Fluvial Geomorphological Assessment and Erosion Hazard Delineation

Sulphur Creek and Tributaries 159 and 163 Sulphur Springs Road Ancaster, Ontario



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GEO Morphix Project No. 24108





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Disclaimer

This report presents professional opinions and findings of a scientific and technical nature based on the knowledge and information available at the time of preparation. This document is prepared solely for the Client, and the data, interpretations, suggestions, recommendations, and opinions expressed in the report pertains only to the project being completed for the Client.

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1 Introduction

GEO Morphix Ltd. (GEO Morphix) was retained to complete a geomorphological assessment and erosion hazard delineation for a portion of Sulphur Creek and its tributaries to support a development at 159 & 163 Sulphur Springs Road in Ancaster, Ontario. The subject property is bounded by Sulphur Springs Road and residential properties to the south and west, natural heritage system to the east, and the provincially significant Sulphur Creek Valley Life Science Area of Natural and Scientific Interest (ANSI) to the north (**Appendix A**). Sulphur Creek flows generally west to east through a waterbody through the northern portion of the subject property. Additionally, a small pond and tributary to Sulphur Creek flows generally west to east through the southern portion of the subject property.

The geomorphological and erosion hazard delineation assessment will, in part, inform the limits of development. The following activities were completed to as part of the geomorphological and erosion hazard assessment:

- Review available background reports and mapping (e.g., watershed/subwatershed reporting, geology, and topography) related to channel form and function and controlling factors related to fluvial geomorphology
- Review recent and historical aerial photographs of the site to understand historical changes in channel form and function
- Delineate watercourse reaches based on a desktop assessment and field confirmation
- Conduct field reconnaissance using standard, industry-accepted tools such as the rapid geomorphic assessment (RGA) (MOE, 2003) and rapid stream assessment technique (RSAT) (Galli, 1996) to evaluate existing instream and riparian conditions (i.e., evidence of ongoing channel processes, active erosion/deposition, or potential channel instability)
- Delineate limits of the meander belt width/erosion hazard on a reach basis using the results of the desktop and field assessments

This report provides a summary of existing geomorphologic conditions and the approach and methodology for erosion hazard delineation. The findings outlined herein should be considered in conjunction with the results of other studies to inform development opportunities and constraints and the overall limit of development (e.g., geotechnical stable slope analyses, floodline analysis and environmental constraints).

2 Background Review and Desktop Assessment

2.1 Site Overview

The subject property is situated within the headwaters of the Sulphur Creek subwatershed, which ultimately drains to Lake Ontario. The Sulphur Creek watershed has a drainage area of approximately 17 km², including the catchments Slote Road, Rifle Range, Jerseyville Road, Mineral Spring Road, Hermitage Ruins, Sulphur Springs Road, and Lower Sulphur Creek. Land use within the watershed predominantly consists of open space (5.33 km²), residential lands (4.66 km²), and agricultural (2.58 km²). Forest cover accounts for 62.2%, meadows cover 1.2%, and wetlands are <1% of the subwatershed cover (Hamilton Conservation Authority, 2010).

A review of publicly available 2021 LiDAR data was conducted using hillside imagery derived at 0.5 m resolution. The subject lands appear relatively flat near Sulphur Springs Road, with topographic relief occurring to the north. In the northern portion of the site, a relatively steep valley and large online pond feature are present. Figure 1 in **Appendix A** demonstrates the extent of the subject property; and the Figure 2 includes hillshade imagery, for reference. A series of small drainage features, including a small pond feature are also present in the southern portion of the subject property. Waterbodies and drainage features are also depicted in Figure 1 (**Appendix A**).

Generally, the surficial geology within the subject property and surrounding area is predominately composed of coarse textured glaciolacustrine deposits comprised of sand, gravel, with some silt and clay (OGS, 2010). A small pocket of Paleozoic bedrock is present along the northeast portion of the subject property and surrounding area. The southern portion of the subject property is located within

the Norfolk Sand Plain physiographic region while the northern portion of the subject property is located within the Niagara Escarpment (Chapman and Putnam, 1984).

2.2 Historical Assessment

A series of historical aerial photographs were reviewed to determine changes to channels or drainage features on site and surrounding land use and land cover. This information, in part, provides an understanding of the historical factors that have contributed to current channel morphodynamics. Various aerial photographs and satellite images from 1934 to 2023 were retrieved to complete the historical assessment and inform the erosion hazard delineation. Specifically, aerial photographs for the years 1934 (1:20,000), 1945 (1:20,000), 1965 (1:20,000), and 1986 (1:25,000) were retrieved from the National Air Photo Library; 1954 (1:17,000) and 1959 (1:30,000) were retrieved from McMaster University Library (Historical Hamilton Portal); 1995 (1:30,000) was retrieved from The Ministry of Natural Resources and Forestry; and 2005, 2014, 2017, 2021, and 2023 were retrieved from Google Earth Pro. All historical aerial photographs are provided in **Appendix B** for reference.

In 1934, the subject property consisted of a residential dwelling, manicured grasses, and immature trees and hedgerows. The watercourse tributary through the northern portion of the property flowed south-west to north-east, exhibiting a straightened channel planform. Surrounding land use included residential development to the south, and agricultural lands with fragmented forests to the north, east, and west. No other drainage features were visible on site in 1934.

Between 1934 and 1945, the northern watercourse planform is no longer identifiable due to tree cover. A small wetland or pond feature is present along the northern tributary. Little to no changes are present in the surrounding land use. Through to 1959, a large pond appears constructed within the northern portion of the subject lands, replacing the previous wetland/pond feature. A trail is present along the edge of the pond. A new access road or driveway is constructed within the subject property, connecting Sulphur Springs Road to the pond. There are no visible changes to the planform of the tributary due to tree cover. Residential development continues to expand to the south.

By 1986, tree cover has matured surrounding the pond, extensively to the north, as well as within the subject property. The upstream tributary (**Reach SCT3**) is visible and exhibits a straight channel planform through a densely vegetated riparian corridor. Residential development expands to just south of Sulphur Springs Road. Surrounding land use changes from agricultural land to predominantly mature forests to the north.

Between 1995 and 2005, tree cover has continued to mature, and density increases around the large pond. With higher resolution aerials, the channel planform downstream of the pond is identifiable. This channel (**Reach SCT1**) exhibits a straight channel planform. The surrounding land use is comprised of residential dwellings to the east, south and west, along with denser forested areas to the north. Less agricultural land is present. Between 2005 and 2023, little to no changes are present within the subject property. The planform of the tributary downstream of the pond (**Reach SCT1**) remains straight. The tributary upstream of the pond (**Reach SCT3**) is still not visible due to dense tree cover.

3 Watercourse Characteristics

3.1 Reach Delineation

Reaches are homogeneous segments of channel used in geomorphological investigations. Reaches are studied semi-independently as each is expected to function in a manner that is at least slightly different from adjoining reaches. This method allows for a meaningful characterization of a watercourse as the aggregate of reaches, or an understanding of a particular reach, for example, as it relates to a proposed activity.

Reaches are delineated based on changes in the following:

- Channel planform
- Channel gradient
- Physiography

- Land cover (land use or vegetation)
- Flow, due to tributary inputs
- Soil type and surficial geology
- Certain types of channel modifications by humans

This follows scientifically defensible methodology proposed by Montgomery and Buffington (1997), Richards et al. (1997), and the Toronto and Region Conservation Authority (2004). Reaches are first delineated as a desktop exercise using available data and information such as aerial photography, topographic maps, geology information and physiography maps. The results are then verified in the field.

Several reaches were delineated in association with the subject lands based on the MNR Ontario Hydro Network and the criteria outlined above. Ultimately, reaches were finalized based on field verification and mapping and include **Reaches SCT1, SCT2, SCT3, SCT4, SCT1-2, SCT1-3** and **SCT1-4**, and **SCT1-5**. It should be noted that reach verification was only completed on features within the subject property. For example, only a short section of **SCT-6** and **SC1** were observed within the property. General descriptions of all reaches are provided below, and mapped extents of the reaches are provided in **Appendix A**.

3.2 General Reach Observations

Field investigations were completed on October 21, 2024, and included the following:

- Descriptions of riparian conditions
- Estimates of bankfull channel dimensions
- Determination of bed and bank material composition and structure
- Observations of erosion, scour, or deposition
- Collection of photographs to document the watercourses, riparian areas and/or valley, surrounding land use, and channel disturbances such as crossing structures

Only portions of reaches within parcel boundaries were assessed in the field. These observations and measurements are summarized **Table 1**. The field descriptions are supported with representative photographs, which are included in **Appendix C**. Field sheets, including those completed for rapid assessments, are provided in **Appendix D**.

	Average Bankfull Width (m)	Average Bankfull Depth (m)	Substrate		Dinavian	
Reach			Riffles	Pools	Riparian Vegetation	Notes
SCT1	2.10	0.26	¹ Clay/silt, sand, and gravel		Continuous, wide riparian buffer of mature trees and shrubs	Sinuous single channel through confined valley. Perched culvert and scour pool was present at the outlet of the waterbody upstream.
SCT2 (Pond Feature)	N/A	N/A	N/A Pond not wadable		Continuous, wide riparian buffer of mature trees and shrubs	Reach contained large, online waterbody with wide, dense riparian buffer.
SCT3	1.04	0.15	Sand, Gravel and cobble	Clay/silt, and sand	Continuous; mature trees and some grasses	Narrow, single channel enters waterbody downstream; knick points present; established riparian vegetation.

Table 1: Summary of general reach characteristics

	Average		Substrate		Diversion	
Reach	Bankfull Width (m)		Riffles	Pools	Riparian Vegetation	Notes
SCT6 (Drainage Feature)	² 0.94	² 0.03	¹ Clay/silt, and sand		Continuous; mature trees and grasses	No defined bed and banks; standing water; approaches manicured lawn west of property line.
SCT1-3 (Piped Drainage Feature)	N/A	N/A	N/A		Continuous immature grasses	Feature is piped from small pond to access road driveway and eastern property line.
SCT1-4 (Pond Feature)	N/A	N/A	N/A		Continuous; immature grasses with a few shrubs and trees	Small pond feature with; riparian buffer contains manicured lawn and sparse trees.
SCT1-5 (Drainage Feature)	N/A	N/A	I/A N/A		Continuous immature grasses with a few trees	Poorly defined overland flow path from pipe flow on adjacent property south of pond.

N/A – Not applicable for reaches that were observed to be waterbodies or poorly defined drainage feature or ditch ¹ Uniform channel bed morphology

² Average wetted width and depth as flow path did not display defined bed or banks. Observations were limited due to site access restrictions

Reach SCT1 was a sinuous single channel that outlets a waterbody before flowing through a confined valley system. The reach begins at the outlet of a waterbody where it flows through a piped system that discharges from a man-made berm. The piped outfall is perched approximately 0.83 metres above the channel bed with a scour pool observed immediately downstream of the outfall. The channel continues to flow through a dense riparian buffer consisting of a continuous coverage of mature trees and shrubs that moderately encroaches the reach. Riffle-pool morphology was absent with runs dominating the geomorphic units. The bed substrates ranged from clay and silt to gravel, whilst the bank substrates were comprised of clay, silt, and sand. The average bankfull width and depth were 2.10 m and 0.26 m, respectively. Bank angles ranged between 60° to 90° and moderate erosion was observed along the channel banks (i.e., approximately 30-60% of the reach). It should be noted that approximately 40-50 metres of this reach was observed due to site access restrictions.

Reach SCT2 was a waterbody along the Sulphur Creek tributary. A wide dense forested buffer was observed around the waterbody. Generally, erosion was not observed around the waterbody however, other observations were limited as the depth of the waterbody was too deep to wade.

Reach SCT3 was a relatively straight channel through a partially confined valley system. The riparian vegetation consisted of trees and grasses minimally encroaching the channel. Localized phragmites were identified at the inlet to the waterbody and a portion of reach furthest downstream. Diverse geomorphic units were identified throughout the reach including riffles, runs, pools, a chute, and a small cascade. The substrate in riffles ranged from sand to cobbles, whilst the pool substrates were comprised of clay, silt, and sand. The average bankfull width and depth were 1.04 m and 0.15 m, respectively. Bank angles ranged between 0° to 30° and minimal undercutting or erosion was observed. Small knickpoints were also observed along the bed.

Reach SCT6 was characterized as a poorly defined feature with a low gradient. Approximately 20 metres of the feature was on the subject property within a pocket of trees. Additional length of the feature was visible from the property line as it crossed a manicured lawn. The feature was characteristic of a headwater drainage feature lacking defined bed and banks. Bankfull measurements were not collected, as there was no discernible, formed channel. Although, standing water was present in one location, and a wetted width and depth were measured at 0.94 m and 0.03 m, respectively.

Reach SCT1-3 was characterized as a piped drainage feature. The feature carries water from the pond at Reach SCT1-4 to the access road culvert, ultimately discharging flows to the eastern extent of the property. Water was not observed on the day at the culverts or downstream (east) of the property line and access road.

Reach SCT1-4 is a small pond in the southern portion of the subject property. The riparian buffer was observed to generally consist of shrubs that were present along the banks, however, immature grasses and some trees were also observed surrounding the waterbody. Generally, erosion was not observed around the waterbody however, other observations were limited as the depth of the waterbody was too deep to wade into.

Reach SCT1-5 was characterized as a poorly defined, artificial drainage feature with a low gradient. The feature is associated with overland flow from an existing pipe from the rear yard of the southern, adjacent property. There was no discernible channel feature, but it was assumed that overland flow ultimately drains to the small pond feature (**Reach SCT1-4**).

3.3 Rapid Geomorphological Assessment Tools

Rapid assessments were completed to identify dominant geomorphic processes, document stream health, and to identify any areas of concern regarding erosion or instability. Channel instability was objectively quantified through the application of the Ontario Ministry of the Environment's (2003) Rapid Geomorphic Assessment (RGA). Observations were quantified using an index that identifies channel sensitivity based on evidence of aggradation, degradation, channel widening, and planimetric adjustment. The index produces values that indicate whether a channel is stable/in regime (score <0.20), stressed/transitional (score 0.21-0.40), or adjusting (score >0.41).

The Rapid Stream Assessment Technique (RSAT) was also employed to provide a broader view of the system as it considers the ecological function of the watercourse (Galli, 1996). Observations were made of channel stability, channel scouring or sediment deposition, instream and riparian habitats, and water quality. The RSAT score ranks the channel as maintaining a poor (<13), fair (13-24), good (25-34), or excellent (35-42) degree of stream health.

Reaches were also classified according to a modified Downs (1995) Channel Evolution Model. The Downs (1995) model describes successional stages of a channel because of perturbation, namely hydromodification. Understanding the current stage of the system is beneficial as this allows one to predict how the channel will continue to evolve or respond to an alteration to the system. The results of these assessments are summarized below.

The RGA score of **Reach SCT1** was 0.188, indicating that the reach was in regime. The dominant geomorphic process shaping the channel was determined to be degradation, largely due to the elevated outlet and scouring that is occurring as a result. The RSAT score was 25, indicating that the reach was in good condition. The limiting feature was the physical instream habitat due to the lack of diverse habitat and generally shallow depth of the channel. Under the Downs (1995) model, the channel was determined to be laterally migrating due to the widening that was also occurring as result of leaning and fallen trees and increase in erosion along the channel. Although, overall, observations showed a generally straight channel.

The RGA score of **Reach SCT3** was 0.273, indicating that the reach was in transition. The dominant geomorphic process shaping the channel was determined to be degradation, largely due to the presence of knick points. The RSAT score was 26, indicating that the reach was in good condition. The limiting feature was the physical instream habitat due to the shallow depth of the channel and lack of deep pools. Under the Downs (1995) model, the channel was determined to be in a depositional condition due to the presence of a low flow channel between outer banks.

The rapid assessment tools were not applied on the remaining reaches as they consisted of waterbodies, piped features, or small poorly defined drainage features.

4 Erosion Hazard Assessment

4.1 Methodology

Most watercourses in southern Ontario have a natural tendency to develop and maintain a meandering planform, provided there are no spatial constraints. A meander belt width or erosion hazard assessment estimates the lateral extent that a meandering channel has historically occupied and will likely occupy in the future. This assessment is therefore useful for determining the potential hazard to proposed activities in the vicinity of a watercourse.

When defining the erosion hazard for a watercourse, Ministry of Natural Resources (MNR, 2002) guidelines treat unconfined and confined systems differently. Confined systems are those where the watercourse is contained within a defined valley, where valley wall contact is possible. In contrast, unconfined systems are those with poorly defined valleys or slopes well outside where the channel could realistically migrate. Unconfined systems are generally found within glaciated plains with flat or gently rolling topography. Partially confined systems are those where meander bends or the channel are adjacent to only one valley wall and the watercourse is therefore restricted in migration and floodplain occupation on one side of the valley system.

In unconfined systems, a meander belt width can be applied, at minimum, based on 20 times the bankfull channel width. Alternatively, the meander belt width can be determined through a detailed geomorphological study that examines the largest channel meanders observed through historical and recent aerial photograph interpretation. The meander belt width can then be graphically defined using orthorectified aerial imagery by determining the channel centerline and the channel's central tendency (i.e., meander belt axis). In cases where the channel is not discernible in aerial photographs or the channel has been substantially modified, empirical models can be used to estimate the meander belt width.

The Ontario Ministry of Natural Resources (MNR) outlines an approach for establishing the erosion hazard where watercourses are confined by valley walls. This approach defines an appropriate erosion setback or toe erosion allowance from a channel bank where the creek is within 15 m of the toe of the valley slope. A toe erosion allowance can be determined in several ways: use of an average annual recession rate; application of a 15 m toe erosion allowance in areas where the channel is within 15 m of the toe of slope; or use of soil information and field observations of geomorphic processes (MNR, 2002). In partially confined systems, a hybrid approach can be used to delineate the erosion hazard whereby an appropriate meander belt width is applied to unconfined portions of a given reach and where the channel is within 15 m of the valley toe, a toe erosion allowance and stable slope allowance are applied.

Through field reconnaissance, it was determined that **Reach SCT1** was confined. Therefore, the erosion hazard limit was defined based on a toe erosion allowance. **Reach SCT3** was partially confined, and therefore both a meander belt width and an appropriate toe erosion allowance were delineated to establish the erosion hazard limit.

As noted previously in this Report, the remaining reaches are characterized as low-order drainage features with limited feature definition or pond features. Meander belt widths have not been delineated for these features as they have limited erosion/migration potential due to their ephemeral/intermittent flow regimes and relatively small drainage areas.

4.2 Reach SCT1 (Confined)

Reach SCT1 was identified as confined within the study area. It is a relatively small tributary situated downstream of the large online pond feature. The reach is densely vegetated and poorly visible through aerial photograph interpretation. Given the poor aerial coverage and limited channel definition observed in the historical and recent aerials, meander migration analysis was not possible to determine an average annual recession rate. As such, we have developed a recommendation below for an appropriate toe erosion allowance based on a combination of reach-level observations of existing geomorphic conditions and guidance outlined by MNR in their technical guide for defining riverine erosion hazards (MNR, 2002).

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The erosion hazard in this location consists of the toe erosion allowance (where the channel is within 15 m of the toe of valley slope), stable slope allowance (completed by others) and an erosion access allowance. Channel bank materials consisted of clay and silt. Given the relatively small size of the feature, a 5 m toe erosion allowance is recommended and is to be applied from the valley toe of slope where the channel is within 15 m of the valley toe. This is consistent with Table 3 of MNR (2002) guidelines for stiff/hard cohesive soil (clays, clay silt) and coarse granular (gravels) till.

It should be noted that only a short section of **Reach SCT1** (30-40 m length) was observed within the subject property due to access limitations. As such, the toe erosion allowance may be subject to refinement depending on downstream channel conditions. Although, the channel appears to be a significant distance from the existing valley slope situated on the south side of the large online pond. The hillshade imagery in Figure 2 of **Appendix A** shows that the section of **SCT1** within the subject property is in the range of 50-60 m from the southern valley slope.

Reach SCT2 consisted of an online pond feature with an adjacent valley wall to the south. Although the pond does not represent a typical erosion hazard due to a lack of channel processes, a 5 m toe erosion allowance is also recommended for this Reach and should be applied from the slope toe.

The erosion hazard extent in confined systems is to also include a stable slope allowance. The stable slope allowance should be determined through a valid geotechnical study and should be reviewed in tandem with the above toe erosion allowance recommendations.

4.3 Reach SCT3 (Partially Confined)

Reach SCT3 was assessed as partially confined. A review of recent and historical aerial imagery was completed but did not indicate the presence of significant meanders along **Reach SCT3** due to mature tree coverage. Given the lack of defined meanders, an empirical modelling approach was used to determine a range of potential meander belt widths and support the definition of the erosion hazard for the unconfined reach through the subject property.

The empirical relations from Williams (1986) were modified to include channel area and width, and applied using the bankfull channel dimensions such that:

$$B_w = 18A^{0.65} + W_b$$
[Eq. 1]

$$B_w = 4.3W_b^{1.12} + W_b$$

where Bw is meander belt width (m), A is bankfull cross-sectional area (m²), and W_b is bankfull channel width (m). An additional 20% buffer, or factor of safety, was applied to the computed belt width values. This addresses issues of under prediction.

The Ward et al. (2002) bankfull width model was also used to determine a meander belt width (ft), *Bw*:

$$B_w = 6W_b^{1.12}$$

The resulting value was then converted to the metric system (m). A 20% factor of safety was not applied to this value due to the approach used in the modelling (i.e., hazard envelope rather than a linear relationship).

The empirical modeling exercise resulted in meander belt widths ranging from 7 m to 8 m for **SCT3**. To be conservative, we recommend a nominal meander belt width of 10 m for **Reach SCT3**. This is an appropriate approach as it is based on site-specific conditions and is considered a conservative value as this reach functions as a straight channel with limited evidence of planform adjustment or active erosion. The final meander belt width is graphically displayed in **Appendix E**.

In partially confined systems where one side of the channel is within 15 m of the slope toe, a toe erosion allowance should also be applied, in combination with a stable slope allowance (completed by others) and an erosion access allowance. Reach SCT3 is partially confined along the eastern side of the channel. The valley slope is visible in the hillshade imagery provided in Figure 2 (**Appendix A**). Channel bank materials consisted of clay and silt. Given the relatively small size of the feature, a 5 m

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[Eq. 3]

[Eq. 2]

toe erosion allowance is recommended and is to be applied from the valley toe of slope where the channel is within 15 m of the valley toe. This is consistent with Table 3 of MNR (2002) guidelines for stiff/hard cohesive soil (clays, clay silt) and coarse granular (gravels) till.

5 Summary

GEO Morphix was retained to complete a fluvial geomorphological assessment and erosion hazard delineation for tributaries of Sulphur Creek in support of a proposed development at 159 & 163 Sulphur Springs Road in Ancaster, Ontario.

GEO Morphix completed a desktop assessment and field investigation to understand existing fluvial geomorphological conditions for the subject property. This included a desktop review of historical and recent aerial photographs, existing geology and topographic mapping, and reach delineation. A tributary of Sulphur Creek is situated along the northern portion of the subject property and includes a large online pond, likely constructed in the late 1950s. Due to heavy tree cover, the tributary upstream and downstream of this pond are not visible in aerial imagery. Several small drainage features are also present in the southern portion of the subject property, but these features displayed limited form or definition or were piped.

Erosion hazard delineation was completed for the main tributary through the northern portion of the subject property. **Reach SCT1** was considered confined within an existing valley system, and a 5 m toe erosion allowance is recommended where the channel is within 15 m of the toe of valley slope. Although, **Reach SCT2** was a large online pond and does not represent a typical erosion hazard due to a lack of channel processes, a 5 m toe erosion allowance is also recommended and should be applied from the toe of slope. Reach SCT3 was classified as partially confined. A meander belt width of 10 m is recommended based on an empirical modelling exercise. On the eastern side of the channel, where there is a defined valley slope, a toe erosion allowance of 5 m is recommended for any locations where the channel is within 15 m of the toe of slope. It should be noted that a stable slope allowance is also required in addition to a toe erosion allowance is applied. The stable slope allowance should be delineated through a valid geotechnical study.

We trust this report meets your current requirements. Should you have any questions, please contact the undersigned.

Respectfully submitted,

Paul Villard, Ph.D., P.Geo., CAN-CISEC, EP, CERP Director, Principal Geomorphologist

Kat Woodrow, M.Sc. Manager of Watershed Studies

6 References

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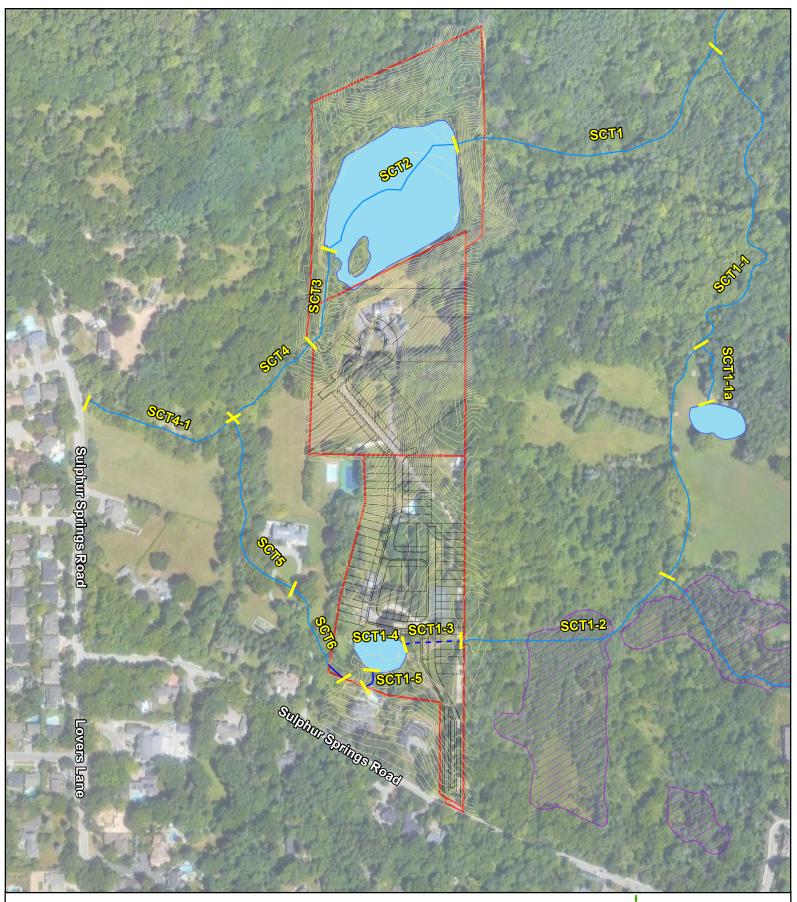
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Appendix A: Study Area and Reach Delineation



Legend

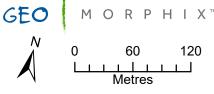
Reach Break and ID
 Watercourse
 Drainage Feature
 Piped Feature

0.5 m Contour

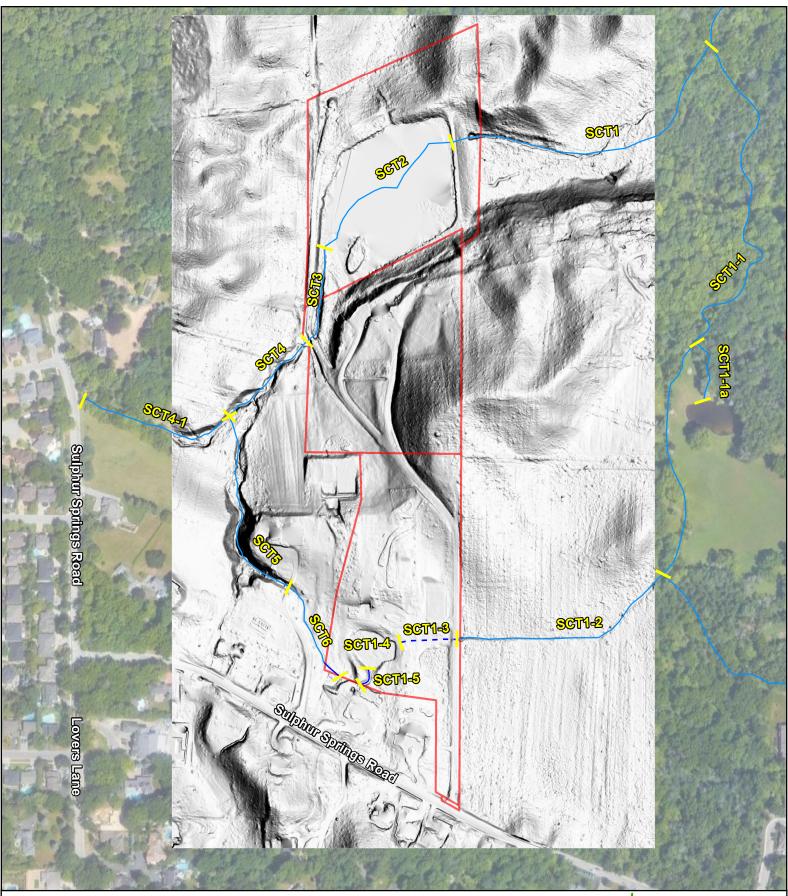
Development Fabric
 Subject Lands
 MNR Mapped Wetland
 OHN Waterbody

Figure 1 Study Area and Reach Delineation

Sulphur Creek Ancaster, Ontario



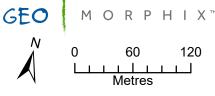
Imagery: Google Earth, 2023. Watercourse: Hamilton, 2024. Waterbody, Watercourse (OHN), Wetland: MNRF, 2024. Subject Lands, Development Fabric: Crozier, 2024. Print Date: October 2024. PN24108. Drawn By: R.A., M.O., K.W.



Legend

Reach Break and ID
 Watercourse
 Drainage Feature
 Piped Feature
 Subject Lands

Figure 2 **Terrain Analysis** Sulphur Creek Ancaster, Ontario

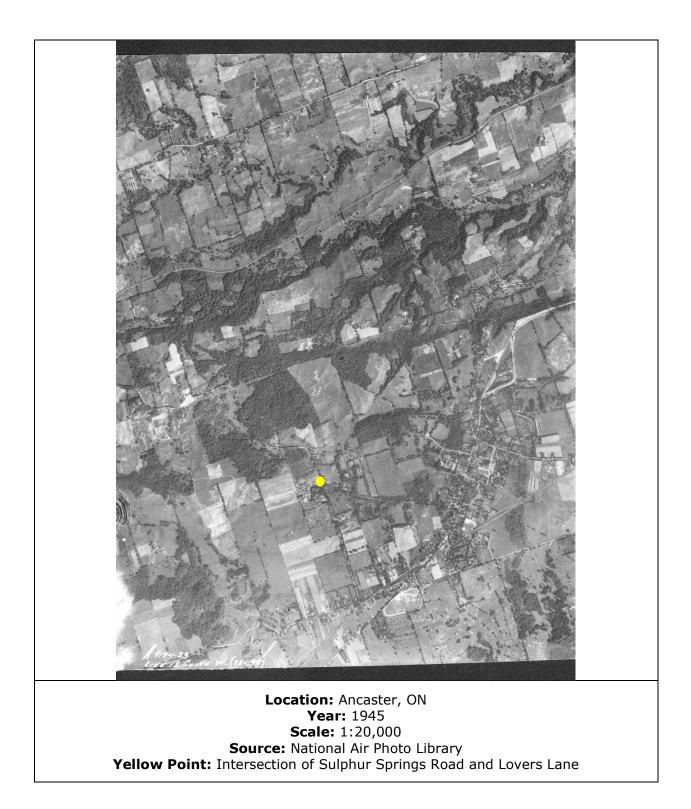


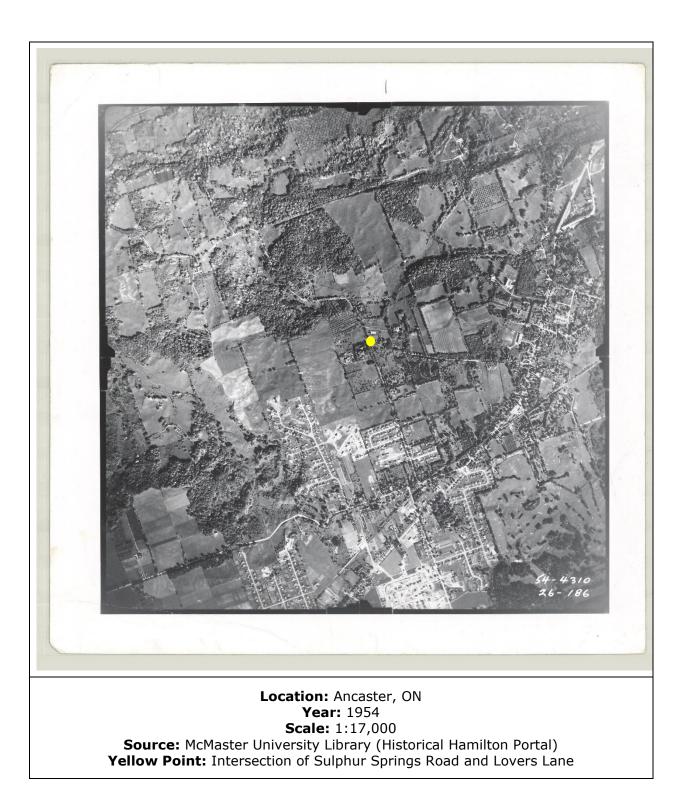
Hillshade: MNRF, 2021. Watercourse: Hamilton, 2024. Watercourse (OHN): MNRF, 2024. Subject Lands: Crozier, 2024. Print Date: November 2024. PN24108. Drawn By: R.A., M.O., K.W.

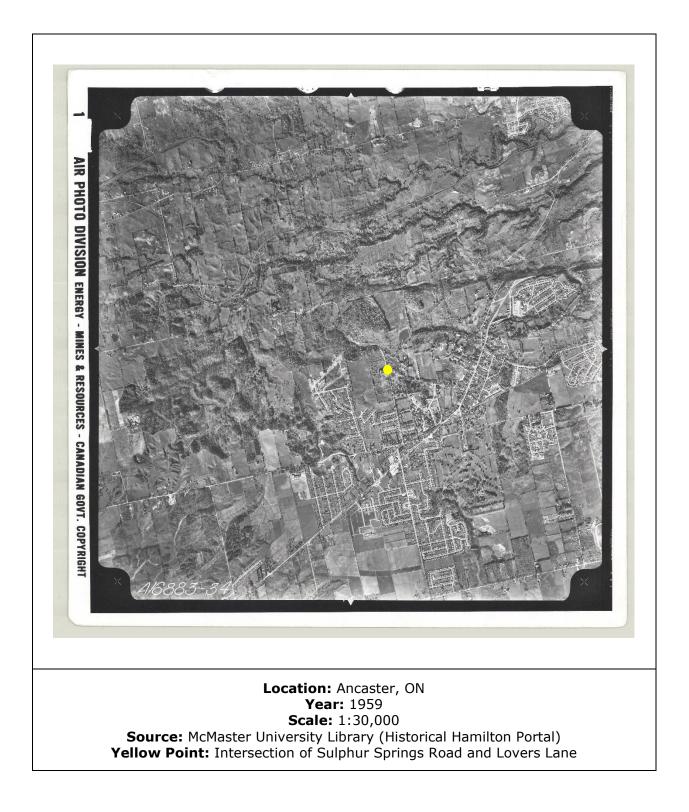
Appendix B: Historical Aerial Photographs



Location: Ancaster, ON Year: 1934 Scale: 1:20,000 Source: National Air Photo Library Yellow Point: Intersection of Sulphur Springs Road and Lovers Lane

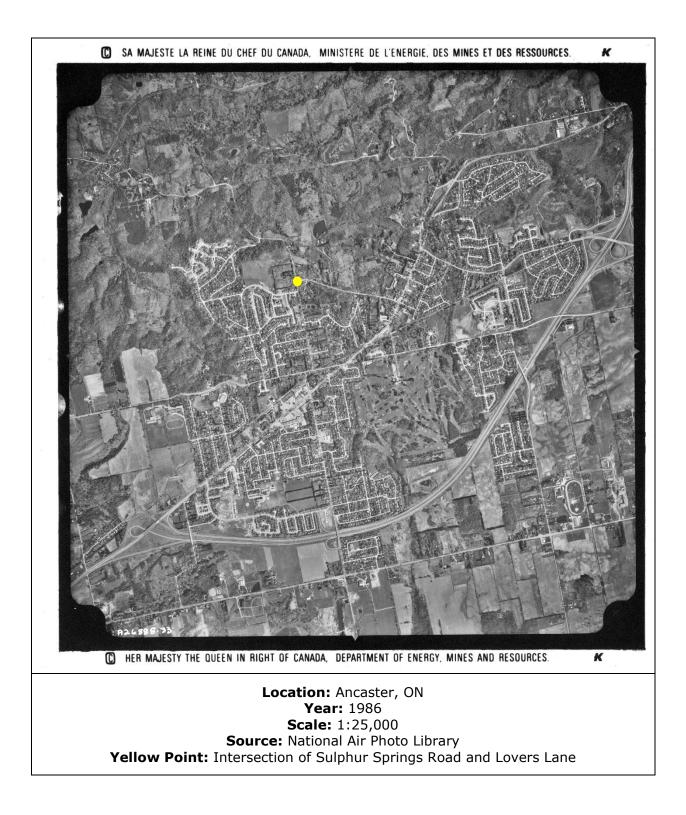


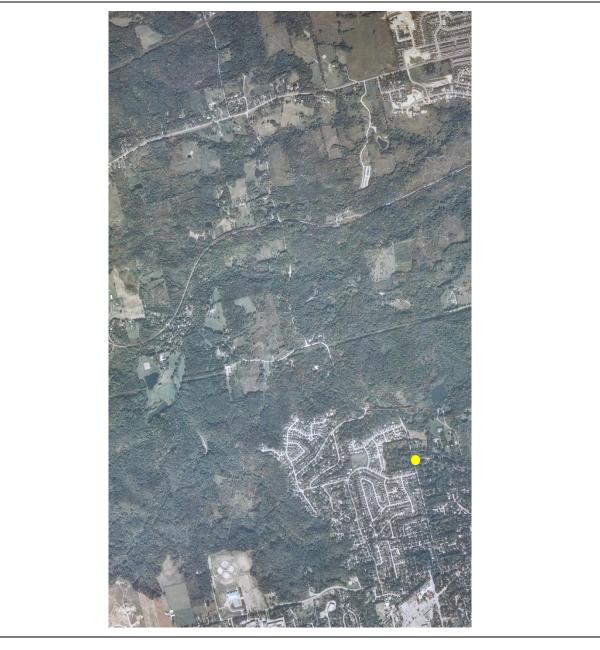




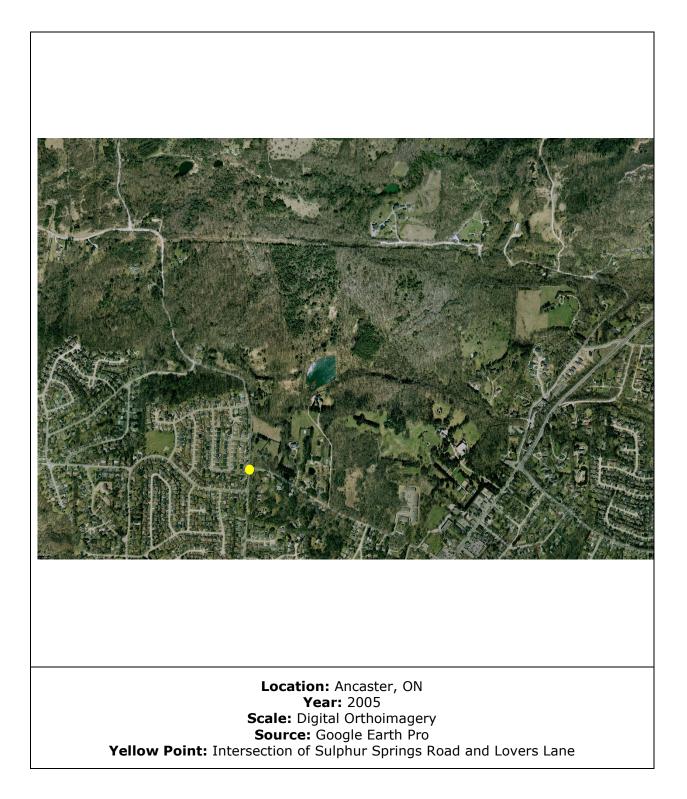


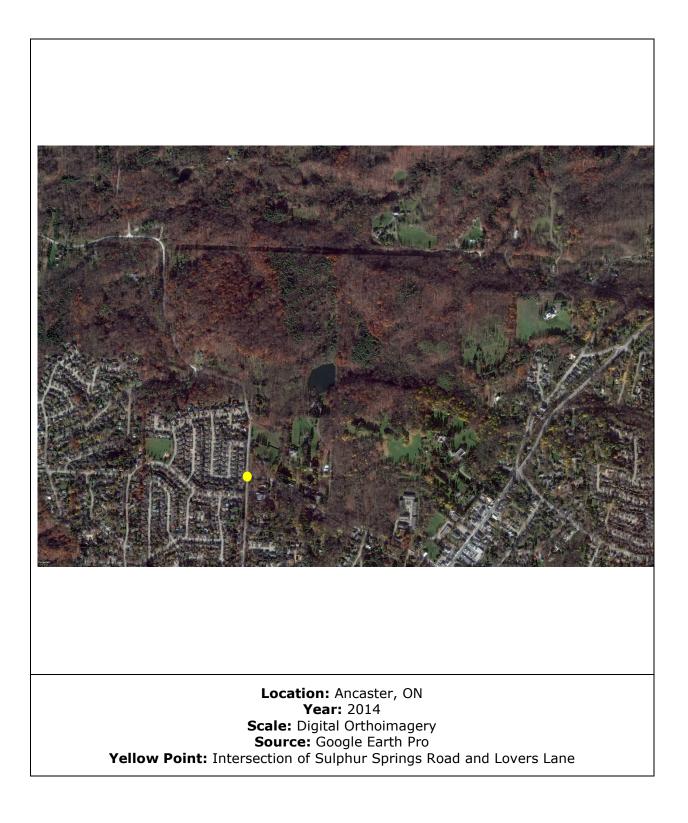
Yellow Point: Intersection of Sulphur Springs Road and Lovers Lane

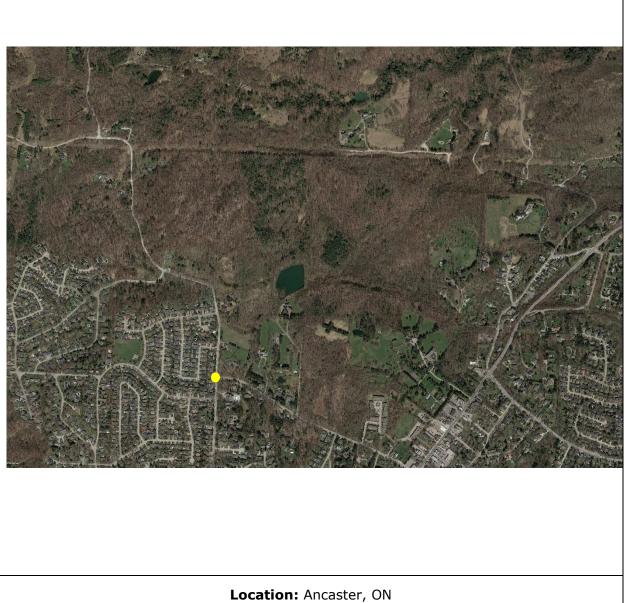




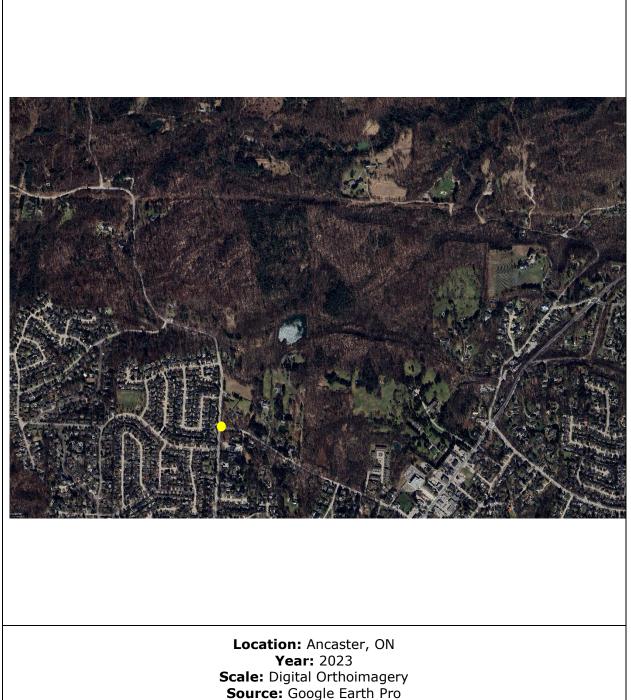
Location: Ancaster, ON Year: 1995 Scale: 1:30,000 Source: Ministry of Natural Resources and Forestry Yellow Point: Intersection of Sulphur Springs Road and Lovers Lane





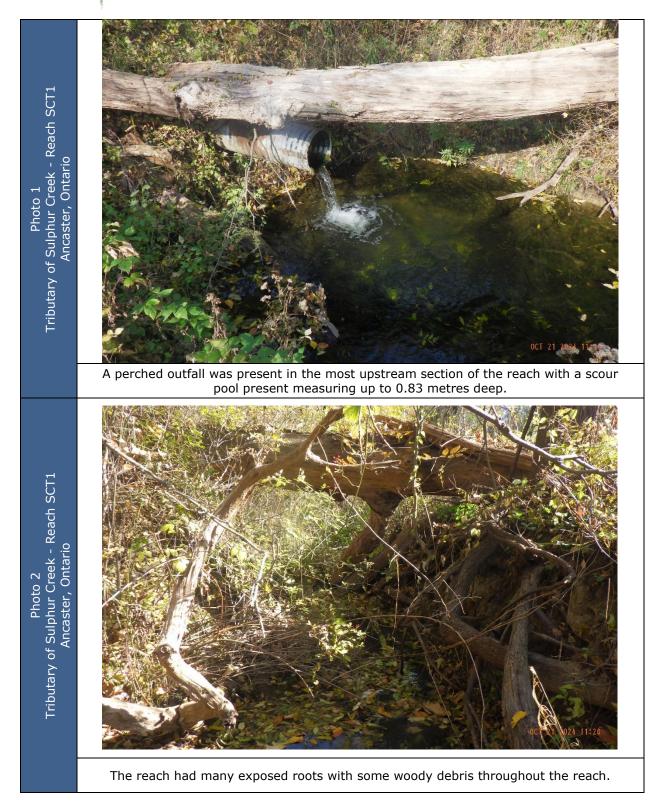


Year: 2017 Scale: Digital Orthoimagery Source: Google Earth Pro Yellow Point: Intersection of Sulphur Springs Road and Lovers Lane

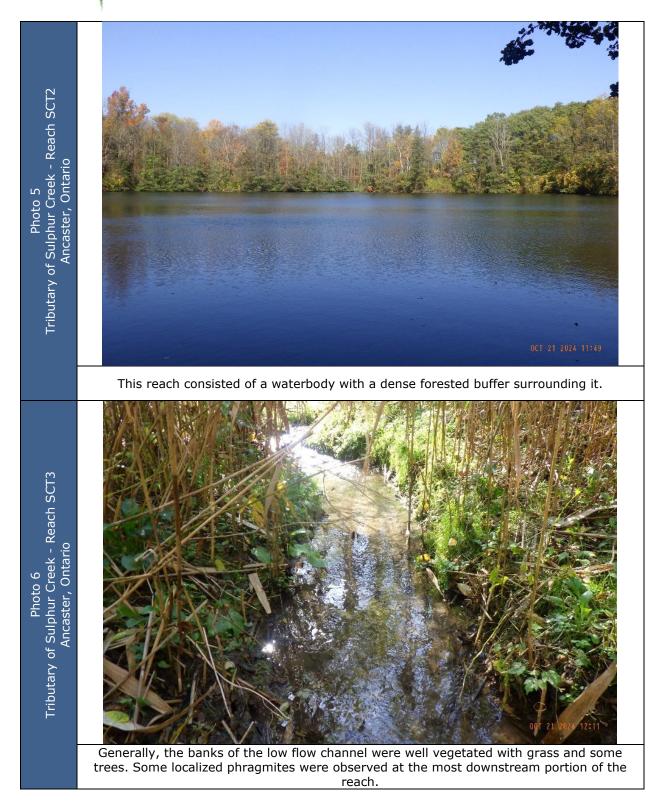


Yellow Point: Intersection of Sulphur Springs Road and Lovers Lane

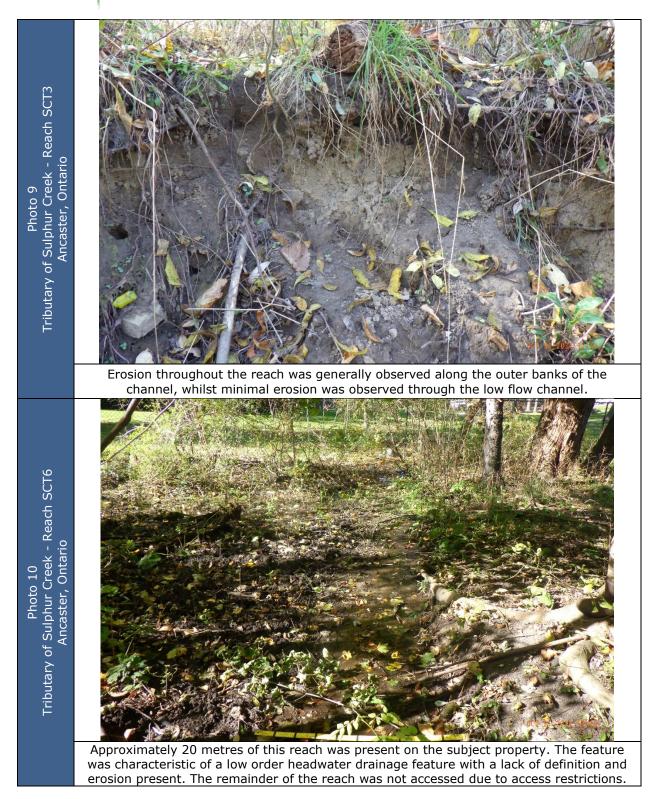
Appendix C: Photographic Record

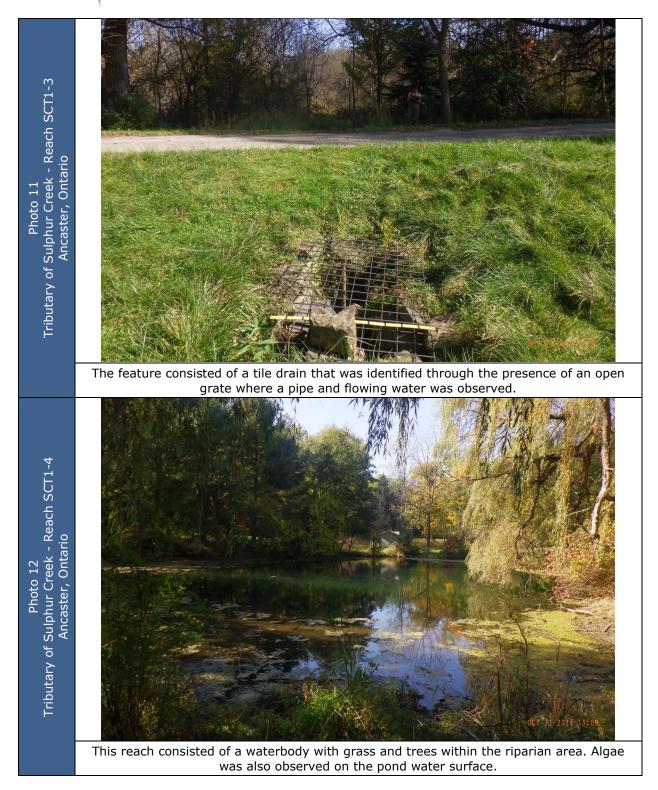


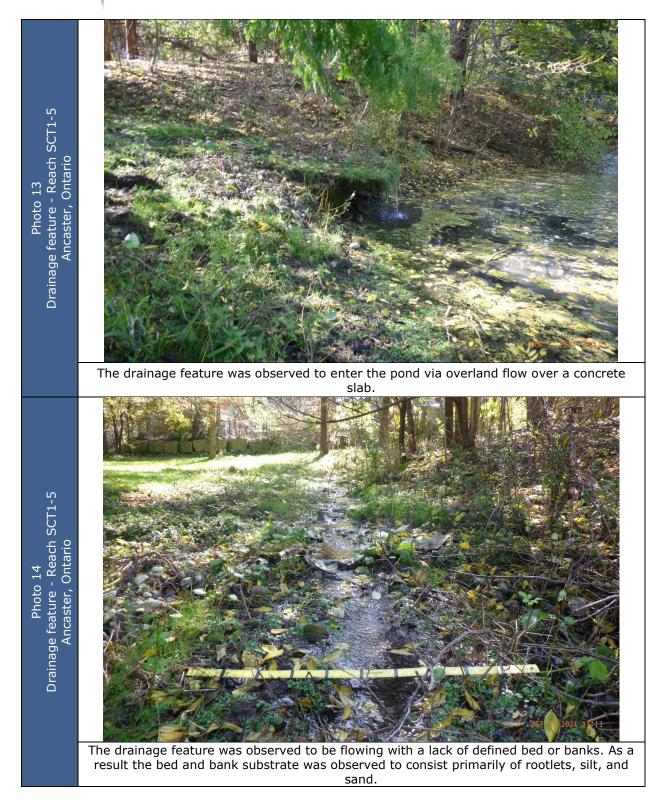














Appendix D: Field Observations

General Site Characteristics

Project Number: 24/09

GEO

						Suphur Creak
Time:		1	1:00 AM		Reach:	SCT1, SCT2
Weat	her:	54	nny, 20° -		Location:	159/163 Suphy Springs P
Field	Staff:		RA CM		Watershed/Subwatershed:	Sulphr (pell Schip
Featu	res	Monito	oring	Site	Sketch	y war and the
	Reach break		Long-profile			Compass
모	Station location	II	Monumented XS	1TT	TA	$\langle \cdot \rangle$
(X	Cross-section	0	Monumented photo	Sc	e.7. 911	(\mathcal{A})
~	Flow direction		Monumented photo	1/1	4.9.2 For details	
	Riffle		direction		prived it	E.J
	Pool Sodimont have		Sediment sampling		inlet	Ee3
	Sediment bar Eroded bank/slope		Erosion pins	7	W X X	w
	Undercut bank		Scour chains	SC3	V	
XXXXX	Bank stabilization	Additio	nal Symbols			
*	Leaning tree				n - /	$\langle \langle \varepsilon \rangle$
····×····×	Fence			E L		
1	Culvert/outfall					
	Swamp/wetland					
WW	Grasses			2		
	Tree					
	Instream log/tree				SC2	
**	Woody debris			53		
RYNG T	Beaver dam			2		
	Vegetated island			=		ES I
ow T						$ \omega $
11	Standing water H1/	Back w	vater	A		
12	Scarcely perceptible			2		
	Smooth surface flow					
	Upwelling			-		
	Rippled			53		
	Unbroken standing w			4		
	Broken standing wave	9			Trail/B	erm
	Chute			6		Perched = 0.83m
19 bstra		Dissipa	ates below free fall	C	SCI	Someter = 0.53m
	Silt	56	Small bouldar			Oftowher pipe
	Sand	50 S7	Small boulder Large boulder		6	Aboth=0.80m
	Gravel	58	Bimodal	-	(G) G)	I SIGHT SCAL DOUL WICH
	Small cobble	59	Bedrock/till	1	h KSI	City = H.163m
	arge cobble		Sal outy th	1/2 a	Wd=0.10m 0.26	MAX AX botabata
ner		1.10		0	Ow= 1.79m	= SI-S3
I	Benchmark	EP	Erosion pin	1	0d=0.24m	Lonk substrate
E	Backsight	RB	Rebar	de la	Thorn ku	rubs 5 3/1 = 51-52
Ę	Downstream	US	Upstream	Vall	X<7	
) C	Voody debris jam	TR	Terrace	2	WW=1.43m bal=0.27	
	alley wall contact	FC	Flood chute		Wd=0.12M V=0.110	
S E	Bottom of slope	FP	Flood plain	Photos		/ /
5 T	op of slope	КР	Knick point	Notes:	Pallal	14
10	death & c	20			Merched height Tho	in bottom of pype
00	a stand of y	ar	pool (scar 1	2001 00	epost at centre).	,
1-0	observed 1	5 4	e degradm	9. 00	nKS 1.5m high.	
			6			.)
	#4		Sonior staff size	£5 ('c .	VI.	11/1
rsion	ted: 21/02/2023		Senior staff sign-c	off (if requi	red): Checked by:	N Completed by:

GEO

Rapid Geon	norphic	Assessment	Project Number:	PNZI	+108			MORPHI
Date:	201	24-10-21	Stream:		Subhur	- Cre	eK	·····
Time:	11.	MAQO	Reach:		SCT1			
Weather:	0	100 14. 72.00	Location:		50/110 5	100	- 000	
Field Staff:	0				124/103 2	wpruc	Spin	gs ra
Tield Staff.	K	T IIM	Watershed/Subwate	ershed:	suppor (reel	Schlark	test-ca
Process			eomorphological Indicator	· · · · · · · · · · · · · · · · · · ·		Pres	sent?	Factor
		escription		w		Yes	No	Value
		obate bar					V	
		oarse materials in riffle	es embedded				1	,
Evidence of		iltation in pools				6	/	DA
Aggradation (AI)		edial bars		· · · · · · · · · · · · · · · · · · ·			V	
()		ccretion on point bars						
		oor longitudinal sorting	and the second	·				-
	7 D	eposition in the overba	ink zone				- V	
	1			Sur	n of indices =		7	10.0
		xposed bridge footing(s				N	IA.	
			n sewer / pipeline / etc.			~		
		evated storm sewer ou				\checkmark]
Evidence of			kets / concrete aprons / etc.			n	1A	
Degradation			of culverts / storm sewer ou	utlets		\checkmark		3/
(DI)		ut face on bar forms					1	78
		ead cutting due to knic					1	
		errace cut through olde					V	
		uspended armour layer					V.	
	10 Cł	nannel worn into undist	turbed overburden / bedrock					
	1			Sun	n of indices =	_3	5	0.375
		illen / leaning trees / fe	· · · · · · · · · · · · · · · · · · ·			\checkmark		_
_		ccurrence of large orga	nic debris				\checkmark	
		posed tree roots				\checkmark		-
Evidence of		asal scour on inside me					/	21
Widening			s of channel through riffle					2/8
(WI)			ts / concrete walls / etc.	-111	107	NI	4	, .
		Length of basal scour >50% through subject reach (full reach assessed) Exposed length of previously buried pipe / cable / etc.						
		Fracture lines along top of bank						
							V.	
	1 10 124	posed building foundat	lion		e f in diana	NX	1-1	207
	1 Fo	wooties of shuts(s)		Sun	n of indices =	3		0.37
		rmation of chute(s)					V	
Evidence of		ngle thread channel to					V	
Planimetric Form		and a second	rm to low bed relief form					01
Adjustment		it-off channel(s) rmation of island(s)						1-1
(PI)			phase with meander form					
		r forms poorly formed					V	
	1 1 100	r tornis poorty tornieu ,	/ Temorked / Temoved	Curre	of indiana	0	- Y	\wedge
lotes: X n (51 05	Vi alilad ili			of indices =	-01	1	0.0
0	HO ED	inpleted ale			(SI) = (AI+		······	0.188
approx.	TU-SL	in ungth of		n Regime	In Transiti		s In A	djustment
on prop	erry;	no neld an	CESS 17	0.00 - 0.20	0.21	- 0.40		0.41
Birth	ALC INC	VIA Strope in	1					



Rapid Stream Assessmen	t Technique	Project Number:	24108	
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MORPHIX"

Date:	12024-10-21	Stream:		Support	reek	
Time:	MADD IL	Reach:	41.64	SCT1	<u>U WIN</u>	
Weather:	SUMM, 20°C	Location:	DIRVEL DIV	159/163 Sulphur Springs rd.		
Field Staff:	PACM	Watershed/Subwate	rshed:	Sulphur Creek Subwatershed		
Category	Poor	Fair		Good	Excellent	
	 < 50% of bank network stable Recent bank sloughing, slumping or failure frequently observed 	 50-70% of bank network stable Recent signs of bank sloughing, slumping or failure fairly common 	stable • Infreque	o of bank network ent signs of bank ng, slumping or	 > 80% of bank network stable No evidence of bank sloughing, slumping or failure 	
Channel	 Stream bend areas highly unstable Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) Bank overhang > 0.8-1.0 m 	 Stream bend areas unstable Outer bank height 0.9- 1.2 m above stream bank (1.5-2.1 m above stream bank for arge mainstem areas) Bank overhang 0.8-0.9m 	Outer bandle of the second secon	bend areas)stable ank height 0.6-0.9 e stream bank (1.2- bove stream bank e mainstem areas) erhang 0.6-0.8 m	 Stream bend areas very stable Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) Bank overhang < 0.6 m 	
Stability	 Young exposed tree roots abundant > 6 recent large tree falls per stream mile 	 common 4-5 recent large tree falls per stream mile Bottom 1/3 of bank is generally highly erodible material Plant/soil matrix compromised 		I tree roots nantly old and naller young roots ant large tree falls am mile	 Exposed tree roots old, large and woody Generally 0-1 recent large tree falls per stream mile 	
	 Bottom 1/3 of bank is highly erodible material Plant/soil matrix severely compromised 			1/3 of bank is y highly resistant il matrix or material	 Bottom 1/3 of bank is generally highly resistant plant/soil matrix or materi 	
1.1.1.1.1	 Channel cross-section is generally trapezoidally- shaped 	 Channel cross-section is generally trapezoidally- shaped 		cross-section is y V- or U-shaped	 Channel cross-section is generally V- or U-shaped 	
Point range			□ 6	0708	□ 9 □ 10 □ 11	
1.0	 > 75% embedded (> 85% embedded for large mainstem areas) 	 50-75% embedded (60- 85% embedded for large mainstem areas) 	59% em	embedded (35- bedded for large n areas)	 Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas) 	
Only deep Scour pool	 Few, if any, deep pools Pool substrate composition >81% sand- silt 	 Low to moderate number of deep pools Pool substrate composition 60-80% sand-silt 	 Moderate number of deep pools Pool substrate composition 30-59% sand-silt 		 High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) Pool substrate composition <30% sand-silt 	
Channel Scouring/ Sediment Deposition	 Streambed streak marks and/or "banana"-shaped sediment deposits common 	 Streambed streak marks and/or "banana"-shaped sediment deposits common 	 Streambed streak marks and/or "banana"-shaped sediment deposits uncommon 		Streambed streak marks and/or "banana"-shaped sediment deposits absent	
	 Fresh, large sand deposits very common in channel Moderate to heavy sand deposition along major portion of overbank area 	 Fresh, large sand deposits common in channel Small localized areas of fresh sand deposits along top of low banks 	uncomm • Small loc	rge sand deposits on in channel calized areas of id deposits along w banks	 Fresh, large sand deposits rare or absent from channel No evidence of fresh sediment deposition on overbank 	
	 Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand 	 Point bars common, moderate to large and unstable with high amount of fresh sand 	well-vege	s small and stable, etated and/or d with little or no d	Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand	
Point range			0	5 🗆 6	X 7 D 8	

	24-10-21	PN: PN24108	Location: 15	9/163 Sulphur Springs	
Category	Poor	Fair	Good	Excellent	
	 Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas) 	 Wetted perimeter 40- 60% of bottom channel width (45-65% for large mainstem areas) 	Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	 Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas) 	
	 Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low) 	 Few pools present, riffles and runs dominant. Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate) 	 Good mix between riffles, runs and pools Relatively diverse velocity and depth of flow 	 Riffles, runs and pool habitat present Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water) 	
Physical Instream	Effice substrate composition: predominantly gravel with high amount of sand < 5% cobble	 Riffle substrate composition: predominantly small cobble, gravel and sand 5-24% cobble 	 Riffle substrate composition: good mix of gravel, cobble, and rubble material 25-49% cobble 	 Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand > 50% cobble 	
Habitat	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	Riffle depth 15-20 cm for large mainstem areas	 Riffle depth > 20 cm for large mainstem areas 	
	 Large moments Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure 	 Large pools generally 30- 46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure 	cm deep (91-122 cm for large mainstem areas) with some overhead	Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure	
	• Extensive channel alteration and/or point bar formation/enlargement	 Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement 	 Slight amount of channel alteration and/or slight increase in point bar formation/enlargement 	No channel alteration or significant point bar formation/enlargement	
	Riffle/Pool ratio 0.49:1 ; ≥1.51:1	 Riffle/Pool ratio 0.5- 0.69:1 ; 1.31-1.5:1 	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	Riffle/Pool ratio 0.9-1.1:1	
NA	 Summer afternoon water temperature > 27°C 	 Summer afternoon water temperature 24-27°C 	Summer afternoon water temperature 20-24°C	Summer afternoon water temperature < 20°C	
Point range		□ 3 □ 4		0708	
	• Substrate fouling level: High (> 50%)	 Substrate fouling level: Moderate (21-50%) 	 Substrate fouling level: Very light (11-20%) 	Substrate fouling level: Rock underside (0-10%)	
Watan Quality	 Brown colour TDS: > 150 mg/L 	Grey colour TDS: 101-150 mg/L	Slightly grey colour TDS: 50-100 mg/L	Clear flow TDS: < 50 mg/L	
Water Quality	Objects visible to depth < 0.15m below surface	Objects visible to depth 0.15-0.5m below surface	 Objects visible to depth 0.5-1.0m below surface 	 Objects visible to depth > 1.0m below surface 	
	 Moderate to strong organic odour 	 Slight to moderate organic odour 	Slight organic odour	• No odour	
Point range	0 0 1 0 2	□ 3 □ 4	₫ 5 🗆 6	□ 7 □ 8	
Riparian	 Narrow riparian area of mostly non-woody vegetation 	 Riparian area predominantly wooded but with major localized gaps 	Forested buffer generally > 31 m wide along major portion of both banks	Wide (> 60 m) mature forested buffer along both banks	
Habitat Conditions	 Canopy coverage: <50% shading (30% for large mainstem areas) 	Canopy coverage: 50- 60% shading (30-44% for large mainstem areas)	 Canopy coverage: 60-79% shading (45-59% for large mainstem areas) 	Canopy coverage: >80% shading (> 60% for large mainstem areas)	
Point range	□ 0 □ 1	□ 2 □ 3	0405	6 0 7	
	score (0-42) = 25	Poor (<13)	Fair (13-24) Good (25-	-34) Excellent (>35)	

Date:	2024-10-21	PNZ4108 Field Staff;				MORPH
lime:	1		KACM		Watershed/Subwatershed:	Suphur Greek
Neather:	Sunny 20°	Stream:		?reek	UTM (Upstream):	
and Use		Reach:	SCT1		UTM (Downstream):	
Table 1)	Table 2) (Table 3)		able 4)	Flow Type (Table 5)	Evidence of Groundwat	er Location: $\frac{h/a}{a}$ Photo:
Riparian Vegetation			Aquatic & In	stream Vegetatio	on	er Quality
(Table 6)		ige (yrs) Immature (<5)	Type (Table 8)	Woody Debris	WD Density	Odour Turbidity (Table 16) (Table 17)
Encroachment (Table 7)	Continuous X > 10	Established (5-30) Mature (>30)	Reach Coverage %	X In Channel	□ Mod	
Channel Characteris	tics					
Sinuosity Type (Table 9)	Sinuosity Degree (Table 10)	Bank Angle □ 0 - 30	Bank Erosion □ < 5%	(Table 19) Bank		bble Boulder Parent Rootlets
Gradient (Table 11)	# of Channels (Table 12)	□ 30 - 60 × 60 - 90	□ 5 - 30% 30 - 60%	Riffle		
(Table 13)	Bank Failure (Table 14)	Undercut	□ 60 - 100%	(if no riffle-pool morphology)		
(Table 15)	Bankfull Indicators (Table 18) 3/5		Bankfull Width (m)	.79 2.40	Wetted Width (m)	
(Table 20)	Sediment Transport Urs Cobserved?	No 🗆 Not Visible	Bankfull Depth (m)	0.24 0.27	Wetted Depth (m)	610 617
Transport ode (Table 21)	% of Bed Active		Undercuts (m)		Velocity (m/s)	0.26 0.11
Geomorphic hits (Table 22)	Mass Movement (Table 23)	1/ lens 100	Pool Depth (m)	.82 -	Velocity Estimate Method	
Riffle-Pool Spacing (m):		% Pools:	Riffle Length (m)		Meander Amplitude (m)	
	del could also	be reasses	er downst	rein aler		s not available)
> Only portr	in of the reach	walked up	to proper	rty Tre.	No access past	property bunday.
tos:						
ion #4					quired): Checked by:	

Weather: Owne 20 ** Reach: SCT2 UTM (Downstream): and Use / Valley Type Channel Type Channel Zone Plow Type Evidence of Groundwater Location: Photo: tiparian Vegetation (Table 2) Channel Type Aquatic & Instream Vegetation Water Quality bominant Type (Table 6) Coverage Channel Xde (vrs) Aquatic & Instream Vegetation Water Quality bominant Type (Table 6) None I - 4 Immature (<s)< td=""> Aquatic & Instream Vegetation Water Quality bominant Type (Table 6) None I - 4 Immature (<s)< td=""> Aquatic & Instream Vegetation Water Quality channel Characteristics Sinuosity Degree (Table 10) Fragmented Xd - 10 Established (5-30) Not Present High III Channel Med Sinuosity Type (Table 10) Sinuosity Degree (Table 10) Sank Angle Bank Argle Bank Erosion (Table 19) Clary/Silt Sand Gravet Cobble Boulder Parent Roc Gradient (Table 11) # of Channels IIII Sol - 5 - 30% Riffle IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII</s)<></s)<>	Time: T'OO AM Stream: Support Creek Utterstear/subviterstead: Support Creek Utterstead: Support Creek Utterstead: Support Creek Utterstead: Support Creek Utterstead: Support Creek Support </th	
Weather: Councy 20 ** Reach: SCT2 UTM (Downstream): and Use	Weather: Owny, 20 ** Reach: SCT2 UTM (Dostream): and Use Valley Type Channel Type Channel Type UTM (Dostream): Table 1) (Table 2) Channel Type Channel Zone Flow Type Evidence of Groundwater Location: Photo: Reach: Coverage Channel Widths Age (yrs) Aquatic & Instream Vegetation Water Quality Dominant Type None 1 - 4 Immature (<5) In Cutbank Low WDJ/S0m: Encroachment Pragmented X 4 - 10 Established (5-30) Reach In Channel Mod Mod Channel Characteristics Sinuosity Degree Mature (>30) Mature (>30) X of Coverage % Sand Gravel Cobble Boulder Parent Root Gradiet 11 # of Channels 1 Bank Angle Son - 60 % Pool In Caty/Silt Sand Gravel Cobble Boulder Parent Root Gradiet 11 # of Channels 1 Bank Angle Son - 60 % Pool In Clay/Silt Sand Gravel Cobble Boulder Parent Root	
Land Use Valley Type Channel Type Channel Zone Flow Type Diff (Downstream): (Table 1) (Table 2) (Table 3) (Table 3) (Table 4) Evidence of Groundwater Location: Photo: Riparian Vegetation Aquatic & Instream Vegetation Aquatic & Instream Vegetation Water Quality Dominant Type Fragmented A - 10 Established (5-30) Turblidity (Table 7) Trabe 7) Aquatic & Instream Vegetation Woody Density Odour Turblidity (Table 7) Trabe 7) Aquatic & Instream Vegetation Woody Density Woody Density Odour Turblidity (Table 7) Trabe 7) Mature (>30) Mature (>30) Turblidity Odour Turblidity (Table 9) Sinuosity Degree Bank Angle Kature (>30) Kature (>30) Kature (>30) Clay/Silt Sand Gravel Cobble Boulder Parent Roc (Table 1) Gradient # of Channels 1 30 - 60 5 - 30% Bank X Image: Cobble Boulder Parent Roc (Table 13) Gradient # of Channels 1 30 - 60 5 - 30% Bank	Land Use Valley Type Channel Type Channel Zone Flow Type Diff (DoWnstream): (Table 1) (Table 2) Channel Type Channel Zone (Table 5) Evidence of Groundwater Location: Photo: Riparian Vegetation Aquatic & Instream Vegetation Water Quality Odour Turbidity Dominant Type Coverage Channel Widths Age (yrs) Type Woody Debris WD Density (Table 7) Fragmented Ad + 10 Established (5-30) Type In Channel Mod Mod (Table 7) Continuous > 10 Mature (>30) Mature (>30) Not Present High In Image: Court (Table 12) Image: Court	
Riparian Vegetation (Table 5) (Table 7) (Table 7) <th colspan<="" td=""><td>Riparian Vegetation Aquatic & Instream Vegetation Water Quality Dominant Type (Table 6) Coverage Channel Widths Age (yrs) Aquatic & Instream Vegetation Water Quality Type (Table 6) None 1 - 4 Immature (<5)</td> In Cutbank Low WD/50m: Water Quality Encroachment (Table 7) Immature (<5)</th>	<td>Riparian Vegetation Aquatic & Instream Vegetation Water Quality Dominant Type (Table 6) Coverage Channel Widths Age (yrs) Aquatic & Instream Vegetation Water Quality Type (Table 6) None 1 - 4 Immature (<5)</td> In Cutbank Low WD/50m: Water Quality Encroachment (Table 7) Immature (<5)	Riparian Vegetation Aquatic & Instream Vegetation Water Quality Dominant Type (Table 6) Coverage Channel Widths Age (yrs) Aquatic & Instream Vegetation Water Quality Type (Table 6) None 1 - 4 Immature (<5)
Dominant Type (Table 6) Coverage None Channel Widths Age (yrs) Water Quality (Table 6) None 1 - 4 Immature (<5)	Dominant Type (Table 6) Coverage (Table 6) Coverage (Table 7) Coverage (Table 7) Coverage (Table 7) Coverage (Table 7) Woody Debris (Table 8) Wo Density (Table 8) Water Quality In Cutbank (Table 7) Image: Continuous (Table 7) Image: Continuous (Table 7) Image: Continuous (Table 10) Image: Continuous (Tab	
(Table 6) I None I - 4 Immature (<5)	(Table 6) Image: construction of the second sec	
Encroachment Pragmented M 4 - 10 Established (5-30) In Cubank Low Model	Encroachment (Table 7) Fragmented $\cancel{4} 4 - 10$ Established (5-30) In Cutbank Low Mod (Table 16) (Table 17) In Channel Mod Mod Mod In Channel Mod In Channel Mod In Channel In Channel In Channel In Channel In Channel Mod In Channel In	
(Table 7) X Continuous > 10 Mature (>30) Reach A Not Present High Z Coverage % X Not Present High Image: Coverage % X Not Present High Z Channel Characteristics Sinuosity Degree (Table 9) Sinuosity Degree (Table 10) Bank Angle X 0 - 30 Bank Erosion X < 5%	Image: Continuous Im	
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	ites: Quaterbooky with depice anaron half and with	
inkt and outlet walled. See reach mapping	I I I I I I I I I I I I I I I I I I I	

General Site Characteristics Project Number: 20/20109

Date:		2	024-10-21		Stream:		Sulphur	cre	IC .
Time:		12	2:00 pm		Reach:		SCT3		~
Weat	her:		Mny, 20"		Location:		159/11/2	Sulah.	- Coning
Field	Staff:	- 11	A CAI		Watershed/Subwaters	chodu	5 100	Superor	Shing
Tiera		1/4/	T CIY	1		sneu:	Suphur	LARK	200400
Featu		Monito		Sit	Sketch	1 KF	Lapprox. In	Con	npass
무	Reach break	ł	Long-profile	Drinne	$\mathcal{H} = \mathcal{H}$	*	/	1	
×	Station location		Monumented XS	Drainge Ditch al	ng //-////	E	XSY	(-	$\langle \epsilon \rangle$
^ ^	Cross-section	-	Monumented photo	trail	NY WI	A W	N=0.90m		-)
\sim	Flow direction		Monumented photo direction		N YE	1 W	1= 0.00m	-	
0	Riffle			Both a	Cotings A		w=1.03m		
	Pool Sediment bar		Sediment sampling	inderc.	ading MA		d= 0.16m	10	
			Erosion pins	43=0.	ading 21	to J	V=0.31m	12	
	Eroded bank/slope		Scour chains	RB=0.5	Ga MA	Jaicue.	ter= 0.881	0	
XXXXXX	Undercut bank Bank stabilization	Additio	onal Symbols	d=0.	zom VAL		0.01		
					1 dill	1 1	K.42	el sbs	tate
7777 xx	Leaning tree Fence				10001 AD	1		02-01	1
1 1	Culvert/outfall			_	=0,19m (,0.08	3m	\-== a	SI-S3	patato
	Swamp/wetland					XS3	1 +	SUN JU	USTRALE
WWW	Grasses				On the www	1-1. OM	31-	21-25	·
œ	Tree				They ! Wo	1= 0.09m	NA.		
	Instream log/tree				- H8-1731 3	W=1.13m			
***	Woody debris				IVEX.				
-	Beaver dam			=	Kp (Casi	cade in ;	this		
	Vegetated island					port	200	1	
Flow T					134		1		
H1	Standing water H1	A Back	water		——————————————————————————————————————	U.C= 015m	1/	X	
H2	Scarcely perceptible			_	Att.	Vilectio		1 1	
H3	Smooth surface flow			VD-	=0.67m - 4 P.	0.30m		1	
H4	Upwelling			An F -	0.6 m - 101	a X	(SZ		1
H5	Rippled					X whi	=1.16m l=p.09m,	1.1	
H6	Unbroken standing v	vave			X	1 Via	Whit deaths	worth	1 1
H7	Broken standing wav	'e			U.C=OIIM	k	w= difficult	to discern	
H8	Chute				I RP19	102	V=0.52	MIS	- X
H9	Free fall H9	A Dissip	ates below free fall		0.31m typ	1 1.0			
Substr	ate				Tag	V	.125m		
S1	Silt	S6	Small boulder		TOB	1XA to	=0.15m		
S2	Sand	S7	Large boulder		1	10tut			
S 3	Gravel	S 8	Bimodal		X	S - poo	1= 0.19m		
S 4	Small cobble	S9	Bedrock/till		Meonder 1	PT & I	Alle Counted	- 1 12	
S5	Large cobble				Hearder ->+	124-1	and derive	= 7.12m	
Other					=1.70m	E 14 1	(5)		
BM	Benchmark	EP	Erosion pin	_	i nl	REVI	W= 0.78m		
BS	Backsight	RB	Rebar	Dh	comites E. Ort		10= 0.14m		
DS	Downstream	US	Upstream	inst	tom vegto on as	Xt.	bw= 0.9/1		
WDJ	Woody debris jam	TR	Terrace		let C VII XM	VY	bd=0.18~		
VWC	Valley wall contact	FC	Flood chute	po	4 VIII	1/	V=0.200	ns	
BOS	Bottom of slope	FP	Flood plain	Photo	os:	¥			
ros	Top of slope	КР	Knick point	Notes	· · · · · · · · · · · · · · · · · · ·				

Version #4 Last edited: 21/02/2023

Senior staff sign-off (if required): _____ Checked by: _____ Completed by: _____ Page ____ of ____

GEO

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Evidence of Aggradation (AI) (AI) Evidence of Degradation (DI) Evidence of Degradation (DI) Evidence of (DI) T Hea B Ter 9 Sus 10 Cha B Evidence of Widening (WI) T Ler B Exp 1 Fal 2 Coa 3 Silt 4 Mea 7 Dep 3 Ele 4 Uno 5 Sco 6 Cut 7 Hea 8 Ter 9 Sus 10 Cha 2 Coa 7 Dep 3 Ele 4 Uno 5 Sco 6 Cut 7 Hea 8 Ter 9 Sus 10 Cha 2 Coa 7 Dep 3 Ele 4 Uno 5 Sco 6 Cut 7 Hea 8 Ter 9 Sus 10 Cha 8 Exp 9 Sus 10 Cha 8 Exp 9 Sus 10 Cha 1 Fal 2 Occ 3 Exp 1 Fal 2 Occ 3 Exp 1 Fal 2 Occ 3 Exp 1 Cha 1 Cha 1 Cha 2 Coa 1 Cha 1 Cha	position in the over posed bridge footin posed sanitary / st wated storm sewe dermined gabion b our pools downstre	ars ting of bed materials erbank zone ng(s) torm sewer / pipeline / etc. r outfall(s)	hed: (of indices =	Sulph Crcek Yes Ves	Subur	Factor Value		
Weather: Summer Field Staff: No. Des Process No. Des 1 Lob 2 Coa Evidence of Aggradation (AI) 1 Lob 2 Coa Field Staff: 3 Silt 2 Coa Evidence of Aggradation (AI) 5 Acc 6 Poc 7 Deg 3 Ele 4 Uno Evidence of Degradation (DI) 1 Exp 3 Ele 4 Uno 5 Scc 5 Scc 9 Sus 10 Cha Evidence of Widening (WI) 1 Fal 2 Occ 3 Exp 3 Exp 3 Exp 4 Bas Ter 9 Sus 10 Cha	M, 20°C Scription Date bar arse materials in r cation in pools dial bars cretion on point ba por longitudinal sort postion in the ove posed bridge footin posed sanitary / st vated storm sewe dermined gabion to pour pools downstree	Location: Watershed/Subwaters Geomorphological Indicator iffles embedded ars ting of bed materials erbank zone ng(s) torm sewer / pipeline / etc. r outfall(s) paskets / concrete aprons / etc.	hed: (59.1163 Sulphir	Т	Subur ent?	Factor Value		
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Evidence of Aggradation (AI) (AI) 5 4 4 6 6 Poc 7 0 6 Poc 7 7 0 et 2 5 4 0 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	arse materials in r ation in pools dial bars cretion on point ba position in the ove posed bridge footin posed sanitary / st vated storm sewe dermined gabion b	ars ting of bed materials erbank zone ng(s) torm sewer / pipeline / etc. r outfall(s) paskets / concrete aprons / etc.	Sum	of indices =			8/7 0.0		
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Aggradation (AI)4Mea (AI)5Acc 6Poc 706Poc 77Deg2Exit 3Ele 4Unit 52Exit 3Ele 4Unit 54Unit 5Scc 6Cut 77Heat 8Ter 9Sus 109Sus 10Chas1Fall 2Occ 3Evidence of Widening (WI)1Fall 2Evidence of Widening (WI)5Bas 60Cut 7Ler 89Fra9Fra	dial bars cretion on point ba or longitudinal sort position in the ove posed bridge footin posed sanitary / st vated storm sewe dermined gabion to pur pools downstre	ting of bed materials erbank zone ng(s) torm sewer / pipeline / etc. r outfall(s) paskets / concrete aprons / etc.	Sum	of indices =			0.0		
(AI) 5 Acc 6 Pool 7 Dep 7 Dep 1 Exp 2 Exp 3 Ele 4 Unit 5 Scc 6 Cut 7 Hei 8 Ter 9 Sus 10 Chi 2 Occ 3 Evidence of 9 Sus 10 Chi 2 Occ 3 Exp 4 Bas 5 Bas 6 Out 7 Ler 8 Exp 6 Out 7 Ler 8 Exp 9 France	position on point ba position in the over posed bridge footin posed sanitary / st vated storm sewe dermined gabion to pour pools downstre	ting of bed materials erbank zone ng(s) torm sewer / pipeline / etc. r outfall(s) paskets / concrete aprons / etc.	Sum	of indices =			0_0		
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7DepIEvidence of Degradation (DI)7Head 56Cut7Head 88Ter9Sus10CharEvidence of Widening (WI)1Fal2Occ3Exp4Bas5Bas6Out7Ler8Exp9Fra	position in the over posed bridge footin posed sanitary / st wated storm sewe dermined gabion b our pools downstre	erbank zone ng(s) torm sewer / pipeline / etc. r outfall(s) paskets / concrete aprons / etc.	Sum	of indices =		7	0_0		
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Evidence of Degradation (DI) (DI) Evidence of (DI) Evidence of Widening (WI) Evidence of Widening (WI) Evidence of Widening (WI) 2 2 4 5 5 2 0 2 3 2 2 2 2 2 2 2 2 2 2 2	posed sanitary / st vated storm sewe dermined gabion t our pools downstre	torm sewer / pipeline / etc. r outfall(s) paskets / concrete aprons / etc.	34						
Evidence of Degradation (DI) (DI) Evidence of (DI) Evidence of Widening (WI) Evidence of Widening (WI) Evidence of Widening (WI) Evidence of Evidence of Cut Fall Fall Fall Fall Fall Fall Fall Fal	posed sanitary / st vated storm sewe dermined gabion t our pools downstre	torm sewer / pipeline / etc. r outfall(s) paskets / concrete aprons / etc.			nx	710			
Evidence of Degradation (DI) (DI) Evidence of Widening (WI)	vated storm sewe dermined gabion b our pools downstre	r outfall(s) paskets / concrete aprons / etc.			100		-		
Evidence of Degradation (DI) 7 Hea 8 Ter 9 Sus 10 Cha 2 Occ 3 Exp 4 Bas 5 Bas 6 Ou 7 Ler 8 Exp 9 Fra	dermined gabion b our pools downstre	oaskets / concrete aprons / etc.			14	1A In	-		
Evidence of Degradation (DI) 7 Hei 8 Ter 9 Sus 10 Cha 10 Cha 11 Fal 2 Occ 3 Exp 4 Bas 5 Bas 6 Ou 7 Ler 8 Exp 9 Fra	our pools downstre		Undermined gabion baskets / concrete aprons / etc.						
Degradation (DI)5Scc Scc 67Hea 88Ter 99Sus 1010Cha2Occ 32Occ 34Bas 6Widening (WI)72Der 88Exp 99Fra		La ba		///	M	3/7			
Evidence of Widening (WI) Fra Evidence of Widening (WI) Fra Fra Fra Fra Fra Fra Fra Fra Fra Fra			lets				//		
8Ter9Sus10Cha10Cha2Occa3Exp4Bas5Bas6Ou7Ler8Exp9Fra	t face on bar form				. /	V	-		
9Sus10Chi10Chi11Fal2Occ3Exp4Bas5Bas6Ou7Ler8Exp9Fra		knickpoint migration	,			./	-		
Evidence of Widening (WI) 7 Ler 8 Exp 9 Fra	rrace cut through (4		
Evidence of Widening (WI) 1 Fal 2 Occ 3 Exp 4 Bas 5 Bas 6 Ou 7 Ler 8 Exp 9 Fra		ayer visible in bank ndisturbed overburden / bedrock			./	~	-		
Evidence of Widening (WI) 2 Occ 3 Exp 4 Bas 5 Bas 6 Ou 7 Ler 8 Exp 9 Fra		laistai bea overbarden / bearock	Sum	of indices =	3	4	0.429		
Evidence of Widening (WI) 2 Occ 3 Exp 4 Bas 5 Bas 6 Ou 7 Ler 8 Exp 9 Fra	len / leaning trees	s / fence posts / etc.			1/				
Evidence of Widening (WI) 3 Exp 4 Bas 5 Bas 6 Ou 7 Ler 8 Exp 9 Fra	currence of large of				V	V	-		
Evidence of Widening (WI) 7 Ler 8 Exp 9 Fra	posed tree roots	\checkmark		1					
Evidence of Widening (WI) 7 Ler 8 Exp 9 Fra	sal scour on inside	e meander bends							
(WI) 6 Ou (WI) 7 Ler 8 Exp 9 Fra	sal scour on both s		1	3/2					
7 Ler 8 Exp 9 Fra	tflanked gabion ba	M	IA	1 /0					
8 Exp 9 Fra	ngth of basal scou	V							
	posed length of pr		1. V.						
10 Exp	acture lines along t		V]					
	posed building fou	N	1/4						
			Sum	of indices =	3	5	0.375		
1 For	rmation of chute(s) (one chute)			V				
2 Sin		el to multiple channel					1		
Evidence of		le form to low bed relief form				1/	21		
	t-off channel(s)					V	1 2/7		
Adjustment 5 For		5)				~			
	rmation of island(s	but of phase with meander form				V			
	rmation of island(s alweg alignment o	med / reworked / removed			V				
	alweg alignment o		Sum	of indices =	2	5	0.286		
Notes:	alweg alignment o		oility Index	(SI) = (AI	+DI+WI+	-PI)/4 =	0.273		
	alweg alignment o	Stal		In Transi			djustment		
uls access vestric	alweg alignment o		Regime		-		-		

Senior staff sign-off (if required): _____ Checked by: _____

_ Completed by: _



Project Number: AP41.08 accment Technique and Chung . m

Date:	2024-10-21	Stream:		Sulphur	Urech
Time:	12:00 pm	Reach:	168	SCT3	
Weather:	Sunny, 20°C	Location:	1997 Sec. 00	159/163 Sulp	shur Springs rd.
Field Staff:	RACM	Watershed/Subwater	shed:	Sulphur Cree	K Subwetersted
Category	Poor	Fair		Good	Excellent
	 < 50% of bank network stable Recent bank sloughing, slumping or failure frequently observed 	 50-70% of bank network stable Recent signs of bank sloughing, slumping or failure fairly common 	• Infrequ	6 of bank network ent signs of bank ng, slumping or	 > 80% of bank network stable No evidence of bank sloughing, slumping or failure
Channel	 Stream bend areas highly unstable Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) Bank overhang > 0.8-1.0 m 	 Stream bend areas unstable Outer bank height 0.9- 1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) Bank overhang 0.8-0.9m 	Outer b m abov 1.5 m a for larg	bend areas stable bank height 0.6-0.9 re stream bank (1.2- above stream bank e mainstem areas) verhang 0.6-0.8 m	 Stream bend areas very stable Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) Bank overhang < 0.6 m
Stability	 Young exposed tree roots abundant > 6 recent large tree falls per stream mile 	 Young exposed tree roots common 4-5 recent large tree falls per stream mile 	predom large, s scarce • 2-3 rec	d tree roots ninantly old and smaller young roots ent large tree falls eam mile	 Exposed tree roots old, large and woody Generally 0-1 recent large tree falls per stream mile
	 Bottom 1/3 of bank is highly erodible material Plant/soil matrix severely compromised 	 Bottom 1/3 of bank is generally highly erodible material Plant/soil matrix compromised 	genera	1/3 of bank is lly highly resistant oil matrix or material	Bottom 1/3 of bank is generally highly resistant plant/soil matrix or mater
	 Channel cross-section is generally trapezoidally- shaped 			el cross-section is Ily V- or U-shaped	Channel cross-section is generally V- or U-shaped
Point range		030405	A	6 0 7 0 8	0 9 0 10 0 11
	 > 75% embedded (> 85% embedded for large mainstem areas) 	• 50-75% embedded (60- 85% embedded for large mainstem areas)	59% er	6 embedded (35- mbedded for large em areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	Few, if any, deep pools Pool substrate composition >81% sand- silt	 Low to moderate number of deep pools Pool substrate composition 60-80% sand-silt 	Pools Pool su	ate number of deep abstrate composition % sand-silt	 High number of deep pool (> 61 cm deep) (> 122 cm deep for large mainstem areas) Pool substrate composition <30% sand-silt
Channel Scouring/ Sediment Deposition	 Streambed streak marks and/or "banana"-shaped sediment deposits common 	 Streambed streak marks and/or "banana"-shaped sediment deposits common 	and/or	bed streak marks "banana"-shaped ent deposits mon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
Deposition	 Fresh, large sand deposits very common in channel Moderate to heavy sand deposition along major portion of overbank area 	Fresh, large sand deposits common in channel Small localized areas of		large sand deposits mon in channel ocalized areas of and deposits along low banks	 Fresh, large sand deposits rare or absent from chann No evidence of fresh sediment deposition on overbank
1.4	 Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand 	Point bars common, moderate to large and unstable with high amount of fresh sand	well-ve	ars small and stable, getated and/or red with little or no and	Point bars few, small and stable, well-vegetated and/or armoured with littl or no fresh sand
Point range				5 6	

Version #2 Last edited: 10/02/2023

GEO

Date: 9	024-10-21	PN: 24108	Location: /5	59/163 Sulphur Springs	
Category	Poor	Fair	Good	Excellent	
	 Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas) 	Wetted perimeter 40- 60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)	
	 Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low) 	 Few pools present, riffle: and runs dominant. Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate) 	 Good mix between riffles, runs and pools Relatively diverse velocity and depth of flow 	 Riffles, runs and pool habitat present Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water) 	
Physical Instream	 Riffle substrate composition: predominantly gravel with high amount of sand < 5% cobble 	 Riffle substrate composition: predominantly small cobble, gravel and sand 5-24% cobble 	 Riffle substrate composition: good mix of gravel, cobble, and rubble material 25-49% cobble 	 Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand > 50% cobble 	
Habitat	Riffle depth < 10 cm for large mainstem areas	Riffle depth 10-15 cm fo large mainstem areas	large mainstem areas	 Riffle depth > 20 cm for large mainstem areas Large pools generally > 61 cm deep (> 122 cm for 	
	Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	 Large pools generally 30 46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure 	cm deep (91-122 cm for large mainstem areas) with some overhead		
	Extensive channel alteration and/or point bar formation/enlargement	 Moderate amount of channel alteration and/o moderate increase in point bar formation/enlargement 	Slight amount of channel alteration and/or slight increase in point bar formation/enlargement		
	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5- 0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1		
MA	Summer afternoon water temperature > 27°C	Summer afternoon water temperature 24-27°C	Summer afternoon water temperature 20-24°C		
Point range		□ 3 🕅 4	0506	0708	
	Substrate fouling level: High (> 50%)	 Substrate fouling level: Moderate (21-50%) 	Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)	
Water Quality	Brown colour TDS: > 150 mg/L	Grey colourTDS: 101-150 mg/L	Slightly grey colour TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L	
	Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	· · · · · · · · · · · · · · · · · · ·	Objects visible to depth > 1.0m below surface	
	 Moderate to strong organic odour 	 Slight to moderate organic odour 	Slight organic odour	No odour	
Point range	00102	□ 3 □ 4	5 6	0708	
Riparian Habitat	 Narrow riparian area of mostly non-woody vegetation 	 Riparian area predominantly wooded but with major localized gaps 	 Forested buffer generally > 31 m wide along major portion of both banks 	 Wide (> 60 m) mature forested buffer along both banks 	
Conditions	Canopy coverage: <50% shading (30% for large mainstem areas)	 Canopy coverage: 50- 60% shading (30-44% for large mainstem areas) 	Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	 Canopy coverage: >80% shading (> 60% for large mainstem areas) 	
Point range	001	□ 2 □ 3	4 🗆 5	0607	
otal overall s	core (0-42) = 26	Poor (<13)	Fair (13-24) Good (25-3	B4) Excellent (>35)	

Version #2 Last edited: 10/02/2023 Senior staff sign-off (if required): _____ Checked by: _____ Completed by: _____

Day

* approx 90-100m of reach accessible on property; Reld access not permitted U/S.

Date:	2024-10-21	Field Staff:	RACM		Watershed/Subwate	rshed: Sulphin	Creek
Time:	12:00 pm	Stream:		eck	UTM (Upstream):	isited. Suprior	UEER
Weather:	Sunny, 20°C	Reach:	SCT3		UTM (Downstream):		
and Use	Valley Type	annel Type	hannel Zone	Flow Type			
Table 1)	(Table 2) (Ta		Table 4)	(Table 5)	Evidence of Gr	oundwater Location:	M/aPhoto:
Riparian Vegetatio	n		Aquatic & Inst	ream Vegetatio	on	Water Quality	
ominant Type	2 Coverage Channel Wi	idths Age (yrs)	Type (Woody Debris	WD Density	Odour	Turbidity
(Table 6)		□ Immature (<5)	(Table 8)	□ In Cutbank	KLow WDJ/50m:	(Table 16)	(Table 17)
Encroachment	Fragmented X4 - 10	0 🛛 Established (5-30)			□ Mod 0.25		2
(Table 7)	Continuous □ > 10	Mature (>30)	Reach Coverage % 5	D Not Present	🗆 High		4
hannel Character	istics		100	lized		<u>L</u>	
Sinuosity Type	Sinuosity Degree	Bank Angle	Bank Erosion	(Table 19)	Clay/Silt Sand Gra	Small	
(Table 9)	(Table 10)	Z X0-30	□ < 5%	(Table 19) Bank	Clay/Silt Sand Gra		Parent Rootlets
Gradient	# of Channels	□ 30 - 60	×5 - 30%	Riffle			
(Table 11)	(Table 12)	□ 60 - 90	□ 30 - 60%	Pool			
Entrenchment	Bank Failure	2 XUndercut	□ 60 - 100%	Bed			
(Table 13)	(Table 14)	2		(if no riffle-pool morphology)		The set of	and a second
(Table 15)	Bankfull Indicators (Table 18)	3/4	Bankfull Width	a1 /	3 Wetted W	idth (m) 7	11/ 10
	=		(m) 🕖			0.70	1.16
(Table 20)	Sediment Transport Observed?	🗆 Yes 🕅 No 🗆 Not Visible	Bankfull Depth (m)	18	0.10 Wetted De	epth (m) () (4	000 000
Transport					1	0,11	0.01
ode (Table 21)	6 % of Bed Active		Undercuts (m) 🕖	.15 0.11	0.08 Veloci	y (m/s) 0,20	0.52
Geomorphic 1/2 k	Mass Movement	7-10-15	Pool Depth	10 a.e.	Velocity	Estimate	
nits (Table 22) 4/3/5	20 (Table 23)	/ 7.ms 65	(m) U	.18 0.15	0,30 Velocity	Method W.444	Ball
K Riffle-Pool	% Riffles:	15 % Pools: 20	Riffle Length (m) 7		Meander A		
Spacing (m):				.14		(m) - 90	
otes: XS4	- phragmi	tes at down	freem pertie	is where	inlet is to	He pand	
N:1.08 210.16	-> some e		resert along	the second se	bents.		
W: 0.90		ererally able	reget ted	1 121	asses & trees	-	3
0.06	- tooting of	Cossing was	observed to	Se tailing	ng along both	bon KS.	115
d: 0.06 1:0.31ms							
otos:							
		•					

GEO

General Site Characteristics Project Number: 17/17/168

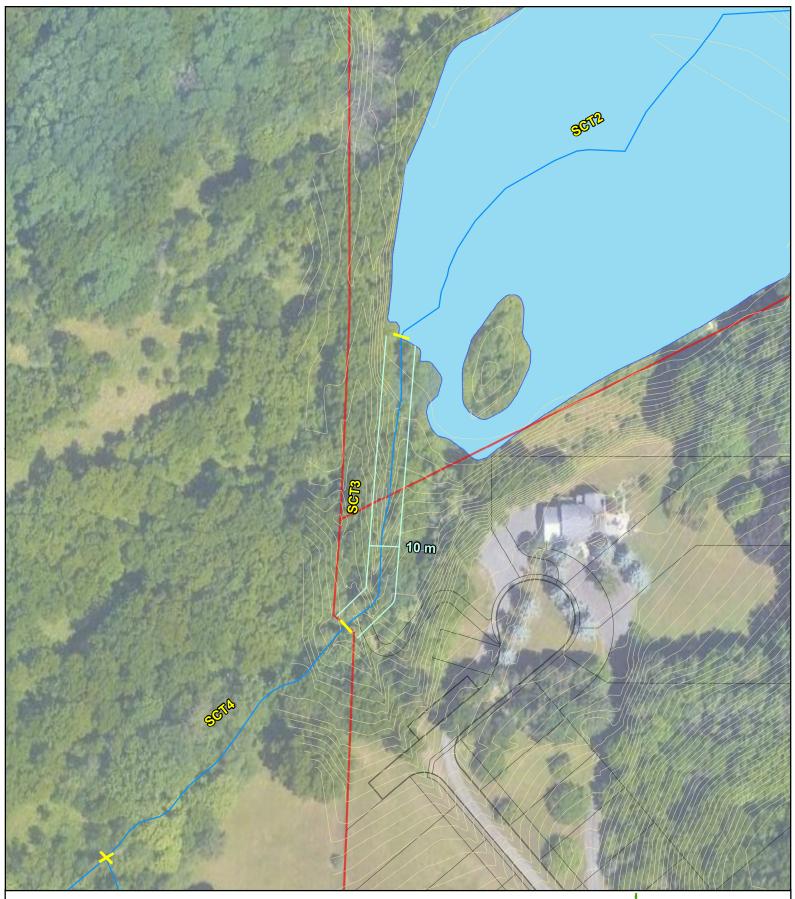
Date:		20	124-10-21		Stream:	+	Trib. of Sulp	phur Creek
Time:			1:00 Dm		Reach:		SCT1-4, SCT1-3	CICCA
Weat	her:	G	MAN 20°C	······································	Location:		1	See al
Field	Staff:	T Ô	IA ONA				01-1-1	Springs rd
			A CM		Watershed/Subwatersh	nea:	Manur locet	K Sibucile
Featu		Monite	oring	SCTA Site	Sketch Hand CV	Vall		Compass
2	Reach break	-0-0-0-		L. HY du	vegetation 5 11	VY		\frown
×	Station location Cross-section		Monumented XS	of the st	MW cottalis (V V	/ W		()
	Flow direction	0	Monumented photo	-MO	(xx		x x -	-\- ×/-
~~	Riffle		Monumented photo direction	JU //	L . (
\bigcirc	Pool		Sediment sampling	M.	" saturated)	66	6	
CERTIFIC O	Sediment bar	And and a second se	Erosion pins	X	Scions		ĸ	0
	Eroded bank/slope	8	Scour chains	WW=0.94m		NC		Parking
	Undercut bank		onal Symbols	WW20.03	sm.		¥ K	
XXXXXX	Bank stabilization		()	E E	e e	K	Ve l	
	Leaning tree	V=	Wetland veg.	_		multip	IC	
//// Х····Ж····Х	-	. Tomat			" Shed	inlet	pipes	· · · · ·
1. 1	Culvert/outfall	=	bat house			1 port	/	
(Swamp/wetland	عليته		X	tt	11		
WWW	Grasses				() OF			
G	Tree		······	X	In at 22 M			
õ	Instream log/tree				Mound of D			
***	Woody debris				SCT1-4			
-	Beaver dam				-x			
W	Vegetated island			X			1	
Flow T	www.www.comment.com.com.com.com.com.com.com.com.com.com						1	
H1	Standing water H1	A Back	water		ipett	M	1 w	
H2	Scarcely perceptible		S	CT1-5	niecland		/	
H3	Smooth surface flow				Avertand flow over		- no visible	
H4	Upwelling			×	concrete plate 200	322	- no visible outlet	
H5	Rippled				n in	~		3
H6	Unbroken standing w	ave			lus imma	ture 4	rees ? bushes	3
H7	Broken standing wav	e		X			()	2
H8	Chute						6) El	irchay
H9	Free fall H94	Dissip	ates below free fall	(6	0
ubstra				(phrag E		ante showing	~
	Silt	S6	Small boulder		Lietland		y tile	
S2	Sand	S7	Large boulder		read the		_ SCT1-3	
	Gravel	S8	Bimodal		(vyeiation	(R	S.	
	Small cobble	S 9	Bedrock/till					
ther	Large cobble					(1		
	Benchmark	EP	Fragion ain	T	P /	_		
	Backsight	RB	Erosion pin Rebar		Road	1		
	Downstream	US			and a second	1	talvert	
	Woody debris jam	TR	Upstream Terrace				- SE1-7	
	Valley wall contact	FC	Flood chute				ofEnno	entry
	Bottom of slope	FP				h.	-poort	defined
			Flood plain	Photos	11			anaang
os	Top of slope	КР	Knick point	Notes:	Algae on por	nd a	nd pand 1	's green.
		CT1-3	tiled up	oto 1	property born	alori		
	Reach S	CT1-4	. Pencl.	1		V		
~ 20	m of SCT6 obs	evedi	and the second sec	of oliva	ity's poorly defined	limi	ted nater not	Town
/ersion)	Senior staff sign-			·	.)	1//
	ited: 21/02/2023	1					. ,	-
		₩SC	T6 Chavaceusti	c of low-	order HDF; no evosion	1	Page	<u></u> of
			overland	flow po	ith.		0	
				1				

Date:	2024-10-21	Field Staff:	RA CM				RPHI
lime:	1:00 pm	Stream:		ek trib	Watershed/Subwatershe	ed: Suphar Creek	
Weather:	Juny, 20°C	Reach:	SUPAU Cre SCT1-3	ek trib	UTM (Upstream):		
and Use	alley Type Channel	······································			UTM (Downstream):		
Table 1) (Table 2) (Table 3)	<u>М/А</u> (т.	able 4)	Flow Type (Table 5)	/ 🗆 Evidence of Ground	water Location: <u>//a</u> Photo:	
Riparian Vegetation		life Drain	Aquatic & Inst	ream Vegetati	on	ater Quality	
Cominant Type 3 (Table 6) 3 Encroachment	□ None □ 1 - 4 □	Age (yrs) I Immature (<5) Established (5-30)	Type (Table 8)	Woody Debris	WD Density Low WDJ/50m: Mod	Odour Turbidit (Table 16) (Table 17	
(Table 7) MA		Mature (>30)	Reach Coverage %	Not Present		2/10	Gre
hannel Characteris	tics						
Sinuosity Type (Table 9) Gradient (Table 11) Entrenchment (Table 13) Down's Model (Table 15) Sed Sorting (Table 20) Transport ode (Table 21)	Sinuosity Degree (Table 10) # of Channels (Table 12) Bank Failure (Table 14) Bankfull Indicators (Table 18) Sediment Transport Observed? Yes	Bank Angle □ 0 - 30 □ 30 - 60 □ 60 - 90 □ Undercut <i>N</i> / <i>A</i> □ No <i>N</i> (Not Visible	Bank Erosion - < 5% - 5 - 30% - 30 - 60% - 60 - 100% ///A Bankfull Width (m) 	(Table 19) Bank Riffle Pool Bed (if no niffle-pool morphology)	Clay/Silt Sand Gravel		otlets
Geomorphic its (Table 22) Riffle-Pool Spacing (m):	Mass Movement (Table 23) % Riffles:	% Pools:	Pool Depth (m)		Velocity Estim Meti	ate	
tes: -> Tiled -> Open -> Across Possible Y -> Overall	Heature From grate observed driveway a culver ile dram continu no visible or su	t was prese to sor that	Vag Showing	s atrize	Based on Hese Schot Culvert.	observations it hu	

Date:	2024-10-2	Number	Field Staff:	4108	- 10	0.		1						MORPHI
Time:				LA CM			Watershed/Subwatershed:				Suphur Creek			
Weather:	Suny, 20°		Stream:		Sulphur Creek			UTM (Upstream):						
Land Use	alley Type		Reach:		_SCT1-4			UTM (D	ownstrea	m):				
(Table 1) (Table 2)	Channel (Table 3)	S	(Table	nel Zone e 4)	1	(Table 5)	10	Evidence o	of Ground	dwater Lo	ocation: h	1a	Photo:
Riparian Vegetation					Aquatic &	Instr	eam Vegetati	on		V	Vater Q	uality		
(Table 6)	Coverage Channel Widths Age (yrs) □ None ⊠(1 - 4) □ Immature (Type (Table 8)		Woody Debris	WD Density			Ode (Table	our	Turbidity (Table 17)		
Encroachment (Table 7) 2	⁷ ⊄Continuous □		¥Established (5- □ Mature (>30)		Reach Coverage %	0	In Channel	🗆 Mod	\times				[2/6(Gn
Channel Characteris	tics													
Sinuosity Type (Table 9)	Sinuosity Degr (Table 1		Bank Angle		ank Erosion < 5%		(Table 19) Bank	Clay/Silt	Sand	Gravel	Cobble	Bouider	Parent	Rootlets
Gradient (Table 11)	# of Channe (Table 1		□ 30 - 60		5 - 30%		Riffle			- 8				
Entrenchment]		□ 60 - 90		30 - 60%		Pool		<u> </u>					
(Table 13)	Bank Failu (Table 1		Undercut		60 - 100%		Bed (if no riffle-pool morphology)	\varkappa	×					
Down's Model (Table 15)	Bankfull Indicator (Table 18			В	ankfull Widi (n	-			Wette	d Width	(m)	12 M Train States and a state of the		
Sed Sorting (Table 20)	Sediment Transpo Observed		🖈 No 🗆 Not Visik	le Ba	ankfull Dept (n	-			Wette	d Depth	(m)			ng Change (C. State of the
Transport ode (Table 21)	% of Bed Activ	re		U	ndercuts (m)			Ve	locity (n	1/s)		0.00.00-Autor = 10200.400000	
Geomorphic nits (Table 22)	Mass Movemer (Table 2			7	Pool Dept (m	Contraction of the local division of the loc			Velo	city Estin Mel	nate			
Riffle-Pool Spacing (m):	% Riffle	s:	% Pools:	Riffle	e Length (m)		Pag gyr versting in Silk i party min similar	Meande	er Amplit				
tes: > This	Reach is	a ar	terbody			·					(,			
> The ripa		fin a		ormo	orily a	2	nanteurce	d land	na Car	th	Q. 4.6-	to al		1 1000
and shrips	surranding		and,			-			4	191	<u>ocve</u>	1810	3(000	s veg
> An over A	as pathing	csent		le h	rest so	Ob_	07,46	pand.	ex	46	mlet	·		
hom satte		ay wa	s also	Dreje	ant al	ing	He sut	leca à	stole o	F pe	nd c	allec XH	ng di	andle
An outlet	outlet.	obser	red ho	were	er a	Arle	dram	west.	d A	e 10	end	ad	pres	ent e
otos:														•

Last edited: 04/04/2023

Appendix E: Meander Belt Width Delineation







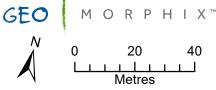
0.5 m Contour



OHN Waterbody

Figure 3

Erosion Hazard Delineation Sulphur Creek Ancaster, Ontario



Imagery: Google Earth, 2023. Watercourse: Hamilton, 2024. Waterbody, Watercourse (OHN), Wetland: MNRF, 2024. Subject Lands, Development Fabric: Crozier, 2024. Meander Belt Width: GEO Morphix Ltd., 2024. Print Date: November 2024. PN24108. Drawn By: R.A., M.O., K.W.