# Channel Design and Geofluvial Assessment

## PURPOSE:

This document provides guidance for the completion of a Channel Design and Geofluvial Assessment which may be required for the submission of an application under the *Planning Act*. All Channel Design and Geofluvial Assessments shall follow the requirements referenced in this document.

A Channel Design and Geofluvial Assessment provides information required for a Planning Application to ensure that erosion hazards are identified and respected, that input is provided as part of stormwater management planning to mitigate costly geomorphic adjustments and to ensure infrastructure such as road crossings and underground linear infrastructure are protected from future lateral and vertical erosion risk. An erosion mitigation assessment may also be required if permanent dewatering discharge is directed to a watercourse to accommodate underground infrastructure such as parking, subject to confirmation by the City that the approach is acceptable.

Geomorphological input is typically required in support of several types of projects and at various stages in planning (e.g., expert plans, secondary plans, and tertiary plans) and design phases (e.g., conceptual, and detailed design). The following types of geomorphological studies can be initiated at various points in the planning and design process:

- Fluvial geomorphological characterization;
- Headwater drainage feature assessments (HDFAs);
- Erosion hazard assessments;
- Erosion threshold and mitigation assessments;
- Infrastructure crossing assessments (e.g., watermains, sanitary sewers, road crossings)
- Natural channel design;

- Stormwater/dewatering outfall siting and treatment design; and
- Baseline Instream monitoring.

Pre-development monitoring, characterization studies and HDFAs are often used to determine flow regimes and development management recommendations. Erosion hazard assessments delineate the natural hazard associated with a watercourse and define, in part, the overall limit of development. Results of erosion threshold and mitigation analyses inform overall stormwater management strategies, identify appropriate locations for infrastructure (e.g., outfalls) when they are proposed within the erosion hazard, as well as outlet-specific erosion mitigation treatments. Often, these types of studies provide baseline conditions that can be used as a reference during construction and post-construction project phases, and as such, it is critical to ensure that the appropriate study(s) is initiated early in a given project to avoid data gaps and project delays.

If channel realignments are required as part of a development, a technical report supporting the conceptual or detailed design should be provided as part of the submission.

In many cases, portions of geomorphological work would be completed in earlier phases of the planning process. In these instances, the geomorphological component of a given project would be to verify/update previously documented conditions and assessments to ensure consistency. Before proceeding with a geomorphological assessment, the extent and detail of work should be defined with the City of Hamilton and other review/approval bodies.

Where there is a watercourse(s) present within or adjacent to a site that poses a potential natural hazard to proposed development and associated infrastructure, and / or stormwater management/dewatering plans are proposed that include discharge to a watercourse(s), a geomorphological study is required. A geomorphological assessment is also required when watercourse relocation and/or restoration is proposed.

With consideration to the above, a fluvial geomorphology study may be required in support of the following planning processes/development application types:

- Master Plan / Subwatershed Study.
- Official Plan Amendment (OPA).
- Draft Plan of Subdivision Application.
- Site Plan Application.
- Land Severance Application.

## PREPARED BY:

A Channel Design and Geofluvial Assessment must be prepared by a Qualified Geomorphologist licensed by the Association of Professional Geoscientists of Ontario or Professional Engineer (P.Eng.) licensed by Professional Engineers Ontario with experience in the field of fluvial geomorphology.

## CONTENTS:

The applicant is encouraged to discuss the study scope, any site-specific considerations and design assumptions with City staff prior to initiating work. In many cases a fluvial geomorphology study is completed in conjunction with stormwater management reports and delineation of limit of development linework.

A Channel Design and Geofluvial Assessment shall contain the following:

- Review any previously completed studies to ensure consistency and identify/address any data gaps;
- Characterize the watershed and existing drainage network;
- Characterize existing watercourse conditions;
- Characterize headwater drainage features (HDFs);
- Develop recommendations for appropriate watercourse and HDF management;
- Delineate constraints to development such as erosion hazards or setback limits for infrastructure crossings (e.g., meander belt widths / 100-year erosion limits);
- Support the design of stormwater management / dewatering strategies that mitigate the potential for erosion; and

- Provide baseline monitoring to determine pre-development watercourse conditions and characterize natural channel adjustment.

The Terms of Reference is organized based on typical project types specific to fluvial geomorphology. The overall project may involve one or more project types described below. Annotated Tables of Contents are also provided separately and align with each project type.

## Fluvial Geomorphological Characterization

A fluvial geomorphological characterization study must contain sufficient information to understand existing drainage feature/watercourse conditions prior to development (e.g., areas of erosion concern or sensitivity, anthropogenic modification, locations of watercourses/drainage features that are high constraint). The following tasks should be included in the project scope:

1. Describe the proposed development and location;
2. Review available background reports and mapping (e.g., watershed/subwatershed studies, geology, topography, conceptual development plans) to inform watershed and drainage network characterization;
3. Describe historical changes in land use, channel planform, and instream characteristics, if feasible, within and upstream of the development that may affect current and future channel form. This exercise is typically completed using historical and recent aerial photographs. Ontario base mapping (OBM) and data collected using remote sensing techniques may also be used, including but not limited to LiDAR, false infrared, and satellite imagery;
4. Delineate watercourse reaches based on desktop review of channel and drainage area characteristics;
5. Conduct rapid geomorphic field assessments to confirm the desktop reach delineation and characterize existing conditions. Rapid assessments should include standardized techniques such as Rapid Geomorphic Assessments (RGA) (MOE, 2003) and Rapid Stream Assessment Techniques (RSAT)

(Galli, 1996). Methods such as the Downs (1995) model, River Styles Framework (Brierley and Fryirs, 2005) and others may also be applied based on the opinion of the Practitioner;

6. At minimum, provide technical input to HDFAs specifically related to sediment supply/ transport and feature form / function following MNRF/TRCA/CVC criteria. HDFAs can be undertaken collaboratively with the project ecologist;
7. If applicable, develop HDF and watercourse management recommendations to inform development opportunities and constraints; and,
8. Prepare a report that documents the above activities, including dates of field work, extent of drainage features/watercourses assessed, any limitations to the assessment (e.g., site access), and all key findings that are relevant to the development.

## Erosion Hazard Assessments

Erosion hazard assessments are typically completed for watercourses that are to be retained to inform, in part, the limit of development and/or the siting of infrastructure such as storm water/dewatering outfalls and road crossings. Meander belt widths should also be calculated for designed channels to ensure the proposed corridor is adequately sized to accommodate the bankfull channel and addresses the potential erosion hazard. The following tasks should be included in the project scope:

9. Complete items 1 to 5 above;
10. Review historical and recent aerial photographs and remote sensing data, as appropriate, to inform the meander belt width / 100-year erosion limit for all features to be retained on the landscape;
11. Erosion hazard delineation will be completed in accordance with the Provincial Planning Statement (PPS, 2024) on defining natural hazards and consider valley setting (i.e. unconfined, partially confined, confined), historical channel form and field-based reach observations;
12. Where the watercourse is confined by valley walls, the erosion hazard limit

is defined by the 100-year erosion rate/toe erosion allowance and the long-term stable top of slope. When imagery and channel form allow for the accurate measurement of individual meanders, measurements should focus on lateral migration (i.e., not downstream migration). The long term stable top of slope should be delineated by a geotechnical engineer;

13. The assessment should also include consideration of any additional setbacks (e.g., erosion access allowance);
14. Map the extent of the erosion hazard to inform, in part, the limit of development; and,
15. Prepare a report that documents the above activities, including the date of field work, extent of drainage features/watercourses assessed, approach to delineation of the erosion hazard, any limitations to the assessment (e.g., site access, poor aerial photograph resolution, dense woody riparian vegetation in aerial imagery), and the extent of all erosion hazards.

## Erosion Threshold and Mitigation Assessments in Support of Stormwater Management / Dewatering

An erosion threshold and mitigation assessment is typically required when stormwater or dewatering discharge is proposed to outlet to a watercourse. Erosion mitigation criteria may have been defined in previous planning stages. The approach taken should be consistent with requirements established for the watershed and address any local, site-specific concerns. The following tasks should be included in the project scope:

16. Complete items 1 to 5 above;
17. Consideration of the location of HDFs may also be required, subject to the proposed outlet location;
18. Complete a detailed geomorphic field assessment to support erosion threshold determination. The detailed assessment will include a longitudinal profile survey of the channel centreline and cross sections, and a detailed review of channel substrate grain size distribution and bank material composition and structure. The site will be downstream, where possible, of

future outlets and be associated with the reach most sensitive to erosion;

19. Erosion threshold calculations should consider both channel substrates and bank composition;
20. Provide technical support for assessing erosion mitigation strategies as part of the proposed stormwater management plan (e.g., modelling of post- to pre-development hydrology scenarios). The assessment should follow accepted erosion mitigation practices outlined in stormwater management guidelines;
21. If an erosion exceedance analysis is required, the study should document the type and source of the hydrological modelling used (e.g. synthetic storms or continuous modelling) and development of an erosion mitigation scenario based on post- to pre-development comparisons of erosion threshold exceedance duration, exceedance frequency, cumulative exceedance volume, and cumulative excess work; and,
22. Prepare a report that documents the above activities, including the date of field work, extent of drainage features/watercourses assessed, approaches used to determine the erosion threshold and complete the erosion exceedance analysis and any limitations to the assessment (e.g., site access).

## Infrastructure Crossing Assessments (Underground Services and Watercourse Crossings)

Crossing assessments are typically completed when road crossings and underground infrastructure are proposed to ensure that potential lateral and vertical erosion hazards are adequately mitigated. Fluvial geomorphologic recommendations should be considered with those of other disciplines (e.g., hydrology and hydraulics, wildlife passage). The following tasks should be included in the project scope:

23. Complete items 1 to 5 above;
24. Consideration of the location of HDFs may also be required, subject to the proposed crossing location;

25. If required based on the project scope and design stage, complete a detailed geomorphic field assessment. The detailed assessment will include a longitudinal profile survey of the channel centreline and cross sections, and a detailed review of channel substrate grain size distribution and bank material composition and structure;
26. Provide technical input and recommendations for any watercourse crossings including location, structure type, span, and skew, as well as any setbacks to address the erosion hazard;
27. When possible, structures should be sited along relatively straight sections of channel, cross perpendicular to the channel, and be of sufficient span to accommodate the potential erosion hazard;
28. A vertical scour assessment may be required where underground services are proposed to ensure adequate depth of cover over the long-term;
29. If instream works are required to mitigate erosion, natural channel design principles should be used at the discretion of the Practitioner; and,
30. Prepare a report that documents the above activities, including the date of field work, extent of drainage features/watercourses assessed, and any constraints or opportunities associated with the assessment/design (e.g., presence of valley walls or excessive erosion, evidence of channel degradation).

## Natural Channel Design

Natural channel design may be completed at the reach scale or as part of local, site specific restoration works. In many cases, conceptual and detailed channel designs are initiated after the completion of a larger overall study such as a comprehensive plan or subwatershed study and follows watercourse management recommendations (e.g., net constraint rankings).

31. Complete Items 1 to 5 above;
32. Consideration of the location of HDFs may also be required, subject to the proposed extent of watercourse/drainage feature realignment;

33. Complete a detailed geomorphic field assessment along a suitable reference reach to inform the design. The assessment will include a longitudinal profile survey of the channel centreline and cross sections, and a detailed review of channel substrate grain size distribution and bank material composition and structure;
34. Provide rationale/describe reasons for channel realignment/restoration;
35. Complete bankfull channel sizing calculations to ensure there is an appropriate connection between the channel and its floodplain to dissipate energy during higher flow events (if site constraints permit). Bankfull channel sizing should be based on data collected along the surveyed reference reach and a review of hydraulic/hydrologic modelling;
36. Determine appropriate channel planform, gradient and morphology based on proposed development plan and any specific site constraints and ecological targets;
37. Confirm that the potential erosion hazard of the designed channel is accommodated with the realigned corridor, if applicable;
38. Complete substrate sizing using velocities/shear stresses/discharges to ensure the design remains stable over a range of flow events (to be refined as detailed design proceeds);
39. Prepare design drawings in planview and profile following principles of natural channel design;
40. Provide general recommendations regarding mechanical stabilization and suitable plantings;
41. Phasing, erosion, and sediment control plans may be prepared at the detailed design stage by practitioner or the project engineer; however, a general understanding of how the project is to be implemented is required at the initial project stage to ensure it is feasible; and,
42. All natural channel designs should be accompanied by a technical brief that details previously completed studies and data reviewed, existing conditions, opportunities and constraints for the design, and rationale for the design approach. In addition, general recommendations for implementation and

post-construction monitoring are to be provided.

## Stormwater / Dewatering Outlet Siting and Treatment Design

43. Complete Items 1 to 5 above along the reach receiving stormwater / dewatering discharge;
44. Consideration of the location of HDFs may also be required, subject to the proposed outlet location;
45. Provide technical input and recommendations for the siting of outlet locations, including consideration of the erosion hazard associated with the receiving watercourse and outlet treatment concepts to mitigate erosion. For example, proposed outlets should be situated at the base of defined watercourse valleys, in previously disturbed and/or open areas where possible, and adjacent to relatively stable sections of channel;
46. Outlet treatments are to consider bioengineered measures to ensure positive drainage and promote detention and infiltration;
47. All stone should be hydraulically sized using velocities/shear stresses/discharges to ensure the outlet treatment remains stable over a range of flow events (to be refined as detailed design proceeds);
48. General recommendations regarding mechanical stabilization and suitable plantings should also be provided; and,
49. All outfall treatment designs should be accompanied by a technical brief that details previously completed studies and data reviewed, existing conditions, opportunities and constraints for the design, and rationale for the design approach. In addition, general recommendations for implementation and post-construction monitoring are to be provided.

## Baseline Instream Monitoring

Should the proposed development for a site include a storm water/dewatering outlet to a watercourse, baseline monitoring may be required as part of the approvals process to determine watercourse flow regime, understand sediment quality / transport, and

characterize instream conditions and natural erosion rates in the pre-development phase. This allows for a comparison of the stability of a feature receiving stormwater/dewatering discharge in the post-development phase to ensure that any potential impacts have been adequately mitigated. The scope of work for baseline monitoring shall include:

50. Collect continuous water level and temperature measurements from April to November to characterize conditions at the upstream and downstream extents of the development and that coincide with major tributary confluences, where applicable;
51. Establish hydrological monitoring cross-sections at instream monitoring locations to assist in calibrating baseline discharge at each site. Cross-sections will be surveyed, and velocity measurements will be collected during a range of flow conditions to develop a stage discharge curve for each feature;
52. Installation of a rain gauge may be recommended if a reliable rain gauge is not operating nearby;
53. If required, conduct surface water quality sampling following applicable guidelines (e.g., Ontario Stream Assessment Protocol). Parameters may include temperature, conductivity, dissolved oxygen, turbidity, and total suspended solids (TSS). The sampling program should be confirmed with the City and Conservation Authority prior to the initiation of work;
54. Conduct geomorphic monitoring at monumented channel cross-sections on a seasonal or annual basis to document erosion and changes in overall channel form;
55. Assess channel substrate quality at monumented cross sections on a seasonal or annual basis through sediment sampling or substrate characterization (e.g., pebble counts), as appropriate;
56. Collect monumented photographs at each sampling location to confirm the location, timing and local conditions during all sampling and monitoring activities;
57. If conducting baseline monitoring to classify the watercourse thermal regime,

document the technique used and illustrate results in graph format; and,

58. Summarize and compile all results of baseline monitoring in a report. Results of baseline monitoring will be used to characterize existing pre-development instream conditions including hydrology, sediment quality, and natural erosion, and will act as a reference for the post-development condition.

## OTHER INFORMATION:

At a minimum, the following resources are recommended when conducting a fluvial geomorphology study:

- Erosion and Sediment Control Guide for Urban Construction (Toronto and Region Conservation Authority, 2019);
- Technical Guidelines for Watercourse Crossings – Version 1.0 (Credit Valley Conservation, 2019);
- Ontario Stream Assessment Protocol – Version 10 (L. Stanfield, 2017);
- Credit Valley Conservation Fluvial Geomorphic Guidelines (Credit Valley Conservation, 2015);
- Crossing Guidelines for Valley and Stream Corridors (Toronto and Region Conservation Authority, 2015);
- Evaluation, Classification and Management of Headwater Drainage Features Guidelines (Credit Valley Conservation and Toronto and Region Conservation, 2014);
- Evaluating the Effectiveness of ‘Natural’ Channel Design Projects: A Protocol for Monitoring New Sites (TRCA et al., 2009);
- Belt Width Delineation Procedures (Toronto and Region Conservation Authority, 2004);
- Stormwater Management Planning and Design Manual (Ministry of the Environment, 2003); and,
- Technical Guide – River & Stream Systems: Erosion Hazard Limit (Ministry of Natural Resources, 2002).

# REVIEWED AND APPROVED BY:

Development Planning and Economic Development Department

Natural Heritage, Planning and Economic Development

Development Approvals, Planning and Economic Development Department

Source Water Protection

The Conservation Authority with regulatory authority over the shoreline for which the Shoreline Assessment Study / Coastal Engineers Study is being completed, namely:

- Hamilton Conservation Authority
- Conservation Halton
- Niagara Peninsula Conservation Authority
- Grand River Conservation Authority

For projects that involve inwater works, consultation with provincial and federal regulatory agencies may be required, including Ministry of Environment, Conservation and Parks, Ministry of Northern Development, Mines, Natural Resources and Forestry, Fisheries and Oceans Canada, and Transport Canada.

# CONTACT:

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Niagara Peninsula Conservation Authority

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Grand River Conservation Authority

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# APPENDICES:

Channel Design and Geofluvial Assessment – Summary Checklist

Channel Design and Geofluvial Assessment – Standard Format for Document and Annotated Table of Contents

# Fluvial Geomorphology Study – Summary Checklist

The form is to be completed by the Professional that prepared the _____.

Use of the form by the City of Hamilton is not to be construed as verification of content.

Refer to the Terms of Reference, Fluvial Geomorphological Study:
Link to Terms of Reference

**If Any Of The Requirements Listed Below Have Not Been Included In The _____, The Study Will Be Considered Incomplete.**

# Summary of Key Information:

| Site Information | Notes | Page # & Section # of Review | Review Includes this Information City Staff (Check) |
|---|---|---|---|
| **Site Address** | | | |
| **Property Owner** | | | |
| **Project Description** | | | |
| **Land Use** | | | |
| **Date Prepared** | | | |
| **Prepared By (Consulting Firm)** | | | |
| Fluvial Geomorphological Characterization | | | |
| **The Report is dated and signed by a Qualified Geomorphologist licensed by the Association of Professional Geoscientists of Ontario or a Professional Engineer licensed by Professional Engineers Ontario with experience in the field of fluvial geomorphology** | | | |
| **Summary of local surficial geology and physiography** | | | |
| **Review of historical and recent aerial imagery and remote sensing data to assess channel adjustments and land uses, as appropriate** | | | |

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| **Rapid assessment field work conducted within the 5 years on a reach basis (site access permitting) using standardized assessment tools (e.g., RGA and RSAT)** | | | |
| **If required, headwater drainage features assessments (HDFAs) undertaken following applicable guidelines (e.g., CVC and TRCA, 2014)** | | | |
| **Representative photographs of the watercourse reach(es), any valley slopes, and riparian conditions during ice-free and snow-free conditions** | | | |
| **Mapping that clearly shows the study area, watercourses and waterbodies, topography, and reach breaks and associated labels overlain on recent aerial imagery** | | | |
| Erosion Hazard Assessments | | | |
| **The Report is dated, signed and stamped by a Qualified Geomorphologist licensed by the Association of Professional Geoscientists of Ontario or a Professional Engineer licensed by Professional Engineers Ontario with experience in the field of Fluvial Geomorphology** | | | |

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| **The erosion hazard assessment considers valley setting (e.g., confined, unconfined, partially confined) and is prepared in accordance with the following, as appropriate:**<br>• **Technical Guide – River & Stream Systems: Erosion Hazard Limit (MNR, 2002)**<br>• **Belt Width Delineation Procedures (TRCA, 2004)**<br>• **Credit Valley Conservation Fluvial Geomorphic Guidelines (CVC, 2015)** | | | |
| **Summary of local surficial geology and physiography** | | | |
| **Review of historical and recent aerial imagery and remote sensing data to assess channel adjustments and land uses, as appropriate** | | | |
| **Rapid assessment field work conducted within the last 5 years on a reach basis (site access permitting) using standardized assessment tools (e.g., RGA and RSAT)** | | | |
| **Representative photographs of the watercourse reach(es), any valley slopes, and riparian conditions during ice-free and snow-free conditions** | | | |

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| **Mapping that clearly shows the study area, watercourses and waterbodies, topography, and reach breaks and associated labels overlain on recent aerial imagery** | | | |
| **Mapping showing the erosion hazard limit** | | | |
| Erosion Threshold and Mitigation Assessments | | | |
| **The Report is dated, signed and stamped by a Qualified Geomorphologist licensed by the Association of Professional Geoscientists of Ontario or a Professional Engineer licensed by Professional Engineers Ontario with experience in the field of fluvial geomorphology** | | | |
| **Summary of local surficial geology and physiography** | | | |
| **Review of historical and recent aerial imagery and remote sensing data to assess channel adjustments and land uses, as appropriate** | | | |
| **Rapid assessment field work conducted within the last 5 years on a reach basis (site access permitting) using standardized assessment tools (e.g., RGA and RSAT) to determine sensitivity to erosion** | | | |

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| **Detailed geomorphological data collected within a representative section of a sensitive reach(es) (e.g., longitudinal profile and cross section survey, channel bank and substrate characterization and size distribution) located downstream of proposed stormwater outlet(s)**<br><br>**Assessment to include a minimum of two monumented cross sections with erosion pins to facilitate field verification and multi-year monitoring, if required** | | | |
| **Representative photographs of the watercourse reach(es), any valley slopes, and riparian conditions during ice-free and snow-free conditions**<br><br>**Photographs of monumented cross sections from set vantage points to facilitate field verification and multi-year monitoring, if required** | | | |
| **Erosion threshold calculated based on scientifically- defensible modelling. Field verification may be required at the discretion of the City** | | | |
| **Post- to pre-exceedance analysis using hydrologic modelling**<br><br>**Hydrologic modelling approach / requirements to be confirmed in consultation with the City of Hamilton and Conservation Authority prior to initiation of study** | | | |
| **Erosion modelling hydrographs provided as a report appendix** | | | |

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| **Mapping that clearly shows the study area, watercourses and waterbodies, reach breaks and associated labels, detailed geomorphic assessment location, and proposed stormwater outlet location(s) overlain on aerial imagery** | | | |
| **Assessment of impacts of proposed stormwater management strategy on downstream receiving watercourse(s) provided** | | | |
| Infrastructure Crossing Assessments (Underground Services and Watercourse Crossings) | | | |
| **The Report is dated, signed and stamped by a Qualified Geomorphologist licensed by the Association of Professional Geoscientists of Ontario or a Professional Engineer licensed by Professional Engineers Ontario with experience in the field of fluvial geomorphology** | | | |
| **Summary of local surficial geology and physiography** | | | |
| **Review of historical and recent aerial imagery and remote sensing data to assess channel adjustments and land uses, as appropriate** | | | |

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| **Rapid assessment field work conducted within the last 3 to 5 years on a reach basis (site access permitting) using standardized assessment tools (e.g., RGA and RSAT)** | | | |
| **Representative photographs of the watercourse reach(es), proposed infrastructure crossing location(s), any valley slopes, and riparian conditions during ice-free and snow-free conditions** | | | |
| **Infrastructure crossing(s) is located along a relatively straight section of channel where there are no significant erosion concerns (e.g., avoids large meanders)** | | | |
| **Mapping that clearly shows the study area, watercourses and waterbodies, reach breaks and associated labels, and crossing infrastructure overlain on aerial imagery** | | | |
| **Infrastructure crossing design accommodates the channel and potential erosion hazard** | | | |
| **If applicable, road crossing inlet(s) and outlet(s) are appropriately designed to remain stable over a range of flow conditions** | | | |

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| **If applicable, any substrates proposed within road crossings have been hydraulically sized to remain stable during a range of flow events** | | | |
| **If required, scour analysis completed to confirm adequate depth of cover and inform erosion control requirements** | | | |
| **Natural Channel De**sign | | | |
| **The Report is dated, signed and stamped by a Qualified Geomorphologist licensed by the Association of Professional Geoscientists of Ontario or a Professional Engineer licensed by Professional Engineers Ontario with experience in the field of fluvial geomorphology** | | | |
| **Summary of local surficial geology and physiography** | | | |
| **Review of historical and recent aerial imagery and remote sensing data to assess channel adjustments and land uses, as appropriate** | | | |
| **Rapid assessment field work conducted within the last 3 to 5 years on a reach basis (site access permitting) using standardized assessment tools (e.g., RGA and RSAT) for all watercourse reaches, whether being retained, modified or realigned** | | | |

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| **Representative photographs of the watercourse reach(es), any valley slopes, proposed outlet location(s) and riparian conditions during ice-free and snow-free conditions** | | | |
| **Detailed geomorphological assessment along a reference reach to inform the design that includes a survey of the longitudinal profile, and representative cross sections, characterization of bank materials, channel substrate composition (sampled for grain size analysis or pebble counts, as appropriate) and a general description of immediate riparian conditions** | | | |
| **Mapping that clearly shows the study area, watercourses and waterbodies, reach breaks and associated labels** | | | |
| **Design Brief documents rationale for the proposed channel planform, gradient, bankfull channel geometry, geomorphology and selected bioengineered treatments** | | | |
| **Drawings in planview:**<br>• **Proposed grading**<br>• **Work area limits**<br>• **Watercourse alignment and channel banks**<br>• **Existing and proposed infrastructure and utility crossings**<br>• **Proposed treatment type / extent**<br>• **Restoration planting plan** | | | |

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| **Drawings in profile view:**<br>• **Existing ground/channel and proposed channel bed and bankfull gradients**<br>• **Proposed grading**<br>• **Existing and proposed crossing infrastructure and utility crossings** | | | |
| **Drawings in cross section view:**<br>• **Cross sectional view(s) of geomorphic units, wetlands and bioengineered treatments, as required**<br>• **Proposed substrate composition**<br>• **Mechanical stabilization measures**<br>• **Restoration planting plan** | | | |
| **Hydraulic stone sizing completed based on velocities/shear stresses/discharges** | | | |
| **Drawings showing details:**<br>• **Restoration planting plan (e.g., live stake planting detail)**<br>• **Floodplain features (e.g., snake hibernacula, basking logs, turtle nesting site)**<br>• **Mechanical stabilization measures** | | | |

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| **Phasing, erosion and sediment control plans are provided at detailed design stage that follow appropriate guidelines and standards and include typical details (e.g. TRCA, 2019)** | | | |
| Stormwater / Dewatering Outfall Siting and Treatment Design | | | |
| **The Report is dated, signed and stamped by a Qualified Geomorphologist licensed by the Association of Professional Geoscientists of Ontario or a Professional Engineer licensed by Professional Engineers Ontario with experience in the field of fluvial geomorphology** | | | |
| **Summary of local surficial geology and physiography** | | | |
| **Review of historical and recent aerial imagery and remote sensing data to assess channel adjustments and land uses, as appropriate** | | | |
| **Rapid assessment field work conducted within the last 5 years on a reach basis (site access permitting) using standardized assessment tools (e.g., RGA and RSAT) where the stormwater outlet(s) is proposed** | | | |

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| **Representative photographs of the watercourse reach(es), any valley slopes, proposed outlet location(s) and riparian conditions during ice-free and snow-free conditions** | | | |
| **Mapping that clearly shows the study area, watercourses and waterbodies, reach breaks and associated labels, and proposed stormwater outlet location(s) overlain on aerial imagery** | | | |
| **Design considers valley setting and topography, and avoids areas of active erosion and sensitive habitats to the extent feasible** | | | |
| **Extent of topographic survey encompasses 15 m upstream and downstream of the proposed stormwater outlet location and includes:**<br>• **Watercourse inverts and thalweg**<br>• **Water level at the time of survey**<br>• **Channel banks**<br>• **Valley slopes and any existing erosion protection measures**<br>• **Existing infrastructure and utilities** | | | |

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| **Drawings in planview are to include:**<br>• **Proposed grading**<br>• **Work area limits**<br>• **Watercourse alignment and channel banks**<br>• **Existing and proposed crossing infrastructure and utilities**<br>• **Extent of the erosion hazard for the receiving watercourse**<br>• **Proposed outlet treatment type(s) / extent**<br>• **Restoration planting plan** | | | |
| **Drawings in profile view:**<br>• **Existing and proposed longitudinal profile of the storm sewer outlet**<br>• **Proposed grading**<br>• **Existing and proposed infrastructure and utility crossings**<br>• **Proposed outlet treatments, including any connecting channel to receiving watercourse**<br>• **Proposed substrate composition for outlet treatments**<br>• **Mechanical stabilization measures**<br>• **Restoration planting plan** | | | |

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| **Drawings in cross section view:**<br>• **Cross sectional view(s) of outfall treatment(s)**<br>• **Proposed substrate composition for outlet treatment(s)**<br>• **Mechanical stabilization measures**<br>• **Restoration planting plan** | | | |
| **Hydraulic stone sizing completed based on maximum proposed velocities at the stormwater outlet** | | | |
| **Drawings showing typical details:**<br>• **Restoration planting plan (e.g., live stake planting detail, seed mixes)**<br>• **Bioengineered outfall treatment(s)**<br>• **Mechanical stabilization measures** | | | |
| **Phasing, erosion and sediment control plans are provided at detailed design stage that follows appropriate guidelines and standards and includes typical details (e.g., TRCA, 2019)** | | | |
| Baseline Instream Monitoring | | | |

| | | | |
|---|---|---|---|
| **The Report is dated and signed by a Qualified Geomorphologist licensed by the Association of Professional Geoscientists of Ontario or a Professional Engineer licensed by Professional Engineers Ontario with experience in the field of fluvial geomorphology** | | | |
| **Continuous flow monitoring locations established at the upstream and downstream extents of study area and the confluence(s) of major tributaries to measure discharge and water temperature (site access permitting)**<br><br>**Monitoring period to extend from April to November** | | | |
| **Monumented hydrological monitoring cross sections established to calibrate discharge at each monitoring location** | | | |
| **Summary of surface water quality parameters measured and associated results and interpretation** | | | |
| **Monumented geomorphic monitoring cross sections and longitudinal profile established to characterize pre-development erosion rates and substrate composition** | | | |

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|---|---|---|---|
| **Sediment size distribution characterized using pebble count techniques or sampled for grain size analysis** | | | |
| **Monumented photographs as a visual record of instream conditions at the time of each monitoring visit** | | | |
| **Characterization of channel erosion based on natural variability** | | | |

Qualified Professional who completed the report summary:

Name:_____

Email:_____

Phone:_____

Date:_____

Signature and Stamp:_____