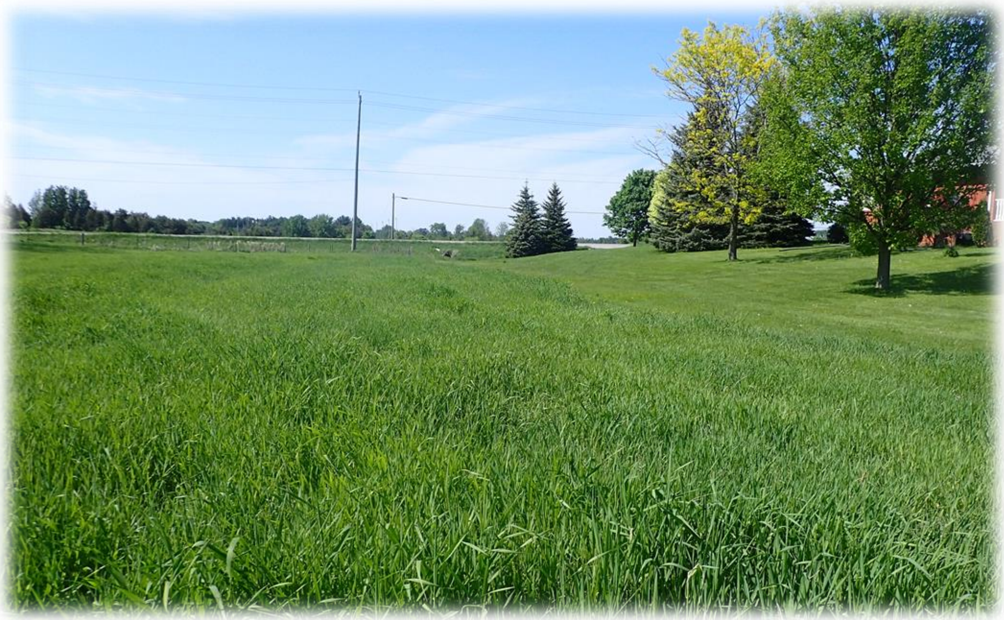
Technical Design Brief: Tributary of Uxbridge Creek

Town of Uxbridge, Ontario



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October 27, 2020
PN20094

GEO MORPHIX
Geomorphology
Earth Science
Observations

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1 Introduction

This design brief provides design recommendations for a bioswale design as part of the proposed 226 Brock Street residential development in the Town of Uxbridge, Ontario. The design serves to convey flows from the SWM Pond to the downstream tie in at Brock Street. A site map is provided in **Appendix A**. The bioswale design serves to improve form and function for this headwater drainage feature, enhance terrestrial diversity and the provision of organics, as well as enhance the retention and detention of flow and sediments.

In developing the design, the following activities were completed:

- A review of the available background materials, including the Conceptual Technical Design Brief (GEO Morphix Ltd., 2018)
- Provide details for the bioswale design including planform, cross sections, and necessary bioengineering details
- Hydraulic sizing of the bioswale materials
- Define corridor requirements
- Recommendations for design implementation including construction timing, and best management practices
- Development of a post-construction monitoring plan

This design brief is provided to facilitate review of the design, which outlines the current geomorphological condition of **Reach UCT1** and design considerations, provides technical details and recommendations for implementation, and monitoring of the proposed design.

2 Existing Conditions

Headwater drainage feature morphology and planform are largely governed by the flow regime and the availability and type of sediments (i.e., surficial geology) within the feature corridor. Physiography, riparian vegetation and land use also physically influence the headwater drainage feature. These factors are explored as they not only offer insight into what governs feature geomorphology, but also potential changes that could be expected in the future as they relate to a proposed activity. Field observations provide us with an in-depth understanding of the factors that impact feature geomorphology within the study area.

2.1 Geology

The study area is within the Peterborough Drumlin Field physiographic region, which is characterized as a drumlin field of various morphologies and orientation (OGS, 2010). The surficial geology is comprised of fine-textured glaciolacustrine deposits and ice-contact stratified deposits. The fine-textured glaciolacustrine deposits are located on the north side of the property and consist mainly of silt and clay with minor sand and gravel present. The ice contact stratified deposits are located at the south end of the property and consist of sand-gravel and minor silt, with clay and till present (OGS, 2003).

2.2 Field Observations

Field observations of **Reach UCT1** were completed on April 10, May 28, and July 19, 2018 previously as part of the conceptual design. The conceptual report recommended under the OSAP Headwater Drainage Assessment that *no management* was required for the reach based on the limited hydrology of the swale feature. However, the proponent wishes to retain the feature on the landscape as an enhanced bioswale. Given the feature has limited morphological variability as noted in the Conceptual Design Brief (GEO Morphix Ltd., 2018) restoration of the feature provides an opportunity to improve form and function and increase habitat and morphological variability.

3 Natural Bioswale Design

3.1 Design Objectives

As previously mentioned, the headwater drainage feature has limited morphology and degraded physical instream habitat conditions. The conceptual design has been reviewed previously by Lake Simcoe Region Conservation Authority and has been generally accepted. The below recommendation are consistent with those provided in the Conceptual Design Brief (GEO Morphix Ltd., 2018).

The proposed design will be a stable bioswale to provide a naturalized form and function. Headwater features like this reach provide detention and retention functions with regards to both flow and sediment. To maintain and enhance these functions, the design needs to provide good communication with the floodplain, as well as diversity in morphology. As such, online wet meadow features will be constructed throughout the corridor. These features enhance terrestrial habitat by increasing diversity and providing a more natural floodplain form. They also provide functional benefits by storing and discharging water over longer attenuated periods.

From a habitat perspective, the important contributions of the headwater drainage feature include organic inputs to the system, and provision of a complex valley system with elements that have a wide range of hydroperiods. The inclusion of a shallow and deep undulation typology with online wet meadow features provides a wide range of hydroperiods.

The primary objectives of the design, therefore, are to:

- Convey flows from the SWMP to the downstream channel
- Improve the function of the headwater drainage feature as well as its interaction with the floodplain
- Improve water quality by extending detention of water through online wet meadow features
- Improve riparian habitat by installing woody plantings and floodplain features

3.2 Bioswale Geometries

A bioswale containing shallow and deep undulations will convey flows along the south of the property into an enhanced bioswale feature with online wet meadows that flows along the east of the property. This feature will provide significant improvements to the headwater drainage feature, as it essentially replicates a natural system. When it is assessed to be an appropriate feature, a bioswale system offers numerous benefits, namely:

- Bed relief for flow variability
- Improve the function of the headwater drainage feature as well as its interaction with the floodplain
- Improve water quality by extending detention of water through online wet meadow features and providing infiltration
- Provide organic inputs through vegetation establishment

Bioswale dimensions are determined by bankfull discharge, as this represents what is generally considered the feature-forming discharge. Back-calculation of discharge from a reference reach, along with support from hydrological modelling, is usually the most appropriate. Due to the lack of a defined feature, and historical impacts to the headwater drainage feature because of agricultural activities, the computed discharge could not be considered accurate or reliable. Additionally, due to changes in hydrology likely to occur as a result of the development, a more appropriate discharge based on hydrological modelling was determined for the reach. Vincent & Associates (2000) completed hydrologic modelling upon review of post-development conditions and computed a bankfull discharge of 0.07 m^3/s. This discharge outlets from the Block 57 stormwater management (SWM) pond and is based on the 2-year storm event (Vincent & Associates, 2000).

Shallow and deep undulation geometries, as well as anticipated bankfull flow conditions, are provided in **Table 1.** A simple Manning's approach was used to size the bioswale dimensions. Since deep undulations contain dead space, this model overpredicts the amount of discharge that they convey. The modelled values for the shallow undulations give a better prediction of the bioswale capacity. The bioswale design comprises of a single reach, which begins as a straight bioswale within a narrow corridor extending 136 m before entering a wider corridor where the bioswale extends 173 m and contains online wetland features. The entire bioswale design is characterized by a constant bankfull gradient of 0.54% and has a total length of 312 m. The bankfull width and depth range from 1.20 m to 1.40 m and 0.15 m to 0.25 m for the shallow and deep undulations, respectively.

Table 1. Bankfull parameters of the proposed bioswale

Bioswale parameter	Bioswale Geometries	
	Shallow Undulation	Deep Undulation
Bankfull width (m)†	1.20	1.40
Average bankfull depth (m)†	0.11	0.14
Maximum bankfull depth (m)†	0.15	0.25
Bankfull width-to-depth ratio	8.00	5.60
Bioswale gradient (%)	1.8	0.54
Bankfull gradient (%)	0.54	0.54
Manning's roughness coefficient, *n*	0.04	0.03
Mean bankfull velocity (m/s) *	0.67	0.63
Bankfull discharge (m^3/s) *	0.09	0.13
Discharge to accommodate (m^3/s)	0.07	0.07
Tractive force at bankfull (N/m^2)††	26.48	14.71
Stream power (W/m)††	15.19	7.48
Unit stream power (W/m^2)††	14.47	7.87
Maximum grain size entrained (m) **	0.03	0.02
Mean grain size entrained **	0.02	0.01

† Based on bankfull gradient
†† Based on riffle gradient
* Based on Manning's equation; as pools contain ineffective space, the velocity and discharge conveyed in them are not presented
** Based on Shields equation, assuming Shields parameter equals 0.06 (gravel)

The sizing of proposed substrate materials was guided by a review of hydraulic conditions in the typical headwater drainage feature cross sections. To provide for a stable bed and level of sorting, native material is proposed for the shallow and deep undulations. A mix of topsoil and granular 'b' is proposed for the online wet meadows to provide for a stable bed and level of sorting, while still maintaining the character of the native material and providing slightly higher stability and opportunity for sediment sorting. Granular 'b' consists of a mix of stone where approximately 20% - 50% of the stone is greater than 0.005 m in diameter, but nothing larger than 0.15 m in diameter. These materials will always have a core of sediment that is not entrained under bankfull flow conditions. A mix of relatively larger substrate (0.15 – 0.20 m diameter riverstone) and granular 'b' is proposed for the stone core wetland, located immediately downstream of the SWM pond headwall. These materials will provide higher stability and will always have a core of sediment that is not entrained under larger storm events (i.e., 100-yr).

The bioswale banks and online wet meadows will be restored using native plant species. This includes appropriate species for the various seed mixes as well as woody vegetation. The plantings are intended to enhance the terrestrial habitat through the provision of habitat diversity, increase floodplain soil stability, and increase floodplain roughness and sedimentation. A tree compensation plan has been completed by Cosburn Nauboris Ltd. Landscape Architects to provide compensation for the trees being removed along the southern property limit. Additional plantings for the remainder of the corridor are provided on drawing RES-1 completed by GEO Morphix Ltd.

3.3 Bioswale Corridor

The bioswale is expected to fully vegetated and have intermittent flows. Given the limited energy and vegetation control, the feature is unlikely to migrate or adjust its planform resulting in no erosion hazard associated with the feature. The valley walls are less than 2.5 m in height, therefore it is not considered a confined system and does not require an erosion setback.

Online wet meadow features will be constructed in addition to the bioswale. These features provide functional benefits such as short-term water retention and sediment banking. Additionally, these features enhance local recharge by allowing for infiltration. Mounds are to be included within the wet meadows to provide added morphological variation.

3.4 Natural Erosion Control

Newly constructed features can be vulnerable to erosion. This is particularly true before vegetation has established along the bioswale banks. While low-flow events should not intensify erosion, the concern for erosion occurs when there are high flows or precipitation events during construction.

For immediate erosion protection, mechanical stabilization in the form of biodegradable erosion control blankets (i.e., coir cloth, jute mat, etc.) should be used. As the blankets will biodegrade over time, this serves as a short-term stabilization measure.

For long-term stability, implementation of a planting plan is recommended. This includes deep rooting native grasses and other herbaceous species seeded along and within bioswale sections, prescription of flood tolerant native shrub and tree species, and use of seed banks within the local soil. Shrubs should be planted close to the bioswale margins to provided maximum benefit with respect to stabilization and bioswale cover.

Potential erosion locations (i.e., along the outside meander bends, immediately downstream of wet meadow features, etc.) should be anticipated, and should be reflected in the planting plan. Live staking and shrub stock should be used adjacent to the bioswale bank to provide immediate benefit as well as long-term infilling. If appropriate live staking methods are followed, this method should provide greater benefits than simple potted or bare root shrub plating. This is because of the potential for higher densities with live staking.

4 Design Implementation

4.1 Construction Timing

Based on resident fish species and their respective life cycles, in-stream work will be restricted to July 1st to March 31st, unless otherwise directed by the Ministry of Natural Resources and Forestry (MNRF).

Vegetation removals associated with clearing, site access and staging should occur outside the key breeding bird period for migratory birds, identified by Environment Canada, to ensure compliance with the Migratory Birds Convention Act (MBCA), 1994 and Migratory Bird Regulations. The breeding season for migratory birds in this part of the country typically extends from as early as March 1 to as late as September 15. Should tree removals be required during the key breeding bird season, a qualified biologist should inspect those trees to ensure that they do not contain nesting birds. It is understood that the MBCA is not restricted to cutting woody vegetation, but also applies to topsoil stripping and grubbing activities, as there are ground nesting bird species that are protected under the Act.

4.2 Best Management Practices

Site inspection should be performed by an inspector with experience overseeing natural feature construction works, as this type of work differs considerably from engineering projects. An experienced inspector will be able to provide quick and appropriate response to issues that may arise and ensure that construction proceeds in accordance with the approved design and contract.

The limits of construction will be delineated to prevent unanticipated impacts to natural surroundings, including trees and the headwater drainage feature. Most of the bioswale can be constructed without interference to the existing headwater drainage feature. To complete the connection with the existing feature, flows will be conveyed around the work area using cofferdams and bypass pumping such that the bioswale can be constructed fully isolated from the active flow area.

All isolated work areas will be dewatered to perform work under dry conditions. Water will be pumped to a sediment filtration system located at least 30 m from the receiving headwater drainage feature and be allowed to naturally flow over a well-vegetation surface and ultimately return to the headwater drainage feature downstream of the work area. This will allow particles to settle before reaching the headwater drainage feature.

All materials and equipment will be stored and operated in such a manner that prevents any deleterious substances from entering the water. Vehicle and equipment re-fuelling and/or maintenance will be conducted away from the headwater drainage feature and be free of fluid leaks and externally cleaned/degreased to prevent the release of deleterious substances.

4.3 Post-Construction Monitoring

A post-construction monitoring program is recommended to assess the performance of the implemented design. Monitoring observations can also be used to determine the need for remedial works. Monitoring is recommended for two full calendar years following the year of construction.

The following monitoring and reporting activities are proposed:

- General observations of the bioswale works should be documented after construction and after the first large flooding event to identify any potential areas of erosion concern
- Collection of a photographic record of site conditions
- Total station as-built survey of the bioswale planform, longitudinal profile and cross sections just after construction to obtain reference data for the following two years
- A general vegetation survey in the spring of each year
- Re-survey of the longitudinal profile and monumented cross sections for two years following construction

- A yearly report for the first year, with a final report at the end of the two-year period

The monitoring would commence immediately after construction and sites would be reviewed annually to identify natural variability of the system. Reporting would be provided annually, with a summary report at the end of each year.

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

Respectfully submitted,

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Geomorphologist

5 References

GEO Morphix Ltd. 2018. Conceptual Design Brief: Tributary of Uxbridge Creek. Town of Uxbridge, Ontario. Project No.: 18072.

Ontario Geological Survey (OGS). 2003. Surficial Geology of Southern Ontario.

Stanfield, L. (editor). 2013. Ontario Stream Assessment Protocol. Version 9.0. Fisheries Policy Section. Ontario Ministry of Natural Resources. Peterborough, Ontario. 505 Pages.

Toronto and Region Conservation Authority and Credit Valley Conservation (TRCA/CVC). 2014. Evaluation, Classification and Management of Headwater Drainage Features Guidelines

Vincent & Associates. 2000. Coral Creek Homes Stormwater Management Detention Facility. Drawing No. SW-1

Appendix A
Site Map


HERREMA BOULEVARD
LOW BOULEVARD
FOURTH AVENUE
DONLAND LANE
BROCK STREET
Tributary of Uxbridge Creek
Stormwater Management Pond
NELKYDD LANE
PLANKS LANE
BROWNSCOMBE CRESCENT
GEO MORPHIX
Tributary of Uxbridge Creek
226 Brock Street, Town of Uxbridge
Westlane Development Group Ltd.
0 50
Metres
N
Imagery: Google Earth Pro, 2016.