West Rainbow Creek Fluvial Geomorphology Assessment and Channel Realignment Guidance

Simpson Road Extension

Simpson Road Landowners Group

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1.0 Introduction

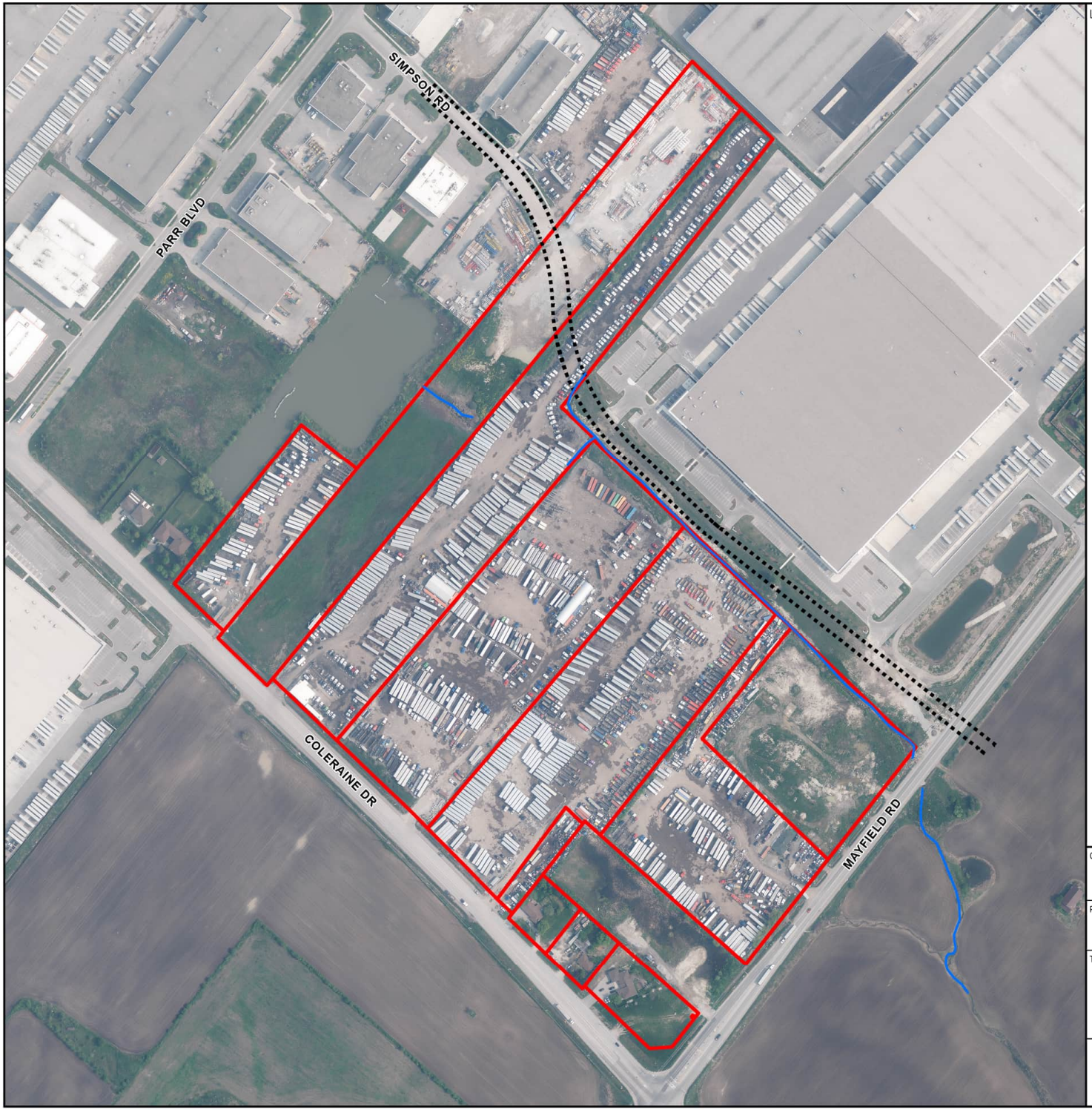
SLR Consulting (Canada) Ltd. (SLR) is pleased to provide the Simpson Road Landowners Group Inc. ("the Landowners Group") with our fluvial geomorphology assessment of West Rainbow Creek, north of Mayfield Road and adjacent to the proposed Simpson Road extension (Study Area), in Bolton, Ontario (**Figure A**). SLR is working in collaboration with Greck and Associates Ltd. (Greck) to complete the channel realignment and naturalization design for West Rainbow Creek. Greck is completing the water resources engineering tasks. GEI Consultants (GEI) is completing the Simpson Road Master Environmental Servicing Plan (MESP) update and Weston Consulting is the planner for the project.

The following report summarizes the project history and builds upon historical characterization of West Rainbow Creek to propose a channel realignment and naturalization design from an existing stormwater pond to Mayfield Road, as part of the Simpson Road extension.

2.0 Background

The Simpson Road extension Study Area is part of the broader Bolton South Industrial Lands area, for which an MESP was completed (Burnside, 2000) to establish preferred management options for protection and/or enhancement of environmental features and their functions, including development of a preferred stormwater management (SWM) plan. The MESP included existing conditions characterization of West Rainbow Creek adjacent to the proposed Simpson Road extension, referred to as "Tributary D" in reporting. At the time of the MESP, the associated drainage area of Tributary D was approximately 91 ha through agricultural swales and drainage ditches that were straightened through past agricultural activities and were generally ill-defined (**Figure B**). Tributary D was considered a "small riverine warmwater system". Small riverine warmwater systems, as described in the Humber River Fisheries Management Plan (MNRF and TRCA, 2005), are first- and second-order tributaries draining from the Peel Plain. Due to the dominance of clay soils and high runoff potential, these tributaries experience significant fluctuations in temperature and stream flow, drying up or attaining high temperatures during summer months. In the Bolton South Industrial Lands (that encompass the study area), the 2000 MESP identifies Tributary D as being highly intermittent and not supporting direct fish habitat, only contributing to downstream habitat. Water quality degradation is apparent due to land clearing for agriculture and increased runoff of agricultural inputs such as fertilizers, pesticides, and manure.

In 2008, the Town of Caledon enacted a By-law preventing approval of new accesses to future developments on existing properties with frontage on Coleraine Drive. As a result of the imposed access restriction, an extension of Simpson Road to Mayfield Road was required to expedite development of vacant land parcels south of Parr Boulevard. A Schedule "C" Municipal Class Environmental Assessment (EA) Study was undertaken for the planned completion of Simpson Road by the Town of Caledon (AMEC, 2012). The EA referenced baseline environmental characterization data from the previously completed 2000 MESP.

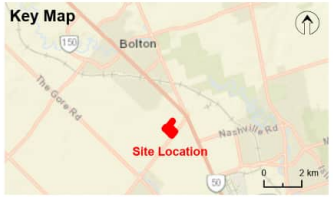


LEGEND

Channel Alignment (2022)

Proposed Road Alignment

Study Area



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Drawn: SM
Checked: TH
Date: Jul 30, 2025

NORTH

Source Notes:
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CLIENT

Simpson Road LO Group

PROJECT

West Rainbow Creek
Fluvial Geomorphology Assessment

TITLE

Study Area

SLR

REF. NO. 233.V24250.00001

Figure A

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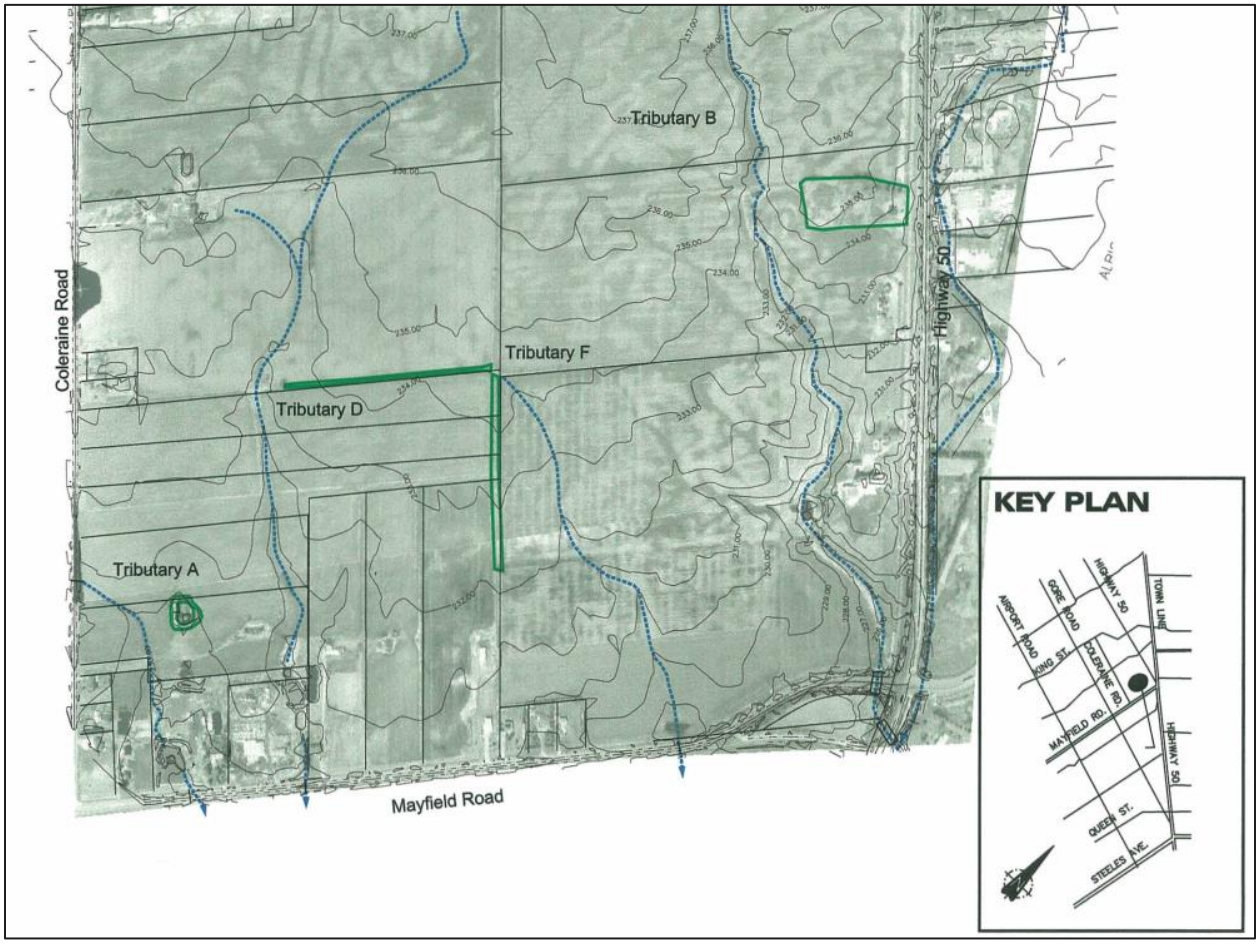


Figure B: Extent of West Rainbow Creek north of Mayfield Road (referred to as "Tributary D") as shown in Figure 6 from Burnside, 2000 (base imagery year of acquisition is unknown)

The EA (2012) identified that realignment and channelization of West Rainbow Creek adjacent to the Simpson Road extension is necessary to improve fluvial geomorphological function and fisheries habitat. The preferred alignment of Simpson Road to Mayfield Road was advanced to detailed design by the Region of Peel and Town of Caledon (Wood, 2020). A detailed natural channel design for West Rainbow Creek was included as part of the road design (Aqualogic, 2014, revised 2015 & 2019). To accommodate flood storage requirements, the proposed top width of the channel corridor was 45 m and the bottom width was 39 m. Within the corridor, a 2 m-wide, 0.5 m-deep bankfull channel would convey a bankfull flow of approximately 0.58 m^3/s. The proposed channel was mostly a straight (i.e. non-meandering) feature with localized pools for fish refuge. The design was issued for review in 2020.

Greck (2025) completed updated hydraulic modelling that determined a 33 m-wide corridor would be sufficient for conveyance and storage of regulatory events for the proposed channel design. Due to the narrower corridor, the proposed channel realignment and naturalization needs to be revisited. Opportunities to improve the geomorphic, hydraulic, and ecologic function of West Rainbow Creek will be evaluated.

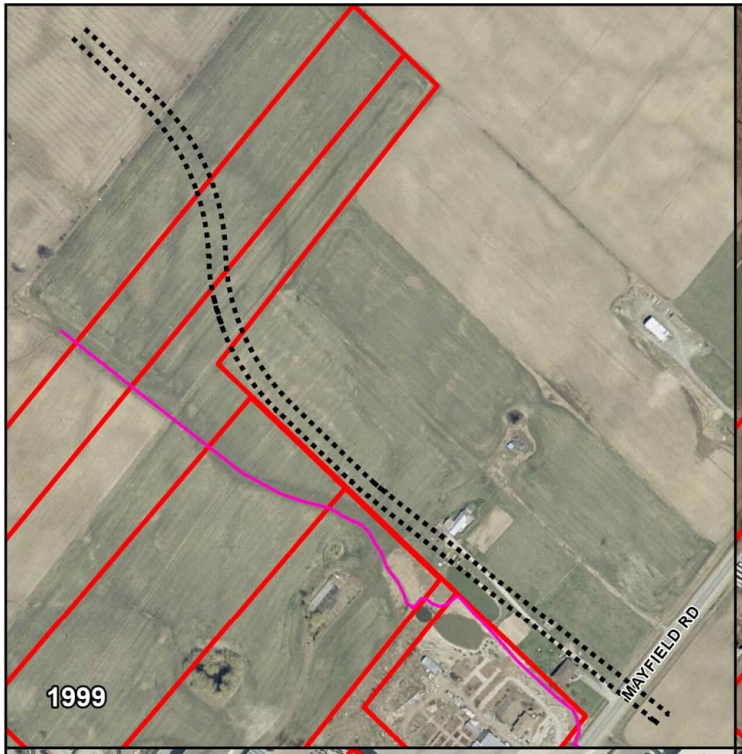
3.0 West Rainbow Creek North of Mayfield Road

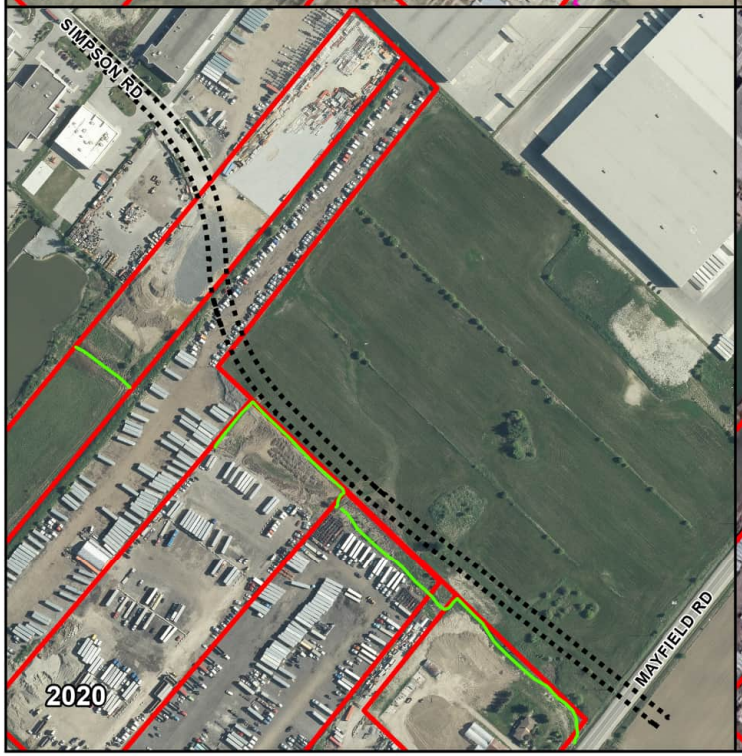
To update and refine the understanding of existing and historical conditions of West Rainbow Creek north of Mayfield Road, SLR completed a scoped historical analysis and field reconnaissance. Orthophotography from 1999, 2009, and 2018-2022 was accessed through the Peel Region online webserver[1]. The centreline was delineated to document channel alterations during the period of coverage (**Figure C**). Field reconnaissance was completed on May 9, 2023 by one of SLR's Fluvial Processes Specialists, to document existing conditions following the initial characterizations by Aqualogic (2019) and Burnside (2000). Minimal antecedent rainfall resulted in near-baseflow conditions during the field reconnaissance.

Prior to 2000, as documented by Burnside, the watercourse drained approximately 91 ha through agricultural fields and two on-line ponds supporting irrigation for a tree nursery along Mayfield Road. The MESP recommended two SWM ponds to manage runoff from the development of the Bolton South Industrial Lands. The northern SWM pond (which is currently the upstream end of West Rainbow Creek) was constructed prior to 2005, enlarged prior to 2009, and captures the upper 55 ha of drainage (Aqualogic, 2014). Between 2009 and 2022, the surrounding properties have transitioned from agricultural to industrial uses (primarily truck parking). As these urban land uses have expanded, particularly between 2018 and 2022 (**Figure C**), the watercourse has been straightened and realigned. The current watercourse alignment is coincident with the property line between the western properties and the Home Depot Innovation Centre to the east.

The existing condition along West Rainbow Creek, north of Mayfield Road, reflects ongoing industrial land use activities and recent channel alterations. At the upstream end, the watercourse outlets from the existing SWM pond to an undeveloped property flowing through a 20-25 m wide riparian corridor. The watercourse, or a culvert conveying flow, could not be located on the subsequent property that was primarily occupied by truck parking (**Figure A**). Evidence of water was noted in several separate locations, but no defined flow path was identified. Through the remainder of the Study Area, the watercourse flows southward along the eastern property boundaries. There is limited to no riparian vegetation, frequent garbage/debris accumulations, and asphalt and fill frequently abut the western bank (**Photos 1-3**). The bankfull cross-section is approximately 1.9 to 3.5 m wide and 0.40 to 0.60 m deep.

[1] https://gisprd.peelregion.ca/arcgis/rest/services/AerialImagery





LEGEND

Channel Planform Year

- 1999
- 2009
- 2020
- 2022
- Proposed Road Alignment
- Study Area

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METRE SCALE

North American Datum 1983
Universal Transverse Mercator Projection Zone 17

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Page Size: Letter (8.5 x 11 inches)

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NORTH

Source Notes:
Historic Imagery (1999, 2009, 2020) provided by Peel Region GIS services, 2022 imagery provided by Google Satellite map service. Contains information licensed under the Open Government Licence – Ontario.

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West Rainbow Creek
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TITLE
Historic Imagery Comparison

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Figure C

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Photo 1: Concrete, fill and truck parking along the top of the west bank (photo taken facing upstream, north, May 2023).

Photo 2: Fill and garbage along west bank, dense vegetation in the channel along east bank (photo taken facing upstream, north, May 2023).

Photo 3: Typical channel cross-section with instream vegetation (May 2023).

4.0 Proposed Valley Corridor Width

As previously outlined in the MESP (AMEC, 2012), the intended goal for West Rainbow Creek was to both preserve an open channel and to restore channel function to conditions prior to agricultural disturbance. The previously proposed design (Aqualogic, 2019) included a bankfull cross-section situated within a 45 m-wide corridor to accommodate flood storage and conveyance. Greck (2025) determined a 33 m-wide corridor would sufficiently meet flood conveyance and storage requirements for regulatory events.

A 33 m-wide corridor is also appropriate from a geomorphological perspective. West Rainbow Creek within the Study Area is not a naturally meandering channel due to its small drainage area and surficial geology. Any historical sinuosity (pre- and post-agricultural) reflects minor undulations in the plain across which it flows. Now that the watershed is urbanized, the channel has the potential to adopt more of a meandering form.

Based on review of LiDAR topographic data and aerial imagery, a discernible channel corridor is observed about 0.4 km downstream of the Study Area along West Rainbow Creek (**Figure D**). The drainage area at the upstream limit of this channel corridor is approximately 130 ha, according to the Ontario Watershed Information Tool. The channel corridor ranges from 16 m to 36 m in width, with the widest sections observed closer to Coleraine Drive. Based on these observed corridor widths, the proposed 33 m-wide channel corridor within the upstream Study Area is appropriate.

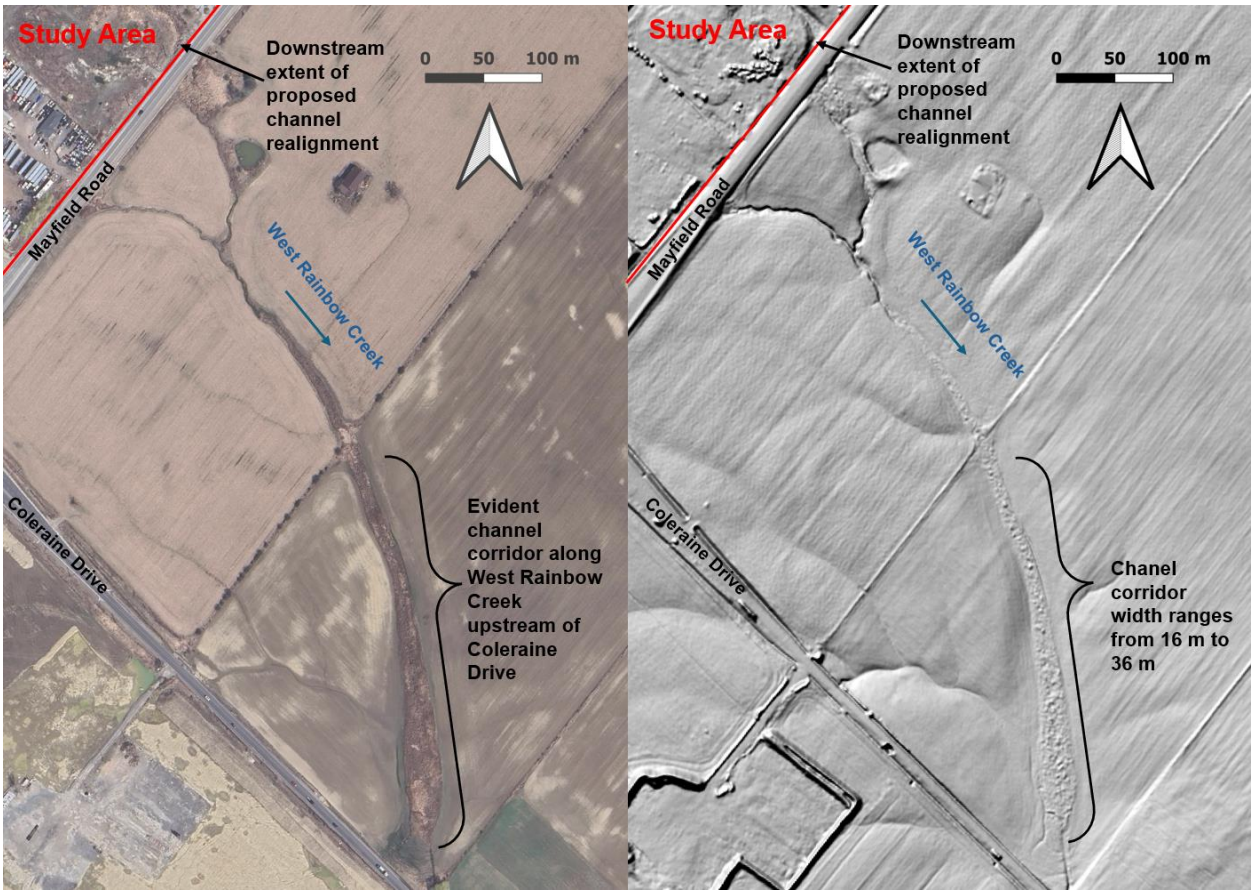

Figure D: A channel corridor is evident in aerial imagery (left image) and LiDAR topographic data (right image) starting about 400 m downstream of the Study Area along West Rainbow Creek. The channel corridor ranges in width from 16 m to 36 m.

As a further check, the existing meander belt was delineated in accordance with TRCA's Belt Width Delineation Procedures (Parish Geomorphic Ltd., 2004) to give confidence that the proposed 33 m-wide corridor can accommodate geomorphic processes over the coming century. Due to the relatively small size of the creek (especially prior to channelization) and widespread historical planform modifications, the meander belt could not be delineated based on historical imagery or the use of a nearby surrogate reach. Instead, the meander belt was established based on an empirical relation. The observed (anthropogenic) dimensions are likely unrepresentative of governing flow conditions, precluding the option of using empirical formulae based on channel dimensions (width or depth). As such, an empirical meander belt width formula developed by the Natural Resources Conservation Service (NRCS, 2007), which utilizes drainage area (equation TS14S-3[2]) as the input variable, was applied to West Rainbow Creek in the Study Area:

$$Meander\ Belt\ Width = 100 \times Drainage\ Area^{0.43}$$

[2] The empirical formula uses imperial measurements. Outputs were converted to metric.

Using 91 ha (Burnside, 2000) as the drainage area for the Study Area, the empirical equation estimated an existing meander belt width of 19 m for West Rainbow Creek in the Study Area. A 20% factor of safety was added to the existing meander belt width to accommodate changes in hydrological and sediment supply regimes due to land use change, resulting in a final meander belt width of 23 m. Thus, based on empirical meander belt estimates and observed downstream channel corridors, a 33-m wide channel corridor can sufficiently accommodate geomorphic processes (e.g. erosion and meander formation and migration).

5.0 Channel Realignment and Naturalization

As a result of a changes to the overall channel corridor dimensions, the proposed channel realignment and naturalization has been revisited. Below are opportunities and constraints for the channel realignment within the Study Area, followed by channel naturalization design considerations.

5.1 Opportunities and Constraints

Channel realignment and naturalization ***opportunities*** for West Rainbow Creek within the Study Area:

- Establish a planform, profile, and cross-section that adhere to the principles of natural channel design. This will improve the ecological, geomorphological, and hydraulic function of West Rainbow Creek in the Study Area. In addition, improving the function of the channel within the Study Area will help improve the timing and magnitude of channel inputs (water, sediment, wood, nutrients) to downstream reaches within the City of Brampton that will likely undergo channel realignment and enhancements as part of future development (Savanta Inc., 2019).
- Remove in-channel debris accumulation that can be a barrier to fish passage and exacerbate erosion.
- Incorporate a low-flow channel for fish refuge and passage given the prolonged periods of low flow.
- Improve the channel's access to its floodplain during flood events to moderate bed and bank erosion and decrease velocities (i.e. improve fish passage) during high flows.
- Incorporate localized geomorphic habitat features along the channel to provide more heterogeneity.
- Establish a riparian area that will improve the ecological, geomorphological, and hydraulic function of West Rainbow Creek.

Channel realignment and naturalization ***constraints*** for West Rainbow Creek within the Study Area:

- The channel approach and exit of vehicle crossings (e.g. driveways, Mayfield Road) should be relatively straight to reduce the risk of erosion near crossing inlets and outlets.
- The overall slope of the proposed channel corridor needs to be very gentle (<0.5%) due to existing topography and to maintain flood storage (Greck, 2025), so channel planform and profile features must be designed accordingly.

- The proposed channel naturalization will need to 'tie in' to the elevations at the upstream pond outlet and the proposed culvert at Mayfield Road.

5.2 Design Considerations

Based on the above opportunities and constraints, design considerations for channel, planform, profile, and cross-sections of West Rainbow Creek from a fluvial geomorphological and ecological perspective are provided.

5.2.1 Channel Planform

- The realigned channel should have an irregular meandering planform that mimics nearby meandering reaches, which will provide habitat heterogeneity and improve geomorphic function.
- The channel approach to and exit from culvert crossings should be relatively straight (i.e. non-meandering) to reduce the erosional risk to infrastructure.

5.2.2 Channel Profile

- Due to the low gradient, incorporation of riffles, glides, and pools is challenging to construct and/or could lead to fish barriers at low flows for most of the realigned channel.
- Culvert crossings, depending on type and geometry, (could be fixed grade control points.
- The channel will have a higher gradient near the downstream end so that it can 'tie in' to the proposed Mayfield Road culvert. The channel slope in this short, steeper section should not exceed 4% to accommodate upstream fish passage and to reduce erosional risk. A 'cascade-pool' morphology will increase energy dissipation and help reduce velocities.

5.2.3 Channel Cross-section

- A three-tiered cross-section is recommended: a 'low-flow channel', a 'high-flow channel', and a 'flood corridor'.
- The flood corridor would convey the regulatory event (Greck, 2025).
- The high-flow channel would convey a flow roughly equal to the 1.5-year return flow. Flows above the 1.5-year return flow would spill onto the floodplain within the broader channel corridor to help dissipate erosive energy.
- The low-flow channel would be an inset along the centreline of the high flow channel and would convey a flow roughly half of the bankfull discharge (0.58 m^3/s; Aqualogic, 2019). A low-flow channel will help maintain connectivity during extended periods of low flows that are typical of urban streams on the Peel Plain. The low-flow channel will have similar dimensions to those issued for review in 2020 (Aqualogic, 2019).

5.2.4 Habitat Features

- Coarse gravel and cobble can be locally placed between meander apices (i.e. where riffles usually form in steeper watercourses). The coarser substrate will provide cover for migrating fish, increase hydraulic diversity, and provide more opportunities for benthic invertebrates.

- Brush layers can be incorporated along the outer banks of the low-flow channel at select meanders. They would provide shade and allocthonous food sources for aquatic organisms and would help moderate erosion potential (i.e. fine-grained sediment input).
- Incorporation of large wood into the low flow channel is not advised due to the anticipated narrow channel width, which could result in debris accumulation and/or irregular bed and bank erosion. Incorporation of large wood into the high flow channel could provide refuge for fish during high flows.

6.0 Closure

SLR appreciates the opportunity to support the Simpson Road Landowners Group. Should you have any questions, please feel free to contact either of the undersigned.

Regards,

SLR Consulting (Canada) Ltd.

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Senior Fluvial Processes Specialist

Robin McKillop, M.Sc., P.Geo., CAN-CISEC
Climate Resilience Lead, Principal Geomorphologist

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