Chapter 7

Markham Collector Twinning

The Regional Municipality of York
The Regional Municipality of Durham

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Contents

7. Markham Collector Twinning 1

7.1 Overview 1

7.1.1 Existing Conditions 1

7.1.1.1 Social and Built Environment 1

7.1.1.2 Natural Environment 2

7.1.1.3 Cultural Environment 2

7.1.2 Conceptual Design 2

7.1.3 Environmental and Community Impacts and Mitigation 2

7.1.4 Capital Cost Estimate and Implementation Plan 2

7.2 Y2 Linear Gravity Sewer 4

7.2.1 Study Area 4

7.2.2 Existing Conditions 6

7.2.2.1 Social and Built Environment 6

7.2.2.2 Natural Environment 11

7.2.2.3 Cultural Environment 29

7.2.3 Conceptual Design 30

7.2.3.1 Design Basis 30

7.2.3.2 Description of Design 31

7.2.3.3 Construction Methods 33

7.2.3.4 Property Requirements 36

7.2.4 Environmental and Community Impacts and Mitigation 36

7.3 Capital Cost Estimate 45

7.3.1 Scope of Work 45

7.3.2 Cost Assumptions 45

7.3.2.1 Excluded Costs 46

7.3.3 Cost Estimate 46

7.4 Implementation Plan 48

7.4.1 Field Investigations 48

7.4.2 Permits 50

7.4.3 Schedule 53

Table index

Table 7.1	Aquifers and Aquitards Through the Study Area	13
Table 7.2	Natural Heritage Characterization Within and Adjacent to Study Area	17
Table 7.3	Areas of Potential Environmental Concern (APEC)	23
Table 7.4	Design Basis for the Development of the Preferred Alignment	30
Table 7.5	Social and Built Environment – Effects and Mitigation	37
Table 7.6	Natural Environment – Effects and Mitigation	40
Table 7.7	Cultural Environment - Effects and Mitigation	44
Table 7.8	Estimated Construction Costs	46
Table 7.9	Estimated Capital Costs	47
Table 7.10	Future Field Investigations	48
Table 7.11	Permits and Approvals Required for the Markham Collector Twinning Project	50
Table 7.12	Proposed Schedule for the Markham Collector Twinning Project	53

Figure index

Figure 7-1	Markham Collector Twinning Project Overview	3
Figure 7-2	Study Area for the Markham Collector Twinning Project	5
Figure 7-3	Land Use Designation within York Region (Source: 2022 York Region Official Plan)	7
Figure 7-4	Sensitive Receptors Along the Proposed Alignment	8
Figure 7-5	Road Network Within the Study Area	10
Figure 7-6	Preferred Alignment Through the Subwatersheds and Drainage Areas	15
Figure 7-7	Environmental Features	20
Figure 7-8	Areas of Potential Environmental Concerns (APECs)	22
Figure 7-9	Proposed Upstream Connection Near Existing MH44-05	32
Figure 7-10	Conceptual Alignment at Rouge River Crossing	34
Figure 7-11	Conceptual Profile at Rouge River Crossing	35
Figure 7-12	Typical Permits and Approvals Timeline for the Markham Collector Twinning Project	52

7. Markham Collector Twinning

7.1 Overview

The existing Markham Collector is a single, 2.4 metre (m)-diameter, 15 kilometre (km) long trunk sewer. It plays a significant role in conveying sanitary flows from the existing upstream catchments (approximately 21,800 hectares) to the Regional Municipality of York's (York Region) Southeast Collector (SEC) and into the Primary Trunk sanitary sewer, which flows to the Duffin Creek Water Pollution Control Plant (WPCP). Built between 1976 and 1978, the existing collector has no redundancy and will exceed capacity before 2052 based on accelerated development that is predicted over the next 28 years, with an 82 percent (%) increase in regional population and a 66% increase in local employment.

York Region intends to design and install a new sanitary trunk sewer to twin the existing Markham Collector. The purpose of the new trunk sewer is to provide increased capacity for the anticipated intensification and growth, to increase resilience and to provide system redundancy and operational flexibility. This project is part of the York Durham Sewage System (YDSS) Expansion program and is known as the Markham Collector Twinning Project, labelled as part of WW5 in the York Region Water and Wastewater Master Plan 2022 and as Y2 for the Project Report.

The information presented in this report is conceptual and will be further refined during the preliminary design stage. All figures and maps produced used data from the York Region, 2021 and 2022 Maxar Aerial Imagery, Land Information Ontario (LIO), Toronto and Region Conservation Authority (TRCA) and Canvec OpenSource Data.

Chapter 7 is broken down into:

1. Study area
2. Existing environmental conditions for social and built environment, natural environment and cultural environment
3. Conceptual design
4. Environmental impacts and mitigation
5. Capital cost estimate and implementation plan.

7.1.1 Existing Conditions

This component examines the existing environmental conditions of the project area and establishes a baseline against which the potential impacts are assessed. These different aspects are evaluated through various methods, including scientific studies and surveys and consultation with interested persons and Indigenous Communities. Factors such as air and water quality, land use patterns, wildlife populations, socio-economic conditions and community resources are evaluated to understand the existing state of the environment as further described in sections 7.1.1.1 to 7.1.1.3.

7.1.1.1 Social and Built Environment

This aspect of the assessment considers the impacts on the social fabric of the community, including human health, quality of life, social well-being and community cohesion, as well as the existing built infrastructure and facilities in the project area. It evaluates factors such as noise, vibration, traffic, public safety, access to services, capacity constraints and changes in land use patterns, recognizing the interplay between social and built elements in the project's environmental impact.

7.1.1.2 Natural Environment

The assessment focuses on the ecological components, such as flora, fauna, ecosystems and natural resources. It evaluates potential impacts on biodiversity, habitats, water quality, air quality, soil quality and the overall functioning of natural systems.

7.1.1.3 Cultural Environment

This aspect examines the cultural heritage, which includes archaeological sites, historical structures, traditional practices and cultural landscapes that may be affected by the proposed project. It considers the potential impacts on cultural identity, traditional knowledge and the cultural significance of the area.

7.1.2 Conceptual Design

This discussion will outline the general design standards, requirements and assumptions for the construction and implementation of the new Markham Collector Twin. General design parameters have been identified in Chapter 3. Site-specific conditions have been included within this chapter. The conceptual drawings for the new Markham Collector Twin are provided in Appendix A.

7.1.3 Environmental and Community Impacts and Mitigation

The desktop existing environmental conditions were compared against the conceptual designs. The findings identified potential environmental impacts and developed mitigation measures that will inform decision-making processes to promote sustainable development that minimizes negative environmental effects while maximizing positive outcomes.

7.1.4 Capital Cost Estimate and Implementation Plan

This aspect discusses the capital cost estimate, future field investigations and permits and approvals required to design and construct the new Markham Collector Twin. These components will be further reviewed and refined during the preliminary design stage.

Figure 7-1 shows the existing Markham Collector, environmental features and the proposed infrastructure components for the Markham Collector Twinning Project, which is discussed in detail throughout this chapter.

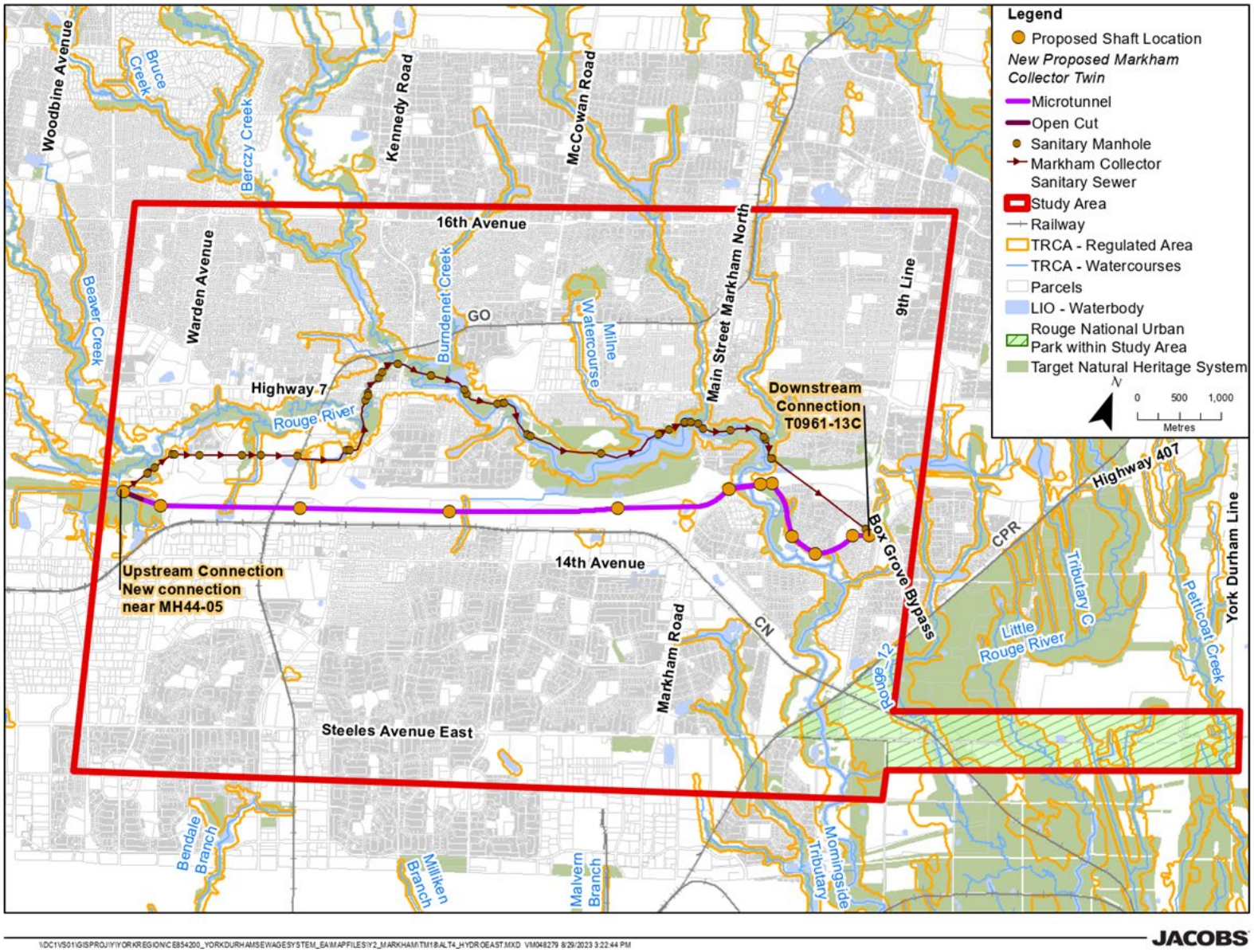

Figure 7-1 **Markham Collector Twinning Project Overview**

7.2 Y2 Linear Gravity Sewer

7.2.1 Study Area

To develop the preferred alignment for the new Markham Collector Twin, a study area of 7,000 hectares was used, considering the existing Markham Collector, the existing sanitary sewer network and surrounding infrastructure, the flat topography, the environmental features and subsurface conditions.

The existing Markham Collector crosses Highway 407 near Warden Avenue. North of that crossing, it runs parallel to Highway 407, with two Highway 7 crossings and several Rouge River and Milne Lake crossings, before it again crosses Highway 407 east of Markham Road and connects to the SEC at Ninth Line.

The new Markham Collector Twin will be approximately 9.5 km long and will run within the hydro corridor south of Highway 407, crossing Markham Road within the Highway 407 Right of Way (ROW), then continuing along the Rouge riverbank to follow the Rouge Bank Drive ROW to the downstream connection point at the existing SEC diversion facility. The advantages of this route, when compared to other routes considered, are the suitability for tunnelling construction, which results in reduced impact on surface features; short length, which reduces capital cost; ability to cross the Rouge River by gravity while maintaining a feasible slope for hydraulic performance, elimination of any conflicts with the existing Markham Collector or SEC, minimal interaction with utilities, flexibility in options for downstream connections and ease of connectivity at end connections. The conceptual design, including the design basis, description of design and construction methods, can be found in section 7.2.3.

As shown in Figure 7-2, the study area is bound by 16th Avenue to the north, Box Grove and Box Grove Collector Road to the east, with an additional area included to encompass the Rouge National Urban Park that is within the area considered for potential alignments, Passmore Avenue to the south and Woodbine Avenue to the west. The study area covers the alternative alignments considered for the new Markham Collector Twin, from the existing upstream connection point at maintenance hole (MH) MH4405 to existing downstream connection points, including the SEC diversion facility, the Box Grove By-pass and the intersection of York Durham Line and Taunton Road, located furthermost east of the Site.

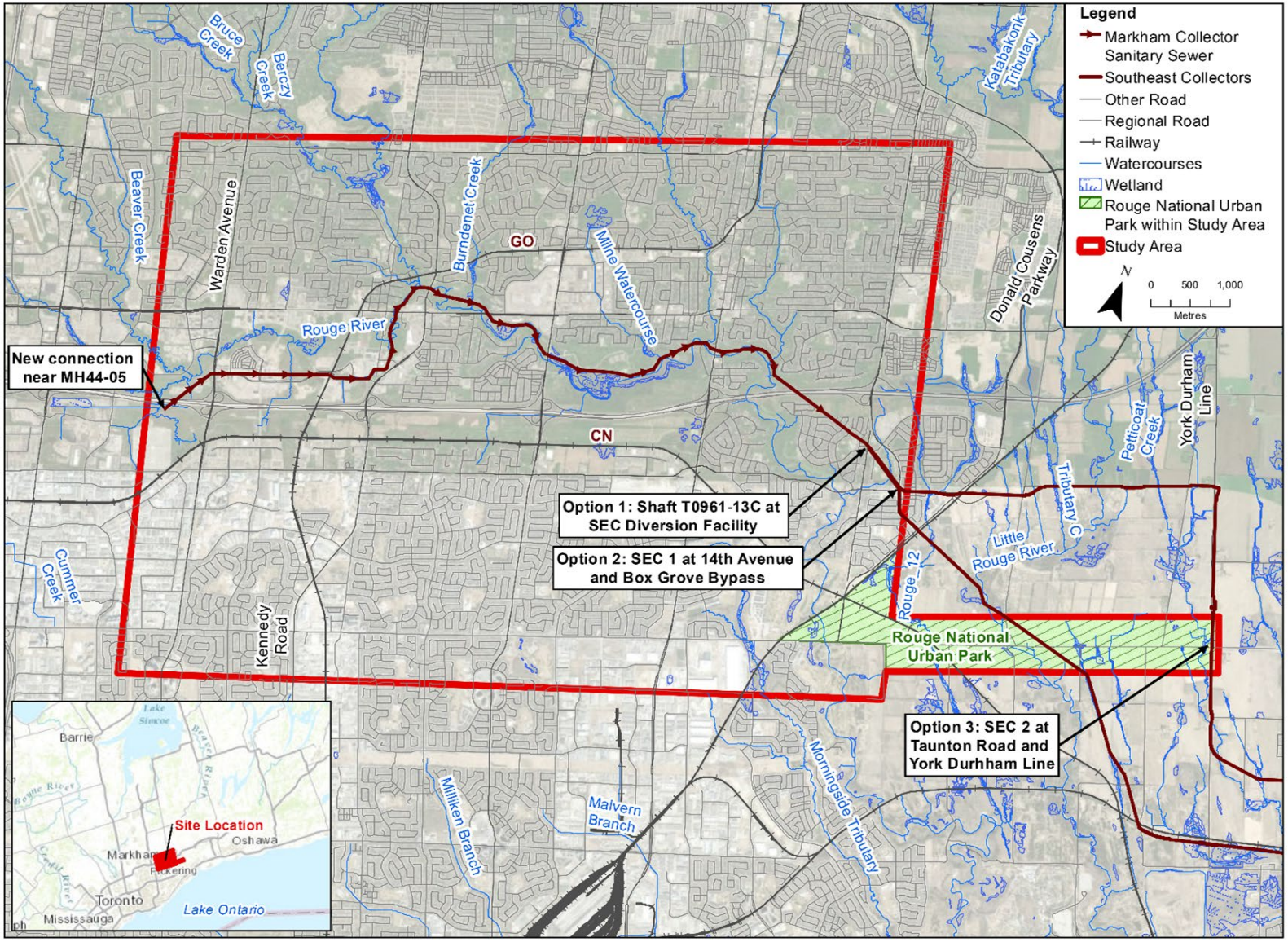

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Figure 7-2 Study Area for the Markham Collector Twinning Project

7.2.2 Existing Conditions

7.2.2.1 Social and Built Environment

The land use within the study area is a mixture of residential and commercial land uses with additional industrial lands, parkland and natural areas. Land use designations from the 2022 Regional Official Plan are shown in Figure 7-3.

The new Markham Collector Twin is proposed to run within the hydro corridor ROW south of Highway 407, crossing Markham Road within the Highway 407 ROW, then continuing along the Rouge riverbank to follow through residential areas along the Rouge Bank Drive ROW to the downstream connection point at the existing SEC diversion facility.

Residential developments are predominantly concentrated to the north of Highway 7 and south of 14th Avenue (including Unionville, Quantztown Vinegar Hill and Box Grove) and are serviced by several commercial areas, including District Energy, malls, restaurants, retail stores, hotels, offices and two golf courses.

Recreational and open spaces are distributed throughout the study area, including Austin Drive Park, Toogood Pond Park and Milne Dam Conservation Park to the north of Highway 407 and Milliken Mills Park, Featherstone Park and Legacy Park to the south. Along with a network of trails, the Rouge National Urban Park is located to the southeast within the study area.

The Canadian National Railway (CNR) corridor runs east-west from Warden Avenue to Markham Road, then turns south toward Steeles Avenue. The hydro corridor is parallel to the CNR corridor. The Metrolinx GO Transit route runs north-south from 16th Avenue to Steeles Avenue.

The remaining areas towards the west are zoned as employment areas where clusters of industrial, business, warehousing and related economic activities are concentrated.

A review of the preferred twinning route was conducted to identify potential sensitive receptors along the route. The alignment is predominantly located in the existing hydro corridor, south of and adjacent to Highway 407. The Markham Executive Golf Course exists near the central segment of the alignment within the hydro corridor. Towards the eastern portion of the alignment, the Rouge River will be crossed before passing through a forested area with recreational trails and entering a residential area. There are residences and recreational areas, including Legacy Park, along the north side of Rouge Bank Drive and, a Community Center and the Markham Green Golf Course along the south side. Figure 7-4 illustrates the preferred alignment for the new Markham Collector Twin and denotes the sensitive receptors in proximity to the alignment.

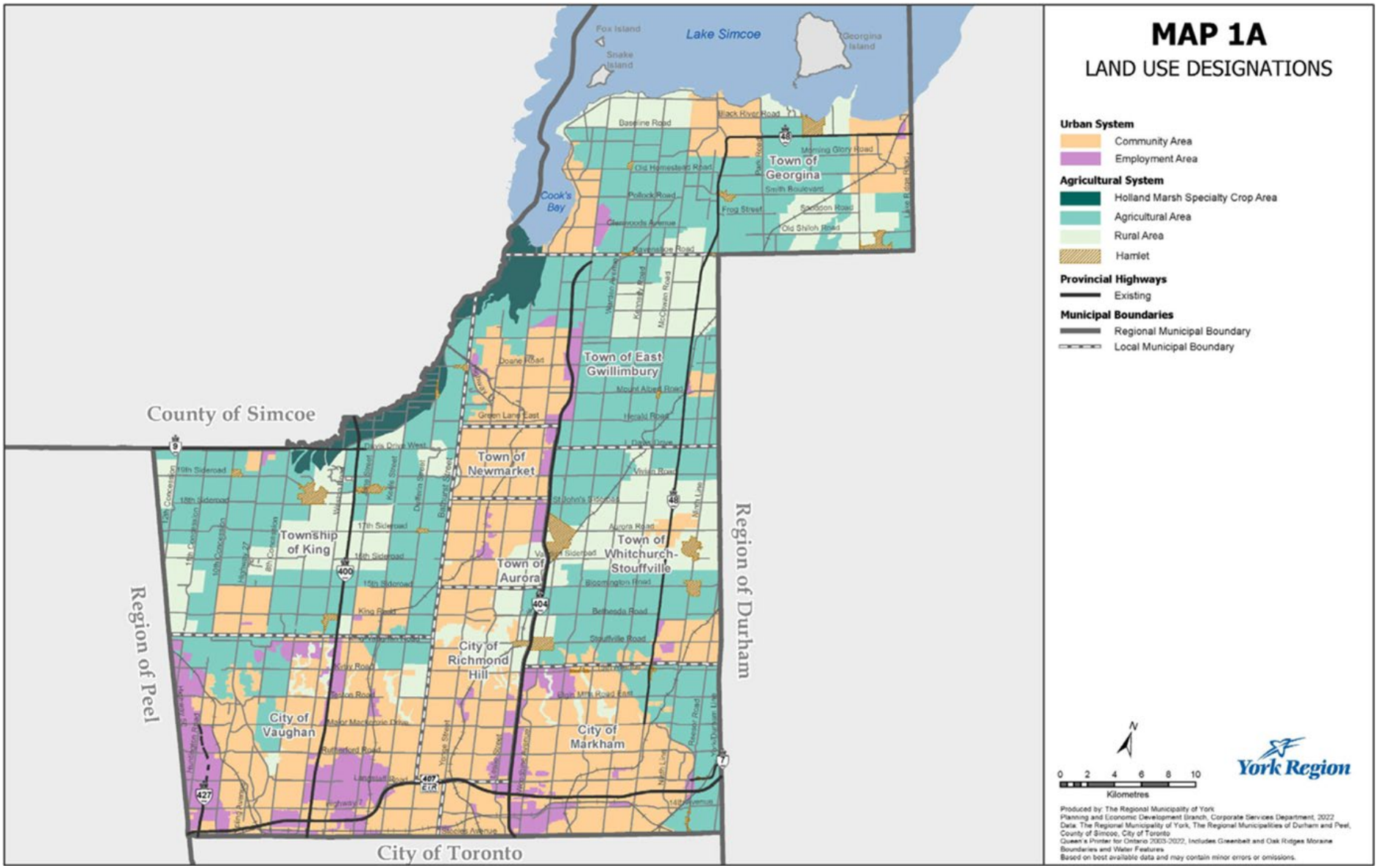

Figure 7-3 **Land Use Designation within York Region (Source: 2022 York Region Official Plan)**

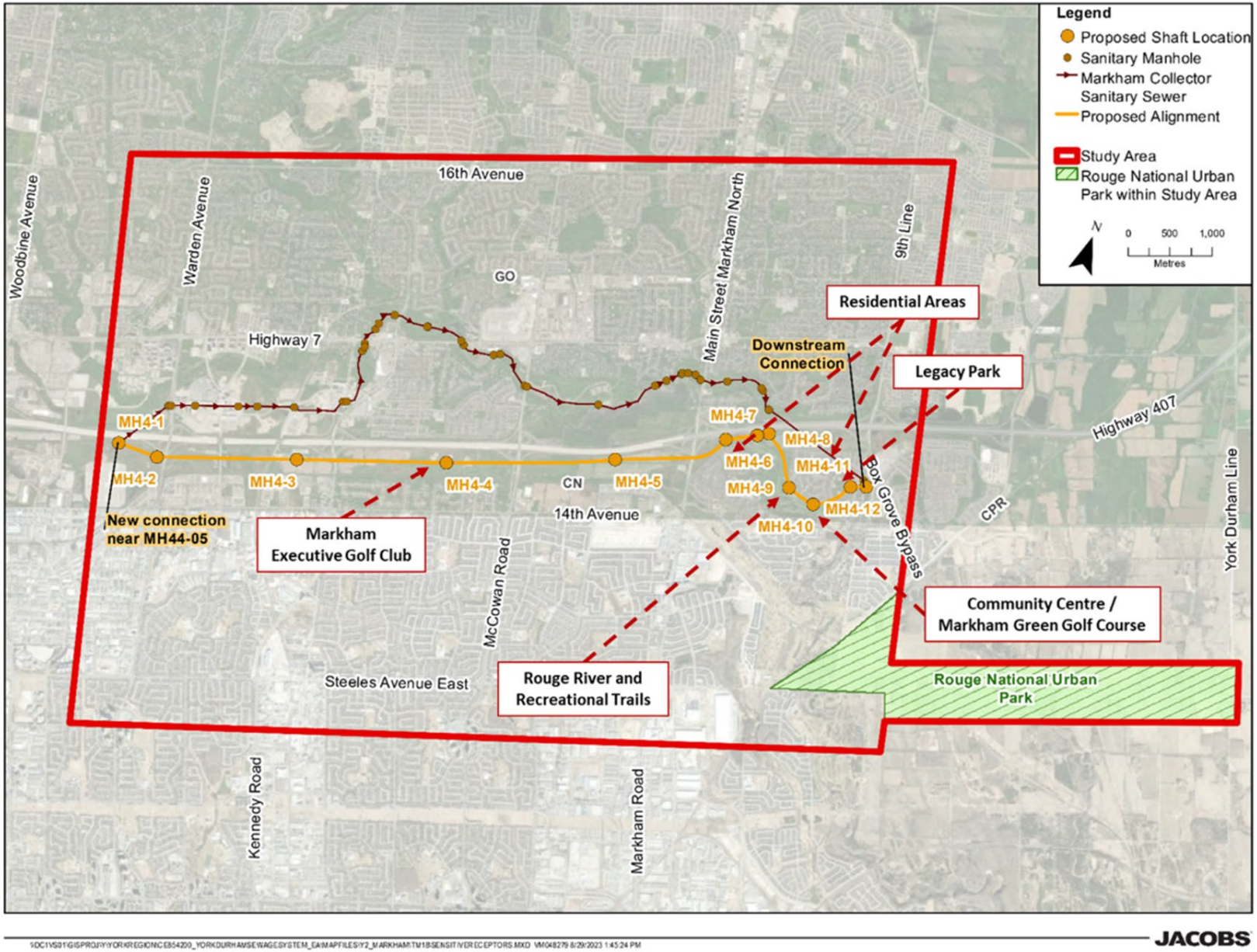

Figure 7-4 **Sensitive Receptors Along the Proposed Alignment**

7.2.2.1.1 Transportation

The City of Markham is served by existing street networks ranging from 41 m to 45 m in width and rapid transit networks (GO Transit, Rapid Transit corridors and Provincial Transitway). The transportation routes illustrated in Figure 7-5 include the Provincial freeway, York Region arterial roadways and major and minor collectors controlled by the City of Markham.

There are ten main road classes recognized within the study area:

– Freeways, Ministry of Transportation (MTO)
– Arterial roads, York Region
– Arterial roads, City of Markham
– Major collector roads, City of Markham
– Minor collector roads, City of Markham
– Local roads, City of Markham
– Major arterial roads, City of Toronto
– Minor arterial roads, City of Toronto
– Collector roads, City of Toronto
– Local roads, City of Toronto.

Freeways are controlled access roads with high traffic volumes and higher speeds. The Provincial freeways are controlled by the Ministry of Transportation (MTO). Highway 407 is a tolled highway managed by the 407 Express Toll Route Concession Company, which crosses the study area west to east, dividing the study area into two distinct north and south sections. Freeway interchanges are found at Warden Street, Kennedy Road, McCowan Road, Markham Road and Ninth Line. Highway 407 is an eight-lane highway which crosses the majority of the study area.

Warden Avenue, Kennedy Road, McCowan Road, Markham Road, Donald Cousens Parkway, 14th Avenue and Highway 7 are York Region arterial roadways. Steeles Avenue is an arterial road operated by the City of Toronto. The City of Markham does not have any roadways classified as arterial roads (defined as up to 32.5-m ROW widths) within the study area. Several other roadways fall under the major collector category for the City of Markham, defined as up to 30.5 m ROW widths, including Birchmount Road, Denison Street, Enterprise Boulevard, Old Kennedy Road, Brimley Road and Middlefield Road. Ninth Line, south of Highway 407 and west of Box Grove By-pass, is a minor collector road controlled by the City of Markham.

All roadways south of Steeles Avenue are operated by the City of Toronto, including both major arterials, Warden Avenue, Birchmount Road, Kennedy Road, Midland Avenue, Brimley Road, McCowan Road and Markham Road, as well as minor arterials, Middlefield Road and Tapscott Road.

The remaining roads within the study area are minor collectors and/or local municipal roads and are maintained by the City of Markham north of Steeles Avenue and the City of Toronto south of Steeles Avenue. They generally carry lower traffic volumes and provide access to individual properties, to other local roads and to collector roads.

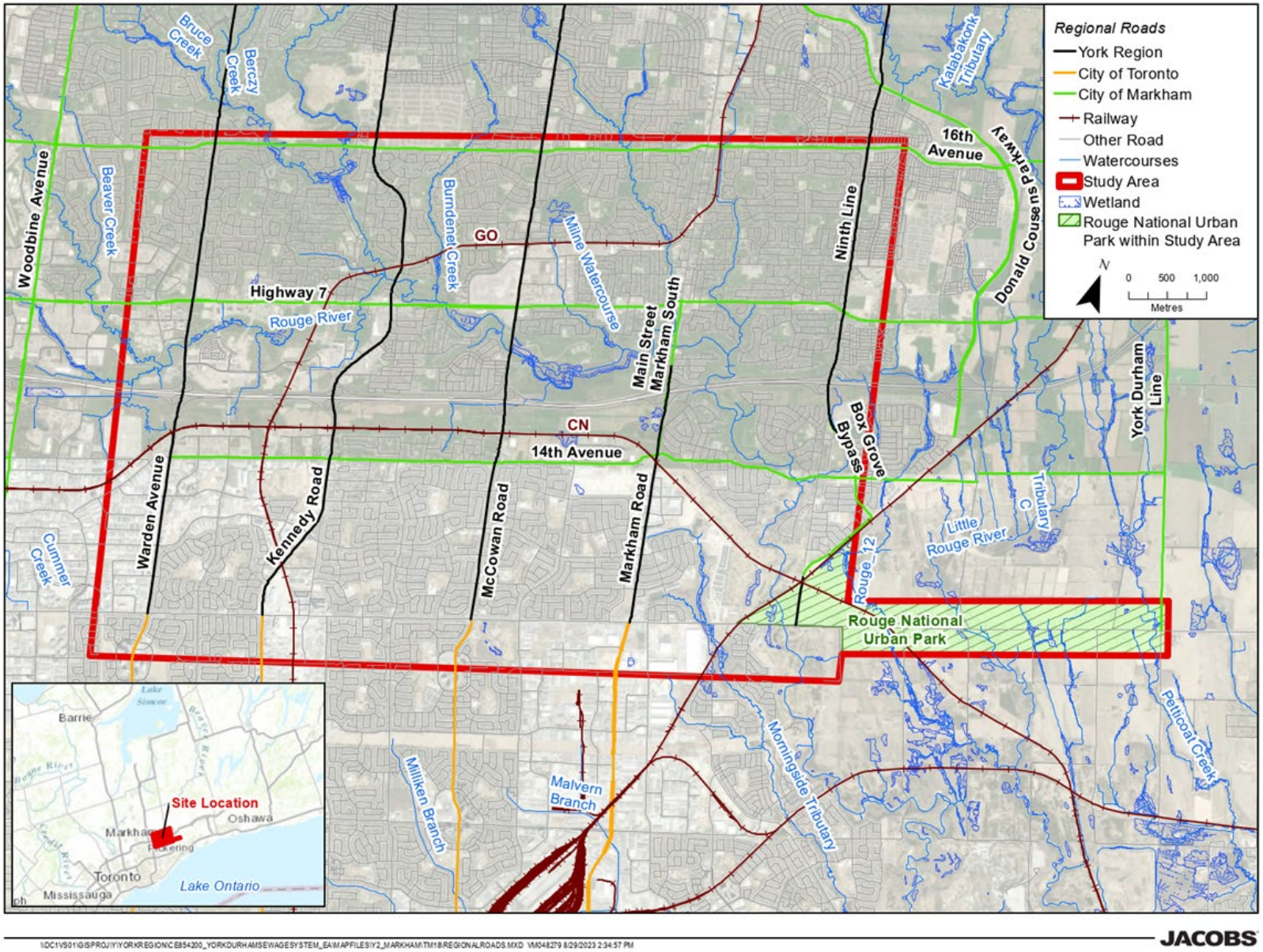

Figure 7-5 **Road Network Within the Study Area**

7.2.2.1.2 Utilities

A hydro corridor runs west to east within the study area. The corridor, south of Highway 407, is parallel to CNR from Warden Avenue to Markham Road, turns south towards Ninth Line and continues beyond the study area boundaries. There are three rows of steel lattice transmission towers within the corridor, and each tower has four cross arms.

The City of Markham is serviced by local utility companies which provide electricity, telecommunications and natural gas. These include:

– Bell Canada, Acronym Solutions, Rogers Communications, Telus Communications, ViaNet and YorkNet for telecommunication services.
– Hydro One Networks Inc. and Alectra Utilities for electrical distributions.
– Enbridge for gas distribution.

7.2.2.2 Natural Environment

7.2.2.2.1 Geotechnical

A desktop review of the available geological information was undertaken within 500 m of the preferred alignment using the available Ontario Geological Maps, water well records from the Ministry of the Environment, Conservation and Parks (MECP), the geotechnical boreholes from the Ontario Ministry of Energy, Ontario Geological Survey (OGS) database, geotechnical and hydrogeological investigation reports provided by York Region, Oak Ridges Moraine Groundwater Program (ORMGP) data, the York Durham Peel Toronto (YDPT) geological model managed by ORMGP and information from the MTO Foundation Library.

The regional physiography, quaternary geology, bedrock geology and the geological conditions of the preferred alignment were identified. The physiography in York Region has been shaped by glacial and post-glacial depositional and erosional processes. The local area falls within the Peel Plain region and the South Slope region. The land surface is a till containing large amounts of shale and limestone, with much of the Peel Plain modified by a veneer of clay occasionally deep enough to be seen to be varved. The quaternary geology of the study area included Glaciolacustrine deposits and Halton Till (Ontario Erie Lobe).

The bedrock geology consists of shale, limestone, dolostone and siltstone of the Georgian Bay Formation, Blue Mountain Formation, Billing Formation, Collingwood Member and Eastview Member from the Paleozoic age. The depth of shale bedrock ranges from 40 m to 60 m. The topography of the area generally slopes toward Lake Ontario's deep valleys, which have been cut into the Peel Plain by rivers and streams. The south slope lies between Lake Ontario and the Oak Ridges Moraine (ORM) and rises 91 m to 122 m with a width of 9.7 km or 11.3 km. The south slope contains a variety of soils that are generally more sandy tills in the east and more clay silt tills further west overlying Georgian Bay shales and Limestones of the Lindsey.

The regional and Site geology generally consists of shale bedrock layers of Paleozoic age, unconformably overlain by a complex package of overburden consisting of glacial and interglacial till deposits interbedded with glaciolacustrine and glaciofluvial sand, silt and clay of Pleistocene age.

The profile of the new Markham Collector Twin shows depths ranging between 7 m and 30 m. Tunnelling is expected to be done in the overburden, not the bedrock, within the glacial till deposits that contain occasional cobbles and boulders as the thickness of overburden ranges from 40 to 60 m. The geological profile will mainly fall in the Lower Newmarket Till with a dominantly sandy silt to silt matrix. The soil types at the tunnel excavation zone and below the tunnel invert are mainly anticipated to be hard clayey silt or very dense sandy silt to silty sand, as seen in historical borehole information.

7.2.2.2.2 Hydrogeological

A hydrogeological desktop review was undertaken using water well records from the MECP, ORMGP data, OGS geotechnical borehole database and historical reports. Data was analyzed using a buffer of 500 m within the preferred alignment to determine the impact on the hydrostratigraphy, groundwater flow and recharge.

Hydrostratigraphy

The regional and Site hydrogeology includes four main aquifer systems:

– Undifferentiated upper sediments (or recent deposits)
– Oak Ridges Moraine Aquifer Complex (ORMAC)
– Thorncliffe Aquifer Complex (TAC), Scarborough Aquifer Complex (SAC)
– Associated aquitards.

A Site-specific summary of the major hydrostratigraphic units expected along the trunk alignment is described in Table 7.1.

Construction of the new Markham Collector Twin will be completed in the lower Newmarket Till. The TAC, immediately below the lower Newmarket Till, is of particular interest to this project as it may be encountered during the construction of the trunk sewer, given the depth of construction and the slope of the pipe.

Table 7.1 Aquifers and Aquitards Through the Study Area

Aquifers and aquitards	Description	Thickness
Undifferentiated upper sediments recent deposits (Aquifer)	An unconfined aquifer consisting of discontinuous fill and unconsolidated overburden deposits.	The deposits range in thickness up to 10 m immediately west of the Rouge River.
Halton/Kettleby Till (Aquitard)	A discontinuous aquitard that acts as a low-permeability cap on the underlying upper and lower Oak Ridges Moraine Aquifer Complex.	The till deposits range in thickness up to 6 m.
Upper Oak Ridges Moraine Aquifer Complex (Aquifer)	A partially confined aquifer that occurs as a thin layer along the eastern and western banks of the Rouge River. Where this aquifer is unconfined, it is likely a highly vulnerable aquifer (HVA).	The confined aquifer is less than 1 m thick at the eastern and western banks of the Rouge River.
Lower Oak Ridges Moraine Aquifer Complex (Aquifer)	A partially confined aquifer that is relatively thin and discontinuous in the project area. Where this aquifer is unconfined.	The deposits range in thickness up to 12 m, with the thickest east of the Rouge River.
Lower Newmarket Till (Aquitard)	A continuous layer that acts as an aquitard to the underlying TAC.	The deposits range in thickness from 8 to 26 m.
Thorncliffe Formation (Aquifer)	Regionally recognized as a highly productive confined aquifer and is laterally continuous.	The deposits range in thickness from 3 to 20 m, located east of the Rouge River. The aquifer poses a hydraulic risk to tunnel construction.
Sunnybrook Formation (Aquitard)	A continuous layer that acts as an aquitard to the underlying Scarborough Formation.	The deposits range in thickness from 3 to 11 m. The unit appears to pinch out west of the trunk alignment.
Scarborough Formation (Aquifer)	A confined aquifer that is discontinuous and appears to consist of channel fill deposits that roughly dip to the east.	The deposits range in thickness up to 23 m, with the thickest at the eastern limit of the trunk alignment.
Georgian Bay/Blue Mountain Formation (Aquitard)	The shale bedrock appears to dip from the west to east.	The deposits range in thickness from 40 m at the western limit to 4 m at the eastern limit.

Groundwater Flow

The shallow groundwater flow direction is mostly consistent with the surface topography of the study area. The water table gradient is mostly north to south to the Rouge River Valley near the study area. In the vicinity of the Rouge River Valley, local groundwater flow may be toward the river, which ultimately discharges to Lake Ontario. The water table gradient is estimated at 0.006 meters per meter (m/m), and the potentiometric surface gradient is estimated at 0.009 m/m.

Recharge

Recharge is the process by which groundwater is replenished and involves the vertical infiltration of water through the subsoil deposits and geologic materials to the saturated zone. The major sources of recharge in the study area are precipitation (rain and snow melt) and, to a lesser extent, inputs from the adjacent rivers.

Groundwater recharge rate estimates for the watershed range from <100 to 300 millimetres per year (mm/year) for the South Slope, Peel Plain and ORM, respectively (TRCA 2007). The amount of groundwater recharge in a particular area depends on surficial geology, topography and the amount of development in that area.

Based on the ORMGP mapping, a downward hydraulic gradient from the upper water table surface to the deeper potentiometric surface is expected in most of the work area. However, an upward hydraulic gradient could be expected in low-lying areas such as the Rouge River Valley and other small tributaries, which are mostly located in the eastern portion of the project area.

7.2.2.2.3 Surface Water

The study area is located within the Upper Beaver, West Highland, East Highland, Lower Rouge and Little Rouge watersheds, as seen in Figure 7-6. The new Markham Collector Twin is within the Upper Beaver and Rouge River watersheds, with regional topography sloping to the south and east toward the river. The ground surface elevation along the proposed trunk sewer alignment ranges between approximately 160 m above sea level (masl) and 190 masl. Much of the study area is within the area managed by the TRCA.

The preferred alignment crosses several water bodies identified as follows:

– Stormwater pond #30 located within the hydro corridor west and east of Birchmount Road.
– Rouge River Creek located within the hydro corridor west of McCowan Road.
– Stormwater pond located within the hydro corridor west of Markham Road.
– Rouge River and tributaries located south of Highway 407 (east of Markham Road) and west of Rouge Bank Drive.
– Old Mill Pond located south of Rouge Bank Drive and Legacy Drive.

Beaver Creek is close to the upstream connection, but construction is not expected to impact the creek. The major water body crossing along the alignment is the Rouge River. All surface water body crossings will be carried out via tunnelling as there are sufficient cover depths except for the Rouge River, where a pipe contraction is proposed. The Rouge River crossing is further described in section 7.2.3.3.4.

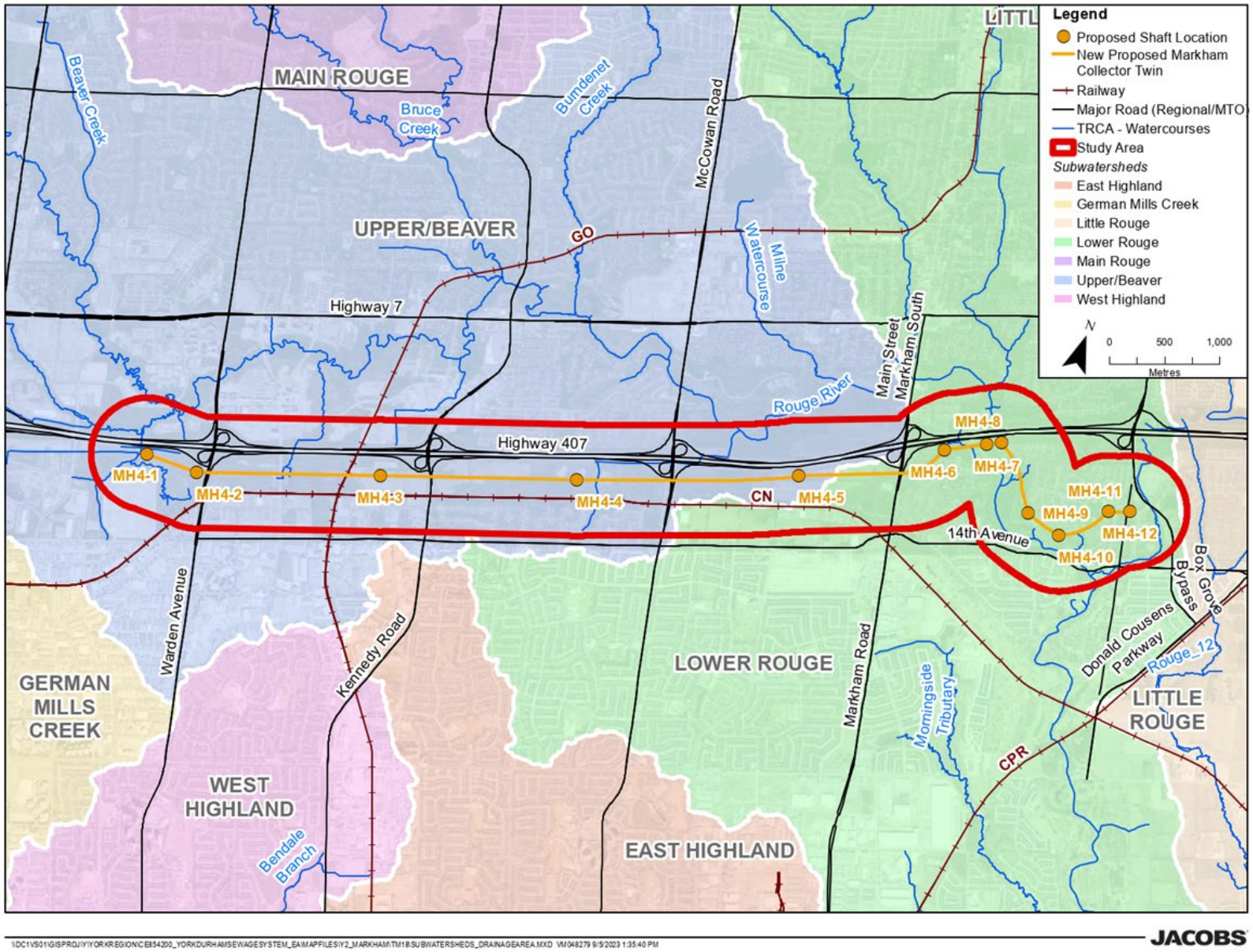

Figure 7-6 **Preferred Alignment Through the Subwatersheds and Drainage Areas**

Rouge River

The Rouge River watershed spans 336 square kilometres (km^2) of land and water in the York and Durham Regions, the Cities of Toronto, Pickering, Markham and Richmond Hill and the Town of Whitchurch-Stouffville. The upper areas of the Rouge River watershed are predominately agricultural, and the lower areas are relatively undisturbed and forested because portions are protected within Rouge River Park. Conversely, the middle reaches of the watershed, which are within the project area, are undergoing some of the most rapid urbanization in the Greater Toronto Area (GTA). As a result, there has been a statistically significant upward trend in average river flows, with an average increase of 1.3% per year since 1962 (Rouge River Watershed Task Force, 2007).

The Rouge River is a permanent watercourse that exhibits an irregularly meandering to sinuous channel pattern that flows quasi-parallel to the proposed alignment for approximately 7,500 m along the north side of Highway 407. The Rouge River then bends south under Highway 407 and flows through the western end of the proposed alignment, where it has incised up to 20 m into overburden deposits.

The western end of the proposed alignment is located within the floodplain of a permanent tributary that flows north under Highway 407 and eventually discharges to the Rouge River's main channel. Furthermore, two minor tributaries are encountered along the western half of the alignment. The first tributary is located approximately equidistant between proposed shafts MH4-2 and MH4-3. The second is located approximately 200 m east of the proposed shaft MH4. Both minor tributaries flow north under Highway 407 and ultimately discharge to the Rouge River's main channel.

The major Rouge River crossing with the preferred alignment is between MH4-6 and MH4-7. Based on TRCA's hydraulic models and mapping, the riverbed at the location of the crossing is at an elevation of approximately 157.1 masl, with a water depth of approximately 1.5 m under normal flow conditions and 4.3 m under the 100-year return period regional storm event.

7.2.2.2.4 Natural Heritage Characterization

Natural heritage in the study area was characterized through an initial desktop background review followed by a reconnaissance survey to confirm and identify existing natural environment conditions. Available online natural heritage background data were accessed in June 2023, along with available mapping from TRCA, NHIC and DFO. Appropriate agencies were also consulted to obtain natural heritage information for the study area and within a 120 m buffer area of adjacent lands along the preferred alignment. In accordance with the Provincial Policy Statement (2020) and the Natural Heritage Reference Manual (2010), 120 m is a standard buffer distance from the alignment for evaluation of potential negative impacts on natural heritage features.

Using the results of the background review, coupled with air photo interpretation and available agency data, the Site reconnaissance survey was completed over four days to obtain additional information about terrestrial resources and natural features. The field investigation included conducting bird surveys, ecological land classification (ELC) of the woodlands, wetlands and cultural areas and Species at Risk (SAR) and aquatic habitat assessments.

Table 7.2 details the natural heritage characterization within or adjacent to the study area, and Figure 7-7 depicts the environmental features.

Table 7.2 Natural Heritage Characterization Within and Adjacent to Study Area

Feature	Description
Areas of natural and scientific interest	Milne Park Wetland Complex was identified approximately 100 m north of the study area.
Vegetation and vegetative communities	Fourteen ecological communities were identified, including: 1. CUM1: Mineral cultural meadow ecosite 2. CUM1-1: Dry-moist old field meadow type 3. FOD7: Fresh-moist lowland deciduous forest ecosite 4. FOD7-3: Fresh-moist willow lowland deciduous forest type 5. FOC4-1: Fresh-moist white cedar coniferous forest type 6. BLO1: Mineral open bluff ecosite 7. FOD7-4: Fresh-moist black walnut lowland deciduous forest type 8. FOM6-1: Fresh-moist sugar maple-hemlock mixed forest type 9. FOM7-1: Fresh-moist white cedar-sugar maple mixed forest type 10. FOC1-2: Dry-fresh white pine-red pine coniferous forest type 11. FOC2-2: Dry-fresh white cedar coniferous forest type 12. SAM1-2: Duckweed mixed shallow aquatic type 13. Industrial community, including highways, commercial areas or construction zones containing canopies, subcanopies and ground cover 14. Residential communities in the eastern corner of the study area, including the Markham Green Club golf course containing canopies, subcanopies and groundcover.
Wildlife	Three wildlife species were identified by direct observations (sight and sound), tracks, scat or droppings (or a combination thereof), including: 1. Monarch (Danaus plexippus) 2. Eastern Cottontail (Sylvilagus floridanus) 3. American Bumble Bee (Bombus pensylvanicus).
Birds	Twenty-three species were observed by sight, song or a combination thereof, including: 1. American Goldfinch (Spinus tristis) 2. Swamp Sparrow (Melospiza georgiana) 3. Willow Flycatcher (Empidonax traillii) 4. Song Sparrow (Melospiza melodia) 5. European Starling (Sturnus vulgaris) 6. Cedar Waxwing (Bombycilla cedrorum) 7. Common Yellowthroat (Geothlypis trichas) 8. Canada Goose (Branta canadensis) 9. Mallard (Anas platyrhynchos) 10. Rock Pigeon (Columba livia) 11. Red-wingded Blackbird (Agelaius phoeniceus) 12. Eastern Kingbird (Tyrannus tyrannus) 13. Brown-headed Cowbird (Molothrus ater) 14. Common Raven (Corvus corax) 15. Winter Wren (Troglodytes hiemalis) 16. Northern Cardinal (Cardinalis cardinalis) 17. American Robin (Turdus migratorius) 18. Blue Jay (Cyanocitta cristata) 19. Chipping Sparrow (Spizella passerine) 20. Wild Turkey (Meleagris gallopavo) 21. Barn Swallow (Hirundo rustica) 22. Great Blue Heron (Ardea Herodias) 23. Killdeer (Charadrius vociferus).

Feature	Description
Bats	At the time of the field survey, no bat habitat was identified within or adjacent to the study area. This will be reviewed during the preliminary design stage when additional field surveys can be conducted if required.
Significant wildlife habitat	The study area included many anthropogenically disturbed areas (i.e., disturbed through human activity, such as CUM1 and industrial), with high foot traffic and poor-quality forested areas with many dead white ash trees; however, some areas may support wildlife, including: – Migratory butterfly stopover areas – Nesting breeding bird habitat.
Seasonal concentration areas	At the time of the field survey, no seasonal concentration areas were observed in the study area. This will be reviewed during the preliminary design stage when additional field surveys can be conducted if required.
Rare vegetation communities or specialized habitats for wildlife	Based on the results of the ELC inventory, rare vegetation communities do not occur within the study area.
Habitat for species of conservation concern	Numerous special concern avifauna (bird) species may be present based on the background investigation. However, no SAR or special concern species were identified during the field survey.
Animal movement corridors	Naturalized animal movement corridors occur within areas of FOD4. Although these ecotones occur within the study area, significant breeding habitats or species occurrences were not identified for species.
Aquatic habitat	Rouge River flows through the Milne Park Wetland Complex, a Provincially Significant Wetland (PSW) located north of the study area and then through the eastern and central portion of the study area. Beaver Creek, a tributary of Rouge River, passes through a small portion of the western tip of the study area. Duffin Creek occurs approximately 320 m east of the study area and is classified as a coldwater (fed by groundwater) aquatic habitat (TRCA, 2003). It flows south through the Lower Duffin Creek Wetland Complex and ends at Lake Ontario.
Aquatic species	Eleven fish species could occur within the Rouge River, including: 1. Bluntnose Minnow (Pimephales notatus) 2. Brook Stickleback (Culaea inconstans) 3. Common Shiner (Luxilus cornutus) 4. Creek Chub (Semotilus atromaculatus) 5. Fathead Minnow (Pimephales promelas) 6. Johnny Darter (Etheostoma nigrum) 7. Largemouth Bass (Micropterus salmoides) 8. Longnose Dace (Rhinichthys cataractae) 9. Pumpkinseed (Lepomis gibbosus) 10. Rainbow Darter (Etheostoma caeruleum) 11. Rainbow Darter (Etheostoma caeruleum).

Feature	Description
Species at Risk (SAR)	Thirty potential SARs were identified, including: Birds: 1. Least Bittern (Botaurus lentiginosus) 2. Peregrine Falcon (Falco peregrinus) 3. Common Nighthawk (Chordeiles minor) 4. Eastern Whip-poor-will (Antrostomus vociferous) 5. Chimney Swift (Chaetura pelagica) 6. Red-headed Woodpecker (Melanerpes erythrocephalus) 7. Eastern Wood-Pewee (Contopus virens) 8. Acadian Flycatcher (Empidonax virescens) 9. Bank Swallow (Riparia riparia) 10. Barn Swallow (Hirundo rustica) 11. Wood Thrush (Hylocichla mustelina) 12. Golden-winged Warbler (Vermivora chrysoptera) 13. Canada Warbler (Cardellina canadensis) 14. Grasshopper Sparrow (Ammodramus savannarum) 15. Bobolink (Dolichonyx oryzivorus) 16. Eastern Meadowlark (Sturnella magna) 17. Piping Plover (Charadrius melodus). Insect: 1. Monarch (Danaus s plexippus) Reptiles and Amphibians: 1. Northern Map Turtle (Graptemys geographica) 2. Midland Painted Turtle (Chrysemys picta marginata) 3. Snapping Turtle (Chelydra serpentina) 4. Eastern Milksnake (Lampropeltis Triangulum) 5. Eastern Ribbonsnake (Thamnophis sauritus). Aquatic: 1. Redside Dace (Clinostomus elongatus) 2. Eastern Pondmussel (Ligumia nasuta). Vegetation: 1. Butternut (Juglans cinerea) 2. Black Ash (Fraxinus nigra) 3. Dense Blazingstar (Liatris spicata.

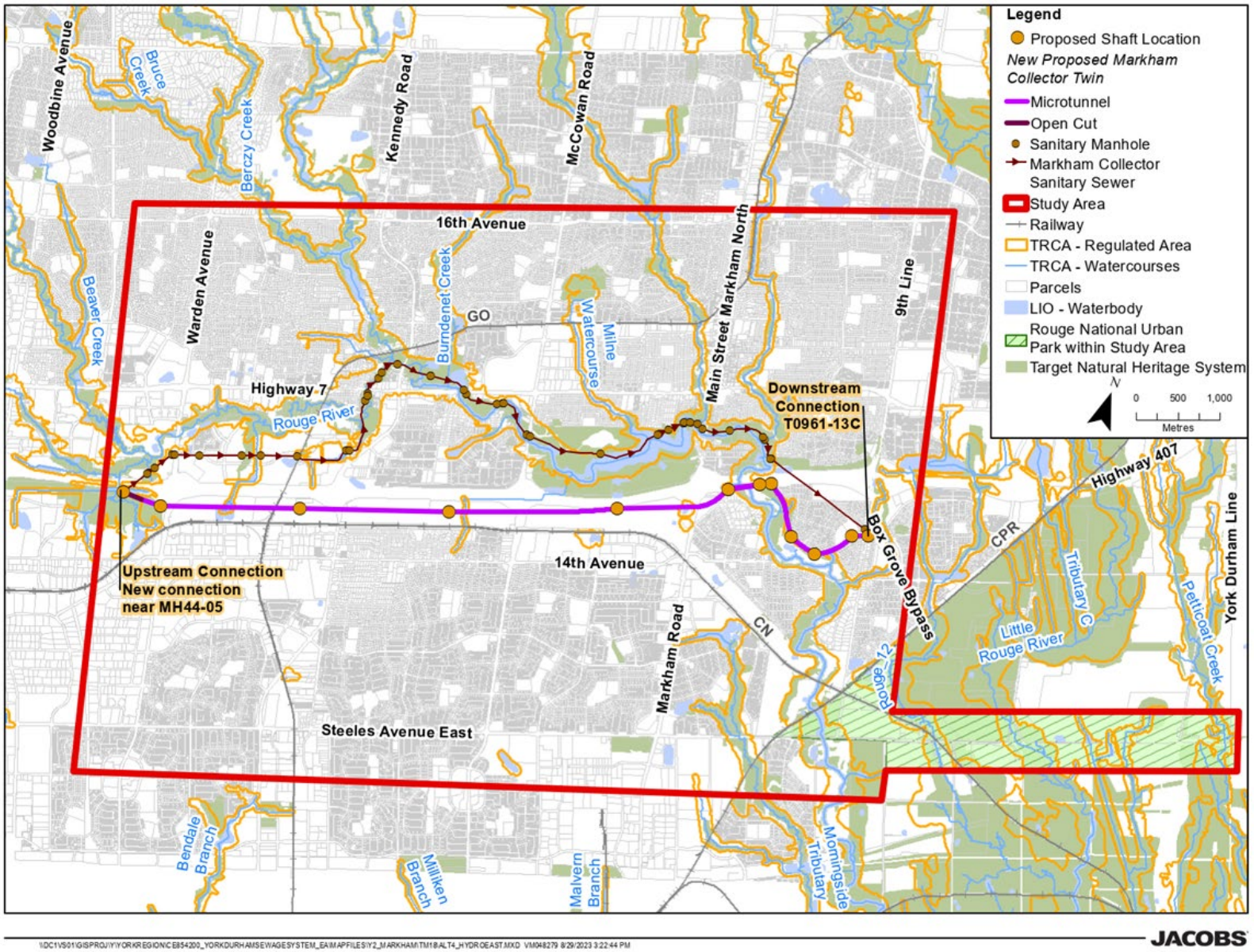

Figure 7-7 **Environmental Features**

7.2.2.2.5 Areas of Potential Environmental Concern

A Phase 1 Environmental Site Assessment (ESA) was conducted that covered the area within 250 m of the preferred alignment for the new Markham Collector Twin known as the Site (Phase One Study Area). The Phase One Property includes streets, rapid transit networks, residential, commercial and industrial land uses, parklands and water bodies, as detailed in section 7.2.2.1.

The Site currently runs through over 70 municipal addresses and has numerous property owners, including the Province of Ontario (Minister of Government Services and His Majesty the King in Right of Ontario represented by the Chair of the Management Board of Cabinet), the Corporation of the City of Markham, Metrolinx, Hydro One Limited and various private property owners.

Based on a review of environmental records (previous environmental reports, aerial photographs and an Environmental Risk Information Services [ERIS] database search), interviews and a Site reconnaissance, the Phase 1 ESA identified potentially contaminating activities (PCAs) and historical land uses of potential environmental interest within the Site. Eighteen areas of potential environmental concern (APEC) were considered to have the potential to impact the Phase One Property, twelve attributable to onsite PCAs and six attributable to various offsite PCAs within the Phase One Study Area.

The identified APECs within the study area consisted of railways, areas of historical use of pesticides on agricultural lands, salt use on provincial, regional and municipal roads, aboveground storage tanks (ASTs), soil stockpiles, transformers, an offsite hydro station and a historical waste disposal site.

Although the use of salt along public roadways has been identified as an APEC in this Phase 1 ESA, under Paragraph 1 of section 49.1 of the revised Ontario Regulation (O. Reg.) 153/04, for the purpose of Part XV.1 of the Environmental Protection Act, the use of salt is a substance applied to surfaces for the safety of vehicular or pedestrian traffic under conditions of snow or ice or both. Therefore, at the discretion of the qualified person for ESAs, according to the MECP, electrical conductivity (EC) and sodium adsorption ratio are not considered contaminants of potential concern (COPCs) for the Phase One Property and are not required to be assessed as part of a Phase 2 ESA. However, under section B, 2. (3.14) of the Rules for Soil Management and Excess Soil Quality Standards (MECP 2022), as these APECs are areas where a substance has been used for the purpose of keeping the area safe for use under conditions of ice and snow, EC and sodium adsorption ratio must be included in the sampling analysis plan for these APECs.

Figure 7-8 shows the locations of the APECs. Table 7.3 summarises the COPCs, which have been identified for each APEC based on the historical operations and type of PCA associated with the APEC.

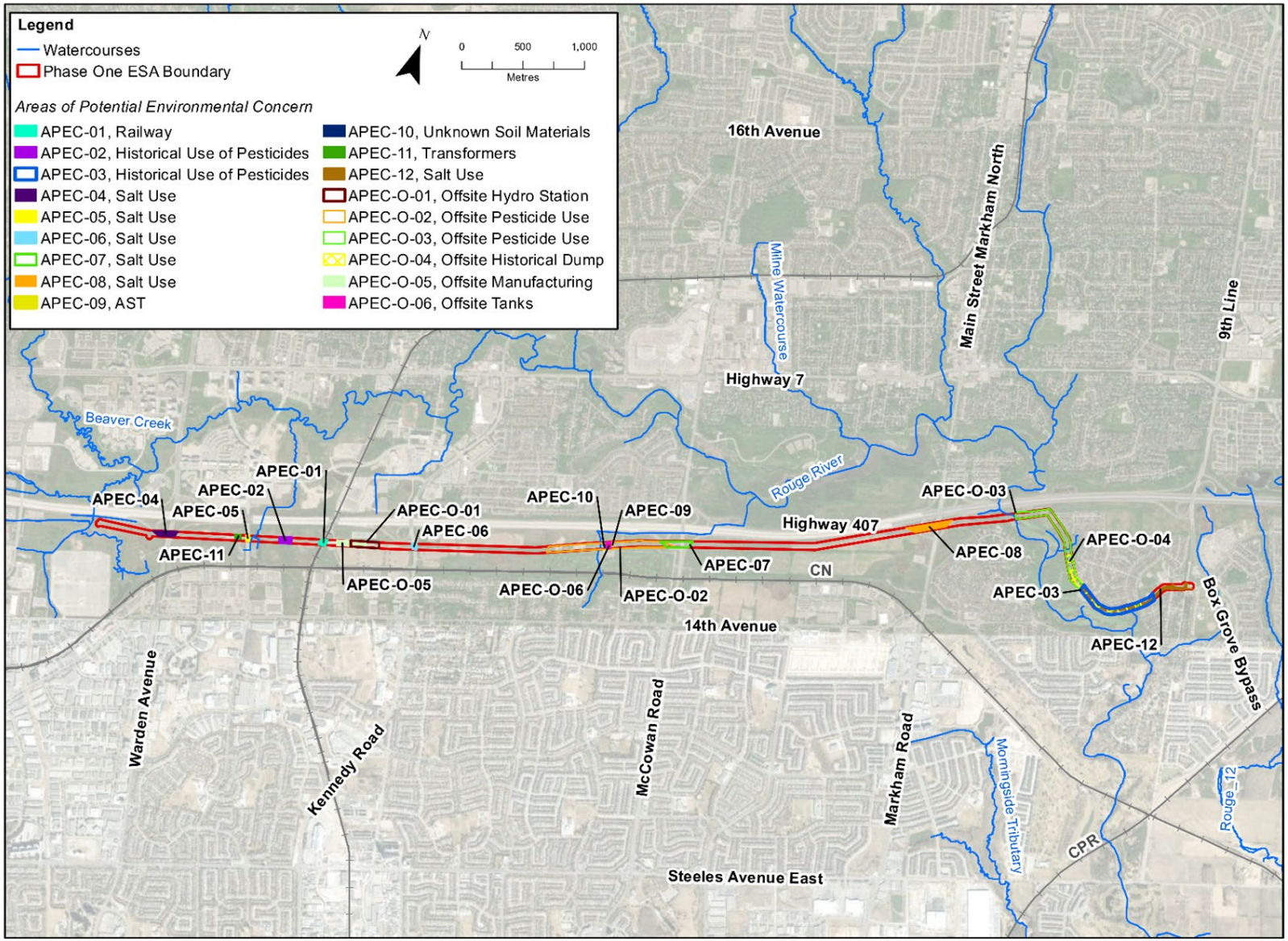

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Figure 7-8 **Areas of Potential Environmental Concerns (APECs)**

Table 7.3 Areas of Potential Environmental Concern (APEC)

APEC ID[1]	APEC Description	Location of APEC on Phase One Property[2]	Potentially contaminating activity[3]	Location of PCA (onsite or offsite)	Contaminants of potential concerns[4]	Media potentially impacted (groundwater, soil and/or sediment)
APEC-01	**Railway:** Based on a review of aerial photographs and historical maps, a railway line (now part of the GO Transit Metrolinx line) runs through the western portion of the Site between Birchmount Road and Kennedy Road in a north-south direction. The railway has been in place since 1878.	Between Birchmount Road and Kennedy Road	46 - Railyards, tracks and spurs	Onsite	PAH, PHC, VOC, metals	Soil and groundwater
APEC-02	**Historical use of pesticides:** Based on a review of the 1954 aerial photograph, the Site was occupied by agricultural land, including a small orchard located between Birchmount Road and Kennedy Road, suggesting the potential historical use of pesticides onsite.	Between Birchmount Road and Kennedy Road	40 - Pesticides (including herbicides, fungicides and anti-fouling agents) manufacturing, processing, bulk storage and large-scale applications	Onsite	OCP	Soil and groundwater
APEC-03	**Historical use of pesticides:** Based on a review of aerial photographs, in 1954, the Box Grove Golf Club was located in the eastern portion of the Site (between Markham Road and Ninth Line, to the north/east of Rouge River). Given the year of the golf course's establishment, it is suspected pesticides have been used on a large-scale application.	Between Markham Road and Ninth Line, to the northeast of Rouge River	40 - Pesticides (including herbicides, fungicides and anti-fouling agents) manufacturing, processing, bulk storage and large-scale applications	Onsite	OCP	Soil and groundwater

[1] APEC means the area on, in, or under a Phase One Property where one or more contaminants are potentially present, as determined through the Phase 1 ESA, including through (a) identification of past or present uses on, in, or under the Phase One Property; and (b) identification of PCAs.
[2] Refer to Figure 7-8 for APEC locations.
[3] PCA means a use or activity as set out in Column A of Table 2 of Schedule D of O. Reg. 153/04 that is occurring or has occurred in a Phase One Study Area.
[4] COPCs were identified using the Method Groups as identified in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act, March 9, 2004, amended as of July 1, 2011. Include the AP Method Groups, namely: Metals, hexavalent chromium, mercury, PAHs, PCBs, PHCs and VOCs.

APEC ID[1]	APEC Description	Location of APEC on Phase One Property[2]	Potentially contaminating activity[3]	Location of PCA (onsite or offsite)	Contaminants of potential concerns[4]	Media potentially impacted (groundwater, soil and/or sediment)
APEC-04	**Salt use:** Based on a review of aerial photographs and historical maps, Warden Avenue has run through the western portion of the Site since 1860. As a public roadway, salt and de-icing materials are used in the winter months for pedestrian and vehicular safety.	Warden Avenue, including on/off route ramps with Highway 407	Other - Activity not defined in O. Reg. 153/04 Table 2 of Schedule D	Onsite	EC, sodium adsorption ratio, Na, Cl	Soil and groundwater
APEC-05	**Salt use:** Based on a review of aerial photographs, Birchmount Road has run through the western area of the Site since 2011. As a public roadway, salt and de-icing materials are used in the winter months for pedestrian and vehicular safety.	Birchmount Road	Other - Activity not defined in O. Reg. 153/04 Table 2 of Schedule D	Onsite	EC, sodium adsorption ratio, Na, Cl	Soil and groundwater
APEC-06	**Salt use:** Based on a review of aerial photographs and historical maps, Kennedy Road has run through the western-central portion of the Site since 1860. As a public roadway, salt and de-icing materials are used in the winter months for pedestrian and vehicular safety.	Kennedy Road	Other - Activity not defined in O. Reg. 153/04 Table 2 of Schedule D	Onsite	EC, sodium adsorption ratio, Na, Cl	Soil and groundwater
APEC-07	**Salt use:** Based on a review of aerial photographs and historical maps, McCowan Road has run through the central portion of the Site since 1860. As a public roadway, salt and de-icing materials are used in the winter months for pedestrian and vehicular safety.	McCowan Road, including on/off route ramps with Highway 407	Other - Activity not defined in O. Reg. 153/04 Table 2 of Schedule D	Onsite	EC, sodium adsorption ratio, Na, Cl	Soil and groundwater

APEC ID[1]	APEC Description	Location of APEC on Phase One Property[2]	Potentially contaminating activity[3]	Location of PCA (onsite or offsite)	Contaminants of potential concerns[4]	Media potentially impacted (groundwater, soil and/or sediment)
APEC-08	**Salt use:** Based on a review of aerial photographs and historical maps, Markham Road has run through the central portion of the Site since 1860. As a public roadway, salt and de-icing materials are used in the winter months for pedestrian and vehicular safety.	Markham Road, including on/off route ramps with Highway 407	Other - Activity not defined in O. Reg. 153/04 Table 2 of Schedule D	Onsite	EC, sodium adsorption ratio, Na, Cl	Soil and groundwater
APEC-09	**AST:** Based on a review of the 2021 and 2022 aerial photographs, two ASTs are located on a concrete pad at the northeast corner of the parking lot associated with the (offsite) Cresthaven Golf Course.	West of McCowan Road	28 - Gasoline and associated products storage in fixed tanks	Onsite	PHC, PAH, VOC	Soil and groundwater
APEC-10	**Unknown soil materials:** Based on a review of the 2021 and 2022 aerial photographs, soil stockpiles of unknown quality and evidence of potential soil movement were visible northwest of the Cresthaven Golf Course parking lot.	West of McCowan Road	30 - Importation of fill material of unknown quality	Onsite	PAH, PHC, VOC, metals	Soil
APEC-11	**Transformers:** Transformers were observed on the Phase One Property, west of Birchmount Road.	West of Birchmount Road	55 - Transformer manufacturing, processing and use	Onsite	PAH, PHC, VOC	Soil and groundwater
APEC-12	**Salt use:** Based on a review of aerial photographs, roadways within the eastern portion of the Site were developed in 1999 (including Rouge Bank Drive, Legacy Drive, Cottontail Avenue and Ninth Line). As public roadways, salt and de-icing materials are used in the winter months for pedestrian and vehicular safety.	Eastern portion of Site	Other - Activity not defined in O. Reg. 153/04 Table 2 of Schedule D	Onsite	EC, sodium adsorption ratio, Na, Cl	Soil and groundwater

APEC ID[1]	APEC Description	Location of APEC on Phase One Property[2]	Potentially contaminating activity[3]	Location of PCA (onsite or offsite)	Contaminants of potential concerns[4]	Media potentially impacted (groundwater, soil and/or sediment)
APEC-O-01	Offsite hydro station: An electrical generating station was observed between Kennedy Road and Birchmount Road, starting with the 2007 aerial photograph.	West of Kennedy Road	18 - Electricity generation, transformation and power stations	Offsite	PHC, PAH	Groundwater
APEC-O-02	**Offsite pesticide use:** Based on a review of aerial photographs, Cresthaven Golf Club has been located adjacent to the south of the Site (west of McCowan Road and north of the CNR railway) since 1970. Given the year of its establishment, it is suspected pesticides have been used on a large-scale application.	Southern portion of Site west of McCowan Road	40 - Pesticides (including herbicides, fungicides and anti-fouling agents) manufacturing, processing, bulk storage and large-scale applications	Offsite	OCP	Soil and groundwater
APEC-O-03	**Offsite pesticide use:** Markham Green Inc. (also known as Markham Green Golf Club Ltd. and Rouge Valley Golf Corporation) is located at 120 Rouge Bank Drive. According to their website, the Markham Green Golf Club comprises holes from the original Box Grove Golf Club, which was established in the 1950s. While no pesticide records were presented in ERIS for the golf course, given the year of its establishment, it is suspected pesticides have been used on a large-scale application.	Southern portion of eastern part of Site	40 - Pesticides (including herbicides, fungicides and anti-fouling agents) manufacturing, Processing, Bulk Storage and Large-Scale Applications	Offsite	OCP	Soil and groundwater

APEC ID[1]	APEC Description	Location of APEC on Phase One Property[2]	Potentially contaminating activity[3]	Location of PCA (onsite or offsite)	Contaminants of potential concerns[4]	Media potentially impacted (groundwater, soil and/or sediment)
APEC-O-04	**Offsite historical dump:** An Anderson's Waste Disposal Sites record was listed for an area located north of 14th Avenue, west of Ninth Line, south of Highway 407 and east of Rouge River. The dump was referred to as the Markham Green Golf Course Dump, which was listed in the Ministry of Environment (MOE) 1979 Site Identification Study, rumoured in or near a golf course. The dump was listed to be active in the 1940s and closed in the 1950s. The property was also listed in the waste disposal sites inventory, which classified the property as "Urban Municipal/ Domestic Waste" and listed the date closed as 1950.	Eastern portion of Site	58 - Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners	Offsite	PAH, PHC, VOC, metals	Groundwater
APEC-O-05	**Offsite manufacturing**: At 170 Duffield Drive, two companies were listed on Scott's Manufacturing Directory. One was for photographic equipment and supplies and nondurable goods not elsewhere classified, while the second company was listed for miscellaneous manufacturing and other home furnishings wholesaler-distributors.	Southern portion of Site west of Kennedy Road	19 - Electronic and computer equipment manufacturing. Other - Activity not defined in O. Reg. 153/04 Table 2 of Schedule D	Offsite	PAH, PHC, VOC, metals	Groundwater

APEC ID[1]	APEC Description	Location of APEC on Phase One Property[2]	Potentially contaminating activity[3]	Location of PCA (onsite or offsite)	Contaminants of potential concerns[4]	Media potentially impacted (groundwater, soil and/or sediment)
APEC-O-06	**Offsite tanks:** During the Site reconnaissance, two ASTs and one steel storage drum of unknown contents were identified to the west of the clubhouse building at Cresthaven Golf Club.	Southern portion of Site west of McCowan Road	28 - Gasoline and associated products storage in fixed tanks	Offsite	PHC, PAH, VOC	Groundwater

Cl = Chloride
ID = Identification
Metals = O. Reg. 153/04 complete metals scan
Na = Sodium
OCP = Organochlorine pesticides
Offsite = Within the Phase One Study Area
Onsite = Phase One Property
PAH = Polycyclic aromatic hydrocarbons
Phase One Property = Y2 Markham Collector Twinning alignment, Markham, Ontario
Phase One Study Area = Properties within 250 m of the Phase One Property
PHC = Petroleum hydrocarbon
VOC = Volatile organic compound

7.2.2.3 Cultural Environment

7.2.2.3.1 Archaeological Resources

A Stage 1 Archaeological Assessment (Background Research and Property Inspection) was conducted to determine the archaeological potential of the project study area, including the preferred alternative alignment, 12 potential shaft locations and the Rouge River crossing. All activities carried out during this assessment were completed in accordance with the Ontario Heritage Act (1990, as amended in 2023) and the 2011 Standards and Guidelines for Consultant Archaeologists (S & G), administered by the Ministry of Citizenship and Multiculturalism (MCM 2011).

Based on the Stage 1 Archaeological Assessment, 43 previously registered archaeological sites were determined to be located within 1 km of the study area. Two registered sites are located within 50 m of the proposed alignment and potential shaft locations.

7.2.2.3.2 Cultural Heritage Landscapes and Built Heritage Resources

A cultural heritage study was conducted within a 50 m radius around the preferred alignment for the new Markham Collector Twin to describe the existing conditions and present an inventory of known and potential Built Heritage Resources (BHRs) and Cultural Heritage Landscapes (CHLs) that may be subject to direct or indirect impacts as a result of the project.

Based on the results of background historical research as well as a review of federal, provincial and municipal registers, inventories and databases, four known BHRs and one potential CHL were identified within the study area. These include one property designated under Part IV of the Ontario Heritage Act, three properties listed on the Register of Properties of Cultural Heritage Value or Interest (CHVI) and one resource identified during background research and the field review.

7.2.3 Conceptual Design

7.2.3.1 Design Basis

The design basis for the selection of the preferred alignment is summarized in Table 7.4.

Table 7.4 Design Basis for the Development of the Preferred Alignment

Design basis	Assumptions
Study area	7,000 hectares (ha)
Study area boundaries	Bounded by 16th Avenue to the north, Box Grove and Box Grove Collector Road to the east, Passmore Avenue to the south and Woodbine Avenue to the west.
Nominal diameter	2400 mm to 2700 mm
Upstream connection point	Near MH44-05 (West of Warden Avenue)
Downstream connection point	T0961-13C at the Southeast Collector Diversion Facility
Design criteria	Based on York Region Design Guidelines (2021), including: – Pipe size and material – Hydraulic design – Air management – Method of construction – Major utility crossings – End connection points
Method of construction	Tunnelling within the ROW
2051 Modelled Peak Flow Rate	6,796 L/s
Land use	Mixture of residential and commercial land uses with an annual intensification of 50% from 2041 to 2051.
Major infrastructure considerations	– Rapid transit networks (Go Rail, Rapid corridors and Provincial transitway). – Transportation Routes (HWY 407, HWY 7, Warden Avenue, Kennedy Road, McCowan Road, Markham Road, Donald Cousens Parkway, 14th Avenue and 16th Avenue). – Hydro corridor.
Environmental feature considerations	– Greenbelt areas – TRCA Regulated Areas, including Rouge River – Rouge National Urban Park – Wetlands – Several wooded areas

The development of the preferred alignment for the new Markham Collector Twin considered eleven conceptual alternative routes between Steeles Avenue and 16th Avenue, taking into consideration the hydraulic performance, construction risk, constructability and costs. The alternatives were screened, and the shortlisted alternatives were evaluated using a set of equally weighted criteria, including technical considerations, natural environmental impacts, social and cultural impacts and economic considerations. Given that the preferred construction method will be tunnelling, one of the major constraints was crossing the Rouge River while maintaining pipe hydraulics. The alignment, shaft locations and associated construction staging areas will be reviewed and refined in the next design stages as more information becomes available.

7.2.3.2 Description of Design

The project components of the Markham Collector Twinning Project are described in sections 7.2.3.2.1 to 7.2.3.2.2.

7.2.3.2.1 New Markham Collector Twin

The current proposed alignment for the new Markham Collector Twin will be approximately 9.5 km long and will run within the hydro corridor south of Highway 407, crossing Markham Road within the Highway 407 ROW, then continuing along the Rouge riverbank to follow the Rouge Bank Drive ROW to the downstream connection point. The nominal diameter will be 2400 mm from the upstream connection to MH4-6. A pipe contraction from 2400 mm in diameter using a twin barrel (each 1350 mm in diameter) is proposed at the Rouge River to cross below the riverbed with sufficient cover for tunnelling and to protect the existing Rouge River streambed. The pipe diameter will then be increased to 2700 mm after the river crossing towards the downstream connection to maintain capacity for a gentler slope. This route would require an agreement with Hydro One Limited for temporary and permanent easement, construction and accessibility for operations and maintenance.

A number of locations are being considered for potential shaft locations that provide connectivity to the existing sanitary network at a conceptual level. A new shaft near the existing MH44-05 is currently proposed for the upstream end connection, as shown in Figure 7-9, and the downstream end connection is currently proposed at shaft T0961-13C at the existing Southeast Collector Diversion Facility. Connecting to this facility, which contains the existing interconnection and chambers for the SEC 1 and 2, will facilitate operational flexibility without the need to construct a new diversion facility or interconnection between the two collectors.

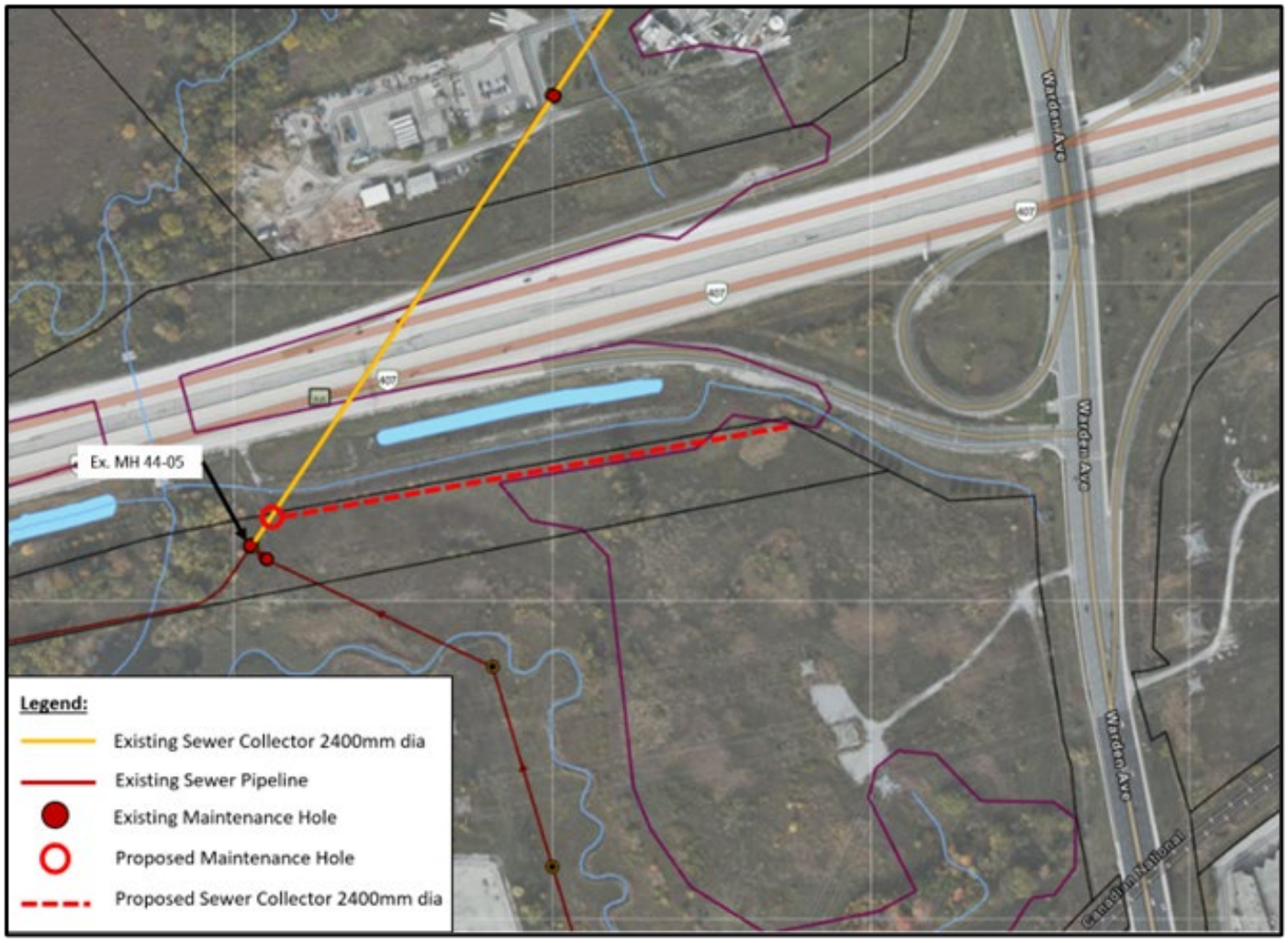

Figure 7-9 Proposed Upstream Connection Near Existing MH44-05

7.2.3.2.2 Shafts and Maintenance Holes

Potential locations for tunnel shafts have been examined in locations that allow for the construction of a compound which will minimize interference to the public. At this conceptual level, 12 potential shaft locations have been examined along the proposed sewer alignment with a maximum depth of 26 m. The shafts will be converted to MHs upon construction completion. Additional MHs will be located at shorter intervals to a maximum of 1,000 m, as required, along the new collector alignment for operations and maintenance. These locations will be identified during the design stage.

Launching shaft compounds must accommodate a larger shaft size due to more equipment, machinery and storage. Launching shaft compounds are designed to have a minimum area of 1,800 m², while receiving shaft compounds were designed to meet a minimum requirement of 800 m². All construction compounds will be temporary and vary in shape and size with the goal of maximizing safety and security for the contractor and the public.

The majority of the shaft compounds are proposed within the hydro corridor and ROWs, which will minimize traffic impacts, utility relocations and tree removals. The tunnel alignment and shaft compounds will be confirmed during the design stages as more accurate information becomes available.

Figure 7-1 shows the currently proposed alignment and shaft locations of the new Markham Collector Twin, and the conceptual drawings detailing the plan and profiles of the collector can be seen in Appendix A.

7.2.3.3 Construction Methods

Construction methods were considered for each project component of the new Markham Collector Twin. These methods will be further reviewed and refined during the preliminary design stage.

7.2.3.3.1 New Markham Collector Twin

The new Markham Collector Twin, with a diameter ranging from 2400 mm to 2700 mm and a depth of pipe cover ranging from 7 m to 30 m deep, will be constructed using tunnelling methods for cover depths exceeding 8 m and open cut for shallower sections. Several trenchless methods were considered, including Microtunnelling Boring Machine (MTBM), Earth Pressure Balance Tunnel Boring Machine (EPBTBM), pipe jacking (PJ) and auger boring (AB).

For the proposed 2400 mm diameter sewer construction, the tunnel is expected to warrant the use of a MTBM, where tunnel drives range from 140 m to 2,006 m. This method is also proposed to be used for the 2700 mm diameter sewer construction. The minimum turning radius of the MTBM is 400 m, with excavation rates expected to be between 0 and 7 rpm, depending on ground conditions.

7.2.3.3.2 Shafts and Maintenance Holes

Twelve preliminary shaft locations for the preferred alignment have been identified and can be seen in Appendix A. The proposed shaft locations were determined based on a number of factors, including operational and constructability requirements, estimated drive lengths, existing utilities and existing ROW. The launching and receiving shaft locations of the preferred alignment will be further evaluated during the design stage.

Tunnel construction will require excavation for both launching and receiving shafts, which will be used to install the new sewer. A geotechnical investigation and subsurface utility engineering (SUE) Level A will need to be conducted during the preliminary and detailed design stage to confirm design details.

Excavation for these tunnel shafts will require large compounds for the necessary equipment, utility relocations, tree removals and, in some locations, temporary lane closures on impacted roadways. Tunnel shafts have been proposed in locations that allow for the construction of a compound, which will minimize interference to the public.

Compounds will be constructed in a sequence that will have one launching shaft compound set up in tandem with the necessary receiving shaft compound. Upon the completion of the tunnel drive from one shaft to the other, appropriate chambers or MHs will be constructed within the shafts to allow for future operations and maintenance work.

Security fencing and hoarding will need to be constructed around each shaft compound to maximize safety. It is estimated that during construction, each compound will be in place for the full duration of construction once initiated. The shaft locations will be selected based on available land in the road ROW, the maximum length of the tunnel and changes in directions. Additional shafts may be required at major road crossings and creek crossings. Shafts will be required at the upstream and downstream end connections. Access to the shaft and avoidance of any major underground or overhead utilities and natural environment impacts will be considered in selecting the final shaft locations.

For microtunnelling launching and receiving shafts, pipe delivery and storage areas will be an integral part of construction works. Allowing for sufficient space for pipe delivery and storage as part of the shaft compound design is integral to the planning and construction process. The final design must allow for adequate staging areas for constructability purposes and construction efficiency while minimizing the impact on the public, property and environment.

7.2.3.3.3 Connection End Points

The upstream end connection will require open cut construction for approximately 250 m from the proposed MH near MH44-05 since the cover depth is approximately 7 m. At the downstream connection, where the cover depth is approximately 19 m, hand mining is proposed to connect to the existing shaft T0961-13C at the SEC diversion facility. Appropriate benching within the existing chamber will be required at each end connection to divert flows into the new sewer.

7.2.3.3.4 Rouge River Crossing

The Rouge River crossing is a critical component of the new Markham Collector Twin. The depth of cover, based on TRCA's hydraulic mapping and models, ranges from 13 m at MH4-6 to less than 2 m at the lowest point mid-stream. Figure 7-10 and Figure 7-11 show the plan and profile of the Rouge River crossing, respectively.

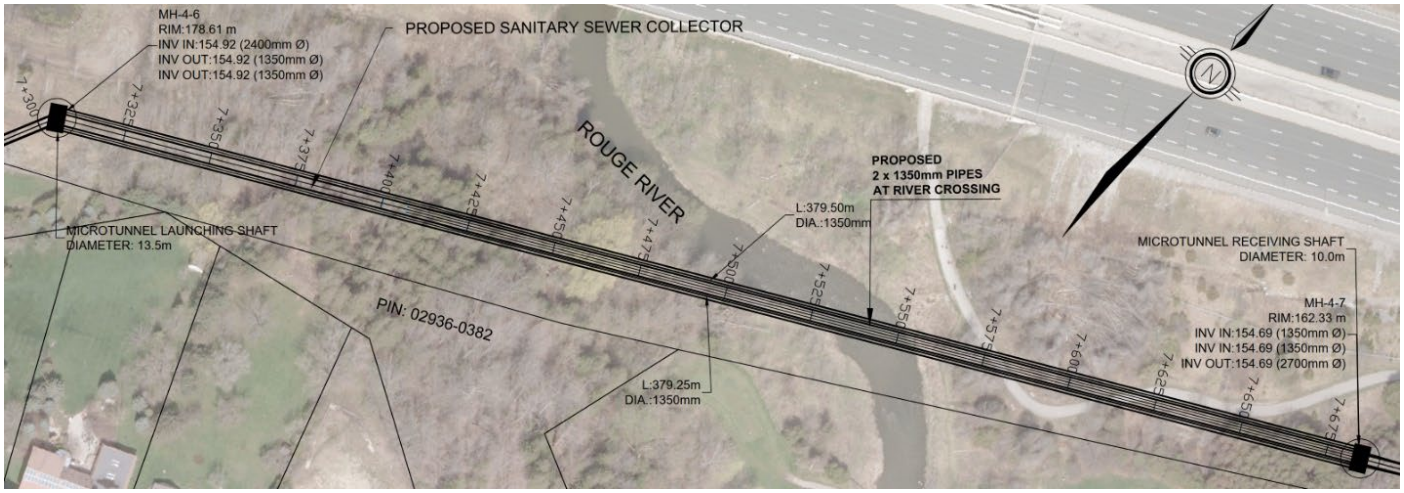

Figure 7-10 Conceptual Alignment at Rouge River Crossing

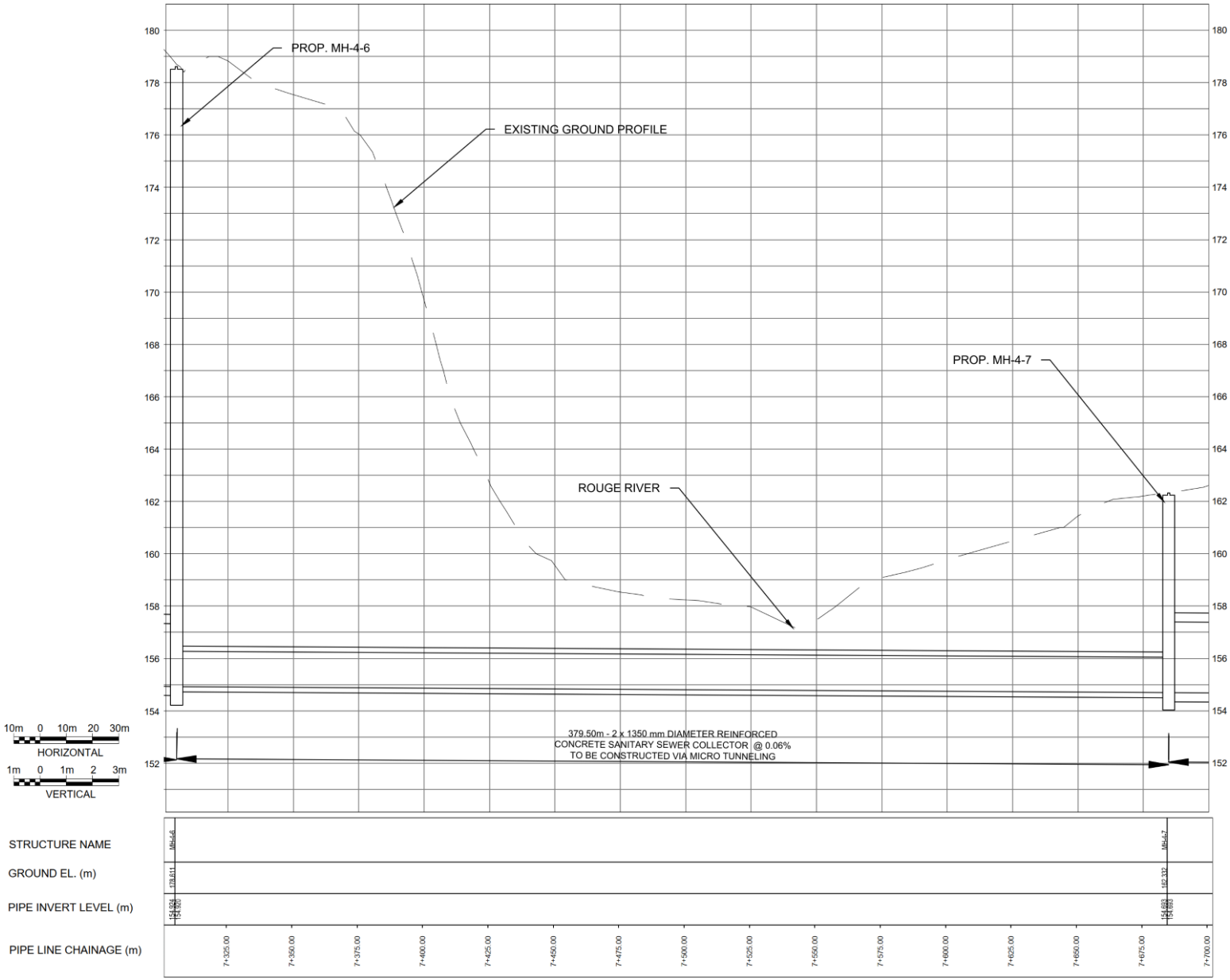

Figure 7-11 Conceptual Profile at Rouge River Crossing

Construction methods for sewers with excavations deeper than 6 m vary depending on the location, space constraints and soil conditions. The construction methods considered for this crossing include open cut construction and tunnelling. Having reviewed both methods, microtunnelling is proposed for the Rouge River crossing. This approach would maintain the natural environment connectivity, mitigate impacts on the Rouge River, be less intrusive than open cut construction and would reduce the dewatering requirements.

To cross the Rouge River, the 2400 mm pipe would be reduced to two 1350 mm pipes under the riverbed, as seen in Appendix A. This approach maintains the hydraulic performance of the new sewer while preserving the minimum cover requirements under the riverbed. A siphon was considered originally but was not recommended due to higher life cycle costs compared to the gravity system.

The proposed construction methods and concept for the Rouge River crossing will be reviewed and refined during the preliminary and detailed design stages based on the surveyed riverbed levels.

7.2.3.4 Property Requirements

The new Markham Collector Twin alignment was selected, in part, based on the minimal disturbance to the built, social and natural environment. The horizontal alignment of the tunnel will be constructed within the available ROWs as much as possible to mitigate property impacts. A desktop review of the land requirements was completed using the OnLand Registry Access and information provided by York Region to determine temporary and permanent easements needed for the new Markham Collector Twin construction, including the estimated twelve construction staging areas and access roads. At the conceptual level, permanent takings are not anticipated. Property requirements, inclusive of temporary construction staging areas, at this concept stage of design are preliminary and will be further assessed during preliminary and detailed design stages.

Land requirements were determined using the listed assumptions:

– Boundary for permanent easement assumed to be 5 m offset from the outer diameter (13 m width) of the new Markham Collector Twin.
– Boundary for permanent easement assumed to be 5 m offset from the outer diameter of the shaft.
– Boundary for the permanent easement assumed for the twin barrel Rouge River crossing will be 17 m (i.e., 5 m offset from the outer diameter of twin 1350 mm pipe with a horizontal clearance of 4 m between pipes).
– Access roads assumed to be 4 m wide for permanent easement.
– Temporary construction staging areas assumed to be 1,800 m^2 for launching shafts and 800 m^2 for receiving shafts. The remaining areas are required for permanent easement.

The current preferred alignment intersected approximately 18 parcels, nine of which are located within MTO lands and/or within the hydro corridor. Agreements would be required with the Ministry of Transportation, Hydro One Limited, Toronto and Region Conservation Authority, Canadian National Railway and Metrolinx to construct the new sewer and the shaft/MHs. The easement locations and required agreements will be reviewed and further refined during the preliminary and detailed design stages.

7.2.4 Environmental and Community Impacts and Mitigation

The Markham Collector Twinning Project will potentially have an impact on the social, built, natural and cultural environments. Desktop studies were done to determine the possible extent of these impacts and to propose mitigation measures that would reduce the likelihood and extent of the impacts should they occur. Table 7.5, Table 7.6 and Table 7.7 summarize the potential impacts on the social and built environment, the natural environment and the cultural environment and recommend mitigation measures that can be adopted during design, construction and operations.

Table 7.5 Social and Built Environment – Effects and Mitigation

Item #	Criteria	Indicators	Potential effects (Positive/Negative)	Avoidance/Mitigation/Compensation
SB-1	Effects on traffic	– Extent of disruption to traffic flows – Proximity to congested traffic zones, construction staging areas and properties	– Traffic operational impacts will be limited to construction traffic entering and exiting the construction staging areas through the nearest public roadway. – Traffic disruptions during construction are expected to be low, with no or minimal impacts on the adjacent road network. – Road closures may be necessary to facilitate construction methods but will be minimized as much as possible to avoid undue disruption to residential community by locating shafts in existing ROWs.	– Construction compounds are likely to be located mostly off-road and not intrude upon any active roadways. – Some restrictions on time-of-day access may be required during construction on these major arterials to avoid impacting peak-hour traffic flows. – Temporary closures can be completed during off-peak times, evenings, or weekends. – Traffic management options in accordance with Ontario Traffic Manual Book 7-Temporary Conditions will be implemented at possible road closure locations. – No street parking in the vicinity of the proposed works within the hydro corridor will be allowed during construction. – Residential street parking would be permitted but not in front of the proposed access. – Single-lane alternative traffic or one-way traffic can be considered for Rouge Bank Drive as this is one of the major arterial ways. – Consideration may be given to construction sequencing in an attempt to avoid high traffic zones as much as possible. This will be reviewed at the preliminary design stage.
SB-2	Effect of noise on sensitive receptors	– Number of sensitive receptors affected and extent and duration of adverse effects during construction	– Construction noise levels at sensitive receptors are expected to be within acceptable limits defined by the FTA noise and vibration assessment manual. – Environmental Noise may cause sleep disturbance and general annoyance. The magnitude of the noise disturbance is dependent on the number of equipment, their proximity to each other and their proximity to sensitive receptors, construction methods and equipment deployed, construction hours and duration of exposure to sensitive receptors.	– Conduct pre-construction surveys to confirm existing conditions as required. – Construction noise impact mitigation measures include, but are not limited to, the following to meet applicable noise criteria: • Siting construction staging to reduce adverse impacts to sensitive receptors where possible. • Use construction equipment compliant with noise level specifications in MECP guidelines NPC-115 and NPC-118. • Design Site enclosures to help contain noise if some equipment is not on the MECP list or cannot be muffled. • Keep equipment in good working order and operate with effective muffling devices where possible. • Use acoustic enclosures for equipment such as generators and compressors. • Use localized movable noise barriers/screens for specific equipment and operations. – Minimize simultaneous operation of equipment where possible, particularly noisy sources. – Implement a no-idling policy onsite (unless necessary for equipment operation). – Restrict construction hours where possible. – Perform construction during daytime hours where possible. If night-time construction is necessary, high-noise activities should be restricted to daytime where possible. – Inform residents before construction of the type of construction and expected duration if occurring outside of by-law limits. – Consider operational duration limits for construction. – Limit the number of heavy trucks onsite to the minimum required, where possible. – Stage construction vehicles away from noise-sensitive locations where possible. – When construction location and design are better known, establish and apply project specific construction noise criteria/exposure limits. – Undertake noise monitoring throughout the construction phase. Where noise level limits are exceeded, additional noise mitigation measures will be considered. – Consider developing a communications protocol which includes timely resolution of complaints. – Additional mitigation measures not listed may be considered as construction progresses.

Item #	Criteria	Indicators	Potential effects (Positive/Negative)	Avoidance/Mitigation/Compensation
		– Number of sensitive receptors affected and extent and duration of adverse effects during operations	– Potential increase in noise emissions due to the operation of pump station fans, blowers and motors.	– Appropriate building and engineering design, such as placing motors indoors or within acoustic enclosures, acoustic louvres for intakes and exhaust, and odour control unit fan enclosure, will be considered. – Procure equipment with low noise emissions, where feasible.
SB-3	Effect of perceptible vibration levels on sensitive receptors	– Number of sensitive receptors affected and extent and duration of adverse effects during construction	– Construction vibration levels at sensitive receptors are expected to be within acceptable limits defined by the FTA noise and vibration assessment manual. – Exposure to vibration may result in public annoyance and possible building damage when equipment is in close proximity.	– Conduct pre-construction surveys to confirm existing conditions as required. – Site construction staging and laydown areas to avoid or reduce impacts to receptors where possible. – Use equipment with low vibration emissions as much as possible. – Provide offsite construction of project components where possible. – Consider alternative means of construction within the defined zone of influence so vibration limits are not exceeded where feasible. – Grade truck travel routes to reduce vibration emissions where feasible. – Maximize the distance between emissions and receivers where possible. – As project planning progresses, review sensitive receptor/building areas and revise mitigation and deployment triggers as necessary. – Specify haul routes to control construction traffic.
		– Number of sensitive receptors affected and extent and duration of adverse effects during operations	– None anticipated	– None planned.

Item #	Criteria	Indicators	Potential effects (Positive/Negative)	Avoidance/Mitigation/Compensation
SB-4	Construction air quality	– Number of sensitive receptors affected and extent and duration of adverse effects during construction	– Ground-level fugitive emissions from construction activities such as material handling and grading, vehicle movement and associated activities are expected to reduce to negligible levels beyond 500 m as dust levels and are expected to quickly attenuate within a short distance of the activities. – Potential air quality impacts due to dust and odour from diesel combustion and particulate emissions. – Exhaust emissions from construction vehicles may contribute to increased levels of CACs. – Some construction activities are likely to have higher dust emissions, which include earthworks activities, demolition activities, travel on dusty or unpaved surfaces with heavy equipment travel, and erosion from uncovered soil storage piles.	– Site construction vehicle activity will be managed to control emissions of odorous contaminants and diesel exhaust as much as possible. – Mitigation measures consistent with Environment Canada's Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities (Cheminfo Services Inc., 2005), and the Ministry of Environment, Conservation and Parks' Technical Bulletin Management Approaches for Industrial Fugitive Dust Sources, will be followed. – Conduct pre-construction surveys to confirm existing conditions as required. – The following mitigation measures can be considered in the Air Quality Management Plan: • All equipment complies with Canadian engine emissions standards. • All equipment is visually inspected prior to use and properly maintained in accordance with the manufacturer's manual. • Landscaping materials ordered close to the time of use to reduce onsite storage. • Methods and equipment for cleanup of accidental spills of dusty materials. • Implement a no-idling policy onsite (unless necessary for equipment operation). • Use of electricity from the grid over diesel generators wherever possible. • Retrofitting of combustion engines with specific exhaust emission control measures - particulate traps. • Application of soil stabilizers or dust control polymers where feasible. • Routine removal of accumulated mud, dirt and debris deposits onsite and regular truck washing. • Paved and unpaved roadway cleaning, watering, or application of acceptable dust suppressants. • Complete earthwork grading after ceasing active construction as per permit requirements. • Temporary seeding or mulching of bare soil and storage piles. • Compression or clodding of soil surfaces and storage piles to reduce erosion. • Confine storage pile activity to the downwind side of piles. • Reduction of activities during high wind conditions. • Full or partial enclosure of demolition activities. • Windscreens or barriers where possible or necessary. • Offsite construction of certain structures or parts of structures to minimize air emission due to interference with the normal flow of traffic. • Scheduling certain construction activities (i.e., Site preparation and earthworks activities, demolition activities, unpaved surfaces with heavy equipment travel, and uncovered soil storage piles) to periods of time when exposure to dust is expected to be limited as much as is feasible. • Limit travel speeds onsite to a maximum of 20 km per hour. • Visually monitor for dust during construction. • Take appropriate actions to contain dust as much as possible. – If disruption of contaminated soils is anticipated at any time, consult with the construction manager to ensure that harmful and/or volatile contaminants are not released. – Consider developing a communications protocol which includes timely resolution of complaints.

Item #	Criteria	Indicators	Potential effects (Positive/Negative)	Avoidance/Mitigation/Compensation
SB-5	Air quality operation	– Number of sensitive receptors affected and extent and duration of adverse effects during operations	– Combustion products and dust due to periodic maintenance of trunks and associated structures.	– Employ mitigation measures as listed above as appropriate.
SB-6	Effect of odours on sensitive receptors	– Number of sensitive receptors affected and extent and duration of adverse effects during construction	– Short-term odour emissions possible during tie-ins	– Employ portable odour control devices as necessary, such as a misting device or portable activated carbon control unit. Choice to be determined during the design stage based on details of the potential odour emissions. – An odour study can be done during the preliminary design stage.
SB-7	Effect on properties	– Extent of displacement of residences, businesses, and other facilities – Extent of temporary or permanent disruption – Extent of construction or permanent easements	– Access to property may be affected during construction activities. – Temporary permanent easements required during construction and for access roads. – Permanent easement required for maintenance and access roads.	– Review shaft locations to minimize impact on properties. – Construct security fencing and hoarding around each shaft compound for safety.

Table 7.6 Natural Environment – Effects and Mitigation

Item #	Criteria	Indicators	Potential effects (Positive/Negative)	Avoidance/Mitigation/Compensation
N-1	Effect on groundwater	– Temporary and/or long-term changes in groundwater quantity and quality	– The TAC may be encountered during tunnel construction east of the Rouge River. – Construction dewatering has the potential to cause the lowering of groundwater elevations within aquifers in direct hydraulic connection with ponds and wetlands. – Hydraulic conductivity of the different hydrostratigraphic units that will be intercepted by the shafts and tunnel. – Seasonal groundwater elevations within each hydrostratigraphic unit that will be intercepted by the shafts and tunnel. Reduction in groundwater quantity resulting in impact to other groundwater users (private well impacts). – Change in groundwater-surface water interaction (reversal of vertical hydraulic gradient) results in impact to terrestrial and aquatic habitat and associated SAR (where applicable) - reduction in baseflow. – Potential effects on groundwater water quality as a result of potential mobilization of contaminated water where active dewatering/depressurization is required. – Potential impacts on groundwater from general construction or operations: • Reduction in groundwater quality from spills or the mismanagement of fuel/chemicals in work areas. • Change in shallow groundwater flow patterns resulting from operation of sewer pipe resulting from increased inflow and infiltration and/or preferential movement of groundwater within trench sediments.	– Collect new information on the hydrological characteristics of the wetlands, ponds and wells, which will allow impact assessments to be completed during the hydrogeological investigation program and aid in the development of applicable risk mitigation measures and monitoring. The new information will also include, but not be limited to: • Additional hydraulic conductivity values required for the different hydrostratigraphic units along the trunk sewer alignment, as there were a limited number of wells within the direct vicinity. • Groundwater chemistry data for each hydrostratigraphic unit at each shaft location and in monitoring wells screened across the tunnel invert along the proposed alignment. – Identification of contaminant sources and spill events within a 500 m radius of the shafts and tunnel alignment.

Item #	Criteria	Indicators	Potential effects (Positive/Negative)	Avoidance/Mitigation/Compensation
N-2	Effect on surface water	– Temporary change in surface water – Long-term change in surface water	– The preferred alignment crosses beneath the Rouge River. – Changes to this surface water body are expected to be minimal, as tunnelling is the recommended construction method. – During construction, the risk of frac-out that temporarily releases bentonite slurry in the water course. – Erosion and sedimentation due to run-off in construction areas. – Decrease of depletion of surface water due to active dewatering or water migration through ground into excavations. – Excavations close to surface water bodies have the potential to cause adverse impacts on aquatic ecosystems. – Water may enter shafts during construction due to dewatering activities in proximity to bodies of water. – Dewatering may also be required due to groundwater intrusion, depending on the depth of water table. – Changes in surface water temperature from groundwater taking and/or discharge to surface water features. – Changes to stream morphology resulting from the release of groundwater dewatering water. The potential reduction in baseflow due to water taking in a lower confined aquifer due to increased downward hydraulic gradients across the aquitard separating the stream and the confined aquifer. – The potential reduction in baseflow from a stream reach that intersects an aquifer in which the water taking is occurring. – Sump and excess process (SEP) water and dewatering discharges at shaft sites impact surface water quality and quantity.	– Frac-out can be mitigated through proper geotechnical investigations, selecting a face pressure appropriate to balance the ground and groundwater conditions and careful monitoring of the pressures during construction. – Contingency plans should be developed in consultation with Regulatory Agencies to determine the method of clean-up based on the anticipated level of impact. These measures can include but not limited to: • Install preventative straw bales or filter sock rings crossing the water flow downstream of the tunnel to contain any possible spills. This could cause some retention of water, in which case the straw bales can be kept onsite to be installed only in case of a spill. • Pump the slurry from within the watercourse using a vac-truck onsite before it spreads along the river. • Install proper erosion and sedimentation measures, such as silt fences and silt socks, and implement Best Management Practices to limit suspended solids and mitigate/avoid potential impacts. • Avoid active dewatering as much as possible. Specify sealed excavation support systems for the shafts to minimize impacts on water bodies. • Refuel equipment at a safe distance from water bodies to avoid spills. Develop and follow clean-up protocol should spills occur.
N-3	Effect on aquatic habitat	– Impact on wetland habitat (Mixed Swamp [SWM] community) during construction and/or operation	– Site preparation and construction activities, including equipment use, may cause disturbance and changes in soil compaction and Site drainage and result in erosion, sedimentation and runoff entering the SWM wetland. – Accidental spills from heavy equipment and Site vehicles may cause the release of deleterious material and introduce invasive species.	– Prepare a sediment and erosion control plan. – Follow relevant MNRF's Best Management Practices for Mitigating the Effects of Roads on Amphibian and Reptile SAR in Ontario (MNRF 2016). – Multibarrier sediment and erosion control measures can be erected to create a barrier between the wetland and construction if required. Silt fences with non-woven geotextile and material density of 270R or greater, in a 1 m distance outside the expected disturbance area, would be considered. These measures and structures would be maintained and enhanced where necessary until construction has been completed and the Site has stabilized. – If herptiles enter the work area, stop work immediately and allow the species to exit the work area naturally. If the species requires relocation, contact the MNRF, as a permit under the Fish and Wildlife Conservation Act is required to complete wildlife salvages.
		– Impact on fish and fish habitat during construction	– Dewatering activities and water discharge resulting in changes in water velocity or temperature; changes in soil and erosion; release of contaminated and sediment-laden water; changes in fish habitat structure and cover; changes in food supply, changes in nutrient concentration; changes in access to habitat leading to the displacement or stranding of fish.	– All relevant requirements of the Fisheries Act will be followed. – A 'Request for Review' will be submitted to DFO for any activities that have the potential to impact fish habitat or habitat of Federally protected aquatic SAR. – In-water works will be planned to consider timing windows as much as possible to protect fish, including their eggs, juveniles, community composition, spawning adults, and/or the organisms upon which they feed. The timing window will be confirmed with MNRF. – Design water management system and dewatering operations as much as possible to prevent erosion and/or release of sediment-laden or contaminated water to any waterbody or wetlands. – Mitigation measures will be incorporated into the routine onsite inspection. Corrective actions, if required, may include additional Site maintenance or altering Site activities to reduce impact. – Monitor dewatering activities as required to confirm sediment-laden discharge and changes in visible scour/erosion.

Item #	Criteria	Indicators	Potential effects (Positive/Negative)	Avoidance/Mitigation/Compensation
		– Impact on fish and fish passage during construction	– Potential FOR reduced opportunities for fish passage. Culvert replacements (if required) and culvert extensions (if required) may result in reduced opportunities for fish to migrate upstream through the study area. – Potential for temporary impact on fish and fish habitat during culvert maintenance or culvert replacements.	– Prepare sediment and erosion control plan. – Implement measures to protect fish and fish habitat during in-water construction activities (i.e., restricted timing window, fish relocation), which can include but not limited to: • Design culvert replacements and culvert extensions to maintain or improve conditions for fish passage and hydraulic conveyance. For any culverts that will be replaced and or extended, complete fish passage analysis (for example, 2-year storm event/bankfull). • Regular onsite inspection during in-water construction. • Post-construction monitoring to confirm conditions with respect to fish passage.
N-4	Effect on Vegetation Communities	– Area of vegetation removal and wetland compensation during construction	– Removal of vegetation communities may result in loss of habitat. – Damage to adjacent vegetation or ELC communities may occur during construction.	– Vegetation removal will be reduced as much as possible and limited to only what is required for construction. – Construction fencing and silt fencing will be installed and maintained whenever it can prevent or reduce damage to adjacent ELC communities. – Vegetation removal requires compensation in accordance with TRCA's Ecosystem Compensation Guidelines (TRCA 2018). – Temporarily disturbed areas will be revegetated using non-invasive, native plantings and seed mix suitable to the Site conditions and surrounding ELC after construction is complete. – Vegetation removals will also be conducted with consideration for potential impacts to sensitive species (for example, SAR) and features (for example, SWH) and appropriate timing windows as much as possible.
		– Number of trees removed during construction	– Ash tree removals, transportation and handling have the potential to facilitate the spread of emerald ash borer (Agrilus planipennis).	– Removal of ash trees, or portions of ash trees, will be carried out in compliance with the Canada Food and Inspection Agency Directive D-03-08: Phytosanitary Requirements to Prevent the Introduction into and spread within Canada of the Emerald Ash Borer (2021), as amended from time to time. To comply with this directive, ash trees requiring removal, including wood, bark or chips, will be restricted from being transported outside of the emerald ash borer regulated areas of Canada. – Confirm precautions are being taken to reduce the risk of the spread of invasive species by cleaning equipment before moving between sites.
N-5	Effect on wildlife and wildlife habitat	– Area of disturbed habitat during construction and/or operations	– Disturbance or destruction of habitat used by monarchs may occur.	– Plant or seed native flowering plants in temporarily disturbed areas as feasible to promote butterfly habitat, including milkweed and forage vegetation. – If vegetation clearing proceeds when monarch larvae may be present (April 1 to September 30), then milkweed plants should be inspected by a qualified professional for monarch larvae before their removal. Larvae can be moved to a location that is suitable and safe under the direction of a qualified biologist. Monarch caterpillars may be moved to other milkweed plants; for other larval stages (i.e., eggs and chrysalis), entire milkweed plants will be transplanted.
		– Impact on migratory breeding birds and nests during operations	– Disturbance or destruction of migratory bird nests may occur during operational vegetation maintenance activities, if applicable.	– All works must comply with the Migratory Birds Convention Act and Endangered Species Act, including timing windows for the nesting period (April 1 to August 31). – Operations will occur outside of the nesting period where feasible. However, if operations or vegetation maintenance activities must occur during the general nesting period, a breeding bird and nest survey will be undertaken before required activities. Nest searches are required and will be completed by a qualified biologist no more than 48 hours before vegetation removal. – If a nest of a migratory bird is found outside this nesting period (including a ground nest), it still receives protection. Implement appropriate buffers based on the type of nests observed per the MBCA.

Item #	Criteria	Indicators	Potential effects (Positive/Negative)	Avoidance/Mitigation/Compensation
		– Impact to SAR (General)	– Disturbance, displacement, or mortality of SAR or SAR habitat may occur.	– Onsite personnel will be provided with information (for example, factsheets and training) that addresses the existence of potential SAR onsite, the identification of the SAR species, and the procedures to follow if an individual is encountered or injured. – Mitigation measures to reduce adverse impacts of project activities on SAR will comply with the ESA. – If SAR are encountered, construction activities in the area will cease immediately, and a qualified biologist will be contacted. The SAR must be allowed to leave the area on its own accord. Construction activities will not proceed until the SAR is safely away from the area. If the SAR does not leave the area on its own in a timely manner, a qualified biologist with training in the proper handling of SAR may be permitted to relocate the SAR safely away from the construction area. – Any SAR individual that is encountered in the study area must be reported to the MECP (SAROntario@ontario.ca) within 48 hours of the observation. – Before construction, investigation of the study area for SAR that may have established following the completion of previous surveys may be undertaken by a qualified biologist, as appropriate. – Onsite inspection will confirm implementation of the mitigation measures. Corrective actions, if required, may include additional Site maintenance or altering Site activities to reduce impact. – Species-specific monitoring activities will be developed, as required, in accordance with the registration and permitting requirements under the ESA. – Monitoring activities to reduce adverse impacts of project activities on SAR will comply with the ESA.
		– Impact on SAR (Barn swallow)	– Disturbance to barn swallow or barn swallow habitat.	– As the only barn swallow sighting occurred in Markham Green Golf Club, if the Golf Club is not expected to be disturbed, mitigation is not anticipated to be required. – Confirm that Markham Green Golf Club is not impacted during detailed design.
N-6	Effect on soils	– Area of erosion and sedimentation during construction – Area of contaminated soils	– Dust and sediment can be created during the construction of staging areas and access roads. – Contaminated soils may be encountered during construction. – Potential ground settlement as a result of active dewatering/depressurization.	– Install sediment traps to deal with storm runoff during construction, where appropriate. – Install silt fences along the perimeters of the construction staging areas where appropriate to capture blowing sand and dust. Watering will also be considered. – Cover exposed excavated material to prevent erosion by rain/wind. – Cover catch basins using filter fabric during construction to prevent migration of sediments to receiving watercourses, where necessary. – Remove sediment from paved roads and access points. – Tarp, monitor and clean trucks transporting soil, waste, or granular material. – Test soils to determine the type of contaminant. Discharge contaminated soils at designated locations. – Re-integrate uncontaminated excess soils (for example, berms) into the project as much as possible.

Table 7.7 Cultural Environment - Effects and Mitigation

Item #	Criteria	Indicators	Potential effects (Positive/Negative)	Avoidance/Mitigation/Compensation
C-1	Effects on known or potential significant archeological resources	– Number and type of known archaeological sites affected – Extent of affected area within potentially archeological sites	– Potential impacts on 43 archaeological resources during construction.	– Stage 2 Archaeological Assessments are required for those parts of the study area that exhibit archaeological potential. This can be done prior to any proposed construction activities on these lands using test pit/ pedestrian survey at 5 m intervals. – Marine archaeological assessment would be required if construction impacts the Rouge River within the high-water mark. – Stage 1 Archaeological Assessment would be required should works extend beyond the current study area.
C-2	Effects on the cultural heritage landscapes	Number and type of cultural heritage resources displaced or disrupted	– Potential impacts on cultural heritage landscapes during construction.	– Construction staging areas and activities should be planned to avoid impacts on cultural heritage resources. – Landscaping, buffering or other forms of mitigation should be designed around the identified cultural heritage landscapes. – Construction across the Rouge River will be scheduled early and done as quickly as possible to minimize impact on the Rouge River. – A qualified heritage consultant should be contacted to confirm the impacts of the proposed work on potential CHLs.
C-3	Effects on built heritage resources	Number and type of built heritage resources displaced or disrupted	– Potential impacts on built heritage resources during construction.	– Construction staging areas and activities should be planned to avoid impacts to BHRs. – Landscaping, buffering or other forms of mitigation should be designed around the identified BHRs. – A qualified heritage consultant should be contacted to confirm the impacts of the proposed work on potential BHRs.

7.3 Capital Cost Estimate

The cost estimate methodology and the estimate basis are from the Association for the Advancement of Cost Engineering International (AACEI) methodology and represent a Class 5 cost estimate with an accuracy of -50% to +100%. The estimate presented reflects the probable cost obtained for the Greater Toronto Area and is a determination of fair market value for the proposed scope of work. Allowances and mark-ups were also included in the estimate for additional items such as design contingency, construction contingency, property acquisition and future investigations.

7.3.1 Scope of Work

The design concept for the new Markham Collector Twin is the installation of a 9.5-km sanitary sewer via tunnelling, connecting to a new manhole near MH 44-05 at the upstream and to shaft T0961-13C at the SEC diversion facility at the downstream connection. The proposed nominal diameter of the pipe is 2400 mm up to the MH4-6, where it crosses the Rouge River using a twin barrel 1350 mm contraction. The pipe diameter then increases to 2700 mm towards the downstream connection to maintain capacity given the gentler slope.

Based on this concept, the scope of work used for the purposes of determining the construction costs includes:

- Supply and installation of 2400 mm sanitary sewer via tunnelling for 7,147 m and via open cut pipe installation for 250 m.
- Supply and installation of two 1350 m sanitary sewers at Rouge River crossing via tunnelling for 275 m.
- Supply and installation of 2700 mm sanitary sewer via tunnelling for 1,875 m and via hand mining for 19 m.
- Staging areas for launching shafts at 6 locations with 1800 m^2 each location and associated chambers and maintenance holes.
- Staging areas for receiving shafts at 6 locations with 800 m^2 for each location and associated chambers and maintenance holes.
- Upstream and downstream connection.
- Site preparation and restoration.

7.3.2 Cost Assumptions

The development of the Cost Estimate was based on general assumptions and allowances, which include, but are not limited to:

1. The sewer will have an inner diameter of 2400 mm with a slope of 0.1% up to MH4-6, an inner diameter of 1350 mm with a slope of 0.1% at the Rouge River crossing and an inner diameter of 2700 mm with a slope of 0.06% after the Rouge River crossing.
2. Construction will be completed by tunnel methods utilizing a MTBM, with an open cut for areas with a cover depth of less than 8 m.
3. Tunnel shafts used for costing are located at all significant sewer bends and spaced at 2000 m along straight runs. Additional MHs will be located at shorter intervals to a maximum of 1,000 m, as required, along the new collector alignment for maintenance. These have not been included in the costing at this conceptual stage. The locations and costing will be determined during the design stage.
4. Access/maintenance chambers are assumed to be situated at proposed shaft locations.
5. Utility relocation will not be required for sewer depths greater than 8 m depth.
6. An allowance of 15% design contingency is considered to cover design and pricing unknowns in the preparation of this estimate. The allowance is not meant to cover additional scope of work or quality modifications but rather to provide some flexibility as the design develops. The design allowance typically decreases as the design progresses and is a nominal percentage at the pre-tender stage.

7. An allowance of 10% construction contingency is considered to cover the unexpected increase in costs or unforeseen Site conditions resulting in design modifications during the construction phase.
8. An allowance of 10% contingency is considered to cover any property acquisition.
9. An allowance of 4% is considered for the cost of future investigations listed in section 7.4.10.
10. All unit costs are inclusive of labour, materials, installation and restoration.
11. All unit prices were based on the best available information at the time the study was completed.
12. Tender prices for similar tunnelling were not available for use. The estimate is assumed to be accurate to +100%, 50%.
13. The project will be constructed under a single contract.

7.3.2.1 Excluded Costs

The cost estimate excludes:

1. Market contingency
2. Non-construction costs which include:
    a. Services during construction
    b. Legal
    c. Owner administration costs
3. Unforeseen significant increase in material prices
4. Unavailability of materials and skilled labour
5. Accelerated or delayed schedule
6. Overtime premium
7. Harmonized sales tax at 13%
8. Escalation rate
9. Land costs based on current market values.

7.3.3 Cost Estimate

The overall opinion of probable construction cost in Table 7.8 is estimated at $372 million (M). When adding a design contingency of 15% and a construction contingency of 10%, the construction cost increases to $463 M. Excluding escalation and HST, the project cost estimate ranges from $232 M (-50%) to $926 M (+100%).

Table 7.8 Estimated Construction Costs

Low range (-50%) ($, excluding HST)	Estimated costs ($, excluding HST)	High range (+100%) ($, excluding HST)
231,541,000	463,081,000	926,162,000

The capital cost shown in Table 7.9 is estimated at $600 M, which includes project construction cost, engineering fee, geotechnical investigation, property acquisition and allowance for any future investigation listed in section 7.4.10.

Table 7.9 Estimated Capital Costs

Item	Description	Amount
1	General construction costs	41,332,000
2	Tunnel construction cost	238,843,000
3	Shaft and MH chamber construction cost	85,703,000
4	Design contingency (15% of Items 1-3)	54,880,000
5	Construction contingency (10% of Items 1-3) plus provisional items	42,332,500
	Total construction cost	**463,081,000**
6	Engineering (15%)	69,462,000
7	Property acquisition (10%)	46,308,000
8	Future investigations (4%) inclusive of $3 M for geotechnical investigations	21,523,000
	Total capital cost (excluding HST) (Class 5 cost estimate, -50% to +100%)	**600,374,000**

7.4 Implementation Plan

7.4.1 Field Investigations

The conceptual design of the new Markham Collector Twin was based on a desktop review of available information and limited field efforts in specific supporting studies. Field investigations are required prior to and during the design stage to ascertain factual data required for preliminary and detailed design, which could either confirm or modify the concept. Table 7.10 lists what is anticipated to be the required future investigations.

Table 7.10 Future Field Investigations

Field Investigation	Comments
Geotechnical	– To confirm initial findings and provide geotechnical information for design. – The minimum total number of boreholes for the proposed alignment is estimated at 96 boreholes. The boreholes are proposed to be advanced for a minimum of three times the diameter of sewer pipes below the invert level of pipes. Soil samples should be collected at each significant stratum and subjected to a careful visual examination in the field in order to determine the soil profile. The cost to undertake these future investigations is approximately $3 M for a total footage of boreholes of 2,400 m and is included in Table 7.9. – Additional boreholes may be required between these boreholes if the stratigraphy changes significantly between the boreholes.
Hydrogeological field investigation	– To confirm existing conditions, obtain factual hydrogeological data prior to preliminary design and identify the following: • Hydraulic conductivity, seasonal groundwater elevations and groundwater chemistry for each hydro stratigraphic unit that will be intercepted by the shafts and tunnel. • Elevations of the aquifer and aquitard units identified. • River flow and surface water and groundwater interaction characteristics within 500 m of the proposed tunnel alignment. • Contaminant sources and spill events within a 500-m radius of the shafts and tunnel alignment were identified. – To analyze the data to predict potential impacts on receptors, estimate dewatering volumes and determine disposal options for dewatering. – To confirm the use of water supply wells within the study area. – The recommended Site investigations include the following: • The drilling and logging of boreholes to a depth below the proposed invert elevation of the trunk sewer. • Constructing groundwater monitoring wells at 100 m intervals along the proposed alignment. These wells will be nested wells (multiple monitoring wells in different hydrostratigraphic units). The number of nested wells at each location is dependent on what is encountered during drilling. For a tunnel, wells are typically installed across the water table, at the tunnel invert and below the tunnel invert. This is dependent on how many hydrostratigraphic units are encountered at each drilling location. Performing single well response tests (falling and rising head slug tests) at each new monitoring well installed along the alignment. • Collecting and analyzing groundwater samples for chemical analysis from each hydrostratigraphic unit encountered at multiple locations along the alignment. • Installing flow and stage monitoring locations upstream, downstream and at the proposed Rouge River crossing. • Installing riverbed piezometers at the Rouge River stage and flow monitoring sites. • Installing flow and stage monitoring locations at proposed Rouge River tributary crossing locations. • Installing surface water elevation monitoring sites at the pond and wetland locations.

Field Investigation	Comments
Natural heritage characterization study	– To confirm the identified species within the study area before construction. – To monitor identified species during construction and operations.
SUE Level D	– To provide the location of subsurface utilities along the route, which conflict with the new Markham Collector Twin.
Topographic surveys	– To confirm ground levels along the preferred alignment, including the Rouge River crossing, to confirm the depth of cover for the new Markham Collector Twin.
Phase 2 ESA	– To address the identified APECs, if a Record of Site Conditions (RSC) is required, a Phase 2 ESA will be necessary. – If an RSC is not required, a Phase 2 ESA investigation is not required under O. Reg. 153/04. At this time, the Region does not intend to file an RSC under O. Reg. 153/04. As an RSC will not be filed for the Phase One Property, a Phase 2 ESA is not compliance driven, and it is at the discretion of the Region to exercise this option. – The Region may consider completing a Phase 2 ESA to investigate the identified APECs both from a due diligence perspective and to support future soil and groundwater management activities where applicable during construction.
Assessment of past uses (APU)	– According to section 11 (2).2 of O. Reg. 406/19, onsite Phase One Property and Excess Soil Management, an APU of the project area is not required if a Phase 1 ESA, within the meaning of O. Reg. 153/04, has been prepared in respect of the project. Therefore, only a single Phase 1 ESA will be completed for the single preferred alignment in general accordance with O. Reg. 153/04 requirements. – However, should an APU be required, as per the Soil Rules (2022), at a minimum, every soil sample required to be taken must be analyzed for all of the following parameters: petroleum hydrocarbons, metals and hydride forming metals. Additionally, SAR and EC must be analyzed for if the soil is excavated from an area where a substance has been used for the purpose of keeping the area safe for use under the conditions of snow or ice. Within the project area, this would include any roadways or areas adjacent to roadways.
Hydrological study	– To assess variability of the Rouge River flows based on the present and future climatic conditions to determine constructability and future capacity constraints. – To understand the interaction between surface water and groundwater flows, which may result in higher groundwater infiltration rate, reducing the capacity of the new Markham Collector Twin.
Fluvial geomorphology study	– To assess the Rouge River channel morphology and understand the interaction between the sediment flow and the watercourse. – To determine the impact of the new Markham Collector Twin on the riverbed and propose mitigation measures during the preliminary design stage.
Cultural heritage	– To provide a property-specific heritage impact assessment on the preferred alignment upon completion of the preliminary designs, which would provide potential impacts and propose more detailed mitigation measures. – If future work requires an expansion of the study area, a qualified heritage consultant should be contacted to confirm the impacts of the proposed work on potential BHRs and CHLs.
Stage 1 archaeology	– To identify any archaeological potential outside of the study area.
Stage 2 archaeology	– To confirm the archaeological potential of the sites identified in Stage 1.

7.4.2 Permits

Various Federal and Provincial legislations and policies, as well as municipal by-laws, govern the planning, design, construction and operation of the new 9.5 km Markham Collector Twin and shafts. The preferred alignment crosses the Rouge River, rail corridors, tributaries of the Rouge River and utilities outside the hydro corridor, which are governed by several regulatory agencies. Coordination with these major stakeholders would be required for the successful completion of the new Markham Collector Twin. A number of permits and regulatory approvals will be required for conformity to engineering design standards, health and safety best practices and environmental regulations.

Table 7.11 identifies the agencies and municipalities to be consulted and the required anticipated approvals and permits. The anticipated permits are based on the conceptual design of the new Markham Collector Twin and will need to be confirmed as part of the detailed design and pre-construction stages. Figure 7-12 shows the anticipated permits and approvals timeline.

Table 7.11 Permits and Approvals Required for the Markham Collector Twinning Project

Agency	Anticipated permit	Assumed minimal approval timeline
Toronto and Region Conservation Authority (TRCA)	Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Permit (Ontario Regulation 166/06)	1 month
Toronto and Region Conservation Authority (TRCA)	Acquisition and Easement	12-18 months
Toronto and Region Conservation Authority (TRCA)	Permission to Enter	0.5 month
City of Markham/York Region	Temporary Dewatering Discharge Application	2-4 months
City of Markham/York Region	Road Occupancy Permit	0.5 month
City of Markham/York Region	Heritage Permit	3 months
City of Markham/York Region	Noise Exemption Permit	1 month
City of Markham/York Region	Tree Cutting	1-2 months
City of Markham/York Region	Site Plan Approval and Building Permit	To be determined
Utility Authorities	Utility Service Clearances	To be determined
Ministry of Environment, Conservation and Parks (MECP)	SAR Consultation and Endangered Species Act Approval	12 months
Ministry of Environment, Conservation and Parks (MECP)	Excess Soil Regulation Consultation	To be determined
Ministry of Environment, Conservation and Parks (MECP)	EASR / PTTW	6-12 months
Ministry of Environment, Conservation and Parks (MECP)	Environmental Compliance Approvals (Environmental Protection Act) – ECA Air & Noise	6-12 months
Ministry of Environment, Conservation and Parks (MECP)	Environmental Compliance Approvals (Environmental Protection Act) – ECA Water	6-12 months
Ministry of Nature, Resources and Forestry (MNRF)	In-Water Construction Timing Window	1-3 months
Ministry of Labour (MOL)	Notice of Project	To be determined
Ministry of Citizenship and Multiculturalism (MCM)	Archaeological Assessment Clearance	To be determined

Agency	Anticipated permit	Assumed minimal approval timeline
Ministry of Transportation of Ontario (MTO)	Standard Encroachment Permit Application (TR-0100)	1 month
Metrolinx	Consent with Metrolinx	To be determined
Infrastructure Ontario (IO)	Secondary Use License/Easement Agreement	To be determined
Transport Canada	TC E-10 Standards Respecting Pipeline Crossings Under Railways	1-2 months
Department of Fisheries and Ocean (DFO)	Project Authorization	2-5 months
Department of Fisheries and Ocean (DFO)	SARA Permit	3 months
Department of Fisheries and Ocean (DFO)	In-Water Construction Authorization	1-2 months
Environment and Climate Change Canada (ECCC)	Species at Risk Act (SARA) Permit	3 months
Environment and Climate Change Canada (ECCC)	Mitigation Measures for Deleterious Substances	1-2 months
Canadian National Railway (CNR)	Consent from CNR	To be determined

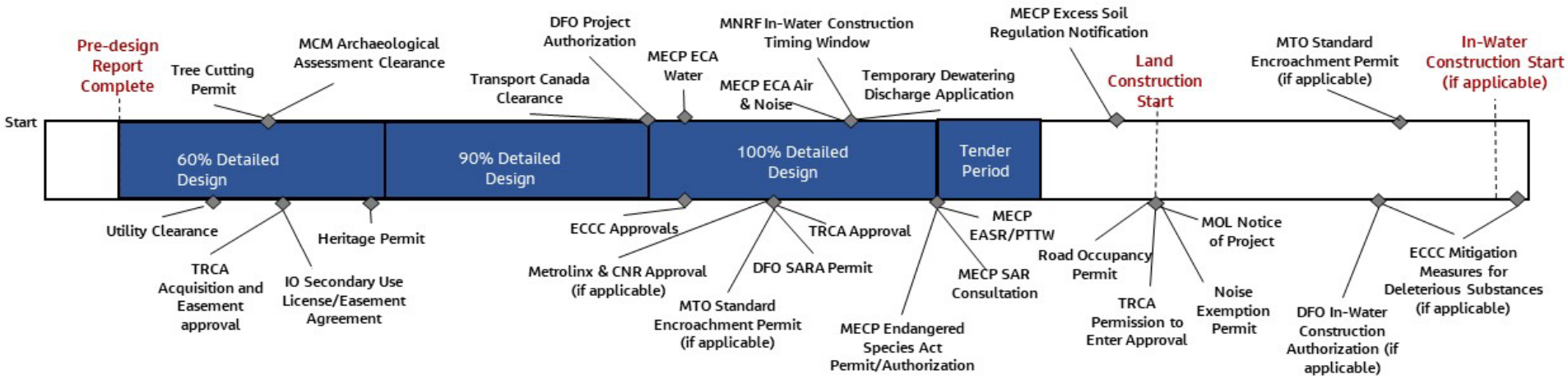

Figure 7-12 Typical Permits and Approvals Timeline for the Markham Collector Twinning Project

7.4.3 Schedule

The 2022 Master Plan identified the project need and implementation timeframe between 2041 and 2051. The results of the hydraulic model analysis confirm that the existing Markham Collector will reach 95% full by capacity and 86% full by depth in 2031, with higher values in 2041. The capacity could be reached even sooner as a result of higher population growth, future changes to the groundwater infiltration rate, and the increasing frequency of more severe storms due to climate change than what was assumed in this analysis. Therefore, based on hydraulic model results, it is recommended to advance the new Markham Collector Twin design and construction to be in service by 2041.

The schedule is assumed to be based on the traditional design-bid-build contract approach. A period of 2.5 years is assumed for planning and design, which comprises of pre-construction activities, including future field investigations listed in section 7.4.10, property acquisition, permits and approvals and preliminary and detailed design. Upon completion of the design, the preferred contractor can be procured using a competitive bidding process.

A construction period of 4.5 years is assumed for the Y2 Markham Collector Twinning Project, depending on ground conditions. Microtunnelling construction for 9.25 km of the preferred alignment is assumed to be done at 7 m per day, open cut construction at 10 m per day for 250 m of the preferred alignment and shaft construction at a production rate of six months per shaft for 12 shafts. The total design and construction period is approximately 7.5 years. Table 7.12 shows the schedule for the Markham Collector Twinning Project and the symbol X denotes the project stage duration. Based on the hydraulic model results and the projected timeline for design and construction, it is recommended that the Markham Collector Twinning Project be implemented earlier than intended in the 2022 Master Plan to facilitate the Bill 23 growth projections.

Table 7.12 Proposed Schedule for the Markham Collector Twinning Project

Description	Duration (years)	1	2	3		4	5	6	7	8	
Planning and design	2.5	x	x	x							
Procurement	0.5				x						
Construction	4.5					x	x	x	x	x	
Commissioning	0.5										x

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