5.8 Sanitary Servicing and Water Distribution

This section briefly outlines proposed servicing of the site. For additional details, refer to Section 8.0 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 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 via new Reach 14W-21 to Reach 14W-14.
- The incorporation of Reach 14W-14A into the SWM facility (Farm Pond and Vegetation Unit 1)
- The proposed re-alignments of Reach 14W-14 and Reach 14W-11A (and the associated riparian areas).
- The change in flow in Reach 14W-12A.
- The encroachment into Reach 14W-16 stream corridor associated with the Burnhamthorpe Road Extension 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, trails and watercourse crossings are discussed in Table 5.15, 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 5.14 to 5.16, WSP 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.

5.9.1 Fish Habitat Enhancement Concepts

Proposed development activities will require review under the federal FA (1985) to determine whether the works will result in a "serious harm to fish". For context, the amendments made to the FA (1985) in July 2013 came into effect in November 2013. These amendments seek to focus the Act's regulatory regime on Canada's commercial, recreational and Aboriginal fisheries. The Act prohibits serious harm to fish, which in the Act is defined as "*the death of fish or any permanent alteration to, or destruction of, fish habitat*". The following concepts have been prepared to address potential adverse effects associated with Reach14W-11A, Reach 14W-14, Reach14W-14A (Farm Pond) and Reach 14W-16. According to NOCSS, 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 it only briefly discussed below as it relates to connecting to the proposed realignment of Reach 14W-14. Based on the results of consultation with the DFO and CH, in 2012, a FA (1985) Authorization (previous version) was not anticipated to be required for realignment or relocation of Reach 14W-14 and Reach 14W-14A (Farm Pond) and as a result, did not require compensation or monitoring (Leah Smith, Environmental Planner, CH; August 16, 2012). It is anticipated that a similar outcome will result from the proposed works under the amended Act. Consultation with DFO will be undertaken to confirm review requirements under the FA (1985) during the detailed design phase of the project.

The proposed reach realignments and Farm Pond removal are also subject to review by the MECP under the ESA (2007) due to the presence of Redside Dace Occupied and Contributing habitat. These proposed activities and enhancements were previously presented to the MNRF in the EIR (December 2012), correspondence and meetings. The MNRF has indicated that the proposed approaches outlined below do not appear to be (in concept) prohibited by the ESA (2007); however, a review of the project will occur during detail design stage of the project with MECP. CH will continue to be circulated on the consultation with the MECP.

The intent of the enhancement concepts is to improve habitat diversity by following natural channel design principles to construct 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 reaches and associated riparian habitat principally associated with the current agricultural land use. These concepts are provided in Section 6.0 of the EIR/FSS, illustrated on Figures 6.4.1 to 6.4.5 and are described below for each specific reach along with additional enhancement opportunities. Please note that in order to maintain consistency with hydraulic analysis WSP have also included reach identifiers identified in Section 6.0 for cross referencing.

Measures to specifically address Redside Dace and their habitat as they relate to ESA (2007) approvals will continue with the MECP at the detailed design phase with CH circulated for their files.

A component of the impact assessment was the examination of the effects of the proposed development including the channel realignments to the flows in the Reaches, and specifically whether the form and function would be retained in the post-development scenario. This required an assessment of flow under three conditions (i.e., wet, dry and average year) in relation to three metrics (i.e., frequency, duration and magnitude) at a number of flow nodes. The assessment related to the ecological form and function is presented in the discussion for Reaches 14W-12A and 14W-22, specifically at three flow nodes, 2 (Reach 14W-12A), 2B (Reach 14W-22) and 9 (Reach 14W-23) as the changes in flows in the remaining nodes were not deemed to have an effect on form and function. Detailed documentation of this analysis is described in detail in the Flow Regime Analysis Memorandum in Appendix 7.4 and Section 7.0.

Reach 14W-13 Realignment (Reach 14W-21) and Removal

This reach will be subjected to removal with a redirection of flow that will recreate a shortened channel length. In order to address the conveyance of seasonal flows onto the Subject Property from the Highway 407 ROW, a new flow conveyance channel (Reach 14W-21) is proposed to be built. Reach 14W-21 will intercept these flows and convey them into Reach 14W-22 (realigned Reach 14W-14). The existing channel associated with Reach 14W-13 located south of the proposed Reach 14W-21, will be removed and all associated downstream flow contributions addressed through SWM facilities. As such, the function of Reach 14W-21 is to maintain the existing headwater flow contribution downstream to Redside Dace habitat in Reach 14W-12 by means of Reach 14W-22. The anticipated reduction in flow and allochthonous inputs that may result from the loss in channel length from Reach 14W-13 is anticipated to be balanced by potential gains from the wider, vegetated and naturalized stream corridor associated with Reach 14W-22.

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

This reach will be realigned along the north and west boundaries of the Subject Property (Figure 6.4.1, 6.4.2 and 6.4.3). The proposed concept for Reach 14W-22 consists of creating a morphologically diverse channel based on natural channel design principles with pools along the outside bend connected by riffle habitat and

a low flow channel. The realignment will outlet into Reach 14W-12A approximately 5 to 20 m upstream of the confluence with Reach 14W-12. This has resulted in a parallel channel approach that has been accepted (in principle) by the Town, CH and the MNRF. Although the ideal connection of Reach 14W-22 to Reach 14W-12A would be where the existing Reach 14W-14 connects to Reach 14W-12A, this was not possible. Examination of the existing topography was undertaken and identified limited opportunities where the proposed connection point could be created based on grades. As such, the review has confirmed that Reach 14W-22 will connect to the lower section of Reach 14W-12A, approximately 5 to 20 m upstream of the confluence with Reach 14W-12. The exact location will be confirmed during detailed design. Refer to Section 6.6 for a detailed description regarding determining the connection point.

This alternating sequence of riffle/pool habitat will provide suitable habitat for the species present including Blacknose Dace, Creek Chub, Bluntnose Minnow and Fathead Minnow that are found within this reach, as well as, contributing to Redside Dace Occupied habitat within Reach 14W-12 in an improved manner over the function of existing Reach 14W-13, Reach 14W-14 and Reach 14W-14A. 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 Reach 14W-12. The connecting low flow channel between riffles and pools will potentially provide the opportunities for fish in downstream reaches, included Redside Dace, to access new habitats in Reach 14W-22 when suitable flows are present, thereby expanding their current habitat range. In addition to the pools and riffles providing habitat for fish, this variety of habitat will support micro-populations of benthic macroinvertebrates for fish to forage on both within Reach 14W-22 and in the associated downstream reaches by means of drift during flow events.

The proposed re-alignment of Reach 14W-14 is not anticipated to result in reduced groundwater inputs from the bedrock into this watercourse system (see Section 4.4.4.6). Under existing conditions, Reach 14W-13 is not interpreted to receive groundwater inputs from the bedrock except at its point of convergence with Reach 14W-14. Reach 14W-14 on the other hand is interpreted to receive bedrock groundwater inputs over its entire on-site length down to its confluence with Reach 14W-12A as the elevations of this channel lie below the interpreted bedrock groundwater levels. Under the post-development condition, the length of proposed realigned channel below the bedrock water table will be slightly longer than the existing length along Reach 14W-14, and the upward groundwater head differential is also expected to be higher as the groundwater table in the bedrock to the west where this realigned channel is proposed. Therefore, it is anticipated that there will be a similar degree of groundwater contributions from the bedrock into the proposed realigned channel compared to the existing condition.

An assessment to the potential change in the flow regime associated with the existing Reach 14W-13 and Reach 14W-14 compared to Reach 14W-22 associated with contributing flows downstream to Reach 14W-12A and ultimately to Reach 14W-12 was undertaken. The overall results of the assessment indicate that the post-development flows in Reach 14W-22 will be less by a range of approximately 15 to 20% of the existing combined flows in Reach 14W-13 and Reach 14W-14 due to a reduction in drainage area. However, this range of reduced flow is within the standard normal error factor for this type of flow assessment. When the assessment is further broken down to each metrics (frequency, duration and magnitude) and for all three flow conditions (wet, dry and average), the proposed flow in 14W-22 is comparable to the existing conditions in all situations. Indicating that the form and function of Reach 14W-14 and Reach 14W-13 related to flow will be maintained post-development within Reach 14W-22. Based on the proposed channel design for Reach 14W-22, it is highly likely that the ecological function of Reach 14W-22 will exceed the existing conditions as it relates to potential fish use, benthic macroinvertebrate production and allochthonous inputs based on the proposed pools, riffles, low flow channel and wider planted riparian stream corridor.

Floodplain wetlands consisting of a combination of meadow marsh habitat and small offline open water wetland features have also been incorporated into the design to recreate the function of the wetlands within the existing floodplain of Reach 14W-14 (Figure 6.4.1 to 6.4.5). 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 periodic flooding of the floodplain, resulting from storm events and spring freshet will recharge these offline wetland-pond features. It is also anticipated that the wetland-pond features may also provide some measure of additional infiltration, though this will be limited somewhat by the fact that such ponds are also proposed in an area where groundwater discharge from the underlying bedrock is anticipated (see Section 4.4.4.4). In addition, these proposed offline wetlands will likely provide new habitats for the anurans displaced from Reach 14W-14A (Farm Pond) during the conversion to a SWM facility.

The realigned channel, Reach 14W-22 will result in a longer stream length than the existing reach with an established wider stream corridor than the existing channel. The longer and wider riparian corridor than currently exists will provide the opportunity to enhance the riparian habitat. Plantings to be used will incorporate Conservation Halton's Landscaping and Tree Preservation Guidelines, as well as, principles identified in *Table 6.3.4 Aquatic and Riparian Management by Reach* as noted in NOCSS 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 (2007) regulated species. As the majority of the reaches 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. The surrounding riparian vegetation will shade the channel to provide a thermal benefit to water temperature, as well as, offer habitat to wildlife and terrestrial insects. During periods of run-off, organic debris and insects will be wash downstream as allochthonous inputs to support other fish and benthic invertebrate communities in other reaches, specifically Redside Dace in Reach 14W-12.

In summary, Reach 14W-22 is anticipated to offer 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 from downstream reaches, including Redside Dace.
- Incorporation of the existing wetland habitat within the floodplain.
- Improved canopy cover through the stream corridor currently consisting of a combination of disturbed riparian habitat and active agricultural fields to increase allochthonous inputs.

As such, it is anticipated that the proposed enhancements will result in an improvement to the productive capacity of this reach over the existing conditions through agricultural operations with a comparable flow contribution to Reach 14W-12A and Reach 14W-12 to the existing conditions. CH in consultation with the DFO consider Reach 14W-14 to provide direct fish habitat; however, the relocation of the channel was considered (in the previous iteration of the FA (1985) to be a low risk harmful alteration, disruption or disruption to fish habitat and would not have required an Authorization (Leah Smith, Environmental Planner, CH; August 16, 2012)). As a result, it is anticipated that these works will not result in "serious harm to fish" and as such, would not require Authorization under the FA (1985).

Timing constraints for in-water works to complete the tie-in of the new stream reach to the existing stream reach (14W-12A), as well as, the proposed two road crossings (Burnhamthorpe Road Extension and Avenue 1) will be confirmed during detailed design through consultation with CH and the MECP. It is anticipated that

construction of the main portion of the realigned channel will not be subject to timing restrictions as it can be constructed entirely offline.

Reach 14W-11A Realignment

Similar to Reach 14W-14, Reach 14W-11A will be realigned along the north and east boundaries of the Subject Property (Figure 6.4.1 to 6.4.5) to become Reach 14W-23. 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 natural channel design principles to create a meandering channel consisting of alternating riffle and pool habitat, with the stream corridor planted to improve riparian habitat and in time, canopy cover.

This alternating sequence of riffle/pool habitat will provide suitable habitat for the species present including Creek Chub, Bluntnose Minnow and Fathead Minnow that are found within this reach, as well as, contributing to Redside Dace Occupied habitat located in the downstream section of Reach 14W-11. Similar to the function of Reach 14W-22, the pool habitat will provide potential refuge habitat where resident fish can congregate during periods of low flow while the low flow channel between riffles and pools will potentially provide the opportunities for fish movement within the reach when flows are present. The pools and riffles habitat will support micro-populations of benthic invertebrates for fish to forage on both within Reach 14W-23 and in Reach 14W-11 downstream by means of drift during increased flow events.

An assessment to the potential change in the flow regime associated with the existing Reach 14W-11A compared to Reach 14W-23 was undertaken. The overall results of the assessment indicate that the post-development flows in Reach 14W-23 will be less by a range of 15 to 20% to the existing conditions across all flow metrics and flow conditions. However, this range of reduced flow is within the standard normal error factor for this type of flow assessment. This reduction is the result of the reduced drainage catchment area post-development. However, even with the proposed slight reduction in flows, the additional habitat features proposed will support the existing fish community by confining the reduce flow into the proposed low flow channel and refuge pools associated with the realignment.

A wider stream corridor that will be planted is proposed for Reach 14W-23 that is far greater than what is present around Reach 14W-11A. Opportunities have been reviewed and suitable area is available to include wetland/meadow marsh habitat along the reach. The design of the offline wetlands will be completed during detailed design. The realigned channel, Reach 14W-23 will have a longer stream length than the existing reach with a wider stream corridor and an enhancement to the riparian habitat. Plantings to be used will incorporate Conservation Halton's Landscaping and Tree Preservation Guidelines, as well as, principles identified in *Table 6.3.4 Aquatic and Riparian Management by Reach* as noted in NOCSS through the planting and seeding of native species to shade the channel to provide a thermal benefit to water temperature, as well as, offer habitat to wildlife and terrestrial insects. The wider riparian corridor will provide important allochthonous inputs to the reach during periods of run-off as organic debris and insects will be wash into the reach and downstream to support other fish and benthic invertebrate communities, specifically Redside Dace in Reach 14W-11.

Reach 14W-11A, as will realigned Reach 14W-23, connect to Reach 14W-11, a reach considered to be High Constraint Stream Corridor Requiring Rehabilitation. As a result, if rehabilitation measures are undertaken in Reach 14W-11, the enhancements proposed in Reach 14W-11A will provide greater continuity and opportunities for further upstream migration of fish, including potentially Redside Dace.

The anticipated benefits associated with these works are again similar to Reach 14W-22 owing to the similarity in habitat that will be created. In summary, Reach 14W-23 is anticipated to offer improved in-water habitat diversity 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 from downstream reaches.
- Improved canopy cover of the proposed stream corridor currently consisting of a combination of disturbed riparian habitat and active agricultural fields to increase allochthonous inputs.

It is anticipated that these enhancement concept measures will not result in a "serious harm to fish" and an Authorization under the FA (1985) will not be required as the function of this reach is expected to be improved over the existing agricultural swale. Timing constraints for in-water works to complete the tie-in of the new stream reach to the existing stream reach will be confirmed during detailed design through consultation with the MNRF. As the realigned channel will be constructed in what is now considered tableland, it is anticipated that only the connection to the existing channel will be subject to timing restrictions while the majority of the channel realignment will not.

Removal of Reach 14W-14A (Farm Pond)

Although NOCSS identifies this feature as a stream reach (14W-14A), the Farm Pond does not function as a linear stream and lacks a definable stream length or flow-through nature (i.e. via a separate inlet and outlet), comparable to an online pond. It also is not influenced by groundwater inputs based on results presented in Section 4.0 of this EIR, to function as a headwater wetland. Reach 14W-14A is a human-made bypass/online pond that receives flow from Reach 14W-13 and Reach 14W-14 that supports a self-sustaining tolerant, cool/warmwater fish population that includes Largemouth Bass. When a certain water elevation is reached, flow is discharged from the Farm Pond back into Reach 14W-12A then into Reach 14W-12. During the summer months the surface water is often the warmest water in the Farm Pond due to stratification of water based on temperature and it is this warm surface water that is the first to discharge from the Farm Pond. This warmwater discharged from the Farm Pond during and following storm events, is considered to result in a detrimental influence on Redside Dace habitat downstream, rather than a positive influence as would be expected from a natural headwater wetland. Although the Farm Pond is considered to represent a unique, larger body of water within the watershed, it is a constructed feature with an average maximum depth of 3 m during the summer, which does not provide distinct pelagic habitat that would differ from that of an online stormwater facility with a large open water section.

Considering that the receiving Reach 14W-12 via Reach 14W-12A supports and is classified as coolwater habitat and is managed as Redside Dace Occupied habitat, the removal of this feature and its incorporation into the SWM pond will remove the potential adverse effects associated with water quality (temperature and dissolved oxygen). The following are excerpts from various regulatory agency publications that support this approach;

- *DFO's Working Around Water? Factsheet Series (Ontario Edition)* bypass 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.

- *DRAFT Guidance for Development Activities in Redside Dace Protected Habitat* (MNR, 2011) p.17 states: "Examples of potential overall benefit actions for Redside Dace may include: decommissioning of artificial ponds connected to occupied streams to improve fish passage and/or water quality (e.g. temperature)."

- *Evaluation, Classification and Management of Headwater Drainage Features Guidelines Approved July 2013* (CVC/TRCA, Finalized January 2014) states: "Online or in-line ponds are typically created on headwater features to provide a source for irrigation or water for livestock. Although these features can provide flow retention, extended discharge, permanent fish habitat, and amphibian breeding areas, their disruption to natural geomorphological processes and thermal impacts are generally not desirable."

The removal of pond habitat (i.e., bypass, online) specifically those contributing to cool/coldwater habitats, is anticipated to improve water quality (i.e., water temperature). These types of features are considered detrimental from a temperature moderation perspective. Although the Farm 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. This has a specific benefit to Redside Dace and their habitat in Reach 14W-12 as it is the receiving watercourse of the Farm Pond (Reach 14W-14A). As indicated above this proposed approach is consistent with the DRAFT Guidance for Development Activities in Redside Dace Protected Habitat (MNR, 2011) as its removal is anticipated to result in an improvement to water quality, specifically as it relates to temperature.

Hydrogeological studies have been undertaken to determine whether there are potential interactions between the groundwater and the constructed Farm Pond feature, please refer to Section 4.0 for greater detail. In general, the hydraulic conductivity of the clay/silt soils found across the site and at the Farm Pond is very low and, as a result, the quantity of groundwater entering into and discharging back into the ground will be low. Based on the hydrogeological investigations that focused on the Farm Pond itself, our understanding is that the Farm Pond does not receive groundwater inputs in sufficient quantities to affect the water level of the Farm Pond, nor to lead to appreciable discharges into the adjacent channel at the top end of the Farm Pond. The water level in the Farm Pond is maintained by surface water inflows and not by groundwater contributions. Groundwater monitoring indicates that the Farm Pond appears to lose water into the ground. Flows from the Farm Pond are associated with surface water inputs that fill the Farm Pond following rain events, and then drains back out to the watercourse network afterward. The very minor groundwater discharge potential that is present near the upstream end of the Farm Pond is far outweighed by the losses back into the ground over the much larger area of the Farm Pond to the east, where the greater downward head differences are recorded. As a result, the removal of the Farm Pond (Reach 14W-14A) from the landscape is not expected to have an adverse effect to the groundwater inputs to the watercourse network.

Considering the manner in which the Farm Pond (Reach 14W-14A) functions and the presence of an ESA (2007) regulated species in the downstream receiving reach that requires coolwater habitat, its removal would be a benefit to aquatic habitat. Based on the existing function, quality of habitat and influence of this feature on receiving reaches, and guidance from NOCSS, CH and DFO, the development plan with respect to the Farm Pond (14W-14A) proposes the following:

- The active storage and hydrologic function of the existing pond will be replicated in the reach corridor.

- The function of the affected aquatic habitat associated with replacing this feature that will be altered by the proposed SWM facility, will be mitigated through further naturalization of the proposed stream corridors associated with other reaches elsewhere on the Subject Property to enhance high constraint reaches.
- The addition of infiltration swales and enhanced treatment of water discharged from the SWM facility to enhance water quality entering red constraint stream reaches that provide direct habitat for a SAR species.

Redirection of Flow from Reach 14W-12A

The proposed, realignment of Reach 14W-14 and removal of the Farm Pond (Reach 14W-14A) and Reach 14W-13 will result in the redirection of flow away from the Reach 14W-12A and redirected to Reach 14W-12. The redirected of flow from Reach 14W-14A upon its conversion to a SWM facility will be to Reach 14W-12 directly through the new SWM facility outlet. The redirected flow associated with Reach 14W-13 and Reach 14W-14 will be combined into the realigned Reach 14W-22 which will outlet into the bottom end of Reach 14W-12A just upstream on the confluence with Reach 14W-12. This redirection of flow has the potential to alter the form and function of a short section of Reach 14W-12A upstream of the tie-in with Reach 14W-22, which NOCSS defines as a poorly defined swale.

Due to the anticipated reduction in flow, an examination to the potential change in the flow regime within with Reach 14W-12A associated with contributing flows downstream to Reach 14W-12 was undertaken. The results suggest that flows will be reduced in Reach 14W-12A under the three assessed flow conditions; wet, dry and average year, when related to frequency, duration and magnitude (refer to the Flow Regime Analysis Memorandum in Appendix 7.4 and described Section 7.0). However, this reduction in flow will only occur in approximately 100 m of Reach 14W-12A upstream of the tie-in of Reach 14W-22 given that the outflow from Reach 14W-22 combined with the proposed flows in Reach 14W-12A post–development have been assessed and determined to provide similar flows to the pre-development condition in Reach 14W-12A. As such, a change in flow to reach 14W-12 and Redside Dace Occupied is not anticipated. In fact, when the proposed combined outflow from Reach 14W-12A, Reach 14W-22 and SWM facilities are combined, there will be increased flows in Reach 14W-12 above the existing condition.

Given the reduction of flow in the upper section of Reach 14W-12A will occur, an assessment to the function of the habitat present was undertaken. Based on habitat descriptions in NOCSS and our multiple site investigations, the habitat in Reach 14W-12A main function appears to provide flow conveyance and nutrient drift (allochthonous inputs) to downstream reaches. Although not confirmed, there is the potential, albeit limited, for the upper section to function as seasonal direct fish habitat should suitable flows be present and passage through the dense cattails at both the upstream and downstream limits is possible.

In order to reduce and mitigate a portion of the anticipated flow change in surface water contributions to the upper section of Reach 14W-12A, the following will be undertaken:

- a portion of surface runoff will be maintained to this reach by:
    - establishing a stream corridor around Reach 14W-12A that is 15 m wider than required by NOCSS;
    - directing flow from infiltration swales to this reach; and.
- capturing and directing roof top runoff to this reach.

The clean runoff from a number of building blocks are to be diverted via a new storm sewer system and a flow splitter that will divert treated runoff to Reach 14W-12A to allow a uniform and sustained level of base flow to be maintained in the receiving reach. Please refer to Section 7.4.3.5 for more details. The wider stream corridor proposed will also function as a source of allochthonous inputs which can be conveyed to the reach along with surface runoff.

Furthermore, the post-development reduction in the function in the upper section of Reach 14W-12A, will be addressed through the habitat created in the realigned Reach 14W-22. The reduction of allochthonous inputs from Reach 14W-13 and Reach 14W-14 via Reach 14W-12A to reach 14W-12 are anticipated to be replicated from the drift inputs from reach 14W-22 and its associated wider vegetated riparian stream corridor with proposed offline wetlands and meadow marsh habitats. It has been confirmed that there is sufficient area within the riparian stream corridor to provide the noted offline wetlands which will be design during detail design. As Reach 14W-22 will be designed with a riffle/pool habitat sequence connected with a low flow channel, there is an opportunity for fish in Reach 14W-12 to move upstream and expand their range. The pool habitat may provide refuge during periods of intermittent flow while the variety of substrates and overhanging vegetation will likely provide a source of food for foraging opportunities.

Although the post-development impacts to the upper section of Reach 14W-12A are significant as they relate to the existing conditions, the habitat assessment indicates that Reach 14W-12A based on its constructed nature, intermittent flows and homogeneous habitat present with limited access for fish has a limited function. That limited function has been shown to be replicated and potentially increased post-development though the mitigation measures proposed for Reach 14W-12A, as well as the design and anticipated function of Reach 14W-22. As such, the redirection of flow from Reach 14W-12A is not anticipated to have an adverse effect to flow conveyance and nutrient drift downstream to Occupied Redside Dace habitat in Reach 14W-12. These anticipated outcomes will be review during the proposed monitoring program.

Review of **Halton Region's Restoration Works in** Reach14W-12 (Dundas Street Culvert)

During detail design, WSP will confirm the new right-of-way along Dundas Street and review the extant of Halton Region's restoration work associated with the culvert replacement under Dundas Street for Reach 14W-12. During this review, it will be determined if there is any opportunity for further channel restoration works which may included removing any remaining portion of the hardened block wall and concrete lined channel, realigning the channel away from the roadway embankment and re-positioning the channel so that it is centred within the channel corridor. This could be undertaken through natural channel design and bio-engineering techniques. Also during detailed design, the MECP will confirm if the proposed impacts to Redside Dace habitat will require an approval under the ESA (2007). If so, this area may potentially be an option to restore the channel to a more naturalize condition to improve Redside Dace habitat as part of an overall benefit measure.

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 and deteriorated state. As a result, their removal has the potential to result in an improvement 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. The proposed removal and channel restoration works will be confirmed and designed during the later detailed design phase of the project.

Green / Open Space Areas

The concept plan incorporates open space areas, sized to accommodate regulatory setbacks. With the exception of compatible land uses within the NHS (NOCSS, Section 6.3.5.2), development in these areas will not occur as the open space areas are defined by regulatory setbacks associated with retained and realigned reaches, wetlands and sensitive natural areas to be retained or considered for rehabilitation during detailed design of the Subject Property. The proposed SWM ponds to the east and west of Reach 14W-12 are located beyond the limits of the identified setbacks for this reach.

The open space provided in the concept plan includes accommodation for the vegetation communities associated with Reach 14W-11, including the Dry-Fresh Oak-Hickory Deciduous Forest (FOD 2-2) and associated floodplain marsh. As the NOCSS has listed this reach as High Constraint with Rehabilitation, this will be left untouched, and retained in full and protected with appropriate setbacks as shown in Figure 5.5.

A designated trail system (Major Trails and On-Roads Trails) associated with the NHS is considered by NOCSS to be the best strategy to discourage informal trail creation. Recreational trails consisting of both On-Roads trails and Major Trails through the NHS are proposed (see Section 3.0). The Major Trails within the Highway 407 West Employment Area (including the Subject Property) have principally been located along the margins of the NHS to minimize encroachments to the actual natural features and maintain the alignment within the existing disturbed areas (Figures 5.7, 5.8a, 5.8b). The impact of these on road trails has been assessed as a part of the road right of way for the road crossing locations.

Within the EIR lands, the trail system largely occurs on existing agricultural land. There are a few locations; however, where the trail system borders the NHS or crosses it. To assess the impacts to these crossings and encroachments additional field investigations were undertaken on September 24, 2014. This investigation assessed impacts in a 20 m corridor from the outer edge of the open space boundary into the open space area. A 20 m width was decided to be a sufficient enough corridor to accommodate the trail location and any grading which may be associated with that trail. Within these corridors, detailed ELC communities were mapped. These are described in the table below, along with possible impacts to these features.

Table 5.13 – Ecological Land Classification and Impacts of Trail System

ELC Community	Vegetation Subunit	Community Description (attributes/functions)	Trail Impacts
2A: Dry-Moist Old Field Meadow (CUM1-1)	2A (1)	• Open meadow, dominated by tolerant grasses (Smooth Brome, Timothy) with occasional forbs (Common Dandelion, Cow Vetch, Field Thistle). • Vegetation is maintained at a very low height by grazing livestock (goats and sheep observed). • The soil sample in this community shows homogeneous dark brown sandy clay with 2% stoniness underlying 8 cm of organic litter layer. The auger became too tough to turn at 75 cm due to the sticky clay.	• Trail construction in this location would have little impact on the natural heritage system. • Trail would have less impact on the vegetation surrounding communities than grazing. • At present animals are grazing in Reach 14W-12, this trail is well removed from that location and would result in an improvement over current uses.

ELC Community	Vegetation Subunit	Community Description (attributes/functions)	Trail Impacts
	2A (2)	• Similar to 2A (2). • Open meadow abundant with tolerant grasses (Smooth Brome) and hardy and unpalatable herbaceous species (Teasel, Field Thistle, Wild Carrot/Queen Anne's Lace, Common Ragweed, New England Aster). • Evidence of prior grazing in this location (stunted growth of herbaceous species, abundance of species with prickles and spines). • Wetland species occur in localized depressions and drainage directed from nearby field including (Reed Canary Grass, Redtop, and Field Mint). • The soil sample taken in this community shows a homogeneous dark brown sandy clay underlying 6 cm of organic litter layer. The auger was refused at 55 cm due to stoniness or bedrock.	• Trail construction in this location would have little impact on the natural heritage system. • Some minor reduction in runoff from the current agricultural field to Reach 14W-12 could occur due to trail construction.
	2A (3)	• Old-field meadow bordering agricultural field and road abundant with Common Ragweed, Teasel, and occasional Wild Carrot, Timothy, Smooth Brome, Chicory, thistles, and Viper's Bugloss. Several agricultural crop escapees found in this unit including Soy, Rye, Amaranth, Clovers, Alfalfa, and Squash/Pumpkin. • Anthropogenic disturbance: adjacent active agricultural use likely results in periodic disturbance (e.g., chemical spraying/vegetation dieback, grazing). • Low botanical quality and health (dominated by non-native grasses and disturbance tolerant species, disturbed by adjacent agricultural activities); Low sensitivity. • The soil sample taken in this community shows a layered soil of 26 cm of dark brown silty clay, over 29 cm of orange brown sandy clay and 8 cm of medium brown sandy clay with 4% stoniness of red and grey shale and limestone. The auger was refused at 61 cm due to stoniness or bedrock.	• By and large the proposed trail borders the edge of this unit and very little impact will occur. • The trail goes through this unit at the western edge of the property, not adjacent to the agricultural field. Impacts in this area will include loss of vegetation and possible disruption to small drainage depressions which drains to Reach 14W-16. These impacts are expected to be negligible and habitat loss will be minimal.
	2A (4)	• Old-field meadow abundant with Goldenrods, New-England Aster, Teasel, Heath Aster, and European Common Reed. Sparse low trees of Red Ash, Manitoba Maple and Common Buckthorn exist here. A small wet depression contained wetland plants including Spotted Touch-me-not, Willow-herb species, Blue Vervain, Bittersweet Nightshade, Bugleweed, Bulrush, and Cattail. • The soil sample taken in this community shows a layered soil of 23 cm of dark brown sandy clay, over 32 cm of dark brown clay with 5% fragments of red shale and 7 cm of brown clay with 70% stoniness of red and grey shale and limestone. The auger was refused at 62 cm due to stoniness or bedrock.	• By and large the proposed trail borders the edge of this unit and very little impact will occur. • Impacts in this area will include loss of vegetation and possible disruption to small drainage depressions which drain to Reach 14W-16. These impacts are expected to be negligible and habitat loss will be minimal.
	2A (5)	• Old-field meadow with shrubs on the slope of the creek valley. Small trees included a row of Pussy Willows and sparse Sugar Maple, Red Ash, Manitoba Maple, and American Elm. The ground layers were abundant with Goldenrods and the occasional New-England Aster, Teasel, Smooth Brome, Wild Carrot and European Common Reed.	• By and large the proposed trail stays well within the agricultural field and very little of the trail is in this unit. Very little impact will occur. • Impacts in this area will include loss of vegetation. This impact will be negligible and habitat loss will be minimal.

ELC Community	Vegetation Subunit	Community Description (attributes/functions)	Trail Impacts
		• The soil sample taken in this community shows a layered soil of 17 cm of brick red silty clay, over 27 cm of brown silty loam. The auger was refused at 44 cm due to stoniness or bedrock.	
2D: Cattail Mineral Shallow Marsh (MAS2-1)		• Cattail dominated wetland coincident with Hydrological feature 'B'. • Narrow-leaved Cattail dominates, with sparse occurrences of Spotted Touch-me-not, Asters, and Goldenrod. • A soil auger in this community shows mineral soil types of Silty Clay over Clay over bedrock (Queenston shale and limestone). Organics were present as a thin organic litter layer (5 cm), and thin organic humic layer (15 cm). This soil is a "mineral" soil. The auger was refused at 60 cm depth due to hitting rock.	• The proposed trail crosses this unit. • Impacts will include vegetation loss and possible disruption to water movement, depending on construction methods. • Impacts can be minimized by using a bridge or boardwalk to cross this unit.
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 on bottomlands within the drainage channel network. • A soil auger in this community shows mineral soil types of Silty Clay over Clay over bedrock (Queenston shale and limestone). Organics were restricted to a very thin organic litter layer (<1 cm), and thin organic fibric layer (5 cm). The auger was refused at 65 cm depth due to hitting rock.	• The proposed trail crosses this unit. • Impacts will include vegetation loss and possible disruption to water movement, depending on construction methods. • Impacts can be minimized by using a bridge or culvert structure to cross this unit while maintaining hydrology as is.
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, Red Ash, and hawthorn along the edges. Ground layer is sparse and includes smooth brome, goldenrod, asters, and long-stalked sedge. • A soil auger in this community shows a mineral soil type of very dry compacted Silty fine Sand. Hand auguring became too difficult after 20 cm.	• The proposed trail alignment is located within the buffer setback from this feature consisting of agricultural field and not within the actual feature. • Impacts could include potential grading resulting in vegetation loss, and edge effects if any trees are removed or die due to soil compaction. • Impacts can be minimized by selecting a trail location as far back from the feature as possible and by minimize grading activities in this location.
HR1		• Broad (approximately 5 m wide) shrub hedgerow with frequent gaps approximately 200 m long. • Dominated by hawthorn and gray dogwood shrubs. • Sparse small Bur Oak and White Oak less than 10 m tall. • Ground layer plants are similar to those found in unit 2A: CUM1-1	• The proposed trail crosses this hedgerow at the boundary with the 407 transitway. • Impacts would include minor vegetation loss for the crossing, and edge effects where trees and shrubs are removed • Impacts can be minimized by minimizing the trail width in this location.
TC3		• Grouping of Trembling aspen in the pasture area	• The proposed trail may remove some or all of the trees in this grouping. • Impacts include vegetation loss of this isolated monocultural grouping.

ELC Community	Vegetation Subunit	Community Description (attributes/functions)	Trail Impacts
			• Impacts can be minimized by avoiding the tree grouping.

During review, CH has expressed interest in the proposed current alignment of the trail, specifically its location in the vicinity of vegetation Unit 5A. As it is WSP's intention to avoid impacts to this unit, the proposed trail has been preliminarily aligned outside of the vegetation Unit 5A but within the buffer setback. During detail design, before the trail alignment is finalized, there will be an opportunity for CH to walk the staked proposed alignment to review and provide comments. At the time, every effort will be reviewed to eliminate impacts to vegetation Unit 5A. If, however; the proposed trail alignment cannot completely avoid impacts to the vegetation Unit 5A (e.g., tree removals), a significant habitat review and targeted SAR surveys will be undertaken in consultation with the MECP during detail design to be in compliance with the NOCSS EIR ToR.

General Channel Realignment Design Considerations

The channel dimensions for the realignments in future reaches 14W-22 and 14W-23 have been established through the use of appropriate geomorphological parameters consistent with this style of feature and have been confirmed through hydraulic modeling. The channels, which are illustrated in Figures 6.4.1 to 6.4.5 incorporate shallow overbank areas consisting of a combination of meadow marsh wetlands and small offline open water wetland features positioned alongside a centralized, meandering channel. Based on the review of corridor widths, there is sufficient area to provide the 2.443 ha of offline wetlands. The design and details of the meadow marsh wetlands and offline open water wetlands will be completed during detail design. This design allows for a greater water storage during moderate to higher flows and opportunities for additional infiltration, while maintaining a low flow channel, which resembles existing channel morphology in Reaches 14W-16 and parts of Reach of 14W-12.

5.9.2 Impacts to Hydrological Features 'A'

The proposed development will impact Hydrological Features 'A', as well as, other wetlands identified within the Subject Property not documented in NOCSS but qualify as Hydrological Features 'A'. As per NOCSS, the form of Hydrological Features 'A' are to be maintained post-development. As such, a preliminary assessment of the impacts to Hydrological Features 'A' and other newly identified wetlands was undertaken based on the proposed development plan to ensure this condition of NOCSS can be met during detail design. This was completed by assessing the area of Hydrological Features 'A' and other wetlands lost to the area proposed within the realigned corridors that would be available for wetland creation. Based on the current proposed development the following losses were noted:

Loss - Hydrological Features 'A'

Reach 14W-14	0.940 ha of MAM2-2
Reach 14W-14A (Farm Pond)	0.531 ha of OAO / SAF1-3 / SAS1-1*

(*CH confirmed on February 07, 2018, that the open water function of the Hydraulic Feature 'A' [Farm Pond] does not need to be replicated)

Loss – Newly Noted Wetlands

Reach 14W-14	0.027 ha MAS2-1
Reach 14W-14	0.607 ha MAM2-2
Reach 14W-14A (Farm Pond)	0.767 ha MAS2-1

Reach 14W-11A 0.102 ha MAM2-2

The total combined loss of Hydrological Features 'A' and newly noted wetlands has been assessed at 2.443 ha.

A review of the revised proposed new corridors associated with the channel realignments for Reach 14W-14 and Reach 14W-11A was undertaken to determine the potential amount of area available for wetland creation. Based on the current proposed development the following area was noted:

New Corridor Areas

Reach 14W-22 and Reach 14W-23 2.58 ha

Based on the current corridor widths proposed for Reach 14W-22 and Reach 14W-23, there is sufficient space to create the 2.443 ha of new offline wetlands.

As such, it appears based on a review of the Draft Plan that there will be adequate space to create new wetlands along the realigned channels to meet the condition of NOCSS regarding the form of the Hydrological Features 'A'. These numbers will be reviewed and refined during detail design, as well as, the development of the design and location of the type of wetlands to be created along the realigned channels. The wetlands to be created will be designed to replicate the function of the Hydrological Features 'A' and the newly noted wetlands (i.e., MAM2-2 and MAS2-1).

The new habitats to be created both within the realigned channel and off-line wetlands are anticipated to create opportunities for the species currently inhabiting the Farm Pond, with the exception of the species that will rely on large open habitats (i.e., snapping turtle). The new channels will have a variety of habitat types (i.e., riffles and pools) to increase habitat diversity for aquatic insects and amphibians. The channels along with the wetlands are anticipated to provided foraging opportunities for reptiles, small mammals and birds. Bird nesting is also anticipated to occur in the wetlands.

The function of the channel and wetlands will be reviewed and evaluated during the post-construction monitoring events, including but not limited to breeding bird surveys, anurans calling surveys, fish community surveys and benthic macroinvertebrate surveys. The staging of works regarding the removal of the Farm Pond and the creation of new wetlands will be reviewed by CH during detailed design.

5.9.3 Encroachment into Reach 14W-16 Stream Corridor Setback

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 in NOCSS (classified by MNRF as Redside Dace Occupied habitat) and two crossings of realigned Reach 14W-22. It is anticipated that the proposed encroachment can be addressed through selection of an appropriately sized stream crossing structure to maintain fish passage and minimize potential serious harm to fish. Encroachment can be further addressed through stream rehabilitation works and the planting for this area 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 Elimination of Avenue 2 Crossing of Reach 14W-16

It is anticipated that impacts to fish and fish habitat within Reach 14W-16 will be further mitigated through the changes to the road alignments, which result in the elimination of the Avenue 2 crossing previously proposed in the development plan.

5.9.5 Overview of Mitigation Measures

Specific mitigation measures are identified for each evaluation factor in Tables 5.14, 5.15, and 5.16. 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 to avoid sedimentation in adjacent natural features. The ESC Plan will be prepared as a condition of Draft Approval, and approved by CH 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 reaches) and
    - treating stormwater runoff (to reduce potential for degradation of water quality in Reach 14W-12 and receiving watercourses downstream of the Subject Property.

    Furthermore, a review of thermal mitigation measures proposed for SWM ponds discharging to Redside Dace habitat will be undertaken at detail design as a condition of draft plan approval. The purpose of the review is to ensure that the outflowing water from the SWM pond is in thermal compliance with the NOCSS Mediation Item: Stormwater Management – Temperature and Dissolved Oxygen Targets (July 12, 2007). In support of establishing thermal mitigation compliance, WSP has been undertaking thermal monitoring in Reach 14W-12 and Reach 14W-16 in 2018 to determine existing baseline thermal conditions. The information collected will be used as an option to establish the thermal targets for the SWM pond discharging flows.

    Additional details of the SWM strategy are provided in Section 7.0.

3. Hydrology/Infiltration. Although the potential for at-source infiltration is limited given soil types (clays and silts), passive infiltration and utilization of at-source measures where local soils permit are recommended. Infiltration swales are recommended for installation at the rear of development lots that back onto natural environmental areas defined by CH hazard limits. These measures will contribute to local recharge. Additional details are provided in Section 4.0 and shown in Figure 4.8.

4. Fish Relocation/Removal. The removal of the Farm Pond (Reach 14W-14A) will require the removal of the resident fish population and either their relocation and/or they will need to be euthanized if a suitable relocation site is unavailable (i.e., stocked fish populations cannot be relocated in Redside Dace habitat) or invasive species are present. A fish community relocation plan will be prepared during detail design and submitted to MNRF for approval prior to undertaking the works. There is the potential that a small offline pond associated with Reach 14W-16 may be suitable for fish relocations from the Farm Pond, this option will also be examined during the detail design phase of the project and incorporated into the fish community relocation plan.

5. Anurans Relocation/Removal. The removal of the Farm Pond (Reach 14W-14A) will impact the existing anuran population and, as such, CH has requested that a new habitat be found for these anurans. An anuran relocation plan will be prepared during detail design and submitted to CH for approval prior to undertaking the works. There is the potential that a small offline pond associated with Reach 14W-16, as well as, the wetlands to be created along Reach 14W-22 and Reach 14W-23 are suitable for the anuran relocations from the Farm Pond. As such, staging will be reviewed during detail design to ensure that the new wetlands along the realigned reaches be created before the habitat in the Farm Pond is altered. This should be noted in the anuran relocation plan.

6. 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 stream corridors associated with realigned/retained reaches is recommended to prevent uncontrolled access and dumping.

7. Spills Management Plan and Best Management Practices (BMPs). These during-construction measures will reduce potential for contamination of groundwater, receiving reaches 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.).

8. Stewardship. Initiatives for stewardship of natural heritage features and wildlife will be incorporated into the development plan, through to property development and ownership. CH recommends the Town of Oakville's "Living the Green Life – Oakville's Guide to Environmental Stewardship" as a helpful document for wildlife stewardship. This document provides information to residents and property owners regarding how to live with wildlife found in the Oakville area. Special stewardship initiatives may be developed during the detail design phase to address SAR considered to use the open green spaces.

9. Monitoring. Monitoring will be undertaken and will follow the adaptive environmental monitoring (AEM) approach to learning from monitoring outcomes and apply the knowledge gained to improve future monitoring outcomes. AEM approach will allows for flexibility in monitoring plan so that modifications and refinements can be incorporated during the monitoring period. By applying AEM, undesirable environmental effects/results can potentially be identified early in the monitoring program and corrected through management interventions to avoid major problems before they occur, as well as, maximize the fulfillment of the monitoring objectives. Details of the AEM approach, including the determination of the monitoring parameters will developed at the detail design stage in discussion with CH.

   Monitoring prior to development to establish baseline conditions for comparison, specifically related to the creation of the realigned reaches as requested by CH. Monitoring during development (e.g., ESC fencing and SWM facility inspection) to ensure mitigation measures are functioning as intended and

whether adaptive mitigation is required to address potential deficiencies. Post-development, a Biological Monitoring program will also be undertaken including aquatic habitat, community vegetation and wildlife monitoring, focusing on retained and re-aligned reaches of the stream corridor network. This monitoring will include but not limited to fish community surveys, breeding birds surveys, anuran calling surveys, benthic macroinvertebrate surveys, temperature and DO monitoring, as well as, a fluvial geomorphic assessment of the realigned reaches. Additional details of the proposed monitoring program are provided in Appendix 7.8. This integrated monitoring approach will help to identify issues of concern and recommend strategies to address problems in a timely manner.

5.10 Conclusions and Recommendations

Based on this review, WSP conclude that development of the Subject Property 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 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 as defined in NOCSS and ESA (2007) Ontario Regulation 242/08.

- The removal of Reach 14W-14A (Farm pond) and its incorporation into a SWM facility will result in the removal of an adverse thermal influence to downstream coolwater fish habitat. The Farm Pond in its current form 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 stream corridor associated with Reach 14W-22 (realigned Reach 14W-14).

- Reaches 14W-14 and 14W-11A will be realigned with the new channel being designed using natural channel design principles (i.e., riffle/pool sequences with a connecting low flow channel).

- Habitat within the upper section of Reach 14W-12A (approximately 100 m) will be subject to a potential alteration; however, measures including maintenance of some surface water contributions from adjacent lots, redirection of rooftop drainage and the construction of infiltration swales along the

reach will provide surface flows to this section. While the realignment of Reach 14W-13 and Reach 14W-14 into Reach 14W-22 will provide an opportunity to enhance the existing habitat through the improvement of habitat diversity in both the channel and associated riparian habitat.

- Realignment works will potentially alter fish habitat in Reach 14W-12A. However, these measures are not anticipated to result in *"serious harm to fish"* and as such Authorization under the FA (1985) is not expected to be required.

- Consultation with the MECP specifically related to Redside Dace, Barn Swallow, Bobolink and Bats related to potential ESA (2007) requirements will be confirmed during detail design. Results of these discussions will be forwarded to CH and the Town for their files.

- The SWM drainage strategy implements an Enhanced Level of treatment for stormwater to ensure protection of the receiving reaches. 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. These options will be examined during detailed design to determine feasibility.

- 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 of infiltration swales receiving clean water (e.g., roof runoff, rear lot drainage, etc.) along the margins of the development setback immediately adjacent to 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 reaches and constructed floodplain wetland habitat in the realigned valleys.

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- The recommended monitoring program will build on existing information, and assess the operation of the SWM facilities, 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 CH 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 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 program will follow the AEM approach and is recommended to ensure that various mitigation and design measures are maintained and operating during construction.

Table 5.16 – Summary of Potential Impacts to Wildlife

Wildlife			
Feature Significance and Sensitivity	Potential Natural Environment Impacts	Mitigation Measures	Residual Effects
<u>Subject Property</u> • The cultivated fields, small woodlands and drainage swales (reaches) network supporting cultural meadow/meadow marsh vegetation provide habitat for common, urban-adapted, open-country, edge, and generalist species and habitat for wetland & woodland associated species. • Some specialized wildlife habitat is present – amphibian breeding habitat in the Farm Pond (Reach 14W-14A). • Four (4) SAR species were recorded (Bobolink, Barn Swallow, Snapping Turtle, and Redside Dace). Implications for Redside Dace are discussed in Table 5.12 Summary of Potential Impacts to Aquatic Resources. • 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) bird species observed are considered area sensitive (Savannah Sparrow, and Northern Harrier). • No woodland amphibian breeding habitat is present <u>Adjacent Lands</u> • 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	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 Farm Pond and reaches are considered temporary as these features will be recreated within the proposed SWM facilities and realigned reaches within a wider riparian stream corridor, respectively. • Movement opportunities. Wildlife passage will be maintained via the retained/realigned stream corridor(s). • Habitat for Bobolink may be impacted. Consultation with MECP will be undertaken during detail design to determine potential ESA (2007) permitting requirements. • 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 Farm Pond (Vegetation Unit 1) will be removed. Anuran species may re-colonize the SWM facilities habitat following construction. Ephemeral pool/pond habitat will be recreated within realigned reaches, and will provide potential amphibian breeding habitat in the post-development landscape. • Indirect Impacts. There is potential for indirect impacts to wildlife habitats on adjacent lands as the result of construction, changes to hydrology and	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 SAR bird species. As noted, consultation with MECP will be undertaken with regards to Bobolink and Barn Swallow; however, impacts to Barn Swallow can be registered under the Notice of Activity under the ESA (2007) for the removal of nest and nesting structures as long as new nesting habitat is provided. The proposed development will conform to the requirements of the ESA (2007) legislation with regards to both of these 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: ESC measures, maintenance of hydrological inputs, fencing/restricted access and stewardship initiatives (e.g., signage, property owner/tenant brochures). • Sediment and erosion controls and SWM facilities. Will be 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-development. • Occupancy-related impacts. Occupancy related impacts to wildlife and wildlife habitat will be mitigated by a combination of measures: <u>fencing</u> along retained/realigned stream corridors to restrict access; and <u>stewardship</u> 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	Residual impacts to wildlife and wildlife habitat resulting from land 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. • While there are direct impacts to anuran breeding habitat, ephemeral pool/pond habitat suitable for anurans breeding will be recreated within the buffers of realigned stream reaches. Anurans may also re-colonize SWM facilities following construction. • Additional measures are proposed to reduce potential for indirect impacts to off-site wildlife habitat (i.e., erosion and sediment controls, 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. This can include, the Town of Oakville publication "*Living the Green Life – Oakville's Guide to Environmental Stewardship*" 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 affected 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 landscape.

Wildlife			
Feature Significance and Sensitivity	Potential Natural Environment Impacts	Mitigation Measures	Residual Effects
area sensitive species, despite the limited amount of interior habitat beyond 100 m of the edge (<1ha). • 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.	occupancy related activities. • Construction-related impacts. These are generally limited to temporary disturbances to the Farm Pond (Vegetation Unit 1) and portions of Vegetation Unit 2 habitats during construction. Potential for sedimentation and contamination are addressed by sediment and erosion 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.	measures will be implemented to recreate the form and function of meadow marsh/shallow marsh and ephemeral Farm Pond habitats within the realigned portions of stream reaches (14W-22). These habitats are anticipated to be suitable to the anurans displaced from the Farm Pond. The re-vegetation plant list will include *Asclepias* species and nectar producing plants to enhance habitat suitability for Monarch Butterfly.	

Table 5.14: Summary of Potential Impacts to Aquatic Resources

Aquatic Resources			
Feature Significance and Sensitivity	Potential Natural Environment Impacts	Mitigation Measures	Residual Effects
<u>Subject Property</u> • West Fourteen Mile Creek tributaries flow through the subject property including Reach 14W-11, Reach 14W-11A, Reach 14W-12, Reach 14W-12A, Reach 14W-13, Reach 14W-14, Reach 14W-14A and Reach 14W-16. • Reach 14W-13 is considered *Low Constraint* with the possibility of elimination/incorporation into SWM plan/surface drainage systems. • Reaches 14W-11A, 14W-14, 14W-14A and 14W-16 are considered *Medium Constraint* for retention in current location or can be relocated with enhancement of the existing conditions. • Reach 14W-11 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 the stream corridor. 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. Rehabilitation options for the concrete retaining wall at the Dundas Street crossing of Reach of 14W-12 will be considered during a later stage of design. Consideration will include replacement options (i.e., bioengineered application to reinforce the existing	<u>Subject Property</u> • Road crossings. The construction of the Burnhamthorpe Road Extension and Avenue 1 will result in crossings of existing reaches. Burnhamthorpe Road Extension will cross over the existing Reach 14W-16 and realigned Reach 14W-14 (new Reach 14W-22). Avenue 1 will cross over the realigned Reach 14W-14 (new Reach 14W-22). Impacts will be to the 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. As such, open bottom culverts will be proposed for all reach crossings. Potential impacts of road crossings included 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 reach at the crossing location, and loss/alteration of habitat during construction due to in-water work. • Burnhamthorpe Road Extension adjacent to Reach 14W-12A stream corridor. The construction of the Burnhamthorpe Road Extension has been realigned to the north of the alignment proposed in the Secondary Plan in order to minimize adverse effects to a downstream section of Reach 14W-12 which is Redside Dace Occupied Habitat. This has resulted in the alignment being located adjacent to the stream corridor associated with Reach 14W-12A. Reach 14W-12A has marginal function as fish 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 *Fisheries Act* through the introduction of deleterious substances and/or result in "serious harm to fish".	<u>Subject Property</u> • 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 reach by minimizing the potential for in-water works. 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). Road alignments have been further investigated and revised in order to mitigate potential adverse effects to the stream corridors. The road alignments have been revised sufficiently to avoid encroachment into the Reaches 14W-12 and 14W-12A stream corridor as was previously the case with the former concept plan; thereby, minimizing potential adverse effects to the reaches and associated riparian habitats. • 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	• 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), serious harm to fish will not occur. In the event that open bottom culverts cannot be used and a box culvert is required, it is anticipated that impacts to fish habitat may not be entirely mitigated and, as a result, the construction of this type of crossing may result in serious harm to fish; thereby, requiring Authorization under the Fisheries Act (1985) and the need for fish habitat enhancement measures to offset the outstanding impacts. • Buried Services Crossing. It is anticipated that impacts to aquatic habitat associated with construction of the reach 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 reaches can also likely be mitigated due to the relatively small size of the reaches and the intermittent flow regime. A review of the service crossing under the Fisheries Act (1985) indicate that a crossing can likely be addressed through standard construction methods and adhering to DFO guidance documents provided the proposed works meet specific conditions. In the event that the proposed construction

Aquatic Resources			
Feature Significance and Sensitivity	Potential Natural Environment Impacts	Mitigation Measures	Residual Effects
banks of this reach.) • Reach 14W-12A is also considered High Constraint; however, due to its form, function and origin as drainage from a constructed bypass pond its function as fish habitat is marginal. • Reach 14W-12 and Reach 14W-16 are Occupied Redside Dace habitat. • Reach 14W-11A, Reach 14W-12A, Reach 14W-13, Reach 14W-14 and Reach 14W-14A are considered Contributing Redside Dace habitat.	• 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 reach bed and banks, temporary access for construction, removal/compaction of vegetation/soils, transport of deleterious substances to the reach. • 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 reach 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. • SWM facilities adjacent to Reach 14W-12 development setback. The proposed locations of the SWM facilities have been located beyond the limits of Reach 14W-12 stream corridor. There will be a minor encroachment into the stream corridor associated with the SWM facilities outlets. The encroachment into Redside Dace (riparian) habitat will continue to be discussed with Ministry of Environment Conservation and Parks (MECP) as it relates to an ESA (2007) approval. • Incorporation of Reach 14W-14A (Farm Pond) into the SWM facility. The removal of the pond and its incorporation into the SWM facility will result in a benefit to the fisheries. This is because the Farm Pond (14W-14A) currently provides warmwater contributions to Reach 14W-12 that supports coolwater species including Redside Dace. Removing this pond, will remove that warm water contribution. Typically the removal of pond habitat (i.e., bypass, online), specifically that outflows to cool/coldwater habitats, is considered an enhancement to fish and fish habitat due to the associated adverse effects to water quality (i.e., water temperature, dissolved oxygen). It is also suggested	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 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. These areas where reach setbacks will be encroached (i.e., SWM facilities outlets into Reach 14W-12, road and service reach crossings), will be restored using native plantings and seeding with the goal to restore the same area that was disturbed by the road. • Timing of in-water construction (if required). In the event that in-water works are required (i.e., footings, open cut) works will adhere to the in-water timing window including permissible works from July 1 to September 15 for Reach 14W-12, Reach 14W-11 and Reach 14W-16 with all	methods do not meet the conditions of these guidance documents and/or the effects cannot be entirely mitigated this construction method has a greater likelihood of resulting in a serious harm to fish and may require Authorization under the Fisheries Act (1985). This assessment is dependent upon site specific impacts; the type of habitat affected and will be determined through a self-assessment and/or review of the project by DFO to determine whether an Authorization is required. The self-assessment and/or DFO consultation will occur once the construction method has been determined at the detail design stage. However, it is anticipated that serious harm to fish will not occur as a result of the construction of buried services. • Encroachments into watercourse setbacks. Residual effects associated with these encroachments are anticipated to be minor due to the limited encroachment (i.e., SWM facilities outlets to 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 of 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: 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	Potential Natural Environment Impacts	Mitigation Measures	Residual Effects
	as a potential overall benefit action in the DRAFT Guidance for Development Activities in Redside Dace Protected Habitat (MNR, 2011). • Removal of Reach 14W-13. This Low Constraint reach will be eliminated: with flow originating from north of Highway 407 directed by the new Reach 14W-21 to the realigned Reach 14W-14 (new Reach 14W-22). • Realignment of Reach 14W-14 and Reach 14W-11A. In the absence of other measures these works are anticipated to contravene the *Fisheries Act* (1985) and may result in serious harm to fish requiring an Authorization. Consultation with DFO during detail design will be undertaken to confirm. • Alteration of flow to Reach 14W-12A. The alteration of flow to this reach is anticipated to have minimal adverse effects to fish habitat due to its limited function on flows. • 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, etc.). • 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 reaches. On site surface runoff will be directed to the proposed SWM facilities resulting in a localized redirection of surface runoff in the Reach 14W-14 catchment area. Reach 14W-13 will be eliminated with flow directed by new Reach 14W-21 to realigned Reach 14W-14 (new Reach 14W-22). These changes will result in a slight shift in the amount of surface water directed to Reach 14W-14 (new Reach 14W-22) between Highway 407	remaining watercourses subject to the period from July 1 to March 31. Any works within Redside Dace habitat associated with Reach 14W-12 and Reach 14W-16 (meanderbelt plus 30 m) will only be permitted from July 1 to September 15. • In-water construction method (if required): If 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 channel. This will permit the construction to occur throughout the year with 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, 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 MNRF. • 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	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) and implementation of infiltration trenches along the boundary of the Open Space Area (Natural Heritage System). • Incorporation of Reach 14W-14A (Farm Pond) into the SWM facility. 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 facility (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 and improve water quality.

Aquatic Resources			
Feature Significance and Sensitivity	Potential Natural Environment Impacts	Mitigation Measures	Residual Effects
	and the SWM facilities. The potential impact is minimal as the remaining 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 to the limits of the site will continue to receive approximately 95% of the existing surface water contributions; thereby, minimizing potential adverse effects to fish habitat in downstream reaches. In general, the results of the hydrologic flow regime comparison shows that under the proposed condition for all reaches, except for Reach 14W-12A, the mean flow values have increased, the peak flows have marginally reduced, and the standard deviation (dispersion of the flow data with respect to the mean) of the flow values has reduced. This means that in all the channels within the Subject Property, there will higher uniform and sustained levels of flows with reduced peaks. • Groundwater contributions. Potential impacts to the groundwater regime and subsequent impacts to base flow in receiving reaches 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 reaches. Although this constitutes the majority of groundwater inputs into the reaches 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 sections of the reaches where refuge pools supporting fish including Redside Dace have been observed.	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 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 through its design (i.e., planting native shrubs around the pond perimeter, bottom-draw outlet structure, 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 reaches 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.	• Realignment of Reach 14W-14, Reach 14W-11A and Alteration of flow to Reach 14W-12A. The realignment of these reaches provides the opportunity to enhance the existing conditions of these altered reaches. 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. Floodplain wetlands will consist of both meadow marsh habitat and small offline open water wetland-pond features. These will recreate habitat loss in Reach 14W-13 and Reach 14W-14 and replicate existing open water features and provide additional opportunities for infiltration. DFO has indicated that Fisheries Act (1985) Authorization will not be required for the removal of Reach 14W-14A, realignment of Reach 14W-11A and consolidation of Reach 14W-14 and Reach 14W-13 into a realigned reach. The proposed approach to address the change in surface water contributions to Reach 14W-12A consists of maintaining a portion of surface runoff (directed via surface flows and an infiltration swale), as well as, the direction of roof top runoff to this reach.

Aquatic Resources			
Feature Significance and Sensitivity	Potential Natural Environment Impacts	Mitigation Measures	Residual Effects
		• Water quality (temporary). ESC 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. • Clean water (i.e., roof runoff) will be directed to the galleries located along the edge of the open space corridor and then will be directed through Reach 14W-12A to Reach 14W-12 in order to maintain surface water contributions to flow. • Monitoring. Potential impacts within the reaches will be assessed using the monitoring program discussed in Section 5.10 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).	
<u>Adjacent Lands</u> • Reach 14W-12 flows downstream of Dundas Street in a meandering defined channel that is considered Redside Dace habitat. .	<u>Adjacent Lands</u> 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,	<u>Adjacent Lands</u> Mitigation measures will be developed through a greater detailed examination of potential impacts during future EIR/FSS studies specific to the draft plan areas.	<u>Adjacent Lands</u> Residual effects will be identified during future EIR/FSS studies specific to the draft plan areas

Aquatic Resources			
Feature Significance and Sensitivity	Potential Natural Environment Impacts	Mitigation Measures	Residual Effects
	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 increased imperviousness are based upon the development proposed. It is anticipated that it will 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.		

Table 5.15: Summary of Potential Impacts to Vegetation

Vegetation			
Feature Significance and Sensitivity	Potential Natural Environment Impacts	Mitigation Measures	Residual Effects
<u>Subject Property</u> • The Subject Property is dominated by active agricultural land uses with a network of drainage swales (reaches) supporting cultural meadow/meadow marsh vegetation. • A small deciduous woodland within the proposed Highway 407 transitway, abuts the existing Highway 407 ROW at the north end of the property. • A Farm Pond (Reach 14W-14A) 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. This feature will be retained in its entirety within the proposed development. • 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, three (3) are associated with hedgerows, and one (1) is located in vegetation unit 4i. <u>Adjacent Lands</u> • 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	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 Reach 14W-14, Reach 14W-13 and Reach 14W-11A. It is important to note that works within the stream corridor downstream of the proposed realigned Reach 14W-11A consisting of Dry Oak-Hickory Forrest Type (FOD2-2) will not be affected. In the event that there are works proposed within this vegetation community, consultation with the Town and CH will be undertaken. • Removal of Vegetation Unit 1 and portions of Vegetation Unit 2A to accommodate construction of a SWM facility. • Removal of Hedgerows HR2, HR3, HR7 and portions of HR4, and removal of Tree Clusters TC1, TC2, and TC3 to accommodate site grading and road construction. • Removal of vegetation from within Vegetation Unit 2A to accommodate construction of the trail system along the south side of Reach 14W-12 and Reach 14W-16. The trail system (Off-Road Major Trail) has been located within close proximity of the limit of the NHS in order to minimize encroachment into established habitats (Figure 5.8). Direct impacts. Direct impacts to vegetation[1] adjacent to the subject property are: • Removal of cultural meadow, cultural thicket and oak dominated deciduous forest to accommodate two new road crossings of the Fourteen Mile Creek valley (part of Core #1). • Removal of hedgerows to accommodate new road	• 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 reaches 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; sediment and erosion 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	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 reach 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 5A and B. 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, sediment and erosion 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	Potential Natural Environment Impacts	Mitigation Measures	Residual Effects
Provincially Significant Wetland complex. • Adjacent lands to the south include Bronte Creek Provincial Park. • Other designated features are present in the general area, including the Bronte Creek provincially significant life science ANSI.	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 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.	species that dominate the existing communities. These measures may include seedbank salvage and/or salvage of sedge 'turf' from densely vegetated portions of relocated reaches. 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.	

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

SIDEROAD 2
BELL SCHOOL LINE
SIDEROAD 2
HENDERSON ROAD
FM1003A
FM1007A
FM1007C
FM1001
REGIONAL ROAD 25
SIDEROAD 1
SIDEROAD 1
BURNHAMTHORPE ROAD WEST
APPLEBY LINE
FM1005
FM1006
FM1007B
FM1007D
FM1003B
FM1008
FM1002
FM1004
HIGHWAY 407
FM1108
FM1107
FM1105
FM1104
REGIONAL ROAD 25
ZENON DRIVE
FM1110
FM1102
FM1109
TREMAINE ROAD
FM1103
FM1106
OLD BRONTE ROAD
DUNDAS STREET
DUNDAS STREET WEST
©2009

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"
- Hydrologic Feature "B"

Watercourse Constraints

- High Constraint Stream Corridor
- High Constraint Stream Corridor - Requiring Rehabilitation
- Medium Constraint Stream Corridor
- Low Constraint Stream Corridor

Scale: 0 120 240 480 720 960 m

Client: QuadReal

Prepared by: wsp

Date: June 2017

Project No.: 1409222001

Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5.1

M:\Jobs\2009\14.09222.001.P01 - 407 West Employment Area\mapping\mxd\2013 04\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
- Vegetation Communities
- Wetland Communities
- Transitway
- Soil Auger Locations

AG Agricultural Field
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)
1D Pondweed Submerged Aquatic (SAS1-1)
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: QuadReal

Prepared by: wsp

Date: June 2017

Project No.: 1409222001

Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5.2

M:\Jobs\2009\14.09222.001.P01 - 407 West Employment Area\mapping\mxd\2017 06\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

HIGHWAY 407

TREMAINE ROAD

ZENON DRIVE

DUNDAS STREET WEST

BB1
BB2
BB3
BB4
BB5
BB6
BB7
A1
A2
A3
A4
A5
A6
A7
A8

Approximately 40 Bobolink observed during breeding bird surveys (June/July 2005)

Approximately 8 Bobolink observed (July 14, 2010)

Approximately 8 Bobolink observed (July 13, 2010)

2 Bobolink observed during water quality monitoring (July 2009)

LEGEND

- Subject Property
- 407 Transitway
- Bird Sampling Stations
- Anuran Sampling Locations
- Bobolink Observation Locations
- Transect Lines
- BOBO-EAME Survey Point Count (2012)
- BOBO-EAME Survey Point Count (2013)

Scale

0 50 100 200 300 400 m

Client: QuadReal

Prepared by: WSP

Date: June 2017

Project No.: 1409222001

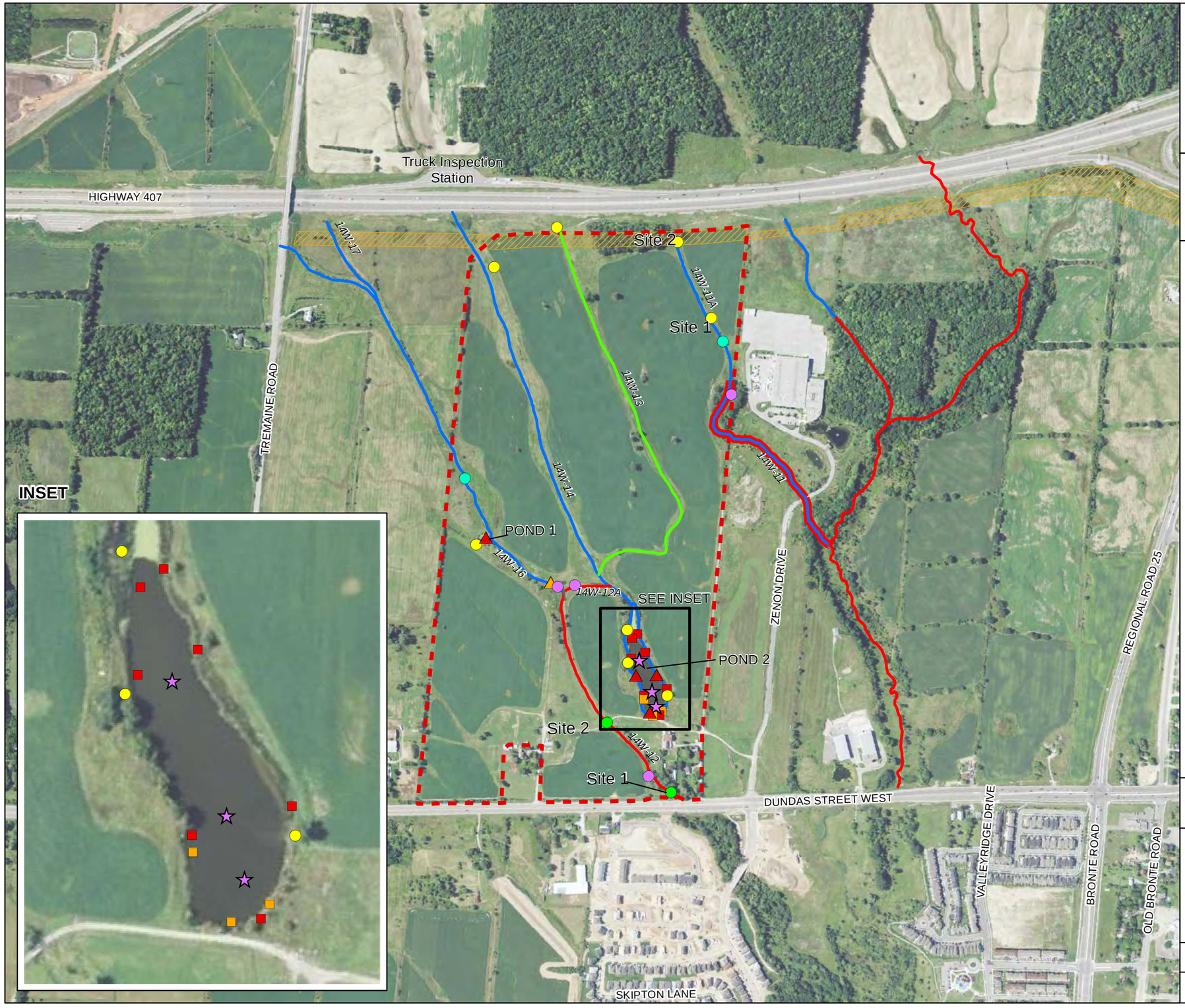
Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5.3

M:\Jobs\2009\14.09222.001.P01 - 407 West Employment Area\Mapping\mxd\2014 07\Figure 5-3 - Wildlife Sampling Locations R2.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)
- Temp Logger Locations (2011)
- Benthic / OSAP (2009)
- Electroshocking Locations (2009)
- Benthic / OSAP and Electroshocking Location (2009)
- Minnow Trap Locations (2002)
- Pot Trap Location (2011)
- Minnow Trap Location (2011)
- 407 Transitway

Watercourse Constraints

- High Constraint Stream Corridor
- High Constraint Stream Corridor - Requiring Rehabilitation
- Medium Constraint Stream Corridor
- Low Constraint Stream Corridor

Scale: 0 65 130 260 390 520 m

Client: QuadReal

Prepared by: wsp

Date: June 2017

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\2012 12\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
- Vegetation Communities
- Wetland Communities
- Open Space Area
- 407 Transitway
- Soil Auger Locations

AG Agricultural Field
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)
1D Pondweed Submerged Aquatic (SAS1-1)
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: QuadReal

Prepared by: wsp

Date: April 2019

Project No.: 1409222001

Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5.5

M:\Jobs\2009\14.09222.001.P01 - 407 West Employment Arealmapping\mxd\2019 04\Figure 5-5 - Vegetation Communities - Proposed Development Impact Review R2.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
- 407 Transitway

Watercourse Constraints

- High Constraint Stream Corridor
- High Constraint Stream Corridor - Requiring Rehabilitation
- Medium Constraint Stream Corridor
- Low Constraint Stream Corridor

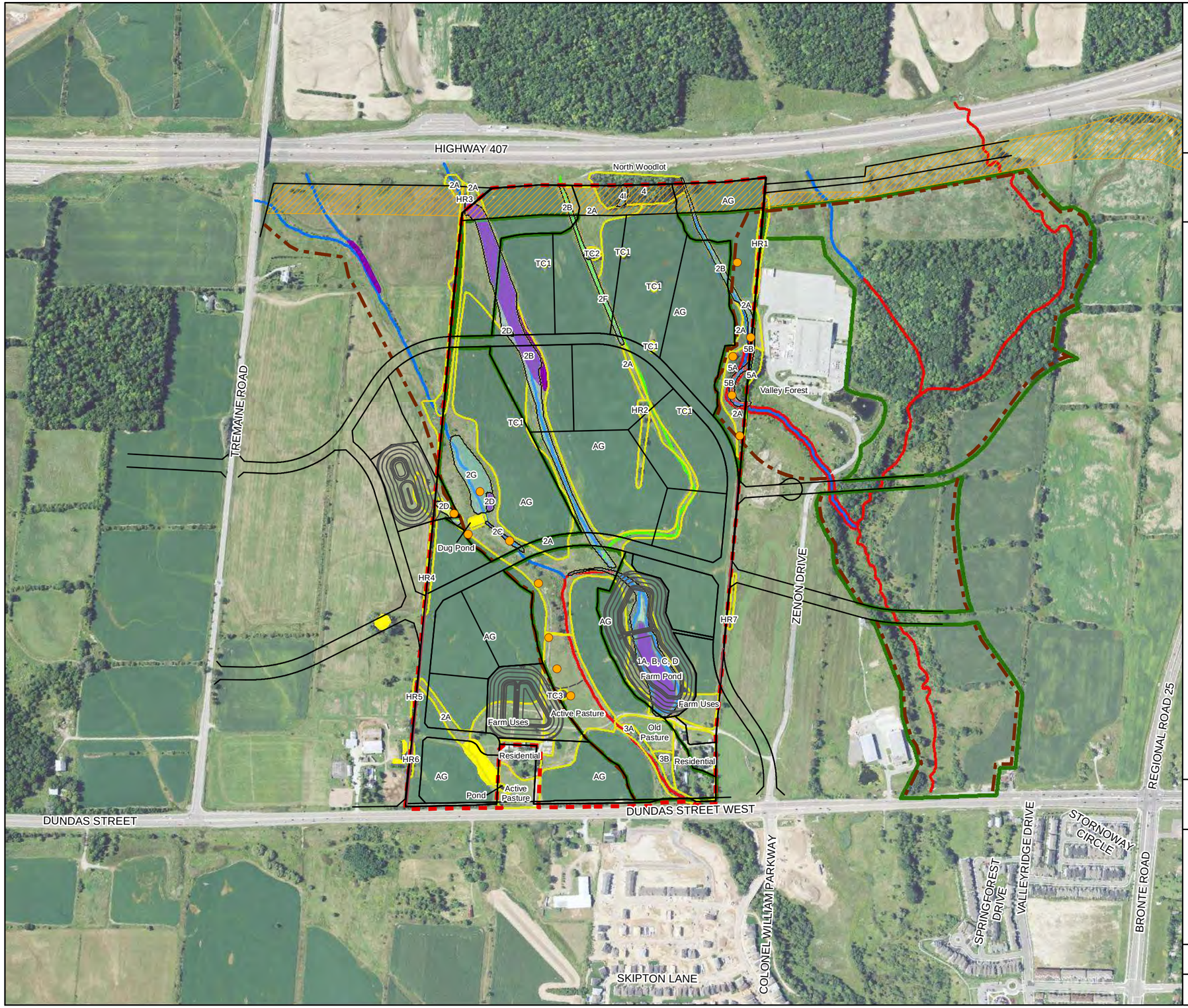
Scale: 0 50 100 200 300 400 m

Client: QuadReal	Prepared by: wsp
Date: April 2019	Project No.: 1409222001
Aerial Photo: © DigitalGlobe, 2010, Google, 2009	**Figure: 5.6**

M:\Jobs\2009\14 09222.001.P01 - 407 West Employment Area\mapping\mxd\2014 07\Figure 5-6 - Aquatic Ecology - Proposed Development Impact Review R2.mxd

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

Natural Heritage Features: Proposed Development Impact Review



LEGEND

- Subject Property
- Vegetation Communities
- Wetland Communities
- Open Space Area
- 407 Transitway
- Hydrologic Feature "A"
- Hydrologic Feature "B"
- Major Trails
- Ditch
- Soil Auger Locations

Watercourse Constraints

- High Constraint Stream Corridor
- High Constraint Stream Corridor - Requiring Rehabilitation
- Medium Constraint Stream Corridor
- Low Constraint Stream Corridor

AG	Agricultural Field
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)
1D	Pondweed Submerged Aquatic (SAS1-1)
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 65 130 260 390 520 m

Client: QuadReal

Prepared by: wsp

Date: April 2019

Project No.: 1409222001

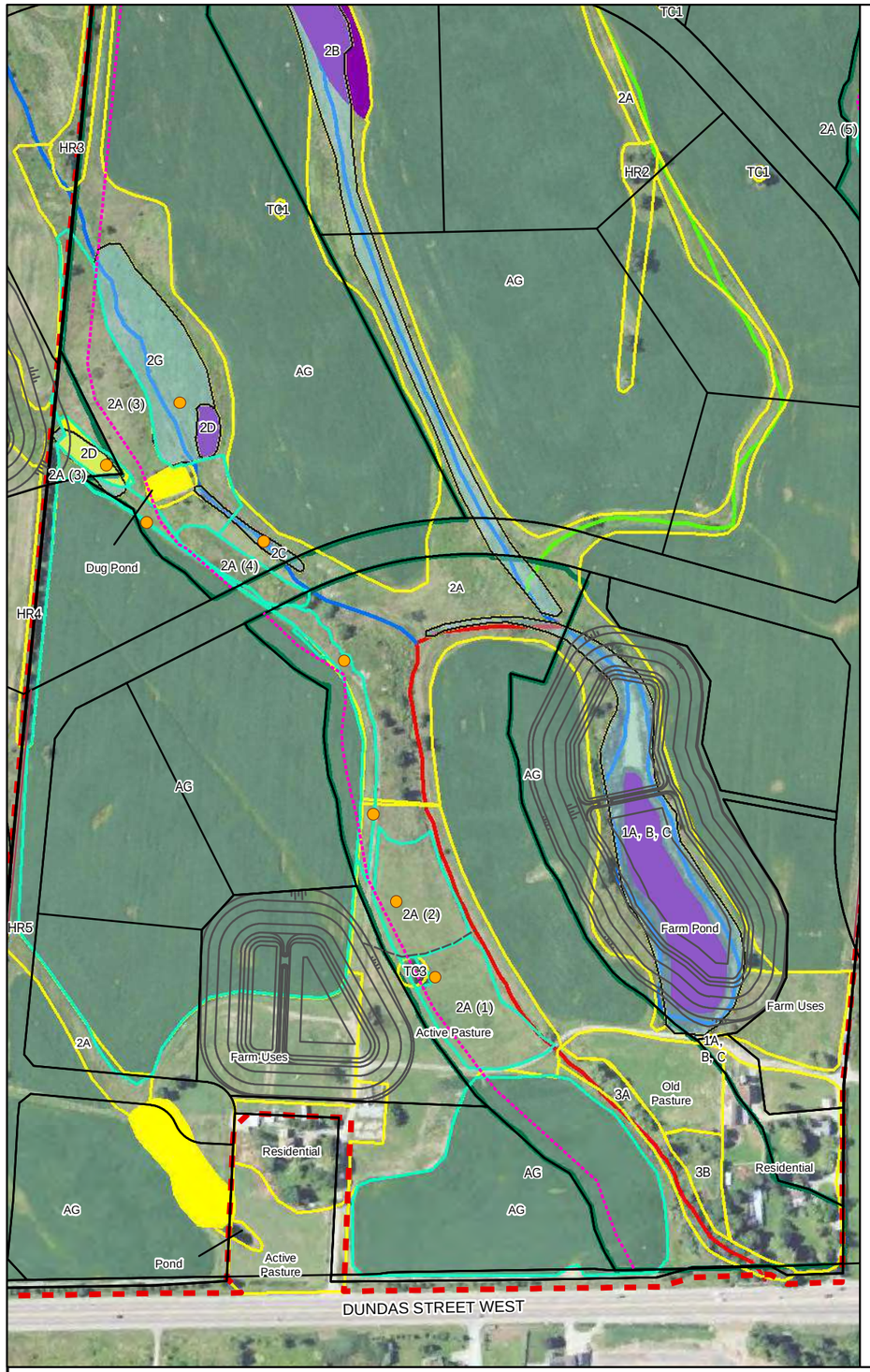
Aerial Photo: © DigitalGlobe, 2010, Google, 2009

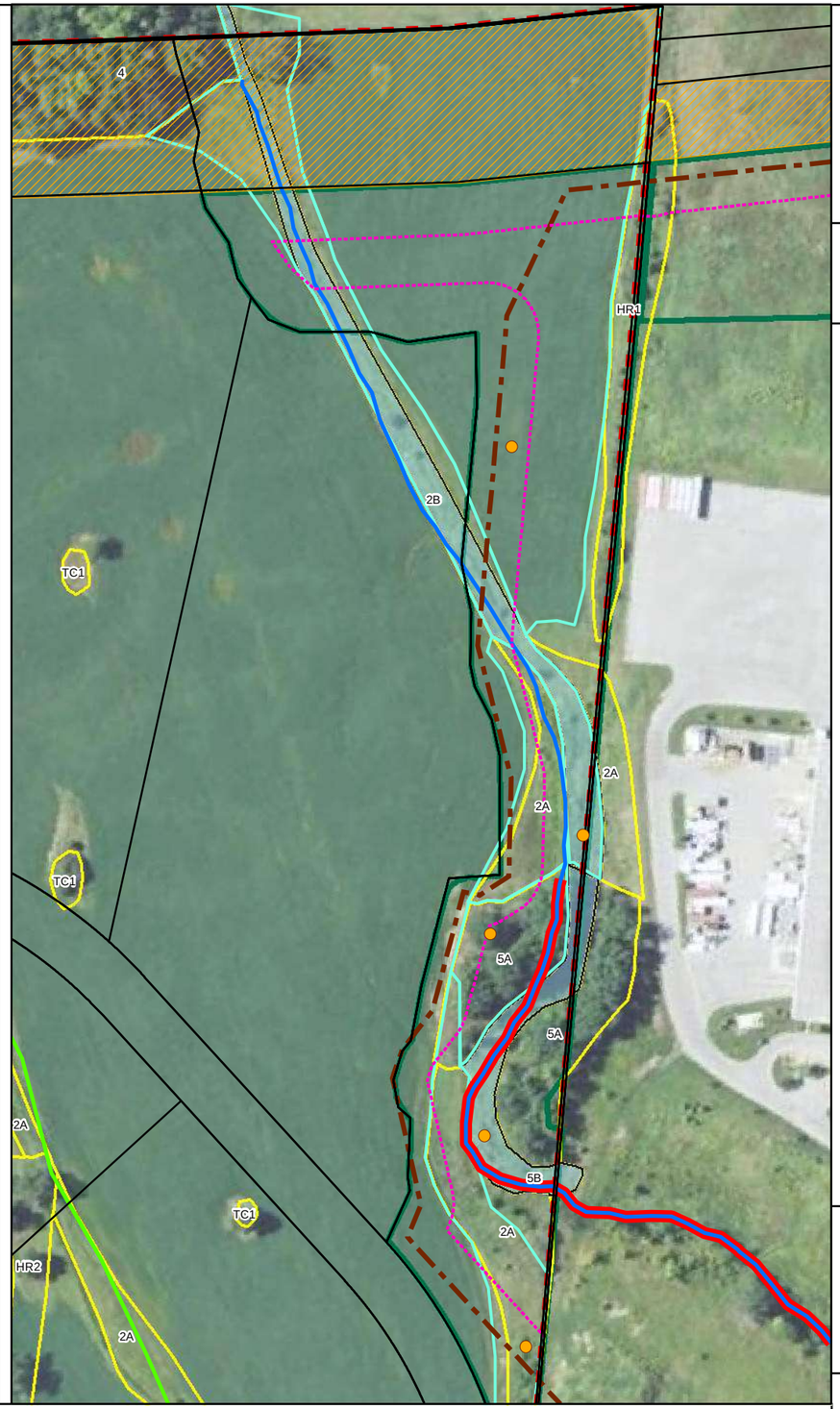
Figure: 5.7

M:\Jobs\2009\14.09222.001.P01 - 407 West Employment Area\mapping\mxd\2019 04\Figure 5-7 - Vegetation Communities - Proposed Development Impact Review.mxd

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

Natural Heritage Features: Proposed Trail Impact Review





LEGEND

- Subject Property
- 20m Study Corridor Boundary
- Vegetation Communities
- Vegetation Communities in Trail Corridor
- Wetland Communities
- Open Space Area
- 407 Transitway
- Hydrologic Feature "A"
- Hydrologic Feature "B"
- Major Trails
- Ditch
- Soil Auger Locations

Watercourse Constraints

- High Constraint Stream Corridor
- High Constraint Stream Corridor - Requiring Rehabilitation
- Medium Constraint Stream Corridor
- Low Constraint Stream Corridor

AG Agricultural Field
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)
1D	Pondweed Submerged Aquatic (SAS1-1)
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)

0 30 60 120 180 240 m

0 15 30 60 90 120 m

Client: QuadReal

Prepared by: WSP

Date: April 2019

Project No.: 1409222001

Aerial Photo: © DigitalGlobe, 2010, Google, 2009

Figure: 5.8

M:\Jobs\2009\14.09222.001.P01 - 407 West Employment Arealmapping\mxd\2019 04\Figure 5-8 - Vegetation Communities - Proposed Trail Impact Review.mxd

6.0 Water Resources

6.0 Water Resources

6.1 Introduction

The proposed development area contains the headwater tributaries of the West Branch of Fourteen Mile Creek which flow generally from west to east. The headwaters enter the development area via 5 culverts (FM1, FM2, FM3, FM4 and FM5) located under Highway 407 and exit the subject property through two culverts (FM-D4 and FM-D5) located under Dundas Street West as shown in Figure 6.1. Two tributaries of West Branch of Fourteen Mile Creek (Reaches 14W-13 and 14W-14) will be diverted upstream of confluence with 14W-16, and an east Reach 14W-11A will be realigned to accommodate the proposed development.

The 14W-12A reach contains a well-defined trapezoidal cross-section and was constructed to allow outflows from the pond to flow back out into Reach 14W-12. The 'A' designation for this sub-reach is intended to illustrate that this area requires altered management recommendations from the remainder of Reach 14W-12. No intent to re-designate NOCSS reaches is implied. In the pre-development condition, Reach 14W-12A receives flow from reaches 14W-13, 14W-14 and from water flowing out of the existing pond. Under post-development conditions, with the consolidation of Reaches 14W-13 and 14W-14 into Reach 14W-22, Reach 14W-12A will continue to receive controlled discharge from the developed upstream catchment (see Section 7), and the forces promoting the current channel form will be altered. Therefore, the distinction for Reach 14W-12A has been carried through the EIR/FSS when addressing issues related to this area.

Changes on the hydrologic features and functions within the Subject Property has been analyzed based on the following phasing plan (refer to Section 7 for hydrologic modelling results):

1. Existing (i.e. pre-development)
2. Interim Conditions Phase 1A
3. Interim Conditions Phase 1B
4. Interim Conditions Phase 2
5. Ultimate Conditions

According to the TOR of the EIR/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.

Details are provided in the following appendices:

- Appendix 6.1: HEC RAS Results
- Appendix 6.2: Proposed Cross Sections

- Appendix 6.3: Proposed Crossings
- Appendix 6.4: Corridor Width Delineation
- Appendix 6.5: EXP Slope Stability Report
- Appendix 6.6: Stream Stability and Drainage Density
- Appendix 6.7: Water Surface Profiles at Tie in of 14W-22 and 14W-12A
- Appendix 6.8: Top of Bank 14W-12A South of Farm Pond

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

The study criteria are multidisciplinary and follow technical direction from the North Oakville EIR and FSS Terms of Reference, 2007, in addition to policy direction and guidance from Town of Oakville, Conservation Halton, MECP, MNRF, and other agencies. Specific references include:

- Corridor Width Delineation (Section 6): ToR Section 3.3.3.1a & b.
- Top of Bank Delineation (Section 6): ToR Section 3.3.3.1c.
- Hydraulic Modelling and Floodplain Mapping (Section 6)
- Hydrologic Model (Section 7):
    - ToR Section 3.3.3.3:
        - Identify the form and function of Hydrologic Feature 'A' and document its ecological and hydrologic relationship to the watercourse; and
        - Identify how the ecological and hydrological relationships of the Hydrologic Feature 'A' is considered in the present stream modification.
    - ToR Section 3.4.4:
        - The modelling approach is to follow commonly accepted practices;
        - 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; and
        - 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.
- Flow Regime (Section 7):
    - Instream Flow Assessment Method (April 1st, 2016 email from Conservation Halton);
    - ToR Section 3.3.3.2: Fish and Fish Habitats; and
    - ToR Section 3.4.3: Preliminary Grading and Drainage Plan.
- Erosion Thresholds (Section 7):

    - The frequency and duration of time (expressed as hours) that the erosive threshold flow is exceeded, in the pre-development condition, is to be matched in the post-development condition (i.e. results are within approximately 5% of the pre-development conditions.)
- Stormwater Management (Section 7): ToR Section 3.4.

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 their form and function, while medium constraint streams are required to preserve their current functions. Low constraint streams can be replaced through infrastructure or stormwater management (SWM) 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;
- NOCSS Setback and buffer requirements.
- Hydrologic features "A".

The following sub-sections include the definition of each component of the Corridor Width Delineation. A summary table is incorporated at the end of Section 6.3, with total corridor width summarized at the end.

6.3.1 Fluvial Geomorphic Requirements

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, most likely to accommodate agricultural practices. The drainage channels have been repeatedly straightened, and a relatively short reach (Reach 14W-12) just upstream of Dundas Street remains in a natural condition.

Reach 14W-12 was observed to have a defined channel. This definition occurs 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.

Approximately 400 m of Reach 14W-16 enters the project site from the west side. Reach 14W-16 was observed to be a poorly defined swale, before its convergence with Reach 14W-12.

The remaining reaches on West Branch of Fourteen Mile Creek 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; and,
- Annable, 1996

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 or 6 m, whichever is higher, is added to each side of meander belt width instead of 100 Year erosion rate.

6.3.2 Top of Bank Requirements

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 6.3A, along with the required setbacks.

Following comprehensive discussions with Conservation Halton and the Town of Oakville concerning the delineation of top of bank for 14W-11, the following findings are noted:

1. The EXP Slope Stability Report recommendations, including location of the stable slope line, erosion allowance offset, and long term stable top of bank, have been incorporated in Figure 6.3A;

2. The physical top of bank limits that were staked as part of the original fieldwork component for previous submissions of the EIR/FSS were plotted in Figure 6.3A with the EXP report recommendations; and

3. As all development limits have been established well beyond the slope areas recommended by the EXP report and protected by the relevant buffers as shown in Figure 6.3A, we feel the comments related to the EXP slope stability analysis have been adequately addressed.

Reach 14W-12 Figure for cross section south of the farm pond is included in Figure 6.3B and Appendix 6.8

6.3.3 Regulatory Floodplain Delineation Requirements

In accordance with NOCSS, a 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.

As noted in NOCSS and discussed with Conservation Halton, a Hazard Allowance of 7.5 m for minor stream, and Hazard Allowance of 15 m for major stream are applied to flood plain, meander belt, or top of bank, whichever is the greatest. In this study, floodplain mapping is shown via two sets of figures:

- As part of corridor width delineation for the interim and ultimate development phases: Figures 6.5.1, 6.5.2, 6.5.3, and 6.5.4
- As part of floodplain mapping for the interim and ultimate development phases: Figures 6.6.1, 6.6.2, 6.6.3, and 6.6.4

6.3.4 Fisheries Setback and NOCSS Setback Requirements

The determination of fisheries setbacks for the associated reaches within the Subject Property was undertaken to address the objectives listed above while adhering to the requirements associated with two documents, NOCSS and the Recovery Strategy for Redside Dace (*Clinostomus elongatus*) in Ontario (2010) in association with the ESA (2007) Ontario Regulation 242/08. Based on that consultation with Conservation Halton, the following was confirmed under the NOCSS Management Report, Section 6.3.4.2, Environmental/Fisheries.

- For Reach 14W-16, Reach 14W-12, Reach 14W-12A(hook)
    - NOCSS Management Report Section 6.3.4.2
        - For the Redside Dace streams, the buffer requirements of the draft Redside Dace Recovery Strategy (Dextrase et al., 2005) are recommended. This would result in buffer widths, for survival habitat, of 30m from top of bank for incised channels and 30m on either side of meander belt width if no defined valley is present."
    - Reach 14W-16, 14-12 and 14W-12A are considered Redside Dace Stream, thus the Fisheries Setback is 30m measured from the meander belt on either side.

- For Reach 14W-11A, Reach 14W-13, 14W-14, Reach 14W-21, Reach 14W-22 and Reach 14W-23
    - NOCSS Management Report Section 6.3.4.2

      "For non-Redside Dace streams, a minimum buffer width is recommended that would provide some level of protection for the stream. Review of the literature and of current practice in southern Ontario suggests that a minimum width of 15m would be appropriate and this width is recommended."
        - NOCSS states that the fisheries setback is measured as 15m on either side of the watercourse from the edge of the bankfull channel.
        - However, the location of the ultimate constructed channel including bankfull width of the study area has not been determined. Based on the consultation with Conservation Halton, the 15m fisheries setback should be measure from the meander belt allowance on the site-specific section plan and profiles.
    - Reach 14W-11A, 14W-13, 14W-14, 14W-21, 14W-22 and 14W-23 are considered Non-Redside Dace Stream, thus the Fisheries Setback is 15m measured from the meander belt on either side.

*6.3.5 **Hydrologic Feature 'A'***

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". There are three Hydrologic Features 'A' in the West Branch of Fourteen Mile Creek within the Subject Property; Reaches 14W-14, 14W-16 and 14W-14A, identified on Figure 7.3.1 of NOCSS. Additional Hydrologic Features 'A' also located along Reach 14W-16, 14W-14, 14W-14A and 14W-11A during field survey, as described in Section 5.2.1.5 and shown on Figure 5.1. Reach 14W-14 will be eliminated and replaced by a realigned channel, Reach 14W-22. Hydrologic Feature 'A' in this area will be replaced by online wetlands and floodplain ponds along the proposed diversion Reach 14W-22 as shown in Figure 6.4.1. Hydrologic Feature 'A' in Reach 14W-16 within the Subject Property will not be disturbed by the development. Therefore, the two Hydrologic Features 'A' will have various setbacks as discussed above. Hydrologic Feature 'A' in Reach 14W-14A associated with the human-made pond in this area functions as an off-line storage area during periods of high flow in the watercourse system, as flow enters the pond during high flows and retreats as the water levels in the watercourse system recede. Hydrologic features "B" and topographic depressions do not contribute to the definition of corridor widths.

Recommendations in terms of maintaining and sustaining Hydrologic Feature 'A' is addressed via the following:

- Section 6.4: Conceptual Natural Channel Design (refer to Figures 6.4.1 to 6.4.4)
- Section 6.5: Riparian Storage Analysis.

6.3.6 Total Corridor Widths

Table 6.2 presents key numbers used in the determination of total corridor width. Specifically:

- Meander Belt Width
- Meander Belt + Factor of Safety
    - Minimum 6m or 10% of Meander Belt on each side, whichever is greater.
- 3:1 Slope Line for Confined Channel
    - Minimum 6m setback on each side measured from Meander Belt + Factor of Safety.
- Regional Floodplain Width.
- 7.5m Erosion Hazard Allowance
    - For Constructed Confined Channel (Reach 14W-21 and 14W-22)
        - 7.5m setback on each side measured from the flood plain width or 3:1 Slope Line, whichever is the greatest.
    - For Natural Unconfined Channel and Constructed Unconfined Channel (Reach 14W-23)
        - 7.5m setback on each side measure from flood plain width or Meander Belt + Factor of Safety, whichever is the greatest
- Woodland Setback
- Fisheries Setback
    - Redside Dace Stream – 30m setback on each side measured from Meander Belt
    - Non Redside Dace Stream – 15m setback on each side measured from Meander Belt

As such, the outside limit of the widest setback will be referred to as the "Development Limit" within the EIF/FSS document.

Figures 6.4.1 to 6.4.4 depict these key setbacks and the development limit, in addition to the Regulatory Floodlines.

Table 6.2 – Total Corridor Width

Development Phasing	Reach	Meander Belt Width (m)	Meander Belt + Factor of Safety Width (m)	3:1 Slope Line Width (m)	Erosion Hazard Allowance Width (m)	Fisheries Setback Width (m)	Total Corridor Width (m)
Interim P1A	14W-12	60	72	n/a	87	120	120
Interim P1B	14W-12	59	71	n/a	86	119	119
	14W-12A	18	30	n/a	45	78	78
	14W-16	44	56	n/a	71	104	104
	14W-21	6	18	33	48	36	48
	14W-22	39	51	77	92	69	92
Interim P2	14W-11	23	35	n/a	50	53	53
	14W-12	66	79.2	n/a	94.2	126	126
	14W-12A	14	26	n/a	41	74	74
	14W-16	44	56	n/a	71	104	104
	14W-21	6	18	33	48	36	48
	14W-22	39	51	77	92	69	92
	14W-23	19	31	n/a	46	49	49
Ultimate	14W-11	23	35	n/a	50	53	53
	14W-12	71	85.2	n/a	100.2	131	131
	14W-12A	14	26	n/a	41	74	74
	14W-16	47	59	n/a	74	107	107
	14W-21	6	18	33	48	36	48
	14W-22	39	51	77	92	69	92
	14W-23	19	31	n/a	46	49	49

6.4 Conceptual Natural Channel Design

Stream rehabilitation opportunities have been identified in the Management Strategy of the NOCSS, which recommends that:

- High Constraint Streams (e.g., Reaches 14W-12, 14W-12A and 14W-16) must be protected in their locations. The only modifications permitted would be through local enhancement or rehabilitation works. No channel modifications are proposed in these reaches.
- 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 (Reach 14W-14) and a low constraint stream (Reach 14W-13) of the West Branch of Fourteen Mile Creek within the development area are proposed to be combined and realigned. New channels are therefore needed to intercept the flows from Reaches 14W-13 and 14W-14 just downstream of the transit corridor and to divert via 14W-21 and 14-W-23 to Reach 14W-12A, approximately 20 m from the confluence with Reach 14W-16. Another medium constraint stream (Figure 6.1), Reach 14W-11A, will be realigned along the transit corridor and northeast limits of the property limits (Reach 14W-23).

6.4.1 Design Criteria

The design criteria for the natural channel design of diversions Reaches 14W-21, 14W-22 and 14W-23 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; and
- A riffle/pool meandering sequence along the flatter channel reaches.

6.4.2 Proposed Channel Morphology

The natural channel design method aims at creating a functional, self-sustaining stream system that provides valuable hydraulic, geomorphic and ecological functions. Streams restored or designed based on the natural channel design principles relies on the fluvial geomorphic characteristics of the river system, which in turn is dependent on the relationships between the disciplines of geology, hydrology and hydraulics. In this study, the concept of natural channel design was used for determining the proposed channel morphology.

For consistency between morphological design, hydrologic analysis, and hydraulic modelling, bankfull flows were estimated based on the 2-year return period.

It should be noted that for the purpose of hydraulic modelling, the channel design parameters, including bankfull depth, width, and riffle length and slope were applied as much as possible, as appropriate to the level and scale of this study. It is understood that the Detailed Design stage will provide input and analysis that is more specific and concise.

6.4.2.1 Reach 14W-16

No alterations will be made to the channel Reach 14W-16, except at the confluence point with the realigned Reach 14W-22

6.4.2.2 Reach 14W-22 Diversion (Realignment of Reaches 14W-13 and 14W-14)

The proposed morphology of the Reach 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 0.79 m^3/s was estimated based on a 2-year return period flow. The proposed Reach 14W-22 connects to an existing Reach 14W-12A. Hence, the longitudinal slope of the proposed Reach 14W-22 is restricted by the upstream and downstream inverts of the existing channel (Appendix 6.7 shows water surface profiles for the tie in). As part of the Detailed Design stage, this will be addressed.

A bankfull width of 1.5 m with a bankfull depth of 0.35 m was selected to provide a bankfull velocity less than 1.7 m/s (to permit vegetative erosion protection of the channel embankments) and a bankfull width to depth ratio greater than 10. The proposed alignment and plan form of Reach 14W-22 is shown in Figures 6.4.1, 6.4.2 and 6.4.3. Typical riffle/pool cross sections for the Reach 14W-22 channel are provided in Figure 6.4.5.

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 Reach 14W-22 are presented in Table 6.3.

6.4.2.3 Reach 14W-21 Diversion

The proposed morphology of the Reach 14W-21 diversion is a relatively straight watercourse. Estimated bankfull discharge is 0.04 m^3/s which corresponds to the 2-year return period flow. A bankfull width of 0.8 m with a bankfull depth of 0.20 m was selected. These dimensions will provide bankfull discharge greater than 0.04 m^3/s and were selected to accommodate construction. The morphological parameters for diversion Reach 14W-21 are presented in Table 6.3. The proposed alignment and plan form of Reach 14W-21 is shown in Figures 6.4.1 and 6.4.2.

6.4.2.4 Reach 14W-23 (Realignment of Reach 14W-11A)

The proposed morphology of the Reach 14W-11A realignment is a relatively straight watercourse with a meandering section. Estimated bankfull discharge based on the 2-year return period is 0.42 m^3/s.

A bankfull width of 0.5 m and a bankfull depth of 0.30 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 Reach 14W-23 channel are provided in Figure 6.4.5.

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 Reach 14W-23 are presented in Table 6.3. The proposed alignment and plan form of Reach 14W-23 is shown in Figures 6.4.1 and 6.4.4.

Table 6.3 – Morphological Parameters for Proposed Channel Diversion and Rehabilitation

	14W-22	14W-21	14W-23
Drainage area	141.99 ha	11.6 ha	49.75 ha
Flow Node	2B	8	9
Bankfull Discharge (2-year flow)	0.79 m^3/s	0.04 m^3/s	0.42 m^3/s
Bankfull Width	1.5 m	0.8 m	0.5 m
Bankfull Depth	0.34 m	0.20 m	0.3 m
Bankfull Width/Depth (Average)	4	4	2
Average Channel Slope	0.46%	0.62%	0.38%
Riffle Slope	0.94%	0.64%	0.92%
Meander Length	35 m	-	18m
Meander Belt Width	39 m	6 m	19 m
Riffle Length	9 m	6 m	6 m
Sinuosity	1.2	1.0	1.1
Entrenchment	1.4 – 2.2	1.4 - 2.2	1.4 – 2.2

6.4.3 Road Crossings

From a functional perspective, a key requirement for the design of the crossings is to protect the existing stream conditions, and minimise any impact on fish passage and fish habitat.

In terms of hydraulic design however, the primary consideration was to satisfy the requirements of the Ministry of Transportation (MTO) Drainage Design Standards (2008) – in particular, the design flows and freeboard/clearance requirements set out in sections WC-1 and WC-2. The requirements of these two sections are summarised below in Table 6.4. The hydraulic modelling results were checked against these criteria, and the final sizing of the crossings was completed in an iterative fashion to verify compliance.

Table 6.4 – Summary of MTO Drainage Design Criteria

Crossing Name	Road Classification	Return Period of Design Flows (years)[1]		Minimum Freeboard (m)[2]	Minimum Clearance (m)[3]
		Span 6.0 m or less	Span greater than 6.0 m		
14W-16A / Arterial One	Minor Arterial	50	100	1.0	1.0
14W-16 / Avenue Three	Collector	25	50	1.0	1.0
14W-22 / Avenue Three	Collector	25	50	1.0	1.0

[1] From MTO Drainage Design Standards, section WC-1, clause 1.1.
[2] From MTO Drainage Design Standards, section WC-2, clause 3.2.1.
[3] From MTO Drainage Design Standards, section WC-2, clause 3.2.2.

It should be noted that freeboard is measured vertically from the high-water level for the design event, to the edge of the travelled lane. Clearance is measured vertically from the high-water level for the design event to the lowest point of the soffit (considered to be the central point of the arch for these structures).

Another important consideration in the design of the crossings was their impact on the Regulatory flood lines. The proposed development limits, and layout of the lots was based, in part, on the Regional flood lines mapped as part of the previous Regional Floodplain Analysis exercise. Significant changes to these lines were therefore not desirable. It should be noted that through compliance with the MTO minimum freeboard/clearance criteria, sufficient flow capacity is typically provided to ensure that changes to floodline elevations in the immediate vicinity of the proposed structures are not significant.

6.5 Hydraulic Analysis

The proposed development area contains the headwater tributaries of the West Branch of Fourteen Mile Creek which generally flows from west to east. As shown in Figure 6.1, the creeks within the subject property boundary are identified as 14W-16, 14W-14, 14W-13 and 14W-11A from west to east; the creek section at the downstream of the confluence of 14W-16, 14W-14 and 14W-13 is called 14W-12. Except the creek reach 14W-13 is a low constraint stream, the others are medium constraint streams.

In accordance with North Oakville Creek Watershed Study (NOCSS), a 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. The hydrologic analysis revealed that the Regional Flood is the larger one (see Section 7.0). Therefore, the floodplain limits were delineated based on the surface water elevations of Regional Flood (i.e. Hurricane Hazel).

6.5.1 Previous Studies

The regulatory floodplain was delineated for Fourteen Mile Creek by Philips Planning and Engineering, in a study titled “Flood Damage Reduction Study on the Fourteen Mile Creek, 1984” and by Triton Engineering Services Ltd. (1992) in a study titled “Fourteen Mile Creek – McCraney Creek Watershed Planning Study”. The HEC-2 model along with Flood Risk Map (Fourteen Mile Creek and McCraney Creek Watershed Study) were obtained from Conservation Halton (CH). The reaches of the Fourteen Mile Creek in the model, which are relevant to the subject site, extended north up to Dundas Street and south to Lake Ontario.

More recently, floodline mapping for Fourteen Mile Creek was completed for the North Oakville Creek Watershed Study (NOCSS) in 2006 and updated in 2007. The HEC-RAS model only extended up to approximately 70 m downstream of Dundas Street.

WSP (formerly MMM Group Limited) combined the two models (HEC-RAS model prepared for NOCSS and the HEC-RAS model converted from the HEC-2 format), while making necessary updates of the cross-sections with up-to-date survey data.

6.5.2 Existing Conditions

The combined HEC-RAS model was used to investigate the current floodplain limits.

The floodplain map (Sheet "upper_14m_mc15" of 1992 Fourteen Mile Creek and McCraney Creek Watershed Study) was overlaid on the subject area and shown in Figure 6.1. It shows the identifications of creeks used in the EIR/FSSR and in HEC-RAS model. The original cross section 165 of HEC-2 model was removed and replaced with cross sections 171 & 169 to represent the Colonel William Parkway Crossing. Table 6.5 provides brief information of the combined HEC-RAS model. As per the identification of river/reach of the HEC-2 model, the majority of the subject site is tributary to River 2 Reach 1; and the remaining area drains to River 1 Reach 1; River 2 Reach 1 joins River 1 Reach 1 at junction "A" (the combined HEC-RAS model) to become River 1 Reach 2. The confluence of the two creeks is location at north of Richview Blvd and west of Bronte Road.

Table 6.5 Information of Combined HEC-RAS Model

River	Reach	Tributary (EIS/FSS Report)	Cross Sections	Note
2	2A	14W-14	XS 3081-221	Combined HEC-RAS model
2	2B	14W-12A	XS240-231	Combined HEC-RAS model
Confluence – Junction "1-4"				Combined HEC-RAS model
2	2C	14W-12A	XS 220.3-220	Combined HEC-RAS model
2	1A	14W-16	XS 210.5-206.1	Combined HEC-RAS model
Confluence - Junction "1-3"				Combined HEC-RAS model
2	1	14W-12	XS 205-169	Combined HEC-RAS model included three existing crossings
2	1		XS 164-160	CH HEC-2 model; XS 165 was removed to represent the current Colonel William Pkwy Crossing
1	1		XS 79-75	CH HEC-2 model
Confluence - Junction "A"				CH HEC-2 model
1	2		XS 74-60	CH HEC-2 model

A new independent HEC-RAS model was developed for the creek 14W-11A/14W-11, which were identified as River 1 Reach 1B. The cross sections were extended from south of Highway 407 to east side of Zenon Drive. The model results were used for the floodplain of creek 14W-11A/14W-11. In addition to this, cross-sections within site area were modified to represent bankfull channel locations based on available topographic information. Additional cross-sections (XS 232-240) on the existing farm pond were included on Reach 14W-12A. As a conservative modelling practice, a permanent pool volume of an existing farm pond is excluded from hydraulic analysis and as summarized below, a higher flow rate of 8.23 m3/s is applied (From Node 2).

6.5.3 Flow Rates

A hydrologic analysis (details included in Section 7.0) was carried out to investigate the flow rates of Regional Flood at various locations under the existing conditions. The flow nodes are shown in Figures 7.4.2 to 7.4.5 under Section 7. The flow rates used in the updated CH model and the new HEC-RAS model were tabulated in Table 6.6.

Table 6.6 Regional Flow Rates used in the Existing Condition Models

Updated CH Model			EIS/FSSR Identifications	Flow Node in Hydrologic Analysis	Regional Flow Rate (m3/s)	Source of Flow Data
River	Reach	XS				
River-2	Reach 2A	3081	14W-14	2	8.23	WSP hydrology analysis
River-2	Reach 2B	240	14W-12A	2	8.23	
River-2	Reach 2C	220.3	14W-12A	2	8.23	
River-2	Reach 1A	210.5	14W-16	1B	8.22	
River-2	Reach 1A	206.3		1	10.29	
River-2	Reach 1	205.1	14W-12	3/3B	19.22	
River-2	Reach 1	203		4	20.34	
River-2	Reach 1	171	South of Dundas Street		28.9	CH hydraulic model
River-1	Reach 1	79			22.9	CH hydraulic model
River-1	Reach 2	74			64.8	
New HEC-RAS Model						
River-1	Reach 1B	14	14W-11A	9	3.06	WSP hydrology analysis
River-1	Reach 1B	10	14W-11	5	3.79	

6.5.4 Existing Crossings and Parameters

A detailed topographic survey of the Bentall lands was undertaken by the WSP Geomatics in January 2012. The DEM provided by the survey data was used to generate an existing ground surface in Civil 3D software. Coordinates for the HEC-RAS cross sections were then defined by cutting sections through the ground surface at the appropriate locations. The locations of these cross-sections are displayed on Figures 6.6.1. The bankfull locations for each cross-section based on the topographic survey information. Three crossings over creek 14W-12 and one crossing over creek 14-11 were incorporated in the model. The culverts' information was obtained from the survey. The crossing data are shown in Table 6.7.

Table 6.7 Information of the Existing Crossings

HEC-RAS Model			EIS/FSSR	Location	Dimension		Type
Crossing ID	River	Reach			Rise (m)	Span (m)	
XS 204.6	2	1	14W-12	Farm access road	1.5	3.6	Conc. Box Culvert
XS 202.5	2	1	14W-12	Dundas Street West	2.5	3.85	Conc. Box Culvert
XS 170	2	1	South of Dundas	Colonel Willian Parkway	3.8	42	Bridge
XS 8.5	1	1B	14W-11/11A	Zenon Drive	0.91 diameter		CPS Pipe

In the model, the values for the expansion and contraction coefficients adopted for expansion and contraction coefficients were 0.3 and 0.1, respectively. The expansion coefficient of 0.5 and contraction coefficient of 0.3 were used in the cross sections at the upstream and downstream of roadway crossings.

Proper calibration of the HEC-RAS model is highly dependent upon the accurate estimation of values for Manning's Roughness Coefficient. No measured water levels were available for model calibration. Based on the Table 3-1 Manning's n Value included in the HEC-RAS Hydraulic Reference Manual, n=0.1 were selected to represent medium to dense bushes at the creek floodplain within the subject site. The roughness values of 0.03 for channel was adopted in the HEC-RAS model.

The flow rates of design floods (2-year up to 100-year) and Regional Flood were obtained from the hydrologic analysis (see Section 7). Simulation of the full range of design floods were conducted with the HEC-RAS model for creeks 14W-16, 14W-14&14W-12 and the HEC-RAS model for creek 14W-11/11A. The Regional Flood water levels resulted from the model are summarized in Table 6.8. They were used for floodplain delineation. The floodplain limit is shown in Figure 6.6.1.

Table 6.8 Regional Flood Water Levels under the Existing Conditions

River	Reach	Cross Section ID	EIS/FSSR Identifications	Existing Regional Water Surface Elevation (m)
River-2	Reach 2A	3081	14W-14	154.76
River-2	Reach 2A	228	14W-14	154.32
River-2	Reach 2A	227	14W-14	153.42
River-2	Reach 2A	226	14W-14	152.87
River-2	Reach 2A	225	14W-14	152.32
River-2	Reach 2A	224	14W-14	151.8
River-2	Reach 2A	223	14W-14	150.96
River-2	Reach 2A	222	14W-14	150.43
River-2	Reach 2A	221	14W-14	149.72
River-2	Reach 2B	240	14W-12A	149.91

River	Reach	Cross Section ID	EIS/FSSR Identifications	Existing Regional Water Surface Elevation (m)
River-2	Reach 2B	239	14W-12A	149.85
River-2	Reach 2B	238	14W-12A	149.84
River-2	Reach 2B	237	14W-12A	149.84
River-2	Reach 2B	236	14W-12A	149.83
River-2	Reach 2B	235	14W-12A	149.81
River-2	Reach 2B	234	14W-12A	149.8
River-2	Reach 2B	233	14W-12A	149.79
River-2	Reach 2B	232	14W-12A	149.77
River-2	Reach 2B	231	14W-12A	149.75
River-2	Reach 2C	220.3	14W-12A	149.75
River-2	Reach 2C	220.2	14W-12A	149.59
River-2	Reach 2C	220.1	14W-12A	149.47
River-2	Reach 2C	220	14W-12A	149.47
River-2	Reach 1A	210.5	14W-16	155.74
River-2	Reach 1A	210	14W-16	155.47
River-2	Reach 1A	209	14W-16	154.89
River-2	Reach 1A	208.3	14W-16	153.57
River-2	Reach 1A	208.2	14W-16	153.2
River-2	Reach 1A	208.1	14W-16	153.09
River-2	Reach 1A	208	14W-16	152.5
River-2	Reach 1A	207	14W-16	151.13
River-2	Reach 1A	206.3	14W-16	150.59
River-2	Reach 1A	206.2	14W-16	150.48
River-2	Reach 1A	206.1	14W-16	149.97
River-2	Reach 1	205.1	14W-12	149.36
River-2	Reach 1	205	14W-12	148.85
River-2	Reach 1	204.75	14W-12	148.38
River-2	Reach 1	204.7	14W-12	148.33
River-2	Reach 1	204.55	14W-12	146.96
River-2	Reach 1	204.5	14W-12	146.81
River-2	Reach 1	204.25	14W-12	146.44
River-2	Reach 1	204	14W-12	145.14
River-2	Reach 1	203	14W-12	145.05
River-2	Reach 1	202.75	14W-12	144.67
River-2	Reach 1	202.25	14W-12	143.69
River-2	Reach 1	202	14W-12	143.33
River-2	Reach 1	201	14W-12	143.27
River-2	Reach 1	171	14W-12	142.97
River-2	Reach 1	169	14W-12	142.7
River-2	Reach 1	164	14W-12	139.25
River-2	Reach 1	163	14W-12	138.47
River-2	Reach 1	162	14W-12	136.76
River-2	Reach 1	161	14W-12	135.3

River	Reach	Cross Section ID	EIS/FSSR Identifications	Existing Regional Water Surface Elevation (m)
River-2	Reach 1	160	14W-12	134.02
River-1	Reach 1B	14	14W-11A	155.34
River-1	Reach 1B	13	14W-11A	155.27
River-1	Reach 1B	12.1	14W-11A	154.71
River-1	Reach 1B	12	14W-11A	154.25
River-1	Reach 1B	11.1	14W-11	153.1
River-1	Reach 1B	11	14W-11	152.76
River-1	Reach 1B	10	14W-11	152.76
River-1	Reach 1B	9	14W-11	152.74
River-1	Reach 1B	8	14W-11	150.51
River-1	Reach 1B	7	14W-11	147.97

6.5.6 Proposed Conditions

The floodplain limits under the post-development conditions are required to restrict development into the regulatory areas. Although the development plan will provide Regional Flood control (i.e. post-development flow will be less than the existing flow level), the uncontrolled regional flood flows were used to delineate floodplain mapping in accordance with the Ministry of Natural Resources and Forest guidelines. However, controlled flow rates were used for conveyance analysis. Therefore, tabulated results will provide summary for both uncontrolled and controlled flow scenarios to ensure that the proposed development will not result in additional impacts.

The site development was phased into Phase 1A, Phase 1B, Phase 2 and Ultimate Condition. Each development phase has different development components till the ultimate conditions. Hence, the existing conditions HEC-RAS models were revised accordingly to reflect the proposed development impacts. The scenarios of the HEC-RAS models representing proposed conditions included the individual development phase. Comparing to the model base (i.e. the existing condition), the revisions of HEC-RAS model in each scenario were tabulated in Table 6.9. The following alterations were incorporated in the model scenarios:

- Channel Realignment

It was proposed that the upstream section of low constraint creek 14W-13 will be realigned to join creek 14W-14 south of the site boundary; this new channel section was named as 14W-21. The alignment of the existing 14W-14 will be close to the west boundary of the site, therefore the realigned creek was identified as 14W-22. The proposed channel 14W-23 will replace creek 14W-11A to join 14W-11.

- New Crossings

The development plan proposes two new roads, Arterial One and Avenue Three from south to north, to overpass creeks 14W-16 and the new realigned creek 14W-22. Four crossings will be constructed. The preliminary size of the new crossings was proposed based on following factors:

- MTO hydraulic design criteria
- CH requirements: all new roads must be designed to provide full access and egress under Regional Storm conditions, and preferably flood free access. In addition, no backwater effects at the river sections; the span of a crossing to be at least 3 times of bankfull width were considered in the crossing sizing.

- Flow Rates

The stormwater management plan was developed to mitigate development impacts. The post-development flows will be restricted to the existing flow levels for 2-year up to a Regional Flood. As discussed previously, flow controls were not considered in the floodplain delineation. In other words, the uncontrolled Regional flood rates (i.e. without flow attenuations in SWM ponds) were used in the HEC-RAS models to obtain water levels for floodplain mapping.

- Geometric Data and Parameters

New cross sections to represent the new aligned creeks were added in the model; the geometric data were obtained from the channel design and the existing topography or the proposed grading plan where applicable. A two tiers cross section was proposed. The expansion/contraction coefficients and Manning's n values are consistent with the HEC-RAS models of existing conditions.

Table 6.9 Model Scenarios of the HEC-RAS Model of Proposed Conditions

Scenario (Development Phase)	River	Reach	EIS/FSSR ID	Revisions in the Base Model				
				Flow Rates	Realignment	Geometric Data of Cross Section	Confluence Move	Crossing
1A	River-2	Reach 1A	14W-16			X		
	River -2	Reach 2A	14W-14					
	River -2	Reach 2B	14W-12A					
	River -2	Reach 1A	14W-12	X		X		Remove local roadway crossing
	River -1	Reach 1B	14W-11A					
1B	River-2	Reach 1A	14W-16	X		X		Add in Arterial One Crossing
	River -2	Reach 2A	14W-22, 14W-21	X	X	X		Add in Arterial One Crossing
	River -2	Reach 2B	14W-12A				X	
	River -2	Reach 1A	14W-12	X		X		
	River -1	Reach 1B	14W-11A					
2	River-2	Reach 1A	14W-16	X		X		Add in Avenue Three Crossing
	River -2	Reach 2A	14W-22, 14W-21	X	X	X		Add in Avenue Three Crossing
	River -2	Reach 2B	14W-12A				X	
	River -2	Reach 1A	14W-12	X		X		
	River -1	Reach 1B	14W-23	X	X	X		
Ultimate	River-2	Reach 1A	14W-16	X		X		All new crossings
	River -2	Reach 2A	14W-22, 14W-21	X	X	X		All new crossings
	River -2	Reach 2B	14W-12A				X	
	River -2	Reach 1A	14W-12	X		X		
	River -1	Reach 1B	14W-23	X	X	X		

Phase 1A

Based on the existing conditions, the following revisions were carried out to represent the grading plan of Phase 1A. The revisions include:

- Revision of the right bank of cross sections 204 to 205 of creek 14W-12; and cross-section 206.1 to 206.3 of creek 14W-16 base on the grading plan at this phase
- Removal of the existing Farm Access road crossing (Crossing 204.6 of HEC-RAS model)
- The flow rates were revised based on the hydrologic modelling results of this development phase

The comparison of flow rates between the existing and Phase 1A (uncontrolled & controlled) is shown in Table 6.10. The HEC-RAS model of creek 14W-11/11A remained unchanged; and flood elevations are consistent with the existing conditions.

Table 6.10 Flow Rates of Phase 1A

Creek ID in HEC-RAS	Creek ID in EIS/FSSR	Existing			Phase 1A			
		Flow Node	XS	Regional Flow Rate (m3/s)	Flow Node	XS	Regional Flow Rate (m3/s)	
							Uncontrolled Flow	Controlled Flow
River2, Reach2A	14W-14	2	3081	8.23	2	228	8.23	8.23
River2, Reach2B	14W-12A	2	240	8.23	2	231.1	8.23	8.23
River2, Reach2C	14W-12A	2	220.3	8.23	2	220.3	8.23	8.23
River2, Reach1A	14W-16	1B	210.5	8.22	1B	210.5	8.22	8.22
		1	206.3	10.29	1	206.3	10.21	10.21
River2, Reach 1	14W-12	3/3B	205.1	19.22	3B	205.1	18.7	18.7
					3	204	20.47	18.99
		4	203	20.34	4	203	20.61	19.14
			171	28.9		171	28.9	28.9
River1, Reach1	14W-11	9	14	3.06	9	14	3.06	3.06
		5	10	3.79	5	10	3.79	3.79

The modelling results in comparison to the existing conditions are included in Table 6.11. Floodplain limits are shown in Figures 6.6.2. This development phase will have negligible alterations of flood elevations.

Table 6.11 Phase 1A- Regional Flood Elevations of 14W-16, 14W21/22, 14W-12, and 14W-12A

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Phase 1A	difference	Phase 1A	difference
River-2	Reach 2A	3081	14W-14	154.76	154.76	0	154.76	0
River-2	Reach 2A	228	14W-14	154.32	154.32	0	154.32	0
River-2	Reach 2A	227	14W-14	153.42	153.42	0	153.42	0
River-2	Reach 2A	226	14W-14	152.87	152.87	0	152.87	0
River-2	Reach 2A	225	14W-14	152.32	152.32	0	152.32	0
River-2	Reach 2A	224	14W-14	151.8	151.8	0	151.8	0
River-2	Reach 2A	223	14W-14	150.96	150.96	0	150.96	0
River-2	Reach 2A	222	14W-14	150.43	150.43	0	150.43	0
River-2	Reach 2A	221	14W-14	149.72	149.72	0	149.72	0
River-2	Reach 2B	240	14W-12A	149.91				
River-2	Reach 2B	239	14W-12A	149.85				
River-2	Reach 2B	238	14W-12A	149.84				
River-2	Reach 2B	237	14W-12A	149.84				
River-2	Reach 2B	236	14W-12A	149.83				
River-2	Reach 2B	235	14W-12A	149.81				
River-2	Reach 2B	234	14W-12A	149.8				
River-2	Reach 2B	233	14W-12A	149.79				
River-2	Reach 2B	232	14W-12A	149.77				
River-2	Reach 2B	231.1	14W-12A		149.75		149.75	
River-2	Reach 2B	231	14W-12A	149.75	149.75	0	149.75	0
River-2	Reach 2C	220.3	14W-12A	149.75	149.75	0	149.75	0
River-2	Reach 2C	220.2	14W-12A	149.59	149.59	0	149.59	0
River-2	Reach 2C	220.1	14W-12A	149.47	149.46	-0.01	149.46	-0.01
River-2	Reach 2C	220	14W-12A	149.47	149.46	-0.01	149.46	-0.01
River-2	Reach 1A	210.5	14W-16	155.74	155.74	0	155.74	0
River-2	Reach 1A	210	14W-16	155.47	155.47	0	155.47	0
River-2	Reach 1A	209	14W-16	154.89	154.89	0	154.89	0
River-2	Reach 1A	208.3	14W-16	153.57	153.57	0	153.57	0
River-2	Reach 1A	208.2	14W-16	153.2	153.2	0	153.2	0
River-2	Reach 1A	208.1	14W-16	153.09	153.09	0	153.09	0
River-2	Reach 1A	208	14W-16	152.5	152.5	0	152.5	0
River-2	Reach 1A	207	14W-16	151.13	151.13	0	151.13	0
River-2	Reach 1A	206.3	14W-16	150.59	150.59	0	150.59	0

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Phase 1A	difference	Phase 1A	difference
River-2	Reach 1A	206.2	14W-16	150.48	150.48	0	150.48	0
River-2	Reach 1A	206.1	14W-16	149.97	149.96	-0.01	149.96	-0.01
River-2	Reach 1	205.1	14W-12	149.36	149.34	-0.02	149.34	-0.02
River-2	Reach 1	205	14W-12	148.85	148.81	-0.04	148.81	-0.04
River-2	Reach 1	204.75	14W-12	148.38	147.84	-0.54	147.84	-0.54
River-2	Reach 1	204.7	14W-12	148.33	147	-1.33	147	-1.33
River-2	Reach 1	204.55	14W-12	146.96	146.94	-0.02	146.94	-0.02
River-2	Reach 1	204.5	14W-12	146.81	146.8	-0.01	146.8	-0.01
River-2	Reach 1	204.25	14W-12	146.44	146.43	-0.01	146.43	-0.01
River-2	Reach 1	204	14W-12	145.14	145.16	0.02	145.05	-0.09
River-2	Reach 1	203	14W-12	145.05	145.07	0.02	144.95	-0.1
River-2	Reach 1	202.75	14W-12	144.67	144.69	0.02	144.58	-0.09
River-2	Reach 1	202.25	14W-12	143.69	143.71	0.02	143.64	-0.05
River-2	Reach 1	202	14W-12	143.33	143.33	0	143.32	-0.01
River-2	Reach 1	201	14W-12	143.27	143.27	0	143.27	0
River-2	Reach 1	171	14W-12	142.97	142.97	0	142.97	0
River-2	Reach 1	169	14W-12	142.7	142.7	0	142.7	0
River-2	Reach 1	164	14W-12	139.25	139.25	0	139.25	0
River-2	Reach 1	163	14W-12	138.47	138.47	0	138.47	0
River-2	Reach 1	162	14W-12	136.76	136.76	0	136.76	0
River-2	Reach 1	161	14W-12	135.3	135.3	0	135.3	0
River-2	Reach 1	160	14W-12	134.02	134.02	0	134.02	0

Phase 1B

Based on the model of Phase 1A, the following revisions were incorporated in the model to represent Phase 1B development:

- Additional cross sections to reflect channel realignments for creeks 14W-21 and 14W-22. The geometric data of these cross sections were obtained from the channel design and the existing topography or the proposed grading plan where applicable,
- A two-tier cross section with low flow channel of 1.5 m width and 0.3 m depth to maximize low flow conditions within channel,
- To meet sinuosity requirement of 1.2 for reach 14W-22, channel length increment from 770 m to 924 m (between XS 296 to XS 305) to sequence riffle/pool meandering sequence,
- Addition of new Arterial One Crossings (as proposed in Table 6.12) over 14W-22 and 14W-16

Table 6.12 New Arterial One Crossings

Crossing ID	River	Reach	EIS/FSSR	Location	Rise (m)	Span (m)	Bankfull Width (m)
XS 206.15	2	1A	14W-16	Arterial One Rd Extension	2.5	18	5.15
XS 296.5	2	2A	14W-22	Arterial One Rd Extension	2.5	12.25	1.5

Table 6.13 Flow Rates of Phase 1B

Creek ID in HEC-RAS	Existing				Phase 1B				
	Creek ID in EIS/FSSR	Flow Node	XS	Regional Flow Rate (m3/s)	Creek ID in EIS/FSSR	Flow Node	XS	Regional Flow Rate (m3/s)	
								Uncontrolled Flow	Controlled Flow
River2, Reach2A	14W-14	2	3081	8.23	14W-21/ 14W-22	2B	3081/ 309	6.68	6.68
River2, Reach2B	14W-12A	2	240	8.23	14W-12A	2	231.1	1.03	0.86
River2, Reach2C	14W-12A	2	220.3	8.23	14W-12A	2A	220.1	7.38	7.29
River2, Reach1A	14W-16	1B	210.5	8.22	14W-16	1B	210.5	8.11	8.11
		1	206.3	10.29		1	206.3	10.06	10.06
River2, Reach 1	14W-12	3/3B	205.1	19.22	14W-12	3B	205.1	18.51	18.06
						3	204	20.32	18.35
		4	203	20.34		4	203	20.46	18.50
			171	28.9			171	28.90	28.90
River1, Reach1	14W-11	9	14	3.06	14W-11	9	14	3.06	3.06
		5	10	3.79		5	10	3.79	3.79

The HEC-RAS model of creek 14W-11/11A remained unchanged; and flood elevations are consistent with the existing conditions.

The Regional Flood elevations of creeks 14W-21&22, 14W-16, 14W-12 obtained from the revised HEC-RAS model are included in Table 6.14. Floodplain limits are shown in Figure 6.6.3. Comparing to the existing conditions, the new Arterial One crossing proposed over creek 14W-16 did not cause any increase of water level at the upstream of the crossing under the controlled flow condition. The floodplain limits should be considered in the development limits. It was confirmed that the proposed new crossings can meet the design criteria. The roadway will not be overtopped during the Regional Flood.

Table 6.14 Phase 1B - Regional Flood Elevations of 14W-16, 14W21/22, 14W-12, and 14W-12A

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Phase 1B	difference	Phase 1B	difference
River-2	Reach 2A2	309	14W-21		154.73		154.73	
River-2	Reach 2A2	308	14W-21		154.47		154.47	
River-2	Reach 2A2	307	14W-21		153.91		153.91	
River-2	Reach 2A2	306	14W-21		153.38		153.38	
River-2	Reach 2A1	3081	14W-22		154.75		154.75	
River-2	Reach 2A1	3071	14W-22		154.32		154.32	
River-2	Reach 2A1	3061	14W-22		153.61		153.61	
River-2	Reach 2A	305	14W-22		152.84		152.84	
River-2	Reach 2A	304	14W-22		152.42		152.42	
River-2	Reach 2A	303	14W-22		152.25		152.25	
River-2	Reach 2A	302	14W-22		152.08		152.08	
River-2	Reach 2A	301	14W-22		151.58		151.58	
River-2	Reach 2A	300	14W-22		151.17		151.17	
River-2	Reach 2A	299	14W-22		150.87		150.87	
River-2	Reach 2A	298	14W-22		150.64		150.64	
River-2	Reach 2A	297	14W-22		150.35		150.35	
New Arterial One Crossing								
River-2	Reach 2A	296	14W-22		150.15		150.15	
River-2	Reach2A	3081	14W-14	154.76				
River-2	Reach 2A	228	14W-14	154.32				
River-2	Reach 2A	227	14W-14	153.42				
River-2	Reach 2A	226	14W-14	152.87				
River-2	Reach 2A	225	14W-14	152.32				
River-2	Reach 2A	224	14W-14	151.8				
River-2	Reach 2A	223	14W-14	150.96				
River-2	Reach 2A	222	14W-14	150.43				
River-2	Reach 2A	221	14W-14	149.72				
River-2	Reach 2B	240	14W-12A	149.91				

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Phase 1B	difference	Phase 1B	difference
River-2	Reach 2B	239	14W-12A	149.85				
River-2	Reach 2B	238	14W-12A	149.84				
River-2	Reach 2B	237	14W-12A	149.84				
River-2	Reach 2B	236	14W-12A	149.83				
River-2	Reach 2B	235	14W-12A	149.81				
River-2	Reach 2B	234	14W-12A	149.8				
River-2	Reach 2B	233	14W-12A	149.79				
River-2	Reach 2B	232	14W-12A	149.77				
River-2	Reach 2B	231.1	14W-12A		149.48		149.47	
River-2	Reach 2B	231	14W-12A	149.75	149.48	-0.27	149.47	-0.28
River-2	Reach 2B	220.3	14W-12A	149.75	149.48	-0.27	149.47	-0.28
River-2	Reach 2B	220.2	14W-12A	149.59	149.48	-0.11	149.47	-0.12
River-2	Reach 2C	220.15	14W-12A		149.47		149.46	
River-2	Reach 2C	220.1	14W-12A	149.47	149.46	-0.01	149.45	-0.02
River-2	Reach 2C	220	14W-12A	149.47	149.46	-0.01	149.45	-0.02
River-2	Reach 1A	210.5	14W-16	155.74	155.74	0	155.74	0
River-2	Reach 1A	210	14W-16	155.47	155.46	-0.01	155.46	-0.01
River-2	Reach 1A	209	14W-16	154.89	154.88	-0.01	154.88	-0.01
River-2	Reach 1A	208.3	14W-16	153.57	153.57	0	153.57	0
River-2	Reach 1A	208.2	14W-16	153.2	153.2	0	153.2	0
River-2	Reach 1A	208.1	14W-16	153.09	153.09	0	153.09	0
River-2	Reach 1A	208	14W-16	152.5	152.49	-0.01	152.49	-0.01
River-2	Reach 1A	207	14W-16	151.13	151.12	-0.01	151.12	-0.01
River-2	Reach 1A	206.3	14W-16	150.59	150.59	0	150.59	0
River-2	Reach 1A	206.2	14W-16	150.48	150.19	-0.29	150.19	-0.29
New Arterial One Crossing								
River-2	Reach 1A	206.1	14W-16	149.97	149.96	-0.01	149.96	-0.01
River-2	Reach 1	205.1	14W-12	149.36	149.34	-0.02	149.33	-0.03
River-2	Reach 1	205	14W-12	148.85	148.8	-0.05	148.78	-0.07
River-2	Reach 1	204.75	14W-12	148.38	147.83	-0.55	147.82	-0.56
River-2	Reach 1	204.7	14W-12	148.33	147	-1.33	146.99	-1.34
River-2	Reach 1	204.55	14W-12	146.96	146.93	-0.03	146.92	-0.04
River-2	Reach 1	204.5	14W-12	146.81	146.8	-0.01	146.78	-0.03
River-2	Reach 1	204.25	14W-12	146.44	146.43	-0.01	146.42	-0.02
River-2	Reach 1	204	14W-12	145.14	145.15	0.01	145	-0.14

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Phase 1B	difference	Phase 1B	difference
River-2	Reach 1	203	14W-12	145.05	145.06	0.01	144.89	-0.16
River-2	Reach 1	202.75	14W-12	144.67	144.68	0.01	144.53	-0.14
River-2	Reach 1	202.25	14W-12	143.69	143.7	0.01	143.61	-0.08
River-2	Reach 1	202	14W-12	143.33	143.33	0	143.32	-0.01
River-2	Reach 1	201	14W-12	143.27	143.27	0	143.27	0
River-2	Reach 1	171	14W-12	142.97	142.97	0	142.97	0
River-2	Reach 1	169	14W-12	142.7	142.7	0	142.7	0
River-2	Reach 1	164	14W-12	139.25	139.25	0	139.25	0
River-2	Reach 1	163	14W-12	138.47	138.47	0	138.47	0
River-2	Reach 1	162	14W-12	136.76	136.76	0	136.76	0
River-2	Reach 1	161	14W-12	135.3	135.3	0	135.3	0
River-2	Reach 1	160	14W-12	134.02	134.02	0	134.02	0

Phase 2

Based on the model of Phase 1B, the following revisions were incorporated in the model to represent Phase 2 development:

- Add two more new Avenue Three Crossings (as proposed in Table 6.15) over 14W-22 and 14W-16
- A two-tier cross section with low flow channel of 0.50 m width and 0.22 m depth to maximize low flow conditions within channel for reach 14W-23.
- To meet sinuosity requirement for reach 14W-23, channel length increment from 323 m to 355 m (between XS 11.1 to XS 12.9) to sequence riffle/pool meandering sequence.
- Revision to channel slope for tie in to the existing ground elevation at cross-section 12.9.
- Update flow rates (as shown in Table 6.16) in the model

Table 6.15 New Avenue Three Crossings

Crossing ID	River	Reach	EIS/FSSR	Location	Rise (m)	Span (m)	Bankfull Width (m)
XS 208.15	2	1A	14W-16	Avenue Three	2.5	18	5.15
XS 302.5	2	2A	14W-22	Avenue Three	2.5	12.25	1.5

Table 6.16 Flow Rates of Phase 2

Creek ID in HEC-RAS	Existing				Phase 2				
	Creek ID in EIS/FSSR	Flow Node	XS	Regional Flow Rate (m3/s)	Creek ID in EIS/FSSR	Flow Node	XS	Regional Flow Rate (m3/s)	
								Uncontrolled Flow	Controlled Flow
River2, Reach2A	14W-14	2	3081	8.23	14W-21/ 14W-22	8	309	0.52	0.52
						6	3081	6.52	6.52
						2B	303	6.67	6.67
River2, Reach2B	14W-12A	2	240	8.23	14W-12A	2	231.1	0.52	0.22
River2, Reach2C	14W-12A	2	220.3	8.23	14W-12A	2A	220.1	7.03	6.89
River2, Reach1A	14W-16	1B	210.5	8.22	14W-16	7	210.5	8.1	7.95
						1B	208.2	8.1	8.1
		1	206.3	10.29		1	206.3	10.04	10.04
River2, Reach 1	14W-12	3/3B	205.1	19.22	14W-12	3B	205.1	20.11	17.72
						3	204	22	18.01
		4	203	20.34		4	203	22.15	18.16
			171	28.9			171	28.9	28.9
River1, Reach1	14W-11	9	14	3.06	14W-11	9	14	2.69	2.69
		5	10	3.79		5	10	3.38	3.38

The HEC-RAS model of creek 14W-11and 11A was revised. The proposed channel 14W-23 replace 14W-11A to join 14W-11. The Regional flood elevations are shown in Table 6.17. Floodplain limits are shown in Figure 6.6.4. Comparing to the existing conditions, the Regional Flow will be slightly decreased. The proposed realignment of the channel will not cause adverse flood impacts to the downstream reach.

Table 6.17 Phase 2- Regional Flood Elevation of Creek 14W-23/14W-11A

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)		
				Existing/1A/1B	Phase 2/ Ultimate	difference
River-1	Reach 1B	14	14W-11A\23	155.34	155.32	-0.03
River-1	Reach 1B	13	14W-11A\23	155.27	155.06	-0.19
River-1	Reach 1B	12.9	14W-23		154.84	
River-1	Reach 1B	12.8	14W-23		154.62	
River-1	Reach 1B	12.7	14W-23		154.46	
River-1	Reach 1B	12.6	14W-23		154.24	
River-1	Reach 1B	12.5	14W-11A\23		154.02	
River-1	Reach 1B	12.4	14W-23		153.78	
River-1	Reach 1B	12.1	14W-11	154.71		
River-1	Reach 1B	12	14W-11	154.25		

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)		
				Existing/1A/1B	Phase 2/ Ultimate	difference
River-1	Reach 1B	11.1	14W-11	153.1	153.09	-0.01
River-1	Reach 1B	11	14W-11	152.76	152.73	-0.03
River-1	Reach 1B	10	14W-11	152.76	152.73	-0.03
River-1	Reach 1B	9	14W-11	152.74	152.71	-0.03
River-1	Reach 1B	8	14W-11	150.51	150.42	-0.09
River-1	Reach 1B	7	14W-11	147.97	147.95	-0.02

The Regional Flood elevations of creeks 14W-21&22, 14W-16, 14W-12 obtained from the revised HEC-RAS model are included in Table 6.18. Floodplain limits are shown in Figure 6.6.4. Comparing to the existing conditions, the new Avenue Three Crossing over creek 14W-16 did not caused any increase of water level at the upstream of the crossing under controlled flow condition. It was confirmed that the proposed new crossings can meet the design criteria.

Table 6.18 Phase 2- Regional Flood Elevation of Creek 14W-16, 14W21/22, 14W-12, and 14W-12A

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Phase 2	difference	Phase 2	difference
River-2	Reach 2A2	309	14W-21		154.35		154.35	
River-2	Reach 2A2	308	14W-21		153.98		153.98	
River-2	Reach 2A2	307	14W-21		153.41		153.41	
River-2	Reach 2A2	306	14W-21		153.13		153.13	
River-2	Reach 2A1	3081	14W-22		154.75		154.75	
River-2	Reach 2A1	3071	14W-22		154.32		154.32	
River-2	Reach 2A1	3061	14W-22		153.60		153.60	
River-2	Reach 2A	305	14W-22		152.81		152.81	
River-2	Reach 2A	304	14W-22		152.55		152.55	
River-2	Reach 2A	303	14W-22		152.25		152.25	
New Avenue Three Extension Crossing								
River-2	Reach 2A	302	14W-22		152.29		152.29	
River-2	Reach 2A	301	14W-22		151.58		151.58	
River-2	Reach 2A	300	14W-22		151.17		151.17	
River-2	Reach 2A	299	14W-22		150.87		150.87	
River-2	Reach 2A	298	14W-22		150.64		150.64	
River-2	Reach 2A	297	14W-22		150.35		150.35	
New Arterial One Crossing								
River-2	Reach 2A	296	14W-22		150.15		150.15	

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Phase 2	difference	Phase 2	difference
River-2	Reach 2A	3081	14W-14	154.76				
River-2	Reach 2A	228	14W-14	154.32				
River-2	Reach 2A	227	14W-14	153.42				
River-2	Reach 2A	226	14W-14	152.87				
River-2	Reach 2A	225	14W-14	152.32				
River-2	Reach 2A	224	14W-14	151.8				
River-2	Reach 2A	223	14W-14	150.96				
River-2	Reach 2A	222	14W-14	150.43				
River-2	Reach 2A	221	14W-14	149.72				
River-2	Reach 2B	240	14W-12A	149.91				
River-2	Reach 2B	239	14W-12A	149.85				
River-2	Reach 2B	238	14W-12A	149.84				
River-2	Reach 2B	237	14W-12A	149.84				
River-2	Reach 2B	236	14W-12A	149.83				
River-2	Reach 2B	235	14W-12A	149.81				
River-2	Reach 2B	234	14W-12A	149.8				
River-2	Reach 2B	233	14W-12A	149.79				
River-2	Reach 2B	232	14W-12A	149.77				
River-2	Reach 2B	231.1	14W-12A		149.51		149.46	
River-2	Reach 2B	231	14W-12A	149.75	149.51	-0.24	149.46	-0.29
River-2	Reach 2B	220.3	14W-12A	149.75	149.51	-0.24	149.46	-0.29
River-2	Reach 2B	220.2	14W-12A	149.59	149.51	-0.08	149.46	-0.13
River-2	Reach 2C	220.15	14W-12A		149.5		149.45	
River-2	Reach 2C	220.1	14W-12A	149.47	149.49	0.02	149.44	-0.03
River-2	Reach 2C	220	14W-12A	149.47	149.49	0.02	149.44	-0.03
River-2	Reach 1A	210.5	14W-16	155.74	155.74	0	155.73	0
River-2	Reach 1A	210	14W-16	155.47	155.47	0	155.46	0
River-2	Reach 1A	209	14W-16	154.89	154.88	-0.01	154.88	-0.01
River-2	Reach 1A	208.3	14W-16	153.57	153.58	0.01	153.57	0
River-2	Reach 1A	208.2	14W-16	153.2	153.14	-0.06	153.14	-0.06
New Avenue Three Extension Crossing								
River-2	Reach 1A	208.1	14W-16	153.09	153.09	0	153.09	0
River-2	Reach 1A	208	14W-16	152.5	152.49	-0.01	152.49	-0.01
River-2	Reach 1A	207	14W-16	151.13	151.12	-0.01	151.12	-0.01
River-2	Reach 1A	206.3	14W-16	150.59	150.59	0	150.59	0
River-2	Reach 1A	206.2	14W-16	150.48	150.19	-0.29	150.19	-0.29

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Phase 2	difference	Phase 2	difference
New Arterial One Crossing								
River-2	Reach 1A	206.1	14W-16	149.97	149.96	-0.01	149.96	-0.01
River-2	Reach 1	205.1	14W-12	149.36	149.39	0.03	149.32	-0.04
River-2	Reach 1	205	14W-12	148.85	148.86	0.01	148.77	-0.08
River-2	Reach 1	204.75	14W-12	148.38	147.89	-0.49	147.8	-0.58
River-2	Reach 1	204.7	14W-12	148.33	147.03	-1.3	146.98	-1.35
River-2	Reach 1	204.55	14W-12	146.96	146.97	0.01	146.91	-0.05
River-2	Reach 1	204.5	14W-12	146.81	146.84	0.03	146.77	-0.04
River-2	Reach 1	204.25	14W-12	146.44	146.46	0.02	146.41	-0.03
River-2	Reach 1	204	14W-12	145.14	145.27	0.13	144.98	-0.16
River-2	Reach 1	203	14W-12	145.05	145.2	0.15	144.86	-0.19
River-2	Reach 1	202.75	14W-12	144.67	144.8	0.13	144.51	-0.16
River-2	Reach 1	202.25	14W-12	143.69	143.78	0.09	143.59	-0.1
River-2	Reach 1	202	14W-12	143.33	143.35	0.02	143.31	-0.02
River-2	Reach 1	201	14W-12	143.27	143.28	0.01	143.26	-0.01
River-2	Reach 1	171	14W-12	142.97	142.97	0	142.97	0
River-2	Reach 1	169	14W-12	142.7	142.7	0	142.7	0
River-2	Reach 1	164	14W-12	139.25	139.25	0	139.25	0
River-2	Reach 1	163	14W-12	138.47	138.47	0	138.47	0
River-2	Reach 1	162	14W-12	136.76	136.76	0	136.76	0
River-2	Reach 1	161	14W-12	135.3	135.3	0	135.3	0
River-2	Reach 1	160	14W-12	134.02	134.02	0	134.02	0

Ultimate Conditions

The preliminary grading plan and development plan for the development land west of the subject site were developed. Correspondingly, the HEC-RAS models for the Ultimate Conditions were revised to incorporate the following changes:

- Geometric data of cross sections 207 to 210.5 were revised to reflect the proposed grading plan at the right bank for this creek section.
- Flow rates (as shown in Table 6.19) were revised.

Table 6.19 Flow Rates of Ultimate Conditions

Creek ID in HEC-RAS	Existing				Ultimate				
	Creek ID in EIS/FSSR	Flow Node	XS	Regional Flow Rate (m3/s)	Creek ID in EIS/FSSR	Flow Node	XS	Regional Flow Rate (m3/s)	
								Uncontrolled Flow	Controlled Flow
River2, Reach2A	14W-14	2	3081	8.23	14W-21/ 14W-22	8	309	0.52	0.52
						6	3081	6.35	6.35
						2B	303	6.5	6.5
River2, Reach2B	14W-12A	2	240	8.23	14W-12A	2	231.1	0.52	0.22
River2, Reach2C	14W-12A	2	220.3	8.23	14W-12A	2A	220.1	6.86	6.72
River2, Reach1A	14W-16	1B	210.5	8.22	14W-16	7	210.5	8.02	7.87
						1B	208.2		8.02
		1	206.3	10.29		1	206.3	11.06	9.44
River2, Reach 1	14W-12	3/3B	205.1	19.22	14W-12	3B	205.1	21.19	16.97
						3	204	23.03	17.26
		4	203	20.34		4	203	23.2	17.41
			171	28.9			171	28.9	28.9
River1, Reach1	14W-11	9	14	3.06	14W-11	9	14	2.69	2.69
		5	10	3.79		5	10	3.38	3.38

In the ultimate conditions, development will not impact the creek 14W-21/14W-11A. The modelling results and floodplain delineation of Phase 2 remain unchanged.

The Regional Flood elevations of creeks 14W-21&22, 14W-16, 14W-12 obtained from the revised HEC-RAS model are included in Table 6.20. Floodplain limits are shown in Figure 6.6.5. Comparing to the existing conditions, there are no increase in water level under controlled flow condition.

Table 6.20 Ultimate Conditions - Regional Flood Elevation of Creek 14W-16, 14W21/22, 14W-12, and 14W-12A

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Ultimate	difference	Ultimate	difference
River-2	Reach 2A2	309	14W-21		154.35		154.35	
River-2	Reach 2A2	308	14W-21		153.98		153.98	
River-2	Reach 2A2	307	14W-21		153.41		153.41	
River-2	Reach 2A2	306	14W-21		153.12		153.12	

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Ultimate	difference	Ultimate	difference
River-2	Reach 2A1	3081	14W-22		154.74		154.74	
River-2	Reach 2A1	3071	14W-22		154.24		154.24	
River-2	Reach 2A1	3061	14W-22		153.59		153.59	
River-2	Reach 2A	305	14W-22		152.80		152.80	
River-2	Reach 2A	304	14W-22		152.54		152.54	
River-2	Reach 2A	303	14W-22		152.24		152.24	
New Avenue Three Extension Crossing								
River-2	Reach 2A	302	14W-22		152.28		152.28	
River-2	Reach 2A	301	14W-22		151.58		151.58	
River-2	Reach 2A	300	14W-22		151.17		151.17	
River-2	Reach 2A	299	14W-22		150.87		150.87	
River-2	Reach 2A	298	14W-22		150.63		150.63	
River-2	Reach 2A	297	14W-22		150.34		150.34	
New Arterial One Crossing								
River-2	Reach 2A	296	14W-22		150.14		150.14	
River-2	Reach 2A	3081	14W-14	154.76				
River-2	Reach 2A	228	14W-14	154.32				
River-2	Reach 2A	227	14W-14	153.42				
River-2	Reach 2A	226	14W-14	152.87				
River-2	Reach 2A	225	14W-14	152.32				
River-2	Reach 2A	224	14W-14	151.8				
River-2	Reach 2A	223	14W-14	150.96				
River-2	Reach 2A	222	14W-14	150.43				
River-2	Reach 2A	221	14W-14	149.72				
River-2	Reach 2B	240	14W-12A	149.91				
River-2	Reach 2B	239	14W-12A	149.85				
River-2	Reach 2B	238	14W-12A	149.84				
River-2	Reach 2B	237	14W-12A	149.84				
River-2	Reach 2B	236	14W-12A	149.83				
River-2	Reach 2B	235	14W-12A	149.81				
River-2	Reach 2B	234	14W-12A	149.8				
River-2	Reach 2B	233	14W-12A	149.79				
River-2	Reach 2B	232	14W-12A	149.77				
River-2	Reach 2B	231.1	14W-12A		149.53		149.45	
River-2	Reach 2B	231	14W-12A	149.75	149.53	-0.22	149.45	-0.3

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Ultimate	difference	Ultimate	difference
River-2	Reach 2B	220.3	14W-12A	149.75	149.53	-0.22	149.45	-0.3
River-2	Reach 2B	220.2	14W-12A	149.59	149.53	-0.06	149.45	-0.14
River-2	Reach 2C	220.15	14W-12A		149.52		149.44	
River-2	Reach 2C	220.1	14W-12A	149.47	149.51	0.04	149.42	-0.05
River-2	Reach 2C	220	14W-12A	149.47	149.51	0.04	149.42	-0.05
River-2	Reach 1A	210.5	14W-16	155.74	155.74	0	155.73	-0.01
River-2	Reach 1A	210	14W-16	155.47	155.47	0	155.46	-0.01
River-2	Reach 1A	209	14W-16	154.89	154.88	-0.01	154.87	-0.02
River-2	Reach 1A	208.3	14W-16	153.57	153.58	0.01	153.57	0
River-2	Reach 1A	208.2	14W-16	153.2	153.15	-0.05	153.15	-0.05
New Avenue Three Extension Crossing								
River-2	Reach 1A	208.1	14W-16	153.09	153.09	0	153.09	0
River-2	Reach 1A	208	14W-16	152.5	152.49	-0.01	152.49	-0.01
River-2	Reach 1A	207	14W-16	151.13	151.15	0.02	151.11	-0.02
River-2	Reach 1A	206.3	14W-16	150.59	150.63	0.04	150.57	-0.02
River-2	Reach 1A	206.2	14W-16	150.48	150.22	-0.26	150.17	-0.31
New Arterial One Crossing								
River-2	Reach 1A	206.1	14W-16	149.97	149.98	0.01	149.94	-0.03
River-2	Reach 1	205.1	14W-12	149.36	149.41	0.05	149.3	-0.06
River-2	Reach 1	205	14W-12	148.85	148.89	0.04	148.75	-0.1
River-2	Reach 1	204.75	14W-12	148.38	147.92	-0.46	147.78	-0.6
River-2	Reach 1	204.7	14W-12	148.33	147.05	-1.28	146.96	-1.37
River-2	Reach 1	204.55	14W-12	146.96	147	0.04	146.89	-0.07
River-2	Reach 1	204.5	14W-12	146.81	146.86	0.05	146.75	-0.06
River-2	Reach 1	204.25	14W-12	146.44	146.48	0.04	146.39	-0.05
River-2	Reach 1	204	14W-12	145.14	145.35	0.21	144.96	-0.18
River-2	Reach 1	203	14W-12	145.05	145.28	0.23	144.8	-0.25
River-2	Reach 1	202.75	14W-12	144.67	144.88	0.21	144.45	-0.22
River-2	Reach 1	202.25	14W-12	143.69	143.83	0.14	143.56	-0.13
River-2	Reach 1	202	14W-12	143.33	143.36	0.03	143.31	-0.02
River-2	Reach 1	201	14W-12	143.27	143.28	0.01	143.26	-0.01
River-2	Reach 1	171	14W-12	142.97	142.97	0	142.97	0
River-2	Reach 1	169	14W-12	142.7	142.7	0	142.7	0
River-2	Reach 1	164	14W-12	139.25	139.25	0	139.25	0
River-2	Reach 1	163	14W-12	138.47	138.47	0	138.47	0

River	Reach	XS	EIS/FSSR Identifications	Regional Water Surface Elevation (m)				
				Existing	Uncontrolled Flow		Controlled Flow	
					Ultimate	difference	Ultimate	difference
River-2	Reach 1	162	14W-12	136.76	136.76	0	136.76	0
River-2	Reach 1	161	14W-12	135.3	135.3	0	135.3	0
River-2	Reach 1	160	14W-12	134.02	134.02	0	134.02	0

In summary, adding new crossings or the revisions of geometric data will have impacts on the creek sections at the upstream of the alternation rather than the downstream, as the flow regime of the creeks is subcritical. Additionally, the development will have Regional Flood control, the full range of floods will be less or equal to the current flow levels. Therefore, the proposed developments in the site will not impact the flood elevations in the Fourteen Miles Creek downstream of the site.

6.5.7 Riparian Storage Assessment

The NOCSS and its related Addendum outline requirements to be addressed when proposing to relocate a medium constraint stream. One such requirement includes maintenance of riparian storage for regulatory floodplains. In particular, any modifications to a stream or floodplain should address the maintenance of riparian 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 realignment was designed appropriately, a riparian storage analysis of each creek reach was undertaken with the HEC-RAS model. The design events flow rates of the subject site under the existing and ultimate controlled flow rates were used in HEC-RAS models to obtain the cumulative riparian storages. In addition, the road crossings were removed from both existing and ultimate condition HEC-RAS models.

Reach 14W-16 and 14W-12

For creeks 14W-16 and 14W-12, there are no channel modification under the proposed grading plan.

Table 6.21 shows the flow rates of the existing conditions and ultimate conditions. Since proposed stormwater management ponds will control the flow, flow rates in ultimate conditions will be less than existing conditions.

Table 6.21 Flow Rates for Reach 14W-16 and 14W-12

Reach	Phases	Design Flow (m^3/s)						
		Regional	100yr	50yr	25yr	10yr	5yr	2yr
14W-16	Existing flow	8.22	3.34	2.95	2.59	2.04	1.69	1.08
	Ultimate flow	7.87	3.19	2.83	2.48	1.96	1.62	1.03

	Difference	*-4%*	*-4%*	*-4%*	*-4%*	*-4%*	*-4%*	*-5%*
14W-12	Existing flow	8.23	3.2	2.83	2.48	1.94	1.59	1
	Ultimate flow	6.35	2.45	2.16	1.89	1.47	1.2	0.75
	Difference	*-23%*	*-23%*	*-24%*	*-24%*	*-24%*	*-25%*	*-25%*

The comparison of riparian storages between the existing and the ultimate development condition is tabulated in Table 6.22.

Table 6.22 Riparian Storage Analysis for Design Flow Rates

Reach	Phases	Riparian Storage Volume (m3)						
		Regional	100yr	50yr	25yr	10yr	5yr	2yr
14W-16	Existing	16610	7640	6910	6210	5090	4350	2910
	Ultimate	15950	7420	6730	6040	4960	4220	2820
	Difference	-4%	-3%	-3%	-3%	-3%	-3%	-3%
14W-12	Existing	10690	4210	3800	3420	2680	2270	1580
	Ultimate	9030	3790	3430	3040	2430	2040	1440
	Difference	-16%	-10%	-10%	-11%	-9%	-10%	-9%

To assist the assessment of the impact on the riparian storage, the standardized flow rates were also utilized in the analysis. A spectrum of standardized flow rates covering the full range design flows were used in HEC-RAS models for both existing and ultimate conditions to obtain the cumulative riparian storages.

For Reach 14W-16 and 14W-12, the design flows were range from 8.23 m^3/s to 0.75 m^3/s. Therefore, the standardized flow rates were set between 8.3 m^3/s to 0.5 m^3/s.

The comparison of riparian storages between the existing and the ultimate development conditions using Standardized flow is tabulated in Table 6.23. The table below concludes that the riparian storage for 14W-16 and 14W-12 will remain unchanged.

Table 6.23 Riparian Storage Analysis for Standardized Flow Rates

Reach	Phases	Riparian Storage Volume (m3)						
		8.3 m^3/s	8 m^3/s	6.5 m^3/s	5 m^3/s	2.5 m^3/s	1 m^3/s	0.5 m^3/s
14W-16	Existing	15030	14580	12250	9840	5660	2630	1550
	Ultimate	15220	14680	12330	9910	5700	2640	1560
	Difference	1.3%	0.7%	0.7%	0.7%	0.7%	0.4%	0.6%
14W-12	Existing	4510	4350	3660	2850	1590	770	440
	Ultimate	4580	4330	3650	2830	1590	770	440
	Difference	1.6%	-0.5%	-0.3%	-0.7%	0.0%	0.0%	0.0%

Reach 14W-11A / 14W-23

Under the proposed grading plan, the proposed channel 14W-23 will replace creek 14W-11A to join 14W-11. The Table 6.24 shows the flow rates of the existing conditions and ultimate conditions.

Table 6.24 Flow Rates for Reach 14W-11A and 14W-23

Reach	Phases	Design Flow (m^3/s)						
		Regional	100yr	50yr	25yr	10yr	5yr	2yr
14W-11A	Existing flow	3.06	1.53	1.35	1.17	0.91	0.73	0.42
14W-23	Ultimate flow	2.69	1.27	1.12	0.97	0.75	0.6	0.34
	Difference	*-12%*	*-17%*	*-17%*	*-17%*	*-18%*	*-18%*	*-19%*

The comparison of riparian storages between the existing and the ultimate development condition is tabulated in Table 6.25. The riparian storage of the new creek 14W-23 will be larger than the current 14W-11A.

Table 6.25 Riparian Storages base on Design Flow Rates

Reach	Phases	Riparian Storage Volume (m3)						
		Regional	100yr	50yr	25yr	10yr	5yr	2yr
14W-11A	Existing	4010	2540	1730	1570	1330	1150	810
14W-23	Ultimate	5940	2910	2650	2380	1980	1510	1070
	Different	48%	15%	53%	52%	49%	31%	32%

For Reach 14W-11A/14W-23, the design flows were range from 3.06 m^3/s to 0.34 m^3/s. Therefore, the standardized flow rates were set between 3.1 m^3/s to 0.2 m^3/s to cover the full range design flow.

The comparison of riparian storages between the existing and the ultimate development conditions using Standardized flow is tabulated in Table 6.26. The riparian storage of the new creek 14W-23 will be larger than the current 14W-11A.

Table 6.26 Riparian Storages base on Standardized Flows

Reach	Phases	Riparian Storage Volume (m3)						
		3.1 m^3/s	2.5 m^3/s	2 m^3/s	1.5 m^3/s	1 m^3/s	0.5 m^3/s	0.2 m^3/s
14W-11A	Existing	3850	3410	2620	1850	1420	910	500
14W-23	Ultimate	6280	5500	4410	3250	2440	1460	650
	Different	63%	61%	68%	76%	72%	60%	30%

Reach 14W-14 / 14W-22

Under existing condition, reach 14W-14 associated with the human-made pond (farm pond) that functions as an off-line storage area during periods of high flow. The high flow from reach 14W-14 will enters the pond and release these flow into the downstream reach 14W-12A.

Under the proposed grading plan, Reach 14W-14 will be replaced by a realigned channel, Reach 14W-22. The confluence of reach 14W-14 and reach 14W-12A will be relocated about 60m downstream. The human-made pond will be replaced by a proposed SWM Pond 3 and divert the flow away from reach 14W-12A.

The Table 6.27 shows the flow rates of the existing conditions and ultimate conditions. As a conservative approach, the flow rates from node 2 were applied to reach 14W-14 instead of using node 2c. Node 2 represent the total outflow from Reach 14W-12, including the flow from reach 14W-14 and the human-made pond. The Ultimate control flow was less than the existing condition flow rates.

Table 6.27 Flow Rates for Reach 14W-14, 14W-12A and 14W-22

Reach	Phases	Design Flow (m^3/s)						
		Regional	100yr	50yr	25yr	10yr	5yr	2yr
14W-14	Existing	8.23	3.2	2.83	2.48	1.94	1.59	1
14W-22	Ultimate	6.35	2.45	2.16	1.89	1.47	1.2	0.75
	Different	*-23%*	*-23%*	*-24%*	*-24%*	*-24%*	*-25%*	*-25%*
14W-12A	Existing	8.23	3.2	2.83	2.48	1.94	1.59	1
14W-12A (reach length that located downstream of new confluence)	Ultimate	6.72	2.59	2.29	2	1.56	1.28	0.8
	Different	*-18%*	*-19%*	*-19%*	*-19%*	*-20%*	*-19%*	*-20%*

The existing condition riparian storage include the following:

- Riparian storage for Reach 14W-14
- The flood storage above the permanent pool in the human-made pond
- Riparian storage for Reach 14W-12A

The cross sections in existing condition HEC-RAS model were revised. Reach 14W-12A and the flood storage about the permanent pool in the human-made pond were combined with Reach 14W-14, representing only single reach due to confluence located on the downstream side. Figure 6.7 shown the HEC-RAS model cross section locations for human-made pond and Reach 14W-12 that combined with Reach 14W-14. Cross section 220.7 to 220.4 were added in the model.

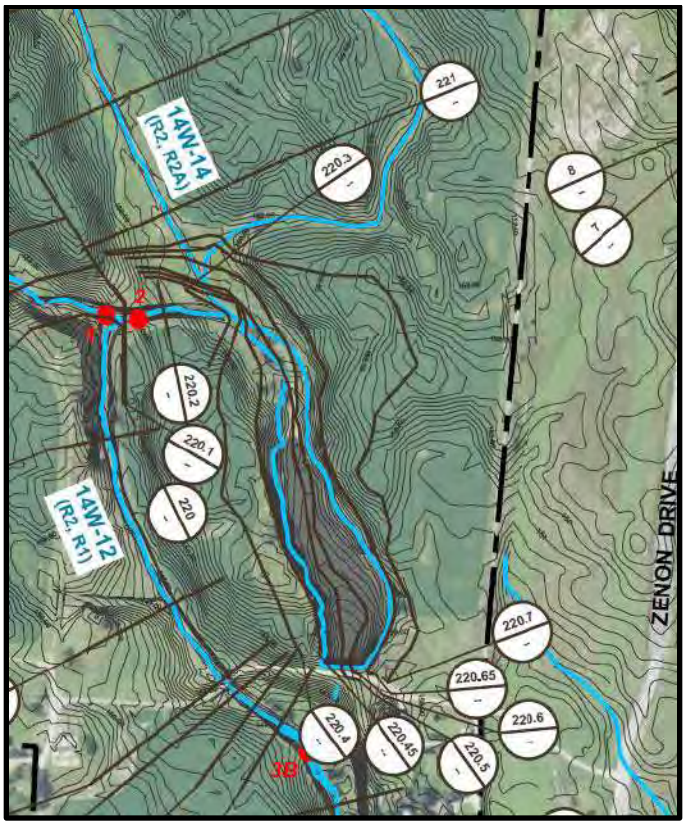


Figure 6.7 - Hec-RAS cross-section location for Riparian Storage existing condition model

The Ultimate development condition riparian storage include the following:

- Riparian storage for Reach 14W-22
- Riparian storage for reach length that cover the downstream of new confluence for Reach 14W-12A

Riparian storage for Proposed SWM Pond 3 did not included in the analysis because it is not part of the riparian system.

Riparian storage for reach length that cover the upstream of new confluence for Reach 14W-12A also not included in the analysis due to the minimal flow rate under Ultimate development condition.

The comparison of riparian storages between the existing and the ultimate development condition is tabulated in Table 6.28. Comparing to the riparian storage of the current creek 14W-14, the realigned creek 14W-22 will have increased riparian storages for all design flow, except for regional flow.

However, the flow reduction for regional flow is -23%, while the storage reduction is only -2.5%. Therefore, with reduce flow, more storage is provided.

Table 6.28 Riparian Storages base on Design Flow Rates

Reach	Phases	Riparian Storage Volume (m3)						
		Regional	100yr	50yr	25yr	10yr	5yr	2yr
14W-14 (including 14W-12A and human-made pond)	Existing	19540	8850	7870	6880	5410	4600	3220
14W-22	Ultimate	18300	9710	8850	8020	6640	5640	3700
14W-12A (reach length that located downstream of new confluence)		750	310	260	210	130	90	40
Total		19050	10020	9110	8230	6770	5730	3740
	Different	-2.5%	13%	16%	20%	25%	25%	19%

Using the standardized flow rate will eliminate the flow impact on water level elevation along creeks and compare the storage based on consistent basis.

For Reach 14W-14/14W-22, the design flows were range from 8.23 m^3/s to 0.8 m^3/s. Therefore, the standardized flow rates were set between 8.3 m^3/s to 0.5 m^3/s to cover the full range design flow.

The comparison of riparian storages between the existing and the ultimate development conditions using Standardized flow is tabulated in Table 6.29. The riparian storage of the new creek 14W-22 will be larger than the current reach 14W-14 (including reach 14W-12A and human-made pond).

Table 6.29 Riparian Storages base on Standardized Flows

Reach	Phases	Riparian Storage Volume (m3)						
		8.3 m^3/s	8 m^3/s	6.5 m^3/s	5 m^3/s	2.5 m^3/s	1 m^3/s	0.5 m^3/s
14W-14 (including 14W-12A and human-made pond)	Existing	19280	18720	15830	12630	6640	3200	1880
14W-22	Ultimate	20960	20500	17920	15150	9480	4740	2340
14W-12A (Downstream of new confluence)		440	440	330	250	120	40	20
Total		21400	20940	18250	15400	9600	4780	2360
	Different	11%	12%	15%	22%	45%	49%	26%

In summary, the riparian storage for Reach 14W-16, 14W-12 and 14W-11A/14W-23 were maintained under the ultimate condition.

For Reach 14W-14/14W-22, the decrease in riparian storage of 2.5% estimated under regional storm is reasonable, especially considering the 23% flow reduction. Moreover, the standardized flow storage estimates shown that the riparian storage for existing condition were maintained under ultimate condition.

6.6 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 channel Reaches 14W-21, 14W-22 and 14W-23. No alterations will be made to the existing Reaches 14W-16 and 14W-12 channels. The existing Reach 14W-16 channel is considered as Redside Dace occupied habitat; hence the channel reach is unaltered and a meander belt plus 30 m setback is applied. The realigned channel Reach 14W-22 is designated a contributing habitat. Based on direction from MNRF, an additional 30 m buffer is maintained between the existing Reach 14W-16 and the proposed realigned Reach 14W-22 channels. The existing Reach 14W-16 channel will continue to flow parallel to the proposed Reach 14W-22 channel to maintain Regional Drainage Densities and preserve the overall length of medium and high constraint watercourses according to NOCSS recommendations. The realigned Reach 14W-22 channel will confluence with Reach 14W-12A, immediately upstream of the confluence with 14W-12.

Table 6.30 shows the existing stream lengths and the proposed stream lengths for the high, medium and low constraint streams. The proposed realignment and rehabilitation of medium constraint streams have almost equal channel lengths as the existing conditions through realignment and meandering of these channels. The existing medium constraint stream length of 1830 m will be replaced with 1389 m length of more defined channel with increased habitat diversity (i.e. riffles, pools, etc.) improving the habitat, especially 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.

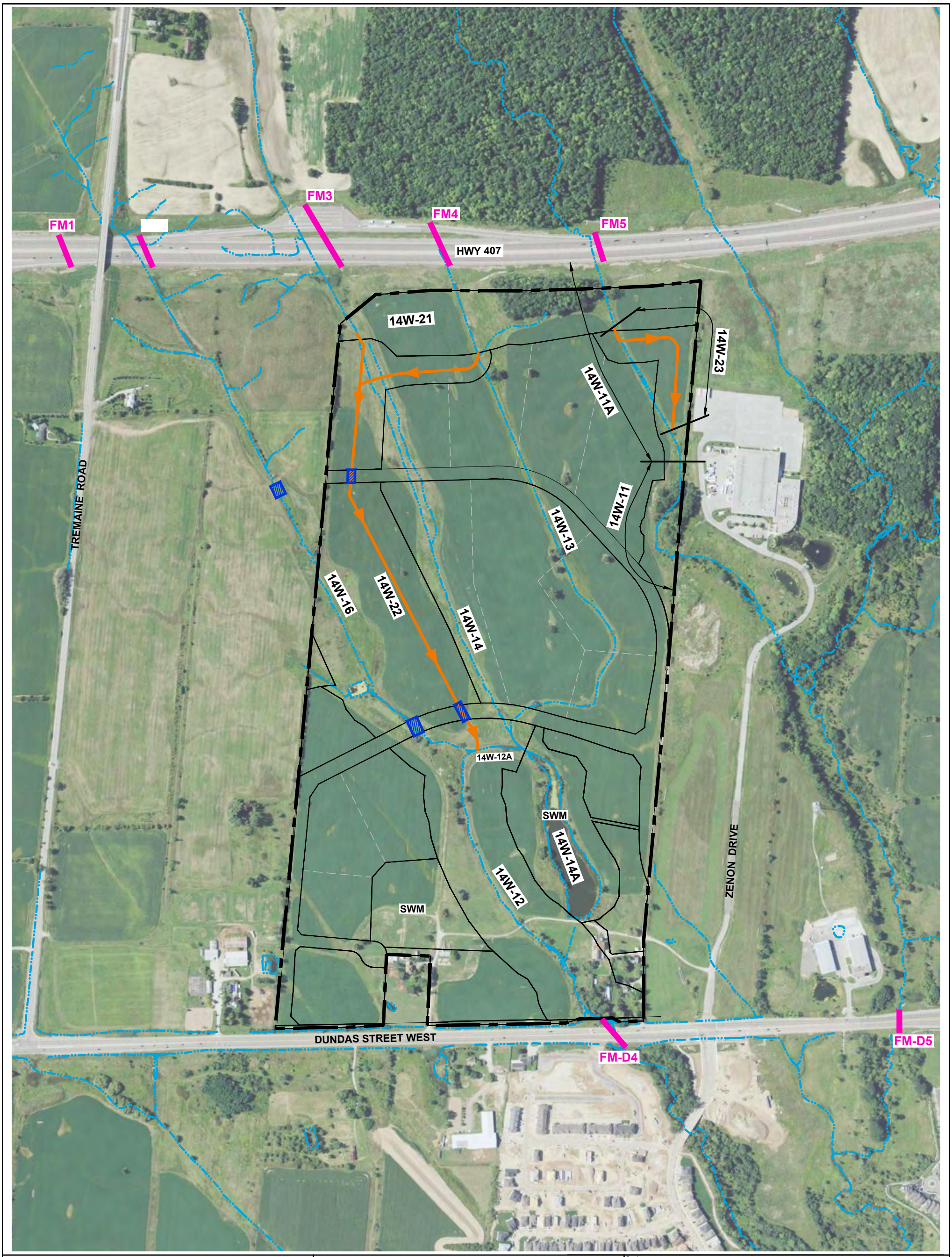
Table 6.30 Existing and Proposed Stream Lengths for High, Medium and Low Constraint Streams

Channel ID	Channel Length (m)						Reference
	Existing			Proposed			
	High	Medium	Low	High	Medium	Low	
14W-12	619			619			River 2, Reach 1, XS 205.1 To XS 202.25
14W-12A	85			17			River2, Reach 2C, XS 220.3 to XS 220
14W-11	157			157			River1, Reach 1B, XS 11.1 to XS 11
14W-11A		348					River1, Reach 1B, XS 14 to XS 11.1
14W-14		787					River2, Reach 2A, XS 3081 to XS 221
14W-14A		300					Human-made pond
14W-16		395		395			River2, Reach 1A, XS 208 to XS 206.1
14W-13			960			94	
14W-21						388	River2, Reach 2A2, XS 309 to XS 306
14W-22					957		River 2, Reach 2A1 & 2A, XS 3081 to XS 296
14W-23					416		River 1, Reach 1B, XS 14 to XS 11.1

Channel ID	Channel Length (m)						Reference
	Existing			Proposed			
	High	Medium	Low	High	Medium	Low	
Total	862	1830	960	1188	1373	482	
Total (High+Medium)	2692			2561			

6.7 Summary

Refinement of corridor width for high and medium constraint streams have been completed based on the guidance provided in the NOCSS. Under the proposed condition, the total channel length of the high and medium constraint streams is reduced by 131 m compared to the existing condition. However, it should be noted that under the existing condition, 300 m of Reach 14W-14A, which is an artificial pond has been incorporated in the drainage density assessment (Drainage density estimates can be found under Appendix 6.6). Furthermore, there is also additional opportunity to compensate for the reduction in length, by incorporating SWM Pond 3 in the drainage density assessment (as indicated by direction from John Parish at the November 13, 2013, Meeting at the Town of Oakville). As indicated in the November 13, 2013 meeting, in this scenario, there may be consideration to allow the SWM Pond 3 length to count as drainage density length from a hydraulic point of view, as the SWM facility is essentially replacing the existing pond in the same location. Conservatively, the proposed SWM Pond 3 length has not been incorporated in our assessment. Two medium constraint tributaries of West Branch of Fourteen Mile Creek in the Subject Property are realigned and a low constraint tributary is eliminated to accommodate the proposed development. At the Detailed Design stage, the principles of "Natural Channel Design" and NOCSS requirements will be pursued further.



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
- PROPOSED CHANNEL DIVERSION

Scale: 0 100 200 300m

Client: QuadReal

Prepared by: wsp

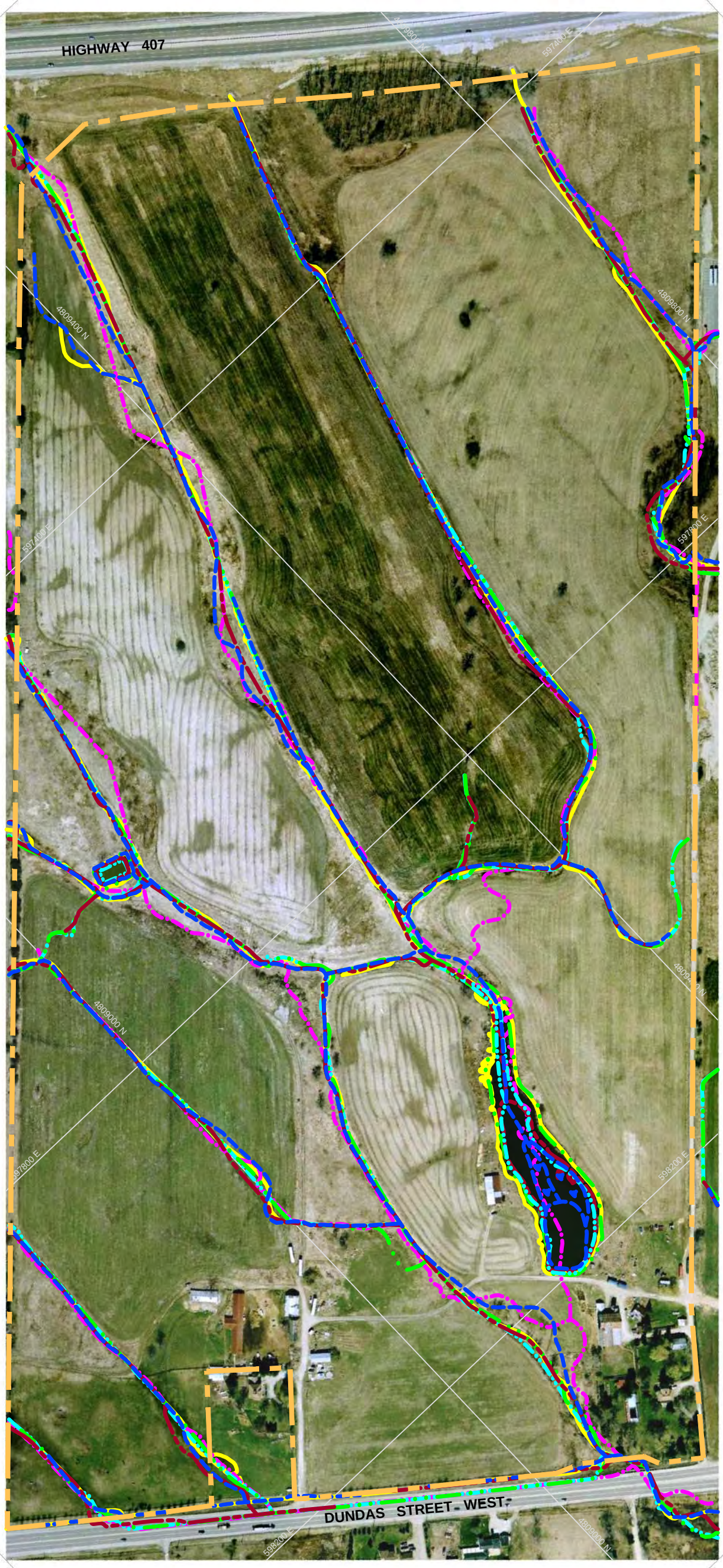
Date: May 2020

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.1

FIGURE 6.2.dwg - Historical Channel Planform T:\14-41\14\09222-001-WR1\REPORT 16 NOV 2019\FIGURES SERIES 6 - ADDITIONAL FIGURES\ Jan 24, 2020 - 2:20pm



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

Historical Channel Planform

LEGEND

- SUBJECT PROPERTY
- 1934 Channel Alignment
- 1960 Channel Alignment
- 1969 Channel Alignment
- 1979 Channel Alignment
- 1988 Channel Alignment
- 2009 Channel Alignment

Scale: 0 50 100 150 200m

Client: QuadReal

Prepared by: wsp

Date: January 2019

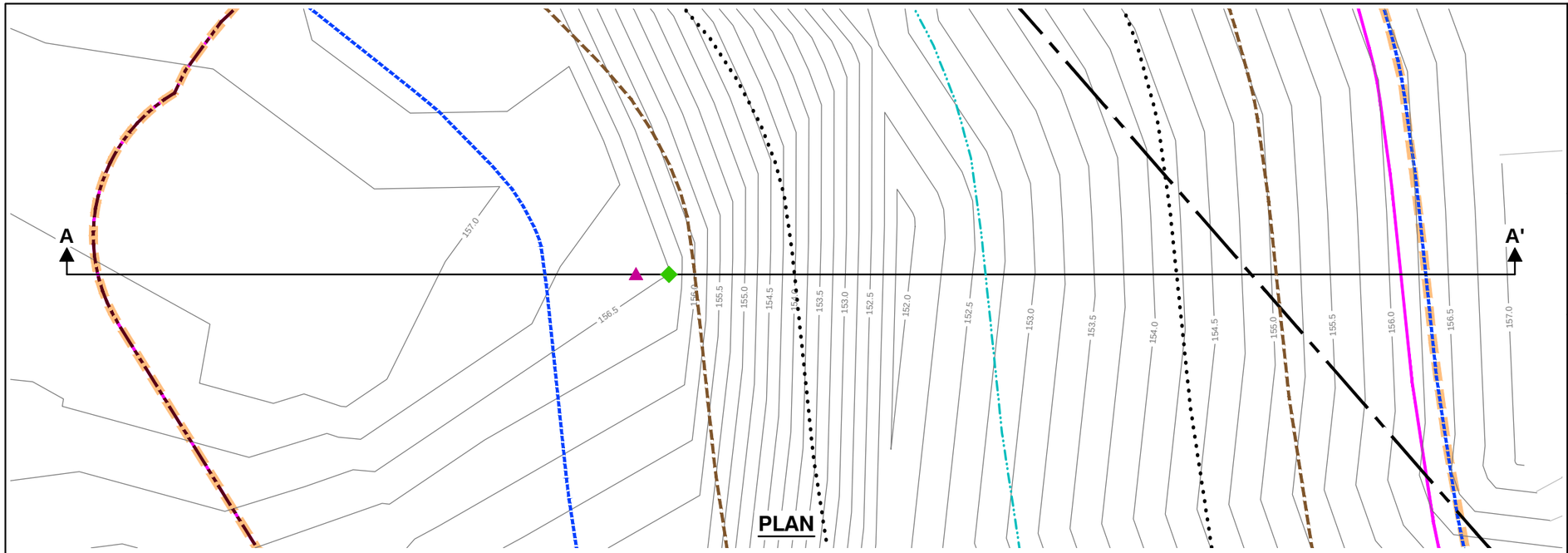
Project No.: 09M-00013-01-WR1

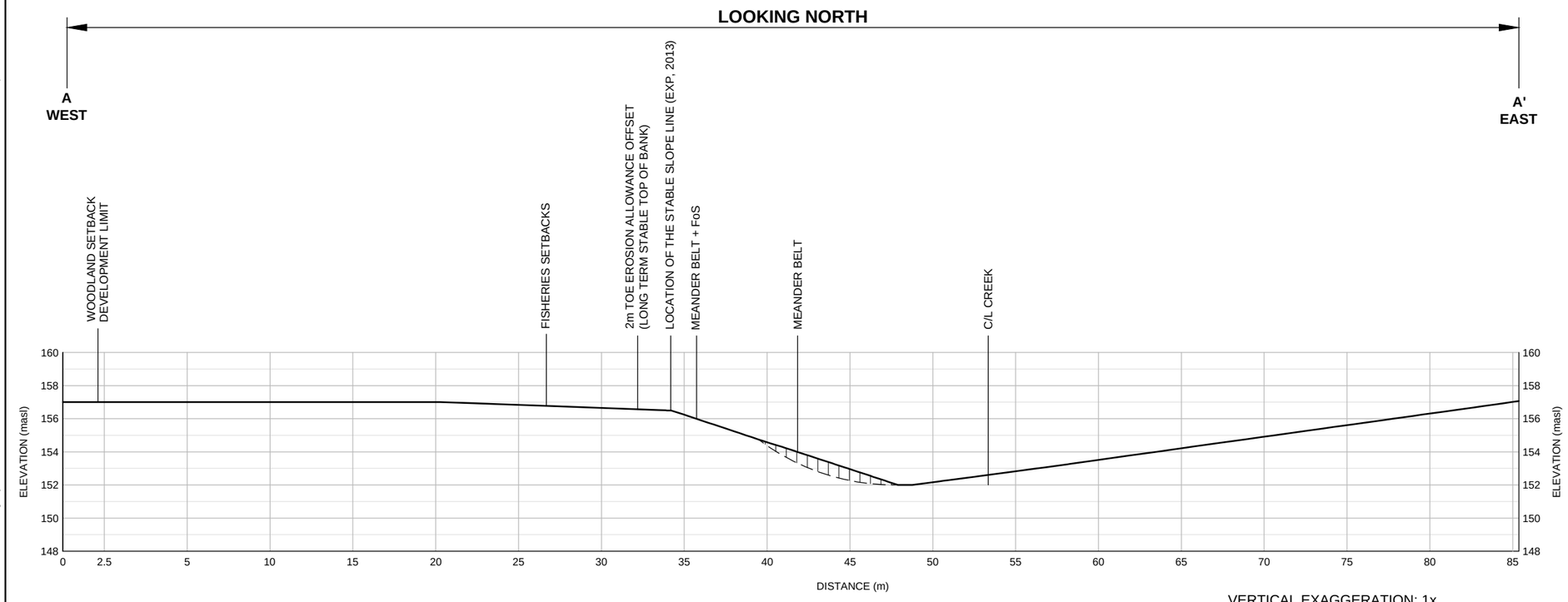
Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.2

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

TOP OF BANK DELINEATION - 14W-11





CROSS-SECTION A-A'

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- MEANDER BELT WIDTH
- MEANDER BELT WIDTH + FoS
- FISHERIES SETBACKS
- HAZARD ALLOWANCE
- WOODLAND SETBACK
- DEVELOPMENT LIMIT
- 2m TOE EROSION ALLOWANCE OFFSET (LONG TERM STABLE TOP OF BANK)
- STABLE SLOPE LINE (EXP, 2013)

Scale: 0 5 10 15m

N

Client: QuadReal

Prepared by: wsp

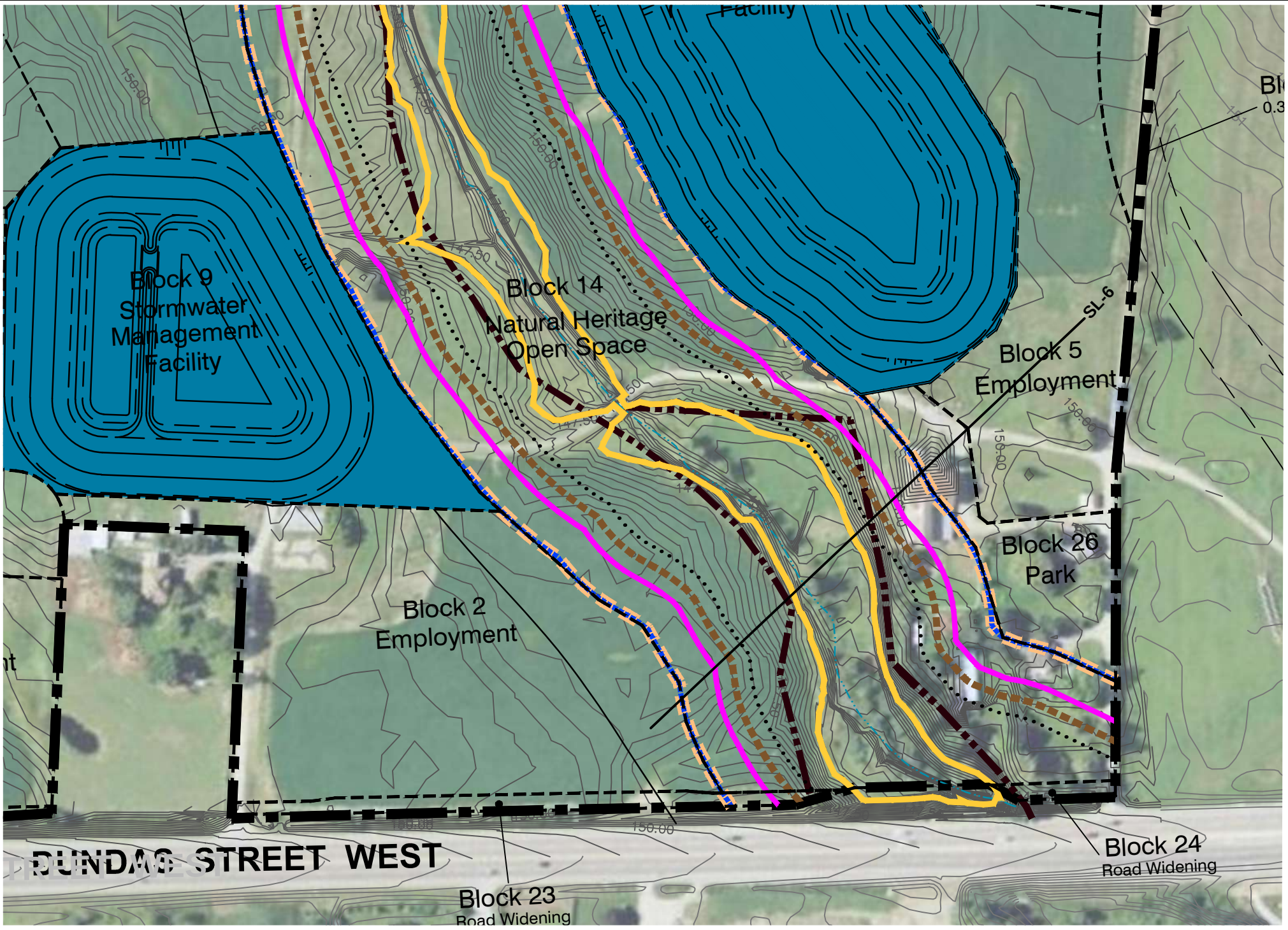
Date: April 2019

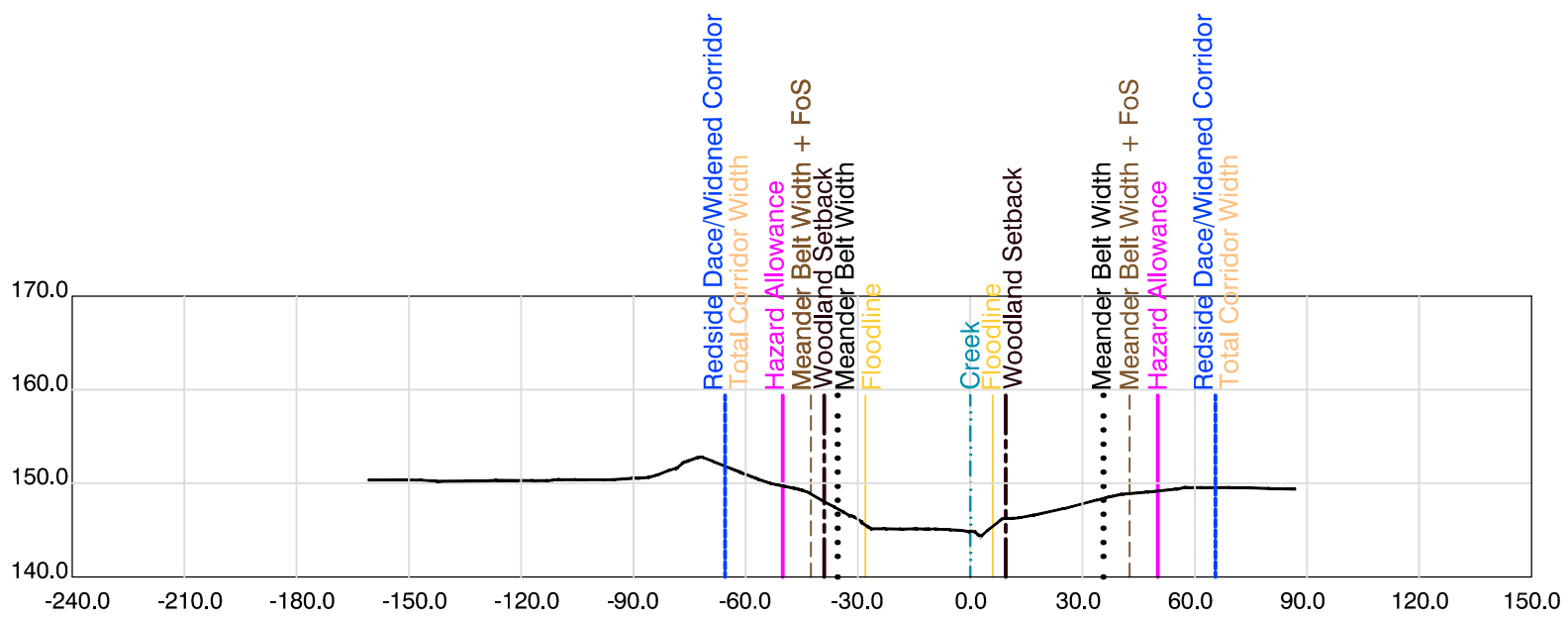
Project No.: 14-09222-001-WR1

Aerial Photo

Figure 6.3A

FIGURE 6.3A - Top of Bank Delineation - 14W-11.dwg Layout 1 \\thfiler1.mmm.ca\cad$\14-41\14\09222-001-WR1\REPORT 15 FEB 2019\FIGURES SERIES 6\ Apr 05, 2019 - 11:18am





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

Cross- Section Downstream of SWM Pond3 (Ultimate Phase)

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- MEANDER BELT WIDTH
- MEANDER BELT + FoS
- HAZARD ALLOWANCE
- WOODLAND SETBACK
- REDSIDE DACE/WIDENED CORRIDOR
- REGULATORY FLOODPLAIN
- TOTAL CORRIDOR WIDTH

Scale
1:2000 0 25 50 75 100m

Client
QuadReal

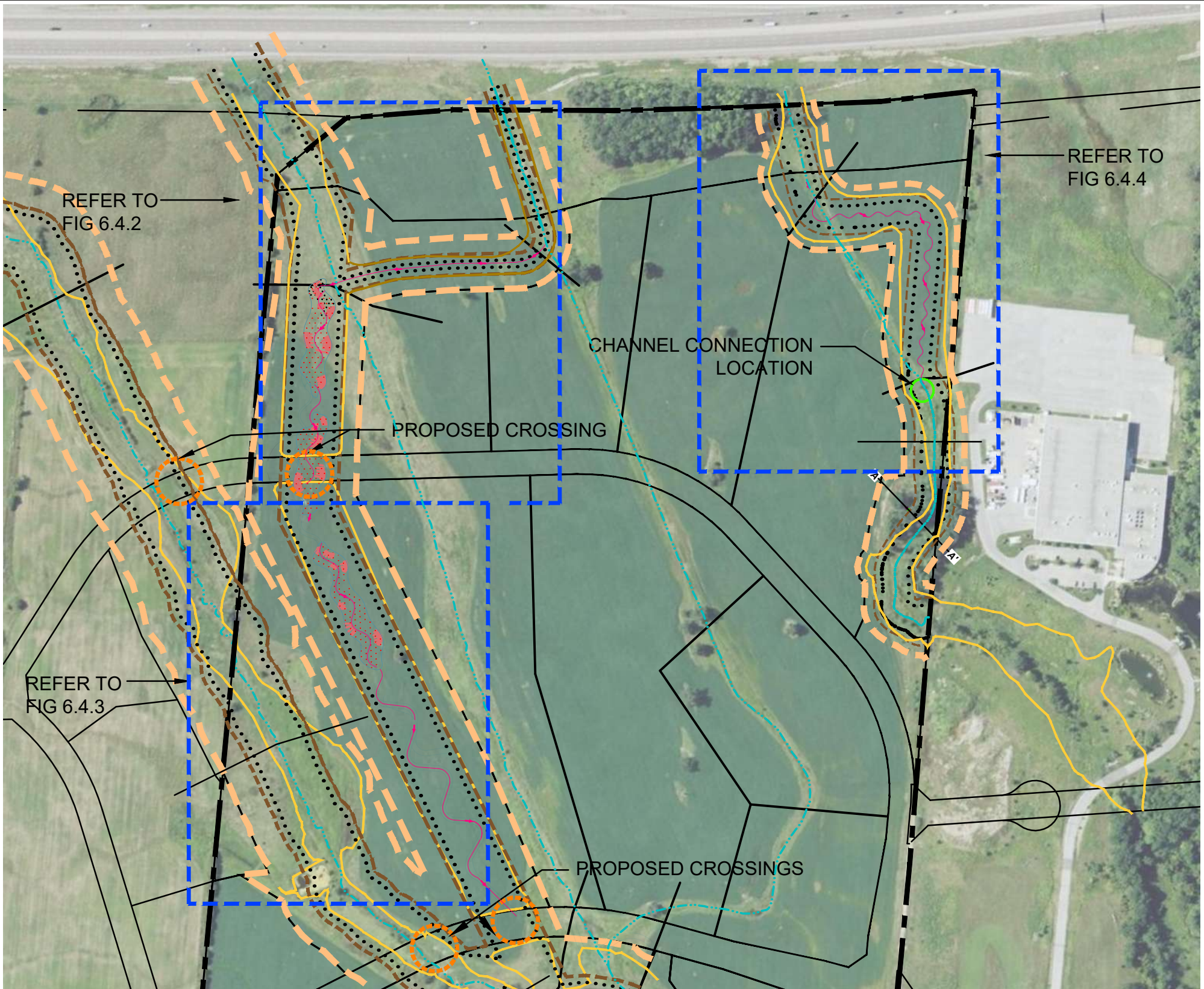
Prepared by
wsp

Date
April 2019

Project No.
14-09222-001-WR1

Aerial Photo

Figure 6.3B



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

14 Mile Creek Natural Channel Design Alignment And Planform -Key Plan (Ultimate Phase)

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- CHANNEL DIVERSION / REHABILITATION
- MEANDER BELT WIDTH
- MEANDER BELT + FoS
- REGULATORY FLOODPLAIN
- NON-REGULATORY FLOODPLAIN
- TOTAL CORRIDOR WIDTH

Scale: 0 50 100 150 200 250m

Client: QuadReal

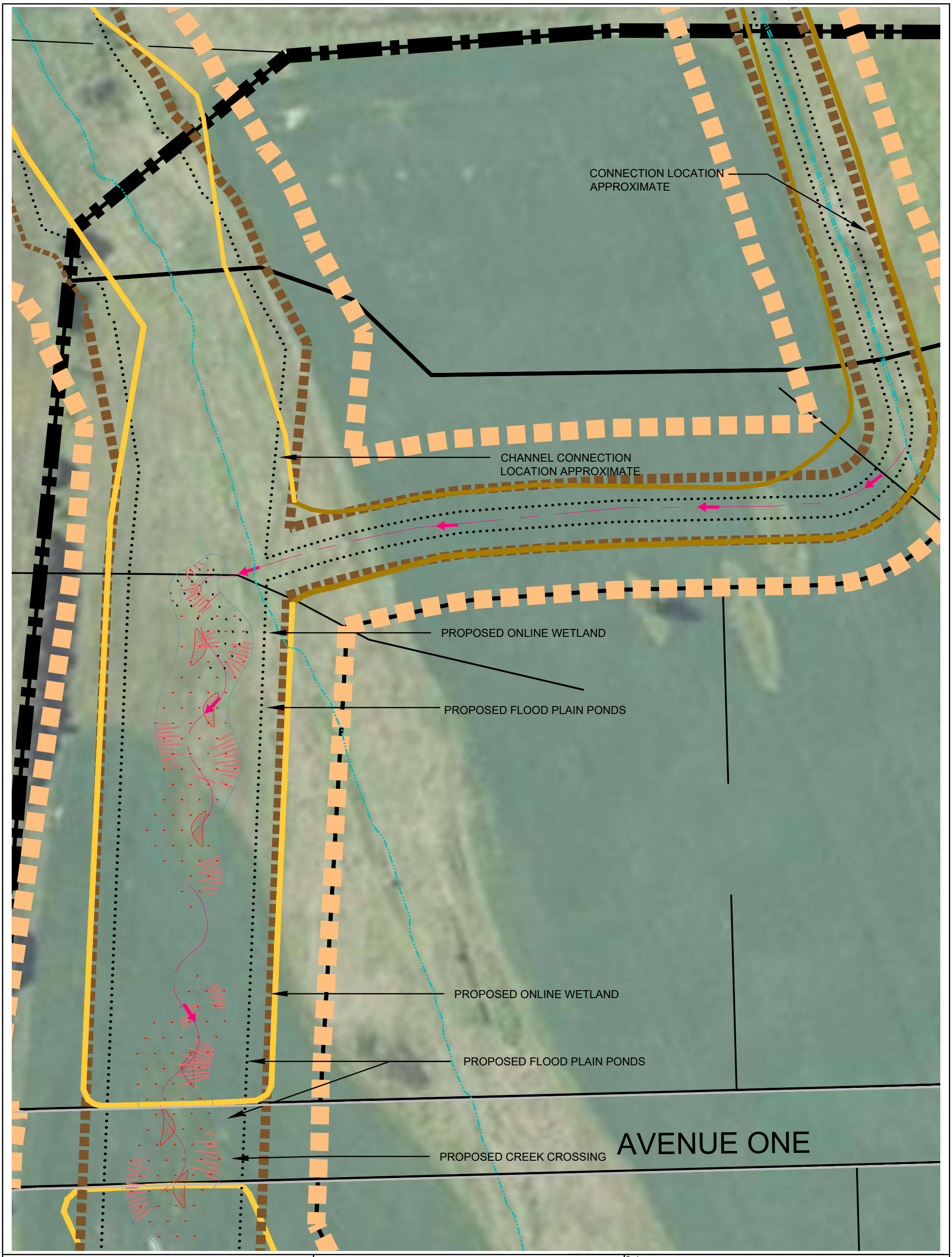
Prepared by: wsp

Date: MAY 2020

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.4.1



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
- EXISTING CREEK
- CHANNEL DIVERSION / REHABILITATION
- MEANDER BELT WIDTH
- MEANDER BELT + FoS
- REGULATORY FLOODPLAIN
- NON-REGULATORY FLOODPLAIN
- TOTAL CORRIDOR WIDTH

Scale: 0 10 20 30 40 50m

Client: QuadReal

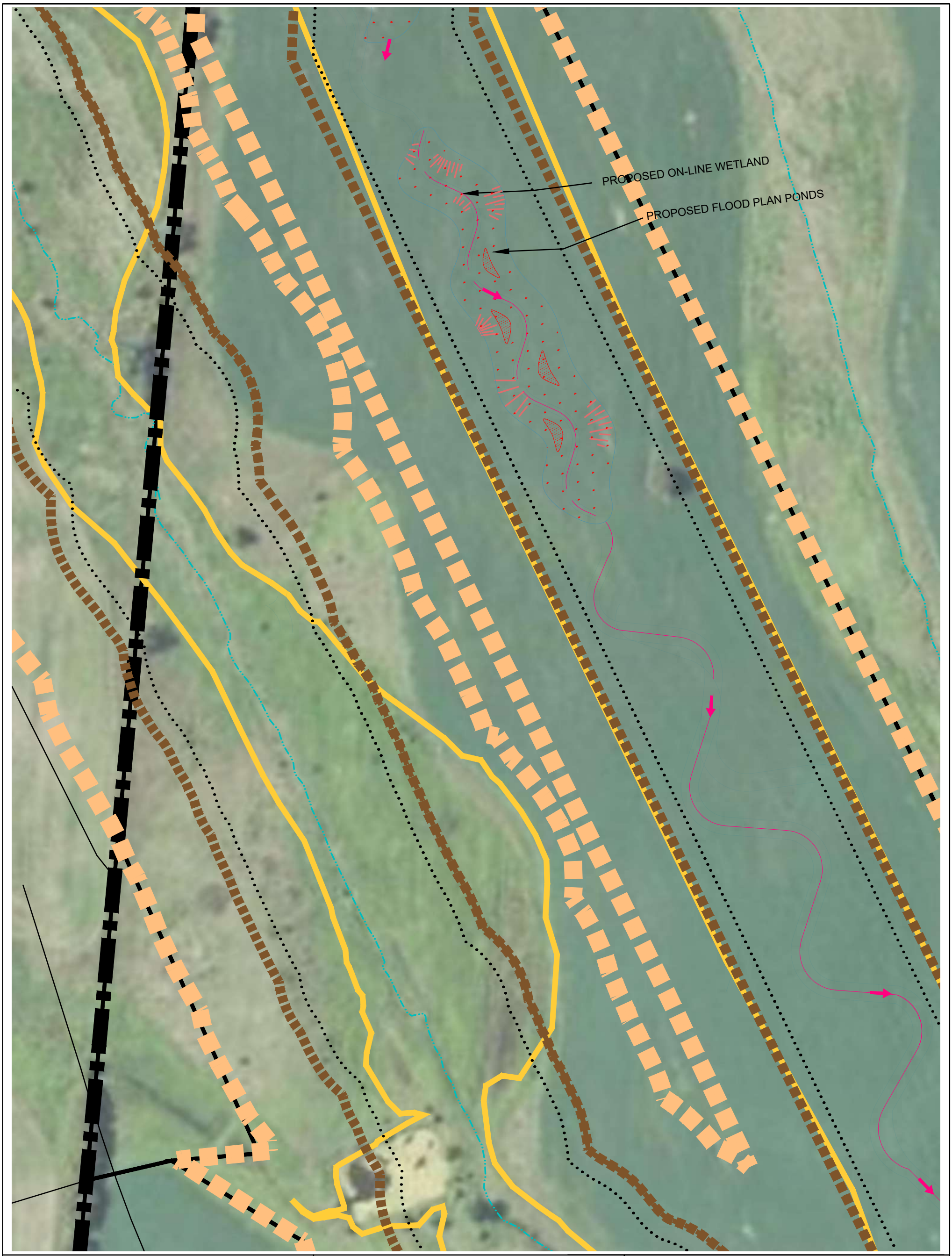
Prepared by: wsp

Date: MAY 2020

Project No.: 09M- 00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.4.2



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

Diversion Channels 14W-22 And reach 14W-16 Rehabilitation Alignment And Planform

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- CHANNEL DIVERSION / REHABILITATION
- MEANDER BELT WIDTH
- MEANDER BELT + FoS
- REGULATORY FLOODPLAIN
- TOTAL CORRIDOR WIDTH

Scale: 0 10 20 30 40 50m

Client: QuadReal

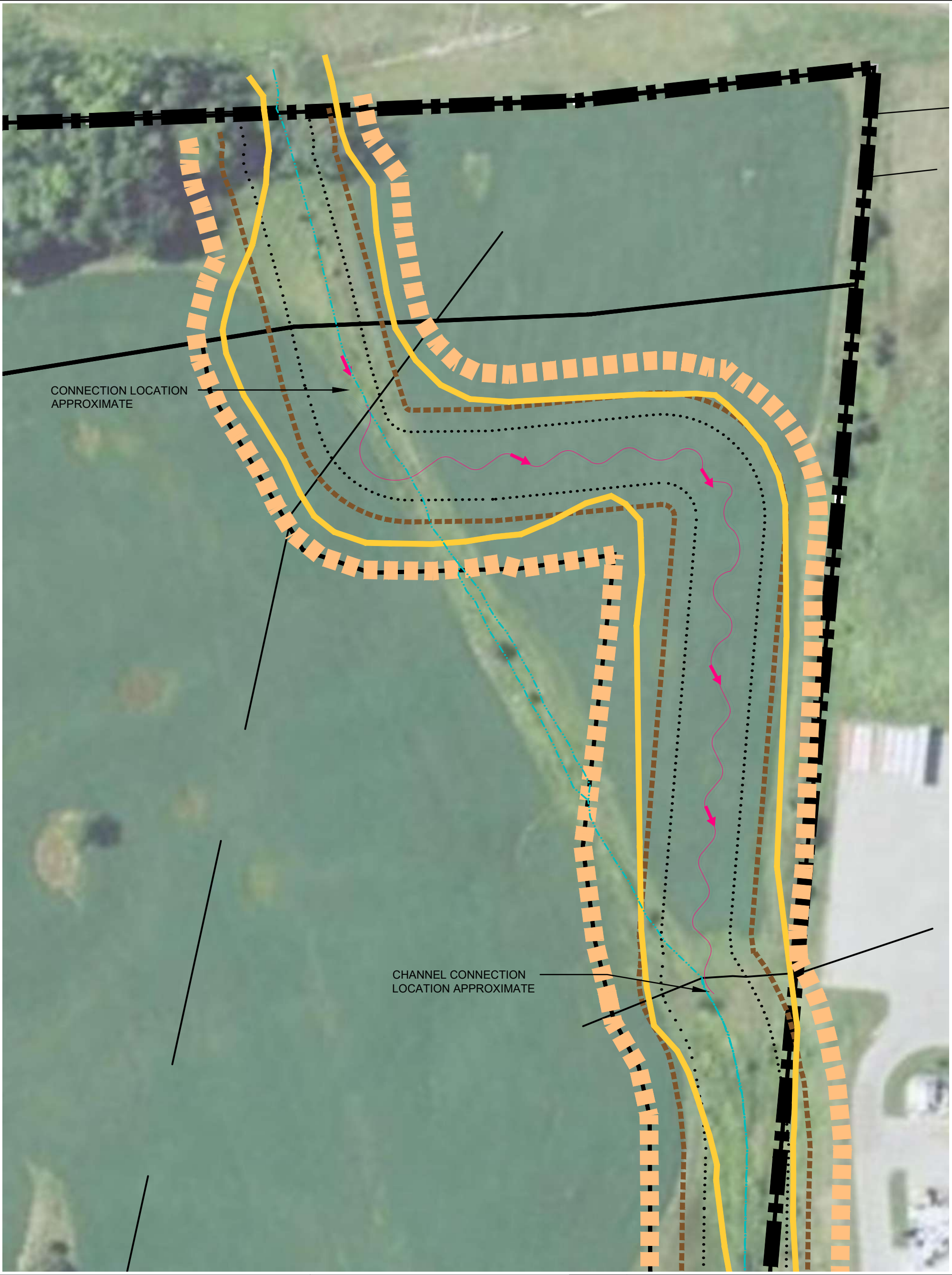
Prepared by: wsp

Date: MAY 2020

Project No.: 09M- 00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.4.3



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

Diversion Channels 14W-23 and 14W-11 Alignment And Planform

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- CHANNEL DIVERSION / REHABILITATION
- MEANDER BELT WIDTH
- MEANDER BELT + FoS
- REGULATORY FLOODPLAIN
- TOTAL CORRIDOR WIDTH

Scale: 0 10 20 30 40 50m

Client: QuadReal

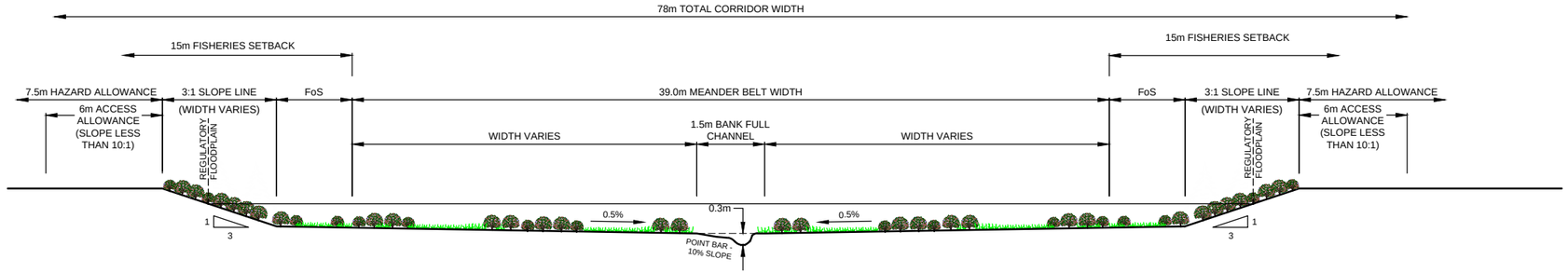
Prepared by: wsp

Date: MAY 2020

Project No.: 09M- 00013-01-WR1

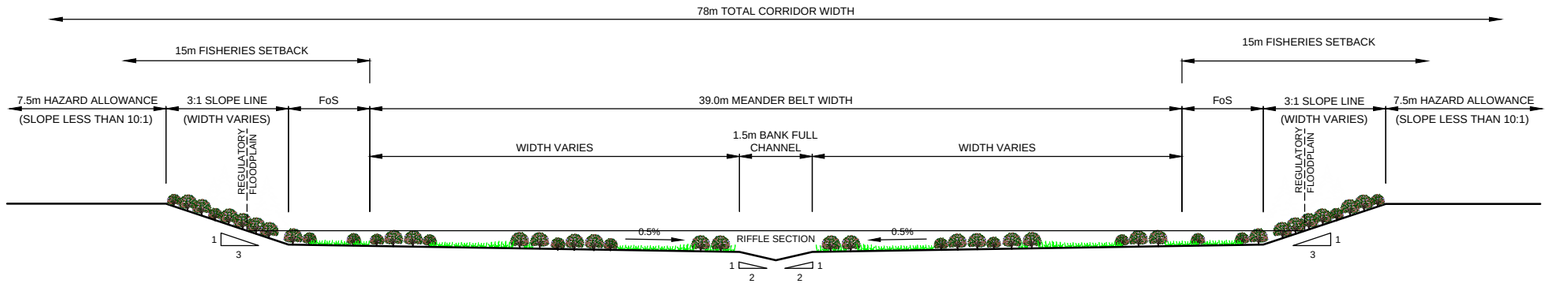
Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.4.4



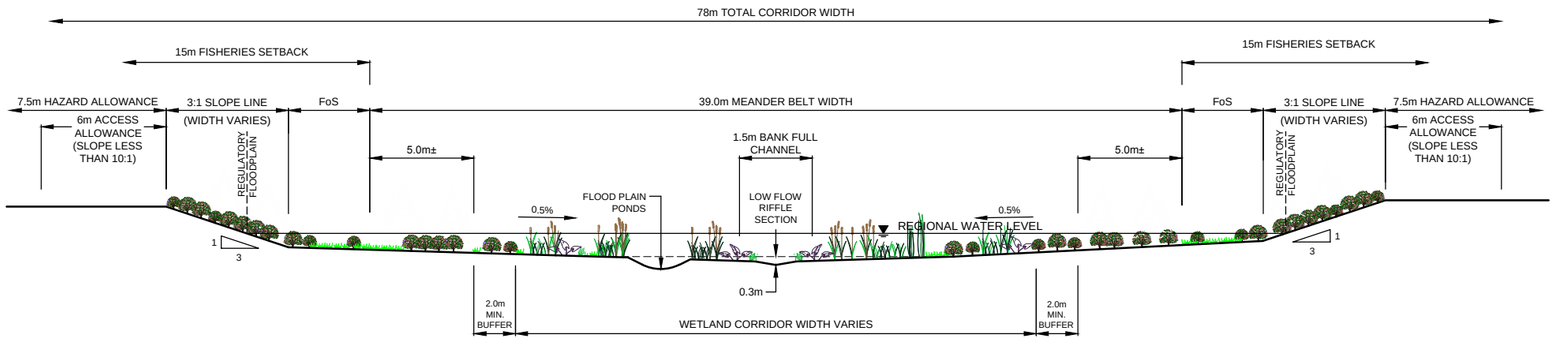
CHANNEL CORRIDOR - CHANNEL OUTSIDE BEND

N.T.S.



CHANNEL CORRIDOR - CHANNEL RIFFLE SECTION BEND

N.T.S.



CHANNEL CORRIDOR - WETLAND LOCATION

N.T.S.

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: AS NOTED

Client: QuadReal

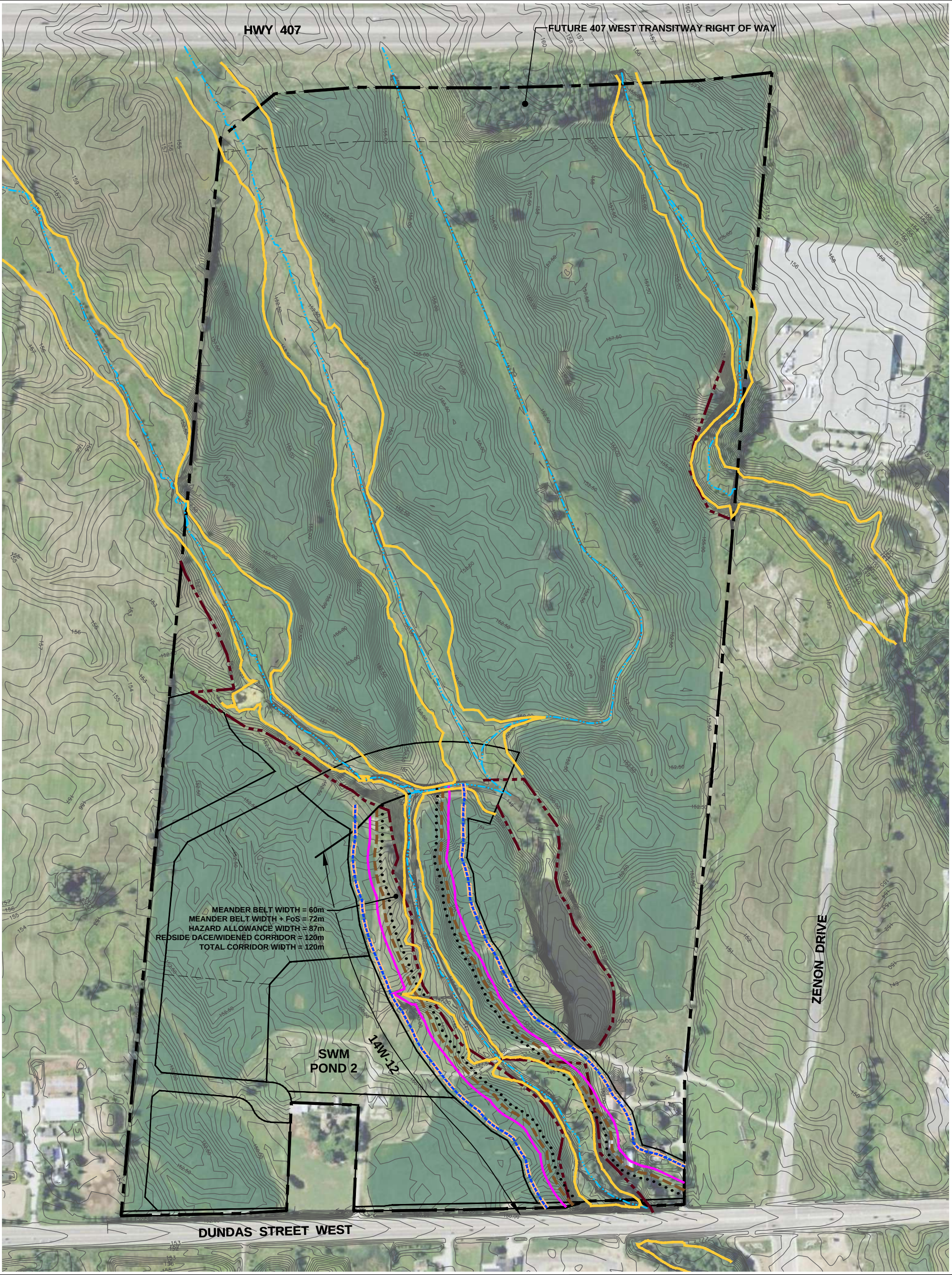
Prepared by: wsp

Date: November 2019

Project No.: 09M-00013-01-WR1

Aerial Photo

Figure 6.4.5



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

Corridor Delineation - Interim Phase 1A Conditions

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- PROPOSED DIVERSION
- MEANDER BELT WIDTH
- MEANDER BELT + FoS
- HAZARD ALLOWANCE
- WOODLAND SETBACK
- REDSIDE DACE/WIDENED CORRIDOR
- REGULATORY FLOODPLAIN
- TOTAL CORRIDOR WIDTH

Scale: 0 50 100 150 200m

Client: QuadReal

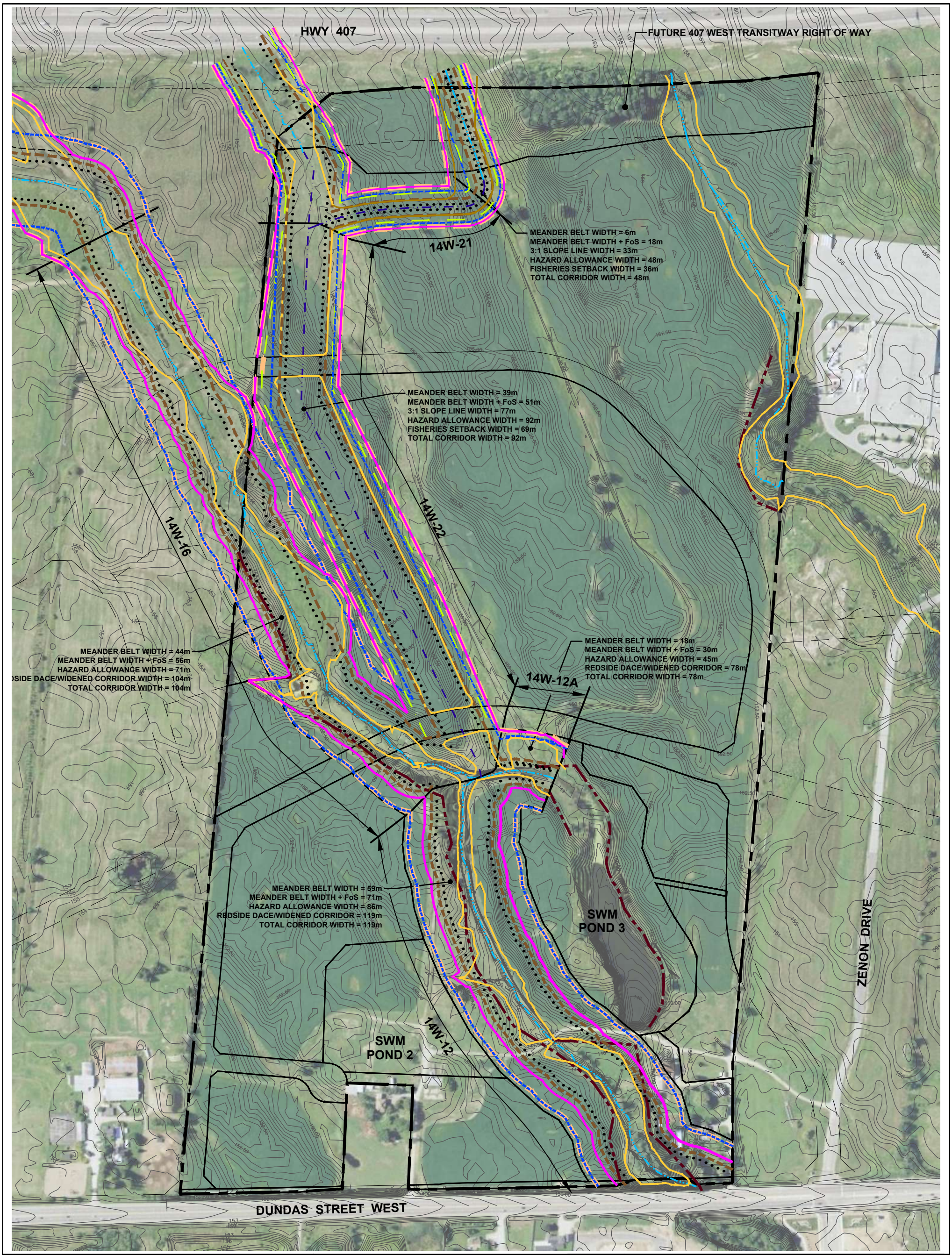
Prepared by: wsp

Date: April 2019

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.5.1



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

Corridor Delineation - Interim Phase 1B Conditions

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- PROPOSED DIVERSION
- MEANDER BELT WIDTH
- MEANDER BELT + FoS
- 3:1 SLOPE LINES FOR PROPOSED CONFINED CHANNEL
- HAZARD ALLOWANCE
- WOODLAND SETBACK
- FISHERIES SETBACKS (30m FOR REDSIDE DACE STREAM) (15m FOR NON-REDSIDE DACE STREAM)
- REGULATORY FLOODPLAIN
- NON-REGULATORY FLOODPLAIN
- TOTAL CORRIDOR WIDTH

Scale: 0 50 100 150 200m

Client: QuadReal

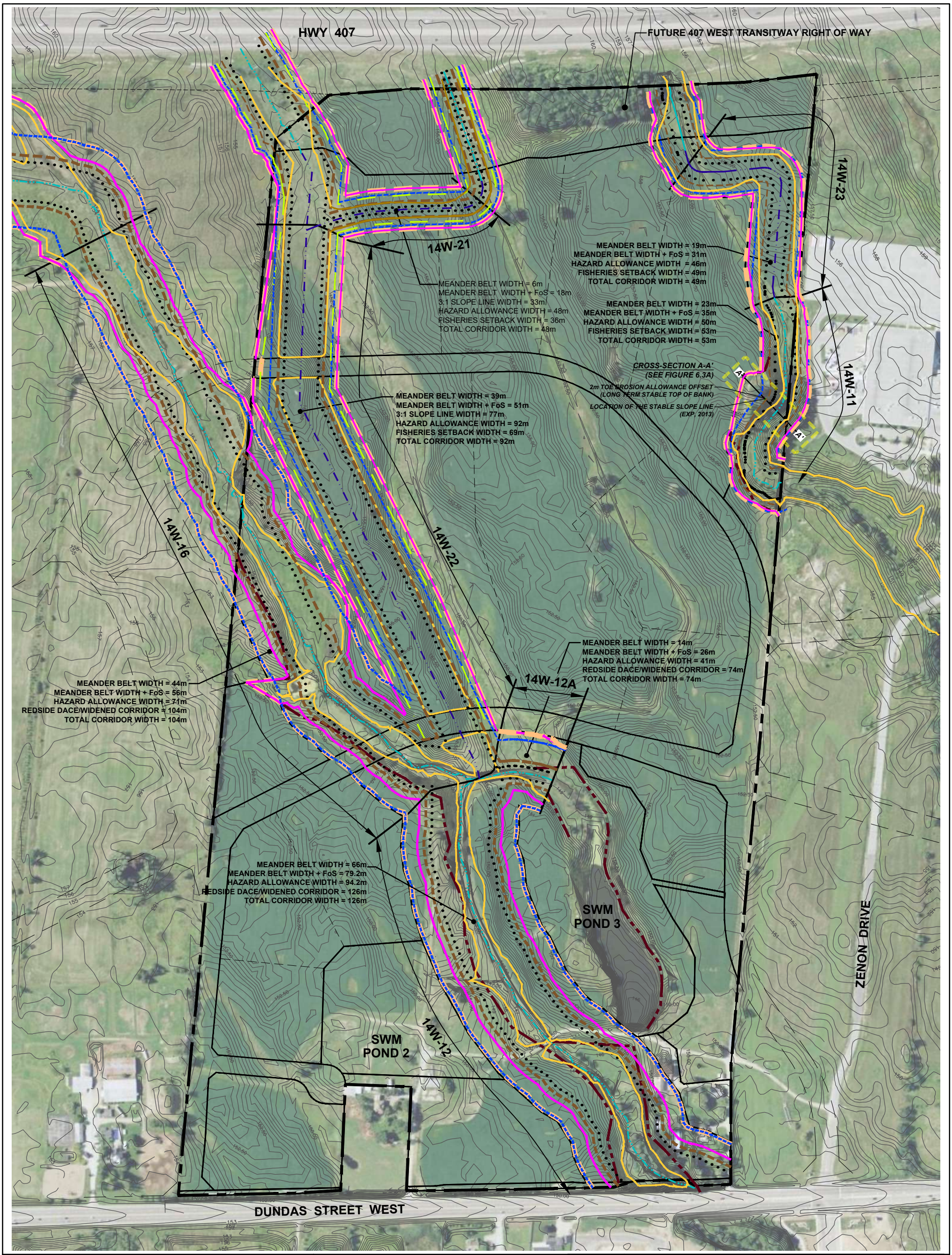
Prepared by: WSP

Date: May 2020

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.5.2



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

Corridor Delineation - Interim Phase 2 Conditions

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- PROPOSED DIVERSION
- MEANDER BELT WIDTH
- MEANDER BELT + FoS
- 3:1 SLOPE LINES FOR CONFINED CHANNEL
- HAZARD ALLOWANCE
- WOODLAND SETBACK
- FISHERIES SETBACKS (30m FOR REDSIDE DACE STREAM) (15m FOR NON-REDSIDE DACE STREAM)
- REGULATORY FLOODPLAIN
- NON-REGULATORY FLOODPLAIN
- TOTAL CORRIDOR WIDTH

Scale: 0 50 100 150 200m

Client: QuadReal

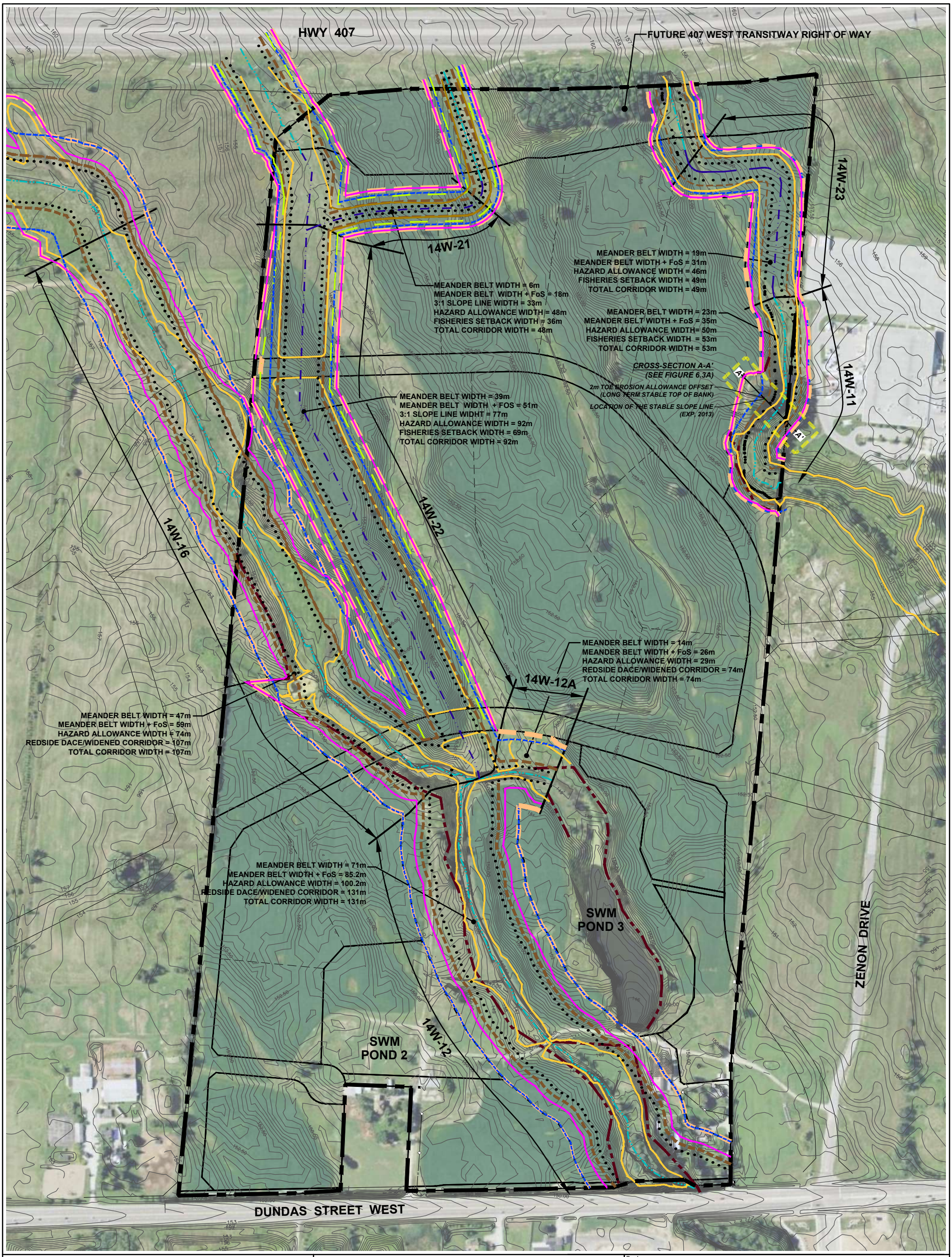
Prepared by: wsp

Date: May 2020

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.5.3



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

Corridor Delineation - Ultimate Conditions

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- PROPOSED DIVERSION
- MEANDER BELT WIDTH
- MEANDER BELT + FoS
- 3:1 SLOPE LINES FOR PROPOSED CONFINED CHANNEL
- HAZARD ALLOWANCE
- WOODLAND SETBACK
- FISHERIES SETBACKS (30m FOR REDSIDE DACE STREAM) (15m FOR NON-REDSIDE DACE STREAM)
- REGULATORY FLOODPLAIN
- NON-REGULATORY FLOODPLAIN
- TOTAL CORRIDOR WIDTH

Scale: 0 50 100 150 200m

Client: QuadReal

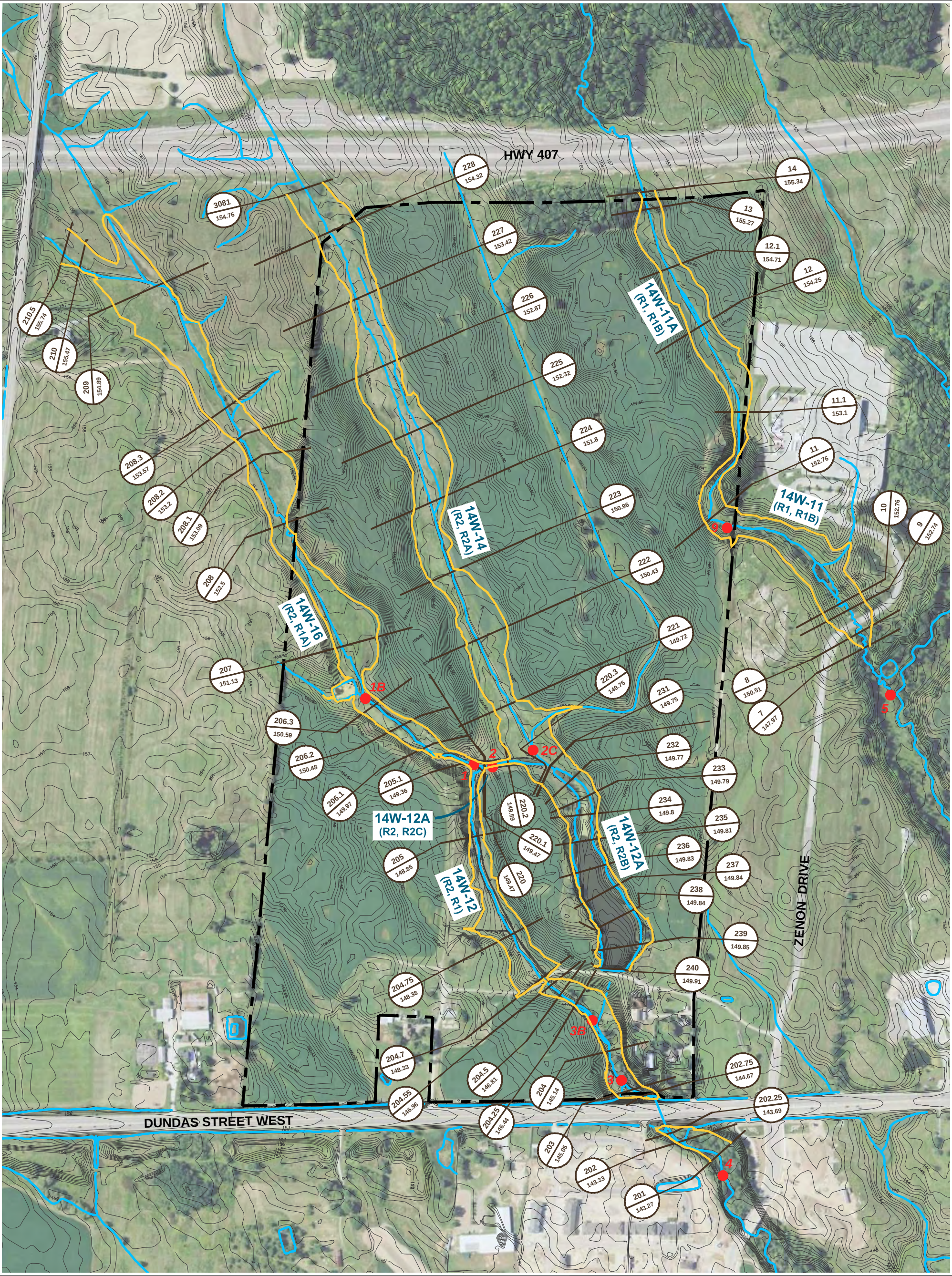
Prepared by: wsp

Date: May 2020

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.5.4



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

Hec-Ras Cross-Sections Existing Conditions

LEGEND

- SUBJECT PROPERTY
- EXISTING REGIONAL FLOODLINE
- HEC-RAS CROSS-SECTION
- 201 / 143.21 — WSP HEC-RAS CROSS-SECTION ID. / REGIONAL FLOOD ELEVATION (masl)
- 3B — HYDROLOGY MODEL FLOW NODES
- 14W-12 (R2, R1) — REACH (EIS/FSS) / REACH ID. / RIVER ID.

Scale: 0 50 100 150 200 250m

Client: QuadReal

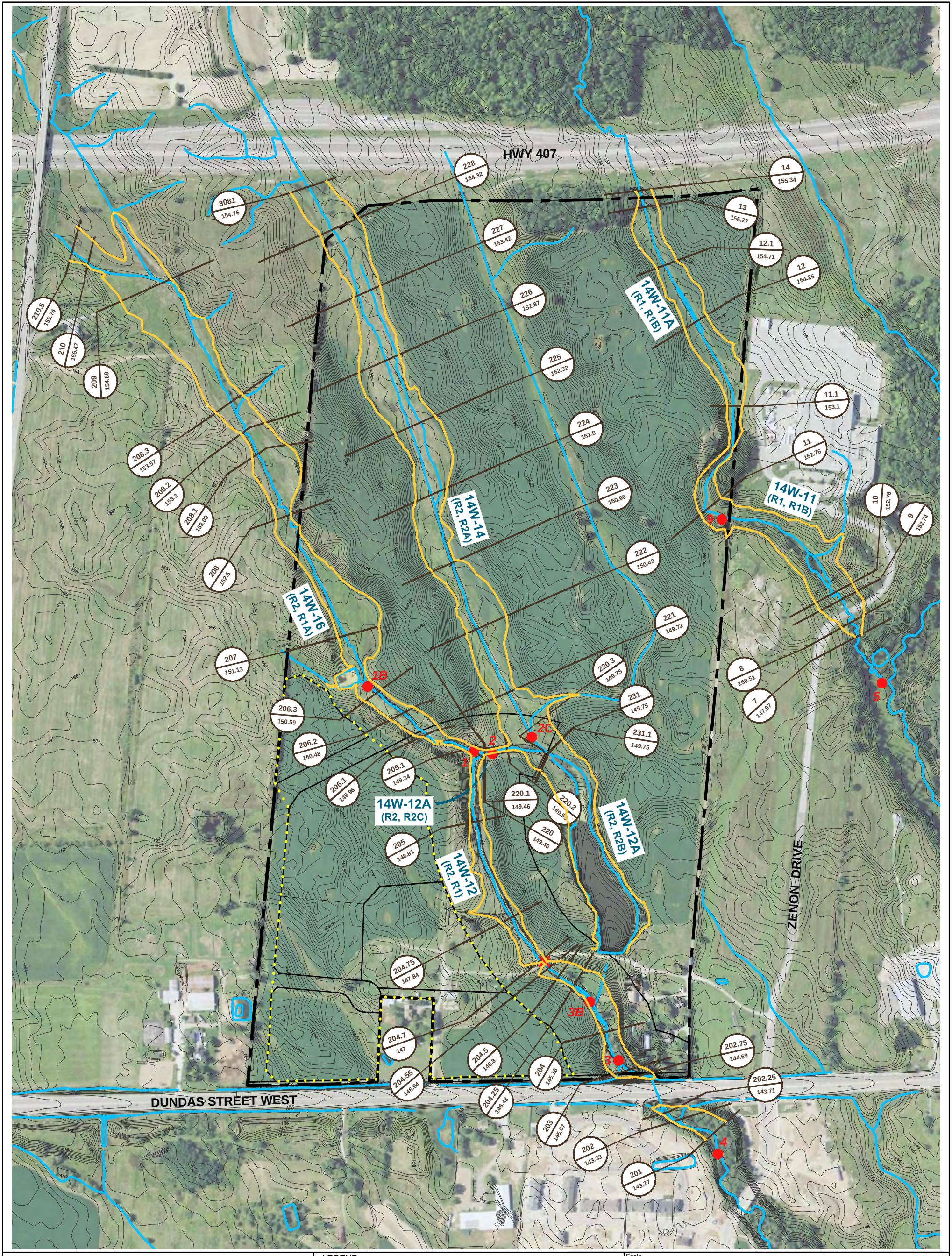
Prepared by: wsp

Date: April 2019

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.6.1



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

Hec-Ras Cross-Sections Interim Phase 1A Conditions

LEGEND

- SUBJECT PROPERTY
- DEVELOPMENT BOUNDARY
- INTERIM PHASE 1A REGIONAL FLOODLINE
- HEC-RAS CROSS-SECTION
- 201 / 143.21 — WSP HEC-RAS CROSS-SECTION ID. / REGIONAL FLOOD ELEVATION (masl)
- 3B — HYDROLOGY MODEL FLOW NODES
- FARM ACCESS ROAD CULVERT REMOVED
- 14W-12 (R2, R1) — REACH (EIS/FSS) / REACH ID. / RIVER ID.

Scale: 0 50 100 150 200 250m

Client: QuadReal

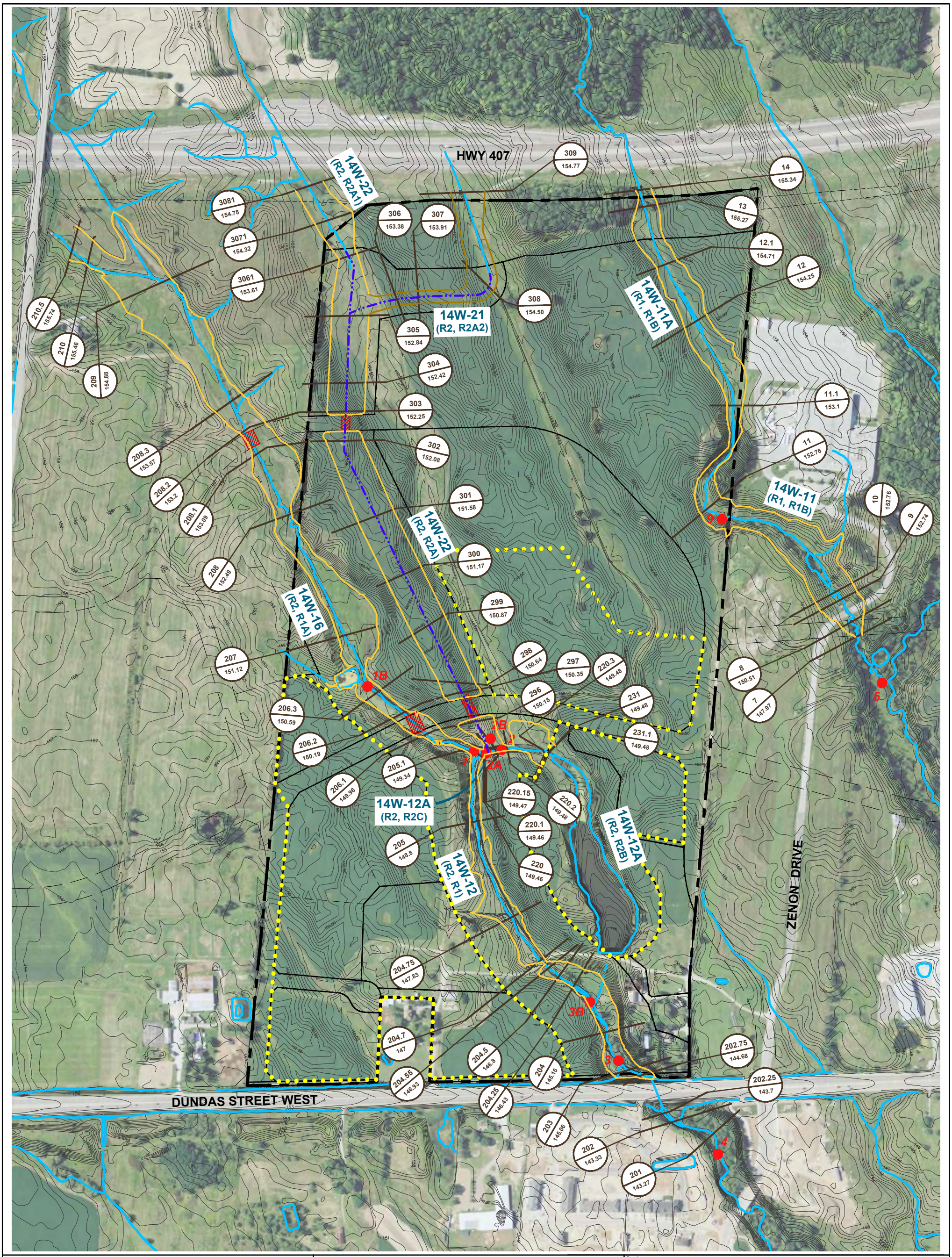
Prepared by: wsp

Date: April 2019

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.6.2



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

Hec-Ras Cross-Sections Interim Phase 1B Conditions

LEGEND

- SUBJECT PROPERTY
- DEVELOPMENT BOUNDARY
- INTERIM PHASE 1B REGIONAL FLOODLINE (REGULATED)
- INTERIM PHASE 1B REGIONAL FLOODLINE (NON-REGULATED)
- HEC-RAS CROSS-SECTION
- 201 / 143.21 — WSP HEC-RAS CROSS-SECTION ID. / REGIONAL FLOOD ELEVATION (masl)
- 3B — HYDROLOGY MODEL FLOW NODES
- PROPOSED ROAD CROSSING
- 14W-12 (R2, R1) — REACH (EIS/FSS) / REACH ID. / RIVER ID.

Scale: 0 50 100 150 200 250m

Client: QuadReal

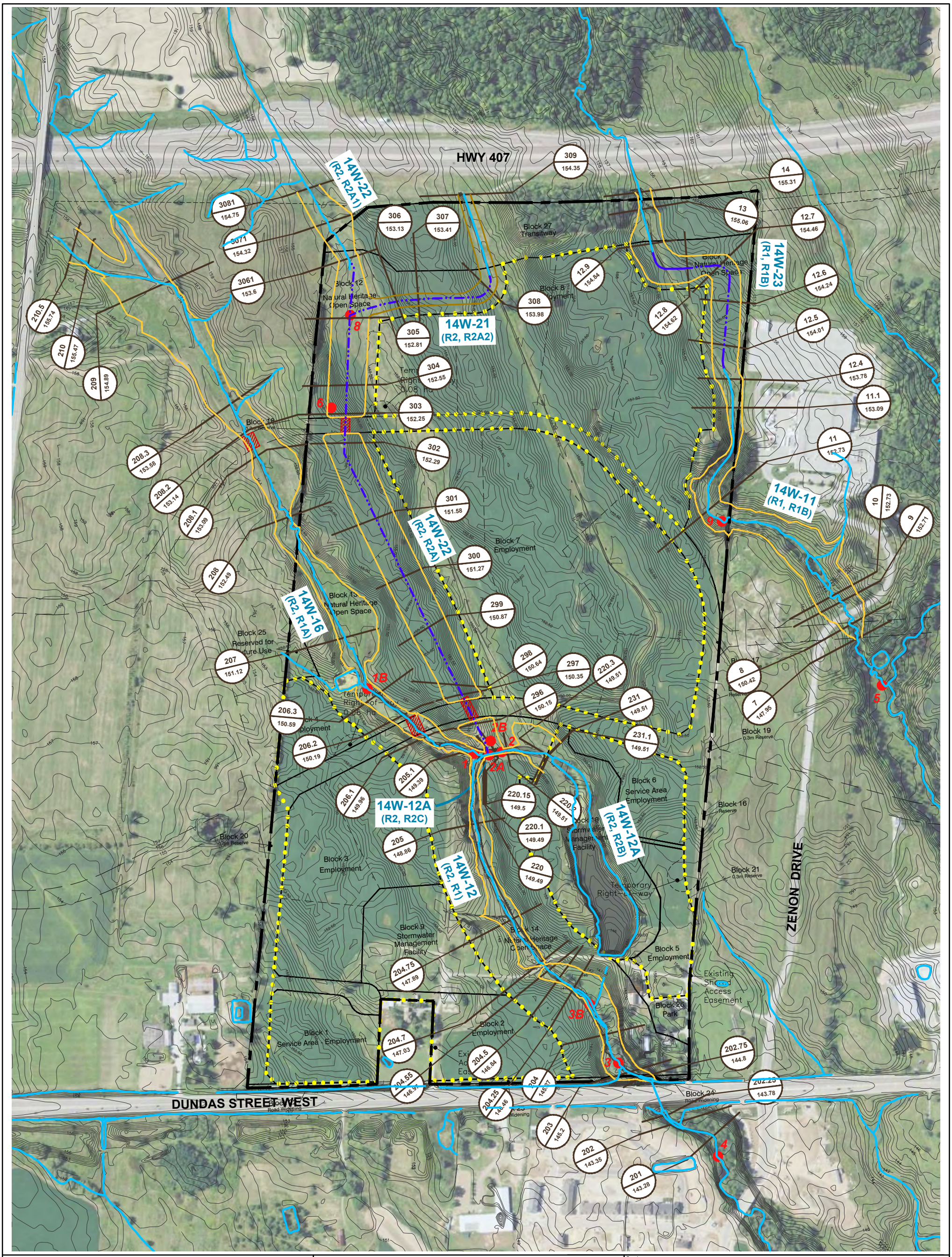
Prepared by: wsp

Date: May 2020

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.6.3



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

Hec-Ras Cross-Sections Interim Phase 2 Conditions

LEGEND

- SUBJECT PROPERTY
- DEVELOPMENT BOUNDARY
- INTERIM PHASE 2 REGIONAL FLOODLINE (REGULATED)
- INTERIM PHASE 2 REGIONAL FLOODLINE (NON-REGULATED)
- HEC-RAS CROSS-SECTION
- 201 / 143.21 — WSP HEC-RAS CROSS-SECTION ID. / REGIONAL FLOOD ELEVATION (masl)
- 3B — HYDROLOGY MODEL FLOW NODES
- PROPOSED ROAD CROSSING
- 14W-12 (R2, R1) — REACH (EIS/FSS) / REACH ID. / RIVER ID.

Scale: 0 50 100 150 200 250m

Client: QuadReal

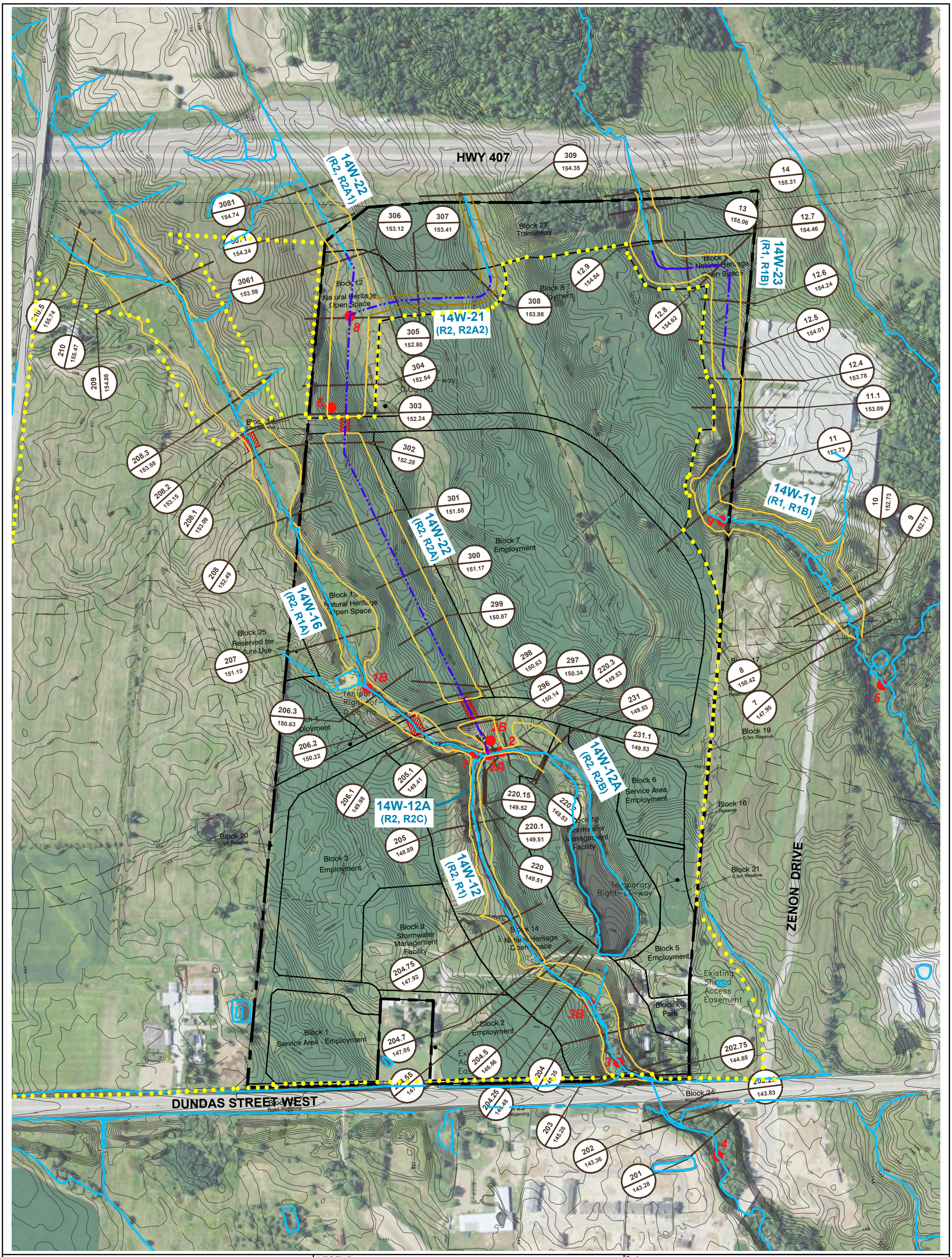
Prepared by: WSP

Date: May 2020

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.6.4



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

Hec-Ras Cross-Sections Ultimate Conditions

LEGEND

- SUBJECT PROPERTY
- DEVELOPMENT BOUNDARY
- ULTIMATE REGIONAL FLOODLINE (REGULATED)
- ULTIMATE REGIONAL FLOODLINE (NON-REGULATED)
- HEC-RAS CROSS-SECTION
- 201 / 143.21 — WSP HEC-RAS CROSS-SECTION ID. / REGIONAL FLOOD ELEVATION (masl)
- 3B — HYDROLOGY MODEL FLOW NODES
- PROPOSED ROAD CROSSING
- 14W-12 (R2, R1) — REACH (EIS/FSS) / REACH ID. / RIVER ID.

Scale: 0 50 100 150 200 250m

Client: QuadReal

Prepared by: wsp

Date: May 2020

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.6.5

7.0 Stormwater Management

7.0 Stormwater Management

7.1 Introduction and Background

The Town of Oakville 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, SWM, 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.

Section 6.3.6 of the NOCSS discusses the SWM 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.

In accordance with NOCSS and the EIR/FSS ToR, this section discusses required SWM related topics for the Subject Property within the 407 West Employment Area in details. It includes:

- Stormwater Management Objectives and Proposed Strategy (Sections 7.2 and 7.3);
- Development of Hydrological Model (Section 7.4);
- Erosion Control Analysis (Section 7.5);
- Hydrologic Flow Regimes Analysis (Section 7.6);
- Topographic Depression Volumes (Section 7.7);
- Design of Stormwater Management Facilities (Section 7.8); and,
- Regional Storm Downstream Impacts (Section 7.9);

The following studies, technical guidelines and references were reviewed and used in the preparation of this section:

- North Oakville Creeks Subwatershed Study (NOCSS), 2006;
- North Oakville Creeks Subwatershed Study Addendum, 2007;
- River & Systems: Flooding Hazard Limit, Technical Guide, Ontario Ministry of Natural Resources, 2002;
- Stormwater Management Planning and Design Manual, MOECC, March 2003;
- Low Impact Development Stormwater Management Planning and Design Guide, CVC and TRCA, 2010;
- Guelph All-Weather Sequential-Events Runoff Model (GAWSER) Reference Manual, April 1996, Schroeter and Associates; and,
- Hydrology of Floods in Canada, A Guide to Planning and Design, NRC, 1989.

7.2 Stormwater Management Objectives

The SWM plan is intended to address multiple objectives including peak flow control (water quantity), water quality, erosion control and maintaining existing hydrologic water balance. The recommended SWM approach detailed in NOCSS is as follows:

- Water Quantity: The NOCSS recommends that SWM 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 Revised Target Unit Area Peak Flow Rates Table (07.06.27) included in the NOCSS Addendum, 2007. The proposed SWM facilities within the study area are designed to provide Regional Storm controls. This is addressed in Sections 7.4, 7.8 and 7.9.

- 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. This is addressed in Section 4.0.

- Water Quality: The NOCSS recommends meeting MOECC's Enhanced Level of water quality protection (Level 1) when sizing SWM facilities for water quality control, 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 facilities 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. This is addressed in Section 7.8.

- 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. The continuous hydrologic simulation was conducted using the Guelph All-Weather Sequential-Events Runoff (GAWSER Version 6.9.25) software to evaluate and confirm the appropriate extended detention storages are provided by the SWM facilities. This is addressed in Sections 7.4 and 7.5.

- Topographic Depressions: The NOCSS recommends that the storage within the topographic depressions be refined and checked against the storage within proposed SWM facilities in the EIR subcatchment area to verify that the SWM facility storage accounts for the depression storage. This is addressed in Section 7.7.

- 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. This is addressed in Section 7.8.

7.3 Stormwater Management Alternatives and Proposed Approach

7.3.1 Evaluation of Stormwater Management Alternatives

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 ToR, in this section the alternative SWM Practices are described, evaluated for application in the development, and a preferred approach is selected to satisfy NOCSS SWM goals, objectives, and targets.

7.3.1.1 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 applicable to the concept plan for the subject lands include discharging clean roof runoff to pervious surfaces, infiltration swales, or soakaway pits, rain gardens, pervious pavements, green roofs and reduced lot gradings. 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 runoff temperature increases and removing sediment, heavy metals and nutrients from runoff. 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 stormwater runoff 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.

7.3.1.2 Evaluation

In reviewing these options for inclusion in the proposed SWM Plan, these alternatives were evaluated on the basis of capabilities, limitations, anticipated risk profiles and physical constraints associated with their implementation. This analysis included the following factors:

- 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 relevant guidelines in the *MOECC Stormwater Management Planning and Design Manual, March 2003*, and the *Low Impact Development Stormwater Management Planning and Design Guide, CVC and TRCA, 2010.*

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 has been implemented with infiltration techniques. These SWMPs are generally less feasible for the proposed industrial/commercial development within the West Branch of 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.

To address the shortfall in infiltration over the developed blocks, infiltration trenches along the watercourse corridor limits have been established that will collect surface drainage from non-developed areas and allow it to infiltrate along the banks and outer meander belts of the watercourses, providing passive infiltration and water sources that will mimic pre-development hydrology inputs to baseflow maintenance. Please refer to Section 4.0 for the post-development water balance analysis, demonstrating a pre- to post-development match in overall infiltration targets to meet the NOCSS objectives.

However, the following opportunities to integrate SWMPs at the lot level will be considered at the detailed design stage. While they will be less effective at promoting pre-development rates of infiltration due to the tight soils, 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.

When combined with the infiltration trenches at the boundaries of the watercourse corridors, post-development water balance has been demonstrated to address the NOCSS targets. Therefore, the techniques listed above should form recommendations for the individual block SWM plans to be followed at the site plan application stage.

Conveyance SWMPs

Conveyance SWMPs, such as pervious pipe systems and wide-bottom swales are not practical for the proposed industrial/commercial development within the West Branch of 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 overly 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 and implemented as recommended techniques at the site plan application stage for the individual development blocks.

End-of-Pipe SWMPs

SWM wet pond (i.e., extended detention ponds) can remove moderate to high levels of sediment from stormwater. When properly designed, SWM wet ponds can effectively achieve peak flow control (water quantity), provide water quality and erosion control, and maintain existing hydrologic water balance.

7.3.2 Proposed Stormwater Management Approach

As indicated previously, the objective of the SWM 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, thus preventing them from entering the receiving watercourse. Based upon the considerations discussed in the previous section, two extended detention wet ponds (i.e., Ponds 2 and 3) are proposed for the development area within the Subject Property. Two additional extended detention wet ponds (i.e., Ponds 1 and 5) are recommended for the adjacent development areas to the west. For study purposes, an additional wet pond located west of Tremaine Road and south of Highway 407 is also included in the analysis to reflect the ultimate development conditions as per Tremaine and Dundas Secondary Plan Subwatershed Study, 2009.

It is recognized that the complete development of the site and the construction of the infrastructures (e.g., SWM facilities, roads, culverts, etc.) will not occur simultaneously. Therefore, progressive development phases are adopted for the proposed study. Table 7.3.1 summarizes the description of the development phases with their associated construction of infrastructures.

Table 7.3.1 – Development Phases

Development Phases	Estimated Development Area (ha) [1)]	SWM Facilities (Ponds)	Channel Realignment (Reach)	Roads [3]	Crossings [3] (Reach)
Phase 1A	17.8 [2)]	Pond 2	None	• Section of Avenue Two • Section of Burnhamthorpe Road Extension	None
Phase 1B	33.4	Pond 2 Pond 3	14W-21 14W-22	• Section of Avenue Two • Section of Avenue Three • Burnhamthorpe Road Extension between Avenue Two and Avenue Three	• Burnhamthorpe Road Extension at 14W-16 • Burnhamthorpe Road Extension at 14W-22
Phase 2	60.0	Pond 2 Pond 3	14W-21 14W-22 14W-23	• Section of Avenue Two • Section of Avenue Three • Burnhamthorpe Road Extension between Avenue Two and Avenue Three • Section of Avenue One	• Burnhamthorpe Road Extension at 14W-16 • Burnhamthorpe Road Extension at 14W-22 • Avenue One at 14W-22 • Avenue One at 14W-16
Ultimate Phase	103.7	Pond 2 Pond 3 Pond 1 Pond 5 Tremaine Pond	14W-21 14W-22 14W-23	• Avenue One • Avenue Two • Avenue Three • Burnhamthorpe Road Extension between Tremaine Road and Avenue Three	• Burnhamthorpe Road Extension at 14W-16 • Burnhamthorpe Road Extension at 14W-22 • Avenue One at 14W-22 • Avenue One at 14W-16

1) Includes SWM Facility (Pond) Blocks
2) Includes a Section of Dundas Street Expansion
3) Conceptual information is provided for reference purposes only.

All the proposed facilities will be wet ponds designed to provide stormwater quality (enhanced level), erosion and quantity control (up to Regional event) in accordance with the criteria referred to in the NOCSS. 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.

Note that in order to allow a uniform and sustained level of flow to be maintained in the Reach 14W-12A channel, it is required to divert flows from rooftops of the proposed buildings. To properly utilize the flows from rooftop, it is assumed that the roof drains will be installed to provide a controlled unit flow rate of 41 L/s/ha at a maximum water depth of 0.15 m on the rooftops. The rooftop storages have been incorporated in the hydrological models for the proposed conditions. Details are discussed in Section 7.4.3. Information on the conceptual design of rooftop controls are included in the Appendix 7.6. The results of the proposed roof controls, including the roof release rates, water ponding depths, utilized ponding storages for the various storm events from 2- to 100- year and Regional storm, are included in the Appendix 7.6.

The computational hydrological simulation was performed by using the GAWSER (Guelph All-Weather Sequential-Events Runoff) hydrologic model. The existing GAWSER model for the West Branch of Fourteen Mile Creek, north of Dundas Street developed as part of the NOCSS study was obtained from CH. The obtained model was revised and updated as required by NOCSS and the EIR/FSS ToR to evaluate the hydrological impact and size the proposed SWM facilities for the subject study.

Low Impact Development and Water Balance

Infiltration measurements, such as infiltration swales, are proposed to maintain existing water balance target for the developments of the subject property. Based on the local soil conditions, infiltration could be used as one effective low impact development (LID) measures in the SWM practice. Together with other lot level, conveyance and end of pipe controls, a treatment train approach will be established for the proposed development. An example of treatment train approach for the proposed development includes a combination of green roof, infiltration trench, bioswale and SWM wet pond. Section 4.0 of the hydrogeology study discusses the post-development water balance mitigation strategy in detail. The locations of the proposed infiltration measurements are shown in Figure 4.7.

The application of these mitigation measures was constrained by site conditions and final design proposal (site plan). Detailed analysis on the implementation of the infiltration and other LIDs will be refined during detailed engineering design stage based on the best available design guidance information available at the time.

Furthermore, since most hydrological models have limitations to quantify infiltration measurements, consequently, it is conservative not to incorporate infiltration measurements in the GAWSER hydrological model for the subject study.

7.4 Development of GAWSER Hydrologic Model

7.4.1 Modelling Methodology

The GAWSER is a modified version of the popular HYMO program developed by the USDA in the early 1970's and was originally developed by the University of Guelph in 1977. In 1996, it was updated and further developed principally by Dr. H. Schroeter. The model has physically-based computational procedures that has evolved over the past 35 years as an available 'Canadian-made' hydrologic modelling tool for water management, planning and operations. It has seen wide application in more than 90 watershed studies in Ontario, including the North Oakville Creeks.

The GAWSER model is a deterministic storm-event hydrologic model which can be used to simulate major hydrologic processes or stream flow hydrographs resulting from precipitation inputs for the purpose of planning, design or evaluating the effects of physical changes in the drainage basin. In GAWSER, precipitation inputs can be defined in terms of rainfall, snowmelt or a combination of both. Recent developments of GAWSER model include features for the statistical analyses of flow data for the determination of erosion indices.

By applying the single storm events (2- to 100- year and Regional event), the GAWSER model was used to determine the design flow hydrographs along water courses and size the proposed SWM facilities for the subject study area. The model was also used for continuous simulations for the purposes of erosion control analysis and hydrologic flow regime analysis. The meteorological input data (hourly rainfall series, temperature, and wind speed) for continuous simulation was directly retrieved from the original GAWSER model provided by CH. It was obtained from the Hamilton Royal Botanical Garden (Hamilton RBG) gauge station (#615330) and extends from 1962 to 1992.

7.4.2 Existing Conditions

The North Oakville EIR/FSS ToR states that, "*The modeling of predevelopment conditions to establish unit flow rate targets for quantity (flood) control (2-year through Regional Storm flows) purposes has been completed as part of NOCSS. Further modelling of predevelopment conditions is not required for this purpose. SWM ponds are to be sized to meet unit flow rate targets*."

However, it has been recognized that the background data to support the model for predevelopment conditions used in NOCSS is outdated. Therefore, it is prudent to revise the original GAWSER model to reflect the latest existing sub-catchment drainage boundaries for the West Branch of Fourteen Mile Creek from NOCSS based on 2002 Town's topographic mapping. Furthermore, the drainage areas from the existing Highway 407 corridor and the existing Regional Road No.5 (Dundas Street) were also delineated and included in the revised existing conditions model. The resulting peak flows (2-year through Regional Storm flows) from the revised model are deemed to be the target flows for the proposed developments.

The comparison of the drainage areas to all EIR Flow Nodes (including Culverts at Highway 407 and Culverts at Dundas Street) between the original NOCSS and the current study are presented in Table 7.4.1. Table 7.4.2 lists the original Unit Flow Rates (UFRs) and Peak Flow Rates (PFRs) from NOCSS. The revised UFRs and PFRs for all EIR Flow Nodes are summarized in Table 7.4.3. Figure 7.4.1 shows the revised existing catchments. The GAWSER model schematic for existing conditions is shown in Figure 7.4.1-SCH. All other detailed information, including catchment parameters are included in Appendix 7.2. Appendix 7.2 also includes a comprehensive flow table (Table APP-7.2) including the existing peak flows from the GAWSER model at all EIR Flow Nodes (Culverts at Highway 407 and Dundas Street) and all Reference Flow Nodes.

Table 7.4.1 – Comparison of Catchment Areas between Original NOCSS and Updated Study

To EIR Nodes		Existing Drainage Area (ha)		Difference (%)	EIR Sub-catchment
		NOCSS	WSP*		
Culverts at HWY 407	FM-1	149.4	118.5	-21%	FM 1001
	FM-2	29.4	27.3	-7%	FM 1002
	FM-3	125.7	119.1	-5%	FM 1003A, FM 1003B
	FM-4	7.3	6.8	-7%	FM 1004
	FM-5	30.3	35.6	17%	FM 1005
	FM-6	33.5	33.6	0%	FM 1006
	FM-7	162.8	170.8	5%	FM 1007A, FM1007B, FM1007C, FM1007D
	FM-8	5.3	5.9	12%	FM 1008
Culverts at Dundas Street	FM-D2	46.6	31.4	-33%	FM1102
	FM-D3	11.7	14.4	23%	FM 1103
	FM-D4	424.0	397.2	-6%	FM1001, FM1002, FM1104, FM1003A, FM1003B, FM1004, FM 1105
	FM-D4a	15.2	16.5	9%	FM1106
	FM-D5	340.0	350.5	3%	FM1005, FM1006, FM1007A, FM1007B, FM1007C, FM1007D, FM1008, FM1108, FM1107, FM1109
Total		1381.2	1327.6	-4%	

* WSP updated drainage areas based on 2002 Town of Oakville topographic mapping.

Table 7.4.2 – Unit Flow Rates and Peak Flow Rates from Original NOCSS

EIR Node		Original NOCSS Drainage Area (ha)	Flow Type[1]	Return Period (Year)						
				2	5	10	25	50	100	Regional
Culverts at HWY 407	FM-1	149.4	UFR ($m^3/s/ha$)	0.006	0.010	0.012	0.015	0.017	0.020	0.049
			PFR (m^3/s)	0.94	1.48	1.79	2.27	2.59	2.93	7.32
	FM-2	29.4	UFR ($m^3/s/ha$)	0.008	0.012	0.015	0.019	0.021	0.024	0.056
			PFR (m^3/s)	0.23	0.36	0.43	0.55	0.63	0.71	1.65
	FM-3	125.7	UFR ($m^3/s/ha$)	0.006	0.009	0.011	0.014	0.016	0.018	0.047
			PFR (m^3/s)	0.71	1.14	1.40	1.79	2.05	2.32	5.95
	FM-4	7.3	UFR ($m^3/s/ha$)	0.001	0.004	0.006	0.008	0.010	0.012	0.041
			PFR (m^3/s)	0.01	0.03	0.04	0.06	0.08	0.09	0.30
	FM-5	30.3	UFR ($m^3/s/ha$)	0.004	0.008	0.011	0.014	0.017	0.020	0.052
			PFR (m^3/s)	0.13	0.25	0.33	0.44	0.51	0.59	1.57
	FM-6	33.5	UFR ($m^3/s/ha$)	0.005	0.009	0.011	0.015	0.018	0.021	0.055
			PFR (m^3/s)	0.15	0.29	0.38	0.51	0.60	0.69	1.83
	FM-7	162.8	UFR ($m^3/s/ha$)	0.006	0.010	0.013	0.016	0.019	0.021	0.053
			PFR (m^3/s)	0.99	1.64	2.05	2.65	3.05	3.48	8.68
	FM-8	5.3	UFR ($m^3/s/ha$)	0.001	0.008	0.013	0.019	0.024	0.029	0.073
			PFR (m^3/s)	0.01	0.04	0.07	0.10	0.13	0.15	0.39
Culverts at Dundas Street	FM-D2	46.6	UFR ($m^3/s/ha$)	0.007	0.011	0.013	0.017	0.020	0.022	0.054
			PFR (m^3/s)	0.31	0.51	0.62	0.80	0.92	1.04	2.50
	FM-D3	11.7	UFR ($m^3/s/ha$)	0.010	0.016	0.019	0.024	0.028	0.031	0.065
			PFR (m^3/s)	0.12	0.19	0.23	0.28	0.32	0.36	0.76
	FM-D4	424.0	UFR ($m^3/s/ha$)	0.006	0.010	0.012	0.015	0.017	0.020	0.049
			PFR (m^3/s)	2.62	4.17	5.09	6.49	7.42	8.39	20.96
	FM-D4a[2]	15.2	UFR ($m^3/s/ha$)	0.013	0.020	0.024	0.030	0.035	0.039	0.073
			PFR (m^3/s)	0.20	0.31	0.37	0.46	0.53	0.59	1.11
	FM-D5	340.0	UFR ($m^3/s/ha$)	0.006	0.010	0.013	0.017	0.019	0.022	0.055
			PFR (m^3/s)	2.01	3.43	4.35	5.68	6.60	7.56	18.73

1) UFR = Unit Flow Rate, PFR = Peak Flow Rate

2) Since UFR at culvert FM-D4A is not specified in NOCSS, the UFR based on Existing Flow from Original NOCSS Model Catchment FM-1106 is used

Table 7.4.3 – Revised Unit Flow Rates and Peak Flow Rates from Current Study

EIR Node		Original NOCSS Drainage Area (ha)	Flow Type[1]	Return Period (Year)						
				2	5	10	25	50	100	Regional
Culverts at HWY 407	FM-1	118.5	UFR ($m^3/s/ha$)	0.006	0.010	0.012	0.015	0.017	0.020	0.049
			PFR (m^3/s)	0.75	1.17	1.42	1.80	2.05	2.32	5.80
	FM-2	27.3	UFR ($m^3/s/ha$)	0.008	0.012	0.015	0.019	0.021	0.024	0.056
			PFR (m^3/s)	0.21	0.33	0.40	0.51	0.58	0.66	1.53
	FM-3	119.1	UFR ($m^3/s/ha$)	0.006	0.009	0.011	0.014	0.016	0.018	0.047
			PFR (m^3/s)	0.68	1.08	1.32	1.69	1.94	2.20	5.64
	FM-4	6.8	UFR ($m^3/s/ha$)	0.001	0.004	0.006	0.008	0.010	0.012	0.041
			PFR (m^3/s)	0.01	0.03	0.04	0.06	0.07	0.08	0.28
	FM-5	35.6	UFR ($m^3/s/ha$)	0.004	0.008	0.011	0.014	0.017	0.020	0.052
			PFR (m^3/s)	0.16	0.29	0.38	0.51	0.60	0.70	1.84
	FM-6	33.6	UFR ($m^3/s/ha$)	0.005	0.009	0.011	0.015	0.018	0.021	0.055
			PFR (m^3/s)	0.15	0.29	0.38	0.51	0.60	0.69	1.83
	FM-7	170.8	UFR ($m^3/s/ha$)	0.006	0.010	0.013	0.016	0.019	0.021	0.053
			PFR (m^3/s)	1.04	1.73	2.15	2.78	3.20	3.65	9.11
	FM-8	5.9	UFR ($m^3/s/ha$)	0.001	0.008	0.013	0.019	0.024	0.029	0.073
			PFR (m^3/s)	0.01	0.05	0.08	0.11	0.14	0.17	0.44
Culverts at Dundas Street	FM-D2	31.4	UFR ($m^3/s/ha$)	0.007	0.011	0.013	0.017	0.020	0.022	0.054
			PFR (m^3/s)	0.21	0.34	0.42	0.54	0.62	0.70	1.69
	FM-D3	14.4	UFR ($m^3/s/ha$)	0.010	0.016	0.019	0.024	0.028	0.031	0.065
			PFR (m^3/s)	0.15	0.23	0.28	0.35	0.40	0.44	0.93
	FM-D4	397.2	UFR ($m^3/s/ha$)	0.006	0.010	0.012	0.015	0.017	0.020	0.049
			PFR (m^3/s)	2.46	3.90	4.77	6.08	6.95	7.86	19.63
	FM-D4a[2]	16.5	UFR ($m^3/s/ha$)	0.013	0.020	0.024	0.030	0.035	0.039	0.073
			PFR (m^3/s)	0.21	0.33	0.40	0.50	0.57	0.64	1.20
	FM-D5	350.5	UFR ($m^3/s/ha$)	0.006	0.010	0.013	0.017	0.019	0.022	0.055
			PFR (m^3/s)	2.07	3.54	4.48	5.85	6.80	7.80	19.31

1) UFR = Unit Flow Rate, PFR = Peak Flow Rate

2) Since UFR at culvert FM-D4A is not specified in NOCSS, the UFR based on Existing Flow from Original NOCSS Model Catchment FM-1106 is used

7.4.3 Post-Development Conditions

7.4.3.1 Development Phasing

As previously discussed in Section 7.3.2, since the development of the site and the construction of the infrastructures (e.g., SWM facilities, roads, culverts, etc.) will not occur simultaneously, progressive development phases are adopted for the proposed study. The detailed description of the development phases is summarized in Table 7.3.1.

7.4.3.2 Post-Development Drainage Boundaries

A preliminary grading plan for the proposed development was prepared and discussed in Section 8.0. The proposed grading was developed to ensure integration with neighbouring lands, cores, linkages and receiving watercourses through all interim development phases and under ultimate development condition. Post-development sub-catchment boundaries have been delineated based on this preliminary grading plan and are shown in Figures 7.4.2, 7.4.3, 7.4.4 and 7.4.5 for the Phase 1A, Phase 1B, Phase 2 and Ultimate Development Condition respectively. Note that the drainage areas reflecting the proposed expansion of Regional Road No.5 (Dundas Street) are included in post-development models. A comparison of the drainage area between the existing and all proposed development conditions at EIR Flow Nodes located at Culverts at Dundas Street West is provided in Table 7.4.4.

Table 7.4.4 – Comparison of Existing and Post-Development Drainage Areas

To EIR Nodes	Existing Drainage Area (ha) *	Phase 1A		Phase 1B		Phase 2		Ultimate Condition	
		Drainage Area (ha)	Difference (ha) from Existing	Drainage Area (ha)	Difference (ha) from Existing	Drainage Area (ha)	Difference (ha) from Existing	Drainage Area (ha)	Difference (ha) from Existing
FM-D2	31.4	31.3	-0.1	31.3	-0.1	31.3	-0.1	40.1	8.7
FM-D3	14.4	0.0	-14.4	0.0	-14.4	0.0	-14.4	0.0	-14.4
FM-D4	397.2	413.5	16.3	413.2	16.0	420.0	22.7	410.8	13.5
FM-D4a	16.5	16.5	0.0	16.7	0.2	14.3	-2.2	14.3	-2.2
FM-D5	350.5	350.5	0.0	350.5	0.0	346.1	-4.4	346.1	-4.4
Total	810.0	811.8	1.8	811.7	1.7	811.7	1.6	811.3	1.2

* WSP updated drainage areas based on 2002 Town of Oakville topographic mapping.

As indicated in Table 7.4.4, the differences of the overall drainage areas between the existing conditions and all interim phases and ultimate conditions are negligible. However, note that under existing conditions, culvert FM-D3 conveys runoff from Catchment 1103 and drains across Dundas St. to a municipal ditch on the road's south side, which discharges to Fourteen Mile Creek immediately south of Culvert FM-D4. Since this ditch functions as conveyance only with no natural heritage features requiring surface flow contributions, it will be eliminated during the proposed development conditions. Under the proposed conditions (all interim phases and ultimate conditions), drainage to culvert FM-D3 together with flows from the section of the proposed Dundas Street expansion (Catchment 1502) will be redirected a proposed Pond 2 and ultimately discharge to Fourteen Mile Creek located upstream of Dundas Street and pass through culvert FM-D4. The detailed discussions on the proposed SWM plans developed for all interim phases and ultimate conditions are provided in the following sections.

7.4.3.3 Conveyance of Minor System Flows

The Subject Property will be serviced by a conventional storm sewer system designed in accordance with Town's standards. The storm sewers will be sized using a 5-year return frequency and the current Town's IDF curves. All runoff from the development areas will be conveyed to the proposed SWM facilities for the study area. The collected runoff will be treated for water quality and quantity control with extended detention for erosion control. The detailed discussions on the proposed SWM design developed for all interim phases and ultimate conditions are provided in the following sections.

7.4.3.4 Conveyance of Major Storm Flows

A design for the 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 Regional 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/s. All overland flow routes will be directed to the SWM facilities. 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. A detailed storm sewer design is discussed in Section 8.0.

7.4.3.5 Post-Development Hydrologic Analysis

In the GAWSER hydrologic 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. A s previous indicated in Section 7.4.2, the West Branch of Fourteen Mile Creek catchments north of Dundas Street were sub-divided into several sub-catchments to reflect the revised existing conditions in the NOCSS study, as shown in Figure 7.4.1. This model was updated to represent the post-development catchment boundaries as shown in Figures 7.4.2, 7.4.3, 7.4.4 and 7.4.5 for Phases 1A, 1B, 2 and Ultimate Conditions, respectively. This was accomplished by changing GAWSER input parameters representing sub-catchment areas and hydrograph parameters. The GAWSER model schematics for the proposed conditions are illustrated in Figures 7.4.2-SCH, 7.4.3-SCH, 7.4.4-SCH and 7.4.5-SCH for Phases 1A, 1B, 2 and Ultimate Conditions, respectively. The catchment parameters for the proposed conditions are included in Appendix 7.2.

The post-development drainage plans as simulated in the GAWSER model for each interim phases and ultimate development conditions are summarized as follows. Section 7.8 discuss the design of the proposed SWM facilities. The drainage areas associated with each proposed SWM facility are summarized in Table 7.8.1.

Phase 1A (Figure 7.4.2)

A section of Avenue Two and a section of Burnhamthorpe Road Extension will be constructed in Phase 1A. The proposed SWM Pond 2 will be constructed to control runoff from the proposed development west of Reach 14W-12 (Catchment 3090) and a section of proposed expansion of Dundas Street West (Catchment

1502) for the storms up to Regional event. Note that flows from Catchment 3000 will also be diverted to Pond 2.

Phase 1B (Figure 7.4.3)

In additional to the development plan of Phase 1A, re-alignment of Reach 14W-21 and 1Reach 4W-22 will occur during Phase 1B. A section of Avenue Three will also be completed. The proposed SWM Pond 3 will be structured to provide controls for the development east of Reach 14W-22 and Reach 14W-12 (Catchments 3200 and 3201). Flows from Catchment 3100 located north of Burnhamthorpe Road Extension will also be diverted to Pond 3. The proposed SWM Pond 3 was design to provide controls for storms up to Regional event.

In order to allow a uniform and sustained level of flow to be maintained in the Reach 14W-12A channel, flows from rooftops of the proposed buildings (2.56ha, Catchment 2309) together with runoff from the existing undeveloped Catchments 2399 (7.68 ha) and local drainage Catchment 4011 will bypass the proposed SWM Pond 3 and be diverted to Reach 14W-12A. Section 7.6 discusses hydrologic flow regime analysis in details. Note that, it has been widely recognized that the runoffs from the building rooftop are considered as clean; therefore, oil-grit separators (OGS) are not required to provide treatment for such areas. Since the application of such strategy requires the detailed locations of the building rooftops, for the conceptual design purposes, it is assumed that the roof drains will be installed at rooftops of the proposed buildings to provide a controlled unit flow rate of 41 L/s/ha at a maximum water depth of 0.15 m on the rooftops. Information on the conceptual design of rooftop controls are included in the Appendix 7.6. The results of the proposed roof controls, including the roof release rates, water ponding depths, utilized ponding storages for the various storm events from 2- to 100- year and Regional storm, are included in the Appendix 7.6. It confirms that it is feasible to implement the required rooftop controls for the subject developments. Detailed design of roof drains and STM connections will be provided during detailed engineering design stage.

Phase 2 (Figure 7.4.4)

The entire lands of Subject Property including Block C3-4 (Azevedo Property) will be developed during Phase 2. Reach 14W-23 will be re-aligned and a section of Avenue One will be completed. The proposed SWM Pond 3 will capture and control flows from the entire development east of Reach 14W-22 and Reach 14W-12 (Catchment 3100 and 3200). Again, the proposed SWM Pond 3 was designed to provide controls for storms up to Regional event.

Note that flows from rooftops of the proposed buildings with a total area of 5.12 ha (Catchment 2309) will be diverted to Reach 14W-12A directly to allow a uniform and sustained level of flow to be maintained in the subject receiving reach. As described previously, it is assumed that the roof drains will be installed at rooftops of the proposed buildings to provide a controlled unit flow rate of 41 L/s/ha at a maximum water depth of 0.15 m on the rooftops. Section 7.6 discusses hydrologic flow regime analysis in details. Again, because the strategy requires the site plan to indicate the final proposed locations of the building rooftops, detailed design on roof drains and STM connections will be provided during detailed engineering design stage. The results of the proposed roof controls, including the roof release rates, water ponding depths, utilized ponding storages for the various storm events from 2- to 100- year and Regional storm, are included in the Appendix 7.6. It confirms that it is feasible to implement the required rooftop controls for the subject developments.

Ultimate Development Conditions (Figure 7.4.5)

Under ultimate development conditions, the lands located west of the Subject Property will be developed (Catchments 3000, 3060, 3050). All associated roads will be competed. These developments will be controlled by additional three SWM Facilities, including Pond 1, Pond 5 and Tremaine Pond (as per Tremaine and Dundas Secondary Plan Subwatershed Study, 2009). Similar to Phase 2, flows from rooftops of the proposed buildings with a total area of 5.12 ha (Catchment 2309) will be diverted to Reach 14W-12A directly to allow a uniform and sustained level of flow to be maintained in the subject receiving reach. Note that it is assumed that the roof drains will be installed at rooftops of the proposed buildings to provide a controlled unit flow rate of 41 L/s/ha at a maximum water depth of 0.15 m on the rooftops. The drainage from the area west of Tremaine Road (Subcatchment 3300) may be diverted to Culvert FM-D1 if it is supported by the detailed analysis in conjunction with the development on the west side of Tremaine Road. However, in the current study, the flows from such Subcatchment 3300 are assumed to continue draining to the east side of Tremaine and discharge to Culvert FM-D2.

Similarly, information on the conceptual design of rooftop controls are included in the Appendix 7.6. The results of the proposed roof controls, including the roof release rates, water ponding depths, utilized ponding storages for the various storm events from 2- to 100- year and Regional storm, are included in the Appendix 7.6. It confirms that it is feasible to implement the required rooftop controls for the subject developments. Detailed design of roof drains and STM connections will be provided during detailed engineering design stage.

7.4.3.6 Results of GAWSER model for Post-Development Conditions

All interim development phases and ultimate development conditions are simulated by using GAWSER hydrological model by incorporating:

- Water quantity controls by the proposed SWM facilities together with the identified rooftop storage for the proposed buildings (during Phase 1B, 2 and Ultimate) for events up to Regional storm through design of the proposed SWM facilities (Section 7.8);
- Erosion controls by providing adequate erosion storage with orifice controls of the proposed SWM facilities through an erosion control analysis (Section 7.5); and,
- Division of clean runoff from proposed building rooftops to allow a uniform and sustained level of flow to be maintained in the Reach 14W-12A channel through a hydrologic flow regime analysis (Section 7.6).

For illustration purposes, Table 7.4.5 provides a comparison of resulting Regional flows between the existing conditions and post-development conditions, including interim phases and ultimate conditions at their respective EIR Flow Nodes along Dundas Street and all Reference Flow Nodes within the study area. The post-development flows for all other storm events (including 2- to 100- year and Region storm) are included in a comprehensive flow table (Table APP-7.2) in the Appendix 7.2.

Table 7.4.5 – Comparison of Existing and Post-Development Peak Flow Rates for Regional Events

Flow Node Name		Peak Flow Rates for Regional Event (m^3/s)				
		Existing Condition	Phase 1A	Phase 1B	Phase 2	Ultimate Condition
EIR Flow Nodes	FM-D2	1.73	1.73	1.73	1.73	1.40
	FM-D3	0.93	-	-	-	-
	FM-D4	19.34	19.14	18.49	18.94	17.76
	FM-D4A	1.23	1.23	1.25	1.07	1.07
	FM-D5	19.71	19.71	19.71	19.33	19.33
Reference Flow Nodes	1	10.29	10.21	10.06	10.04	9.44
	1A	10.20	10.10	10.00	9.98	9.39
	1B	8.22	8.22	8.11	8.10	8.02
	2	8.23	8.23	0.86	0.22	0.22
	2C	7.88	7.88	-	-	-
	2B	-	-	6.68	6.67	6.50
	2A	-	-	7.29	6.89	6.72
	3A	18.45	18.36	17.29	16.83	16.11
	3B	19.22	18.70	18.04	18.36	17.34
	3	19.22	19.00	18.34	18.83	17.64
	4	20.34	19.14	18.49	18.94	17.76
	5	3.79	3.79	3.79	3.38	3.38
	6	-	-	-	6.52	6.35
	7	-	-	-	7.95	7.87
	8	-	-	-	0.52	0.52
	9	3.06	3.06	3.06	2.69	2.69

As indicated in Table 7.4.5 and Table APP-7.2 in the Appendix 7.2, with proposed SWM facilities, the peak flows for all post-development conditions will be controlled to those under the existing conditions for all design storms including 2 to 100-year and Regional events. Consequently, the investigation of the potential increases to flood risk for the entire downstream watercourse to its outlet at Lake Ontario is not required by NOCSS. However, we understand that the quantity controls of upstream reaches would delay the peak flows to correspond more closely with the timing of the peak flow in the main branch; thereby, causing the potential increases in peak flows in the receiving watercourse downstream. As a prudent measure, a hydrological analysis for the entire Fourteen Mile Creek subwatershed was carried out to determine the flows at downstream locations and ensure there would be no impact due to the development at subject lands located at upstream of the subwatershed during Regional storm conditions. The Regional control downstream impact is discussed in Section 7.9.

7.5 Erosion Control Analysis

As noted in the North Oakville EIR and FSS ToR, erosion thresholds are meant to be integrated into a SWM system design in such a manner that existing channel erosion or aggradation is not exacerbated. The recommended method for assessing pre- and post-development erosion potential is to perform erosion threshold modelling. Erosion threshold represents the point at which sustained flows will tend to entrain and transport sediments. The critical shear stress represents the erosion threshold value, which when exceeded, creates erosive tendencies in the channel bed and banks.

The 14 Mile Creek Tributaries Fluvial Geomorphological and Erosion Threshold Assessment report completed by Water's Edge on October 21, 2013 (included in Appendix 7.1) assessed the Fourteen Mile Creek tributaries and summarized critical shear stresses and critical flows for relevant reaches. The summarized values in the report were used to establish erosion control in previous WSP EIR/FSS submissions. As part of the erosion control analysis, critical flow values of 0.25 m^3/s for Reach C and 1.48 m^3/s for Reach B were used. Both values generated exceedances that were not acceptable to CH. CH required that the differences in erosion exceedances (duration and frequency) between existing conditions and proposed conditions (including all interim conditions and ultimate development conditions) are within a 5% limit.

Following a peer review memo by Ecosystem Recovery, Water's Edge was requested to clarify and confirm their erosion threshold recommendations, which were deemed inconsistent and unclear by the peer reviewer. As a result, Water's Edge prepared a memo to WPS dated March 10, 2016 (included in Appendix 7.1), recommending to run the erosion control analysis based on Reach D (critical flow = 0.96 m^3/s), which was determined to be the most sensitive reach based on the findings of both Ecosystem Recovery and Water's Edge. Another memo was issued by Water's Edge (May 3, 2017) to address comments from CH and the Town, concerning the selection of critical flows, reaches, and erosion threshold calculations (included in Appendix 7.1).

To perform the erosion control analysis, a continuous simulation was performed by using the GAWSER hydrologic model. Continuous simulation models can determine the potential cumulative impacts of multiple SWM facilities on the upstream and downstream development areas and calculate erosion indices by examining the historical rainfall records and the flow rates in the watercourse. For the subject study, the meteorological input data (hourly rainfall series, temperature, and wind speed) for the GAWSER model was obtained from the Hamilton RBG gauge station (#615330) with a 30-year of records from 1962 to 1992.

Erosion exceedance analysis was conducted using a critical flow of 0.96 m^3/s for Reach D upstream of Dundas Street (Reference Node 3). The modelling process adopts a trial and error approach which includes a considerable number of attempts by adjusting outlet structures of the proposed SWM facilities (e.g., sizes and inverts of the orifice plates) to achieve the computational target (i.e., 5% of exceedance difference).

A summary of the erosion exceedance analysis results is shown in Table 7.5.1. The determined detention times required to release the 25 mm erosion control storages for each proposed SWM facility for all interim phases and ultimate conditions are summarized in Table 7.5.2. All other related information is included in Appendix 7.3.

Table 7.5.1 – Results of Erosion Control Analysis for Reach D Upstream of Dundas Street (Reference Node 3)

Development Conditions	Drainage Area (ha)	Hours		Pulses	
		Exceedance	Difference	Exceedance	Difference
Existing	395.4	719	N/A	99	N/A
Phase 1A	400.3	755	5.01%	102	3.03%
Phase 1B	400.0	731	1.67%	97	-2.02%
Phase 2	406.7	752	4.59%	97	-2.02%
Ultimate Condition	406.7	754	4.87%	94	-5.05%

Table 7.5.2 – SWM Ponds Detention Times for Erosion Controls

Pond #	Detention Time for Erosion Control (Hr)	
	Phase 1A, Phase 1B and Phase 2	Ultimate Conditions
Pond 2	47.3	47.3
Pond 3	53.4	41.3
Pond 5	N/A	46.9
Pond 1	N/A	42.4

As shown in Table 7.5.1, by utilizing the SWM facilities during all interim phases and under ultimate development conditions, all the duration and frequency exceedances are within the 5% margin specified in the EIR/FSS ToR. Therefore, it can be concluded that no further erosion analysis is needed. Impacts of these changes on the pre-development flow regime, including aquatic habitat and sediment transport are discussed in Section 7.6 of Hydrologic Flow Regimes Analysis.

Note that, to achieve the specified exceedances limits for all interim phase and ultimate development conditions, an adjustment of the outlet structure to reduce the detention time of Pond 3 will be required under ultimate development conditions (Table 7.5.2). Section 7.8 will discuss the design of the SWM facilities in detail.

7.6 Hydrologic Flow Regimes Analysis

The Hydrologic Flow Regime Analysis is included in Appendix 7.4 – Hydrologic Flow Regimes Analysis Calculations. The analysis discusses impacts on streamflow regime during three typical years: Dry Year, Wet Year, and Average Year. Monthly flows have been compared based on magnitude, duration and frequency. For impacts on Reach 14W-12A, Reach 14W-22, and Reach 14-W23, the results show the following key findings:

- For Reach 14W-12A, impact on streamflow regime is inevitable due to the proposed development. To allow a uniform and sustained level of flow to be maintained in the Reach 14W-12A channel, measurements are proposed to provide required surface runoff compensation to the Reach. It includes diverting flows from rooftops of the proposed buildings and/or from the existing undeveloped catchments. Table 7.6.1 provides a summary of the required surface runoff compensation measurements to the Reach 14W-12A during all development phases.

Table 7.6.1 – Summary of Surface Water Compensation to 14W-12A

Phase	Runoff Compensation Measures								
	Flow from Local NHS Area			Flow from Rooftop of Proposed Building			Flow from Pre-Development Surface Drainage Area (Open Space)		
	Area ID	Area (ha)	Imp (%)	Area ID	Area (ha)	Imp (%)	Area ID	Area (ha)	Imp (%)
1a	Not Req.								
1b	4011	0.57	2	2309	2.56	100	2399	7.68	5
2	4011	0.57	2	2309	5.12	100	Not Req.		
Ultimate	4011	0.57	2	2309	5.12	100	Not Req.		

The Flow Regimes Analysis indicates that with the proposed measurements, the peak flows under all development phases are capable of filling the wetted perimeter and sustaining continuity downstream to Reach 14W-12. This has been presented via cross sections from the HEC RAS model, to confirm hydraulic conditions. The channel is not sustained by sediment entrainment flows and geomorphic functions as noted in Appendix 7.1 (i.e., field investigation by WSP staff);

- For Reach 14W-22, there is no impact to duration and frequency of monthly flows. Magnitude of peak flows on a monthly basis are expected to decrease by 15 to 20%, which is a minor impact, due to a reduced drainage area. The peak flows under all development phases are capable of filling the wetted perimeter and sustaining continuity downstream to Reach 14W-12. This has been presented via cross sections from the HEC RAS model, to confirm hydraulic conditions. Sediment entrainment flows (10% exceedance) are maintained; and,
- For Reach 14W-23, there is no impact to duration and frequency of monthly flows. Magnitude of peak flows on monthly basis are expected to decrease by 15 to 20%, which is a minor impact due to a reduced drainage area. The peak flows under all development phases are capable of filling the wetted perimeter and sustaining continuity downstream. This has been presented via cross sections from the HEC RAS model, to confirm hydraulic conditions. Sediment entrainment flows (10% exceedance) are maintained

7.7 Topographic Depression Volumes

The NOCSS document recommends that surface storage volumes in area topographic depressions be identified and comparisons be made to SWM facility storage. Further clarification was provided as part of a mediation agreement, provided Mediation Item: Depressional Storage (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 (man-made) created storage was to be excluded from this evaluation. As also described in this agreement, to ensure that the storage volume of the depression areas is maintained, the calculated depression volume was to be compared to the proposed SWM facility volume within the 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 subject development property are shown in Figure 7.7.1 and listed in Table 7.7.1.

Table 7.7.1 – Topographic Depressions in the Subject Property Development Area

ID	Drainage Direction	NOCSS Classification	Proposed Development (Ultimate)
1	Fourteen Mile Creek West: Culvert FM-D4	Topographic Depression	Replaced by Employment Development Block
2	Fourteen Mile Creek West: Culvert FM-D4	Topographic Depression	Replaced by Employment Development Block
3	Fourteen Mile Creek West: Culvert FM-D4	Topographic Depression	Replaced by Employment Development Block
4	Fourteen Mile Creek West: Culvert FM-D4	Hydrologic Feature 'A'	Replaced by Employment Development Block Realignment of Reach 14W-14
5	Fourteen Mile Creek West: Culvert FM-D4	Hydrologic Feature 'A'	Replaced by Proposed SWM Pond 3
6	Fourteen Mile Creek West: Culvert FM-D4	Hydrologic Feature 'A'	Remain Existing Reach 14W-16
7	Fourteen Mile Creek West: Culvert FM-D4	Hydrologic Feature 'B'	Remain Existing Reach 14W-16
8	Fourteen Mile Creek West: Culvert FM-D4	Hydrologic Feature 'B'	Replaced by Proposed SWM Pond 5
9	Fourteen Mile Creek West: Culvert FM-D3	Hydrologic Feature 'B'	Replaced by Employment Development Block

A detailed topographic survey of the development area was carried out by WSP (formally MMM) in 2011 including topographic depressions. As indicated in Table 7.7.1, depression storage analysis will not be carried out for Depressions 6 and 7 as they will be kept its original condition in the post-development conditions. Depression storage analysis will not also be carried out for Depressions 5 and 8 as they will be replaced by proposed SWM facilities. In addition, Depression 1 is located in relatively flat area and could not be identified during the topographic survey. Therefore, topographic depressional storage analysis was carried out for Depressions 2, 3, 4 and 9 within the Subject Property development area. The topographic depressional storages were estimated using Civil3D software and are presented in Table 7.7.2.

Table 7.7.2 – Depressional Storage Calculations

ID	Calculated Dep. Storage (m^3)	Within Drainage Area of Pond No.	Available Storage in SWM Facilities
2	18	SWM Pond 3	Permanent Pool Volume = 28,690 m^3 Active Storage (100-Year) - Simulated/Modelled = 24,381 m^3 Active Storage (Regional) - Simulated/Modelled = 64,583 m^3
3	5		
4	21		
9	120	SWM Pond 2	Permanent Pool Volume = 10,431 m^3 Active Storage (100-Year) = 13,981 m^3 Active Storage (Regional Control) = 40,505 m^3

The total volume of Depression 2, 3, 4 and 9 is significantly less than the proposed SWM facility volume as presented in Table 7.7.2. Therefore, no additional analysis or change to the SWM facility design is required.

7.8 Design of Stormwater Management Facilities

7.8.1 General

The hydrological models developed for the subject study area include a total of five (5) SWM facilities (wet ponds) under ultimate development conditions. As shown in Figure 7.4.5, the locations of the wet ponds have been sited based on the principle of maintaining existing drainage patterns and flow regimes in the undisturbed channel reaches to the extent practicable. As previously indicated in Section 7.3.2 and shown in Table 7.3.1, the proposed SWM facilities will be constructed progressively in accordance with the development phases. Section 7.4.3.5 discusses the modelling approach for these proposed SWM facilities during all interim phase and ultimate development conditions. The drainage areas for the proposed SWM wet ponds in the subject study is provided in Table 7.8.1. A brief summary of each proposed SWM wet pond is provided as follows:

- Pond 2: It will be constructed during Phase 1A and located on the south-west side of Reach 14W-12. It will provide all required controls for the developments within the Subject Property and a section of the Dundas Street expansion area (refer to Section 7.8.2 for details). During ultimate development conditions, Pond 2 will also provide controls for an area located west of the Subject Property and south of the proposed Pond 1;

- Pond 3: It will be constructed from Phase 1B and located on the east side of Reach 14W-12. It will replace the existing depression #5 Hydrologic Feature 'A' as shown in Figure 7.7.1. Pond 3 will provide all required controls for the developments within the Subject Property. During ultimate development conditions, Pond 3 will also provide controls for an area immediately outside of the property boundary, located west of Reach 14W-22 and south of Highway 407 (Catchment 3080). Note that, during interim phases and ultimate development conditions, flows from certain pond contributing areas (e.g., rooftops of the proposed buildings and/or undeveloped existing areas) will be diverted to bypass the Pond 3 and discharge directly to Reach 14W-12A to allow a uniform and sustained level of flow to be maintained in the receiving reach;

- Pond 5: It will be constructed under ultimate conditions. Pond 5 will provide controls for the development immediately outside of the Subject Property boundary located west of Reach 14W-16 and east of Tremaine Road, south of Highway 407. A portion of Pond 5 Block will also replace an existing depression #8 Hydrologic Feature 'B' as shown in Figure 7.7.1;

- Pond 1: It will be constructed under ultimate conditions. Pond 1 will provide controls for the development immediately outside of the Subject Property boundary located between the proposed Avenue Two and Tremaine Road north of Dundas Street. Note that an area located south of the Pond 1 where flows cannot be captured by the Pond 1 will drain to proposed Pond 2 for the required treatments; and,

  Tremaine Pond: It will be constructed during ultimate development conditions. The pond will be located west of Tremaine Road and south of Highway 407. It is one of the three SWM facilities recommended in the Tremaine and Dundas Secondary Plan Subwatershed Study (2009) for the West Branch of Fourteen Mile Creek drainage areas west of Tremaine Road and south of Highway 407. For the modelling purposes, Tremaine Pond is included in the GAWSER model to properly

determine the post-development flows along the downstream watercourses under ultimate development conditions. Since the Tremaine Pond will be located within the Tremaine and Dundas Secondary Plan Subwatershed Study (2009) area, the design of such pond will be carried out in the future study and is not considered in this study.

Table 7.8.1 – Drainage Areas for the Proposed SWM Ponds

Pond #	Phase 1A		Phase 1B		Phase 2		Ultimate	
	Drainage Area (ha)	Imperviousness (%)	Drainage Area (ha)	Imperviousness (%)	Drainage Area (ha)	Imperviousness (%)	Drainage Area (ha)	Imperviousness (%)
Pond 2	17.8	89	17.8	89	17.8	89	20.8	89
Pond 3	-	-	24.6	50	37.0	90	39.9	90
Pond 1	-	-	-	-	-	-	23.6	88
Pond 5	-	-	-	-	-	-	14.4	88

This section of the report documents the outline design work completed for SWM Ponds 2, 3, 5 and 1, which includes preliminary grading proposals, design of the outlet control structures, and hydrologic modelling to verify compliance with the target discharge rates at all downstream EIS flow nodes and reference flow nodes. Preliminary calculations have been undertaken to confirm that the allowances of the blocks of these proposed SWM facilities are adequate. All the proposed facilities will be designed to provide stormwater quality (enhanced level), erosion and quantity control (up to Regional event) in accordance with the criteria referred to in the NOCSS.

7.8.2 Dundas Street Expansion

As previously discussed in Section 7.4, the proposed expansion of Regional Road No.5 (Dundas Street) were included in the post-development model for the subject study. All related data required for the modelling purposes regarding the design of the proposed expansion are obtained from the Environmental Study Report (ESR) - Dundas Street Class EA Study Brant Street to Bronte Road, MMM Group, May 2015. On-site controls will be provided for the most sections of the proposed Dundas Street expansion, except a section of the area (Catchment 1502), which will drain and be treated by the proposed Pond 2 located within the Subject Property. All related information regarding the Dundas Street Expansion catchments, including the catchment parameters, modelling results and the reverent sections/drawings of the ESR report are included in the Appendix 7.5.

Note that the existing culvert FM-D2 (C21A) at Dundas Street is an 825 mm diameter CSP culvert. As indicated in ESR (MMM, May 2015), during the Regional Storm event, Dundas Street will be overtopped. Therefore, the existing culvert FM-D2 (C21A) will be replaced by a new 1050 mm diameter concrete culvert to convey the Regional Storm flow.

7.8.3 Pond Design Overview and Control Criteria

The SWM facilities were designed as 'wet ponds' in accordance with the Section 4.6.2 of the 2003 Ontario Ministry of the Environment (MOE) Stormwater Management Planning and Design Manual (SWMPDM). The specific SWM facilities requirements provided in the Town of Oakville Development Engineering Procedures

& Guidelines Manual were also adhered to. Major and minor stormwater flows will be conveyed to the pond facilities by the proposed storm sewer and overland flow system. Section 8.0 discusses the sewer design in detail. All required facility functions are provided in a single depression with an internal barrier berm to separate the facility into a forebay and a main treatment cell. Major and minor flow from the drainage area will enter the forebay for gross particulate settling and erosive energy dissipation. Flow then enters the main cell where a combination of treatment actions, similar to plug flow and continuous flow reactor dynamics allow for water quality treatment of raw stormwater flows. Treated flow exits the facility at the downstream end through the outlet control structure. The outlet structure consists of a flow control MH configured with an orifice-controlled reverse slope pipe draining flow from the deeper pool areas of the main cell, a flow weir and an orifice-controlled outflow pipe draining to the downstream. An emergency spillway provides capability for each SWM ponds to pass the uncontrolled Regional flows if the outlet structure is blocked, or otherwise non-functional. Further details on the design targets for the outlet control structures are set out in the following sections.

The identified control criteria of the pond design are summarized as follows:

- Water Quality (Section 7.8.4): The proposed SWM facilities will be designed to meet MOECC's Enhanced Level of water quality protection (Level 1) for water quality control, phosphorus control and fisheries protection;

- Erosion Control (Section 7.8.5): In accordance with the results from the detailed erosion threshold analyses, the proposed SWM facilities will be designed to provide erosion controls extended detention so that the existing channel erosion or aggradation is not exacerbated by development;

- Water Quantity (Section 7.8.6): The proposed SWM facilities will be designed to provide water quantity (flood) controls for the 2-year to 100-year return period events and the Regional storm;

- Water Balance: No specific SWM facility functions are required at this design stage to address site-wide water balance issues. Please see Section 4.0 for specific information on how water balance issues are addressed.

A summary of the key SWM facilities design features, alongside the minimum requirements set out in the MOECC and Town's guidance documents, is provided at the end of Section 7.8.8 in Table 7.8.9. The following sections discuss the designs of the proposed SWM facilities in details.

7.8.4 Water Quality Control

Table 3.2 of the MOECC's SWM Planning & Design Manual (2003) sets out the volumetric storage requirements for various types of SWM facility to achieve different levels of water quality protection. The proposed SWM facilities in the subject study are targeting an 'Enhanced Level' of water quality treatment (long-term removal of 80% of total suspended solids), in line with MOE recommendations. Table 7.8.2 below summarises the calculations undertaken to determine the required permanent pool volumes in each pond, and demonstrates that the volumes provided in the preliminary grading design exceed these requirements. Note that all facilities for water quality controls are designed based on ultimate development conditions.

Table 7.8.2 – Summary of SWM Pond Permanent Pool Requirements under Ultimate Development Conditions

Element	Pond 2	Pond 3	Pond 1	Pond 5
Drainage Area (ha) [1]	20.8	39.9	23.6	14.4
Imperviousness (%)	89	90	88	88
Storage Criteria for Enhanced Level Treatment (m^3/ha) [2]	257	258	255	255
Storage Required for Enhanced Level Treatment (m^3)	5,331	10,295	6,005	3,672
Permanent Pool Storage Required (m^3)	4,501	8,701	5,063	3,096
Water Quality Extended Detention (m^3) [3]	830	1,594	942	576
Permanent Pool Volume Provided (m^3)	9,497	23,678	14,564	3,679

1) Drainage areas for each SWM ponds are based on the identified proposed development areas and exclude the rooftop areas which will bypass the SWM pond and drain to the receiving water courses directly.
2) Based on interpolation of storage volumes from MOECC Table 3.2 – includes permanent pool volume and 40 m^3/ha allowance for extended detention.
3) Based on 40 m^3/ha as per MOECC Table 3.2 – typically exceeded by Erosion Control Extended Detention requirements.

It is confirmed that the permanent pool volumes provided by all proposed SWM facilities exceed the minimum requirements for 'Enhanced Level' treatment calculated in accordance with the MOECC SWM Planning & Design Manual. All detailed SWM facility calculations are included in Appendix 7.6.

An operations and maintenance manual will be provided at the detailed design stage for those who will assume responsibility for maintaining the facilities. It will cover the appropriate monitoring and maintenance activities that should be followed to keep the facility in good working order. It will also cover the requirements for removal of accumulated sediment/TSS at the base of the pond. A preliminary monitoring program has been outlined in Appendix 7.8.

Note that to allow a uniform and sustained level of flow to be maintained in the Reach 14W-12A channel, starting Phase 1B through ultimate development conditions, flows from rooftops of the proposed buildings and/or runoff from the existing pre-developed areas will bypass the proposed SWM Pond 3 and be diverted to Reach 14W-12A. Since it has been widely recognized that the runoff from the building rooftops is considered as clean, additional water quality treatment (e.g., oil-grit separator) is not required for such areas.

According to the North Oakville Subwatershed Management Strategy (July 12, 2007), mediation item on total phosphorus, a "no net increase in the total phosphorus" can be ensured using SWM facilities providing enhanced level of control. Therefore, if ponds are designed with enhanced level of control, there will be no requirement to analyze total phosphorus in subsequent studies.

According to the North Oakville Subwatershed Management Strategy (July 12, 2007), mediation item on DO, a target of 6 mg/L was set, which is the provincial standard. Excerpts from the mediation item indicate:
"*With respect to DO, Enhanced Level requirements for SWM facility design do not specifically address DO performance levels. Therefore, DO targets and monitoring are for the purposes of collecting data on the functioning of these facilities from a DO perspective. It will be analyzed to determine their function with respect to DO, but results will not impact pond assumption*."

7.8.5 Extended Detention Erosion Control

CH required that the differences in erosion exceedances (duration and frequency) between existing conditions and proposed conditions (including all interim conditions and ultimate development conditions) are within a 5% limit, so that the existing channel erosion or aggradation is not exacerbated by development. To meet such criteria, an erosion control analysis was undertaken for the receiving watercourses (refer to Section 7.5 for details). Furthermore, based on discussion with the Town staff, the drawdown times for the 25 mm storm event in each SWM facility are required to be between 24 to 48 hrs. This requirement dictated the size of the orifice plates that control discharge from the reverse-slope pipes. The required sizes were calculated using the falling head orifice equation – and the results are summarised below in Table 7.8.3. Full calculations are provided in Appendix 7.6.

Table 7.8.3 –Summary of SWM Pond Erosion Control Design

Element	Pond 2	Pond 3		Pond 1	Pond 5
Required Extended Detention Storage for Erosion Control (m^3) [1]	4,162	7,994		4,639	2,837
Provided Extended Detention Storage for Erosion Control (m^3)	7,155	12,381		7,552	4,926
Permanent Pool Elevation (m)	146.69	146.20		152.00	153.00
Extended Detention Elevation (m)	147.64	147.00		153.00	154.20
Max. Extended Detention Depth (m)	0.95	0.80		1.00	1.20
Development Phases	Ultimate Conditions	Phase 1A, Phase 1B and Phase 2	Ultimate Conditions	Ultimate Conditions	Ultimate Conditions
Orifice Diameter (mm)	200	255	290	215	155
Peak Outflow Rate (m^3/s)	0.078	0.117	0.149	0.096	0.054
Drawdown Time (hours)	47.3	53.4	41.3	42.4	46.9

1) Calculated runoff volume during a 25 mm rainfall event provided by hydrologic modelling.

As shown in above Table 7.8.3, with properly sized orifice plates, all proposed SWM facilities will be able to retain adequate erosion control volumes and release them for 24 to 48 hours during the ultimate development conditions. Note that in order to maintain the differences in erosion exceedances between existing conditions and proposed conditions (including all interim conditions and ultimate development conditions) within a 5% limit (Table 7.5.1), the orifice plate for Pond 3 needs to be adjusted under ultimate development conditions

(change orifice plate from 255 mm diameter to 290 mm diameter). Furthermore, as previously mentioned in Section 7.5, the modelling process adopts trial and error approach. Best efforts have been made during the process to achieve the target of the 5% of exceedance difference. The final results of the erosion analysis modeling show that the drawdown time for Pond 3 during interim conditions (i.e., Phases 1A, 1B and 2) has to be relatively longer than 48 hours (i.e., 53.4 hours) in order to meet the 5% limits. Such increase is acceptable, since it is insignificant and will only occur during interim phases.

Note that the drawdown times for the 25 mm storm event in each facility were calculated using the falling head orifice equation and based on Equation 4.10 in SWM Planning and Design Manual (MOECC, March 2003) for erosion control purposes. During less frequent events (e.g., 5 to 100-year events), excess water will flow through high flow control structures (e.g., weir and spillway as later described in Section 7.8.6). The times required to drain the water for each facility through high flow control structures were obtained from the outflow hydrographs as the outputs from the GAWSER model. Appendix 7.6 includes summary tables of the calculated total drawdown times (including both flows through low flow orifice for erosion control and high flow weir and spillway for quantity controls) related to each design storm for SWM Ponds 2 and 3.

7.8.6 SWM Forebay Design

A sediment forebay is required at inlet of each SWM ponds to settle out most of the sediment load within an area that can be accessed for maintenance. According to MOECC's design manual, the forebay length should be greater than or equal to the larger of the settling and dispersion lengths. Table 7.8.4 provides a summary of the minimum forebay dimensions for each SWM ponds.

Table 7.8.4 – Summary of SWM Pond Forebay Design

Element		Pond 2	Pond 3	Pond 1	Pond 5
Sediment Forebay	Minimum Forebay Length (m)	21.56	22.58	22.54	15.36
	Minimum Bottom Width (m)	2.70	2.82	2.82	1.92
	Maximum Forebay Surface Area	33% of Total Pond Area	33% of Total Pond Area	33% of Total Pond Area	33% of Total Pond Area

The location of the forebay for each pond is shown in the drawings of the servicing plans included in the Section 8.0. Detailed forebay calculations are included in Appendix 7.6.

7.8.7 Water Quantity Control

All proposed SWM facilities were design to provide quantity/flood control for storm events up to the Regional storm. For design purposes, the required quantity control storages for all facilities were determined based on the ultimate development conditions and were evaluated and confirmed through the model simulations for all interim conditions. The target discharge rates for each SWM facility was established based on the existing flows at the relevant locations during ultimate development conditions. Once the designs were complete for the facility grading, the stage-storage-discharge relationships (facility rating curves) were determined based on the designed flow control structures. The rating curves were then tested in the hydrologic model to verify compliance with the target flow rates as established in Section 7.4.2. It was achieved by comparing the post-development flows for all interim phases and ultimate development conditions with the defined target flows at at the respective EIR Flow Nodes along Dundas Street and all Reference Flow Nodes within the study area.

The control structure for each of the facilities includes three elements which are described as follows:

1) Low Flow Control (Erosion Control): a reversed pipe connecting the bottom of the outlet to a control manhole (integrated with flow weirs) where an orifice plate installed at the invert of the reversed pipe (upstream side of control manhole) was sized to meet erosion control criteria;

2) High Flow Control (Flood Control up to Regional Storm Event): a control manhole integrated with one (1) or two (2) flow weirs. Such control manhole is installed at the extended detention (erosion control) elevation. A properly sized pipe connecting the control manhole to the downstream is required for water quantity controls and to ensure the flow can route through the facility during major storm events up to Regional storm event. A second orifice plate is installed at the pipe invert located at the downstream side of the control manhole; and,

3) Emergency Spill: The emergency spillway is constructed 0.10 m above the designed Regional flow elevations to guard against the possibility that the outlet structures are blocked, or otherwise non-functional. As per identified design criteria, a freeboard allowance of a minimum 0.30 m above the designed Regional flow elevations is also provided.

Tailwater Assessment

Due to the site constraints, some proposed SWM Ponds will have submerged outlet conditions, which will potentially impact the pond design and result in reduced water heads on the outlets (i.e., parameter *h* in the orifice equation and weir equation). To properly evaluate the potential outlet blockages associated with the ponds, tailwater conditions have been assessed and incorporated in the required pond design for the proposed development. Based on the assessment, water heads of Pond 3 were reduced to reflect the submerged outlet conditions during the Regional storm event. This was achieved by giving a higher invert elevation (to reflect the reduced water head values) of the orifice at outlet control MH in the pond design.

Details of the outlet control structures are summarised below in Table 7.8.5, and full calculations for the facility design including stage-storage-discharge relationship are included in Appendix 7.6. Details on a conceptual design of the outlet structure, including locations, dimensions, pond cross sections, etc., are

provided in the drawings included in Section 8.0. Note that the current study provides preliminary designs for each proposed SWM facility servicing the developments in the subject study areas as per the EIR/FSS ToR. Detailed SWM designs will be required during consequent development application process.

Table 7.8.5 – Summary of SWM Pond Outlet Control Structures

Element		Pond 2	Pond 3	Pond 1	Pond 5
Low Flow Control	Reversed Pipe Orifice Invert - Permanent Pool Elevation (masl)	146.69	146.20 (at Permanent Pool); 146.39 (for Tailwater Analysis)	152.00	153.00
	Reversed Pipe Orifice Diameter (mm)	200	290 (Ultimate) 255 (All Interim)	215	155
Flow Control MH (Flood Control up to Regional Event)	Weir Invert - Erosion Control Extended Detention - (masl)	147.64	147.00	153.00	154.20
	Weir Width/Opening (m)	2.00	2.00	2.00	2.00
	Invert of a Pipe Connecting the Control MH to D/S	146.69	146.20 (at Permanent Pool); 146.39 (for Tailwater Analysis)	152.00	153.00
	D/S Pipe Orifice Diameter (mm)	270	400	350	240
	High Flow Weir (2nd Weir) - Width/Opening (m)	Not required	Not required	Not required	0.80
	High Flow Weir (2nd Weir) - Invert (masl)	Not required	Not required	Not required	157.10
Emergency Spill (to pass uncontrolled Regional Flows)	Spillway Invert - (masl)	150.84	149.88	156.10	157.36
	Spillway Width (m)	15.00	20.00	15.00	10.00
Freeboard	Top of Regional Storm Storage Elevation (masl) - Provided	150.74	149.78	156.00	157.26
	Top of Regional Storm Storage Elevation (masl) - Simulated/Modelled	150.63	149.47	155.84	157.26
	Top of Pond Elevation including Freeboard (masl)	151.44	151.00	156.75	157.80
	Freeboard Depth (m)	0.81	1.53	0.91	0.54

1) For Phases 1A, 1B and 2
2) Under Ultimate Development Condition

Appendix 7.6 contains calculations that determine the stage-storage-discharge relationship for the outlet control configurations described above. These discharge relationships were then used to run the hydrologic model for all post-development conditions, and verify that the target discharge rates were being achieved. The following Tables 7.8.6, 7.8.7, 7.8.8 and 7.8.9 summarise the modelled inflow, simulated outflow rates and utilized active storage volumes in Ponds 2, 3, 1 and 5 respectively by using the GAWSER model, for each return period under ultimate development conditions.

Table 7.8.6 – Model Results of Proposed Pond 2 under Ultimate Development Conditions

Storm Events	Inflow (m^3/s)	Target Outflow (m^3/s)	Simulated Outflow (m^3/s)	Utilized Storage (ha*m)	Elevations (m)
2-Yr	0.698	0.107	0.071	0.6166	147.84
5-Yr	0.974	0.165	0.078	0.8721	147.87
10-Yr	1.146	0.198	0.094	0.9939	147.95
25-Yr	1.361	0.250	0.133	1.1700	148.13
50-Yr	1.523	0.284	0.157	1.2759	148.25
100-Yr	1.683	0.319	0.184	1.3981	148.38
Regional	1.842	0.787	0.301	4.0505	150.63

Table 7.8.7 – Model Results of Proposed Pond 3 under Ultimate Development Conditions

Storm Events	Inflow (m^3/s)	Target Outflow (m^3/s)	Simulated Outflow (m^3/s)	Utilized Storage (ha*m)	Elevations (m)
2-Yr	0.925	0.253	0.118	1.1951	146.97
5-Yr	1.281	0.390	0.184	1.5270	147.15
10-Yr	1.492	0.467	0.231	1.7237	147.27
25-Yr	1.788	0.590	0.300	2.0154	147.44
50-Yr	1.996	0.670	0.329	2.1959	147.54
100-Yr	2.207	0.754	0.344	2.4381	147.66
Regional	3.233	1.857	1.438	6.4583	149.47

Table 7.8.8 – Model Results of Proposed Pond 1 under Ultimate Development Conditions

Storm Events	Inflow (m^3/s)	Target Outflow (m^3/s)	Simulated Outflow (m^3/s)	Utilized Storage (ha*m)	Elevations (m)
2-Yr	0.796	0.165	0.087	0.6808	152.90
5-Yr	1.111	0.269	0.150	0.8843	153.14
10-Yr	1.306	0.332	0.198	0.9930	153.25
25-Yr	1.555	0.426	0.269	1.1543	153.43
50-Yr	1.739	0.490	0.303	1.2553	153.53
100-Yr	1.923	0.557	0.318	1.3884	153.68
Regional	2.266	1.299	0.497	3.9624	155.84

Table 7.8.9 – Model Results of Proposed Pond 5 under Ultimate Development Conditions

Storm Events	Inflow (m^3/s)	Target Outflow (m^3/s)	Simulated Outflow (m^3/s)	Utilized Storage (ha*m)	Elevations (m)
2-Yr	0.487	0.100	0.049	0.4302	154.10
5-Yr	0.679	0.153	0.067	0.5756	154.40
10-Yr	0.799	0.182	0.090	0.6501	154.54
25-Yr	0.951	0.229	0.125	0.7598	154.74
50-Yr	1.063	0.260	0.145	0.8262	154.87
100-Yr	1.176	0.292	0.168	0.9028	155.01
Regional	1.385	0.715	0.342	2.5943	157.26

A comparison of resulting Regional flows between the existing conditions and controlled post-development conditions, including interim phases and ultimate conditions at the respective EIR Flow Nodes along Dundas Street and all Reference Flow Nodes within the study area is previously shown in Table 7.4.5. The resulting post-development flows for all other storm events (including 2 to 100-year and the Regional storm) are included in a comprehensive flow table (Table APP-7.2) in the Appendix 7.2. Preliminary details of the proposed SWM facilities are provided in Section 8.0.

Note that, as indicated previously, rooftop storages have been proposed for the proposed developments for the purpose of hydrologic flow regimes analysis for the Reach 14W-12A channel. Such rooftop storages were incorporated in the hydrological models for the proposed conditions. Details are discussed in Section 7.4.3. Information on the conceptual design of rooftop controls are included in the Appendix 7.6. The results of the proposed roof controls, including the roof release rates, water ponding depths, utilized ponding storages for the various storm events from 2- to 100- year and Regional storm, are included in the Appendix 7.6.

7.8.8 Thermal Mitigation

According to the North Oakville Subwatershed Management Strategy (July 12, 2007), mediation item on temperature and DO targets, a conservative maximum daily temperature target of 20^0C needs to be maintained. Excerpts from the mediation item indicate:

"*SWM facilities will incorporate measures to address temperature reduction where feasible and practical. It is agreed that there are limited measures available to be used for temperature reduction including pond, outfall and creek plantings, bottom draw outlets, pond configuration and outfall cooling trenches…..Should post construction show that temperature targets are not being met where these types of measures are included in pond design, it is recognized that there may be very limited opportunities to further reduce temperatures….In other words, best efforts use of acceptable measures for temperature reduction on SWM facilities is required*."

All proposed SWM facilities within the subject study area are designed to incorporate 3.0 m permanent pool depths. Based on discussions with CH, MNRF and the Town staff, it has been recognized that deeper permanent pool will provide benefits for the thermal mitigation as required by the NOCSS.

7.8.9 Summary of SWM Pond Design

Preliminary designs have been completed for the four (4) SWM facilities (wet ponds) associated with the subject study area. The designs are in line with the MOECC and the Town's design guidelines. Each facility will provide water quality treatment (to 'Enhanced Level'), erosion control (24- to 48-hour detention of the 25 mm storm event and maintain the differences of erosion exceedance within 5% for post-development conditions), and water quantity control functions – such that controlled release rates for all events from the 2 to 100-year return periods and Regional storm are within the targets set by hydrologic modelling, in order to maintain existing flow regimes in the receiving reach. Table 7.8.10 below provides a summary of the design features of each SWM facility, and compares them to the criteria suggested by the MOECC and the Town's design guidelines.

The proposed facilities meet all the 'minimum criteria', plus many of the 'preferred criteria' as well.

Table 7.8.10 – Summary of Pond Design Criteria

Design Element	MOE Minimum Criteria	MOE Preferred Criteria	Town of Oakville Criteria	Pond 2	Pond 3	Pond 1	Pond 5
Drainage Area	5 ha.	> 10 ha.	-	17.8 ha [1) 2) 3)] 20.8 ha [4)]	24.6 [2)] 37.0 [3)] 39.9 [4)]	23.6 [4)]	14.4 [4)]
Treatment Volume [5)]	As per table 3.2.	Increase PP by max. expected ice vol.	-	PP vol. approx. 132% above minimum MOE Table 3.2 requirement.	PP vol. approx. 230% above minimum MOE Table 3.2 requirement.	PP vol. approx. 188% above minimum MOE Table 3.2 requirement.	PP vol. approx. 19% above minimum MOE Table 3.2 requirement.
		Increase active storage to 25% of total volume		Active storage 72% of total vol.	Active storage 55% of total vol.	Active storage 63% of total vol.	Active storage 74% of total vol.
Active Storage Detention	24 hours	24 hours		47.3 hrs [4)]	53.4 hrs [1) 2) 3)] 41.3 hrs [4)]	42.4 [4)]	46.9 [4)]
Forebay	Min. Depth 1.0 m	Min. Depth 1.5 m	Min. Depth 1.5 m	Depth 3.0 m	Depth 3.0 m	Depth 3.0 m	Depth 3.0 m
	Min. Forebay Length based on Settling and Dispersion Calculations (m)			21.56	22.58	22.54	15.36
	Min. Forebay Bottom Width based on 1/8 of the Forebay Length (m)			2.70	2.82	2.82	1.92
	Max. Area 33% of PP			Max. Area 33% of PP	Max. Area 33% of PP	Max. Area 33% of PP	Max. Area 33% of PP
Length to Width Ratio	Overall Min. 3:1	From 4:1 to 5:1	Min. 3:1	Forebay approx. 3:1	Forebay approx. 2:1	Forebay approx. 3:1	Forebay approx. 3:1
	Forebay Min. 2:1			Overall approx. 4:1	Overall approx. 4:1	Overall approx. 4:1	Overall approx. 4:1
Permanent Pool Depth	Max. Depth 3 m	Max. Depth 2.5 m	Min. Depth 1.2 m	3.00 m	3.00 m	3.00 m	3.00 m
	Mean Depth 1-2 m	Mean Depth 1-2 m					
Active Storage Depth	Water Quality & Erosion Control Max. 1.5 m	Water Quality & Erosion Control Max. 1.0 m		Water Quality & Erosion Control: 0.95 m	Water Quality & Erosion Control: 0.80 m	Water Quality & Erosion Control: 1.00 m	Water Quality & Erosion Control: 1.20 m
	Total Depth 2.0 m (100-yr event)	Total Depth 2.0 m (100-yr event)	Max. Depth 2.0 m (100-yr event)	100-Year Depth: 1.69 m [6)] Regional Depth: 3.94 m [7)]	100-Year Depth: 1.46 m [6)] Regional Depth: 3.27 m [7)]	100-Year Depth: 1.68 m [6)] Regional Depth: 3.84 m [7)]	100-Year Depth: 2.01 m [6)] Regional Depth: 4.26 m [7)]

Design Element	MOE Minimum Criteria	MOE Preferred Criteria	Town of Oakville Criteria	Pond 2	Pond 3	Pond 1	Pond 5
Side Slopes	5:1 for 3 m either side of PP Max. 3:1 elsewhere	7:1 near normal water level plus use of 0.3 m steps 4:1 elsewhere	Min. 7:1 3 m either side of PP Min. 5:1 to upper limit of extended detention Min. 4:1 below the '7:1' zone Min. 3: 1 elsewhere	As per Oakville criteria (exceeds MOE requirements)	As per Oakville criteria (exceeds MOE requirements)	As per MOE criteria	As per MOE criteria
Inlet	Min. Pipe Dia. 450 mm Slope > 1%	-	At PP elevation or max. 0.3 m above	Exceeds minimum criteria.	Exceeds minimum criteria.	Exceeds minimum criteria.	Exceeds minimum criteria.
Outlet	Min. Pipe Dia. 450 mm Reverse Slope Pipe Min. Dia. 150 mm Slope > 1% Orifice Min. Dia. 75 mm	Orifice Min. Dia. 100 mm	Primary outlet to be bottom draw	Exceeds minimum criteria. Orifice 200 mm dia.	Exceeds minimum criteria. Orifice 255 mm dia. 1) 2) 3) 290 4)	Exceeds minimum criteria. Orifice 215 mm dia.	Exceeds minimum criteria. Orifice 155 mm dia.
Buffer	Min. 7.5 m above max. water quality/erosion control level Min. 3 m above water quantity control level	-	7.5 m buffer beyond 100-year high water level (max. buffer grade 10%)	As per Oakville criteria (exceeds MOE requirements)	As per Oakville criteria (exceeds MOE requirements)	As per Oakville criteria (exceeds MOE requirements)	As per Oakville criteria (exceeds MOE requirements)

1) Phase 1A
2) Phase 1B
3) Phase 2
4) Ultimate Development Conditions
5) Ultimate Development Conditions as Most Conservative Scenarios
6) 100-Year depth based on the calculated utilized storage volume from the model for 100-year simulations
7) Regional Storm depth based on the calculated utilized storage volume from the model for Regional storm simulations

A pre- and post-construction monitoring plan for the different SWM facilities, realigned reaches, and different municipal infrastructures is provided in Appendix 7.8. The monitoring plan outlined in Appendix 7.8 describes the monitoring strategy and the items to be monitored.

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 proposed SWM facilities within the Subject Property are designed to provide Regional controls for the developments. Therefore, an investigation of the potential increase to flood risk is not required as per NOCSS. However, we understand that the quantity controls of upstream tributaries would delay the peak flows to correspond more closely with the timing of the peak flow in the main branch, thereby, causing the potential increases in peak flows in the receiving watercourse downstream. As a prudent measure, a hydrological analysis for the entire Fourteen Mile Creek subwatershed was carried out to determine the flows at downstream locations and ensure there would be no impact due to the development at subject lands located at upstream of the subwatershed during Regional storm conditions.

The original hydrological model was obtained from the "*Fourteen Mile Creek and McCraney Creek System Flood Mitigation Opportunities Study*" provided the Town. The model was developed by using PCSWMM model for the entire Fourteen Mile Creek sub-watershed. The resulting post-development hydrographs at Reference Node 4 (immediate downstream of culvert FM-D3 at Dundas Street) from GAWSER model for the Regional event scenarios were input to the same flow node location in PCSWMM model (Conduit # 3660.527, PCSWMM Node # DS1 as shown in Figures APP-7.7.1 and APP-7.7.2). The results of the Regional peak discharge rates at downstream locations along Fourteen Mile Creek from PCSWMM simulations are summarized in Table 7.9.1. Table 7.9.1 also provides a comparison between existing, uncontrolled and controlled conditions for all interim and ultimate development scenarios.

Table 7.9.1 – Downstream Regional Flow Comparison

PCSWMM Downstream Flow Node			DS1	DS2	DS3	DS4	DS5	DS6
PCSWMM Catchment			215	210	110	108	107	101
Location			Dundas Rd	Richview Blvd	Bronte Rd	Fourteen Mile Lands	HWY 403	Lake Ontario
Area (ha)			408	457	1063	1605	2318	3118
Existing		Regional Flow (m^3/s)	20.3	23.2	89.9	139.8	192.6	243.2
PH1A	Uncontrolled	Regional Flow (m^3/s)	20.6	23.8	90.5	140.4	193.2	243.7
		% difference	1.3%	2.7%	0.7%	0.5%	0.3%	0.2%
	Controlled	Regional Flow (m^3/s)	19.1	21.9	88.7	138.6	191.5	242.2
		% difference	-5.9%	-5.8%	-1.3%	-0.9%	-0.6%	-0.4%
PH1B	Uncontrolled	Regional Flow (m^3/s)	20.5	23.9	90.6	140.5	193.3	243.8
		% difference	0.5%	3.0%	0.8%	0.5%	0.4%	0.2%
	Controlled	Regional Flow (m^3/s)	18.5	21.5	88.5	138.3	191.3	242.0
		% difference	-9.1%	-7.3%	-1.6%	-1.0%	-0.7%	-0.5%
PH2	Uncontrolled	Regional Flow (m^3/s)	22.1	26.2	92.9	142.8	195.4	245.8
		% difference	8.8%	12.9%	3.3%	2.1%	1.4%	1.0%
	Controlled	Regional Flow (m^3/s)	18.2	20.9	87.9	137.7	190.8	241.5
		% difference	-10.8%	-10.0%	-2.3%	-1.5%	-1.0%	-0.7%
Ultimate	Uncontrolled	Regional Flow (m^3/s)	23.2	27.5	94.3	144.1	196.6	246.8
		% difference	14.0%	18.5%	4.8%	3.1%	2.1%	1.5%
	Controlled	Regional Flow (m^3/s)	17.4	20.1	87.2	137.0	190.2	241.1
		% difference	-14.5%	-13.2%	-3.0%	-2.0%	-1.2%	-0.9%

As shown in Table 7.9.1, with the proposed SWM facilities providing Regional controls for the developments within the study area, peak flows at all downstream flow nodes along Fourteen Mile Creek to its outlet at Lake Ontario will be lower than the existing levels during Regional event. Consequently, it is confirmed that there will be no impact to the downstream watercourses due to the development of the Subject Property located upstream of the sub-watershed.

Details of this analysis are provided in Appendix 7.7. Appendix 7.7 also includes Figure APP-7.7.1 which shows the PCSWMM sub-catchment boundary plan. PCSWMM model schematic is also included in Figure APP-7.7.2 in Appendix 7.7.

7.10 Summary

In accordance with NOCSS and the EIR/FSS ToR, a SWM plan has been developed for the Subject Property within the 407 West Employment Area. The following provides a summary for the developed SWM plan.

- Water Quantity: The SWM facilities are sized to control of post-development peak flows to pre-development levels for the 2 to 100-year return period events and the Regional storm.

- Water Quality: The SWM facilities are designed to meet MOECC's Enhanced Level of water quality protection (Level 1) for water quality control, phosphorus control and fisheries protection.

- Erosion Control: The detailed erosion threshold analyses including a fluvial geomorphological study were performed to ensure the proposed SWM facilities would provide adequate erosion control protection for the downstream watercourses, so that existing channel erosion or aggradation is not exacerbated by development.

- Hydrologic Flow Regimes Analysis: A comprehensive investigation of impact of development has been carried out on all flow nodes within the Subject Property. Where reaches were to be realigned or where habitat concerns had been communicated with the study team, detailed assessments were incorporated. Specifically, the magnitude of peak flows will decrease by approximately 15 to 20% from existing conditions for Reach 14W-22, and Reach 14W-23, and the duration and frequency will be similar. For 14W-12A, although significant reductions in streamflows are anticipated, the wetted perimeter and continuity of the flows will be maintained.

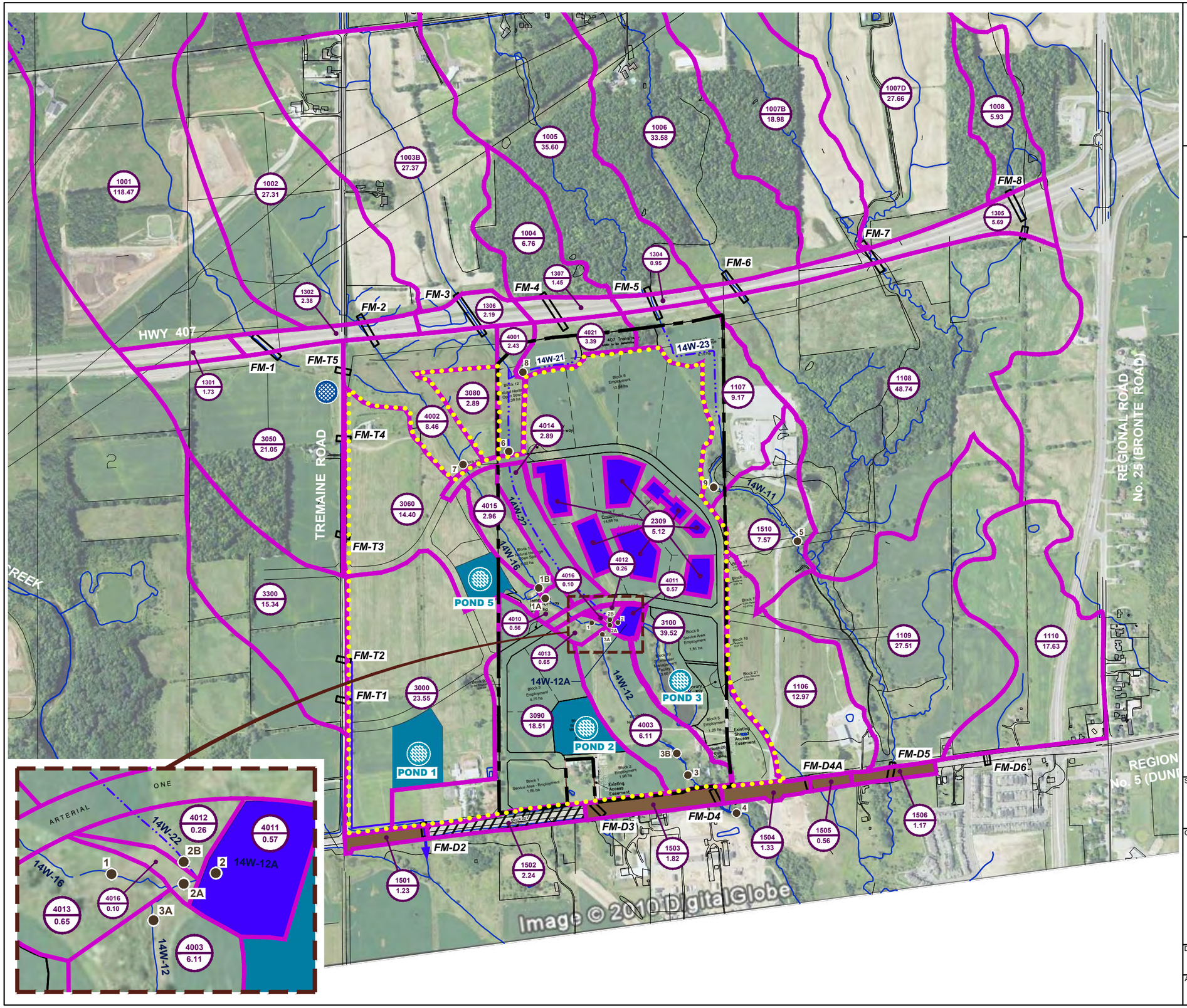
- Topographic Depression Volumes: Evaluation of the existing depression storage was performed to ensure that the natural depression storage would be maintained in the SWM system.

- SWM Pond Design: The SWM facilities are design to meet all the criteria as enforced by the MOECC and in accordance with the Town's design guidelines.

- Downstream Impacts for Regional Storm: The proposed SWM facilities will provide Regional controls for the developments within the subject lands, and as such, there will be no impact to the downstream watercourses due to the developments of the Subject Property located at upstream of the sub-watershed.

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

Ultimate Drainage Boundaries and Reference Nodes



LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- PROPOSED REALIGNED CREEK
- CULVERTS (EIR NODES)
- 3000 / 7.82 — SUB-CATCHMENT No. / AREA (ha)
- PROPOSED SWM POND (INTERIM)
- 1 — REFERENCE NODE
- DEVELOPMENT BOUNDARY
- POND 2 DRAINAGE AREA
- SWM BLOCKS
- DUNDAS ST. CONTROLS BY ON-SITE STORAGE AND DRAINS TO DOWNSTREAM
- DUNDAS ST. DRAINS TO POND 2
- POND 3 DRAINAGE AREA
- AREA DRAINS TO 14W-12A (REF. NODE 2)
- TREMAINE POND DRAINAGE AREA
- POND 5 DRAINAGE AREA
- POND 1 DRAINAGE AREA

Scale: 1 : 10,000 (0 0.1 0.2 0.3 0.4 0.5km)

Client: QuadReal

Prepared by: WSP

Date: June 2018

Project No.: 09M-00013-01-WR1

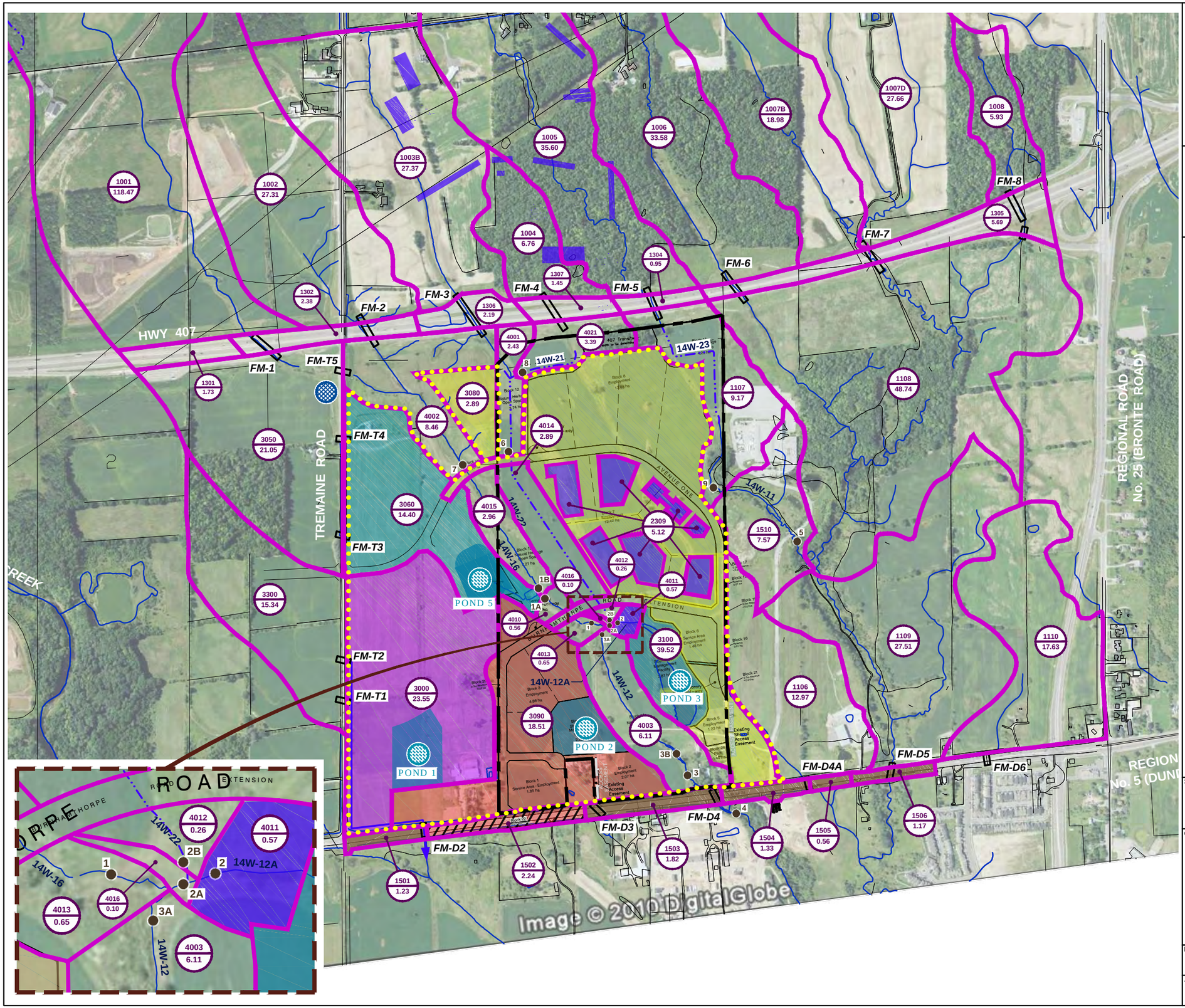
Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 7.4.5

FIGURE 7.4.5.dwg - Ultimate Drainage Boundaries & Reference Nodes T:\14-41\1140\9222-001-WR1\REPORT 18 MAY 2020\FIGURES SERIES 7\ Jun 01, 2020 - 12:29am

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

Ultimate Drainage Boundaries and Reference Nodes



LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- PROPOSED REALIGNED CREEK
- CULVERTS (EIR NODES)
- SUB-CATCHMENT No. (3000) / AREA (ha) (7.82)
- PROPOSED SWM POND (INTERIM)
- REFERENCE NODE (1)
- DEVELOPMENT BOUNDARY
- POND 2 DRAINAGE AREA
- SWM BLOCKS
- DUNDAS ST. CONTROLS BY ON-SITE STORAGE AND DRAINS TO DOWNSTREAM
- DUNDAS ST. DRAINS TO POND 2
- POND 3 DRAINAGE AREA
- AREA DRAINS TO 14W-12A (REF. NODE 2)
- TREMAINE POND DRAINAGE AREA
- POND 5 DRAINAGE AREA
- POND 1 DRAINAGE AREA

Scale: 1 : 10,000 (0 0.1 0.2 0.3 0.4 0.5km)

Client: QuadReal

Prepared by: wsp

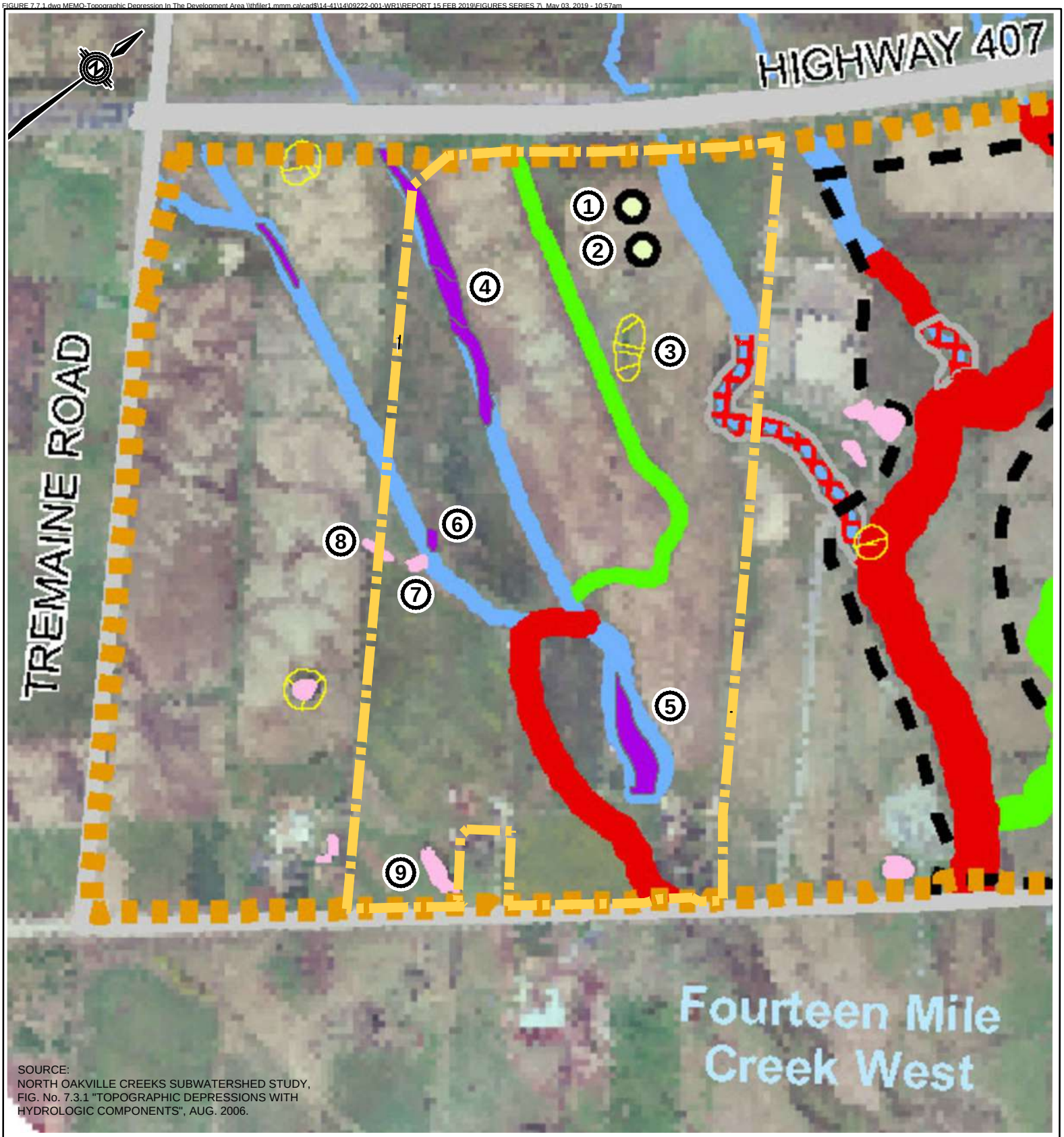
Date: April 2019

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 7.4.5

FIGURE 7.4.5.dwg - Ultimate Drainage Boundaries & Reference Nodes \\thfiler1.mmm.ca\cad$\14-411\409222-001-WR1\REPORT 15 FEB 2019\FIGURES SERIES 7\ Apr 26, 2019 - 6:35pm



SOURCE:
NORTH OAKVILLE CREEKS SUBWATERSHED STUDY, FIG. No. 7.3.1 "TOPOGRAPHIC DEPRESSIONS WITH HYDROLOGIC COMPONENTS", AUG. 2006.

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

Topographic Depression in the Development Area

LEGEND

- Secondary Plan Boundary
- Core
- Linkage
- Hydrologic Feature 'A'
- Hydrologic Feature 'B'
- Topographic Depressions (with Hydrologic Component)
- Topographic Depressions
- Watercourse

Stream Corridor

- High Constraint
- High Constraint - Requiring Rehabilitation
- Medium Constraint
- Low Constraint

Scale: 0 0.1 0.2 0.3 0.4 0.5km

Client: QuadReal

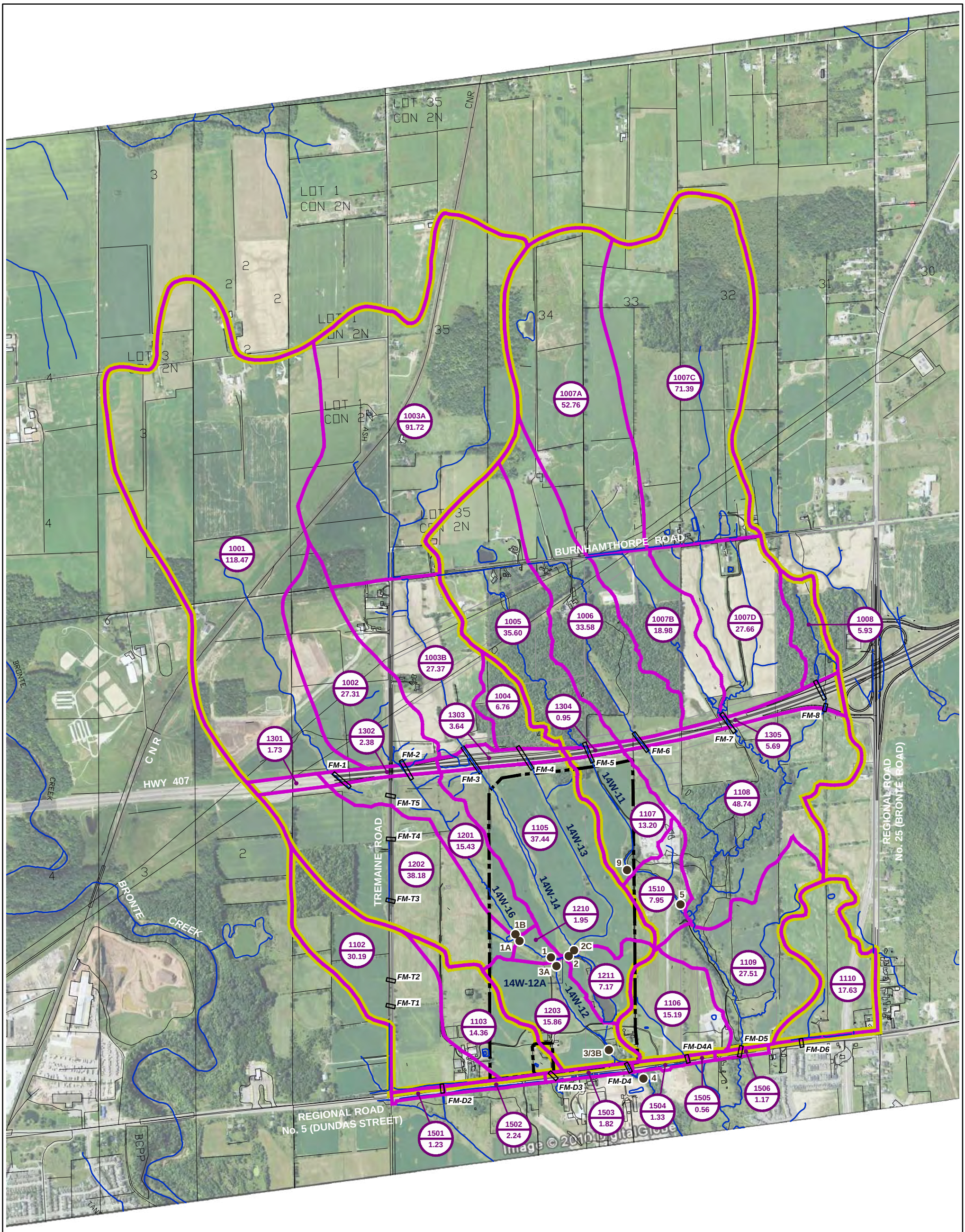
Prepared by: wsp

Date: April 2018

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 7.7.1



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

Existing Drainage Boundaries and Reference Nodes (Revised from NOCSS by MMM)

LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EIR SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- CULVERTS (EIR NODES)
- 1001 / 118.47 — SUB-CATCHMENT No. / AREA (ha)
- 1 — REFERENCE NODE

Scale: 1 : 15,000 (0 0.1 0.25 0.5 0.75km)

Client: QuadReal

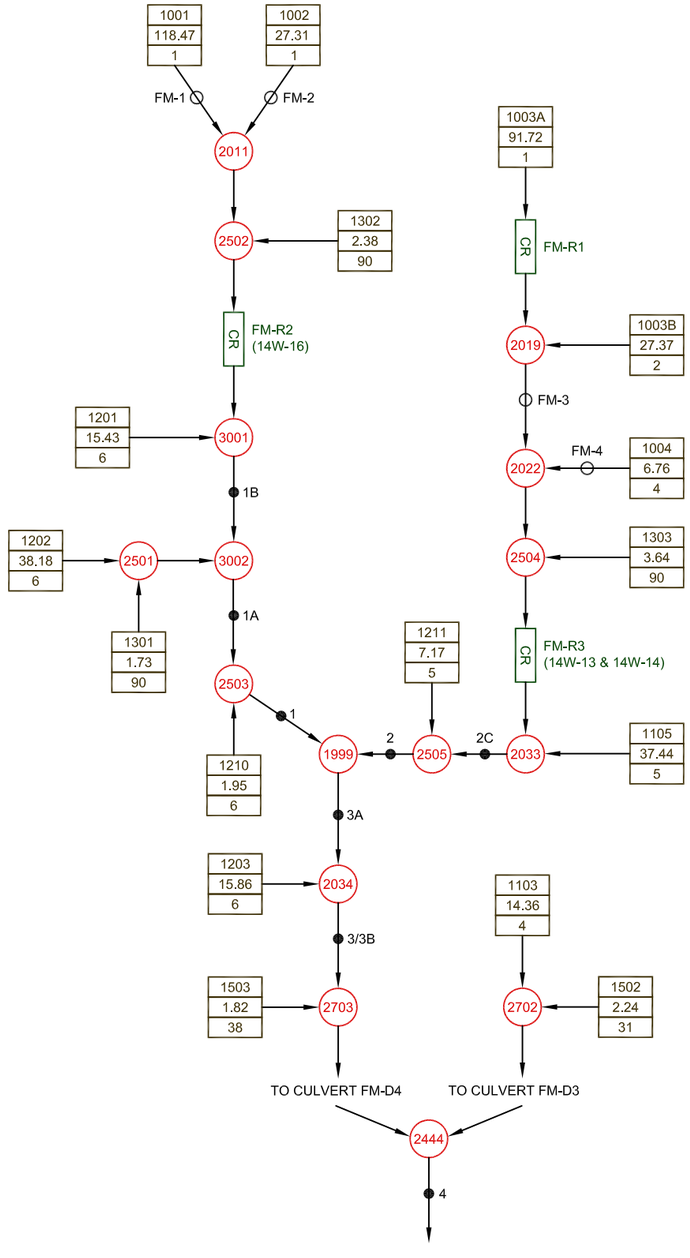
Prepared by: WSP

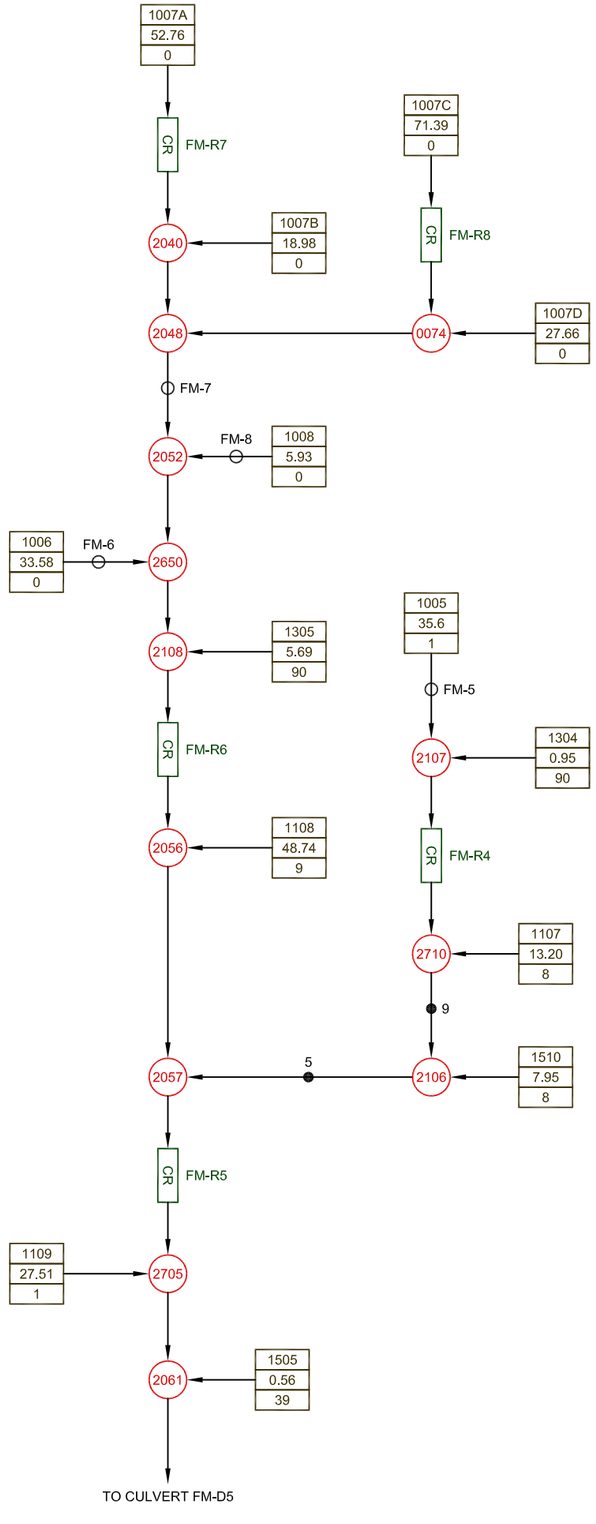
Date: April 2018

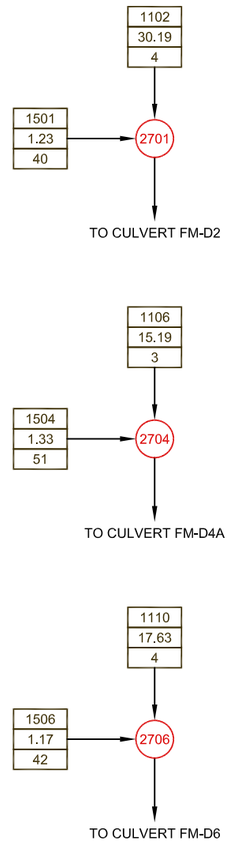
Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 7.4.1







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

Modelling Schematic - Existing Conditions

LEGEND

- 1105 / 37.44 / 5 — CATCHMENT ID. / CATCHMENT AREA (ha) / CATCHMENT IMPERVIOUSNESS (%)
- ADDHYD
- CR — CHANNEL ROUTING
- ROUTE RESERVOIR
- DIV — DIVERSION
- CULVERT (EIR NODE)
- REFERENCE NODE

Scale: N.T.S.

Client: QuadReal

Prepared by: WSP

Date: April 2018

Project No.: 09M-00013-01-WR1

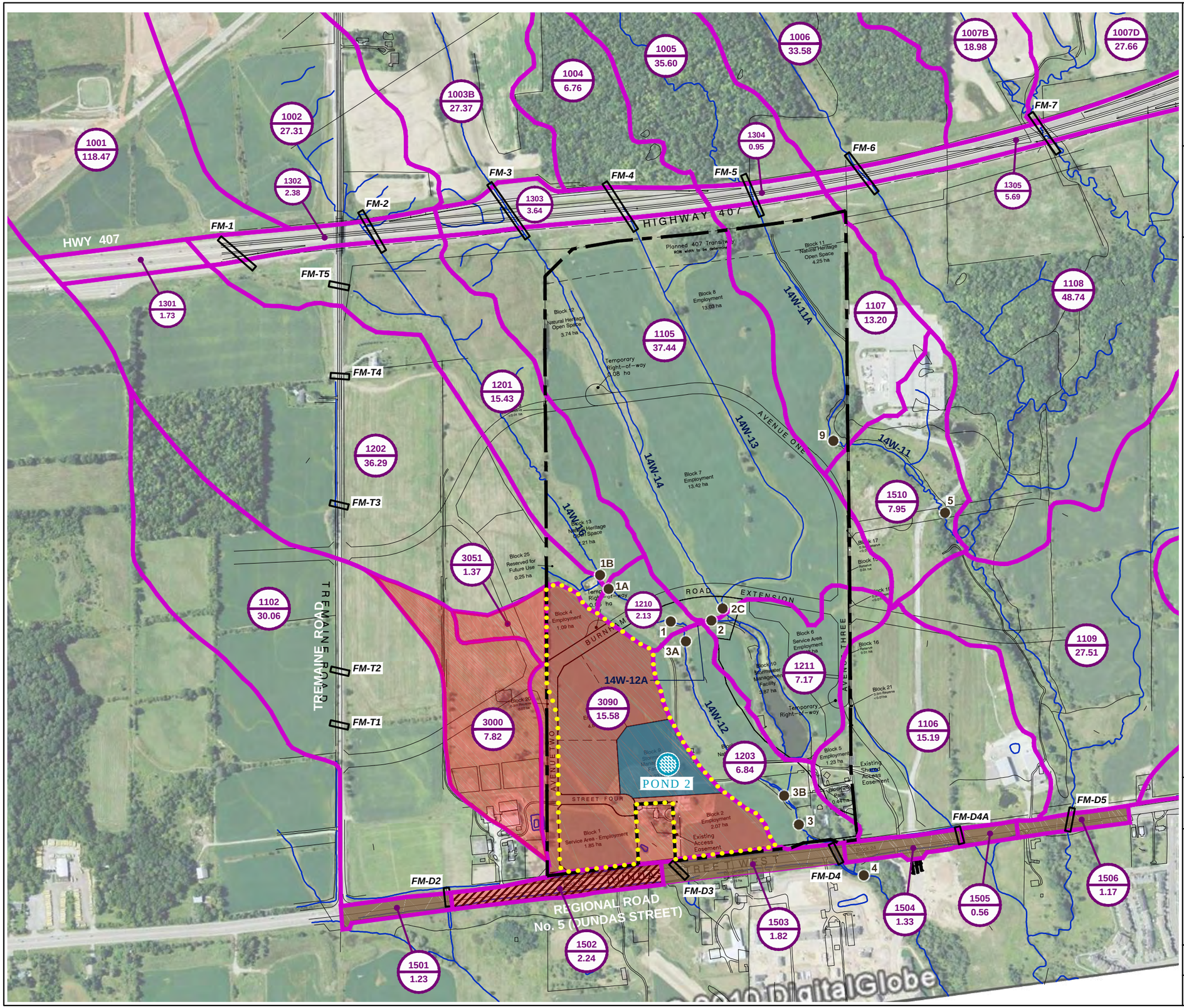
Aerial Photo

Figure 7.4.1-SCH

FIGURE SCHEMATICS.dwg FIGURE 7.4.1-SCH - Modelling Schematic - Existing Conditions S:\114-4111\4109222-001-WR1\REPORT 14 MARCH 2018\FIGURES SERIES 7\, Apr 02, 2018 - 10:15am

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

Interim Phase 1A Drainage Boundaries and Reference Nodes



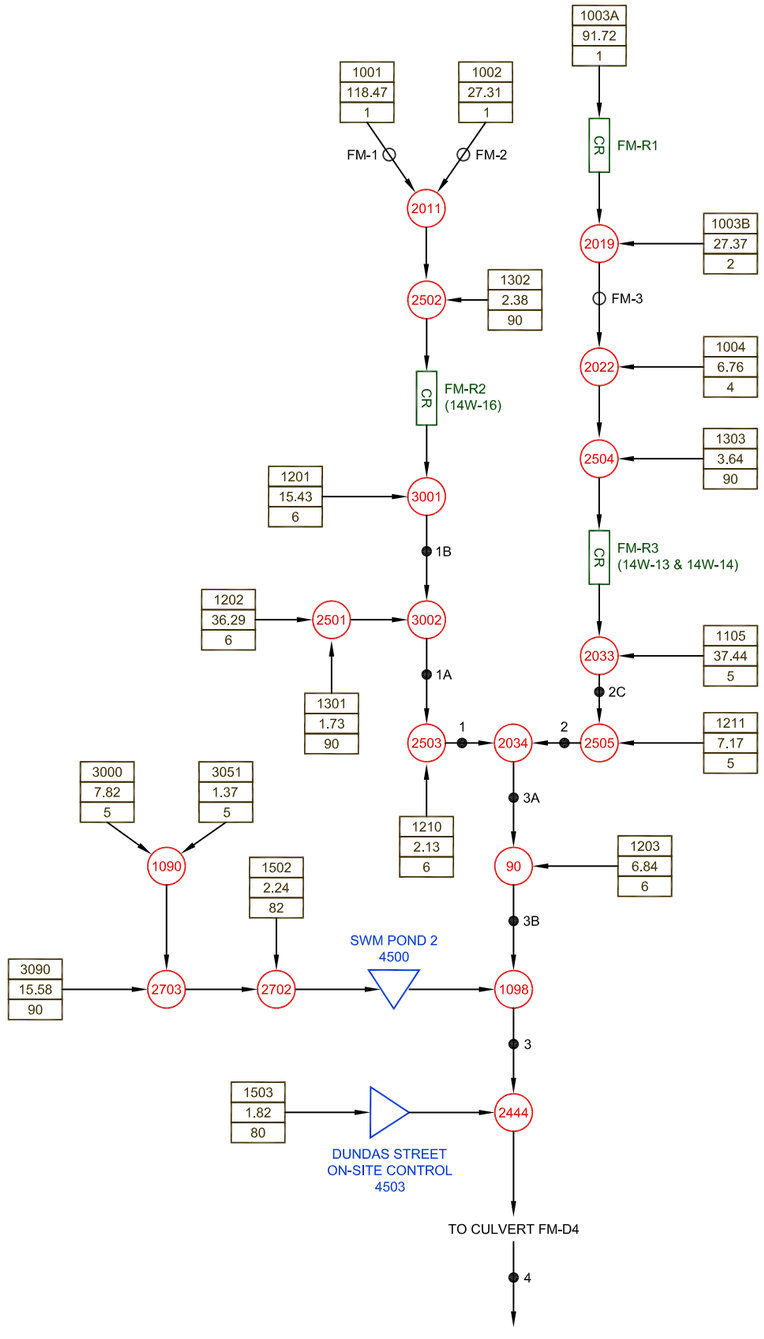
LEGEND

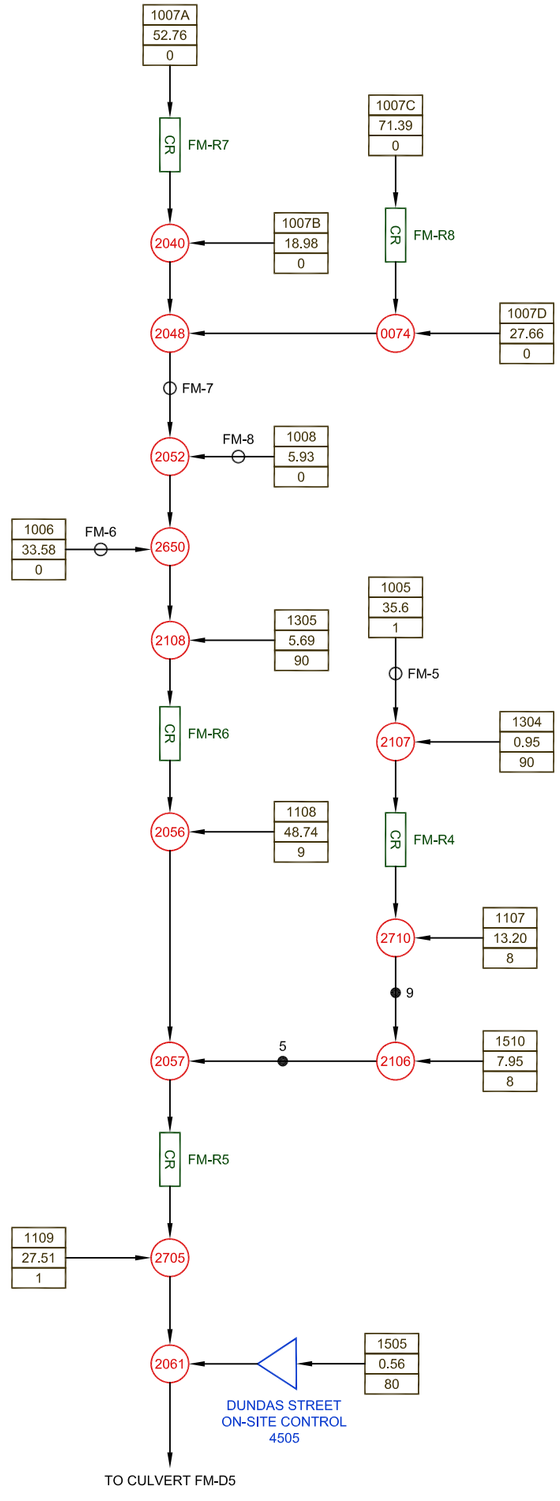
- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- CULVERTS (EIR NODES)
- SUB-CATCHMENT No. (3000) / AREA (ha) (7.82)
- PROPOSED SWM POND (INTERIM)
- REFERENCE NODE (1)
- DEVELOPMENT BOUNDARY
- POND 2 DRAINAGE AREA
- SWM BLOCKS
- DUNDAS ST. CONTROLS BY ON-SITE STORAGE AND DRAINS TO DOWNSTREAM
- DUNDAS ST. DRAINS TO POND 2

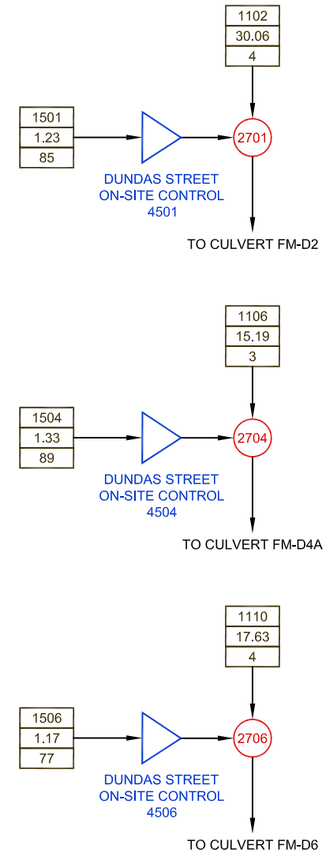
Scale 1 : 7,500 (0, 100, 200, 300, 400m)

Client	Prepared by
Date: April 2019	Project No.: 09M-00013-01-WR1
Aerial Photo: © DigitalGlobe 2010, Google 2009	**Figure 7.4.2**

FIGURE 7.4.2.dwg - Interim Phase 1A Drainage Boundaries & Reference Nodes \\thfiler1.mmm.ca\cad\514-41\1409222-001-WR1\REPORT 15 FEB 2019\FIGURES SERIES 7\ Apr 26, 2019 - 3:20pm







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

Modelling Schematic - Interim Phase 1A Conditions

LEGEND

- 1105 / 37.44 / 5 — CATCHMENT ID. / CATCHMENT AREA (ha) / CATCHMENT IMPERVIOUSNESS (%)
- CULVERT (EIR NODE)
- REFERENCE NODE
- ADDHYD
- CR — CHANNEL ROUTING
- ROUTE RESERVOIR
- DIV — DIVERSION

Scale: N.T.S.

Client: QuadReal

Prepared by: WSP

Date: April 2018

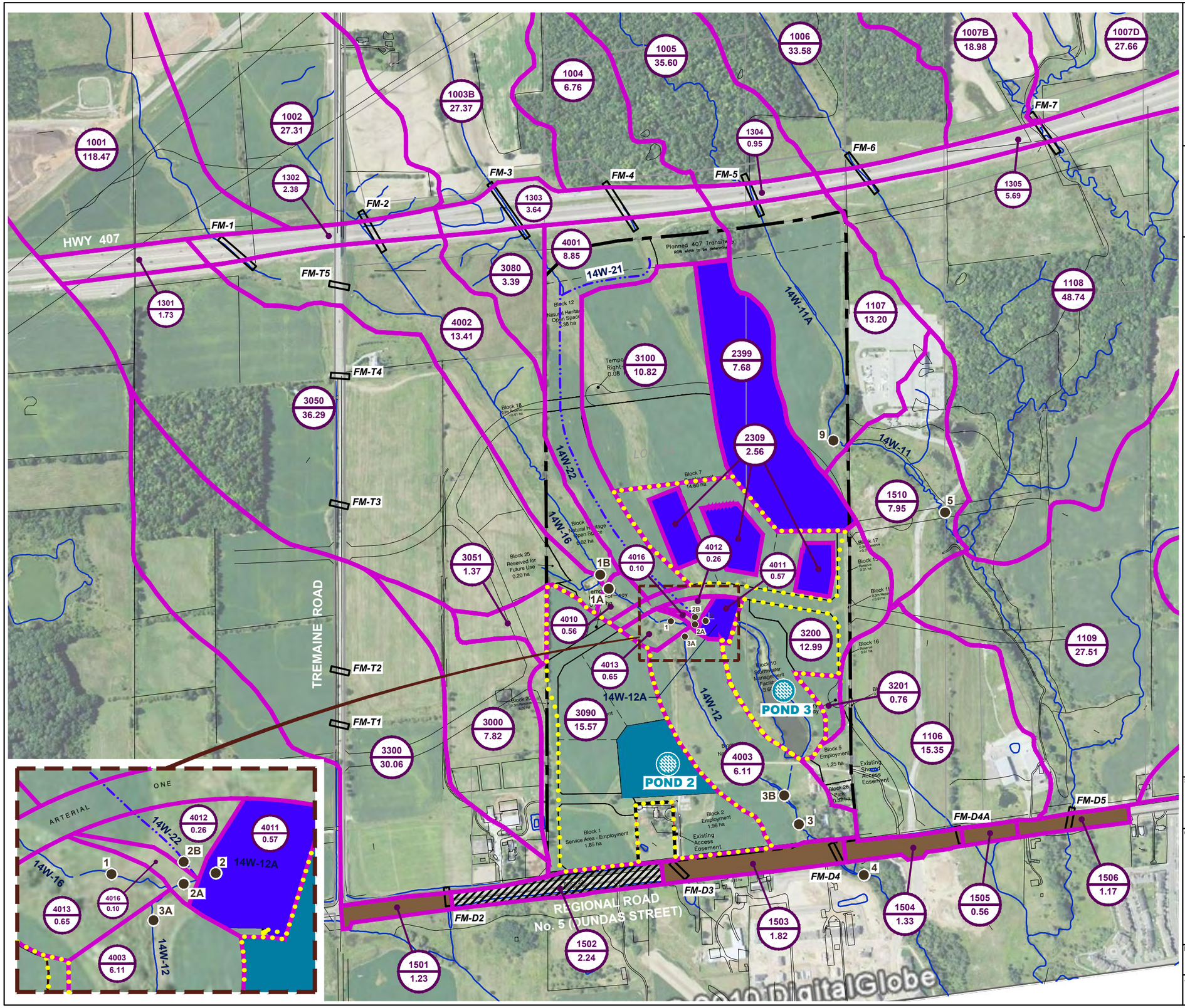
Project No.: 09M-00013-01-WR1

Aerial Photo

Figure 7.4.2-SCH

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

Interim Phase 1B Drainage Boundaries and Reference Nodes



LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- PROPOSED REALIGNED CREEK
- CULVERTS (EIR NODES)
- SUB-CATCHMENT No. (3000)
- AREA (ha) (7.82)
- PROPOSED SWM POND (INTERIM)
- REFERENCE NODE (1)
- DEVELOPMENT BOUNDARY
- POND 2 DRAINAGE AREA
- SWM BLOCKS
- DUNDAS ST. CONTROLS BY ON-SITE STORAGE AND DRAINS TO DOWNSTREAM
- DUNDAS ST. DRAINS TO POND 2
- POND 3 DRAINAGE AREA
- AREA DRAINS TO 14W-12A (REF. NODE 2)

Scale: 1 : 7,500 (0, 100, 200, 300, 400m)

Client: QuadReal

Prepared by: WSP

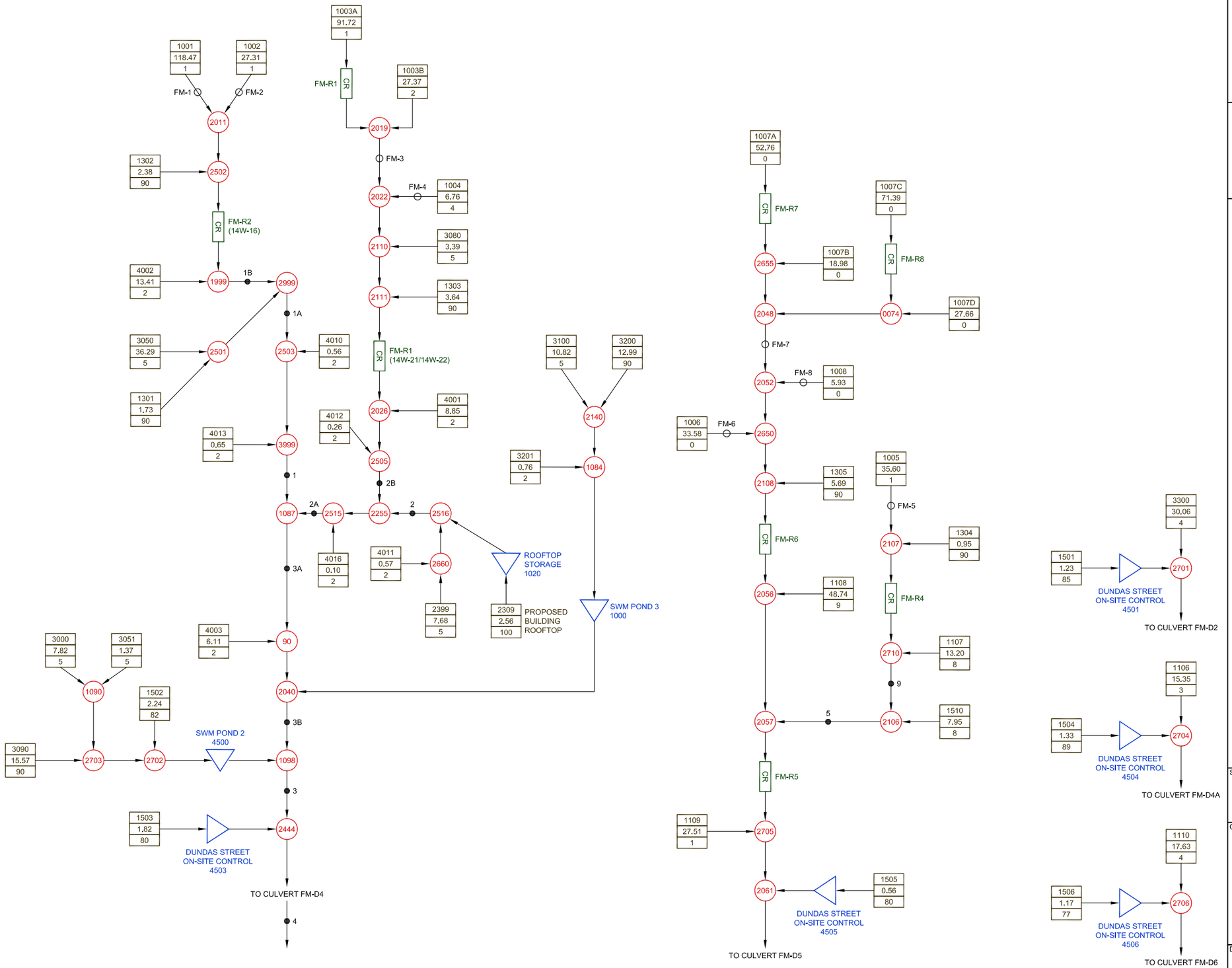
Date: June 2018

Project No.: 09M-00013-01-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 7.4.3

FIGURE 7.4.3.dwg - Interim Phase 1B Drainage Boundaries & Reference Nodes T:\14-41\14\09222-001-WR1\REPORT 18 MAY 2020\FIGURES SERIES 7\ Jun 01, 2020 - 12:23am



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

Modelling Schematic - Interim Phase 1B Conditions

LEGEND

- 1105 / 37.44 / 5 — CATCHMENT ID. / CATCHMENT AREA (ha) / CATCHMENT IMPERVIOUSNESS (%)
- ADDHYD
- CR — CHANNEL ROUTING
- ROUTE RESERVOIR
- DIV — DIVERSION
- CULVERT (EIR NODE)
- REFERENCE NODE

Scale: N.T.S.

Client: QuadReal

Prepared by: WSP

Date: April 2018

Project No.: 09M-00013-01-WR1

Aerial Photo

Figure 7.4.3-SCH

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

Interim Phase 2 Drainage Boundaries and Reference Nodes

LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- PROPOSED REALIGNED CREEK
- CULVERTS (EIR NODES)
- SUB-CATCHMENT No. (e.g. 3000 / 7.82)
- AREA (ha)
- PROPOSED SWM POND (INTERIM)
- REFERENCE NODE
- DEVELOPMENT BOUNDARY
- POND 2 DRAINAGE AREA
- SWM BLOCKS
- DUNDAS ST. CONTROLS BY ON-SITE STORAGE AND DRAINS TO DOWNSTREAM
- DUNDAS ST. DRAINS TO POND 2
- POND 3 DRAINAGE AREA
- AREA DRAINS TO 14W-12A (REF. NODE 2)

Scale: 1 : 7,500 (0, 100, 200, 300, 400m)

Client: QuadReal

Prepared by: WSP

Date: June 2018

Project No.: 09M-00013-01-WR1

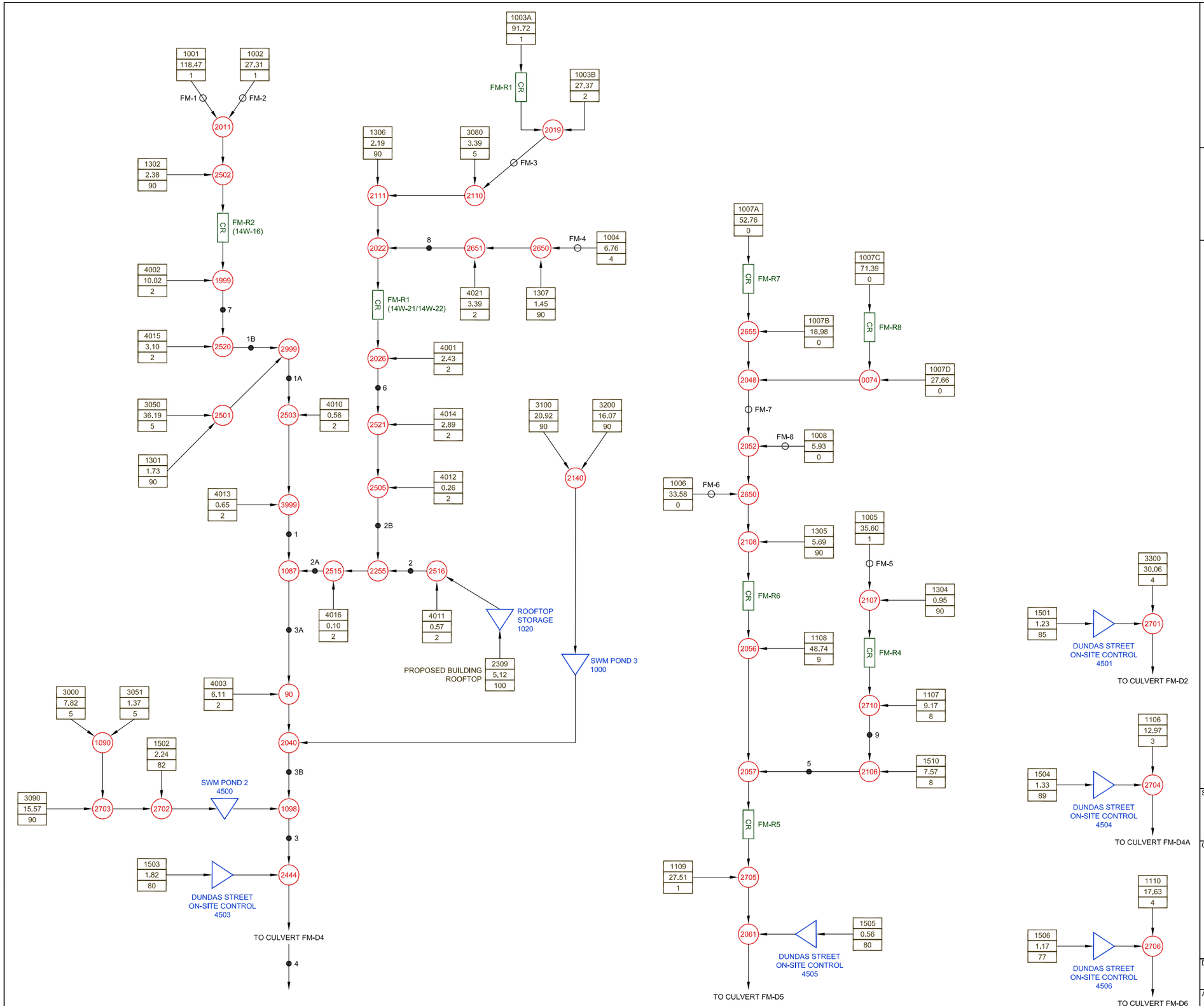
Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 7.4.4

FIGURE 7.4.4.dwg - Interim Phase 2 Drainage Boundaries & Reference Nodes T:\14-41\14\09222-001-WR1\REPORT 18 MAY 2020\FIGURES SERIES 7\, Jun 01, 2020 - 12:28am

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

Modelling Schematic - Interim Phase 2 Conditions



LEGEND

- 1105 / 37.44 / 5 — CATCHMENT ID. / CATCHMENT AREA (ha) / CATCHMENT IMPERVIOUSNESS (%)
- ADDHYD
- CR — CHANNEL ROUTING
- ROUTE RESERVOIR
- DIV — DIVERSION
- CULVERT (EIR NODE)
- REFERENCE NODE

Scale: N.T.S.

Client: QuadReal

Prepared by: WSP

Date: April 2018

Project No.: 09M-00013-01-WR1

Aerial Photo

Figure 7.4.4-SCH

FIGURE SCHEMATICS.dwg FIGURE 7.4.4-SCH - Modelling Schematic - Interim Phase 2 Conditions S:\114-41\1\09222-001-WR1\REPORT 14 MARCH 2018\FIGURES SERIES 7\ Apr 02, 2018 - 10:26am

8.0 Municipal Services

8.0 Municipal Services

8.1 Introduction

The municipal services component of the 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 SWM 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 considering the natural features and topography of the site. This is appropriate at the EIR/FSS level.

To develop the municipal servicing design the Region's Water and Wastewater Master Plan (WWMP) and the SWM Plan 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 (ASP) prepared by WSP (formerly MMM Group), which was approved by the Region (June 2014). The ASP generally covers the lands bounded by Dundas Street West, Bronte Road, the Highway 407 and Tremaine Road. The EIR/FSS is consistent with the ASP and does not create undue constraints on the servicing of other lands within or external to the ASP boundary. The Region's WWMP indicates that the servicing of the lands to the east and west are to be self-contained. Specifically, the lands to the west known as the Evergreen Secondary Plan (formerly Tremaine and Dundas Secondary Plan, are currently in the Public Consultation Phase. A draft Land Use Plan and Secondary Plan was prepared for consultation in June of 2018. WSP have reviewed the Water and Wastewater Servicing Assessment prepared by AECOM (September 2009) for the lands. This report indicates that water servicing is to be provided from the proposed watermain on Tremaine Road, sanitary servicing is tributary to the trunk sewer on Dundas Street West, and the Secondary Plan options included in the report indicate that SWM will be provided onsite. This is generally in conformance with the servicing strategy outlined in the ASP and in this EIR/FSS.

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 SWM Plan for the 407 West Employment Area is generally consistent with NOCSS. 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 provides the Town 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 WWMP 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 to service anticipated growth within Milton and Oakville. A subsequent expansion to 125,000 m^3/d is currently underway; and construction is expected to be completed soon.

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 by development throughout the region. Expansion of capacity will trigger the need for various other changes or improvements such as biosolids handling and a new outfall (currently underway).

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 407 West Employment Area, the lands to their east and a portion of the expected growth in Milton.

The 407 West Employment Area generally slopes from north to south and towards the centre of the lands, approximately 180 m to the east of Colonel William Parkway at Dundas Street. The WWMP 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's WWMP does not show the sewers within the 407 West Employment Area. One of the purposes of this report is to apply the WWMP concept to the Land Use 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 western natural heritage system (NHS) and east of Tremaine Road will be conveyed south by an internal wastewater sewer along an internal Avenue 2 to the Trunk Sewer on Dundas Street West 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 the future Burnhamthorpe Road Extension, Avenue 3 or on Dundas Street West. The wastewater flows from the lands between the two natural heritage areas will be conveyed south along an internal Avenue 3 and discharged to the existing wastewater system on the south side of Dundas Street at Colonel William Parkway. The lands east of the Fourteen Mile Creek NHS and west of Bronte Road will be conveyed south along Avenue 3 and will connect to the Trunk Sewer on Dundas Street West which will then discharge to the existing system at the south side of Dundas Street at Colonel William Parkway. The trunk sewer and downstream system on Colonel William Parkway has been designed to accommodate an external area of 362 ha and an equivalent

residential population of 8,145 people. Please refer to the design calculations and drainage plan for the Bronte Creek Community completed by Stantec in Appendix 8.1.

There is the possibility for the flows from a portion of the lands between the Fourteen Mile Creek NHS and Bronte Road to discharge to the existing system at Valleyridge Drive. The Region has advised that the sewers on Valleyridge Drive were designed to accommodate an external area of 80 ha with an equivalent population of 10,000 people. As shown on Figure 8.2, the 407 West Employment Area lands that would be tributary to this sewer have an area of approximately 40 ha and an equivalent population of 4,500 people. This alternative servicing option would require extending the existing sewer to Dundas Street and would eliminate the need for a sewer on Dundas crossing the Fourteen Mile Creek NHS. This is shown on Figure 8.2 as an alternative wastewater sewer alignment.

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***

A Sanitary Trunk Sewer (Regional project 6911) along Dundas Street 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

Sewage generated in the 407 West Employment Area Land Use Plans has been assessed and compared to the WWMP. The design criteria that the Region has utilized in the WWMP 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's wastewater system criteria are as follows in Table 8.1:

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	26.00
Industrial	m^3/ha/d	34.38	17.63
Institutional	m^3/ha/d	10.94	10.94

The modified Harmon Peaking Factor equation is used to determine the peak flows for the collection system. The average day wastewater flow criteria for wastewater treatment include 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 407 West Employment Area is illustrated in Table 8.2. Commercial land use demands have been applied to the entire site to provide a conservative estimate and to allow for flexibility with respect to the ultimate land use mix.

Table 8.2 – Generated WWTP Flows: 407 West Employment Area Land Use Plan Projections

	Residential ML/d	Commercial ML/d	Industrial ML/d	Institutional ML/d	Total ML/d
Average Daily Flow	0.0	4.1	0.0	0.0	4.0

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 407 West Employment Area.

The difference in the peak flows between the Region's projections and from those generated from the 407 West Employment Area Land Use Plan combined with the proposed increase in pipe slope in some instances will impact the sizing of the Dundas Street trunk sewer by one pipe size in some locations. Industrial land use demands have been applied to the entire site to provide a conservative estimate and to allow for flexibility with respect to the ultimate land use mix.

Table 8.3 – Peak Generated Collection System at Colonel William Parkway Trunk Sewer: 407 West Employment Area Only

	Residential L/s	Commercial L/s	Industrial L/s	Institutional L/s	Sub total L/s
Average Flow	0.0	0.0	57.76	0.0	57.76
Peaking Factor	4.3	4.3	2.631	4.3	
K	0.80	0.80	0.80	0.80	0.80
Peak Flow	0.0	0.0	121.57	0	121.57
Infiltration	0.0	0.0	41.52	0.0	41.52
Sub total	0.0	0.0	163.1	0.0	163.1

*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 the proposed drainage boundaries are 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 WWMP 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 conceptual design has been undertaken for the trunk wastewater sewer on Dundas Street West, which is presented on the attached drawings, P1-P17.

8.2.6.2 Internal Collection Systems

To convey wastewater drainage from the Subject Property 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.

Several factors were considered that would influence the proposed alternatives. The factors include environmental features, existing topography, proposed road patterns, SWM 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 ha of developable lands with an estimated equivalent population of 3,805 people. These local sewers allow the Dundas Street trunk to be kept at a nominal depth.

The adjacent Tremaine and 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. According to the City of Burlington, the Secondary Plan has been adopted by the City but is pending acceptance from the Region. At present there are 3 land use options proposed which include approximately 56 ha 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	Sub 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
Peak Flow	24.56	0.0	0.0	0.0	24.56
Infiltration	16.0	0.0	0.0	0.0	16.0
Sub Total	40.6	0.0	0.0	0.0	40.6

The Region has expressed concerns relating to the servicing of the lands on the east side of Old Bronte Road, north of Dundas. This area includes approximately 13 ha of existing residential development with an equivalent population of 715 people, and is currently serviced by septic systems. In servicing these lands in the future, it is expected that wastewater flows cannot be conveyed to the trunk sewer on Grand Oak Trail, as this would require a crossing of the NHS to the east. As such, it is proposed that a new wastewater sewer be constructed on Old Bronte Road connecting to the existing 825mm trunk sewer on Old Bronte Road north of Dundas Street West. Construction of this local sewer will have to be coordinated with the Region. The wastewater flows generated by the existing Old Bronte Road residential development are shown in Table 8.5.

Table 8.5 – Peak Generated Collection System Flows to Dundas Trunk Sewer – Existing Old Bronte Road Residential Development

	Residential L/S	Commercial L/S	Industrial L/S	Institutional L/S	Sub Total L/S
Average Flow	2.3	0.0	0.0	0.0	2.3
Peaking Factor	3.89	4.3	4.3	4.3	
K	1.0	1.0	1.0	1.0	1.0
Peak Flow	8.95	0.0	0.0	0.0	8.95
Infiltration	4.1	0.0	0.0	0.0	4.1
Sub Total	13.1	0.0	0.0	0.0	13.1

It is expected that the Sixteen Hollow Lands to the east of the 407 West Employment Lands will be serviced by the existing wastewater sewer located at approximately Third Line and Dundas Street West and will not impact any of the sewers utilized by the 407 West Employment Lands.

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 existing system along Colonel William Parkway from Dundas Street West to the south limit of the Bronte Creek Community has been designed to accommodate 362 ha of development with an equivalent population of 8,145. The design sheet and drainage plan for the Bronte Creek Community are available in Appendix 8.1.

The Bronte Creek Community design sheets have been used to assist with the analysis of the proposed development of the 407 West Employment Area. The proposed 407 West Employment Area and the external contributors (Tremaine Neighbourhood and the Old Bronte Road properties) that contribute to the Colonel William Parkway collect from a total area of 202.6 ha and an equivalent population of 19,131 people with a combined wastewater flow of approximately 194 L/s at the Colonel William Parkway and Dundas Street West manhole and 223 L/s at the south limit of the Bronte Creek Community. In contrast, the Bronte Creek Community analysis completed by Stantec shows a total flow contribution of approximately 180 L/s at the Colonel William Parkway and Dundas Street West manhole and 210 L/s at the south limit of the Bronte Creek Community. This does represent an increase of approximately 14 L/s at the Colonel William Parkway and Dundas Street West manhole, and 13 L/s at the south limit of the Bronte Creek Community; however, at no point is the capacity of any leg of sewer greater than 75%. It should also be noted that the wastewater generation values used for both the Tremaine Subdivision and the 407 West Employment Area are the highest values possible. This wastewater analysis is a worst-case scenario.

Conceptual Plan-Profiles of the Wastewater Sewer design are provided in Appendix 8.3.

8.2.8 Mitigation Measures for Wastewater Crossings of Watercourses and Natural Heritage

To provide a service connection to Blocks P1 and P3, it will be necessary for the wastewater sewer to cross watercourses and the NHS at two locations. Wherever possible, the wastewater sewer alignment will be kept within the proposed right-of-way (ROW) and will go over the culvert structure.

In circumstances where a bridge will be used or where going over the culvert is not possible, the wastewater sewer will be installed using a trenchless technology, such as, jack and bore or directional drilling below the watercourse or natural feature preferably within the ROW. The sewer should be installed using a steel liner or another acceptable form of protective casing, with the launching and receiving pits positioned as far as practically possible from the watercourse or natural feature. All crossings should be a minimum of 3.0 m below the watercourse or natural feature and must follow all geotechnical recommendations. This will have a carry through effect of lowering the entire wastewater sewer system and therefore, needs to be taken into consideration during the early stages of detail design.

Where the culvert or bridge structure requires piles or other deep foundations and the use of trenchless construction is not feasible within the ROW, the wastewater sewer alignment will be moved outside of the ROW to a point where it will not influence the structure foundation. The launching and receiving pits will be located as far as practically possible from the watercourse or natural feature. The alternative alignments and

profiles of the proposed wastewater collection system with respect to the crossings are shown on Drawings P1-17.

Should the existing culverts along Dundas Street be replaced with bridges, Option 2 will be implemented, as indicated on Exhibit 3.6 and the Plan-Profiles in Appendix C. In Option 2, the sanitary drainage area from Avenue 5 will be directed to the existing system on Valleyridge Drive to avoid the crossing of the watercourse. The sanitary sewer along Dundas Street between Avenue 3 and Avenue 5 will be routed around the bridge structure and installed using trenchless technology with a minimum depth of 3.0 m below the existing watercourse.

The crossing of any Redside Dace habitat watercourse will require review and approval from the Ministry of Environment, Conservation and Parks (MECP) prior to the construction of the crossing infrastructure. Each crossing permit will have specific requirements; however, for the crossings within the 407 West Employment Lands, it should be expected that the following will be required:

- Construction will be during the permissible Redside Dace in-water construction window of July 1 to September 15;
- Construction will utilize trenchless construction methods;
- Utilities will be installed at a depth of at least 3 m below the bottom of a Redside Dace habitat watercourse;
- A specific contingency plan will need to be prepared for each crossing to address all concerns of the construction methodology proposed;
- All disturbed soils will need to be stabilized using a methodology approved by the MNRF; and
- Erosion and sediment control measures will remain in place until final restoration has been completed.

8.3 Conceptual Water Servicing Strategy

The Region's 'Sustainable Halton Water and Wastewater WWMP' dated September 2011 set out a strategy for the long term and orderly development of the Region's infrastructure. This report was prepared in response to the new Official Plan (ROPA 38) and Phasing (ROPA 39). In the case of water, this report addressed supply, pressure districts, storage and distribution. This report also addresses timing and provides 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 Land Use Plan for the 407 West Employment 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 WWMP 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) is now complete and commissioned.

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.

8.3.2 Pressure Districts

The Subject Property, consistent with Section 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 166 m. 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).

The Region has recently constructed a 1200 mm watermain on Dundas Street from Tremaine Road to Bronte Road. This watermain will directly supply the 407 West Employment Area. We understand that the supply to Zone 3 has been augmented via a 1200 mm watermain connection on Dundas Street from 400 m east of Bronte Road to Neyagawa Boulevard. This supply is connected to the existing Zone 3 water supply (Moore Reservoir on Sixth Line) via the existing 600 mm 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. The 407 West Employment Area will also receive supply from the Burlington Zone B3 via a 900 mm watermain on Dundas Street from Appleby Line to Tremaine Road.

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.

The existing storage available in Oakville Zone 3 is sufficient for long term build-out of the FSS Study Area, and 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 Ti**ming*

The infrastructure described above will be constructed on an as-required basis for each phase of development. 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 WWMP and supplemented with the Region's Design Criteria as required. 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 WWMP. Any difference in the demand estimated in the WWMP is due to an increase of undevelopable natural heritage areas throughout the 407 West Employment 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 m^3/ha/day	Industrial m^3/ha/day	Institutional m^3/ha/day
Average Day Demand	314	26.00	17.63	10.94
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 407 West Employment Area at build-out by applying the above criteria to the development statistics described in Figure 3.1. Commercial land use demands have been applied to the entire site to provide a conservative estimate and to allow for flexibility with respect to the ultimate land use mix.

Table 8.8 – Flow Demands: Linear Infrastructure (407 West Employment Area Land Use Plan Population Projections)

	Residential (ML/d)	Commercial (ML/d)	Industrial (ML/d)	Institutional (ML/d)	Total (ML/d)
Average Day Demand	0.0	4.1	0.0	0.0	4.1
Maximum Day	0.0	7.7	0.0	0.0	7.7
Peak Hour	0.0	12.2	0.0	0.0	12.2

*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 WWMP 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 1200 mm PD3 supply main on Dundas Street from Bronte Road to Tremaine Road (completed); and

- The 600 mm 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 600 mm 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 1200 mm 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 provided a copy of the Region's Water Distribution Model dated August 12, 2008 to assist WSP in modeling the proposed ASP 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'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	190.27 m	196.00 m
Node for Minimum HGL	WJ-1152-O	NO-248
Maximum HGL	190.97 m	196.24 m
Node for Maximum HGL	NO-245, 246, 251, 252, 253 WJ-3114-O, & WJ-3116-O	NO-241, 245, 246, 251, 252, 253, WJ-1150-O, WJ3114-O, & WJ-3116-O
Minimum System Pressure (psi)	41.16 psi	48.66 psi
Node for Minimum System Pressure	NO-239	NO-239
Maximum System Pressure (psi)	62.51 psi	70.00 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 head loss in the proposed system is only 0.08 m during a maximum day demand and 0.18 m during a peak hour demand. The low head loss in the overall system indicates that the watermains are adequately sized and that increasing the watermain sizes from the proposed 1200/600 mm trunk watermains and the 300 mm distribution watermains is not required.

During the initial phases of development, all attempts will be made to provide full looping of the internal water distribution systems; this may require interim or temporary watermains. In cases where looping is not possible, a regular flushing program will be required at all dead ends.

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. All office towers and large scale industrial buildings will likely require boosters to provide proper fire protection; this needs to be evaluated at the detailed design stage on a case-by-case basis.

8.3.11 Additional Design Considerations

8.3.11.1Local Service Watermains

The 407 West Employment Area Land Use 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 FSS primarily addresses the watermain sizes for the transmission and major distribution watermains. Local distribution mains have been conceptually sized in this study but will need to be addressed in more detail through the Functional Servicing Reports supporting the various Draft Plans of Subdivision and Site Plan Applications and will be in accordance with the Region's published standards for water connections. Each proposed building will need to be evaluated at the detailed design stage to determine if a booster is required for that development to meet the water demand and fire service requirements.

As part of this development, the connections to the 1200mm diameter trunk watermain on the south side of Dundas Street will be constructed at the cost of the proponent.

All service connections will be in designed in accordance with the Region's published standards for water connections.

8.3.11.2 Mitigation 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 FSS Study Area and the rest of the FSS Study Area. While it is a priority to loop systems where possible and as soon as the opportunity is available, it may be necessary to service development areas with single feed watermains during various phases of development until the future watermain loops can be constructed. The phasing will likely move to the north from Dundas Street West, which may create circumstances where there are single feed, dead-end watermains. During the interim condition, if there are single feed watermains, a regular flushing practice will be required to maintain water quality. Autoflushers or a manual flushing program will be utilized on all interim single feed watermains. The autoflushers will be placed in locations and programed to ensure that adequate water quality is maintained until full looping of watermains occurs. The flushing program, including the flushing frequency and discharge locations, will be determined in conjunction with Region staff. The flushing program will be completed and funded by the developer in accordance with Halton Region requirements. The current interim design does not require a flushing program. In the current interim design does not require a flushing program for any of the phases with no active dead end watermains. Any dead end watermains will be for the connection of future phases and will be inactive by use of a closed valve until such time as the next phase is operational. Periodic flushing of any dead end watermains can be completed if necessary.

Wherever possible during interim conditions, interim watermain loops will be utilized. This may include the use of private watermains to close the loop. Upon completion of the full water distribution system, any private watermains used exclusively for looping will be decommissioned in accordance with Region's requirements.

During the development process, each phase will be evaluated on a case by case basis to determine how adequate water quality will be maintained in the water distribution system.

8.3.11.3 Mitigation Measures for Watermain Crossings of Watercourses and Natural Heritage

In order to provide a robust water distribution system with complete looping, it will be necessary for the watermain to cross watercourses and the NHS. Wherever possible, the watermain alignment will be kept within the proposed ROW and will go over the culvert structure or hung on a bridge structure if a bridge is utilized.

In circumstances where going over the culvert or hanging the watermain on a bridge is not possible, the watermain will be installed using a trenchless technology such as jack and bore or directional drilling below the watercourse or natural feature preferably within ROW. The watermain should be installed using a steel liner or another acceptable form of protective casing, with the launching and receiving pits positioned as far as practically possible from the watercourse or natural feature. All crossings should be a minimum of 3.0 m below the watercourse or natural feature and must follow all geotechnical recommendations.

Where the culvert or bridge structure requires piles or other deep foundations and the use of trenchless construction is not feasible within the ROW, the watermain alignment will be moved outside of the ROW to a point where it will not influence the structure foundation. The launching and receiving pits will be located as far as practically possible from the watercourse or natural feature. The alternative alignments and profiles of the proposed water distribution system with respect to the crossings are shown on Drawings P1-17.

The crossing of any Redside Dace habitat watercourse will require review and approval from the MECP prior to the construction of the crossing infrastructure. Each crossing permit will have specific requirements from the MECP; however for the crossings within the FSS Study Area, it should be expected that the following will be required:

- Construction will be during the permissible Redside Dace in-water construction window of July 1 to September 15;
- Construction will utilize trenchless construction methods;
- Utilities will be installed at a depth of at least 3 m below the bottom of a Redside Dace habitat watercourse;
- A specific contingency plan will need to be prepared for each crossing to address all concerns of the construction methodology proposed;
- All disturbed soils will need to be stabilized using a methodology approved by the MNRF; and
- Erosion and sediment control measures will remain in place until final restoration has been completed.

8.4 Stormwater

8.4.1 General

There are currently no storm sewers or SWM facilities to service the FSS Study Area. The existing conditions currently drain overland primarily by sheet flow into the existing watercourses onsite. These watercourses 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 SWM Plan presented in Section 7.0.

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 SWM 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's design criteria. Please note that the storm drainage illustrated to the east of Avenue 3 within Subcatchments FM108, FM1109, FM1110 and FM1110.1 on Figure 8.5 is conceptual only and had not been evaluated by the review agencies with respect to feasibility and NHS impacts and as such, is subject to change. The storm design sheets are available in Appendix 8.3. The Plan-Profiles of the storm design are available in Appendix 8.4.

Wherever possible, the runoff from Regional roads will be directed to SWM facilities of adjacent developments for quantity and quality treatment. Due to grading constraints, many sections of Dundas Street are not able

to drain to SWM facilities within the 407 West Area. The section of Dundas Street noted as Catchment 1502 in Section 7.8.2 will drain and be treated by proposed Pond 2.

8.4.3 Major Storm System (Overland Flow)

The proposed major storm system is in accordance with SWM plan as described in Section 7.0 of this report. The overland flow route will convey flows up to the 1:100 year storm event to the SWM facility containing the major flows within the road ROW. 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 180 m 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 SWM 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 conceptual road grades all meet the Town of Oakville criteria, all road grades fall between 0.5% and 3.5%. The conceptual lot grading will generally slope towards the right of way so that the stormwater can be treated in the stormwater management facilities. Both the conceptual 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. Please note that the grading illustrated to the east of Avenue Three within Subcatchments FM-1108, FM-1109, FM-1110 and FM-1110.1 on Figure 8.5 is conceptual only and had not been evaluated by the review agencies with respect to feasibility and Natural Heritage System impacts and as such is subject to change.

8.6 Phasing

Consideration has been given to the incremental installation of municipal services to coincide with the proposed phasing strategy. This may require the construction of temporary services within easements or temporary ROWs in the event that services cannot be installed in their ultimate alignments (i.e., on the lands of other owners). As noted previously, to ensure security and redundancy in the water distribution system, temporary private watermains will be required to provide looping. Conceptual phased servicing plans are illustrated in Figure 8.7.1, 8.7.2 and 8.7.3. Similarly, the site grading will be performed on a phased basis to coincide with the areas to be developed. Road crossings of the NHS systems will be installed only when required to service development. Conceptual phased grading plans are illustrated in Figure 8.8.1, 8.8.2 and 8.8.3. Further consideration for the phased construction of services and grading will be completed at the time of development of each phase.

The development of Phase 2 will include a portion of the 600mm diameter Regional Watermain along Avenue 3 within the subject property which will require the installation of the remainder of the trunk watermain on the adjacent properties along Avenue 3 and Avenue 1 between Bronte Road and Tremaine Road to complete

the water distribution system. The development of the adjacent lands is expected to be after development of the subject lands. The design and construction of the all watermains will allow for connection to the future watermains from adjacent properties and will be coordinated to the fullest extent possible and to the satisfaction of Halton Region. All watermains will be constructed within the future right of ways and the design of the subject property allows for flexibility in the road network and servicing design in the adjacent properties. It is noted that the works in the subdivision will not be assumed by the Region until the full watermain system is installed in accordance with the ASP.

8.7 Private Water Well and Septic System Decommissioning

There are private wells and septic systems located on the subject property for the farming activities on the subject property. Prior to construction, all private wells and septic systems onsite will be decommissioned in accordance with MECP requirements.

8.8 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.

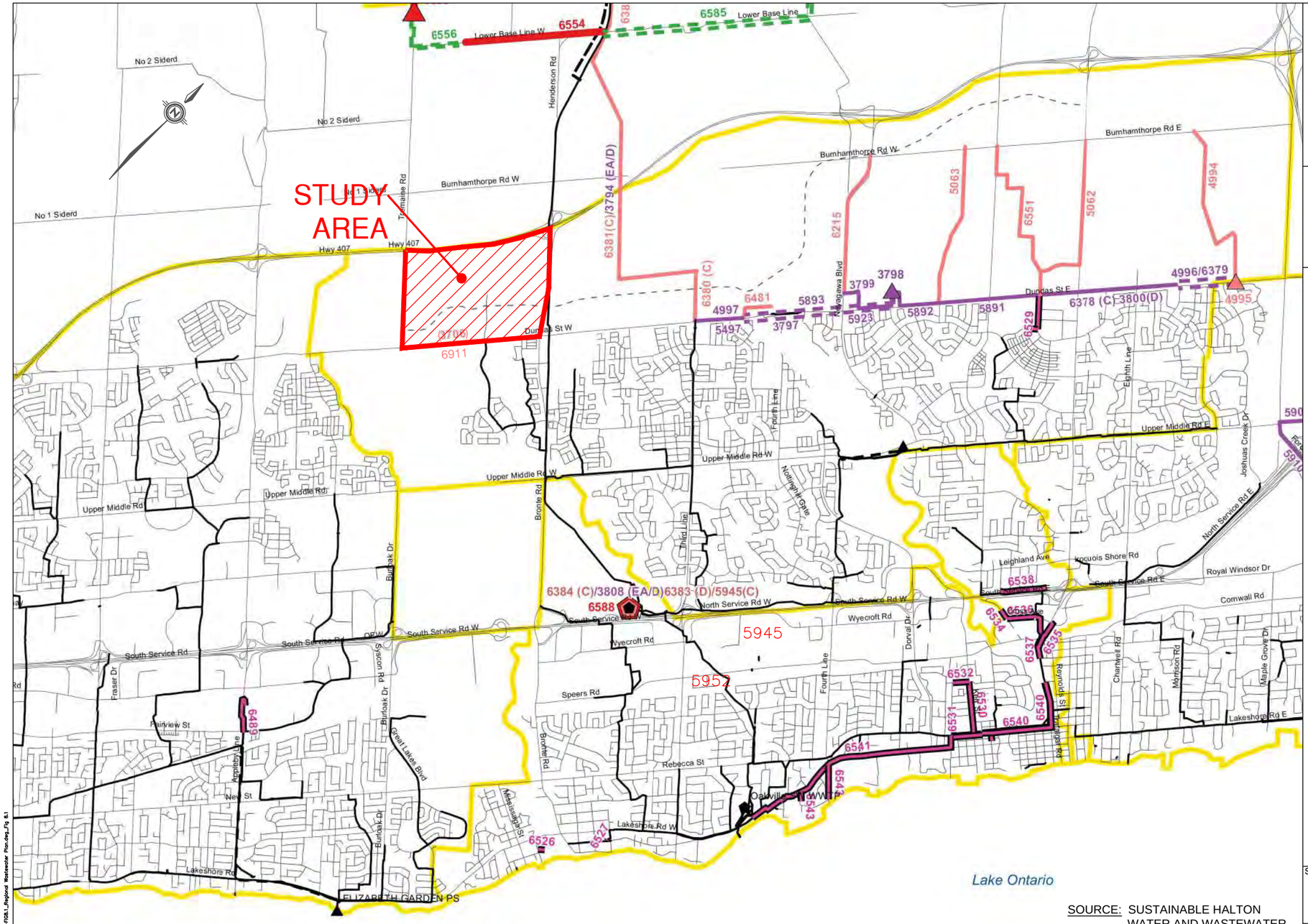
The minor storm system will consist of gravity sewers within the conceptual road network that will discharge to a SWM facility for treatment based on the catchment areas indicated in Section 7.0. The major storm system will convey the major storm flows via an overland flow route along the road ROWs to 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 SWM Plan detailed in Section 7.0. The conceptual grading plan is illustrated on Figure 8.6.

The overall servicing and grading design has considered the proposed phasing of the development. Municipal services, roads and grading works will be installed incrementally as needed to service development. Conceptual phasing of the servicing and grading are illustrated on Figures 8.7.1, 8.7.2, 8.7.3, 8.8.1, 8.8.2 and 8.8.3.

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

REGIONAL WASTEWATER PLAN



SOURCE: SUSTAINABLE HALTON WATER AND WASTEWATER MASTER PLAN, AECOM 2011

Legend

Existing Infrastructure
- Wastewater Pumping Station
- Wastewater Treatment Plant
- Wastewater Main
- Wastewater Forcemain

Previously Approved Infrastructure
- Wastewater Pumping Station
- Wastewater Treatment Plant
- Wastewater Main
- Distribution-Built Boundary Wastewater main

Proposed/Upgrade Infrastructure
- Wastewater Pumping Station
- Wastewater Treatment Plant
- Proposed Alignment - Wastewater Main
- Wastewater Forcemain

Funded Infrastructure
- Wastewater Pumping Station
- Wastewater Treatment Plant
- Wastewater Main
- Wastewater Forcemain
- WWTP Drainage Area
- Proposed Lake Base Service Area

Scale: NTS

Client: QuadReal

Prepared by: wsp

Date: MAY 2020

Project No.: 1409222.001

FIGURE 8.1

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

WASTEWATER DRAINAGE PLAN

HIGHWAY 407

PLANNED 407 TRANSITWAY

TREMAINE ROAD

BRONTE ROAD

EXTERNAL BY OTHERS

DUNDAS STREET WEST

AVENUE ONE

AVENUE TWO

AVENUE THREE

AVENUE FIVE

ARTERIAL ONE

STREET FOUR

NATURAL HERITAGE AREA

Block P1 2.88 ha
Block P2-1 1.58 ha
Temporary Right-of-way 0.08 ha
Block P2-2 2.30 ha
Block P2-3 2.93 ha
Block P2-4 3.35 ha
Block P3 (E) 7.67 ha
SWM 2.70 ha
Block P4 11.64 ha
Block P5 3.88 ha
Block P6 3.87 ha
Block P7 (E) 2.43 ha
Block P8 2.76 ha
Block G1-1 5.22 ha
Block G1-2 3.46 ha
Block G2-1 4.78 ha
Block G2-2 3.58 ha
Block G2-3 3.54 ha
Block G3 3.99 ha
Block G3-1 1.60 ha
Block G3-1-1 1.09 ha
Block G3-2 1.30 ha
Block G3-3 1.85 ha
Block G3-4 0.87 ha
Block G4 1.96 ha
Block G5-1 4.12 ha
Block G5-2 2.53 ha
Block G5-5 2.69 ha
Block G5-6 2.08 ha
Block G6 4.29 ha
Block G7 3.34 ha
Block G8 3.70 ha
Block G9 7.33 ha
Block G10 3.42 ha
Block C1 3.24 ha
Block C2-1 0.63 ha
Block C2-2 1.09 ha
Block C3-1 1.60 ha
Block C3-2 1.30 ha
Block C3-3 1.85 ha
Block C3-4 0.87 ha
Block C3-5 2.07 ha
Block C4-1 1.48 ha
Block C4-2 1.23 ha
Block C5-1 1.71 ha
Block C5-2 2.53 ha
Block C6 2.90 ha
Block C7 0.31 ha
Block C8 2.18 ha
SWM 0.25 ha
SWM 1.78 ha
SWM 2.50 ha
SWM 2.23
SWM 3.87 ha
SWM 2.37 ha
SWM 1.61 ha
50.08 / 5379
53.23 / 6080
39.42 / 4540
56.0 / 2170
13.0 / 715
2.43 / 304

MH1A MH1 MH2 MH2A MH7A MH10A MH12A MH17A MH19A MH20B MH22A MH24A MH25A MH26A MH33A MH37A MH39A MH41A MH42A MH47A MH48A MH50A MH59A MH60A MH63A MH66A MH68A MH74A MHD1

300Ø SAN @ 0.5%
300Ø SAN @ 0.7%
300Ø SAN @ 1.0%
300Ø SAN @ 1.4%
300Ø SAN @ 2.5%
300Ø SAN @ 1.2%
300Ø SAN @ 0.5% (IF REQUIRED)
375Ø SAN @ 0.5%
600Ø SAN @ 0.5%
450Ø SAN @ 0.5%
450Ø SAN @ 1.25%
200Ø SAN @ 1.0%
EX. 825Ø SAN
EX. MH9

EX.MH22A CONNECT TO EXISTING 600Ø ON COLONEL WILLIAM PARKWAY

SAN SEWER FROM MHD4 TO MHD6 NOT REQUIRED FOR OPTION 2.

SERVICING OPTION 2: CONNECT TO EXISTING 300Ø ON VALLEYRIDGE DRIVE.

LEGEND

- SANITARY SEWER
- SANITARY MANHOLE
- SANITARY DRAINAGE BOUNDARY
- ALTERNATIVE SANITARY SEWER ALIGNMENT
- EXTERNAL SANITARY SEWER (B.O.)
- EXISTING SANITARY SEWER
- 39.40 / 4533 — TRIBUTARY AREA (Ha) / TRIBUTARY POPULATION
- 13.0 / 715 — EXTERNAL TRIBUTARY AREA (Ha) / EXTERNAL TRIBUTARY POPULATION
- FUTURE CULVERT CROSSING
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES

NOTES:

- For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area
- Right-of-way requirements for future 407 Transitway to be determined
- The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

Scale 0 100 200 300 400 500m

Client: QuadReal

Prepared by: wsp

Date: MAY 2020

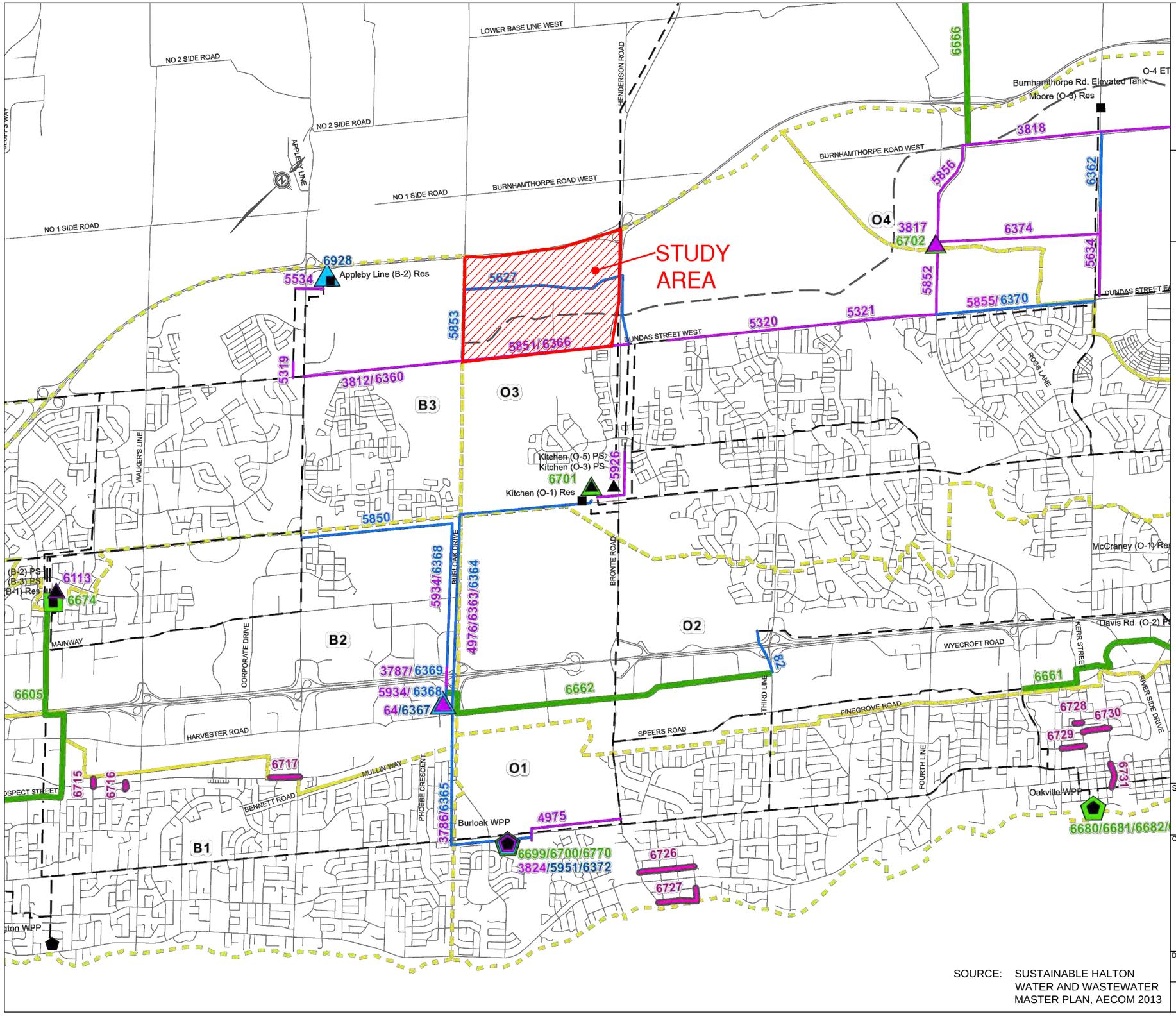
Project No.: 1409222.001

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

Existing Infrastructure
- Water Pumping Station
- Water Well
- Water Standpipe
- Water Reservoir
- Water Purification Plant
- Elevated Water Tower
- Existing Watermain

Previously Approved Infrastructure
- Water Pumping Station
- Water Well
- Water Purification Plant
- Water Reservoir
- Watermain (Proposed/Upgrade Infrastructure)

Proposed/Upgrade Infrastructure
- Water Pumping Station
- Water Well
- Water Purification Plant
- Water Reservoir
- Watermain
- Distribution-Built Boundary Watermain

Funded Infrastructure
- Water Pumping Station
- Water Reservoir
- Watermain (Proposed/Upgrade Infrastructure)
- Existing Interregional connections
- Existing Milton Groundwater Servicing
- Existing Central Milton Groundwater Service Area Boundary
- Water Pressure Zones
- Proposed Lake Base Service Area

SOURCE: SUSTAINABLE HALTON WATER AND WASTEWATER MASTER PLAN, AECOM 2013

Scale: NTS

Client: QuadReal

Prepared by: WSP

Date: MAY 2020

Project No.: 1409222.001

FIGURE 8.3

PRINTED ON: FILE NAME: X:\DIV10\14-09222\MUN\ASP-FSS Exhibits\EX2.1-FIG8.3_Regional Water Plan.dwg_Fig 8.3

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

WATER DISTRIBUTION PLAN

HIGHWAY 407
PLANNED 407 TRANSITWAY
TREMAINE ROAD
BRONTE ROAD
Block P1 2.88 ha
Block P2-1 1.58 ha
Block P2-2 2.30 ha
Block P2-3 2.93 ha
Block P2-4 3.35 ha
PROPOSED 600Ø REGIONAL WATERMAIN
Block G1-1 5.22 ha
Block G1-2 3.46 ha
AVENUE THREE
Block G5-6 2.08 ha
Block G5-5 2.69 ha
NATURAL HERITAGE AREA
Block G3-1-1 1.09 ha
Block G5-1 4.12 ha
Block C5-2 2.53 ha
Block P3 (E) 7.67 ha
NATURAL HERITAGE AREA
SWM 2.70 ha
Block P4 11.64 ha
PROPOSED 600Ø REGIONAL WATERMAIN
Block G2-1 4.78 ha
PROPOSED 300Ø LOCAL WATERMAIN
AVENUE TWO
SWM 1.78 ha
SWM 0.25 ha
PROPOSED 300Ø LOCAL WATERMAIN
Block C5-1 1.71 ha
Block G7 3.34 ha
AVENUE ONE
NATURAL HERITAGE AREA
Block G8 3.70 ha
Block G9 7.33 ha
Block P5 3.88 ha
EXISTING 900Ø REGIONAL WATERMAIN ZONE 6 WATERMAIN
PROPOSED 600Ø REGIONAL WATERMAIN
Block C2-1 0.63 ha
Block C2-2 1.09 ha
ARTERIAL ONE
NATURAL HERITAGE AREA
Block C4-1 1.48 ha
PROPOSED 300Ø LOCAL WATERMAIN
Block G2-2 3.58 ha
Block G2-3 3.54 ha
Block G4 1.96 ha
SWM 3.87 ha
AVENUE THREE
Block G6 4.29 ha
SWM 2.37 ha
SWM 1.61 ha
Block G10 3.42 ha
Block P6 3.87 ha
PROPOSED 600Ø REGIONAL WATERMAIN
PROPOSED 300Ø LOCAL WATERMAIN
Block G3-1 1.60 ha
PROPOSED 300Ø LOCAL WATERMAIN
Block G3 3.99 ha
SWM 2.50 ha
Block G3-2 1.30 ha
STREET FOUR
SWM 2.23
Block C4-2 1.23 ha
AVENUE FIVE
PROPOSED 300Ø LOCAL WATERMAIN
Block C1 3.24 ha
Block P8 2.76 ha
PROPOSED 300Ø LOCAL WATERMAIN
Block C3-3 1.85 ha
Block C3-4 0.87 ha
Block C3-5 2.07 ha
PROPOSED 300Ø LOCAL WATERMAIN TO SERVICE BLOCK C3-4 AND C3-5
Block C4-3 1.56 ha
Block C6 2.90 ha
Block P7 (E) 2.43 ha
Block C7 0.31 ha
Block C8 2.18 ha
EXISTING 900Ø REGIONAL WATERMAIN
EXISTING 1200Ø REGIONAL WATERMAIN
DUNDAS STREET WEST
EXISTING 1200Ø REGIONAL WATERMAIN
PROPOSED 150Ø LOCAL WATERMAIN TO BE CONSTRUCTED WITH REDEVELOPMENT OF EX BLOCK P7

LEGEND

- EXISTING REGIONAL WATERMAIN
- PROPOSED REGIONAL WATERMAIN
- PROPOSED LOCAL WATERMAIN
- FUTURE CULVERT CROSSING
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES

NOTES:

– For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area

– Right–of–way requirements for future 407 Transitway to be determined

– The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

Scale 0 100 200 300 400 500m

Client: QuadReal

Prepared by: wsp

Date: MAY 2020

Project No.: 1409222.001

FIGURE 8.4

FILE NAME: X:\DIV10\14-09222\MUN\ASP-FSS Exhibits\EX2.6-FIG8.4_Water Distribution Plan.dwg_Fig 8.4

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

STORMWATER DRAINAGE PLAN

HIGHWAY 407

PLANNED 407 TRANSITWAY

BRONTE ROAD

TREMAINE ROAD

DUNDAS STREET WEST

AVENUE ONE

AVENUE THREE

AVENUE FIVE

ARTERIAL ONE

STREET FOUR

NATURAL HERITAGE AREA

NATURAL HERITAGE SYSTEM

Block G1-1 5.22 ha

Block G1-2 3.46 ha

Block G2-1 4.78 ha

Block G2-2 3.58 ha

Block G2-3 3.54 ha

Block G3 3.99 ha

Block G3-1 1.09 ha

Block G3-1 1.60 ha

Block G3-2 1.30 ha

Block G4 1.96 ha

Block G5-1 4.12 ha

Block G5-5 2.69 ha

Block G5-6 2.08 ha

Block G6 4.29 ha

Block G7 3.34 ha

Block G8 3.70 ha

Block G9 7.33 ha

Block G10 3.42 ha

Block P1 2.38 ha

Block P2-1 1.58 ha

Block P2-2 2.30 ha

Block P2-3 2.93 ha

Block P2-4 3.35 ha

Block P3 (E) 7.67 ha

Block P4 11.64 ha

Block P5 3.88 ha

Block P6 3.87 ha

Block P7 (E) 2.43 ha

Block P8 2.76 ha

Block C1 3.24 ha

Block C2-1 0.63 ha

Block C2-2 1.09 ha

Block C3-3 1.85 ha

Block C3-4 0.87 ha

Block C3-5 2.07 ha

Block C4-1 1.48 ha

Block C4-2 1.23 ha

Block C4-3 1.56 ha

Block C5-1 1.71 ha

Block C5-2 2.53 ha

Block C6 2.90 ha

Block C7 0.31 ha

Block C8 2.18 ha

SWM 0.25 ha

SWM 1.78 ha

SWM 2.50 ha

SWM 0.23 ha

SWM 3.87 ha

SWM 2.37 ha

SWM 1.61 ha

SWM 2.70 ha POND 6

POND 1

POND 2

POND 3

POND 4

POND 7

2.89 / 0.90

14.09 / 0.90

38.83 / 0.90

22.79 / 0.90

18.27 / 0.90

16.76 / 0.90

15.46 / 0.90

29.93 / 0.90

34.0 / 0.90

SWM FOR EXISTING DEVELOPMENT TO BE SELF-CONTAINED

INV. 151.73

INV. 144.86

INV. 149.22

INV. 151.39

MH1 MH2 MH3 MH4 MH5 MH6 MH7 MH8 MH9 MH10 MH11 MH12 MH13 MH14 MH15 MH17 MH18 MH20 MH25 MH26 MH27 MH28 MH29 MH30 MH31 MH32 MH33 MH34 MH35 MH36 MH37 MH38 MH39 MH40 MH41 MH42 MH43 MH44 MH45 MH46 MH47 MH48 MH49 MH50 MH51 MH52 MH53 MH54 MH55 MH56 MH57

HW1 HW2 HW3A HW3B HW4 HW5 HW6 HW7

STORM DRAINAGE ILLUSTRATED TO THE EAST OF AVENUE THREE WITHIN SUBCATCHMENTS FM-1108, FM-1109, FM-1110 AND FM1110.1 ARE CONCEPTUAL ONLY AND HAVE NOT BEEN EVALUATED BY THE REVIEW AGENCIES WITH RESPECT TO FEASIBILITY OF NATURAL HERITAGE SYSTEM IMPACTS AND AS SUCH ARE SUBJECT TO POTENTIALLY SUBSTANTIAL CHANGES.

LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- PROPOSED REALIGNED CREEK
- CULVERTS (EIR NODES)
- SUB-CATCHMENT No.
- AREA (ha)
- PROPOSED SWM POND (INTERIM)
- REFERENCE NODE
- DEVELOPMENT BOUNDARY
- POND 2 DRAINAGE AREA
- SWM BLOCKS
- DUNDAS ST. CONTROLS BY ON-SITE STORAGE AND DRAINS TO DOWNSTREAM
- DUNDAS ST. DRAINS TO POND 2
- POND 3 DRAINAGE AREA
- AREA DRAINS TO 14W-12A (REF. NODE 2)
- TREMAINE POND DRAINAGE AREA
- POND 5 DRAINAGE AREA
- POND 1 DRAINAGE AREA

LEGEND

- STORM SEWER
- STORM MANHOLE
- STORM DRAINAGE BOUNDARY
- OVERLAND FLOW ROUTE
- TRIBUTARY AREA (Ha)
- RUN-OFF CO-EFFICIENT
- FUTURE CULVERT CROSSING
- PROPOSED INFILTRATION SWALE
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES

NOTES:

– For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area

– Right–of–way requirements for future 407 Transitway to be determined

– The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

Scale

0 100 200 300 400 500m

Client: QuadReal

Prepared by: wsp

Date: MAY 2020

Project No.: 1409222.001

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

CONCEPTUAL GRADING PLAN

HIGHWAY 407
PLANNED 407 TRANSITWAY
TREMAINE ROAD
BRONTE ROAD
DUNDAS STREET WEST
AVENUE ONE
AVENUE TWO
AVENUE THREE
AVENUE FIVE
ARTERIAL ONE
STREET FOUR
Block G1-1 5.22 ha
Block G1-2 3.46 ha
Block G2-1 4.78 ha
Block G2-2 3.58 ha
Block G2-3 3.54 ha
Block G3 3.99 ha
Block C1 3.24 ha
Block P1 2.88 ha
Block P2-1 1.58 ha
Block P2-2 2.30 ha
Block P2-3 2.93 ha
Block P2-4 3.35 ha
Block P3 (E) 7.67 ha
Block P4 11.64 ha
Block P5 3.88 ha
Block P6 3.87 ha
Block P7 (E) 2.43 ha
Block P8 2.76 ha
Block G3-1 1.60 ha
Block G3-2 1.30 ha
Block G3-3 1.85 ha
Block G3-4 0.87 ha
Block G4 1.96 ha
Block G5-1 4.12 ha
Block G5-5 2.69 ha
Block G5-6 2.08 ha
Block G6 4.29 ha
Block G7 3.34 ha
Block G8 3.70 ha
Block G9 7.33 ha
Block G10 3.42 ha
Block C2-1 0.63 ha
Block C2-2 1.09 ha
Block C3-5 2.07 ha
Block C4-1 1.48 ha
Block C4-2 1.23 ha
Block C4-3 1.56 ha
Block C5-1 1.71 ha
Block C5-2 2.53 ha
Block C6 2.90 ha
Block C7 0.31 ha
Block C8 2.18 ha
Block G1-3 1.09 ha
SWM 1.78 ha
SWM 0.25 ha
SWM 2.50 ha
SWM 2.23
SWM 3.87 ha
SWM 2.37 ha
SWM 2.70 ha
SWM 1.61 ha
NATURAL HERITAGE AREA
NATURAL HERITAGE AREA
NATURAL HERITAGE AREA
NATURAL HERITAGE AREA
158.51
159.40
160.55 HP
158.84
159.80 LP
159.00 +/-
160.43 HP
158.01 LP
158.46 HP
158.03 HP
157.95
157.81
156.65 LP
158.00
158.00 HP
152.04 LP
154.03 HP
153.65 +/-
156.49
154.29
153.35
153.69
155.30 HP
156.29
157.50
156.00
155.70 HP
156.50
161.76
161.53 +/-
154.61
153.46
151.60 LP
152.39
152.68HP
154.58 HP
153.84
156.44 HP
151.30
150.00 LP
150.50 LP
150.90 HP
150.80 LP
151.20 HP
151.10 LP
151.25 HP
149.15
148.00+/-
153.69
151.30
151.50+/-
153.10 LP
153.50 HP
153.40 LP
150.00
2.0%
0.5%
2.5%
0.9%
1.0%
1.2%
0.6%
0.7%
1.1%
1.9%
2.6%

NOTES:
- For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area
- Right-of-way requirements for future 407 Transitway to be determined
- The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

STORM DRAINAGE ILLUSTRATED TO THE EAST OF AVENUE THREE WITHIN SUBCATCHMENTS FM-1108, FM-1109, FM-1110 AND FM1110.1 ARE CONCEPTUAL ONLY AND HAVE NOT BEEN EVALUATED BY THE REVIEW AGENCIES WITH RESPECT TO FEASIBILITY OF NATURAL HERITAGE SYSTEM IMPACTS AND AS SUCH ARE SUBJECT TO POTENTIALLY SUBSTANTIAL CHANGES.

LEGEND
- 2.0% PROPOSED ROAD GRADE
- 240.70 PROPOSED ROAD ELEVATION
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES
- 3:1 SLOPING

Scale 0 100 200 300 400 500m

Client: QuadReal

Prepared by: wsp

Date: MAY 2020

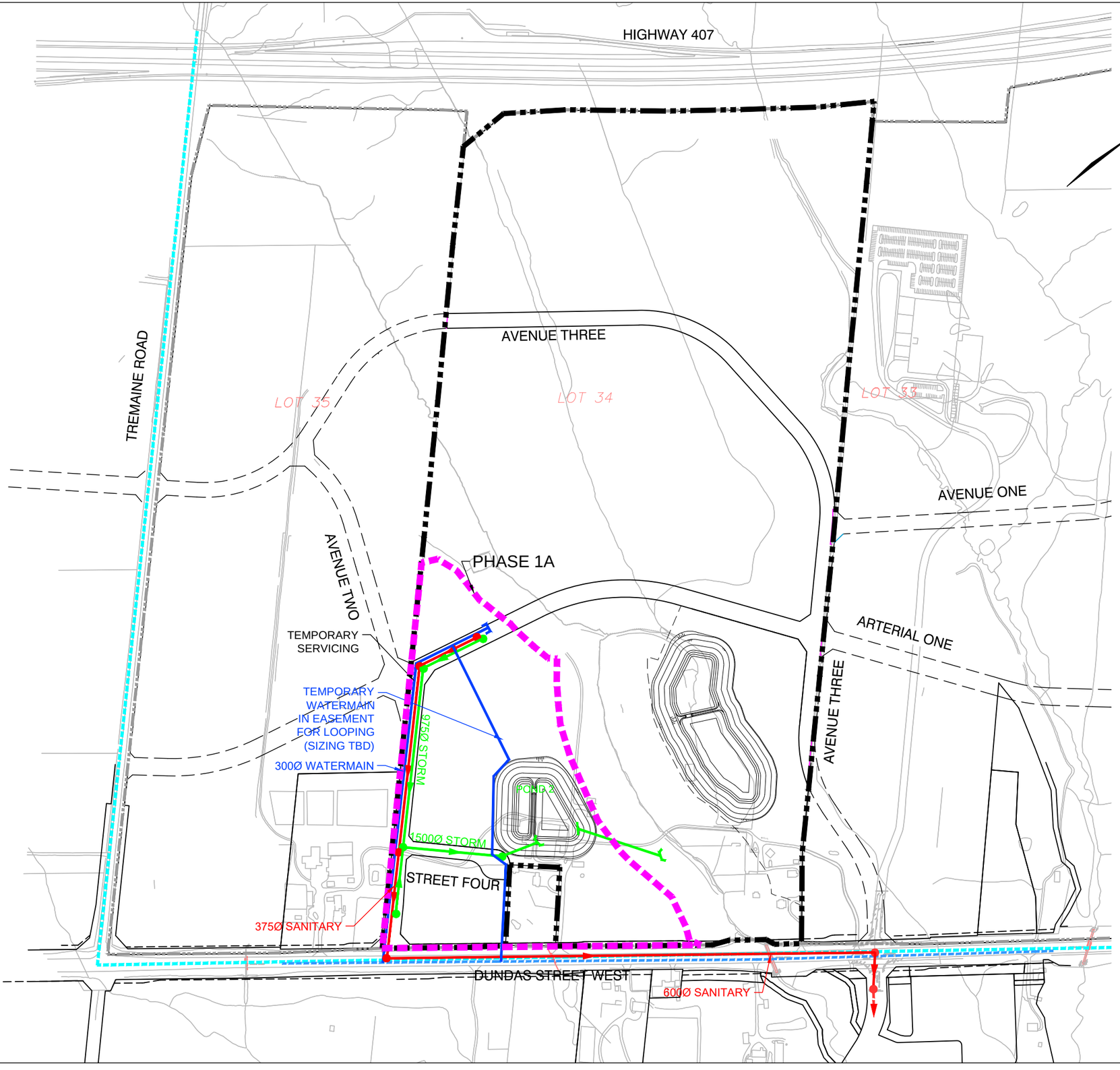
Project No.: 1409222.001

FIGURE 8.6

FILE NAME: X:\DIV10\14-09222\MUN\ASP-FSS Exhibits\FIG 8.6 - Conceptual Grading.dwg_Fig 8.6

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

INTERIM SERVICING PLAN PHASE 1A



LEGEND

- PROPOSED SANITARY SEWER
- EXISTING SANITARY SEWER
- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- PROPOSED WATERMAIN
- EXISTING WATERMAIN
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES
- PHASE LIMITS

NOTES:

– For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area

– Right–of–way requirements for future 407 Transitway to be determined

– The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

Scale: 0 100 200 300 400 500m

Client: QuadReal

Prepared by: wsp

Date: APRIL 2019

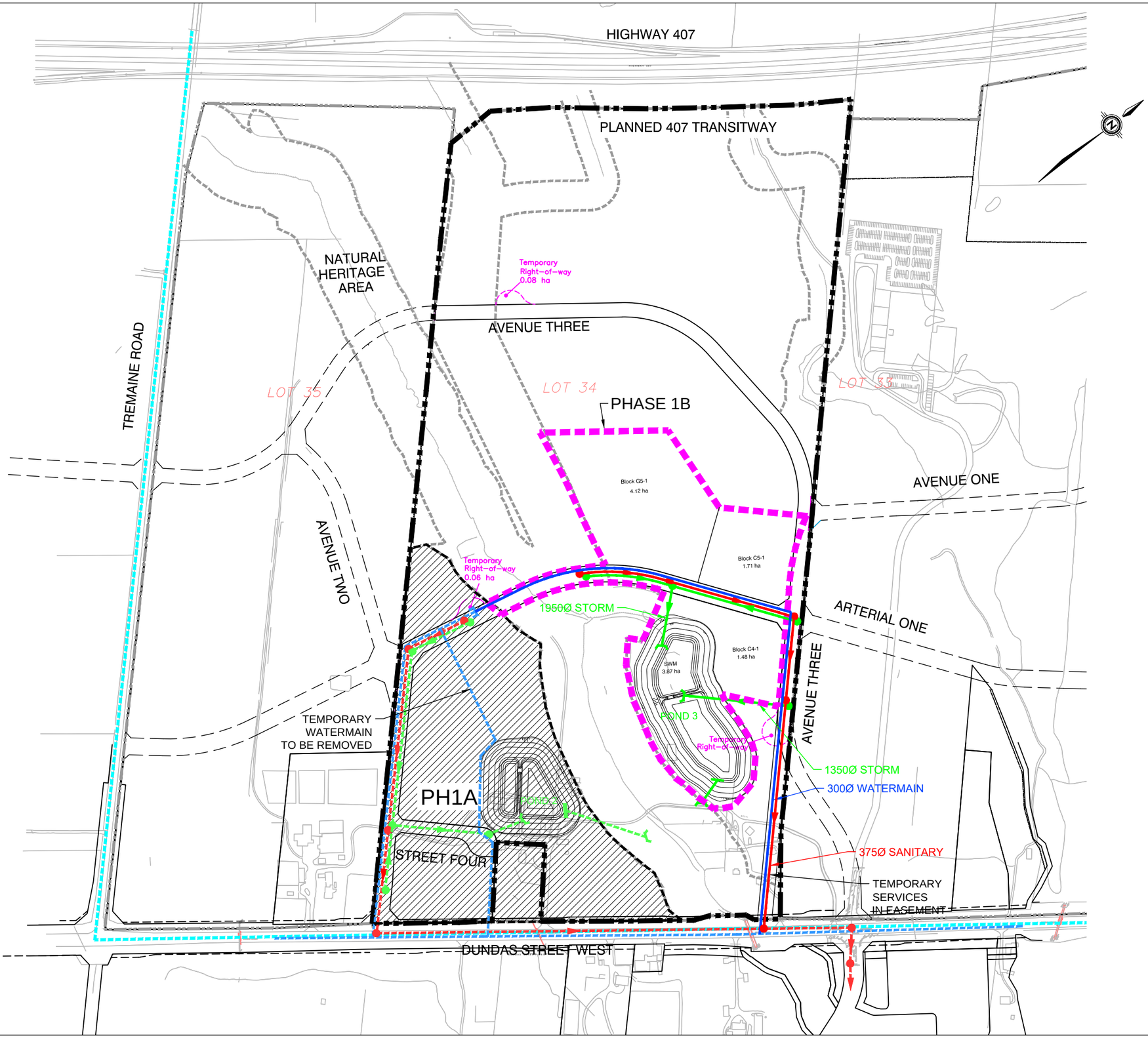
Project No.: 1409222.001

FIGURE 8.7.1

FILE NAME: X:\DIVIO\14-09222\MUN\ASP-FSS Exhibits\09022_Fig 8.7.1_2_3.dwg_Fig 8.7.1

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

INTERIM SERVICING PLAN PHASE 1B



LEGEND

- PROPOSED SANITARY SEWER
- EXISTING SANITARY SEWER
- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- PROPOSED WATERMAIN
- EXISTING WATERMAIN
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES
- PHASE LIMITS

NOTES:

– For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area

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– The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

Scale 0 100 200 300 400 500m

Client: QuadReal

Prepared by: wsp

Date: APRIL 2019

Project No.: 1409222.001

FIGURE 8.7.2

FILE NAME: x:\DIV10\14-09222\MUN\ASP-FSS Exhibits\09022_Fig 8.7.1_2_3.dwg_Fig 8.7.2

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

INTERIM SERVICING PLAN PHASE 2

HIGHWAY 407

PLANNED 407 TRANSITWAY

NATURAL HERITAGE AREA

TREMAINE ROAD

AVENUE TWO

AVENUE THREE

AVENUE ONE

ARTERIAL ONE

STREET FOUR

DUNDAS STREET WEST

PHASE 2

LOT 35

LOT 34

LOT 35

PH1A

PH1B

Block P2-1
1.58 ha

Block P2-2
2.30 ha

Block P2-3
2.93 ha

Block P2-4
3.35 ha

Block G5-6
2.08 ha

Block G5-5
2.69 ha

Block C5-2
2.53 ha

Temporary Right-of-way 0.08 ha

Temporary Right-of-way 0.06 ha

Temporary Right-of-way

600Ø WATERMAIN

300Ø SANITARY

900Ø STORM

1500Ø STORM

300Ø WATERMAIN

1800Ø STORM

1200Ø STORM

POND 1

POND 2

TEMPORARY WATERMAIN IN EASEMENT FOR LOOPING (SIZING TBD)

TEMPORARY SERVICING

TEMPORARY SERVICING TO BE REMOVED

LEGEND

- PROPOSED SANITARY SEWER
- EXISTING SANITARY SEWER
- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- PROPOSED WATERMAIN
- EXISTING WATERMAIN
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES
- PHASE LIMITS

NOTES:

– For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area

– Right–of–way requirements for future 407 Transitway to be determined

– The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

Scale

0 100 200 300 400 500m

Client

QuadReal

Prepared by

wsp

Date

APRIL 2019

Project No.

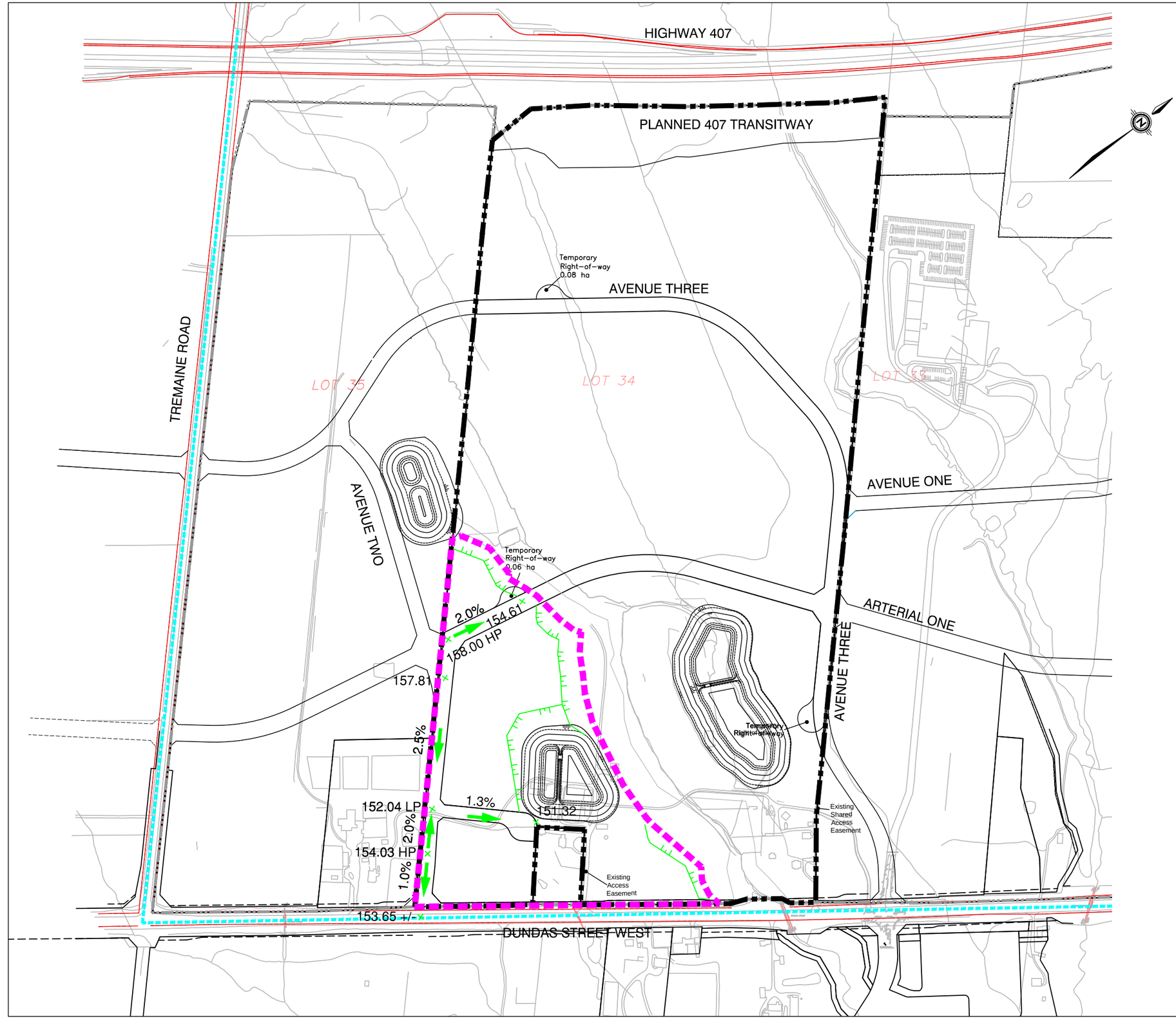
1409222.001

FIGURE 8.7.3

FILE NAME: X:\DIV10\14-09222\MUN\ASP-FSS Exhibits\09022_Fig 8.7.1_2_3.dwg_Fig 8.7.3

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

INTERIM GRADING PLAN PHASE 1A



LEGEND

- 2.0% — PROPOSED ROAD GRADE
- 240.70 × — PROPOSED ROAD ELEVATION
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES
- 3:1 SLOPING

NOTES:

– For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area

– Right-of-way requirements for future 407 Transitway to be determined

– The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

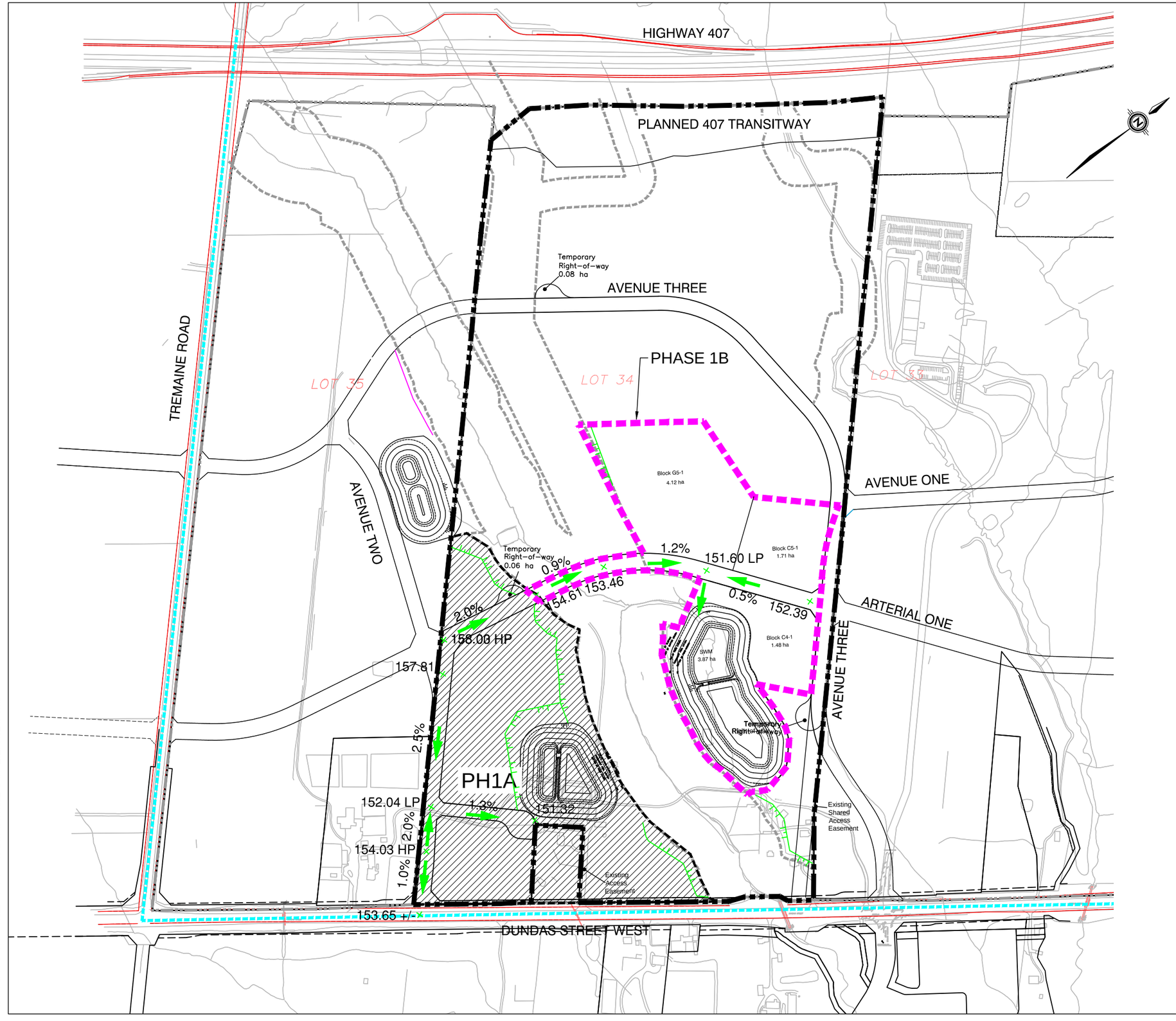
Scale: 0 100 200 300 400 500m

Client	Prepared by
QuadReal	wsp
Date: APRIL 2019	Project No.: 1409222.001
	FIGURE 8.8.1

FILE NAME: X:\DIV1O\14-09222\MUN\ASP-FSS Exhibits\09022_Fig 8.8.1_2_3.dwg_Fig 8.8.1

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

INTERIM GRADING PLAN PHASE 1B



LEGEND

- 2.0% — PROPOSED ROAD GRADE
- 240.70 × — PROPOSED ROAD ELEVATION
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES
- 3:1 SLOPING

NOTES:

– For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area

– Right–of–way requirements for future 407 Transitway to be determined

– The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

Scale: 0 100 200 300 400 500m

Client: QuadReal

Prepared by: wsp

Date: APRIL 2019

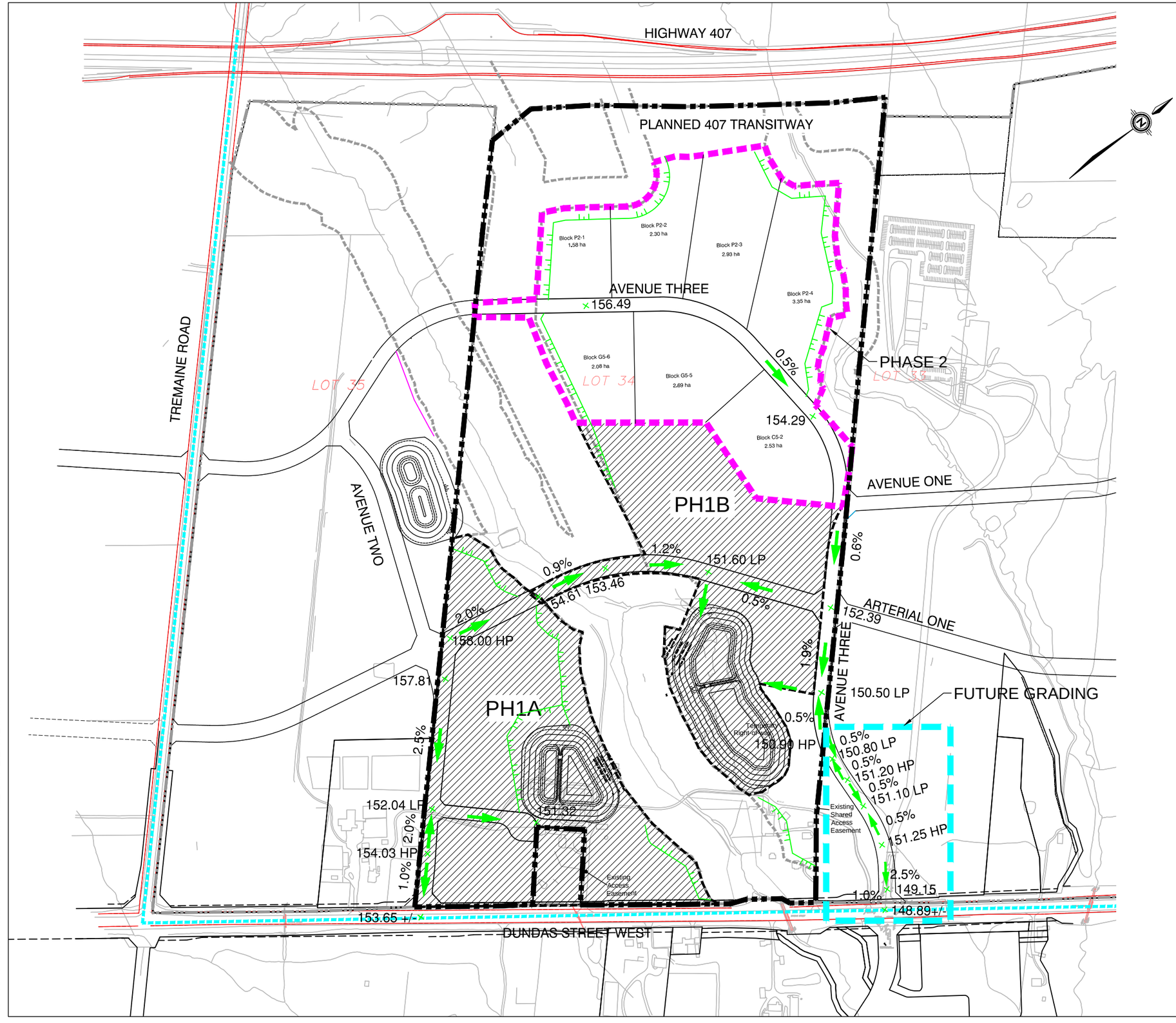
Project No.: 1409222.001

FIGURE 8.8.2

FILE NAME: X:\DIV10\14-09222\MUN\ASP-FSS Exhibits\09022_Fig 8.8.1_2_3.dwg_Fig 8.8.2

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

INTERIM GRADING PLAN PHASE 2



LEGEND

- 2.0% — PROPOSED ROAD GRADE
- 240.70 × — PROPOSED ROAD ELEVATION
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES
- 3:1 SLOPING

NOTES:

– For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area

– Right–of–way requirements for future 407 Transitway to be determined

– The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

Scale

0 100 200 300 400 500m

Client	Prepared by
QuadReal	wsp
Date: APRIL 2019	Project No.: 1409222.001
	FIGURE 8.8.3

FILE NAME: X:\DIV\O\14-09222\MUN\ASP-FSS Exhibits\09022_Fig 8.8.1_2_3.dwg_Fig 8.8.3

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

WASTEWATER ANALYSIS PLAN

HIGHWAY 407

PLANNED 407 TRANSITWAY

TREMAINE ROAD

BRONTE ROAD

EXTERNAL BY OTHERS

EXTERNAL BY OTHERS

DUNDAS STREET WEST

AVENUE ONE

AVENUE TWO

AVENUE THREE

AVENUE FIVE

ARTERIAL ONE

STREET FOUR

NATURAL HERITAGE AREA

NATURAL HERITAGE AREA

NATURAL HERITAGE AREA

Block P1 2.88 ha

Block P2-1 1.58 ha

Temporary Right-of-way 0.08 ha

Block P2-2 2.30 ha

Block P2-3 2.93 ha

Block P2-4 3.35 ha

Block P3 (E) 7.67 ha

SWM 2.70 ha

Block P4 11.64 ha

Block P5 3.88 ha

Block P6 3.87 ha

Block P7 (E) 2.43 ha

Block P8 2.76 ha

Block G1-1 5.22 ha

Block G1-2 3.46 ha

Block G2-1 4.78 ha

Block G2-2 3.58 ha

Block G2-3 3.54 ha

Block G3 3.99 ha

Block G3-1 1.60 ha

Block G3-1-1 1.09 ha

Block G3-2 1.30 ha

Block G3-3 1.85 ha

Block G3-4 0.87 ha

Block G4 1.96 ha

Block G5-1 4.12 ha

Block G5-5 2.69 ha

Block G5-6 2.08 ha

Block G6 4.29 ha

Block G7 3.34 ha

Block G8 3.70 ha

Block G9 7.33 ha

Block G10 3.42 ha

Block C1 3.24 ha

Block C2-1 0.63 ha

Block C2-2 1.09 ha

Block C3-1 1.60 ha

Block C3-2 1.30 ha

Block C3-3 1.85 ha

Block C3-4 0.87 ha

Block C3-5 2.07 ha

Block C4-1 1.48 ha

Block C4-2 1.23 ha

Block C4-3 1.56 ha

Block C5-1 1.71 ha

Block C5-2 2.53 ha

Block C6 2.90 ha

Block C7 0.31 ha

Block C8 2.18 ha

SWM 1.78 ha

SWM 0.25 ha

SWM 2.50 ha

SWM 2.23

SWM 3.87 ha

SWM 2.37 ha

SWM 1.61 ha

50.08 / 5379

53.23 / 6080

2.43 / 304

39.42 / 4540

56.0 / 2170

13.0 / 715

MH1 MH1A MH2 MH2A MH7A MH10 MH10A MH11 MH11A MH12 MH12A MH19A MH20B MH22A MH24A MH25A MH26A MH33A MH37A MH39A MH41A MH42A MH47A MH48A MH50A MH59A MH60A MH63A MH66A MH68A MH74A MHD1

300Ø SAN @ 1.4%

300Ø SAN @ 0.7%

300Ø SAN @ 1.0%

300Ø SAN @ 1.2%

300Ø SAN @ 0.5%

300Ø SAN @ 0.5% (IF REQUIRED)

300Ø SAN @ 2.5%

300Ø SAN @ 0.6%

375Ø SAN @ 0.5%

600Ø SAN @ 0.5%

450Ø SAN @ 0.5%

450Ø SAN @ 1.25%

200Ø SAN @ 1.0%

EX. 825Ø SAN

EX. MH9

EX.MH22A CONNECT TO EXISTING 600Ø ON COLONEL WILLIAM PARKWAY

SAN SEWER FROM MHD4 TO MHD6 NOT REQUIRED FOR OPTION 2.

SERVICING OPTION 2: CONNECT TO EXISTING 300Ø ON VALLEYRIDGE DRIVE.

LEGEND

- SANITARY SEWER
- SANITARY MANHOLE
- SANITARY DRAINAGE BOUNDARY
- ALTERNATIVE SANITARY SEWER ALIGNMENT
- EXTERNAL SANITARY SEWER (B.O.)
- EXISTING SANITARY SEWER
- 39.40 / 4533 — TRIBUTARY AREA (Ha) / TRIBUTARY POPULATION
- 13.0 / 715 — EXTERNAL TRIBUTARY AREA (Ha) / EXTERNAL TRIBUTARY POPULATION
- FUTURE CULVERT CROSSING
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES

NOTES:

- For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area
- Right-of-way requirements for future 407 Transitway to be determined
- The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

Scale 0 100 200 300 400 500m

Client: QuadReal

Prepared by: wsp

Date: MAY 2020

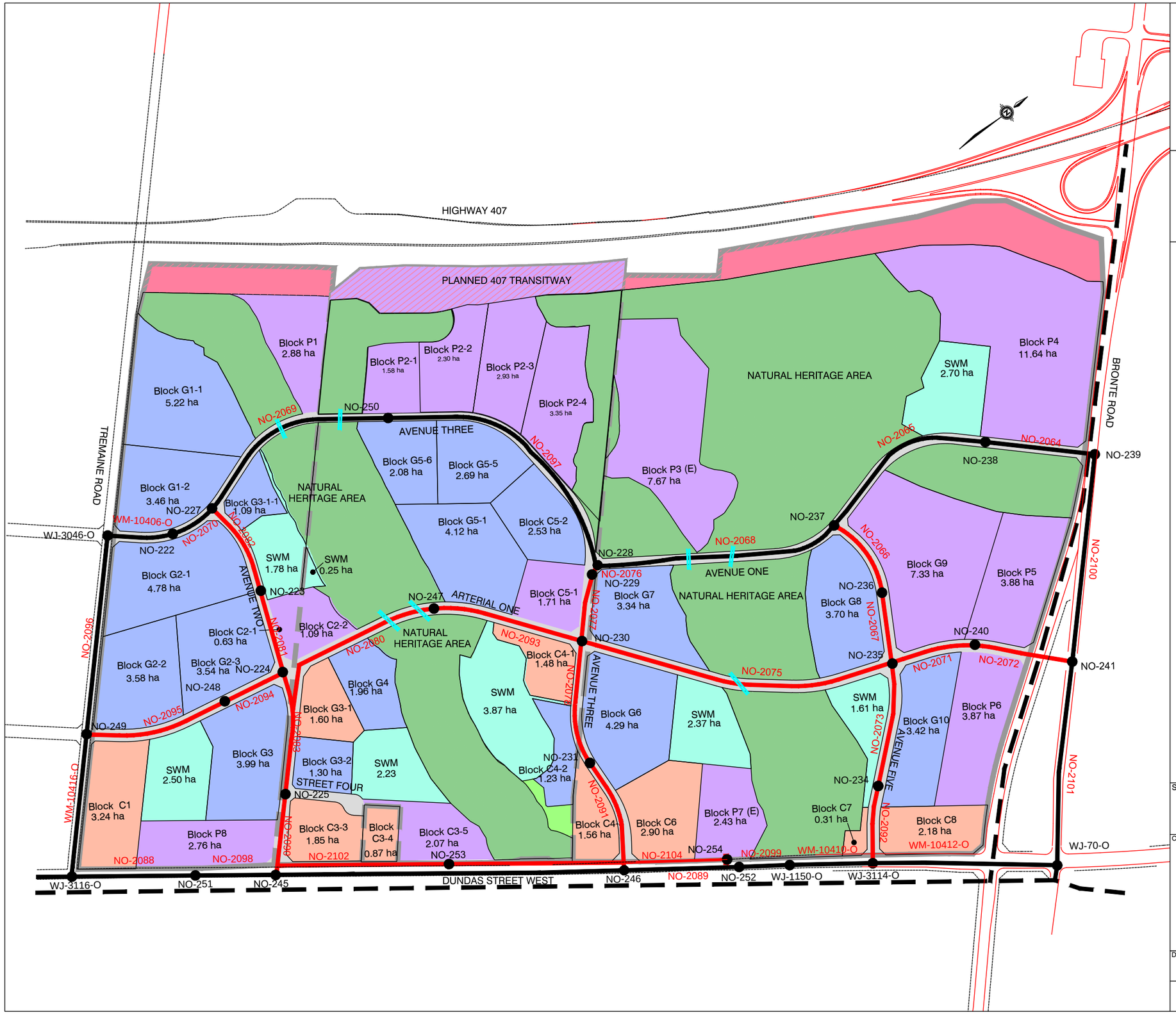
Project No.: 1409222.001

FIGURE A-8.1

FILE NAME: X:\DIV10\14-09222\MUN\ASP-FSS Exhibits\EX3.6-FIG8.2_Wastewater Drainage Plan.dwg_Fig A-8.1

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

WATER ANALYSIS PLAN



LEGEND

- EXISTING REGIONAL WATERMAIN
- PROPOSED REGIONAL WATERMAIN
- PROPOSED LOCAL WATERMAIN
- WATER ANALYSIS NODE
- FUTURE CULVERT CROSSING
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES

NOTES:

– For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area

– Right–of–way requirements for future 407 Transitway to be determined

– The Natural Heritage System on lands owned by others is conceptual, as shown in the North Oakville West Secondary Plan, and is subject to further study.

Scale

0 100 200 300 400 500m

Client

QuadRea

Prepared by

wsp

Date

MAY 2020

Project No.

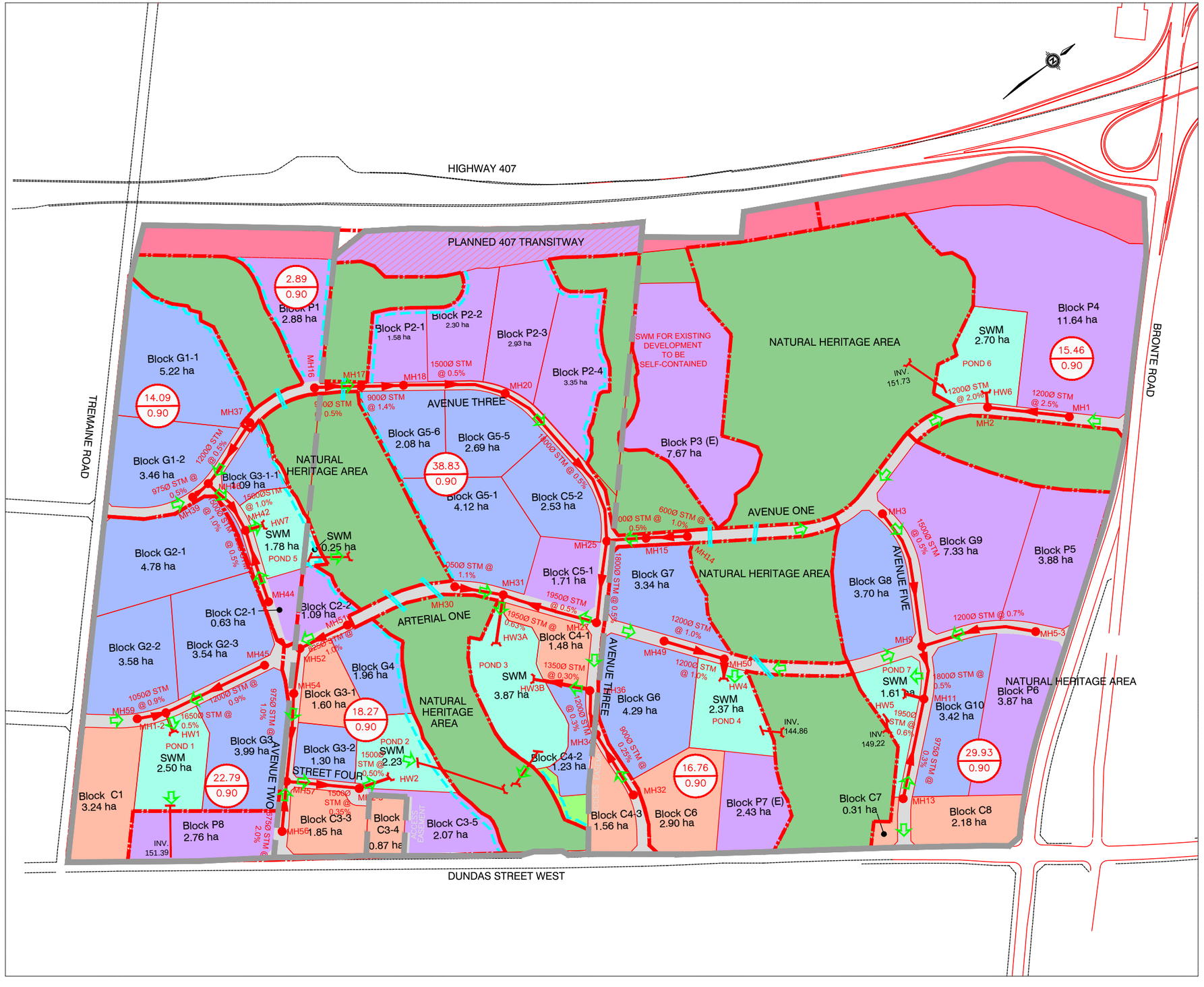
1409222.001

FIGURE A-8.2

FILE NAME: X:\DIV10\14–09222\MUN\ASP–FSS Exhibits\APP A1–8.2_Water Analysis.dwg_Fig A–8.2

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

STORMWATER ANALYSIS PLAN



LEGEND

- STORM SEWER
- STORM MANHOLE
- STORM DRAINAGE BOUNDARY
- OVERLAND FLOW ROUTE
- TRIBUTARY AREA (Ha) / RUN-OFF CO-EFFICIENT
- FUTURE CULVERT CROSSING
- PROPOSED INFILTRATION SWALE
- 407 WEST EMPLOYMENT AREA
- PROPERTY BOUNDARIES

NOTES:

– For the purposes of the analysis land use, natural heritage and storm water sizing and location assumptions have been made for the entire 407 West Employment Area

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Scale: 0 100 200 300 400 500m

Client: QuadReal

Prepared by: wsp

Date: MAY 2020

Project No.: 1409222.001

FIGURE A-8.3

FILE NAME: X:\DIV10\14-09222\MUN\ASP-FSS Exhibits\APP 8.3_Stormwater Analysis.dwg_Fig A-8.3