GERMAN MILLS CREEK GEOMORPHIC SYSTEMS MASTER PLAN

ENVIRONMENTAL ASSESSMENT FILE REPORT

Prepared for:
CITY OF TORONTO – TORONTO WATER

Prepared by:
MATRIX SOLUTIONS INC., A MONTROSE ENVIRONMENTAL COMPANY

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EXECUTIVE SUMMARY

On August 19, 2005, a storm exceeding the 1-in-100-year event and classified as a tornado remnant occurred in north Toronto, resulting in extensive creek erosion along German Mills Creek. City of Toronto infrastructure, including bridges, pathways, maintenance holes, and sanitary sewers in and adjacent to the creek were exposed, representing a risk to public safety. Following temporary repair efforts, additional damages occurred during subsequent storm events. Urban stream channels such as German Mills Creek have been identified as unstable and adjusting to a changed pattern of streamflow, primarily due to increased runoff from impervious surfaces associated with urban development and an absence of stormwater management controls. Such changes have increased bed and bank erosion, particularly acute during large storm events, resulting in altered stream morphology, damage or increased risk of damage to infrastructure, and decreased habitat quality.

The primary study objective was to evaluate the existing geomorphic and ecological conditions of German Mills Creek and develop a Master Plan to rehabilitate the channel and mitigate further sustained erosion and risk to infrastructure.

Master Plan

This study reviews the historical and existing creek and watershed conditions, identifies and prioritizes erosion sites, provides potential rehabilitation alternatives, and proposes preferred alternatives for specific project sites within the German Mills Creek. The Master Plan was carried out following the City's Geomorphic System Master Plan (GSMP) approach, which was developed to follow the Municipal Class Environmental Assessment (MCEA; 2000, amended 2007, 2011, and 2015) process in conjunction with applying the Adaptive Management of Stream Corridors (AMSC) principles (MNR 2001). For this study, Approach Number 2 was followed that involves the preparation of a Master Plan at the conclusion of Phases 1 and 2 of the MCEA process, where the level of investigation, consultation, and documentation are sufficient to fulfill the requirements of Schedule B projects. The final Notice of Completion for the Master Plan is also the Notice of Completion for the Schedule B projects recommended in the Master Plan.

The Master Plan allows for an integrated planning approach for German Mills Creek within the City of Toronto, and a methodology for implementing the necessary rehabilitation efforts. In evaluating options, a broad-based process is used including functional performance, environmental, social, and economic considerations. The Master Plan uses the MNR (2001) guide, *The Adaptive Management of Stream Corridors in Ontario*, as the foundation for defining the appropriate content for EA purposes at different study stages. An assessment that integrates information including hydraulic and hydrologic modelling, existing infrastructure, terrestrial, vegetative, and aquatic habitat, land use changes within the watershed, historical adjustments to channel planform, geomorphic conditions, and geologic data allows for a comprehensive evaluation of the preferred alternatives to be presented.

Study Conclusions Concerning Geomorphology and Ecological State of the Creek

The study area is located within the German Mills Creek subwatershed, which comprises a portion of the larger Don River watershed. The entirety of the German Mills Creek channel extends 26 km in length and contains a drainage area of approximately 41.7 km^2. Its headwaters originate on the southern slope of the Oak Ridges Moraine, eventually draining into the Don River East Branch. The German Mills Creek subwatershed is highly urbanized and the creek has undergone historic channel realignments and straightening.

The focus of this study is on the lower-most reaches of German Mills Creek within Toronto from Steeles Avenue to the confluence with the East Don River. This section of German Mills Creek was divided into study segments, or “reaches” based on physical characteristics such as channel form, sinuosity, gradient, hydrology, local geology, degree of valley confinement, and the impact of road crossings. Four reaches (GM-1 to GM-4) were delineated for the study area and extensively studied. The individual reaches were observed to be in various stages of geomorphic adjustment and degradation in the study area. The urbanized flow regime has altered the dynamics of the German Mills Creek system resulting in channel instability, exposed infrastructure, and risk for future damage. The creek is typically entrenched and disconnected from the floodplain, with the most downstream reach (Reach GM-1) documented to have the greatest increases in channel width since 1954, but appears to be starting development of a wider floodplain at a lower elevation in local sections.

Erosion risks sites throughout the study area were identified and prioritized for the protection of sewer infrastructure. Lower-risk sites were grouped with higher risk sites in close proximity, resulting in 11 Project Sites within German Mills Creek and a twelfth Project Site for the Bestview Tributary. The entire Bestview Tributary was assessed as a single site for this study as instability downstream could eventually pose risk to the upper, engineered segment.

German Mills Creek can be deemed as high-quality aquatic habitat, with two potential barriers to fish movement under low-flow conditions. Based on existing fish community data and the thermal regime, German Mills Creek is classified warm/cool water system (TRCA 2009). The system exhibits a high proportion of benthic organisms with moderate or higher tolerance to low water quality. In general, the water quality, as assessed through benthic metrics, was determined to be fairly poor to fair.

Study Conclusions Concerning Climate Change Assessment

Climate and environment are one of the four resilience challenges facing the City of Toronto (the City), as identified in the *Toronto Resilience Strategy* (City of Toronto 2019). As such, a climate change assessment approach was developed in consultation with City staff to meet the project objectives and included the following: 1) future rainfall scenarios; 2) hydrological modelling; 3) geomorphic impact analysis; and 4) geomorphic system master plan evaluation of impacts. From the results and analysis presented, a 10% increase on average in the erosional forces that initiate movement of channel bed materials (e.g., flow velocity) and a 100% increase on average in sediment transport work (i.e., mass that is moved) may be expected due to climate change impacts on future rainfall to German Mills Creek.

As part of the development of alternatives for the study, several design approaches will be considered and evaluated based on potential for added climate resilience and/or redundancy, to protect Toronto Water infrastructure over the intermediate and long term. The alternative concepts, and the recommended timelines for intervention, will also be evaluated based on potential for climate changes to impact the design life and maintenance requirements of any new erosion mitigation assets. Following adaptive management approaches, designing to shorter-time periods (e.g., 2050) may be considered appropriate to balance the cost of migration for managing creek erosion with the uncertainty of longer-term climate outcomes. As such, the design approach needs to consider how erosion mitigation infrastructure can be maintained, adapted, and effectively modified to meet future climate conditions with ongoing monitoring and watershed planning activities by the City and TRCA. The GSMP climate change assessment report provides detailed analyses and results that support the selection of preferred alternative solutions and conceptual design options (Appendix D).

STUDY METHODS AND CONCLUSIONS

Adaptive Management Study Process and Findings

With the issues having been identified along German Mills Creek, various alternatives to address the issues were considered, including the ‘Do Nothing’ alternative, ‘Local Works,’ ‘Local Works with Reach-scale Floodplain Connections,’ and ‘Reach Works.’ Descriptions for each are provided below:

- **Alternative 1 - Do Nothing** – leaving existing conditions as is with no design mitigation, resulting in further channel degradation and erosion, with potential or continued exposure and/or undermining Toronto Water infrastructure; could consist of continued monitoring where priority sites are already exposed and are likely to require emergency works (local placement of riprap rock protection). For sites where erosion risk may be lower, monitoring may also be recommended.

- **Alternative 2 - Local Works (sub-reach scale, <200 m length)** – local erosion mitigation projects of less than 200 m in channel length, including adjustments to both the channel bed and banks, to address high priority sites and nearby secondary sites which typically fall within the project extents of local works designs, with a range of design options to be considered.

- **Alternative 3 - Local Works with Reach-scale Floodplain Connections** - local works (Alternative 2, bed and bank modifications, less than 200 m) and enhancing floodplain connectivity with bank modifications in between the local works sites to strategically increase floodplain conveyance, balancing proposed works with tree removals.

- **Alternative 4 - Reach Works (>200 m length)** – reach scale channel works of greater than 200 m in channel length to realign and/or restore the channel and floodplain connectivity in a new configuration, including some level of erosion control, with a range of design options to be considered to address a collection of local erosion mitigation project sites.

Consultation and Engagement

The public and agency consultation and Indigenous engagement requirements for a Schedule B project under the Municipal Class EA process were followed, including:

- A Notice of Study Commencement was distributed on October 3, 2022, to inform the public and applicable agencies that the Class EA is being undertaken.

- Toronto and Region Conservation Authority (TRCA) was engaged on May 19, 2023; an overview of the site characterization, erosion risk assessment, project sites, and alternatives generation and evaluation were provided. Consultation occurred through different stages of the project and including design recommendations and discussion around erosion monitoring in Bestview Tributary.

- Following the notice of engagement, the Stage 1 archaeological report was supplied to Indigenous communities, including the Chippewas of Rama First Nation, who responded, requesting revisions to include a detailed history of the Chippewas of Rama First Nation.

- A Public Information Centre (PIC) was held onsite on August 18, 2023, and included a presentation (poster boards), accompanied by a site walk to local issue locations. Attendees included project staff from the City and Matrix and interested members of the public. A survey was provided that included general questions regarding relationship to the project (GSMP Study Area), and sections for specific comments with respect to individual project sites and each alternative. In, general many of the attendance live near the study area, and visit the creek/corridor for leisure, recreation, with some utilizing it to travel to specific destinations. Comments from the public on project sites were specific, including timing of channel works with respect to other infrastructure, opportunities to protect the multi-use trail, the individual's preferred alternative selection, and concerns around park/trail closures for extended periods of time. Following discussion of the approach and perceived advantages and disadvantages regarding the various intervention strategies, most participants were satisfied with the recommended preferred alternatives.

Preferred Alternatives

After having evaluated each alternative against the established criteria and consulting all interested parties, preferred alternatives were selected for each Project Site as follows:

- **Alternative 1 (Do Nothing)** – The preferred alternative for **Project Site 12** (Bestview Tributary). TW assets are limited to an outfall at the upstream end of the tributary with a stable armourstone channel downstream. Erosion monitoring is recommended (including by TRCA).

- **Alternative 2 (Local Works)** – preferred alternative for **Project Sites 4, 5, 6, 7, 10, and 11**. This includes spot treatments at Project 11 and sub-reach (<200 m) channel modifications or treatments at Project Sites 4, 5, 6, 7, and 10.

- **Alternative 3 (Local Works with Floodplain Connections) –** The preferred alternative for **Project Sites 1, 2, 3, 8, and 9**. This consists of local sub-reach (<200 m) channel modifications and treatments, which are connected upstream and/or downstream to other project sites through sections of floodplain grading to reduce overall instream erosion potential.

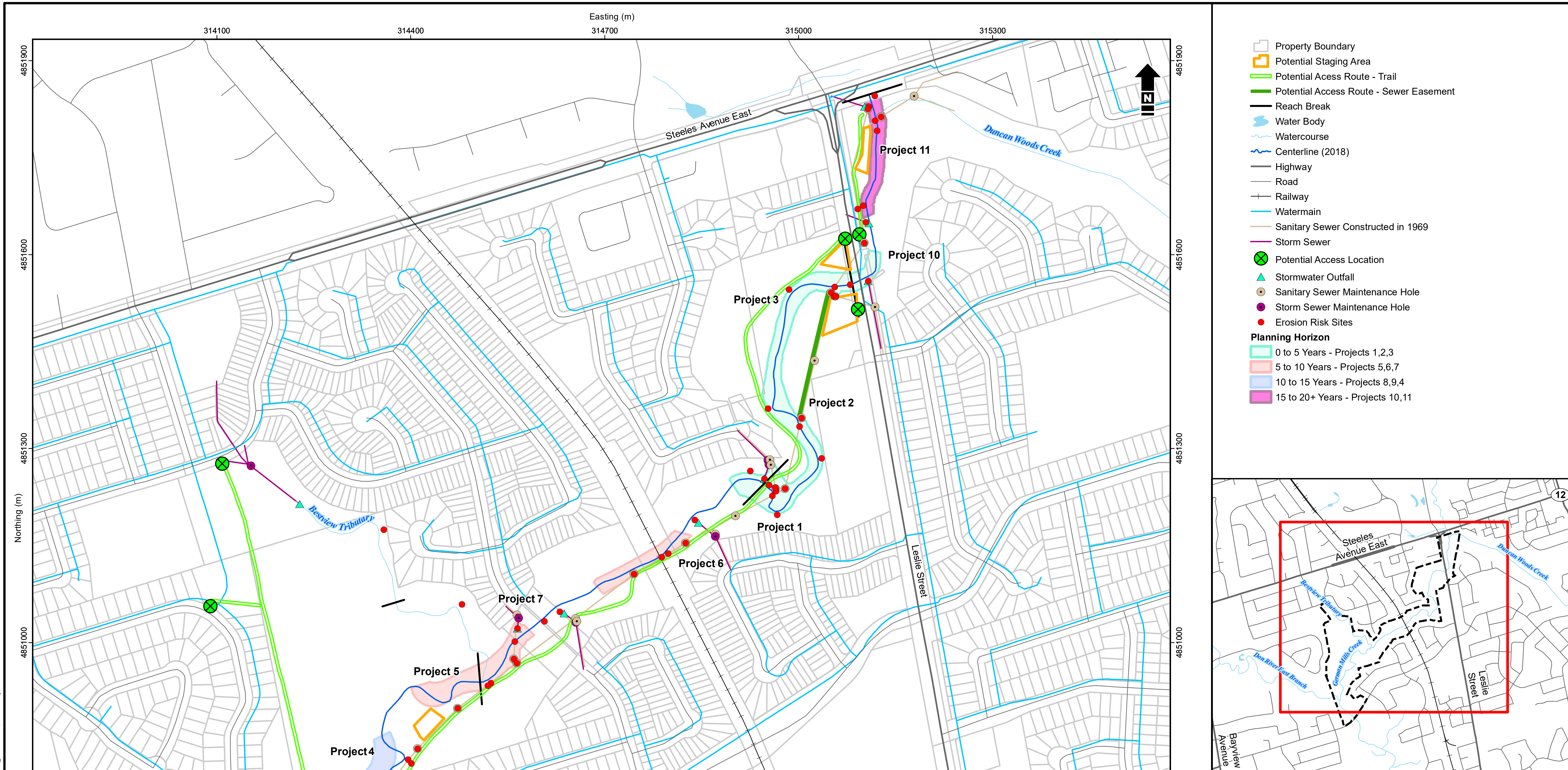
Implementation

The implementation of the recommended preferred alternatives is based on a 20-year timeline and would commence after the EA posting and the review process of the Master Plan is complete (Figure A). A phased approach is to occur over the following time frames: 0 to 5 years, 5 to 10 years, 10 to 15, and 15 to 20+ years. The sequence of implementation would ensure that rehabilitation at the most critical sites are considered priority and are carried out first. Table A summarizes the implementation plan and confirms the EA Schedule associated with the rehabilitation works at each Project Site. Past management in urban streams has generally been reactive, and often on an emergency basis, including at German Mills Creek. The implementation process will utilize the adaptive environmental management (AEM) approach to inform decision making and monitoring of rehabilitation work (MNR 2001). The approach recognizes that the system as designed and constructed is not permanent, but rather is expected to change over time as it continues to adjust to land use impacts and the effects of climate change. To account for this future uncertainty, the AEM approach emphasizes three additional steps following implementation: Monitor, Evaluate, and Adjust. By employing this approach, the likelihood of future damage and risk is minimized as the mitigation measures are adjusted as necessary to ensure success based on the results of the monitoring.

TABLE I German Mills Creek Geomorphic Systems Master Plan Implementation

Time Period	Project Site # (Reach)	EA Schedule
0 to 5 Years	1 (GM-3) 2 (GM-3) 3 (GM-3 and GM-4)	B B B
5 to 10 Years	7 (GM-2) 5 (GM-1 and GM-2) 6 (GM-2)	B B B
10 to 15 Years	4 (GM-1) 8 (GM-1) 9 (GM-1)	B B B
15 to 20+ Years	10 (GM-4) 11 (GM-4)	B A or B*
Monitoring	12 (Bestview Tributary)	n/a

*Aspects of rehabilitation for site 11 may be advanced as Schedule A. However, works around Steeles Avenue are substantial and likely fall into Schedule B.



Disclaimer: Watermain and sewers have been clipped to the Focused Study Area.

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1:6,000 metres
60 0 60 120
NAD27 MTM zone 10

Matrix Solutions Inc.
A Montrose Environmental Company

City of Toronto
German Mills Creek GSMP EA

Implementation Plan

Date:	Project:	Submitter:	Reviewer:
November 2023	32227	J. McDonald	R. Phillips

Figure 1

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ATTACHMENT 1 German Mills Creek Geomorphic Systems Master Plan Environmental Assessment, Public Consultation: August 2023 (presentation slides)
ATTACHMENT 2 Concept Drawings for Preferred Alternative

LIST OF ACRONYMS

AEM –Adaptive Environmental Management

AMSC –Adaptive Management of Stream Corridors

ANSI –Areas of Natural and Scientific Interest

CNR – Canadian National Railway

DFO – Department of Fisheries and Oceans

EA –Environmental Assessment

EAA –*Environmental Assessment Act*

ELC –Ecological Land Classification

ESA – *Endangered Species Act*

GMGSMP – German Mills Geomorphic Systems Master Plan

GSMP – Geomorphic Systems Master Plan

MBW –Meander Belt Width

MCEA –Municipal Class Environmental Assessment

MECP –Ministry of the Environment, Conservation and Parks

MNR –Ministry of Natural Resources

MNRF –Ministry of Natural Resources and Forestry

OSAP –Ontario Stream Assessment Protocol

PF&R –Parks, Forestry & Recreation

PIC –Public Information Centre

RGA –Rapid Geomorphic Assessment

RSAT –Rapid Stream Assessment Technique

SAR – Species At Risk

SCC –Species of Conservation Concern

SHL –Scour Hazard Limit

STS – Sanitary Trunk Sewer

SWH –Significant Wildlife Habitat

TOB –Top of Bank

TRCA – Toronto and Region Conservation Authority

TTE –Time to Exposure

TW – Toronto Water

TWAG –Toronto Water Assett Geodatabase

WWFMP – Wet Weather Flow Management Master Plan

1 INTRODUCTION

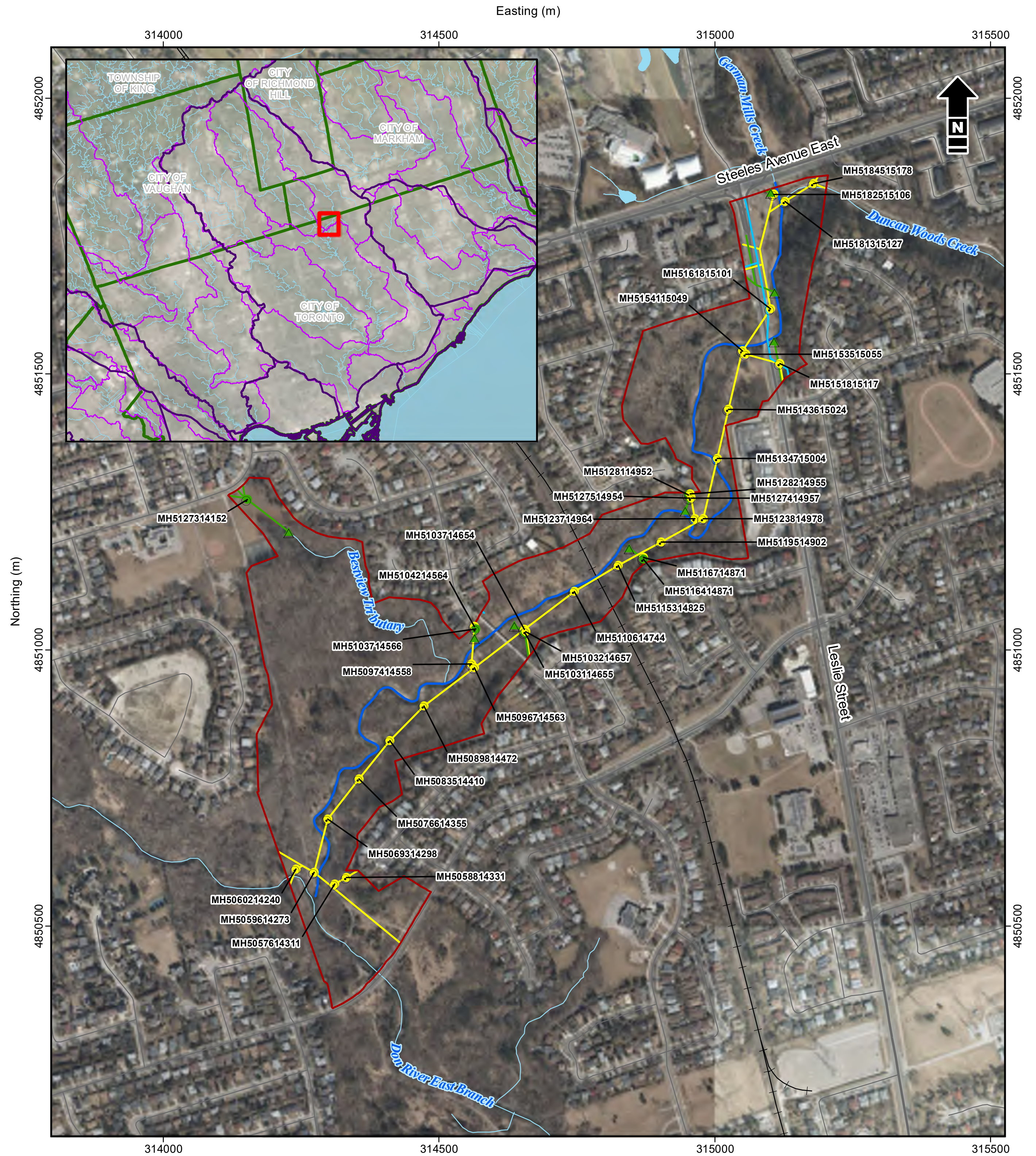
1.1 Overview

The City of Toronto (City) is developing geomorphic system master plans (GSMP) to manage risk to Toronto Water (TW) infrastructure located within the corridors of its rivers. The City has retained Matrix Solutions Inc., a Montrose Environmental company (Matrix), to prepare a GSMP for the section of the German Mills Creek that is situated within its urban limits. The 2 km long study area of German Mills Creek (Figure 1-1) was identified in the 2003 Wet Weather Flow Management Master Plan (2003 WWFMP; City of Toronto 2003) as a priority for stream restoration (Don River, Area 4, Reach 17). Of historical importance for the current study (shortly after the 2003 WWFMP), an extreme flood event in 2005 caused significant erosion and exposed sewer infrastructure in many Toronto watercourses, including sections within the German Mills Creek system. Near the upstream limit of the study area is the confluence of the Duncan Creek tributary, where the City has been progressively working to stabilize and rehabilitate associated damages along the tributary channel. Working downstream from Steeles Avenue and the Duncan Creek confluence, the study area of German Mills Creek is the next logical step to manage erosion and risks to TW infrastructure within the local study area.

An initial inventory of erosion risks has identified three exposed maintenance holes for the sanitary trunk sewer (STS) within the study area (Figure 1-2), with approximately 11 other maintenance holes at potential risk in the future (moderate and low risk). With respect to the potential risks due to vertical degradation of German Mills Creek, there are six pipe crossings of the STS under the watercourse and two locations where lateral sewer pipes cross. The active bank erosion and lateral meander bend migration of German Mills Creek within the study area represent an ongoing risk to the STS, which runs parallel to the channel trend down the valley, and to several stormwater outfalls discharging along the active channel. While both vertical and horizontal risks will be assessed for German Mills Creek, it is understood that active lateral channel migration poses the most immediate and long-term risks to the STS and storm outfalls within the reach.

The GSMP is conducted as a Master Plan Environmental Assessment (EA) study that follows the framework of the Municipal Class Environmental Assessment (MCEA) and has been completed in association with the Adaptive Management of Stream Corridors (AMSC) in Ontario protocol.

The intent of the GSMP is to build upon previous study findings to document existing conditions and to establish a systems-based understanding of the study area with consideration of aquatic habitat, geomorphology, and hydrology/hydraulics. This understanding forms the basis for establishment of a holistic balance and proactive approach to protecting TW infrastructure while also promoting a stable watercourse and healthy environmental corridor along German Mills Creek. The study incorporates an understanding of climate change and associated expectations and risks as they may relate to TW infrastructure.



Focused Study Area
Watershed Boundary
Subwatershed Boundary
Municipal Boundary
Watercourse
Highway
Road
Railway
German Mills Creek Within GSMP Study Area

Sanitary Sewer
Storm Sewer
Watermain
Sanitary Sewer Maintenance Hole
Storm Sewer Maintenance Hole
Stormwater Outfall

Disclaimer: Sewers have been clipped to the Focused Study Area.

Reference: Contains information licensed under the Open Government Licence – Ontario. Imagery (2018) obtained from Canada Map Sales. used under license. Imagery provided by Source: Esri, Maxar, Earthstar Geographics, and the GIS User

1:10,000 metres
100 0 100 200
NAD27 MTM zone 10

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Toronto
German Mills Creek GSMP EA

General Study Area

Date:	Project:	Submitter:	Reviewer:
July 2022	32227	N. Cyples	J. McDonald

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Figure 1-1

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FIGURE 1-2 Photographs of Three Exposed Maintenance Holes

A) MH5123714964; B) MH5134715004; and C) MH5154115049

1.2 Study Goals and Objectives

The primary goal of the project is to generate a list of design alternatives, which upon implementation of the preferred alternative, aim to reduce the risks of erosion threatening TW infrastructure within the study area of German Mills Creek. Secondary goals are to enhance local aquatic and riparian ecosystems using natural channel design principles and to ensure climate change resiliency in the erosion mitigation strategies used to protect infrastructure over an effective design life.

The 2003 WWFMP (City of Toronto 2003) sets the tone for the most water related projects in the City and has been considered when formulating the alternative solutions for the German Mills Creek GSMP. The goal of the WWFMP is to reduce and ultimately eliminate the adverse impacts of wet weather flow on the built and natural environment in a timely and sustainable manner and to achieve a measurable improvement in the ecosystem health of the watersheds.

The three main project objectives required to achieve the goals of the study include the following:

- **Project Objective 1 - Existing Conditions and Risk Assessment:** undertake the analyses required to assess and characterize past and existing conditions for stream morphology, hydrology and hydraulics, aquatic habitat, terrestrial habitat, and TW infrastructure along German Mills Creek.

- **Project Objective 2 - Evaluate Alternatives to Meet Project Goals:** identify and evaluate rehabilitation alternatives that will contribute to the long-term protection of TW infrastructure while minimizing the effects on the riparian ecosystem and improving aquatic habitat.

- **Project Objective 3 - Select Preferred Solutions Through Municipal Class Environmental Assessment and Consultation Processes:** select preferred solution(s) following an evaluation of environmental, social, and economic factors that will protect TW infrastructure.

The current study provides the City with a multidisciplinary investigation of the processes that have contributed to the physical degradation of German Mills Creek and are expected to lead to further erosion and degradation in the future. The findings of the integrated technical study are intended to guide the development of a long-term plan for rehabilitation of German Mills Creek, where appropriate, to protect TW infrastructure that has already been damaged or is at risk of being damaged in the future as a result of erosion. The City's GSMP approach has been developed to follow the MCEA process in conjunction with applying the AMSC principles.

1.3 Municipal Class Environmental Assessment and Master Planning

1.3.1 Overview

All municipalities in Ontario are subject to the provisions of the Ontario *Environmental Assessment Act* (EAA; 1990) and its requirements to prepare an EA for applicable public works (or municipal infrastructure) projects. The Municipal Engineers Association (MEA) MCEA document (October 2000, as amended in 2007, 2011 and 2015) provides municipalities with a phased, streamlined, and self-administered framework for EA planning of public works projects in accordance with the provisions of the EAA.

Approved by the Minister of the Environment, Conservation and Parks (MECP), the MCEA process enables the planning and execution of municipal infrastructure projects in accordance with an approved procedure that is designed to ensure that potential impacts (or effects) on the natural, social, economic, cultural, and technical environment are taken into consideration on a consistent basis. Provided the MCEA process is followed, municipalities are not required to obtain project-specific approval under the EAA from the Ministry of the Environment, Conservation and Parks (MECP).

Class EAs are prepared for approval by the Minister of the Environment. The Master Plan approach recognizes the importance of planning a group of related projects as part of an overall system. This helps define the justification and context of individual projects with respect to the larger system in order to meet the needs of the community. Provided the process is followed, projects and activities included under the Class EA do not require formal review and approval under the EAA. In this fashion, the Class EA process expedites the environmental assessment of smaller recurring projects.

Appendix A provides detail on the EA process including the sequence of steps, project schedules, and Part II orders.

1.4 Adaptive Management of Stream Corridors

The City of Toronto advocates reliance on the *Framework for Adaptive Management* (MNR 2001) document as a guide for undertaking Geomorphic System Master Plan studies (Figure 1-3). This framework, developed in consultation with other regulatory agencies, municipalities, and practitioners, represents a 7-stage study process that takes a project from: 1) problem formation, to 2) preliminary planning and assessment, 3) detailed analysis for planning and design, 4) implementation, 5) monitoring, 6) evaluation, and 7) adjustment. The procedure represents an orderly approach for completing a thorough and comprehensive investigation to first gain an understanding of the nature and extent of a perceived problem in the study area, and then to identify the cause(s) that contribute to the "problem." Once a thorough integrated understanding of the geomorphic, biologic/ecologic, and water resources components of the study area (e.g., German Mills Creek) has been achieved, then this information is used to develop and evaluate alternative solutions to mitigate the 'problem' or to identify appropriate restoration solutions (Stages 1 to 3).

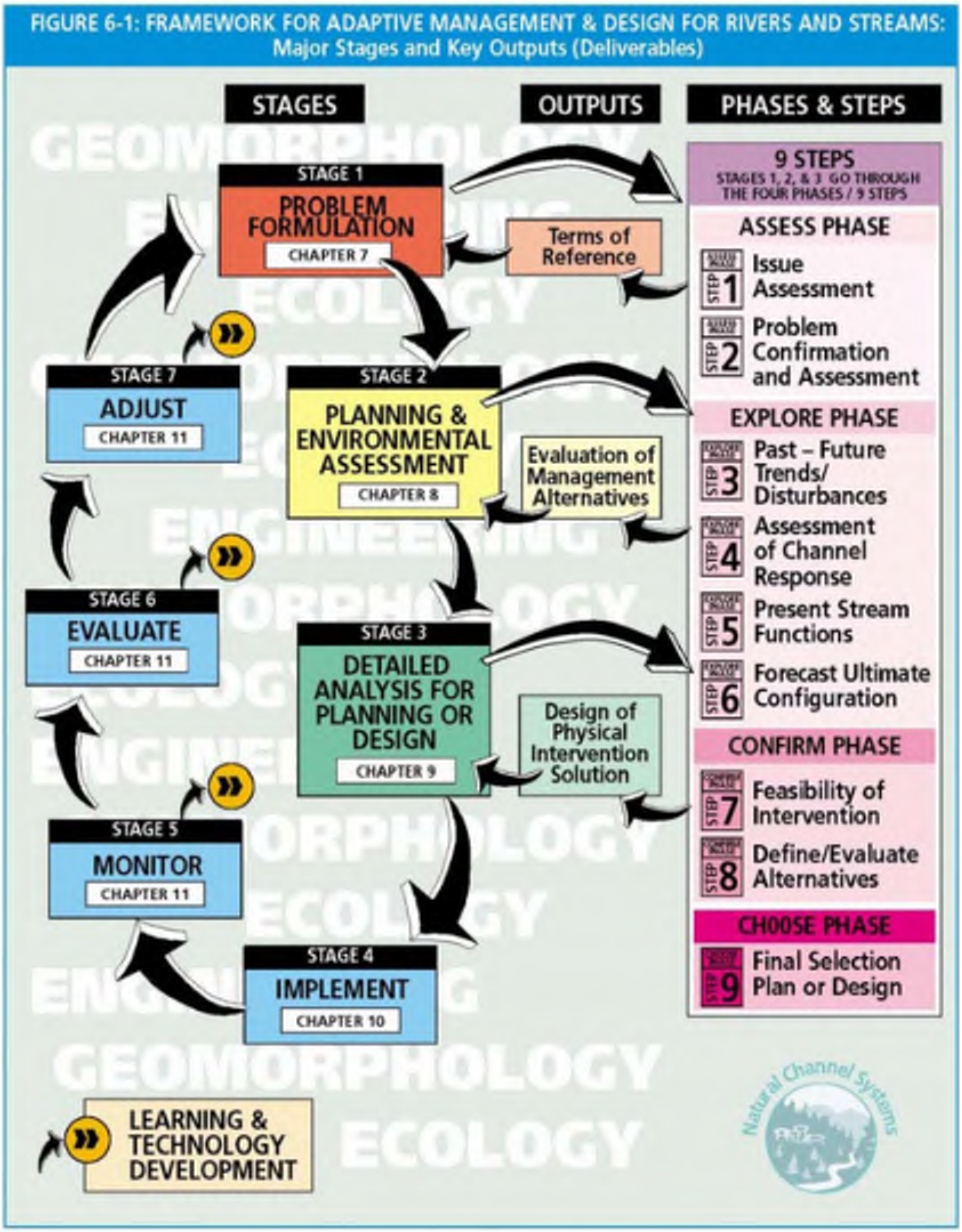


FIGURE 1-3 Framework for Adaptive Management and Design for Rivers and Streams (MNR 2001)

The first three stages of the MNR framework are grouped into four study phases; each phase is subdivided into nine study steps. The four study phases, which are similar to the EA process are summarized in Table 1-1. The GSMP project completes the first three phases (Assess, Explore, Confirm) and addresses the fourth phase (Choose).

The City has selected the MNR (2001) framework to guide development of GSMP projects as it promotes consistency amongst different practitioners and ensure a comprehensive study approach. The framework identifies the types and depths of analyses that are undertaken so that a thorough understanding of existing conditions is gained from which reasonable alternatives are identified and evaluated. As such, the MNR (2001) framework provides the fundamental basis for undertaking the Provincial Class EA process by ensuring that studies and design projects provide a broad scoped analysis approach, considers all alternatives for the proposed works, and provides opportunity for public input into the decision-making process.

1.5 Geomorphic Systems Master Plan Approach

Following a master planning approach, the GSMP work plan is streamlined to follow the AMSC principles while addressing the MCEA process to ensure each step in the analysis, design, and planning process is fully integrated (Table 1-1).

TABLE 1-1 Combined Class Environmental Assessment and Adaptive Management Process for the Geomorphic Systems Master Plan

Municipal Class Environmental Assessment	Ministry of Natural Resources and Forestry Adaptive Management of Stream Corridors in Ontario (MNR 2001)	Combined Geomorphic Systems Master Plan Approach
Environmental Assessment Phase 1: Problem and/or Opportunity		
Identify Problem or Opportunity	Steps 1 and 2: Issue Assessment	Phase 1: Issue Assessment and Problem Confirmation
Environmental Assessment Phase 2: Alternative Solutions		
Inventory of Natural, Social, and Economic Conditions	Step 3: Past/Future Trend Disturbances Step 4: Assessment of Channel Response Step 5: Present Stream Functions Step 6: Forecast Ultimate Configuration	Phase 2: Development of Alternative Solutions
Identify Alternative Solutions	Step 7: Feasibility of Intervention Step 8: Define/Evaluate Alternatives	Phase 3: Define and Evaluate Alternative Solutions
Evaluation of Alternatives - Identify Impacts of Alternative Solutions and Mitigation Measures	Step 8: Define/Evaluate Alternatives	
Select Preferred Solutions	Step 9: Final Selection Plan or Design	Phase 4: Selection of Preferred Solution(s)
Review and Confirm Choice of Project Schedules		

1.6 Consultation

The Municipal Class EA process provides that all views be taken into consideration during the planning and design phases of the project. It is imperative that concerned citizens, Indigenous rights holders, local interest groups, government agencies, and non-governmental organizations receive project information and are provided the opportunity to comment as the project progresses. Public Information Centres (PICs) are held to provide detailed information regarding the study, obtain feedback on the evaluation of alternative options and the development of long-term remedial measures, and address any concerns raised regarding the proposed works and long-term solutions prior to finalizing the study. Details regarding the consultation completed for this study are Included in Section 4.5 and includes a record of consultation with First Nations, review agencies, and members of the public.

2 PHASE 1: ISSUE ASSESSMENT AND PROBLEM CONFIRMATION

2.1 Background Review and Data Gaps

The first phase of study in both the MCEA and AMSC framework (Steps 1 and 2, Appendix A) is to confirm the problem and/or opportunity that has been identified by a proponent (Table 1-1, and Appendix B). Specific to German Mills Creek, the City has identified risk to TW infrastructure that should be addressed to protect public health and safety both in the short term, and in consideration of future changes due to climate change. Confirmation of this issue is the focus of the Phase 1 study and is accomplished through a review of existing information.

Various studies and documentation of both the natural and built environment have previously been completed for German Mills Creek, including the length that is situated within the City limits. Data and background information are available in study and monitoring reports, GIS databases, environmental inventories, air photographs, drawings, models, and maintenance records. Throughout the GSMP study, information was received from the City of Toronto, Toronto and Region Conservation Authority, and the MECP, and others (Appendix B and Appendix C). A summary of the reviewed data is presented in Table 2-1.

TABLE 2-1 Summary of Data Reviewed

Topic or Discipline	Information Available	Source
Previous Reports	*Wet Weather Flow Management Master Plan, Overview and Implementation Plan* (WWFMP)	City of Toronto (2003)
	Schedule B Municipal Class Environmental Assessment - Project File, German Mills Settlers Park Sanitary Infrastructure Protection Project (German Mills Settlers Park EA)	TRCA (2019)
	Taylor-Massey Creek Geomorphic Systems Master Plan, Municipal Class Environmental Assessment	PARISH Aquatic Services (2015)
	Taylor Massey Creek Geomorphic Risk Assessment & Implementation Plan	Aquafor Beech (2021d)
	Duncan Creek design (2013) and monitoring reports (2018-2020)	Aquafor Beech (2021c)
	Wet Weather Flow Management Guidelines (WWFMG)	City of Toronto (2006)
	Don River Watershed Plan, Implementation Guide	TRCA (2009)
	TRCA *Stormwater Management Criteria*	TRCA (2012)

Topic or Discipline	Information Available	Source
Base Mapping and Aerial Imagery	General base mapping layers: • Toronto centerline (TCL; SHP), linear representations of streets, walkways, rivers, railways, highways, and administrative boundaries within Toronto • Parcel data (SHP), property boundaries • Property data maps (PDM; DWG), building envelopes, railway lines, major watercourses, curbs, catch basins, hydrants, streetlights/poles, municipal addresses, street names, property lines, street lines, and right-of-way boundaries • Edge of road (SHP), physical area of street systems	City of Toronto
	Topographic data: • Enterprise stereoscopic model (ESM; DWG), 2005 • Digital terrain model (DTM; DWG), 2005	City of Toronto
	Easements (digital TIFF files only)	City of Toronto
	Infrastructure and utilities: • Toronto Water asset geodatabase (TWAG); GDB and online access to DCAD), location and plan position of storm, sanitary, and watermains, stormwater outfalls, and maintenance holes • City utility mapping (CUMAP; DWG) underground and aboveground utility maps, including sewer and water infrastructure • Engineering drawings for Toronto Water infrastructure (see Infrastructure and Utilities)	City of Toronto
	Watercourses, erosion, and ecological data (see Geomorphology and Erosion & Ecology): • Watercourses, TRCA open data portal, polylines to represent centre channel • Ecological land classification mapping data (2021) • Floral and faunal observation mapping data (2021)	TRCA
	Aerial imagery: • Orthoimagery (2005, 2009, 2011, 2012, 2014, 2015, 2016, 2017, 2018) • Historical aerial imagery (1954, 1965, 1978)	City of Toronto
	LiDAR digital elevation model, online open source • 0.5 m resolution LiDAR Data (Lidar DTM 2015 Package D)	MNRF (2021a)
Infrastructure and Utilities	Engineering drawings: • STS drawings 1268 C 301, 1268 D 6634, 1268 D 6656, 1268 D 6657, 1268 D 6658, 1268 D 6659, 1268 D 6660, 1268 D 6661, 1268 D 6662, 1268 D 6663, 1268 D 7315 • Pineway Pedestrian Bridge drawing S-4001-12019 • Steeles Avenue Bridge drawings • Leslie Street Bridge drawings • Metrolinx Railway drawings • East Don Parkland Trail pedestrian bridge drawings	City of Toronto
	CCTV footage - Toronto Water CCTV Cloud Repository	City of Toronto
	Third-party utility drawings or markups	Utilities
	City of Toronto City Utility Mapping (CUMAP)	City of Toronto
	City of Toronto TWAG Mapping/DCAD	City of Toronto
	Leslie Street Bridge inspection forms and photographs (ID 332 OSIM 2019)	City of Toronto

Topic or Discipline	Information Available	Source
Geomorphology and Erosion	Duncan Creek (Phase 4) monitoring plan	
	Duncan Creek Phases 3 and 4 design drawings	
	TRCA Riverine Erosion Monitoring Database (GIS)	TRCA
	TRCA Toronto Water structure inspections	TRCA
	Engineering drawings - STS (see Infrastructure and Utilities)	City of Toronto
	Aerial imagery - georeferenced and orthorectified (see Base Mapping and Aerial Imagery)	City of Toronto
Ecology	German Mills Settlers Park EA	TRCA (2019)
	Terrestrial and aquatic SAR, wetlands, areas of natural and scientific interest (ANSI), and environmentally significant area (ESA) - *Natural Heritage Information Centre Database*	MNRF (2021b)
	Aquatic SAR records - Fisheries and Oceans Canada	DFO
	Bird species recordings (including SAR) - *Atlas of the Breeding Birds of Ontario, 2001-2005*	Cadman et al. (2007)
	Insect species recordings (including SAR) - *Ontario Butterfly Atlas*	TEA (2024)
	Reptile and amphibian recordings (including SAR) - *Ontario Reptile and Amphibian Atlas*	Ontario Nature (2022)
	Fish community, mammal, and bird species with known habitat overlapping with study area, amphibian recordings, and flora recordings - TRCA Schedule B MCEA	TRCA (2019)
	Ecological Land Classification (ELC) mapping data	TRCA (2021)
	Floral and faunal observation mapping data	TRCA (2021)
	Fish community data - TRCA open source (accessed 2021) and TRCA Schedule B MCEA	TRCA (2019)
	SAR information request	MECP (2021 Pers. Comm.)
Hydrology and Hydraulics	Updated PCSWMM hydrological model for the Don River system and associated report (most up to date hydrology for German Mills Creek subwatershed)	AECOM (2018)
	One-dimensional (1D) steady-state HEC-RAS hydraulic model of the Don River system (Phase 1) and associated report • Model geometry extends from Pottery Road in the Lower Don Parklands, north to Steeles Avenue East, approximately 50 m upstream of the confluence of German Mills Creek and Duncan Creek	KGS Group (2020)
	1D steady-state HEC-RAS hydraulic model of the Don River and its tributaries north of Steeles Avenue (Phase 2) and associated report • Model geometry extends from Steeles Avenue, north to Hearthside Avenue and Bathurst Street in Richmond Hill	WSP (2021)
Climate Change Assessment	See Appendix D	Various
Archaeological Assessment	Stage 1 Archaeological Assessment conducted by TRCA	TRCA (2021)

2.2 Confirmation of Goals and Objectives

As stated in Section 1.2, the 2003 WWFMP (City of Toronto 2003) set the tone for the most water-related projects in the City and was considered when formulating the alternative solutions for the German Mills Creek GSMP. The primary goal for the 2003 WWFMP is to reduce and ultimately eliminate the adverse impacts of wet weather flow on the built and natural environment in a timely and sustainable manner and to achieve a measurable improvement in the ecosystem health of the watersheds.

To achieve the above goal, 13 technical objectives were developed relating to water quality, water quantity, natural areas and wildlife, and the sewer system. Appendix B provides a detailed overview of the 13 technical objectives of from the WWFMP.

The goals and objectives of the German Mills Creek GSMP (Section 1.2) generally align with the 2003 WWFMP study and are expected to contribute directly or indirectly to many of the technical objectives (Appendix B). The City's GSMP studies fall under the watercourse management component of the WWFMP as documented in the most recent update (2017 WWFMP; City of Toronto 2017a).

The German Mills Creek GSMP also aligns with the Toronto Ravine Strategy (City of Toronto 2017b), contributing to implementation of its five guiding principles of protect, invest, connect, partner, and celebrate.

The goals and objectives of the study were confirmed through Phase 1 of the study, including review of background information and data, and through discussions and a site walk with City staff (refer to Section 1.2). Refinements to the project objectives were also proposed (Appendix B), including, considerations for evaluating all erosion risks with a prioritization for Toronto Water assets, developing an appropriate climate change assessment and integration with the development and evaluation of alternative solutions, included continuing to follow the current EA process, and utilizing the concepts presented in the GSMP to support detailed design and the RFP/RFQ process for the City.

3 PHASE 2: DEVELOPMENT OF ALTERNATIVE SOLUTIONS

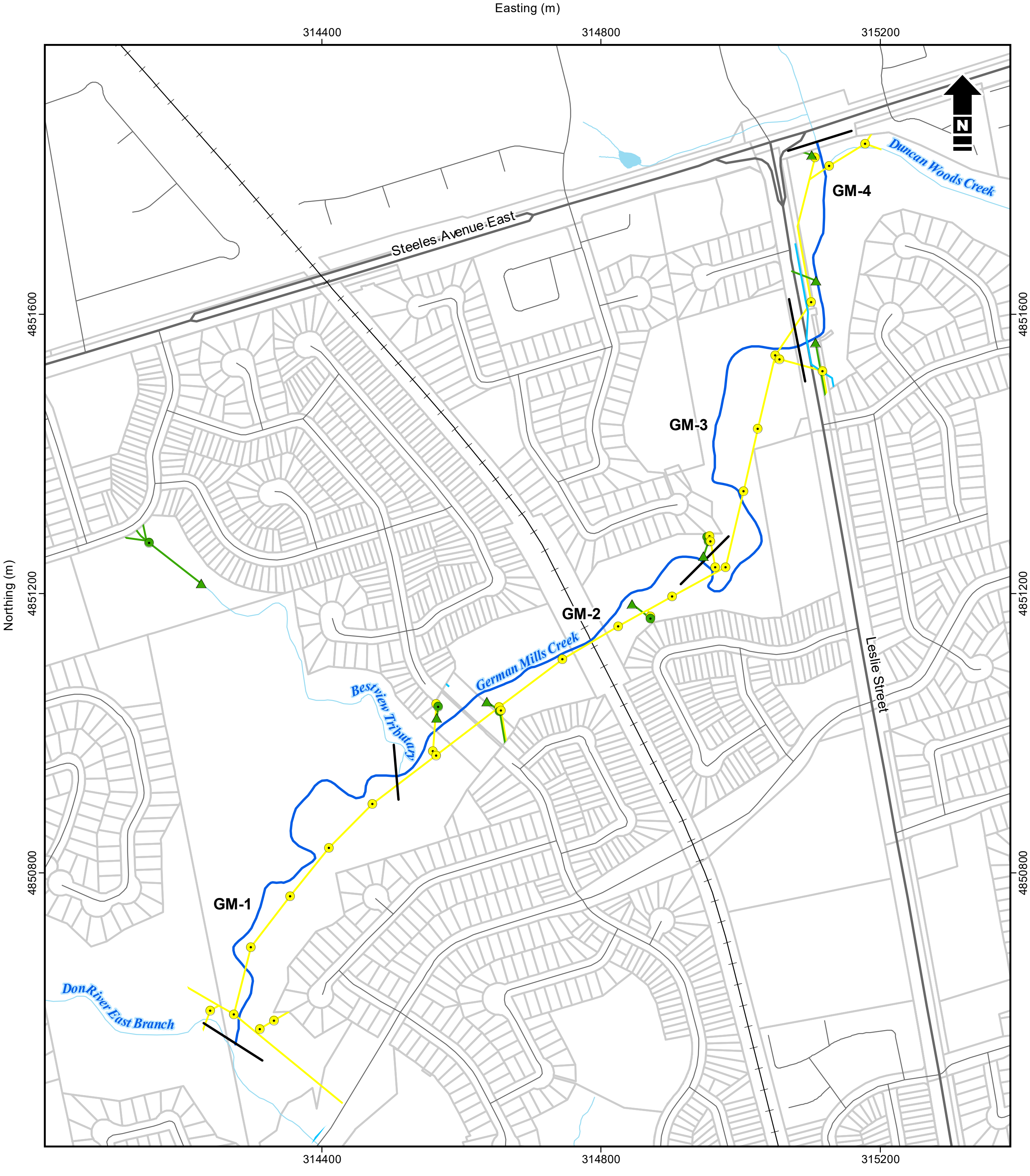
Phase 2 provides the City with a multidisciplinary investigation of the processes that have contributed to the physical degradation of the creek and, as such, are expected to lead to further erosion and degradation in the future. The following sub-sections present key observations, analysis, and findings regarding existing conditions of German Mills Creek as well as forecasted the future conditions of the channel to help assess future risks to TW infrastructure. Also included are a list of alternative solutions to specifically address erosion concerns based on the identification of 12 erosion mitigation project areas. The Phase 2 Development of Alternative Solutions Report (see Appendix C) expands upon the findings and alternatives presented below, with detailed documentation of the technical work completed to characterize the study area and support the development of alternatives. The following summarizes key outcomes of the Phase 2 assessment.

3.1 Desktop Characterization and Historical Assessment

The study area is located within the German Mills subwatershed, which comprises a portion of the larger Don River watershed. The entirety of the German Mills Creek channel extends 26 km in length and contains a drainage area of approximately 41.7 km^2. Its headwaters originate on the southern slope of the Oak Ridges Moraine, eventually draining into the Don River East Branch. The focus of this study is on the lower-most reaches of German Mills Creek within Toronto from Steeles Avenue to the confluence with the East Don River (Figure 1-1).

Reaches of German Mills Creek, as relatively uniform sections of the channel in terms of form and processes, were delineated based on parameters such as local geology, topography, valley setting, hydrology, riparian vegetation, land use, and artificial modifications to the channel (e.g., road crossing). Reaches for the study area are presented in Figure 3-1 based on recent base mapping, orthophotography and verified as part of field assessment. Channel planform, geometry, slope, as well as valley confinement and the impact of road crossings were the criteria generally used to determine reach breaks.

Toronto and Region Conservation Authority (TRCA) completed a Stage 1 archaeological assessment for the study area; the full report is provided in Appendix C-1. It was determined that there is very high potential for encountering pre-contact Indigenous sites and historical Euro-Canadian sites in the study area. Additionally, four archaeological sites and a heritage property are registered within 1 km of the study area. As a result, Stage 2 archaeological assessments are recommended for all areas within the immediate study area, with the exception of the footprint of the multi-use trail, and recent trail and watercourse construction in the vicinity of Steeles Avenue and Leslie Street, prior to any ground disturbance activities.



Property Boundary
Watercourse
German Mills Creek Within GSMP Study Area
Highway
Road
Railway
Reach Break
Sanitary Sewer
Storm Sewer
Watermain
Stormwater Outfall
Sanitary Sewer Maintenance Hole
Storm Sewer Maintenance Hole

1:8,000 metres
80 0 80 160
NAD27 MTM zone 10

Disclaimer: Sewers have been clipped to the Focused Study Area.

Reference: Contains information licensed under the Open Government Licence – Ontario. Imagery (2018) obtained from Canada Map Sales. used under license. Imagery provided by . Used under license.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Toronto
German Mills Creek GSMP EA

Reach Breaks

Date:	Project:	Submitter:	Reviewer:
December 2021	32227	N. Cyples	J. McDonald

Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.

Figure 3-1

I:\CityofToronto\32227\FiguresAndTables\GMY\2021\Report\Figure-2-2-Reach_Breaks.mxd - Letter_P - 06-Dec-21, 08:56 PM - lmwright - TID001

Insight into the historical and existing land use of the study area has been primarily derived from aerial photograph records (1954, 1965, 1978, and 2005 through 2018), archaeological assessments, and other background documents (e.g., TRCA watershed reports). Prior to the 1820s, valleys associated with the Don River were described as dense forests comprised numerous species of tree and shrubs. Forest clearing of the Don Valley followed and was ongoing into the 1900s (TRCA 2021). Air photograph interpretation revealed that there was still significant evidence of forest clearing, with relatively limited forest cover, compared to the current state (2018). The change from rural to urban land use with subdivision development occurred from south to north along Leslie Street and easterly along Steeles Avenue from Bayview Road beginning in the late 1960s, with subdivision construction ongoing in 1978 and into the early 1980s. Construction of asphalt roads and subsequent widening and bridge upgrades along Steeles Avenue and Leslie Street represent the only major transportation upgrades within the study area. Stormwater and sanitary sewer servicing for area developments use the valley as a point to discharge water (stormwater) or transport sewage (sanitary) via trunk gravity sewers.

The German Mills Creek watershed is currently highly urbanized (82% urban landcover) and has been subject to close to a century of direct and indirect adjustment as land use changed and urban settlement expanded. The creek is naturally a meandering stream through within a well-developed floodplain and valley. It is naturally confined by steep valley contacts, and it is further influenced by interactions between soft and moderately consolidated soil materials (i.e., glacial, glaciofluvial, and glaciolacustrine deposits). Over time, urbanization has led to increased, unmanaged stormwater runoff that has modified the prevailing flow regime and increased the magnitude and frequency of the flood response.

Mapped channel alignments from the available historical aerial photographs are provided in Figure 3-2. The historic channel alignments revealed a pronounced and significant reduction of channel length, approximately 500 m, which has been interpreted to be primarily the result of artificial channel realignments associated with construction of the sewers (see Section 3.2). Channel widening is evident in the historic analysis as a more gradual process, with less dramatic adjustment compared to length reductions, with the exception of Reach GM-1 (Appendix C).

Channel Planform – 1954
Channel Planform – 1965
Channel Planform – 1978
Channel Planform – 2005
Channel Planform – 2018
Reach Break
Watercourse
Highway
Road
Railway
Sanitary Sewer Constructed in 1969
Storm Sewer
Watermain
Stormwater Outfall
Sanitary Sewer Maintenance Hole
Storm Sewer Maintenance Hole

Disclaimer: Sewers have been clipped to the Focused Study Area.

Reference: Contains information licensed under the Open Government Licence – Ontario. Imagery (2018) obtained from Canada Map Sales. used under license. Imagery provided by City of Toronto. Used under license.

1:6,000 metres
60 0 60 120
NAD27 MTM zone 10

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ENVIRONMENT & ENGINEERING

City of Toronto
German Mills Creek GSMP EA

Overview of Historical Channel Traces

Date:	Project:	Submitter:	Reviewer:
December 2021	32227	N. Cyples	J. McDonald

Figure 3-2

3.2 Past and Future Trends and Disturbances

The preceding sections provide a brief overview of historical land use changes and channel conditions, while the following section seeks to interpret these observed adjustments in the context of past disturbances and to outline and potentially predict future trends in channel stability. The past disturbances include:

- **Hydrological Flow Regime**: changes in land cover and land use conversion such as urbanization tend to reduce infiltration and increase runoff, which is notably concerning in the absence of stormwater management quantity controls. The result are greater frequency and magnitude of flood events, and a loss of seasonality with flood peaks occurring throughout the year. This change in flow regime is herein referred to as hydromodification. The subwatershed is highly urbanized and lacks appropriate stormwater management (TRCA 2009b). The typical natural response to increased flows, and secondarily a decrease in the natural sediment supply, includes channel incision, widening, and planform adjustment (e.g., cutoffs). Overall, reaches within the study area have become wider and shorter suggesting a natural response to the flow regime; however, the reduced channel length appears to be mainly a result of direct modification to support development and infrastructure. Channel adjustments also occur in response to flood events. Aerial imagery was reviewed for natural responses to flood events and the distance from the bank to maintenance holes was measured to determine annual migration rates (Appendix C). Overall, Reaches GM-1 and GM-3 appear to be the most active in terms of channel and bank migration, with migration leading to the exposure of three maintenance holes in Reach GM-3. These processes will continue to occur in response to the current and future flow regime. Rates of adjustment may accelerate as the flow regime increases if there is no mitigation through stormwater management retrofits and upgrades or channel design.

- **Sanitary Sewer Construction**: channel disturbance and realignments starting in the late 1960s associated with major earthworks in the valley corridor to construct the sanitary and storm sewers servicing the adjacent residential developments in the table lands. The Leslie-Steeles STS was constructed in 1969. Design drawings for the sewer from Steeles Avenue to the confluence with the Don River indicate that localized spot treatments (riprap) were proposed to provide vertical and/or lateral stability (Appendix C-3). No channel realignments or cut-offs were proposed; however, there was a distinct reduction in channel length by 1978 through Reach GM-3. Aerial imagery revealed two long meanders were cut off between 1969 and 1970, apparently to support the STS construction. Design drawings showed six creek crossings with riprap protection, while only two crossings remained after construction at the upstream and downstream limit.

- **Valley Grading and Slope Stabilization**: cut-and-fill earthworks modifications to the valley side slopes was completed to accommodate the residential developments in the table lands. Valley grading occurred within Reach GM-2 between 1965 and 1978. The channel was straightened, and three meander bends were cut off and filled in, resulting in the approximate loss of 215 m of channel and a substantial amount of floodplain area. Another instance of channelization and valley regrading occurred in Reach GM-1 between 1978 and 1981, presumably to mitigate risk to existing properties up slope rather than in anticipation of subdivision development. Approximately 54 m of channel was lost as the meander was cut off, and the abandoned feature was infilled. Detailed mapping is available in Appendix C-3, while Figure 3-2 above includes the artificial cutoffs mentioned here in GM-2.

- **Transportation Crossing and Pedestrian Trails**: local channel modifications associated with historical road and railway construction, bridge construction and upgrades, and pedestrian trails and bridges. Within the study area there were channel modifications associated with upgrades to Leslie Street and Steeles Avenue, a railway bridge, as well as a pedestrian and recreational trail system with several pedestrian bridges. Further details are provided in Appendix C-3.

- **Next Generation Stream Restoration and Channel Engineering**: more recent channel reconstruction works for Duncan Creek (Phase 1, 2013) were extended to the confluence with German Mills Creek and 30 m downstream into German Mills Creek (Reach GM-4), including rocky-riffle and armourstone rib grade control, to locally stabilize the channel. Annual monitoring reports by Aquafor Beech (2021a, 2021b, 2021c) note that there has been ongoing localized scour of the bed and banks; however, current conditions pose “no significant risks to the adjacent assets in the short-medium term, including City’s sanitary sewer, trail systems, and private properties.”

Future increases in runoff and flow are not expected to be caused by new suburban developments as the German Mills Creek subwatershed is essentially fully urbanized (82% urban landcover), with an estimated impervious surface area of 47% (AECOM 2018). Other past disturbances to German Mills Creek will have ongoing impacts on the channel, but they can be managed through the GSMP and EA study processes with implementation of mitigation works to reduce risks where necessary. While it is possible that future stormwater management strategies implemented in the watershed could help to reduce historical increases in urban runoff, most of the watershed is outside of Toronto and thus does not fall under previous City plans to manage stormwater (see Section 3.6.1). Channel restoration is required to address the current conditions and enhance stability within the active channel undergoing response to urban flows generated upstream. Climate change also poses a significant risk to the future stability of German Mills Creek and to the associated City infrastructure within the valley corridor. A climate change assessment (Appendix D) was completed to inform alternative design approaches and their evaluation for potential for added climate resilience and/or redundancy to protect Toronto Water infrastructure over the intermediate and long-term.

3.3 Geomorphic Present Conditions

Stream reaches are defined in Section 3.1 based on the desktop review and historical assessment. Within the study area of German Mills Creek, four reaches were delineated (Figure 3-1). Reach characteristics such as reach length and sinuosity (ratio of channel length to valley length) are summarized in Table 3-1.

TABLE 3-1 Summary of German Mills Creek Reach Characteristics

Reach	Channel Length (m)	Sinuosity
GM-1	615	1.37
GM-2	557	1.04
GM-3	560	1.67
GM-4	320	1.09

Field assessments were completed between July 2021 and September 2021 to confirm the desktop-based reach delineation and document existing channel conditions. During the field assessments, all four reaches of German Mills Creek (GM-1 to GM-4) were walked, and the following tasks were undertaken as part of the fluvial geomorphic assessment:

- reach characterization of channel morphology and bed/bank substrate with photographs (photograph log of each reach is located in Appendix C-5)
- Rapid Assessments: Rapid Geomorphic Assessment (RGA), and Rapid Stream Assessment Technique (RSAT)
- bank condition scoring in 20 m segments
- identification of geomorphic erosion risk sites
- detailed topographic survey, including geomorphic survey of German Mills Creek and proximal Toronto Water infrastructure (i.e., maintenance holes, sewer alignment, outfalls, etc.)

Definitions and discussion regarding rapid assessments, bank condition scoring, and erosion risk site inventory are described in Sections 3.4.

Detailed topography of the channel and surrounding floodplain was surveyed to characterize channel geometry and sediment within the creek, complete hydraulic model updates, and to inform the risk assessment (depth of cover) from the active channel to TW assets (sanitary sewers and maintenance holes). A longitudinal profile was surveyed from Steeles Avenue to the confluence with the East Don River (extending approx. 20 m downstream into the East Don River). A total of 23 cross-sections were surveyed, including 18 monitoring cross-sections (with benchmarks) and 5 additional cross-sections in known areas of risk to infrastructure. Appendix C provides an overview of the extent of the longitudinal channel profile, cross-section locations, and substrate quantification.

3.4 Assessment of Channel Response

To provide insight into existing geomorphic conditions on a reach basis, rapid field reconnaissance was completed in July 2021. Rapid assessment techniques, RGA and RSAT were applied to determine the dominant geomorphic processes affecting each reach. Table 3-2 summarizes observed conditions in each reach. Additional photographs of each reach are provided in Appendix C-5.

TABLE 3-2 Reach Descriptions

Reach	Description	
GM-1		Channel planform regains sinuosity in this reach and contains several large pools with high rates of lateral migration (0.5 to 0.6 m/year) in the direction of the sanitary sewer. Although entrenched in some locations, this reach has a well-developed floodplain in comparison to other reaches. Occasional valley wall contacts with vertical bank faces were noted. Mid-reach there are a series of weirs acting as grade control and large riprap armouring the banks. This reach has the most natural channel cross-section within the study area with pool-riffle morphology, a meandering channel planform, and the widest riparian forest.
GM-2		Historically straightened reach to accommodate the sanitary sewer constructed in 1969. This reach exhibits entrenchment and is lined with riprap and gabion baskets at bridge crossings and the railway. Riprap appears to be in good condition; however, the sanitary sewer which runs parallel to the creek and is at risk of exposure. Pool-riffle morphology remains present but is better developed away from armoured areas. Riparian vegetation is typically forested, and the channel is not well-connected to the floodplain in this reach, causing channel incision. Incision is evidenced by exposed clay along the toe of bank, the concrete apron at outfall perched, and local bed scour near armoured areas.
GM-3		This reach has undergone substantial channel widening resulting in the exposure of three maintenance holes (downstream of Leslie St., mid-reach, and near pedestrian bridge). Previous bank armouring such as riprap and armourstone walls are in relatively poor condition and are becoming undermined. Large bank attached and medial gravel bars are prevalent. Due to channel widening, bank slumps and undercut banks are also common. This reach has a moderately natural cross-section with a meandering planform, riffle-pool morphology, fairly intact riparian cover, and good biological indicators.

Reach	Description	
GM-4		Moderately steep reach. Channel has been straightened upstream of Leslie Street. Valley is narrowed by the Leslie Street embankment. Channel is confined by valley slope to the east. Grade control rib structures have been constructed downstream of Steeles Avenue bridge and confluence with Duncan Woods Creek. Channel has scoured around gabion basket. Bank erosion is frequent, bank armouring includes rounded riverstone, armourstone, and sheet piling. This reach has a modified planform, narrow riparian zone, and less developed riffle-pool morphology.
Bestview Tributary		Steep gradient, highly entrenched tributary channel. Armourstone banks and riprap-lined bed in upstream reach. Natural channel boundary in downstream reach with gravel and sand lobate bars in channel, steeply eroded banks with exposed roots in forested valley. Undisturbed overburden locally exposed, large woody debris in channel with debris jams common. Lower gradient section at confluence with German Mills Creek main channel.

The RSAT results indicate that reaches within the study area have moderate stream health. Channel stability, scour and deposition, and instream habitat are among the lowest-scoring factors. Channel stability in the downstream reaches (GM-1 and GM-2) is classified by the RGA as Transitional, but at the boundary of being In Adjustment. The upstream reaches (GM-3 and GM-4) are In Adjustment, which reflects a slightly greater degree of channel instability compared to reaches downstream. The natural reach of the Bestview Tributary exhibits abundant evidence of channel instability and unstable RGA score classified as In Adjustment. Channel processes included widening, degradation, and aggradation based on a range of field indices that suggest concurrent processes of channel enlargement and aggregational sediment dynamics. The Phase 2 report in Appendix C provides further details of the rapid assessment scores for the study area along German Mills Creek. The lower reach of the Bestview Tributary was also assessed; the upper reach was not scored as it is an engineered armourstone and riprap-lined channel.

The present condition of the watercourse should be considered in the context of the evolution of the fluvial system over time. Channel evolution models help conceptualize how alluvial channels may respond to disturbances, natural or human-induced, through a series of morphological adjustments that can be generalized into an evolutionary sequence common to streams in different physiographic settings. The Wilket Creek model (Bevan et al. 2008) classifies channel types I through V, which depict five stages of channel evolution for urban channels when underlain by semi-alluvial till (see Appendix C for full description of the Wilket Creek channel evolution model). As described in Stage I (pre-urban channel), German Mills Creek within the study area was historically connected to a forested floodplain, albeit within a distinct valley. As urbanization occurred, the flow regime would likely have become flashier due to increased catchment imperviousness, as in Stage II involving widening with meander extension. Channel adjustments that occurred as part of urbanization are discussed in Section 3.2. Natural avulsions as described in Stage III were not observed in the historic photographic record; however, anthropogenic straightening may be considered similar as it reduces channel length and leads to increased in velocity and sediment transport. Current channel conditions indicate that the channel has incised (Stage IV). Within Reaches GM-2, GM-3, and GM-4, the creek is typically entrenched and disconnected from the floodplain, indicating Stage IV. Reach GM-1 may be in Stage V, as this reach showed the greatest increase in channel width since 1954 and it is entrenched but appears to be developing a wider floodplain at a lower elevation.

3.4.1 Bank Conditions and Erosion Site Assessment

The ultimate objective of the overall project was to evaluate the risk to TW infrastructure from fluvial processes and develop a prioritization and implementation plan for stabilization/remediation. Field characterization to support this included an inventory of bank conditions and channel stability as well as the evaluation of specific erosion risk sites where TW infrastructure is currently or potentially at risk to erosion (both lateral bank erosion and vertical bed scour). The following bank condition and erosion site field assessments form the initial component of the overall risk assessment and prioritization (Figure 3-3, with details in Appendix C).

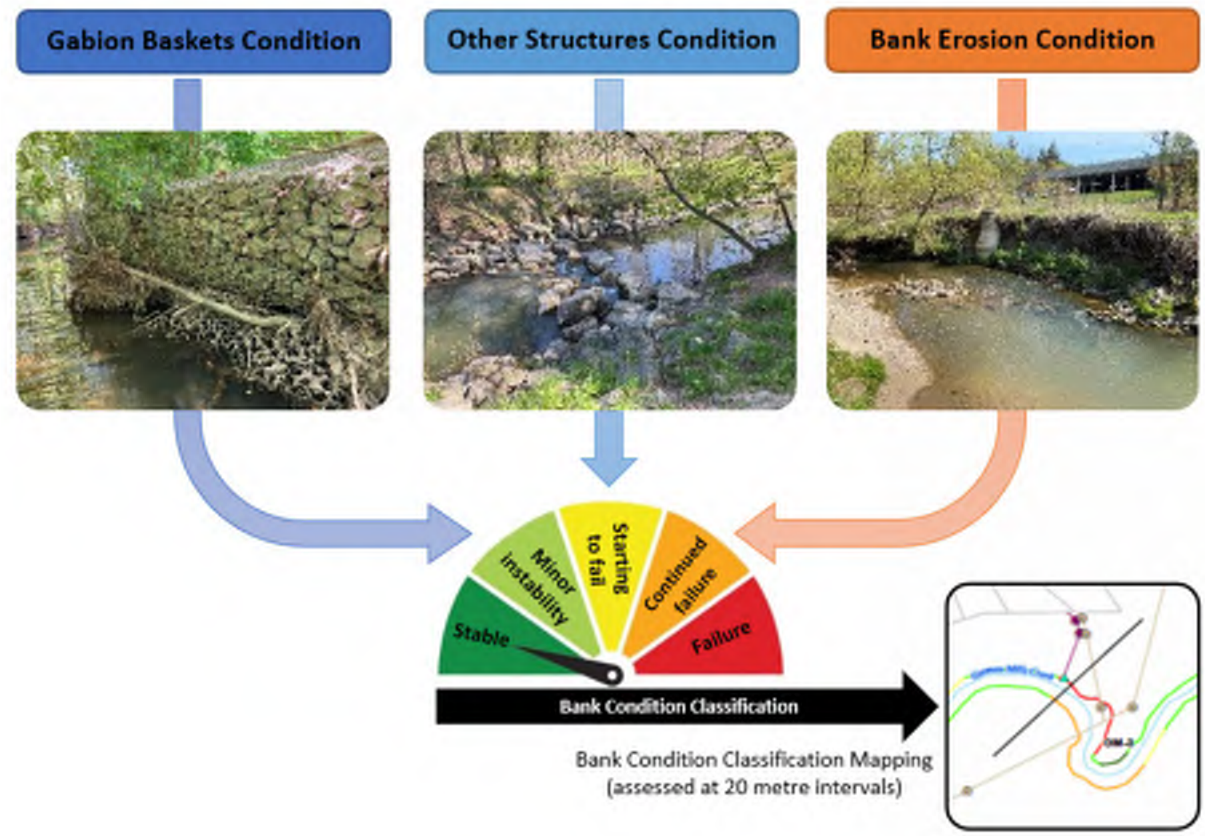
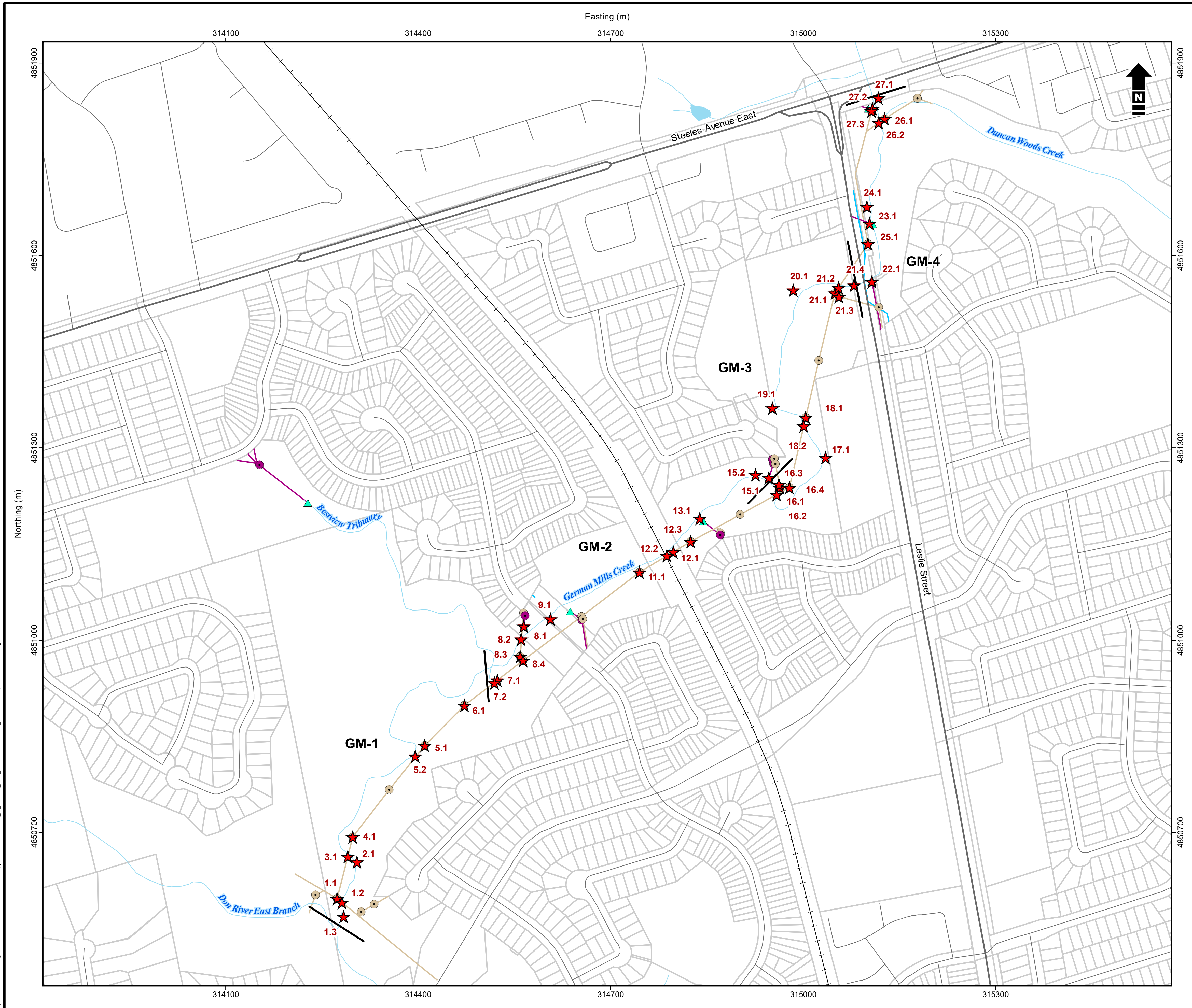
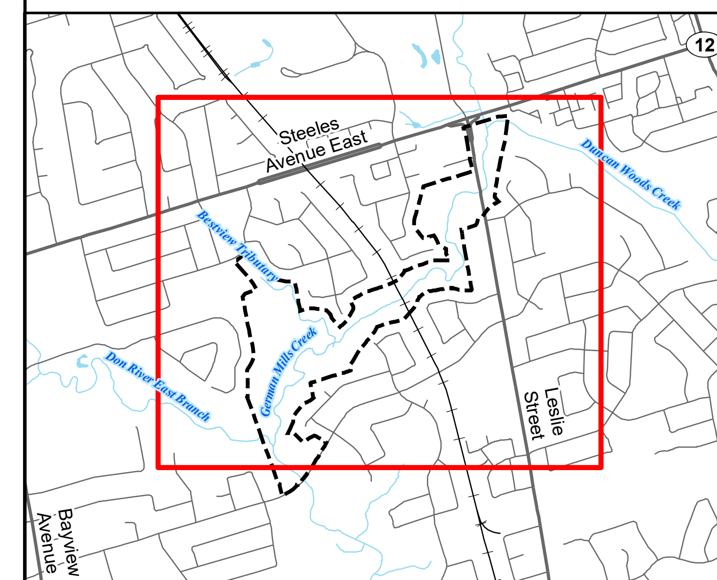


FIGURE 3-3 Bank Condition Scoring Framework (details in Appendix C)

A standardized approach to characterizing bank materials and conditions was completed, whereby the channel banks were assessed and scored in the field at 20 m intervals along the mapped centreline of the channel using the 2018 bankfull centreline. Bank condition was assessed for natural and treated (engineered) banks and was classified based on bank stability (e.g., stable, minor instability [erosion], starting to fail, continuing to fail, or complete bank failure). Appendix C-6 provides further detail on the risk assessment methodology and bank scoring. Following the bank condition assessments, erosion risk sites were identified in terms of their lateral and vertical erosion hazards with respect to property and infrastructure, with a specific focus on TW sewer infrastructure. A desktop risk inventory was completed using City orthoimagery in conjunction with TW infrastructure (sewers, watermains, outfalls, maintenance holes, etc.) from the Toronto Water Asset Geodatabase (TWAG). Erosion sites were identified at sewer crossing locations within the creek (vertical risk) and at locations where the creek banks were proximal to sewer pipes, maintenance holes, outfalls, pathways, and properties (lateral risk). A total of 56 erosion risk sites were identified as presented on Figure 3-4, with details provided in Appendix C. Further discussion regarding the ranking of erosion risk sites is presented in Section 3.8.





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ENVIRONMENT & ENGINEERING

City of Toronto
German Mills Creek GSMP EA

Overview of Erosion Risk Sites

Date:	Project:	Submitter:	Reviewer:
December 2021	32227	N. Cyples	J. McDonald

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Figure
3-4

3.5 Infrastructure Engineering Review

Data was collected for TW assets and third-party utilities to form a composite utility plan in the project vicinity. Drawings and mapping of TW assets, sewers, and water mains were provided by the City (Table 2-1). Markups, as-builts, and plans for any future works in the area were requested and received for all third-party utility owners within the project limits. A topographic survey was completed of storm sewer outfalls and select sanitary sewer maintenance hole rims, with measure downs to pipe inverts at critical locations. A three-dimensional model of the TW sanitary sewer system through the project limits was then generated using a combination of data sources (Appendix C-7).

3.6 Present Stream Functions

3.6.1 Hydrology and Hydraulics

Section 3.2 describes the past trends in channel response to the altered flow regime due to urbanization. Pervious documentation (Section 2.1) describes the current state of the subwatershed, its hydrology, the channel response (erosion/enlargement), with recommendations being provided for retroactive stormwater management and future development requirements (e.g., WWFMP 2003; Don River Watershed Plan Implementation Guide – TRCA 2009c; Stormwater Management Criteria – TRCA 2012). Despite these past recommendations, erosion response to peak flows under the altered flow regime will continue as the study area is located at the most downstream section of the watershed. There is limited stormwater management upstream (many historically developed areas), and limited, if any, ability locally for the City to substantially reduce the effects of peak flows substantially enough to offset primarily unmanaged flow from upstream.

Hydrology and hydraulic information and models provided by TRCA are summarized in Appendix C. Current survey data and recent modelling effort by previous consultants was utilized to develop an "existing conditions" hydraulic model. This model was to be used as a baseline to compare design alternatives for the GSMP study. Further details on the updates made by Matrix to the existing conditions model are provided in Appendix C.

The Matrix existing conditions model was run using the same peak hydrology flows as determined by previous consultants (Appendix C). Some variation in results is expected with the introduction of new survey details, and model extension upstream of Steeles Avenue compared to previous work. The most noteworthy change is the reduction of water surface elevations upstream of the Leslie Street bridge which eliminated the overtopping and backwatering during the Regional event. Overall, the updated existing conditions model provides an effective tool for the purpose of evaluating and assessing design alternatives.

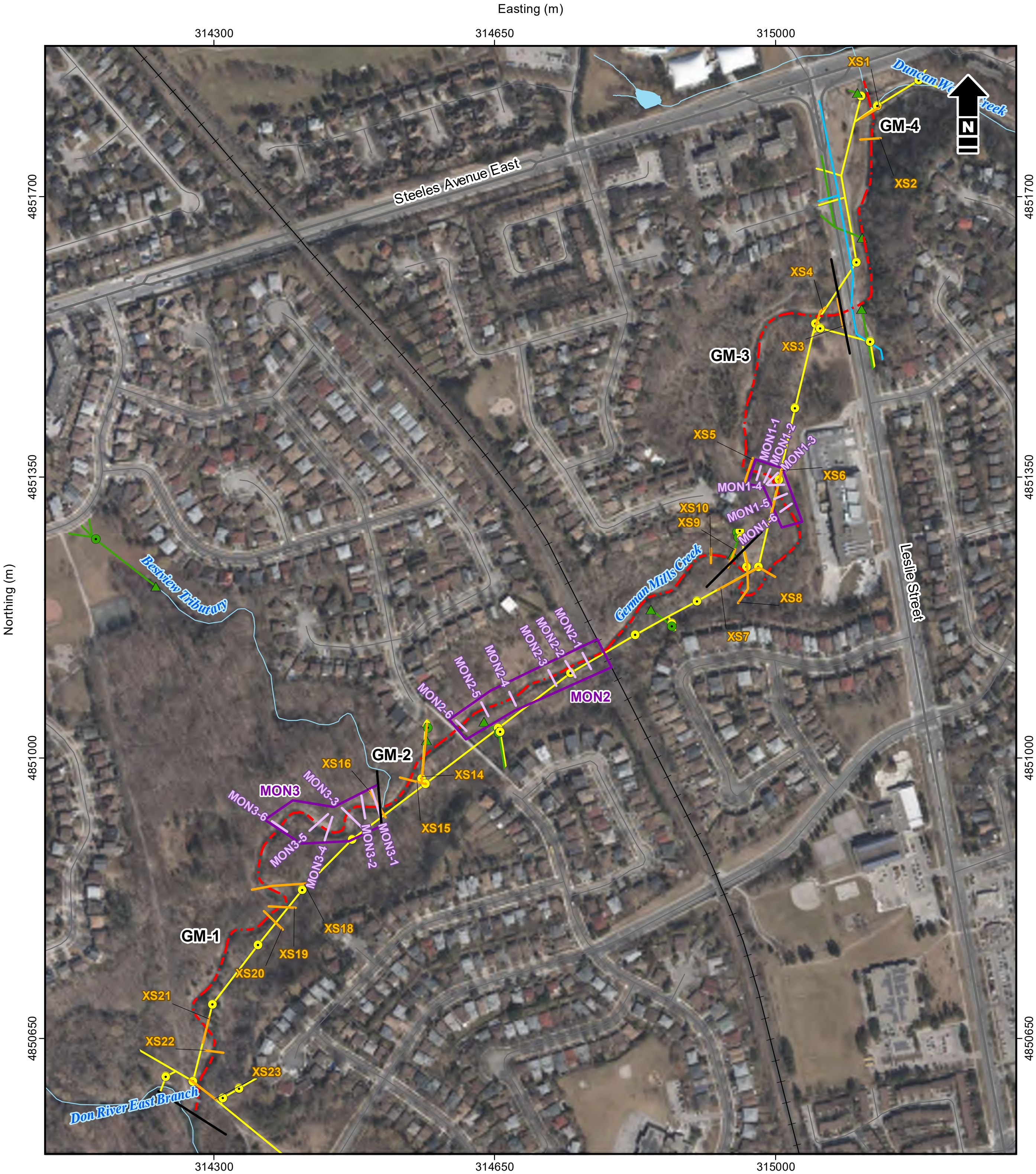
3.6.2 Channel Geometry and Hydraulics

A detailed geomorphological assessment was completed as part of the overall characterization of the study area, and to establish erosion monitoring sites. Detailed geomorphic data was collected within three erosion monitoring areas as described in Appendix C, with locations identified in Figure 3-5.

Bankfull channel dimensions, which represent the typical geometry in response to prevailing flows, were surveyed based on field indicators of "bankfull" such as inflections in the bank profile and changes in vegetation. Dimensions were surveyed at representative cross-section locations, and connected with a profile survey that was completed for the entire study area. Summary bankfull dimensions are presented in Appendix C, with widths ranging from approximately 7 m up to 15 m overall. The average bankfull depth among all sites ranged from 0.53 to 1.21 m, with a maximum bankfull depth of 2.09 m within the riprap-lined section below monitoring site 1 (MON1).

Entrenchment ratios were calculated for each cross-section and provide an indication on the connectivity of the bankfull channel to the surrounding floodplain. In equilibrium systems, the bankfull channel is directly connected to the floodplain (same elevation). Based on the Rosgen (1994) classification of river channels, an entrenchment ratio of 1.0:1.4 indicates that the channel is "entrenched"(disconnected) Entrenchment ratios of 1.41:2.2 represent "moderate entrenchment" (slightly disconnected). In general, cross-sections for German Mills Creek were classified as either "entrenched" or "moderately entrenched." Lower reaches displayed some portions that were not entrenched; therefore, the channel is considered to be moderately entrenched overall.

Based on survey dimensions, bankfull and top of bank (TOB) hydraulics were estimated for each of the detailed survey locations. The former was based on bankfull indicators as described above, while the latter evaluated the channel hydraulics at the inflection between the main channel and the floodplain of this incised system. The intent here is to evaluate the hydraulics that likely have the greatest in-stream velocity and shear stresses. The estimation of in-channel hydraulics allows for an erosion threshold analysis to quantify the instability of the channel. The results first indicate that bankfull flows based on the field surveys fall between 38% and 74% of the 2-year flow, suggesting that they may occur multiple times a year. TOB flows for sites within Reaches GM-1 and GM-2 exceed the 100-year event, while the TOB within Reach 1 occurs between 25- and 50-year event discharges. Cross-sectional plots in HEC-RAS suggest that the cross-section, in several cases contain up to the 100-year event prior to spilling into the floodplain, with many in the 25- to 50-year range at the floodplain elevation. This indicates that the channel has limited floodplain relief up to the 100-year event, and conveys the forces associated with infrequent events within the main channel, contributing to the continued incision and enlargement observed both historically and presently.



Monitoring Site
Watercourse
Highway
Road
Railway
Reach Break
Surveyed Monitoring Cross-section
Surveyed Infrastructure Cross-section

Surveyed Long Profile
Sanitary Sewer
Storm Sewer
Watermain
Sanitary Sewer Maintenance Hole
Storm Sewer Maintenance Hole
Stormwater Outfall

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City of Toronto
German Mills Creek GSMP EA

Survey Extents

Date:	Project:	Submitter:	Reviewer:
December 2021	32227	N. Cyples	J. McDonald

Figure
3-5

3.6.3 Erosion Thresholds

Erosion thresholds are used to determine the hydraulic conditions (i.e., discharge, channel depth, average channel velocity, etc.) that would entrain bed and/or bank materials of a given particle size (e.g., gravel, sand). The typical objective is to ensure that hydrological conditions from future changes do not result in channel flow exceeding the threshold discharge more frequently than under existing conditions, where the existing condition is considered representative of the more natural condition. However, in this study, the estimated erosion thresholds are used to characterize the existing condition and potential for erosion of observed bed and bank materials along detailed survey locations. Details of the erosion threshold analysis are available in Appendix C.

The results reveal that the median particle size is predicted to mobilize within Reaches GM-3 and GM-2 relatively frequently, with the critical discharge at 20% of the estimated bankfull discharge, or close to bankfull (102% in Reach GM-2), respectively. Based on these calculations, considerably larger events, perhaps exceeding the 100-year flood (30% of bankfull), would be expected before the median particle size on the bed is entrained for Reach GM-1. This difference is primarily due to differences in slope between GM-1 and GM-2, with GM-2 being 4 times steeper. Additionally, floodplain accessibility in Reach GM-1 is greater (less entrenched), and therefore velocities are attenuated within the local floodplain compared to sections upstream. Differences in channel adjustment may support these thresholds whereby channel widening, and planform adjustment were primarily observed within monitoring site 3 (Reach GM-1), while bed incision and entrenchment were most evident through monitoring sites 1 and 2 (Reaches GM-3 and GM-2, respectively).

3.6.4 Geomorphic Monitoring – Baseline Conditions

Detailed geomorphic sites were selected to both characterize the site and to establish monumented stations for repeat monitoring. As a part of the GSMP, 2 years of data were collected and compared. Three geomorphic monitoring sites were selected within Reaches GM-1, GM-2, and GM-3 at locations where channel adjustment was expected (Figure 3-5). At these locations, stream morphology was characterized once annually (in the fall) for 2 years through a detailed channel survey of the channel profile and monumented cross-sections. Repeat substrate characterization and flow measurements were also included as part of the monitoring.

Geomorphic adjustments were observed during the monitoring period most notably within monitoring site 1 (MON1, Reach GM-3) and monitoring site 3 (MON3, Reach GM-1), where the creek has less erosion protection as compared with monitoring site 2 (MON2, Reach GM-2). Within these monitoring sites, the channel has a meandering planform and documented changes over 2-year period included bank migration, bank slumping and bar movement, downstream riffle migration, and partial infilling of pools. Noticeable changes observed visually included bank erosion, a felled tree, bar reworking, and movement of large woody debris. The type of channel substrate was similar among sites and did not change in any of the three monitoring sites beyond the expected natural range of variability, but the changes in the longitudinal profile indicated that bed materials were mobile over the monitoring period where the channel bed is not protected. Detailed results from the 2-year monitoring program are provided in the full monitoring report in Appendix E.

3.6.5 Characterization of Biotic Communities

To characterize the terrestrial and aquatic resources within the study area, Matrix used the findings from a background review and field surveys. The methodology is described in Appendix C-8. Agency correspondence from the MECP and TRCA are also provided in Appendix C-8. Please refer to Appendix C for ecological mapping and detailed tabular results.

Terrestrial Resources

Ecological Land Classification (ELC) maps from the TRCA were used to assess 30 different vegetation classes. One community is considered provincially rare, one community is considered locally rare, and six communities are considered of conservation concern in the urban matrix (L4 ranked). Disturbance to these communities should be avoided where possible.

A total of 94 plant species were recorded during the detailed investigation, none of which were SAR or provincially ranked species. Disturbance should be avoided where possible. Eleven invasive species were recorded within the study area; the most prolific was Dog Strangling Vine. The City has a spraying program in place to help reduce this plants presence, but it still has a large population within the valley corridor.

Incidental wildlife observations while conducting field work, with two species listed as special concern recorded including Eastern Wood Pewee and Monarch, as well as two invasive species including Goldfish and Japanese Beetle. No provincially rare species were observed; however, one locally rare species, the Great Blue Heron, was observed.

Significant wildlife habitat (SWH) was assessed based on aerial photography, background review, and field investigations performed by Matrix. The full SWH evaluation is provided in Appendix C-8 with a summary of the confirmed or candidate SWH. A specific evaluation with regards to species of conservation concern (SCC) is also provided in Appendix C-8.

Aquatic Resources

German Mills Creek throughout the study area has a defined riffle-pool system. Fish habitat features were mapped in relation to riffle, runs, and pools. There are many opportunities for fish to spawn, feed, and find refuge throughout the watercourse. Schools of fish were observed during field visits at multiple points throughout the watercourse. Based on the information collected and the observation of many fish throughout the system, German Mills Creek can be deemed as high-quality aquatic habitat, with two potential barriers to fish movement under low-flow conditions.

Based on existing fish community data and the thermal regime, German Mills Creek is classified warm/cool water system (TRCA 2009b). All fish species observed are species are common and secure in Ontario. One invasive fish species was recorded: Goldfish. The appropriate in-water work timing window for German Mills Creek in this area was identified by TRCA in the Schedule B German Mills EA to be between July 1 and March 31 (TRCA 2019).

Species at Risk

The background review identified 14 potential SAR that could occur within the study. All SAR identified were screened to determine the likelihood of occurrence and whether suitable habitat is present. The full SAR evaluation is provided in Appendix C-8. The results of the assessment indicated that five species were unlikely to inhabit the area based on the lack of appropriate habitat. Nine species were identified as potentially occurring within the study area including butternut, Redside dace, bank swallow, barn swallow, and four SAR bats.

3.6.6 Aquatic Monitoring

Ecological monitoring was completed over two years to establish a baseline profile of the natural heritage character within the subject reach. Aquatic habitat condition was assessed through background review, application of the Ontario Stream Assessment Protocol (OSAP), water quality measurements, and benthic biomonitoring within the three monitoring locations utilized for the geomorphic field program. Year 1 and Year 2 ecological monitoring were completed in August/September 2021 and September/October 2022, respectively.

An aquatic habitat assessment was conducted within each monitoring site to generally characterize the reach morphological features as they pertain to supporting aquatic life. Typically, all reaches exhibited similar bed substrate profiles, with riffles dominated by cobbles and large gravels, pools dominated by silt and sand, and runs varying in composition. All monitoring sites exhibited signs of erosion and/or bank dysfunction. Detailed results from the 2-year monitoring program are provided in the full monitoring report in Appendix E.

3.7 Geomorphic Future Conditions

The assessment of past and present conditions for German Mills Creek provides a basis from which to forecast future geomorphic conditions. This section of the report focuses on forecasting the future conditions of the channel with respect to historical land use changes and existing channel conditions and assesses the associated erosion risks to TW infrastructure. German Mills is still responding to urban land use change (i.e., hydromodification), and with the assessment of channel enlargement it is expected that the channel will continue to widen and degrade for some decades to come. The effects of climate change were assessed separately; the climate change assessment is provided in Appendix D. An overarching concept for the assessment of future geomorphic conditions is the “ultimate channel configuration” that forecasts future channel conditions in terms of bankfull channel dimensions and capacity, along with the associated scaling of channel planform sinuosity and riffle-pool spacings.

Appendix C provides a detailed analysis of expected channel adjustments, assumptions made, and potential design opportunities and enhancements with consideration of local constraints. The analysis attempts to provide expectations in channel enlargement, sinuosity (length), and pool-riffle spacing, while utilizing channel evolution models to understand the current status of German Mills Creek and its trajectory as it responds to the urbanized flow regime (i.e., hydromodification).

Trends from the channel evolution model and evidence from Reach 1 suggest that the channel is trending to develop a lower floodplain and bankfull channel. Given this trend, there is potential to increase pool-riffle spacing (approximately five to seven widths) with added sinuosity, for a channel that conveys a more frequent event, with a lower, accessible floodplain set within the enlarged cross-section. It is possible to allow future enlargement and channel development to occur naturally where constraints are less imposing. This is most achievable through Reach 3 and Reach 1, but there are some opportunities through Reaches GM-2 and GM-4, which would require site-specific design approaches due to the higher degree of constraints.

For future conditions and design purposes, it may be possible to maintain smaller scale riffle-pool spacings in the range of five channel widths based on an inset bankfull channel width of 10 to 20 m, but if the larger-scale channel width in the future is in range of 20 to 30 m wide, the associated riffle-pool spacing would need to be doubled to 100 m which would only be possible to design at the reach-scale. It is likely that riffle-pool spacing and design will need to consider multiple scales of channel size between a more frequent flow bankfull channel (nested) and larger floodway channel, potentially with two scales of riffle-pool features (i.e., more frequent and dynamic features nested on larger spaced riffle structures that may be less dynamic).

Generally, future channel designs for the study area should reference channel geometry for a range of existing conditions to provide variable geomorphic form and function, while also considering the scale and flexibility required to meet future ultimate channel conditions. Accommodating future channel forms and alignments with respect to both existing and ultimate conditions may be accomplished by combining a range of “hard” and “soft” design approaches, depending on project extents, connectivity with natural sections, and phasing. Further discussion regarding how climate change has been considered within the GSMP is provided in Appendix D with specific inputs to the alternative evaluation process also summarized in Section 4.4.4.

3.8 Geomorphic Risk Assessment

Building on the forecasts of ultimate channel configuration, the study methodology is based on assessment of geomorphic risk with respect to TW infrastructure in particular, while also considering risks to other public infrastructure and private property. The following components of the geomorphic risk assessment are documented in the current report:

- **Erosion Hazard Assessment** – defining of long-term horizontal and vertical erosion hazard limits (100-year), including identification of associated locations of geotechnical stable slope hazards.

- **Erosion Risk Inventory** – desktop and field-based inventories of lateral and vertical risk sites due to existing channel conditions and predicted future channel movement.

3.8.1 Erosion Hazard Assessment

Horizontal erosion hazards for unconfined stream reaches are typically delineated as a corridor termed a meander belt width (MBW; MNR 2002, PARISH 2004). The MBW encompasses the natural erosion hazard associated with active channel migration and avulsion. It is delineated by mapping planform characteristics (current and historical), and/or empirical relationships. The MBW was determined for German Mills Creek GSMP study area to confirm the extent of TW infrastructure within the long-term erosion hazard and to support further detailed assessments of shorter-term erosion hazard risks. The MBW generally follows the valley trend and encompasses areas of the historical channel alignment. The MBW values range from 44 to 90 m, with narrower belt widths in reaches that have undergone channel realignment and straightening such as Reaches GM-2 and GM-3. Potential geotechnical hazard areas were identified for further investigation through future studies.

Vertical (scour) erosion hazards were assessed following CVC (2019) guidelines, and further details are provided in the Appendix C. The recommended 100-year scour hazard limit (SHL) for the German Mills Creek within the study area is 3.2 m below the average riffle grade, calculated based on a maximum general scour (i.e., scour pools) of 1.6 m and an average natural scour (i.e., degradation) of 1.6 m. General scour was based on the maximum pool depth below riffle grade elevation surveyed through the study area in the 2021. Natural scour was based on the average degradation rate of 1.6 cm/year (1.6 m per century) determined by comparing the 1969 channel bed elevations in the STS engineering drawings with the most recent 2021 field survey. The historical depth of scour measured for German Mills and other creeks in the region, as presented Appendix C, represent exceptional impacts due to land use change and urbanization in the catchment, and may or may not be appropriate for extrapolation to predict future degradation over the next 100 years. While the average vertical erosion rate of 1.6 cm/year from historical measurements may in fact be conservatively high, climate change impacts are likely to add an additional perturbation to increase erosion in the fluvial system, so a conservative estimate is warranted.

Based on the erosion hazard assessments, nearly all of TW infrastructure within the valley of German Mills Creek within the study area is considered to be within the long-term horizontal and vertical erosion hazards (see mapping in Appendix C).

3.8.1.1 Erosion Risk Inventory

Erosion risk sites were identified in terms of their lateral and vertical erosion hazards with respect to property and infrastructure, with a specific focus on TW sewer infrastructure. A total of 56 erosion risk sites were identified and are presented above in Figure 3-3. An initial summary of erosion risk sites, risk type, distance to structure, and bank condition classification was presented in Section 3.4. To quantify geomorphic risk to TW infrastructure in terms of probability, basic time to exposure (TTE) methods were used.

Horizontal risks were considered over the next 100 years. The horizontal TTE was calculated using erosion rates determined at both a site-specific and a reach scale from the historic planform analysis. Bankfull channel planform traces were digitized using historic aerial imagery and 100-year lateral migration rates were estimated from the historical meander migration. Migration rates varied between reaches, but generally ranged between 0.2 m/year (20 m per 100 years) and 0.6 m/year (60 m per 100 years), with detailed results and statistics included in Appendix C. Yearly migration rates were applied to each erosion risk site to determine the estimated horizontal TTE of TW infrastructure based on the current distance from the closest channel bank. These migration rates were also applied in the projection of a 25-year erosion limit. The rates applied and 25-year projection, in the context of lateral risk sites can help to identify the potential extent of erosion risk mitigation projects, and group individual sites into larger scale design projects. Risk ranking and prioritization is discussed further in Section 3.9.

Vertical risks to TW infrastructure were assessed based on a channel profile analysis and the 100-year SHL. A factor of safety was not added to the SHL as the risk assessment is to evaluate the TTE for existing infrastructure, the 100-year natural scour hazard estimated to be 1.6 m below riffle grade and the overall 100-year SHL (natural scour and general scour) estimated to be 3.2 m. Vertical risks are further detailed in Appendix C. One lateral sewer pipe is exposed, three pipe crossings are within the 100-year degradation limit, and five pipe crossings are within the SHL. In addition, there are six sections of the STS and lateral sewer identified where future horizontal migration risks could generate new crossings where pipes would also be within the SHL. Credit for existing erosion controls on the channel bed have not been accounted for in the delineated SHL but are included in the TTE calculations presented in Section 3.9.

3.9 Erosion Site Prioritization

This section presents the results of the German Mills Creek geomorphic risk assessment with respect to the horizontal (lateral) and vertical (scour) erosion hazards associated with TW and private infrastructure. The risk assessment particularly focuses on the risk to TW sewer infrastructure within the vicinity of the creek and rankings were determined based on results of the erosion risk site inventory and erosion hazard rates discussed in Section 3.8 and detailed in Appendix C. The erosion hazard rates were then used to derive the TTE to infrastructure, in other words the estimated time the active channel will come in contact with infrastructure. For horizontal risks, TTE is calculated by the horizontal distance to infrastructure divided by the erosion hazard rate, while for vertical risks TTE is calculated by the depth of cover over infrastructure divided by the scour rate (Appendix C). For some erosion risk sites, the TTE was calculated for both horizontal and vertical erosion risks, but only the smallest TTE is reported for prioritization. In two cases (erosion risk sites 1.2 and 8.2), horizontal erosion rates were used to estimate the downstream migration of scour pools that could potentially expose the sewer pipes, but in both cases the vertical TTE was less.

For this study, an erosion control credit has also been added for existing channel treatments where natural rates of erosion would be inhibited. The erosion control credit was determined using a life cycle framework adapted from the Taylor-Massey Risk Assessment Study (Aquafor Beech 2021d) which was applied to erosion control structures within the study area using bank condition scores (Section 3.4); further details are provided in the Appendix C. GM-1 and GM-3 consist of mostly natural banks with local armouring, while GM-2 and GM-4 contain more erosion control structures. Compared to other recent studies in Toronto, German Mills Creek contains fewer erosion control structures, and thus most erosion risk sites were not assigned erosion control credit.

Erosion risk sites were each assigned an individual site ranking (1 to 56) based on a total risk assessment score (Appendix C-10) The total risk assessment score is the product of the risk probability (TTE = 1 to 5) and the risk severity (asset ranking 1 to 5, with TW sewers and watermains scoring 5) with final values ranging from 1 to 25 (Figure 3-6). Based on the top 11 erosion risk sites (primary), the remaining sites (secondary) were grouped with the primary sites in close proximity to generate local erosion mitigation projects. A twelfth project was identified for the upper reaches of Bestview Tributary and the entire Bestview Tributary has been evaluated as a single site for this study as instability downstream can eventually pose risk to the upper reach. The local project rankings (1 to 112) are presented in Appendix C-11 and summarized in Table 3-3. These top 12 local projects will be advanced through development and evaluation of alternative EA process for the German Mills Creek GSMP (Figure 3-7).

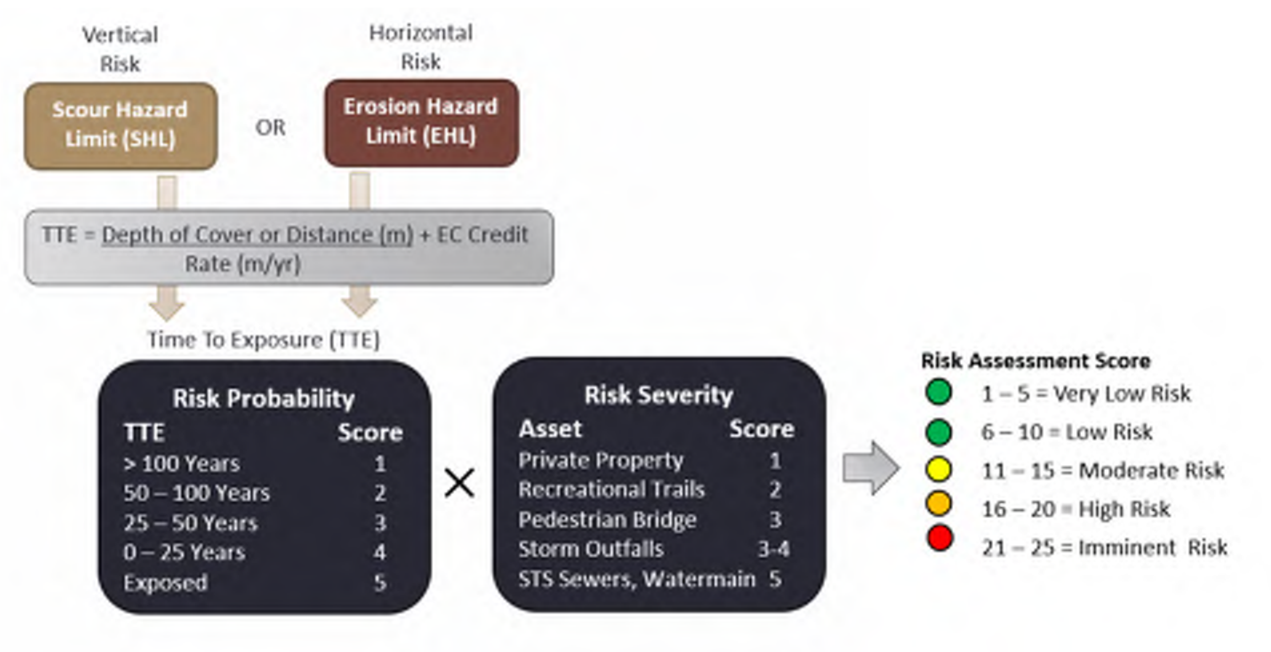
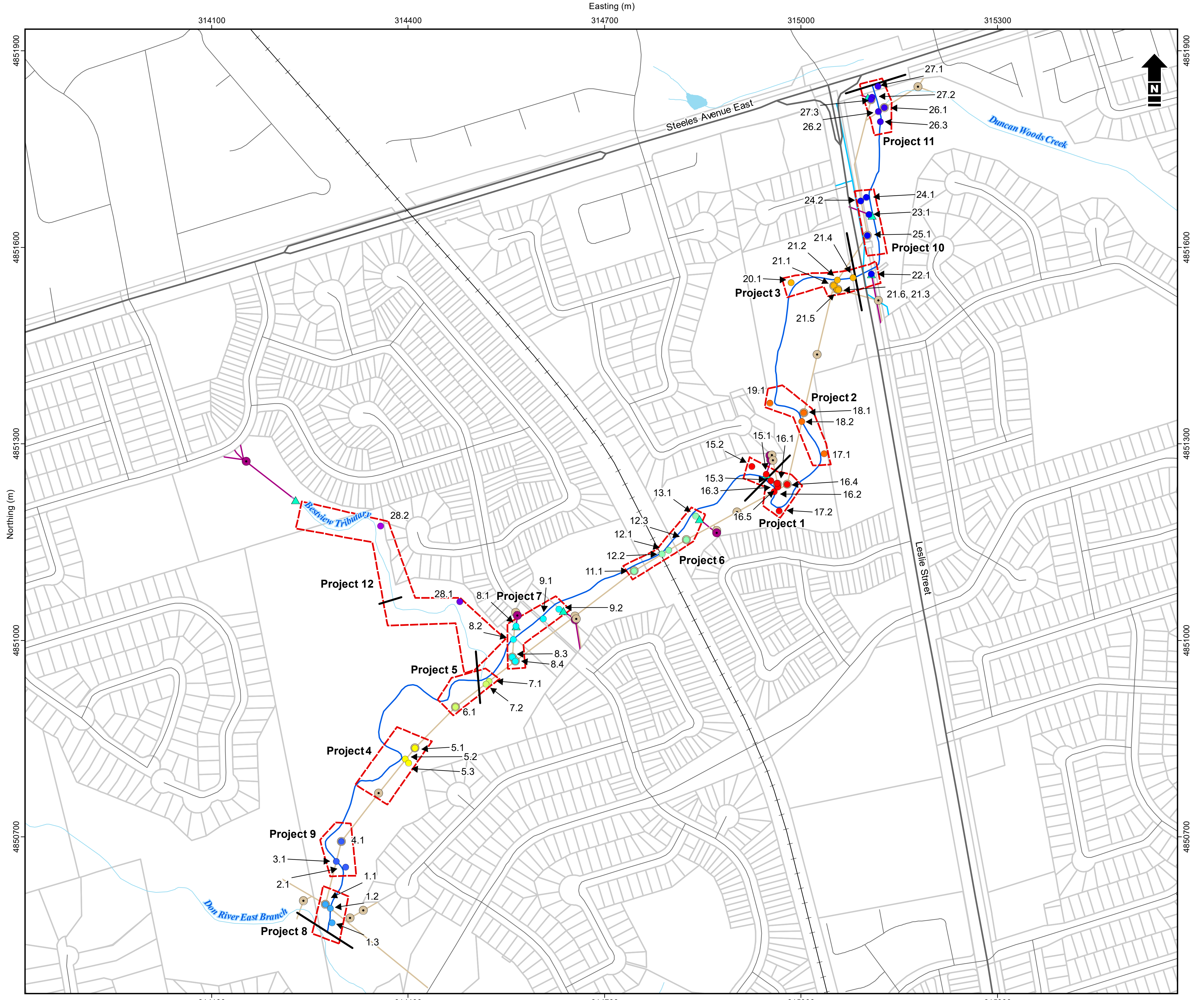


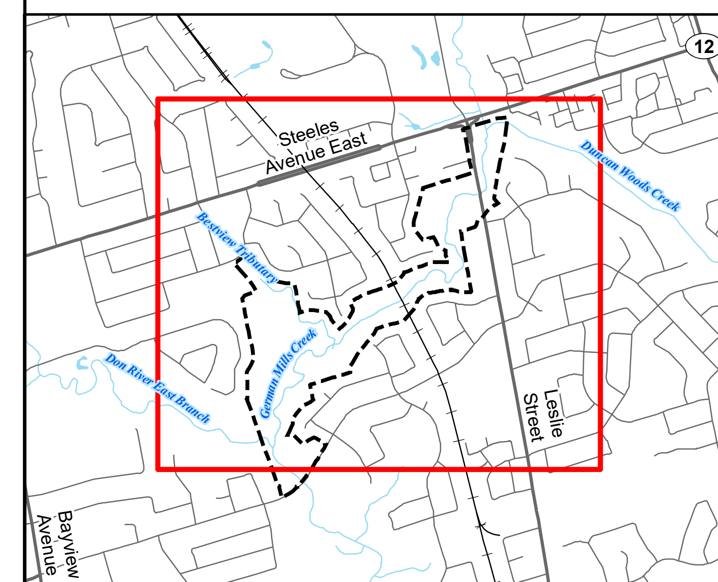
FIGURE 3-6 Summary of Total Risk Assessment Score



Property Boundary
Reach Break
Watercourse
Centerline (2018)
Highway
Road
Railway
Watermain
Sanitary Sewer Constructed in 1969
Storm Sewer
Stormwater Outfall
Sanitary Sewer Maintenance Hole
Storm Sewer Maintenance Hole

Local Project Rank

1
2
3
4
5
6
7
8
9
10
11
12
13



Disclaimer: Watermain and sewers have been clipped to the Focused Study Area.

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Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Toronto
German Mills Creek GSMP EA

Overview of Erosion Risk Projects

Date:	Project:	Submitter:	Reviewer:
December 2022	32227	N. Cyples	R. Phillips

Figure
3-7

TABLE 3-3 Project Ranking 1 to 12 Based on Highest Priority Sites and Associated Secondary Sites

3.10 Development of All Alternatives

3.10.1 Feasibility of Intervention

It is evident from the assessment of existing conditions and processes in the creek that further damage to TW infrastructure will occur without any intervention in German Mills Creek. Prior to the development of alternative solutions, the feasibility of intervention should be examined. Intervention can occur at different scales (watershed, reach-based, and site-specific), and generally the approach is based on the extent of the affected processes. The following summarizes key points with respect to the feasibility of intervention, based on a review of the 2003 WWFMP, and analysis of intervention recommendations (refer to Appendix F for additional details):

- The analysis of the 2003 WWFMP concluded that watershed or subwatershed scale source controls, even if implemented on significant areas of the watershed, are insufficient to significantly reduce channel erosion; source controls such as low impact development measures make a minor contribution to improve the stream geomorphic function.

- Restoration will still be required to address the current conditions and maintain stability from the runoff and resulting peak flows that are generated further upstream. The 2003 WWFMP suggests that stream restoration would still be required to achieve the moderate enhancement targets.

Based on these results, it was determined that direct intervention should be the approach mandated for stream rehabilitation and restoration in the study area. Therefore, for the purposes of the Master Plan, only reach-scale and local-scale (subreach) options are deemed appropriate for consideration to fulfill the stated objectives summarized in Section 1.2.

The following list briefly summarizes considerations and constraints in the developing alternative solutions and the evaluation criteria:

- Minimize risk to and protect sanitary sewer (trunk and lateral) and maintenance holes.

- Enhance geomorphic form and function through cross-section, planform, and profile designs and create a “nested” bankfull channel with accessible floodplain.

- Avoid increasing floodlines and reduce where possible (TRCA mandates).

- Work with and avoid destabilizing existing design elements (e.g., Duncan Creek design) or repair/enhance where required (e.g., existing armourstone treatments).

- Valley constraints (avoid toe erosion and slope destabilization).

- Avoid/reduce risks to private property.

- Minimize risks to park users (human safety) throughout and specifically along the multipurpose trail and at pedestrian bridges. Consider realignment and/or replacement of park features where warranted (e.g., crossings that impose unfavourable channel alignments, and/or undersized crossings, realign trail, move benches).
- Avoid or minimize/mitigate risk to terrestrial resources and habitat (e.g., tree damage/removal, wetlands).
- Avoid or minimize/mitigate risk to aquatic resources and habitat and consider thermal regime or target thermal regime.
- Consider protection of species at risk and protection or enhancement of species at risk habitat.
- Protect and integrate channel design with other infrastructure, including rail corridor and crossing, City roads and bridges, stormwater infrastructure, water mains, gas lines, and streetlights.
- Design and construction cost considerations and efficiencies.
- Avoid disruption to archaeological resources - completion of Stage 2 and Stage 3 investigations are required and should support the detailed design.
- Seek acceptability by agencies, public, and First Nations, through timely, comprehensive, and responsive consultations.

3.10.2 Development of Alternatives

With watershed scale solutions being screened out for practical application within the scope of the current Master Plan (Section 3.2), potential options have been developed and evaluated at the reach scale (channel lengths >200 m), and the local or subreach scale (channel lengths <200 m). At both scales, channel lengths with common hydraulic/morphologic characteristics are selected for intervention based on the issues observed along the reach. However, the local scale allows for existing areas of lesser or low risk and relative stability to continue to adjust to any interventions completed at the local scale.

The following list of alternative solutions has been developed for the German Mills Creek GSMP study to specifically address the erosion concerns documented in the top 12 local erosion mitigation projects as identified in Section 3.9 (additional detail in Appendix C). The term "reach scale" or "sub-reach scale" throughout the development of alternatives is not in reference to the four reaches delineated for the study area, but rather an approximate threshold channel length of 200 m for proposed works, with anything greater than 200 m being considered within a reach scale, and less than within a sub-reach scale:

Alternative 1 - Do Nothing - leaving existing conditions as-is with no design mitigation, resulting in further channel degradation and erosion, with potential or continued exposure and/or undermining TW infrastructure; could consist of continued monitoring where priority sites are already exposed and are likely to require emergency works (local placement of riprap rock protection).Monitoring may also be recommended for sites where erosion risk may be lower, or TTE longer.

Alternative 2 - Local Works (sub-reach scale, <200 m length) - local erosion mitigation projects of less than 200 m in channel length, including adjustments to both the channel bed and banks, to address high priority sites and nearby secondary sites which typically fall within the project extents of local works designs, with a range of design options to be considered.

Alternative 3 - Local Works with Reach-scale Floodplain Connections - local works (Alternative 2, bed and bank modifications, less than 200 m) and enhancing floodplain connectivity with bank modifications in between the local works sites to strategically increase floodplain conveyance, balancing proposed works with tree removals.

Alternative 4 - Reach Works (>200 m length) - reach-scale channel works of greater than 200 m in channel length to realign and/or restore the channel and floodplain connectivity in a new configuration, including some level of erosion control, with a range of design options to be considered to address a collection of local erosion mitigation project sites.

A variety of erosion mitigation approaches are available to address the erosion risk identified in this study, including structural bank treatments (e.g., armourstone, vegetated rock buttresses, rock toe protection), in-stream treatments and grade controls (e.g., armoured riffles and rocky ramps, rib structures, flow deflectors), bioengineering (e.g., live staking and brush layering, log crib-walls, sod matts and vegetated coir-warp soils), and channel realignments (e.g., meandering, terraced floodplain, stream training). Specifically for Alternatives 2 and 3 (local works) and Alternative 4 (reach works), there is a spectrum of design options ranging from "harder" to "softer" approaches, but also hybrid and mixed combinations of approaches are possible:

- "Harder" river engineering approaches relying heavily on in-channel structures to balance fluvial dynamics more toward channel stability. These are to be utilized at high-risk sites with imposing constraints and/or higher in-stream stresses.

- "Softer" channel realignments relying more strategically on channel realignments, buried erosion control structures (set within the floodplain, between the active channel and TW infrastructure), and bioengineering to balance fluvial dynamics more toward channel flexibility. These softer approaches are to be utilized at lower-risk sites, where lower in-stream stresses lend to the sustainability of these features and/or the channel has limited constraints and more lateral freedoms.

A hybrid approach may be recommended to allow for some flexibility within an erodible corridor, with softer approaches being applied along the active channel (e.g., vegetated banks or other bioengineering), but harder, buried erosion protection for TW infrastructure set back in the floodplain that has a greater TTE (e.g., buried armourstone along a pipe at horizontal risk).

Alternatives 2 through 4 propose a nested “bankfull” channel with a constructed, accessible floodplain, and set within a larger cross-section as slopes grade up to the existing floodplain. This results in a varying top width and substantial material removals (soil and vegetation). As a preferred alternative is selected, the top width should be refined toward detailed design to balance between hydraulic capacity of larger flood events and the necessary removals of excess soils and mature trees.

3.11 Climate Change Assessment

Climate and environment are one of the four resilience challenges facing the City of Toronto (the City), as identified in the *Toronto Resilience Strategy* (City of Toronto 2019). As such, a climate change assessment approach was developed in consultation with City staff to meet the project objectives and included the following: 1) future rainfall scenarios; 2) hydrological modelling; 3) geomorphic impact analysis; and 4) geomorphic system master plan evaluation of impacts. From the results and analysis presented in Appendix D, a 10% increase on average in the erosional forces that initiate movement of channel bed materials (e.g., flow velocity) and a 100% increase on average in sediment transport work (i.e., mass that is moved) may be expected due to climate change impacts on future rainfall to German Mills Creek.

As part of the development of alternatives for the study, several design approaches will be considered and evaluated based on potential for added climate resilience and/or redundancy, to protect Toronto Water infrastructure over the intermediate and long term. The alternative concepts, and the recommended timelines for intervention, will also be evaluated based on potential for climate changes to impact the design life and maintenance requirements of any new erosion mitigation assets. Following adaptive management approaches, designing to shorter-time periods (e.g., 2050) may be considered appropriate to balance the cost of migration for managing creek erosion with the uncertainty of longer-term climate outcomes. As such, the design approach needs to consider how erosion mitigation infrastructure can be maintained, adapted, and effectively modified to meet future climate conditions with ongoing monitoring and watershed planning activities by the City and TRCA. The GSMP climate change assessment report provides detailed analyses and results that support the selection of preferred alternative solutions and conceptual design options (Appendix D).

4 PHASE 3: DEFINE AND EVALUATE ALTERNATIVE SOLUTIONS

The following sections specifically define how each of the four alternatives described in Section 3.10 may be implemented for each project site. The alternatives have been evaluated with defined criteria and indicators, with consideration for a natural clustering of project sites for design and construction. The preferred option has been selected and advanced to conceptual design. Appendix F provides a fulsome overview of each alternative. The following provides a summary of the application of each alternative on the reach/site scale. Appendix F-1 includes conceptual drawings for the following design alternatives.

4.1.1 Alternative 1: Do Nothing

The do-nothing scenario will allow ongoing bank migration and channel incision to expose or further expose and potentially destabilize TW infrastructure (sewer crossings and maintenance holes). As a result, priority sites where infrastructure is exposed or nearly exposed would likely require immediate or near-term emergency works stabilization localized to the immediate risk site. Emergency works are typically hard stabilization measures (i.e., armourstone, riprap, etc.) without any substantial realignment, floodplain improvements, or ecological enhancements.

It is anticipated that sites with the highest risk score will require stabilization either immediately or within 1 to 5 years, including (in order of severity):

- Reach 3: bank and bed stabilization for exposed lateral maintenance hole and sewer and two exposed trunk sewer maintenance holes and near surface crossings – Project Sites 1, 2, and 3.

- Reaches 1 and 2 (at confluence with Bestview Tributary): bank stabilization for at risk trunk sewer pipe parallel to pathway Project Site 5.

- Reach 2 (in vicinity of rail crossing): bank stabilization at nearly exposed maintenance holes. Riprap is currently providing some protection, though unstable at Project Site 6.

- Reach 2 (downstream of valley pedestrian bridge): lateral sewer crossing at risk to incision Project Site 7.

4.1.1.1 Monitoring

If a project site is evaluated with Alternative 1 as the preferred alternative the development and implementation of an erosion monitoring program may be recommended. Similarly, the GSMP identifies erosion sites throughout, including those that may not present specific risk to TW assets, that could be included in a holistic monitoring program. However, with the exception of Alternative 4, some erosion risk sites identified through Phases 1 and 2 may not be captured through the alternatives development and associated concept designs (i.e., they fall beyond project site limits). In these cases, monitoring may be recommended with the appropriate stakeholder identified (e.g., Urban Forestry and Parks, TRCA).

4.1.2 Alternative 2: Local Works

Alternative 2 proposes works to address single or multiple erosion risk sites through a local natural channel design approach incorporating hard erosion control structures where required. The length of restoration/stabilization design is generally less than 200 m and includes planform, profile, and cross-section design upgrades with a combination of “hard” and “soft” treatments to protect and enhance the geomorphic, hydraulic, and ecological character. Within each reach, the following issues may be addressed through local works:

- Reach 1; Project Sites 4, 8, and 9: replacement of the existing, undersized bridge upstream of the confluence with the East Don River and protection of the trunk sewer crossing (Project Sites 8 and 9) to maintain a depth of cover that is greater than 1 m. Bank stabilization required along the right bank (looking upstream) to manage local constraints (valley confinement and trail protection). Project Site 4 includes a realignment away from potential exposure of the trunk sewer, with a tie in to the existing riprap channel mid reach.

- Reaches 1 and 2; Project Sites 5 and 7: local works within the vicinity of the confluence with Bestview Tributary extend approx. upstream 150 m and downstream 100 m. Channel realignment is proposed with a similar or greater sinuosity than the existing condition. Bank protection is proposed to protect trunk sewer pipes currently at risk to exposure and to ensure that high flows do not continue to pose risk to these structures. A stable riffle will be designed to tie into the upstream end and backwater existing riffle feature upstream of pedestrian bridge. Lateral sewer crossing is proposed to be relocated and lowered to achieve a sufficient depth of cover that is greater than 1 m (note: elevating the profile to an acceptable depth of cover over the existing crossing would require a substantial design length greater than 500 m to attain feasible tie in elevations, and would significantly change the floodline hazard elevations i.e., Alternative 4).

- Reach 2; Project Site 6: channel widening is proposed under railway bridge. This alternative may slightly realign the channel centreline away from the trunk sewer and at risk maintenance holes (right bank looking upstream). Only narrow benching and slope regrading can be achieved within the existing constraints (e.g., sewer, railway crossing/grading, recreational trail).

- Reach 3 (and tie in to Reach 2); Project Sites 1, 2, and 3: each of these three project sites include the same issues and requirements for stability: maintenance hole exposure and bed stabilization to maintain greater than 1 m depth of cover over STS pipes. Project Site 1 includes a fully exposed lateral maintenance hole and partial exposure of the lateral pipe. In addition to local channel works, Alternative 2 proposes an option to deal with the exposed lateral maintenance hole and pipe: realign the lateral to tie into the trunk sewer at an upstream maintenance hole, removing the existing exposed maintenance hole from the channel. Throughout each project site, the limit of grading (top width) varies from 15 to 25 m, and where the limit falls adjacent to a maintenance hole, an embedded armourstone wall is proposed to sustain the existing location of each maintenance hole. The bankfull channel and centreline are proposed to be realigned away from existing at risk maintenance holes that are proposed to remain in the future.

- Reach 4; Project Site 10: at the location of a failed drop structure (gabion), slight channel realignment away from the eroding valley slope (right bank looking upstream) and bank stabilization on approach to and extending down to the existing armourstone wall along the Leslie Street embankment are proposed. The design riffle proposed here is essentially an extension of the existing armoured riffle design within Reach 4.

- Bestview Tributary - Project Site 12: for Alternative 2, bank stabilization measures would be proposed along the Bestview Tributary within the downstream reach to reduce the erosion risks to private residences at the top of the valley slope, and to better transition into confluence, reducing downstream impacts to TW infrastructure in vicinity of confluence (Project Site 5). The upstream reach consists of a riprap channel with armourstone wall banks that conveys flows from a large stormwater outfall draining from Bestview Park. The banks of the engineered reach upstream are in relatively stable condition, with some ongoing redistribution of the riprap and gabion stone on the bed.

4.1.3 Alternative 3: Local Works with Reach-scale Floodplain Connections

Alternative 3 includes all the bed and bank modifications and erosion protection enhancements proposed for local works under Alternative 2 with additional floodplain grading of the banks between local works segments. In Alternative 3, strategic bankfull grading, benching, and slope regrading between local work segments will provide improved continuity of the flood conveyance through out the reach. This will reduce the potential impacts of hydraulic contraction and expansion for flows above bankfull (i.e., locally increased and decreased velocities, and associated erosion and sedimentation processes) and will further reduce the risk to the sanitary sewer associated with overall instability (incision and widening). The proposed cross-section through these inter-local works sites will work with the current trends in bankfull landform development (e.g., bars, benches) and their elevations to formalize and widen floodplain benches with limited disturbance of the existing channel bed. Channel training and other softer treatments (e.g., embedded wood, gravel/cobble lenses) may be included within the floodplain enhancements, along with appropriate riparian vegetation and habitat enhancements (e.g., undulating topography). Strategic areas of bank regrading and associated hydraulic benefits will be balanced with tree removals through the detailed design process.

4.1.4 Alternative 4: Reach Works

Alternative 4 proposes a full-scale creek corridor design potentially from Steeles Avenue to the East Don confluence or for individual reaches greater then 200 m in length, including plan, profile, and cross-section with the creation of floodplain benches and grading up to the existing floodplain elevation. This option may address all project sites similar to Alternatives 2 and 3, with channel realignment away from at-risk infrastructure and bank protection. Full channel realignment with greater sinuosity in the bankfull channel is proposed compared to the local works options (Alternatives 2 and 3). This option maintains the nested bankfull channel within a constructed floodplain, set within a larger cross-section that grades up to the existing floodplain elevation. The extent of bank treatments is greater as a more sinuous channel and wider floodplain throughout create more interactions with valley, trail, and other infrastructure (e.g., stormwater outfalls). The full realignment and sinuous “bankfull” channel allow for the ability to provide increased depth of cover at sewer crossings (e.g., Project Sites 1 and 7); however, it is still recommended that options to relocate the lateral sewer crossings at these two project sites are considered for a long-term solution that minimizes the future risks and maintenance requirements. The proposed profile includes a mostly regular sequence of pools and riffles, with some lengthened pools along select bends throughout. Trunk sewer pipe crossings are protected by strategically placed riffles (with a stabilizing armour layer potentially buried below substrate). Channel training and other softer treatments (e.g., embedded wood, gravel/cobble lenses) may be included within the floodplain enhancements, along with appropriate riparian vegetation and habitat enhancements (e.g., undulating topography).

4.2 Alternatives Assessment

The opportunities, objectives, and constraints in Section 3.10 were used to direct the discussion of the alternatives (Section 4.1). Each of the alternatives was evaluated based on five components: technical and engineering considerations, physical environment and TW infrastructure risk, natural environment, economic environment, and social and cultural environment, with each component consisting of several criteria summarized in Table 4-1.

TABLE 4-1 Criteria for Evaluating Alternative Solutions

Category	Criteria	Indicator
Physical Environment and Toronto Water Infrastructure	Risk Assessment	• Ability to reduce the immediate risk to TW infrastructure caused by watercourse erosion.
	Erosion Hazard	• Ability to reduce long-term erosion hazard risks (including slope stability) within the channel.
	Flood Hazard	• Ability to reduce adverse impacts of flooding in an urban environment, minimizing risk to infrastructure. In particular in the overbank zone of the creek, where increased flooding may limit access required to maintain the sites.
Natural Environment	Geomorphic Form and Function	• Ability to improve geomorphic stability and natural components of watercourse function.
	Improvements to Aquatic Habitat/ Community	• Greater improvements to fish and aquatic habitat/community including substrate, overhanging vegetation, turbidity (water quality), and passage/connectivity.
	Minimize Impacts to Aquatic Habitat/ Community	• Limit disturbance to fish and aquatic habitat/populations (temporary or permanent loss) including species at risk.
	Improvements to Water Quality and Groundwater Connectivity	• Ability to adapt to and be resilient to a changed hydrological flow regime and accompanied geomorphic response, including due to climate change.
	Improvements to Terrestrial Habitat	• Ability to improve connectivity, diversity, and sustainability of terrestrial habitat.
	Minimize Impacts to Terrestrial Habitat	• Ability to limit disturbance to existing woodlots/other terrestrial habitat and natural heritage features and vegetation by type, including Environmentally Significant Areas, Areas of Natural and Scientific Interest, wildlife corridors, species at risk, and others. • Ability to balance tree removals against flood hazards. • Evaluated through a comparison of area of disturbance in ha based on conceptual grading limits (18 to 24 m wide corridor).

Category	Criteria	Indicator
	Climate Change Resiliency	• Ability to adapt to and be resilient to a changed hydrological flow regime and accompanied geomorphic response due to climate change.
Social and Cultural Environment	Landowner and Public Acceptance	• Ability to be accepted by landowners and community including First Nations and Indigenous consultation. This includes acceptance of impacts to trees.
	Short-term Impacts to Community	• Ability to limit short-term (2 to 5 years) negative impacts, such as erosion damage, closures, and noise, on the community. Impacts relate to doing nothing or during construction.
	Long-term Impacts to Community	• Ability to produce long-term positive impacts, such as improved environment, education, amenities, and aesthetics, on the community. Impacts relate to doing nothing or following construction (including climate change sustainability).
	Flood Hazard to Public	• Ability to reduce impacts to private and public property (i.e., dwellings, pathways, etc.) resulting from flooding.
	Cultural Heritage and Archaeological Resources	• Ability to protect built heritage resources, cultural heritage landscapes and archaeological resources.
Economic Environment	Capital Cost	• Estimated capital costs for implementing the alternative solution. • Includes consideration for tree removals and restoration (including off-site plantings), based on a relative comparison of the area of disturbance, and potential for restoration based on a 3:1 planting to removal ratio, and a spacing of 2.5 m on centre for plantings. • Includes consideration for excess soils based on a relative comparison of the area of disturbance/volume of excavated material. • Capital costs determined at the evaluation stage based on a rate of \$5,000/linear metre for natural channel design sections, and \$1,000/linear metre for floodplain connections.
	Lifecycle Cost Consideration	• Ability to limit the long-term reoccurring costs of intervening to address chronic erosion issues, such as reoccurring erosion over a span of 30 years.
	Cost Effectiveness (Economy of Scale)	• Ability to provide multiple improvements, such as more infrastructure protection and less environmental and social disturbances, at a cost less than the total of completing all the improvements separately. Includes the ability for Toronto Water to partner and share costs with other infrastructure owners with infrastructure at risk of erosion.
	Climate Change Risk	• Ability to buffer against financial uncertainties of climate change.
Technical and Engineering Considerations	Regulatory Agency Acceptance	• Ability to satisfy regulatory agency (City of Toronto, TRCA, DFO, Urban Forestry, provincial) mandates.
	Ease of Implementation/Constructability	• Potential impacts to surrounding infrastructure during and after construction. • Ability to limit tree removals and excess soils. • Soils estimated based on an assumed mean depth of 1.5 m.
	Resource Effectiveness	• Ability to provide multiple improvements, such as more infrastructure protection, using less operational resources than if the improvements were completed separately. Includes the ability to reduce engineering, permitting, and administration services to free up resources for other priority work.

Category	Criteria	Indicator
	Climate Change Adaptation	• Ability to satisfy regulatory mandates in response to climate change. This includes the ability to support habitat restoration benefits, long-term generational benefits, and resiliency and sustainability benefits that may still be in development stages with reference to existing policies and mandates.

4.3 Scoring Methodology

The alternatives were evaluated for each project site (Project Sites 1 to 12), using each criterion to produce a summary score. A higher score is considered preferable, with 1 being the least preferable, and 5 being the most preferable. Specific information on scoring for each alternative is provided in Table 4-2. When there is no difference in perceived value, the alternatives will receive the same score (3). This may occur when the criterion is not applicable to the alternative. To arrive at the summary score, each category receives a normalized score such that it receives a 20% weighting.

TABLE 4-2 Scoring Methodology

Score	Description
1	Least positive, or negative, impact Greatest cost Environmental degradation Difficult implementation
2	Minor negative impact High cost Low to no environmental benefit/enhancement Difficult Implementation
3	Neutral impact Moderate environmental benefit/enhancement Moderate cost Ability to implement with some challenges
4	Minor positive impact Low cost High environmental enhancement/gain Fairly easy to implement with minor challenges
5	Most positive, or beneficial, impact Lowest cost Environmental enhancement/gain Ease of implementation

4.4 Alternatives Evaluation

Matrix completed a detailed assessment of each alternative solution. In the evaluation approach, rankings consider the advantages and disadvantages of each alternative to address the project objectives with the least environmental effects and the most technical benefits, which forms the rationale for the identification of the preferred alternative.

A comparative evaluation in a matrix format was prepared and used to present the evaluation of alternative solutions for each project site. Appendix F-2 includes detailed evaluation/scoring matrices for each project site, followed by descriptive matrices to support the interpretation of the evaluation of alternatives for project sites that had similar scores. Section 4.4.5 presents summary scores (out of 100) per alternative, for each project site, with grey cells indicating the preliminary preferred alternative.

4.4.1 Terrestrial Impacts Versus Hydraulic Benefits

Further consideration of the criteria to minimize impacts to terrestrial habitat included estimations of areas of disturbance (i.e., footprints of proposed works), approximate densities of trees (i.e., diameter at breast height >10 cm), and associated estimates of the number of trees impacted for each project under each alternative. An initial assessment of the number of trees to be removed by project and alternative was completed as documented and mapped in Appendix F-3.

It is expected that the full tree compensation will not be provided onsite; therefore, the balance of compensation will need to be paid for in offsite compensation. These additional cost for tree compensations have been included under the capital costs discussion in Section 4.4.3.

4.4.2 Excess Soils Considerations

The main objective of Ontario Regulation 406/19 (O. Reg. 406/19) is to stop illegal dumping activities and encourage the reuse of soils on the original site and/or moving it to a reuse site. O. Reg. 406/19 aims to ensure property owners with excess soil are testing soil for contamination and assessing it to determine if it is suitable for offsite disposal.

For a preliminary assessment of possible excess soils costs over and above typical channel construction costs, its has been assumed that 50% of the required excavations will be reused onsite, while the remaining 50% will require disposal offsite, based on cut estimates for each alternative.

The unit cost for disposal of excavated materials offsite over and above standard unit costs for earthworks with onsite reuse varies significantly with degree of soil contamination if present. The cost for offsite disposal of contaminated soils can be between double and an order of magnitude higher unit costs for slightly to heavy or severely contaminated soils; therefore, project budgets will need to include adequate contingency allowances in case contaminated soils are encountered during construction. As such, it is increasing becoming best practice to undertake a minimum level of soil testing for due diligence during the detailed design stage to reduce the uncertainty of the excavated soil quality and constrain the amount of contingency required for tendering the project.

A summary table to the project areas, volumes, and preliminary excess soil costs for each alternative is provided in Appendix F-2.

4.4.3 Capital and Life Cycle Cost Considerations

To help inform the evaluation of alternatives, high-level cost estimates have been developed for channel construction and restoration on a linear metre basis. For natural channel design segments (plan, profile, cross-section, treatments) a value of $5,000/m was applied. For those areas only subject to grading (i.e., floodplain connections), a value of $1,000/m was used. Further detailed cost estimates should be developed for the preferred alternatives in Phase 4 through conceptual design reporting for each Project Site.

A summary of the preliminary capital costs for each of the projects and proposed alternatives is provided in Table 4-3. It is noted that the total values summed at the bottom the table (in millions of dollars) are for each alternative if all projects were to be selected under that alternative. The preliminary preferred alternative costs for each project scoring the highest in Section 4.4.5 are summarized in Table 4-4 (shown as project groups), with the estimated total for construction of all projects at $8.67 million in 2023 dollars.

TABLE 4-3 Summary of Capital Cost Estimates for German Mills Channel Works Alternatives (in millions of dollars; year of estimate 2023)

Project Site	Channel and Floodplain Restoration [1]				Excess Soils Allowance [2]			Offsite Tree Removal Costs [3]			Total Estimated Costs		
	Alt 1 [4]	Alt 2	Alt 3	Alt 4	Alt 2	Alt 3	Alt 4	Alt 2	Alt 3	Alt 4	Alt 2	Alt 3	Alt 4
1	0.33	0.65	0.75	1.13	0.10	0.13	0.15	0.14	0.17	0.23	0.89	1.05	1.51
2	0.35	0.70	0.79	1.13	0.10	0.15	0.19	0.07	0.12	0.16	0.87	1.06	1.48
3	0.60	1.20	1.26	1.50	0.08	0.09	0.11	0.06	0.07	0.10	1.34	1.42	1.71
4	0.23	0.45	0.60	1.20	0.06	0.14	0.15	0.04	0.14	0.15	0.55	0.88	1.50
5	0.43	0.85	0.91	1.13	0.10	0.12	0.12	0.07	0.10	0.10	1.02	1.13	1.35
6	0.38	0.75	0.87	1.33	0.09	0.13	0.15	0.06	0.10	0.12	0.90	1.10	1.60
7	0.18	0.35	0.41	0.65	0.06	0.11	0.13	0.04	0.08	0.10	0.45	0.60	0.88
8	0.23	0.45	0.45	0.45	0.05	0.05	0.05	0.13	0.13	0.13	0.63	0.63	0.63
9	0.05	0.10	0.20	0.58	0.03	0.09	0.11	0.07	0.28	0.27	0.20	0.57	0.96
10	0.18	0.35	0.39	0.55	0.04	0.07	0.07	0.00	0.02	0.03	0.39	0.48	0.65
11	0.13	0.25	0.28	0.38	0.00	0.05	0.05	0.00	0.02	0.03	0.25	0.35	0.46
12	0.05	0.50	0.50	0.50	0.02	0.02	0.02	0.01	0.02	0.02	0.53	0.54	0.54
TOTAL	**$3.10**	**$6.60**	**$7.41**	**$10.53**	**$0.73**	**$1.15**	**$1.30**	**$0.69**	**$1.25**	**$1.44**	**$8.02**	**$9.81**	**$13.27**

Notes:
(1) Cost estimate of $5,000 per linear metre of channel and floodplain restoration, including typical earthworks material reuse onsite, imported stone materials, and onsite tree plantings and vegetation restoration.
(2) Assuming 50% of clean excavated materials for offsite disposal at unit rate of $50/m^3.
(3) Assuming replacement rate of 3 × $583 per tree removed for offsite compensation.
(4) Monitoring, maintenance, and possible emergency works for Alternative 1 taken as percentage of Alternative 2; 50% for a 10-year period for sites where Toronto Water infrastructure at risk (Project Sites 1 to 11); 10% for 10 years where Toronto Water infrastructure not at risk (Project Site 12).

TABLE 4-4 Estimated Costs of Preliminary Preferred Alternative (in millions of dollars)

Project Site Groups	Alternative 1 (1)	Alternative 2	Alternative 3	Alternative 4
1, 2, 3	$1.28	$3.10	$3.53	$4.70
4, 8, 9 (2)	$0.50	$1.38	$2.08	$3.09
5, 6, 7	$0.98	$2.37	$2.83	$3.83
10, 11	$0.30	$0.64	$0.83	$1.11
12	$0.05	$0.53	$0.54	$0.54
Total Estimated Cost of Preliminary Preferred Alternatives (2023 value) = $8.67 million				

Notes:
(1) Alternative 1 does not include costs of catastrophic failure of TW infrastructure, and thus were scored low in evaluation. Monitoring, maintenance, and possible emergency works for Alternative 1 taken as percentage of Alternative 2; 50% for a 10-year period for sites where TW infrastructure at risk (projects 1 to 11); 10% for 10 years where TW infrastructure not at risk (project 12).
(2) Preliminary preferred alternative for Project 4 is Alternative 2, but project costs have been grouped with as floodplain connection between Project 9 and Project 4 being recommended.

To further support the alternative evaluation, a basic life cycle cost analysis was undertaken as presented in Table 4-5, whereby costs are standardized to a 30-year depreciation period and expressed as the value to implement or replace the asset in about 30 years time (2053) assuming an average annual rate of inflation of 3%. For this analysis, it is assumed that capital investment costs for each alternative are for increasing life spans as relative ratios expressed to a 30-year standard (i.e., Alternative 2). The costs of Alternative 1 are expressed for a 10-year life cycle, assuming recurring monitoring and possible emergency works, but costs do not include potential catastrophic failure of TW infrastructure. Generally, Alternative 3 as presented has the best investment over the period, except for in the case of Project Site 12 where no TW infrastructure is at risk beyond the stormwater outfall. For projects scoring highest for Alternative 2 (Section 4.4.5) the scoring of other evaluation criteria outweighed the associated economic criteria.

TABLE 4-5 Life Cycle Cost Analysis Future Value Standardized to 2053 (in millions of dollars)(1)

	Alternative 1 (2)	Alternative 2	Alternative 3	Alternative 4
Life Cycle (years)	10	30	50	60
Standardized Ratio	3	1	0.6	0.5
Project Groups				
1, 2, 3	$9.28	$7.52	$5.14	$5.70
4, 8, 9 (3)	$3.64	$3.35	$3.03	$3.75
5, 6, 7	$7.10	$5.75	$4.12	$4.65
10, 11	$2.18	$1.55	$1.21	$1.35
12	$0.36	$1.29	$0.79	$0.66
Total Estimated Cost of Preliminary Preferred Alternatives (2053) = $15.84 million				

Notes:
(1) Standardized to 30-year depreciation period using an annual inflation rate of 3%.
(2) Alternative 1 does not include costs of catastrophic failure of TW infrastructure and, thus, were scored low in evaluation.
(3) Preliminary preferred alternative for Project Site 4 is Alternative 2, but project costs have been grouped as floodplain connection between Project Site 9 and Project Site 4 being recommended.

4.4.4 Climate Change Assessment

The City has recognized climate change as a major challenge facing the City, especially in terms of future resilience of infrastructure to erosion and flood hazards associated with its drainage systems, watercourses, and ravines. As such, the proposed evaluation criteria described in Section 4 include an element of climate change under every category:

- Physical Environment and TW Infrastructure: erosion and flood hazards
- Natural Environment: climate change resiliency
- Social and Cultural Environment: long-term impacts to the community including sustainability
- Economic Environment: climate change risks (including financial)
- Technical and Engineering Considerations: climate change adaptation as new regulatory policies

A detailed technical climate change assessment has been documented within Appendix D, which supports the evaluation of alternatives presented herein. While the results vary considerably over a range of future climate scenarios, with no single future climate scenario more or less accurate to predict climate change impacts, increases are anticipated in flows, hydraulic forces, and hydrogeomorphic indices that will contribute to increases in erosion, sediment transport, and channel dynamics. These increased rates of geomorphic processes include both large flood event-based erosion hazards and cumulative geomorphic work from a range of annual frequent flows. Strategies to build resilience into in the systems and protect TW infrastructure include increased factors of safety in the erosion control structures, designed allowances for flexibility in the system, or combination of both structure and flexibility. Given the potential magnitude of increases in erosional forces and erosion rates due to climate change, and the associated uncertainty in all predictions, strictly managing the erosion hazard with rigid erosion structures is not expected to be the best capital investment. Engineered channels using hard structural approaches alone are at risk of accelerated deterioration over time and possible catastrophic failure due to extreme events that are expected under future climate scenarios. Therefore, a combined approach for both hard erosion protection elements integrated into a more flexible alluvial channel system provides a balanced approach to mitigate the hydrological and fluvial effects of climate change.

4.4.5 Preliminary Preferred Alternative

Table 4-6 provides summary results per alternative for each project site. Grey cells indicate the preliminary preferred alternative for each, that was then presented to stakeholders through the consultation process described in Section 4.5, prior to finalizing the preferred alternative and proceeding with the development of an implementation plan (Section 6) and conceptual designs.

TABLE 4-6 Summary Scores Per Alternative

Project Site (Priority Site)	Reach	Alt 1	Alt 2	Alt 3	Alt 4
P1	GM-3	35.1	61.3	**73.1**	71.8
P2	GM-3	35.1	63.6	**73.4**	69.4
P3	GM-3	35.1	67.7	**77.5**	73.5
P4	GM-1	35.1	**74.4**	70.9	70.1
P5	GM-1	35.1	**76.6**	71.7	68.2
P6	GM-2	35.1	**77.0**	71.9	70.3
P7	GM-2	34.1	**76.6**	75.2	68.0
P8	GM-1	34.1	76.5	**78.0**	68.0
P9	GM-1	34.1	72.1	**77.0**	69.0
P10	GM-4	35.4	**72.6**	71.7	66.2
P11	GM-4	38.6	**73.5**	72.4	70.0
P12	GM-BV-1/BV-2	**65.1**	56.0	51.2	49.3

Note: Grey shading indicates preferred option for each priority site

4.5 Consultation

An essential component of the EA process is ongoing consultation with area stakeholders to confirm the project objective, evaluate constraints, and develop and evaluate potential solutions. This begins through the Notice of Study Commencement through to the Public Review Period of the project file upon completion. The consultation provides stakeholders with the opportunity to express concerns across several aspects of the project including current issues, issues with construction, concerns around the environment, and capital costs. For the German Mills Creek Geomorphic Systems Master Plan study, the City provided information on the study purpose, the study area, details and process, including evaluation criteria, and recommended solutions and facilitated opportunities for feedback. Feedback through this engagement was used to refine the development of preliminary alternatives, and to select the final preferred solution for each project site.

4.5.1 Notification

Notification channels included electronic distribution and printed notices delivered through Canada Post. Contact lists were developed to include First Nations, agencies, utilities and institutions, along with community groups and local organisations and were updated at each stage of the study.

The public and agency consultation requirements for a Schedule B project under the Municipal Class EA process include:

- issuing a Notice of Study Commencement to inform the public and applicable agencies that the Class EA is being undertaken

- conducting a PIC to present information and solicit feedback on the problem or opportunity; the need for the project; the inventories of the natural, social, and economic environments; and the planning and design details based on these inventories

- issuing a Notice of Study Completion to inform the public and applicable agencies that the Class EA has been completed, and that the project file is available for review and comment

A Notice of Study Commencement was issued via email and print in October 2022 that provided information about the purpose of the study and the study process. A Notice of Public Consultation was circulated the week of August 1, 2023, at the onset of public consultation, and provided information about the recommended solutions and opportunities for feedback as part of the public consultation process. Notices were sent via Canada Post direct mail to 5,412 residential and business addresses in the study area. An emailed notice was also circulated to 28 community interest groups, and 69 government agencies and utility companies. A project website was created and updated to include public consultation materials and a link to the feedback survey: toronto.ca/GermanMills.

A copy of the notice of commencement and notice of public consultation are provided in Appendix G1 and G2, respectively. The following provides additional details on the overall project consultation.

4.5.2 Indigenous Communities Engagement

Under provincial environmental laws, proponents must consult with Indigenous communities during the EA process, for which the nature of the consultation will vary depending on the project. For example, some Indigenous communities may be consulted based on interest and others for which a project may impact established or asserted Aboriginal rights of Indigenous communities.

Consultation with First Nations by the project team is by delegated authority through the Ministry of Environment, Conservation and Parks (MECP). The MECP identified the following First Nations with potential interest in the German Mills Creek Geomorphic Systems Master Plan:

- Alderville First Nation
- Beausoleil First Nation, with copy to the Williams Treaties First Nations
- Chippewas of Georgina Island First Nation
- Chippewas of Rama First Nation (Chippewas of Mnjikaning)
- Curve Lake First Nation
- Hiawatha First Nation o Huron-Wendat First Nation
- Mississaugas of Scugog Island First Nation
- Mississaugas of the Credit First Nation

The following information was provided to identified First Nations as well as Six Nations of the Grand River:

- Notice of Commencement (October 2022)
- Stage 1 Archaeology Report (December 2023)
- Notice of Public Consultation providing information on the recommended solutions (October 2023)

Copies of the notices are provided in Appendix G-3.

Response to communication was received from the Chippewas of Rama First Nation, the Hiawatha First Nation, the Huron - Wendat First Nation, Mississaugas of Scugog Island First Nation, and Six Nations of the Grand River.

Follow-up requests were received from Chippewas of Rama, who requested a review of the historical account presented in the Stage One Archaeology Report which is appended in Appendix C-1, and from the Six Nations of the Grand River who expressed a desire to participate in Stage Two archeological field work. Appendix G-3 includes a record of Indigenous communities' engagement.

4.5.3 Agency Consultation

Following the notice of commencement, TRCA was engaged on May 19, 2023, and provided an overview of the site characterization, erosion risk assessment, project sites, and alternatives generation and evaluation.

Comments were received (Dated July 7, 2023) and responses have been populated. A record of email correspondence, meeting slides, and a comment/response table are included in Appendix G-4. Some specific comments were provided, but general themes included:

- Apply natural channel design principals/solutions for watercourses and natural systems, where possible
- Design a bankfull channel that will overtop for events greater than the 2-year flood
- Avoid designing zones of hydraulic contraction and expansion
- Avoid sensitive features such as wetlands
- Consultation with TRCA at the detailed design and construction

Additionally, prior to the development of alternatives, some additional details regarding Project Site 12 (Bestview Tributary) were provided to the City as a slide deck for discussion with the TRCA (date December 16, 2022). The intent was to highlight erosion concerns within the Bestview Tributary that do not pose risk to TW infrastructure currently, but may present concerns with respect to valley slope erosion. This was presented to TRCA early in the process with the anticipation that erosion monitoring would be required at a minimum, pending the alternatives evaluation (Appendix G-4).

Additional comments were received by TRCA August 22, 2024, after review of the full draft Master Plan report. TRCA comments and Matrix/City responses to the draft Master Plan comments are also provided in Appendix G4.

Agency review, including feedback from the Toronto and Region Conservation Authority, who are responsible for areas within the creek, and utilities that responded with location details, will continue through future detailed design as required.

The list of agencies and utilities contacted is provided in Appendix G4.

4.5.4 Private Property Impacts

There are no anticipated impacts to private property as a result of study recommendations.

4.5.5 Public Information Centre

Public consultation activities took place between August 1 and September 1, 2023, providing members of the public and community groups with an opportunity to learn about the study, ask questions, and provide feedback. Feedback was received during meetings, via email and phone, and through an online survey.

A public drop-in event and site walk took place on August 19, 2023, from 9:00 a.m. to 11:00 a.m. at a park area adjacent to the German Mills Creek. The event was attended by 49 participants in addition to those who dropped-in without signing-in. The online survey received 17 responses. Emails were received from 13 individuals.

Many of the participants who provided feedback observed erosion in the creek. There is a general desire to see necessary improvements made to the creek as soon as possible, and support for the recommended work to protect water and sewer infrastructure. Concerns focused on potential impacts of construction on vegetation including impact to the tree canopy and wildlife habitats. There is also concern for the impacts of construction on the trail and access to the trail during construction, based on experience with other recent trail closures in the area. Invasive species have been reported in the creek and there is an interest in replanting with native species following construction. People with concerns for erosion on private property were directed to the Toronto and Region Conservation Authority.

The Public Consultation Report and Public Information Presentation is provided in Appendix G-2.

5 PHASE 4: SELECTION OF PREFERRED SOLUTION

5.1 Preferred Alternative(s)

Based on the evaluation of alternatives, and consultation, Alternative 3 (local works with floodplain connection) has been identified as the preferred solution for Project Sites 1, 2, 3, 8, and 9, while Alternative 2 (local works) has been identified as the preferred solution for Project Sites 4, 5, 6, 7, 10, and 11. Alternative 1 has been selected for Project Site 12 (Bestview Tributary). The following summary of the preferred alternatives for the study area is compiled for each Project Site, with some sites being clustered as the ultimate solution is a continuous design between sites.

Though the evaluation, consideration of comments received from TRCA and members of the public following the PIC was made, particularly when concerns relate to enhancing flood capacity, reducing constriction and expansion, minimizing disturbance to natural areas, avoiding sensitive features, considering opportunities to enhance natural features and park uses, protection of human safety (trail), cost efficiencies, and construction timing and disturbance to park use (construction closures).

Ranking rationale is appended in Appendix F-1 and concepts of the preferred options are attached at the end of this document (Attachment 2).

5.1.1 Alternative 2 – Local Works - Project Sites 4, 5, 6, 7, 10, 11

The preferred alternative for Project Sites 4, 5, 6, 7, 10, 11 is **Alternative 2 - Local Works,** which involves either site-specific spot treatments/repair, or geomorphically-referenced river engineering (GRRE), for channel design over a relatively short channel length or "sub-reach" (<200 m).

At **Project Site 11,** only spot treatments are proposed where two lower-priority erosion risk sites are located within a relatively stable portion of the creek, with one site being specific to a previously constructed armourstone rib that has slightly displace, and another site being at Steeles Avenue where two outfalls have elevated with failing associated features (e.g., concrete apron).

Projects 4, 5, 6, 7, and 10 include modifications to the plan and profile, within local constraints (e.g., valley, sewer, trails, roads, other crossings), and appropriately-sited bed and bank modifications and treatments. This involves relatively short design sequences of riffles and pools (<200 m), a nested bankfull channel with floodplain creation, and a combination of harder (armourstone) bank treatments and bioengineering, depending on the proximity of TW infrastructure and other area constraints. Since there are instances where project sites are within the extent of sub-reach scale works, there is a natural clustering of sites that becomes apparent, and issues may be addressed with a continuous design, as is the case with Project Sites 5 and 7. Profile designs aim to maximize the depth of cover over sewer crossings with strategic placement of the riffle crest over a sewer crossing, without requiring reach-scale natural channel design. At Project Site 7, profile enhancements have been developed at the conceptual level in combination with a sewer realignment (developed by WSP in 2022; Appendix F-5) to reduce the length of sewer beneath the channel, which provides the ability to maximize depth of cover.

Extending designs down through Project Site 5 allows for the riffle placement at Project Site 7, while realigning the channel away from the trunk sewer, maintenance holes, and multi-use trail at Project Site 5.

5.1.2 Alternative 3 – Local Works with Floodplain Connections - Project Sites 1, 2, 3, 8, and 9

The preferred alternative for Project Sites 1, 2, 3, 8, and 9 is **Alternative 3 - Local Works with Floodplain Connections**, which consists of local works as described in Alternative 2, with additional enhancements extending upstream and/or downstream through the creation of a bankfull floodplain and regraded slopes, without compromising the otherwise stable natural bankfull channel. This floodplain connectivity allows for a broader reduction of in-stream stresses by attenuating less-frequent flows (above bankfull) into a wider cross-section. This also reduces potential issues of expansion and contraction at under high flows, as the corridor may narrow between areas of local works. As a result, this provides better sustainability for local works, without requiring complete disturbance and realignment of the existing channel throughout the entire study area.

For these project sites, TW infrastructure is at significant risk in all five project areas: three exposed maintenance holes and sewer crossings at risk of exposure requiring additional depth of cover and bank stabilization. In general, evaluation scores for these projects have resulted in a preferred option of Alternative 3 with the following commonalities:

- Addresses erosion risk and sustainability of sewer protection works:
  - Combined realignment and floodplain connectivity will reduce flooding impacts; the channel will be able to convey higher flows in floodplain, reducing overall erosion, which can be significant under extreme events (that are becoming more common), resulting in a longer lifespan of proposed concept designs.
- Allows for strategic restoration and tree preservation plans to be balanced between areas of grading within local works and those associated with floodplain connections (longitudinally) to maintain the overall flood hazard reduction and in-stream erosion reduction:
  - There is potential for terrestrial habitat improvements along connecting reaches while minimizing tree impacts with floodplain regrading objectives. Detailed tree surveys can be used direct floodplain grading to minimize damage or removal of trees.
- Cost effectiveness: ability to provide multiple improvements by completing single projects for multiple sites, with the ability to cost share with other Toronto departments (e.g., Parks and Forestry, Transportation). Through a grouping of projects into one construction period, there can be efficiencies in design costs (one contract, one drawing set), construction costs (mobilization, access, staging, bulk materials), and permitting/approvals costs (DFO, TRCA, MNRF), for example. This provides adequate protection for exposed or near-exposed TW infrastructure, but at a lesser cost than reach works (Alternative 4), and with less disturbance and materials requirements as profile modifications are not proposed throughout.

- Resource effectiveness: Ability to provide multiple improvements with greater efficiency and less permitting.
  - Projects are proximal to each other or address several existing or imminent risk sites; therefore, by connecting local work sites, there is a greater efficiency in permitting and approvals and will be better phased than Alternatives 2 and 4. Projects may be awarded through single RFPs (depending on phasing), allowing for better scope and cost controls with design consultants.

Project Sites 1, 2, 3, 8, and 9 design concepts include modifications to the plan and profile within local constraints (e.g., valley, sewer, trails, roads, other crossings), and appropriately sited bed and bank modifications and treatments. This involves relatively short design sequences of riffles and pools (<200 m), a nested bankfull channel with floodplain creation, and a combination of harder (armourstone) bank treatments and bioengineering, depending on the proximity of TW infrastructure and other area constraints. These design sequences are then connected upstream and/or downstream to other project sites through sections of floodplain grading to reduce the overall in-stream erosion potential at these specific project sites. These connections act to group Project Sites 1, 2, and 3 together and Project Sites 4, 8, and 9 together.

Note that Project Site 4 (preferred Alternative 2) is listed here, as there is a floodplain connection downstream associated with the preferred alternative for Project Sites 8 and 9, for the benefit of long-term stability and sustainability through Project Sites 8 and 9.

Channel realignments and profiled designs aim for a near-perpendicular crossing at existing locations, where strategically placed riffles maximize depth of cover. The removal of an existing, exposed lateral maintenance hole at Project Site 1 is proposed with realignment of the sewer lateral (prepared by WSP 2022; Appendix F-5) to connect to an existing trunk sanitary maintenance hole. This removes existing risk to both the exposed maintenance hole and lateral pipe, while also providing additional floodplain area for creek design/restoration (removing lateral sewer constraint). Exposed or near-exposed maintenance holes through Project Sites 1, 2, and 3 are proposed to be stabilized with riprap and armourstone, in addition to realignment of the creek away from the risk, within given constraints.

Where possible, existing treatments should be reworked, which occur primarily in Project Sites 2, 8, and 9, where armourstone may be replaced or redesigned.

5.1.3 Alternative 1 – Do Nothing – Project Site 12

Project Site 12, Bestview Tributary, has Alternative 1 as the preferred outcome, for which monitoring is most appropriate action. Toronto Water assets are limited to an outfall at the upstream end of the tributary, with a stable armourstone channel extending downstream. Erosion monitoring should be implemented to observe channel and valley toe instability (potential) in the lower, natural portion of the tributary, while observing any changes in the stability of the armourstone channel over time.

5.2 Best Management Practices

As designs advance for each project area, supporting documentation should include direction for implementing best management practices to enhance the overall benefits at each location. This will consist of erosion and sediment control measures and timely site restoration designed to address specific requirements for vegetation establishment as a function of the season. As the footprint of the rehabilitation sections will be larger than the space currently occupied by the channel, in order to provide more geomorphic stability, loss of riparian vegetation is unavoidable. Loss of trees will be addressed through woody material compensation plantings following existing City Parks, Recreation and Forestry, and TRCA requirements. The plantings will provide stability to the creek banks as the plant roots rive structure to the soil matrix. Additionally, plantings will encourage the proliferation of native and local plant species, rather than that of invasive species.

Public education campaigns may be conducted to raise awareness of creek erosion problems and encourage a mentality of stewardship to enhance and protect the stream corridor. In addition, education regarding rules and regulations of floodplain management and the stormwater cycle can motivate public support for projects that positively benefit the natural environment around the creek.

Erosion monitoring programs should be implemented, particularly those that have been recommended for the Do Nothing alternative, occurring regularly to allow for the identification of any risks that may develop. Inspection of instream and riparian vegetation should identify where vegetation may be required or where maintenance may be needed. Changes to aquatic and terrestrial habitats should be observed including bird and waterfowl habitats. Various elements of the stream should be monitored such as cross-sectional characteristics and meander bend erosion. An assessment of implemented Local Improvements and Section Restorations allows for an adaptive management approach whereby monitoring can identify any weak points or unpredicted changes that may occur. It also allows for an assessment of the success of the designs and can be used to direct future rehabilitation activities.

6 IMPLEMENTATION PLAN

The implementation plan outlines the necessary next steps to implement the stream management recommendations as part of the EA and Master Planning approach and includes information pertaining the grouping and prioritization of the proposed erosion mitigation projects. The plan also includes other key implementation considerations to be evaluated as part of the detailed design phase. As part of the overall GSMP, recommendations for maintenance and monitoring have also been provided to further support a long-term stream management strategy by the City of Toronto (Section 6.4).

6.1 Erosion Mitigation Project Implementation

The implementation plan for the recommended erosion mitigation projects identified in the German Mills GSMP is presented in Table 6-1. For capital planning and budgeting purposes, a feasible implementation plan for the recommended erosion mitigation projects is organized into 0 to 5, 5 to 10, 10 to 15, and 15 to 25+ year planning horizons (Table 6-1). It is understood that the City will review and apply this implementation plan in the context of City-wide priorities for critical projects to protect TW infrastructure, and therefore the recommended timing may need to be adjusted to reflect a broader implementation plan with respect to engineering capacity and capital budget constraints.

The preferred alternative for each project will be implemented based on their priority over the next 20+ years. All erosion risks were assessed within the study area (i.e., infrastructure, parks, private property); however, the prioritization of erosion sites and projects was primarily based on the erosion risk and severity specifically to TW infrastructure (Section 3.9), with the top 12 sites ranging from “imminent risk” (highest risk category) to “low risk.” Each priority site has been identified as an individual project site, with several secondary erosion sites that can be addressed through the overall design for each project, and these secondary sites include other lower-risk TW infrastructure sites, and other non-TW erosion sites, such as risk to parks/trails, transportation, and private property.

Multiple project sites have been naturally clustered areas based on proximity to each other as well as level of erosion risk posing threat to TW infrastructure, with each cluster captured within the same planning horizon. This clustering within the recommended implementation plan (Table 6-1) also allows for floodplain connections (Alternative 3) to be constructed in the same phase. There are instances where this clustering has apparently placed risk rankings out of sequence, and in some cases beyond their expected TTE;. however, the risk assessment has been applied as a semi-quantitative tool that is intended to place sites within general categories of risk (e.g., high-risk), while there are other valid considerations for design and construction phasing that contribute to the implementation plan, such as limiting impacts and disruption from construction, staging and access, park use, and overall costs. Design alternatives were assessed with the objective to minimize impacts to adjacent regulated features, and where direct or indirect impacts are anticipated, they should follow TRCA’s criteria to avoid, mitigate, and compensate. It is recommended that all erosion sites continue to be monitored (annually and following infrequent storms) and that the implementation of priority projects may need to be adjusted accordingly.

This implementation guide should be considered preliminary for the priority project sites, grouped into time horizons for design and implementation that may be refined as studies continue following the completion of the German Mills GSMP. Design and permit requirements may vary between project sites, which will require further planning and coordination at detailed design stage. This will include detailed identification of staging areas and access routes, and construction phasing plans whereby impacts will be reduced by grouping rehabilitation sites based on opportunities for shared staging and access. The recommended project phasing is mapped on Figure 6-1, and Table 6-1 provides information to describe each project, including:

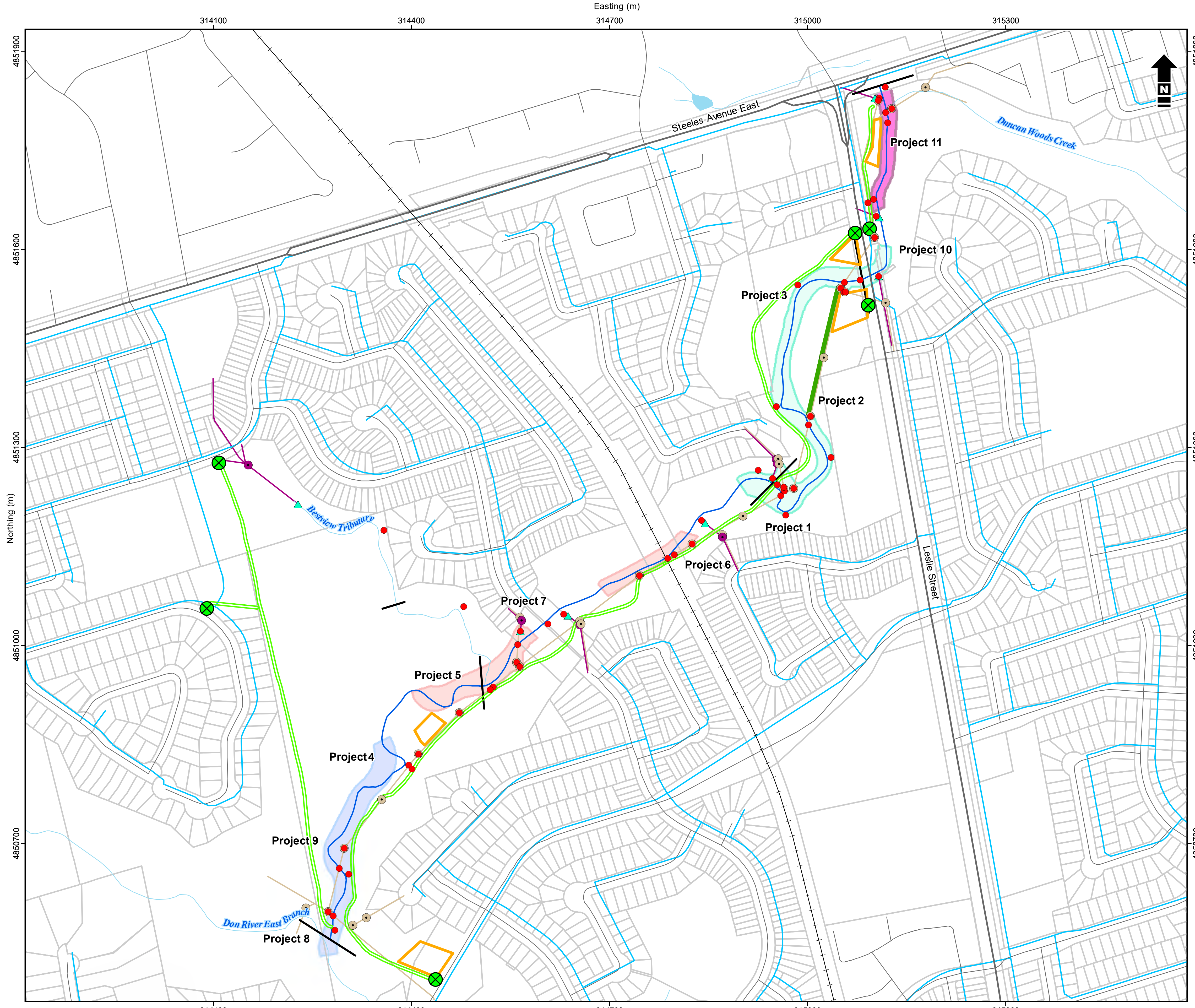
- reach ID and reach length
- priority and secondary site numbers
- description of risk to TW infrastructure and proposed mitigation

- EA Schedule (A, B, etc.)
- property ownership
- planning horizon
- estimated cost

TABLE 6-1 Implementation of Erosion Mitigation Sites Based on Priority Risk

Project No.	Priority Erosion Site#	Secondary Erosion Sites	Reach	Length (m)	Risks and Opportunities	EA Schedule	Property Ownership	Cost Estimate*	Planning Horizon
0 to 5 Years									
1	**16.1**	**15.1, 15.2, 15.3, 16.2, 16.3, 16.4, 16.5, 17.2**	**3**	130	Exposed maintenance hole, public safety risk (steep, high banks). Relocate sewer/MH, regrade and stabilize banks, expand floodplain locally, and connect floodplain between sites upstream and downstream.	B	TRCA	$1,050,000	0 to 5 years
2	**18.1**	**17.1, 18.2, 19.1**	**3**	140	Exposed maintenance hole, public safety risk (steep, high banks). Protect MH, regrade and stabilize banks, expand floodplain locally, connect floodplain between sites upstream and downstream.	B	TRCA	$1,060,000	0 to 5 years
3	**21.1**	**20.1, 21.2, 21.3, 21.4, 21.5, 21.6**	**3 and 4 (lower)**	240	Exposed maintenance hole, public safety risk (steep, high banks). Protect MH, regrade and stabilize banks, expand floodplain locally, connect floodplain between sites upstream and downstream. Stabilize channel through Leslie Street to reduce scour downstream.	B	TRCA/City (Leslie Street)	$1,420,000	0 to 5 years
							Subtotal	**$3,530,000**	
5 to 10 Years									
7	**8.2**	**8.1, 8.3, 8.4, 9.1, 9.2**	**2**	70	Vertical risk to sanitary sewer crossing. Realign sewer perpendicular to creek, increase depth of cover. Expand floodplain locally.	B	TRCA	$450,000	5 to 10 years
5	**7.1**	**6.1, 7.2**	**1 and 2 (lower)**	170	Pipe adjacent, MH at risk, trail at risk along steep, high banks (public safety). Stabilize bank in position around MH/pipe/trail, realign upstream and downstream to tie in better. Add protection for public.	B	TRCA	$1,020,000	5 to 10 years
6	**11.1**	**12.1, 12.2, 12.3, 13.1**	**2**	150	Maintenance hole at risk, pipe adjacent, trail at risk, CN crossing constraint. Install armourstone as pipe/MH/trail protection, allowing for cross-section enlargement for frequent flows. Replace scour pool with pool-riffle series.	B	TRCA/Metrolinx	$900,000	5 to 10 years
							Subtotal	**$2,370,000**	
10 to 15 Years									
4	**5.2**	**5.1, 5.3**	**1**	90	Pipe adjacent at risk. Realign creek away from pipe, regrade banks and expand floodplain locally.	B	TRCA	$550,000	10 to 15 years
8	**1.1**	**1.2, 1.3**	**1**	90	Maintenance hole/pipe adjacent, trail at risk along steep slope as armourstone is undermined.	B	TRCA	$630,000	10 to 15 years
9	**3.1**	**2.1, 4.1**	**1**	20	Pipe adjacent, trail at risk along steep slopes.	B	TRCA	$570,000	10 to 15 years
							Subtotal	**$1,750,000**	
15 to 20+ Years									
10	**24.2**	**22.1, 23.1, 24.1, 25.1**	**4**	70	Sanitary sewer adjacent, slope/pipe at risk. Stabilize bed, realign creek slightly, and stabilize banks adjacent to Leslie Street.	B	TRCA	$390,000	15 to 20+ years
11	**26.1**	**1, 24,**	**4**	50	Scour downstream of Steeles Avenue undermining outfalls, putting MH at risk. Some destabilization of previously constructed riffle/ramp feature. Local stabilization of bed and banks required.	B	TRCA	$250,000	15 to 20+ years
							Subtotal	**$640,000**	
Monitoring									
12	**28.1**	**n/a**	**Bestview Tributary**	100	Property at risk along crest of valley slope. Monitoring of toe erosion/instability along valley provides opportunity to better characterize risk and determine need for action.	n/a	TRCA/Private	TRCA	

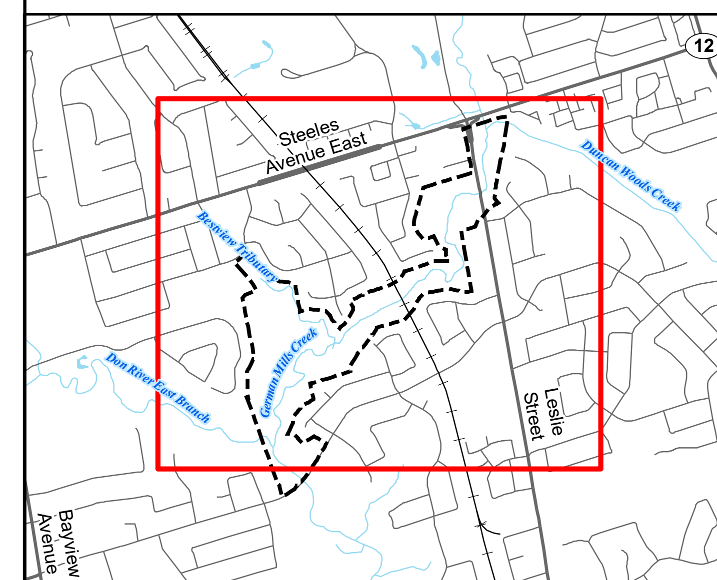
Notes:
Refer to Figure 3-7 for Project and Erosion Site Locations.
Toronto Asset IDs associated with priority and secondary erosion sites are included in Table 3-3
* Cost estimate includes 15% for engineering design approvals and 15% contingency, rounded up to the nearest $100K, but exclusive of HST.



- Property Boundary
- Potential Staging Area
- Potential Access Route - Trail
- Potential Access Route - Sewer Easement
- Reach Break
- Water Body
- Watercourse
- Centerline (2018)
- Highway
- Road
- Railway
- Watermain
- Sanitary Sewer Constructed in 1969
- Storm Sewer
- Potential Access Location
- Stormwater Outfall
- Sanitary Sewer Maintenance Hole
- Storm Sewer Maintenance Hole
- Erosion Risk Sites

Planning Horizon

- 0 to 5 Years - Projects 1,2,3
- 5 to 10 Years - Projects 5,6,7
- 10 to 15 Years - Projects 8,9,4
- 15 to 20+ Years - Projects 10,11



Disclaimer: Watermain and sewers have been clipped to the Focused Study Area.

Reference: Contains information licensed under the Open Government Licence – Ontario.

1:6,000 metres
60 0 60 120
NAD27 MTM zone 10

Matrix Solutions Inc.
A Montrose Environmental Company

City of Toronto
German Mills Creek GSMP EA

Implementation Plan

Date:	Project:	Submitter:	Reviewer:
November 2023	32227	J. McDonald	R. Phillips

Figure 6-1

6.1.1 Coordination with Other City Departments and Project Scheduling

Several issues within the GSMP study area have been identified by City staff, TRCA, interested parties during site walks, and by members of the public during the September 2023 PIC. These issues encompass hazard land management, instream water quality, aquatic habitat, watercourse erosion, wetlands and vegetation/tree impacts, trails and access, construction, and other infrastructure. Opportunities exist to coordinate corridor enhancements, including access and trails with Toronto Parks, Forestry & Recreation (PF&R; access/trails, tree mitigation and plantings), Toronto Transportation Services (Leslie Street and Steeles Ave crossings), and Canadian National (rail crossing). However, the prioritization and implementation plan as recommended in Table 6-1 serves to protect and mitigate current and potential erosion issues associated with Toronto Water infrastructure as the main priority and should form the basis for project scheduling.

Toronto Water will lead these stream restoration projects in consultation with PF&R, Transportation Services, and TRCA. Other applicable City departments and TRCA should be engaged with respect to other varying characteristics and concerns between project areas (e.g., wetlands, natural heritage, trails, soils, etc.). Coordination with these departments and/or organizations allows for the potential for additional opportunities for paired restoration to arise. This coordination of efforts allows for holistic restoration of both aquatic and terrestrial systems, and social enhancements providing additional overall benefit.

6.2 Other Implementation Considerations for Detailed Design

At the detailed design stage there are many common elements required for successful implementation of conceptual designs for the recommended erosion mitigation projects including:

- **Topographic Survey** – A detailed topographic survey (geodetic) will be completed for each of the project sites in order to obtain updated topographic and property information required for the detailed design (e.g., total station, RTK/GPS, LiDAR).

- **Supporting Investigations** – Studies in support of the Master Plan should be confirmed and/or updated through detailed design (i.e., fluvial geomorphology, archaeology, hydrology and hydraulics, aquatic habitat, vegetation and tree inventories, and wetland assessments). Additional studies required for detailed design include, but are not limited to, a stage 2 archaeological assessment, subsurface utilities, geotechnical, structural engineering (for structure replacements), landscape architecture, and contaminated soils investigations. Section 4.4.2 suggests that it is best practice to undertake a minimum level of soil testing for to reduce the uncertainty of the excavated soil quality better determine an appropriate contingency for soil removal and disposal.

- **Climate Change** – Implications and the adaptation of climate change to the watercourse and natural system should continue to be evaluated through analyses during the detailed design stage.

- **Restoration Planting Plan and Tree Protection** – Vegetation restoration plans must be developed for each project site, specifying native species to be used to restore channel banks, the floodplain, and access and staging to ensure they are replanted and restored in accordance with regulatory agency requirements. Any potential improvements/enhancements (additional plantings, wetland enhancement, etc.) to the natural system within the vicinity of the proposed project should be identified at detailed design.

- **Construction Staging, Tendering, and Supervision** – Site-specific construction staging plans are to be included within the detailed design packages. The construction access route and staging areas are to be identified for each detailed design.

- **Agency Review and Permitting** – Design and supporting documentation will need to be submitted to relevant regulatory agencies for review and approval.

  - Toronto and Region Conservation Authority
  - Department of Fisheries and Oceans (DFO)

    - Construction works must adhere to the fisheries timing windows and approval is required for fish collection permits.

  - Design will be required to adhere to regulations specified in the Ontario Endangered Species Act (ESA 2007).

  - Metrolinx should be engaged for project work in the vicinity of the bridge over German Mills Creek (GMGSMP Project 5).

- **Property Ownership** – The land is primarily under ownership of TRCA, with some access potential along City easements.

  - Any work on private property (including access) will require initiation of a discussion with landowners to explain the issue(s) and why restorative measures are required. The City or appointed contractor must obtain approval to undertake work on private property (not anticipated), or property utilization for access (e.g., Canadian Memorial Chiropractic College).

- **Pre- and Post-Construction Monitoring** – Typically a post-construction monitoring program for a period of 3 to 5 years following construction is part of the permitting agreement.

  - **Pre-Construction:** Inspection before and during construction to document and photograph site conditions associated with the channel construction process at least once prior to construction and weekly during construction.

  - **Post-Construction:** Inspection of channel stability immediately post-construction accompanied by an as-built survey of the completed channel works (profile, cross-section, etc.) and well as follow up monitoring visits 3 to 5 years post-construction to document channel form, function, and vegetative health of restoration and bank treatment planting; monitoring report to be submitted once annually to regulatory agencies and stakeholders.

- **Long-term Stream Monitoring** – Field walk inspections shall be completed in 5-year cycles following completion of post-construction monitoring to monitor reach-based channel form and function, erosion, and flooding concerns. It is expected that TRCA would complete and manage this program, however City staff will confirm responsibility and requirements.

6.3 Master Plan 5-Year Review

As per provincial planning regulations, Master Plans are to be reviewed after 5 years to confirm if any amendments are required. If during project implementation conditions are found to have changed such that the preferred alternative cannot be implemented, an addendum may be prepared for the specific project. Potential changes which may trigger the need for a detailed review and update of the Master Plan include:

- Major changes to original assumptions
- Major changes to components of the Master Plan
- Significant new environmental effects
- Major changes in proposed timing of projects within the Master Plan

6.4 Next Steps

6.4.1 Detailed Design Considerations

Appendix H contains an outline of considerations for the detailed design stage in the implementation of stream rehabilitation plans. Included is a description of detailed design drawing requirements and additional site investigations, data collection, analyses, and mapping that may be required to supplement the information identified in the Master Plan and inform the design process. The additional investigations are listed below and are further detailed in Appendix H, Sections H.3.1 to H.3.13:

- Topographic Survey
- Geotechnical Investigation
- Archaeological Investigation
- Utility Locations
- Existing Sanitary Sewer Crossings
- Vegetation Inventory and Tree Protection/Removal
- Hydraulic Analyses
- Aquatic Habitat Analysis

- Site Access and Staging
- Construction Phasing and Related Notes
- Erosion and Sediment Control
- Restoration Plantings

6.4.2 Ancillary Tasks

In addition to the specific tasks pertaining to the detailed design process and to the preparation of construction drawings, there are ancillary tasks that need to be undertaken to obtain approvals and to foster appropriate community relations.

6.4.2.1 Work on Private Property

Proposed works and access should primarily be within City- or TRCA-owned lands, or within easements. However, there is potential for work near private property, and potential for access requirements along private property boundaries. Appendix H, Section 4.1 provides general steps followed by municipalities in dealing with private landowners are outlined in Appendix H, Section 4.1.

6.4.2.2 Agency Review and Permitting

Upon completion of the detailed design, the design and supporting documentation will need to be submitted to regulatory agencies for review and approval. Approvals and Permitting are described in Appendix H, Section 4.3.

6.4.2.3 Mitigation

The major mitigation activities will be associated with the Implementation of Best Management Practices (BMPs) documented in Section 5.2 of the Master Plan.

6.4.3 Construction

6.4.3.1 Constructability, Access, ESC

Several sites, or portions of project sites can potentially be constructed while German Mills Creek continues to flow in its existing channel. This reduces the need to create a long-term bypass channel or flume. However, the majority of works for Alternatives 2 and 3 may require flow management accomplished using a “dam and pump” system that isolates the construction works by installation of coffer dams and a continuous flow pump and conduit, or through construction of an open flume. During stream bypass operation, fish relocation will likely be required in order to limit the number of stranded fish during each phase of construction. The bypass will depend on the volume of flow expected at the time of construction, and coffer dam dimensions will need to be designed in accordance with the serviceability requirements.

Access for all project sites will generally be from the existing multi-use pathway, located along extensive sections of the creek valley. Access from City streets to the pathway or to the creek works may require a temporary steel mat crossing buried pipe and other creek sections. The access route may be required to remove excess fill from the site and deliver materials. Access from the pathway alongside sections of the creek may require lighter equipment and materials. Site-specific street access points to the trail should be determined at the detailed design stage.

Special provisions for construction access through private property may be required, though less likely (please see Appendix H, Section 4.1 for further details); the existing easement for the STS through some portions of the valley may provide an access route. Such access should be considered when trying to reduce the overall impact to park users.

Environmental protection, sediment, and erosion control systems will need to be in place prior to commencement of construction activity to prevent deleterious substances from entering the creek. Silt fence, erosion control blankets, and site fencing are required where construction disturbs surface cover or where susceptibility to erosion is high.

Site access and staging, construction phasing, and erosion and sediment control are further described in Appendix H, Sections H.3.10 to H.3.12.

6.4.3.2 Construction Timing and Duration

Ideally construction would take place during seasons of low-flow to reduce the risk of nuisance flood and erosion susceptibility. The MNRF fisheries timing window is expected to restrict instream activity from April 1 to June 30. Available timing is therefore the summer and winter months. The advantages of winter construction can include that frozen conditions generally facilitate access through traversing across fill areas with little damage and restoration required. Consideration in the timing should be given to restoring areas at a time when bioengineering material (live cuttings) are dormant (November to March) and can be applied so that growth occurs in the following spring. Planting, adjustments, warrantee work, and final restoration can occur in the spring of the following year. The construction duration for Alternative 2 Local Works is estimated to be approximately 2 to 3 months, while the works associated with Alternative 3 Local Works with Floodplain Connections is estimated to require 3 to 5 months.

6.4.3.3 Materials and Cost Control

The market price of materials and availability affect all sites. This involves armourstone, granular material, rock material, and restoration plantings. Of the materials used, armourstone has the highest fluctuating value related to availability and market demand. If work is to proceed in the winter months, demand for material is typically lower compared to the summer months.

The implementation contract, if taken to public tender, could use a lump sum approach for most projects, but would require a unit price and lump sum item for contract administration. Unit prices should be maximized where possible to control quantity interpretations. Lump sum items are generally required for fill disposal or grading and excavation operations. Tender/Contract Specification Documents and Construction Administration and Supervision are described in Section H.4.5 and Section H.4.6, respectively.

6.4.4 Monitoring Plan and Adaptive Management

A long-term monitoring plan should be established to allow for the determination of maintenance needs, to document success and failures, and to re-establish the priority list. Detailed designs are premised on an adaptive management approach, in recognition that the system as designed and constructed is not permanent, but rather is expected to change and adjust over time as the stream continues to adjust to land use impacts and the impacts of climate change. Subsequent to the completion of the detailed design (Stage 3) and construction (Stage 4), the remaining stages of the MNR (2002) Adaptive Management for Stream Corridor Management Framework should be implemented; these include:

- Stage 5: Monitor
- Stage 6: Evaluate
- Stage 7: Adjust

Monitoring of the site with regular inspections is recommended and is to be conducted to monitor creek geomorphology, instream and riparian vegetation, and terrestrial and aquatic habitats. Metrics of the stream, including cross-sectional characteristics, profile, and planform location, changes to aquatic habitat etc., should be monitored. Inspection of instream and riparian vegetation should identify vegetation growth, both where further planting may be required and where maintenance is required. Changes to terrestrial habitats should be observed, including bird and waterfowl habitats.

The adaptive management approach requires a forecast of channel response against which to develop a hypothesis of effect (i.e., environmental response to action), and from which to develop an informed monitoring program. The basis for a forecast of geomorphic systems response after channel restoration can be made, based on the geomorphic insight provided in this study report. It is more problematic to provide a forecast of aquatic system response, however best efforts should be made.

Stages 5 to 7 of the Adaptive Management framework are further detailed in Appendix H, Section H.5.

6.5 Maintenance and Monitoring Plan Development

This section outlines recommendations for the following maintenance and monitoring plans:

- Post-Construction Monitoring Program for Erosion Mitigation Projects
- Maintenance and Monitoring Plan
- Long-Term Stream Monitoring Program
- Maintenance Schedule and Life Cycle Expectations

Current site monitoring completed for the GSMP is summarized in Appendix E.

6.5.1 Post-Construction Monitoring Program

For channel restoration projects, conservation authorities typically require a commitment to post-construction monitoring for a period of 3 to 5 years following construction as a part of the permitting agreement.

Pre-Construction and During Construction

- Field inspections conducted periodically before and during construction to document and photograph site conditions associated with the channel construction process.
- Field inspections conducted at least once prior to construction and weekly during the construction period.
- Photographs collected from the same vantage point to allow for time series comparison.

Immediately Post-Construction

- Site inspection including monitoring channel stability during the stabilization period.
- As-built survey of the completed culvert and channel works (plan, profile, and cross- sections) to verify implementation of design within reasonable tolerances.
- Drawings prepared for the as-built survey for inclusion in the first monitoring report.

Post-Construction Monitoring

- Post-construction monitoring for channel form and vegetation in years 1, 2, and 3 post-construction.
- Monitoring site visits, typically 1 per monitoring year in the late spring/early summer, including monitoring of intended channel functions and restoration works (Additional inspections after large storms to be completed by the City).
- Monitoring reports (3) submitted to stakeholders and regulatory agencies in January of each year following monitoring activities. Reports to include field assessment of channel form and restoration including the following items:
  - Planform (bank stability and treatments and tie-ins, years 1 to 3 post-construction)
  - Profile (upstream and downstream culvert tie-ins, years 1 to 3 post-construction)
  - Cross-section (flow concentration and width adjustments, years 1 to 3 post-construction)
  - Planting success (including bank and slope treatments, years 1 to 3 and 5 post-construction)
  - Photographic inventory and map to document observations (years 1 to 3 post-construction)

- ✦ Recommendations for any required mitigation measures (channel works, years 1 to 3 post-construction, and vegetation, years 1 to 3 and 5 post-construction)

Adaptive management responses related to restoration works should include replacement/repair of failed restoration measures identified through monitoring.

6.5.2 Maintenance and Monitoring Plans

The following guidelines are intended to address the various issues identified in the erosion assessment site inventory to provide cost- effective maintenance and monitoring of the stream system to ensure:

- The stream system is stable and functioning as predicted or envisioned in the Master Plan
- The City is aware when erosion controls are functioning improperly
- The City is aware when stream inspection and maintenance is needed
- The City is aware of any stream stewardship opportunities

The types of work identified for the maintenance program may include, but are not limited to:

- Minor rehabilitation measures for isolated erosion areas
- Instream debris removal, such as garbage and tree branches
- Repairs to stream assets such as displaced stones/materials in channel linings
- Exiting and proposed retaining walls (armourstone, gabion basket, and sheetpile), failing storm outlet spillways, etc.
- Removal of dead or invasive vegetation
- Planting vegetation
- Dredging of culverts and storm outlets
- Flushing of storm sewers that outlet directly to a stream
- Placement of monitoring equipment, etc.

6.5.3 Long-term Stream Monitoring Program

Regular monitoring inspections once annually over a 3-year period are recommended to monitor channel adjustment and the establishment of vegetation in bank treatments and the floodplain. Various elements of channel morphology including stabilization of the creek, changes in channel cross-section and profile, as well as monitoring of the channel substrate. Following the 3-year monitoring period, 5-year inspection cycle field walks are recommended to observe the functionality of the design and to document any issues requiring maintenance of the design or replanting of vegetation.

6.5.4 Maintenance Schedule and Life Cycle Expectations

Routine – activities typically smaller in scope, and without the use of heavy equipment. Routine works do not require dewatering of the channel, altering or infilling of the floodplain, and are considered low-risk to the natural environment. Routine maintenance works typically do not require conservation authority permit.

Complex – activities typically larger in scope, often requiring use of heavy equipment. Complex works may require dewatering, flow management, erosion and sediment control applications, and typically require engineered drawings and a conservation authority permit.

TABLE 6-2 Typical Maintenance Activities with Routine Versus Complex Categorization

Activity	Details	Equipment	Category	TRCA Permit
Woody Debris Removal - Minor	Removal from channel and floodplain, leave onsite if desired	Hand tools (chain saw, winch, come-along)	Routine	No
Woody Debris Removal - Major	Wood chipped and removed from site	Heavy equipment (excavator, skid steer, loader, chain saw, chipper)	Complex	Yes
Storm Sewer Outfall Clearing	Removal of local sediment and debris blockage from channel and floodplain	Hand tools (shovel, rake)	Routine	No
Storm Sewer Outfall Repair or Replacement	Replacement of outfall infrastructure or repair of local erosion	Heavy Equipment (excavator, concrete, armourstone, riprap)	Complex	Yes
Repair Fenceline	Repair of fencelines along top of slope, may involve resetting posts	Hand tools (auger, concrete, saw)	Routine	Yes/No*
Remove and Replace Fenceline	Removal and replacement of fencelines which have failed	Hand tools (auger, concrete)	Complex	Yes
Gabion Basket Repair	Replacement of gabion baskets with new baskets, armourstone, or natural channel design	Heavy Equipment (excavator, armour/roundstone)	Complex	Yes
Sediment Removal from Channel	Removal of mass sediment accumulations, with excavated materials removed from channel and floodplain	Flow bypass/dewatering equipment, mini excavators	Complex	Yes
Minor Erosion or Scour Protection	Local erosion of banks or scouring, may be addressed through reinstatement of natural channel materials (rock, soil), with plantings	Hand placement of rock, soil, plantings	Complex	Yes
Removal of Garbage	Trash and debris buildup, often including shopping carts, bicycles, mattresses, removed from corridor and disposed of	Boots or waders, winch, come-along, trash bag	Routine	No

7 STUDY SUMMARY

7.1 Overview of Master Plan Process

This study reviewed the historical and existing German Mills Creek conditions within the City of Toronto, identified and prioritized erosion sites, provided potential rehabilitation alternatives, and proposed a preferred alternative for specific project sites within German Mills Creek from Steeles Avenue to the confluence with the East Don River. The Master Plan was carried out following the City's GSMP approach, which was developed to follow the MCEA process (2000, amended 2007, 2011, and 2015) in conjunction with application of the AMSC principles (MNR 2001). Approach Number 2 was followed that involves the preparation of a Master Plan at the conclusion of Phases 1 and 2 of the Municipal Class EA process, where the level of investigation, consultation, and documentation are sufficient to fulfill the requirements of Schedule B projects. The final Notice of Completion for the Master Plan is also the Notice of Completion for the Schedule B projects recommended in the Master Plan.

The Master Plan allows for an integrated planning approach for the German Mills Creek study area, and a methodology for implementing the necessary rehabilitation efforts for German Mills Creek. In evaluating options, a broad-based process is used including functional performance, environmental, social, and economic considerations. The Master Plan uses the MNR (2001) guide, "The Adaptive Management of Stream Corridors in Ontario," as the foundation for defining the appropriate content for EA purposes at different study stages. An assessment that integrates information including hydraulic and hydrologic modelling, existing infrastructure, terrestrial, vegetative, and aquatic habitat, land use changes within the watershed, historical adjustments to channel planform, geomorphic conditions, and geologic data allows for a comprehensive evaluation of the preferred alternatives to be presented.

7.2 Study Conclusions for Geomorphic Systems Master Plan

Conclusions regarding the present state of German Mills Creek include that an urbanized flow regime has altered the dynamics of the German Mills Creek system resulting in channel instability, exposed infrastructure, degraded natural features, and risk for future damage. The inventory of issues includes:

- Low channel stability
- Incised channel and entrenchment with limited floodplain connectivity
- Exposed sanitary sewer pipe and three exposed maintenance holes, primarily due to historic bank erosion and lateral channel migration processes
- Additional lateral and vertical erosion risks to sanitary sewer (trunk and lateral) and maintenance holes – near-term risks (note, vertical depth of cover for STS generally acceptable, lower near-term risk)
- Public infrastructure at risk (multi-use pathways, pedestrian bridges, etc.)
- Existing bank armouring in poor condition
- Local erosion at or near valley wall contacts

- Local erosion at or near private property
- Disturbance to vegetation and localized debris jams
- Scour around elevated outfalls
- Degradation of aquatic habitat and two potential fish barriers during baseflow conditions

If left unmitigated, geomorphic processes will continue to degrade natural functions and continue to expose or compromise infrastructure along the German Mills Creek corridor. Unlike many other high priority Toronto Water sites across the City, the depth of cover for STS crossings within the German Mills Creek study area is generally adequate and the sewer pipes are at lower risk with respect to vertical scour and degradation hazards compared to other sites. Conversely, historic bank erosion rates are relatively high within the study area, resulting in associated hazards from lateral channel migration and the subsequent exposure of maintenance holes. As such the alternative solutions are focused more so on bank treatments and floodplain accessibility to protect the sewers from bank erosion and lateral channel migration, rather than requiring harder engineering solutions that armour the channel bed.

Alternatives to address channel instability were developed, and following consultation, the preferred alternatives were determined to be Local Works or Local Works with Floodplain Connections for Project Sites within German Mills Creek study area. The 'Do Nothing' approach and monitoring was recommended for Bestview Tributary (i.e., Project 12). These solutions are to be implemented using a phased approach over the next 20+ years based on risk assessment, ensuring that rehabilitation works at the most critical sites are completed first. Past management in urban streams has generally been reactive, and often on an emergency basis, including at German Mills Creek. The implementation process will utilize the adaptive environmental management approach to inform decision making and monitoring of rehabilitation works (MNR 2001).

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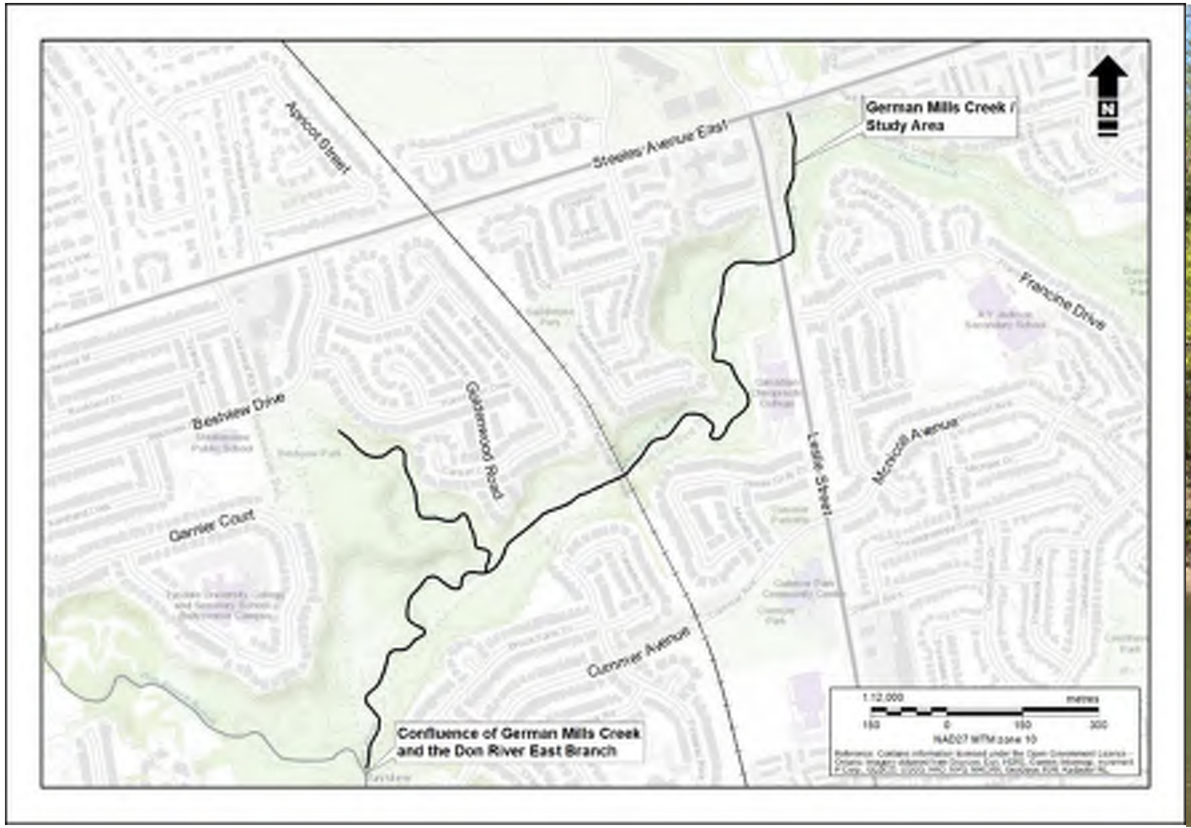
ATTACHMENT 1

German Mills Creek Geomorphic Systems Master Plan Environmental Assessment Public Consultation



German Mills Creek Geomorphic Systems Master Plan Environmental Assessment

Public Consultation: August 2023

TORONTO

German Mills Creek Geomorphic Systems Master Plan

In 2021 the City of Toronto initiated the German Mills Creek Geomorphic Systems Master Plan (GSMP) Environmental Assessment (EA), as one of five ongoing GSMPs across the City to identify and assess water and stormwater infrastructure in German Mills that is at risk of erosion from high flows due to storms and snow melt runoff.

Study Purpose:

- To identify concerns related to erosion that may damage the City's water and stormwater infrastructure
- To develop solutions that protect the City's water and stormwater infrastructure from excessive erosion processes within the stream
- To improve stream functions, such as increasing stream bank stability, reducing erosion, enhancing stormwater conveyance, and improving habitats

The City's sewer and water infrastructure in and alongside streams include:

- **Watermains** to supply drinking water to homes and businesses
- **Storm sewers** to collect rain and snow-melt from streets and properties and discharge it into streams (via outfalls)
- **Sanitary sewers** to collect and transport sewage from homes and businesses for treatment

This study is not focused on trails, trail access, trees, invasive species or other park features.

Study Process

This study is being undertaken as a Master Plan which is a long-range plan that examines the needs within a geographic area and provides a framework and vision for recommended improvements. The study will follow the Municipal Class Environmental Assessment study process, an approved planning process under the Ontario Environmental Assessment Act, which includes providing opportunities for public input.

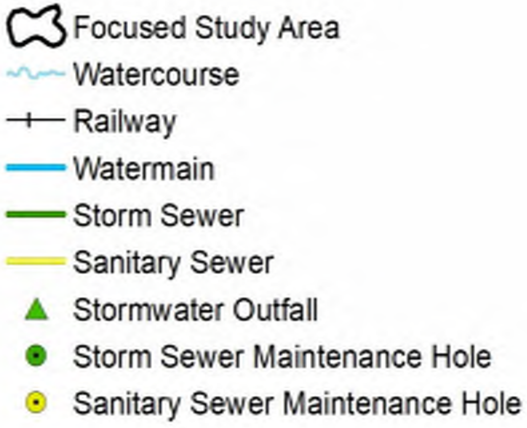
1. Identify problems and primary causes
2. Collect data, perform fieldwork, examine existing and future conditions
3. Develop, evaluate and recommend alternative solutions
4. Consult public, review agencies, and utilities
5. Complete study report and make available for public review
6. Prioritize Infrastructure Repair Works

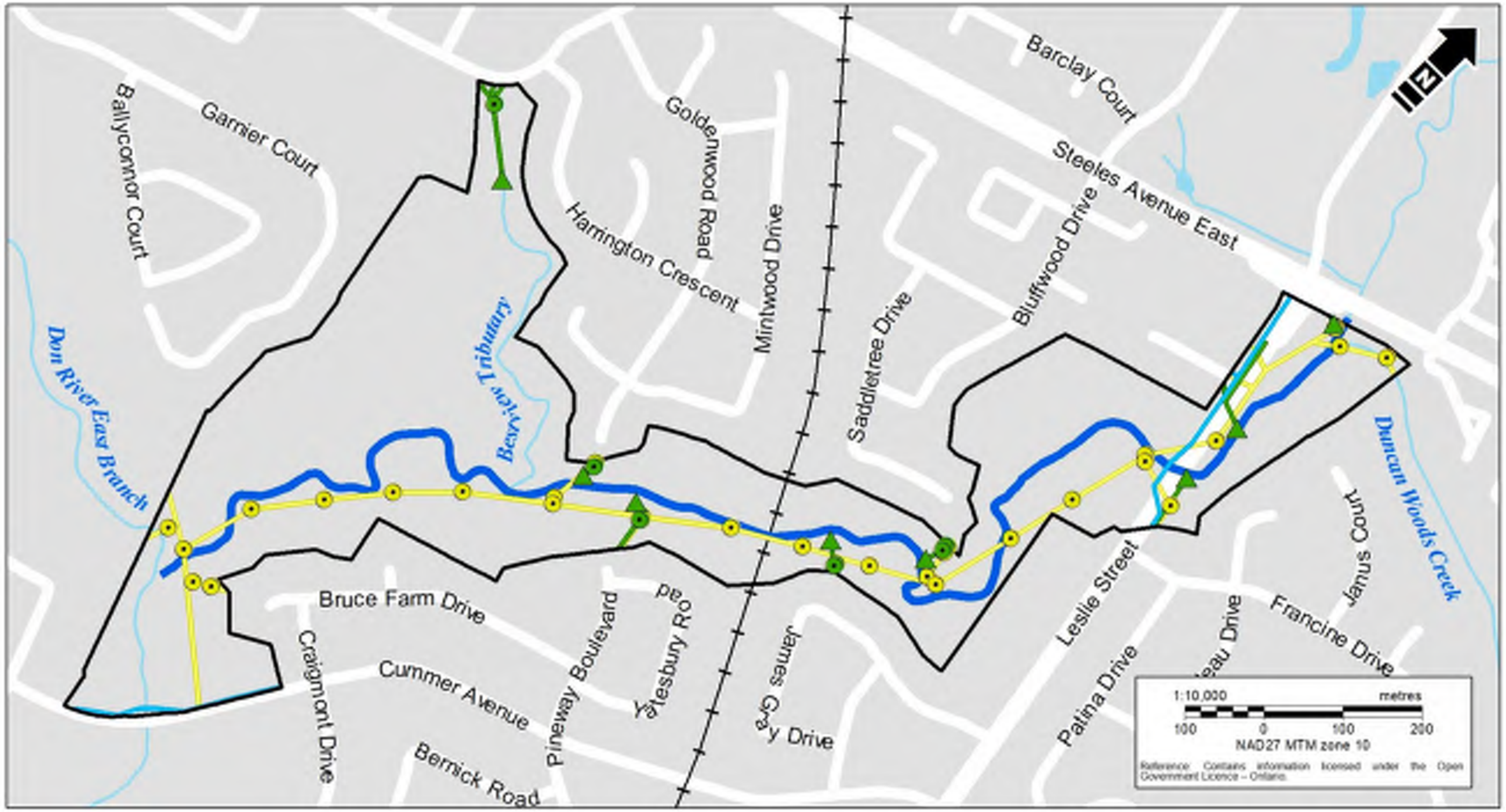
After the study completion the City will:

- Prioritise projects from all five ongoing GSMPs based on a city-wide approach for creek and river restoration and erosion control work

Study Area

The study area is the two-kilometer length of German Mills Creek from Steeles Avenue East to where it meets the East Don River in the west.





Level of Erosion Risk

The level of risk caused by erosion was based on a technical assessment characterizing risk probability (time to exposure), existing bank protection, and risk severity should damage occur.

Very Low – Low-risk Sites

- Infrastructure and site conditions are stable
- Limited monitoring is required

Medium-risk Sites

- Infrastructure and site conditions are relatively stable
- Limited/some monitoring may be required

High-risk Sites

- Infrastructure is not exposed but is expected within 5 years
- Regular monitoring may be required

Imminent-risk Sites

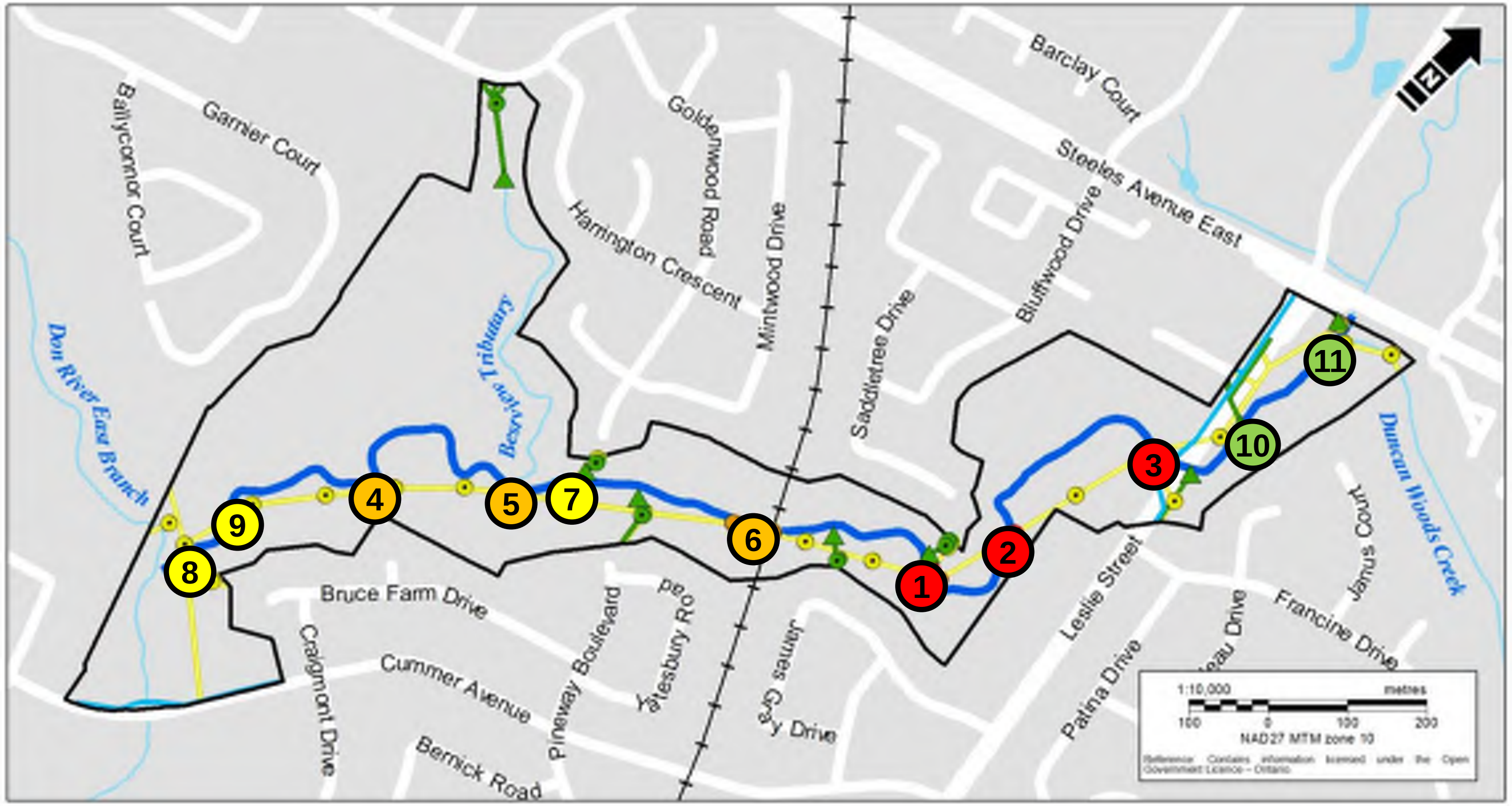
- Infrastructure is exposed and at risk of failure; requires immediate attention
- Regular monitoring and improvements to the infrastructure are required

Priority Sites Based on Risk

The study area includes 56 City of Toronto water, stormwater and sanitary sewer infrastructure sites.

Level of risk was assessed for 43 water and stormwater sites.

Based on the risk assessment, 11 priority project sites were identified for further evaluation as part of the study.



Imminent Risk Priority Projects 1 to 3

High Risk Priority Projects 4 to 6

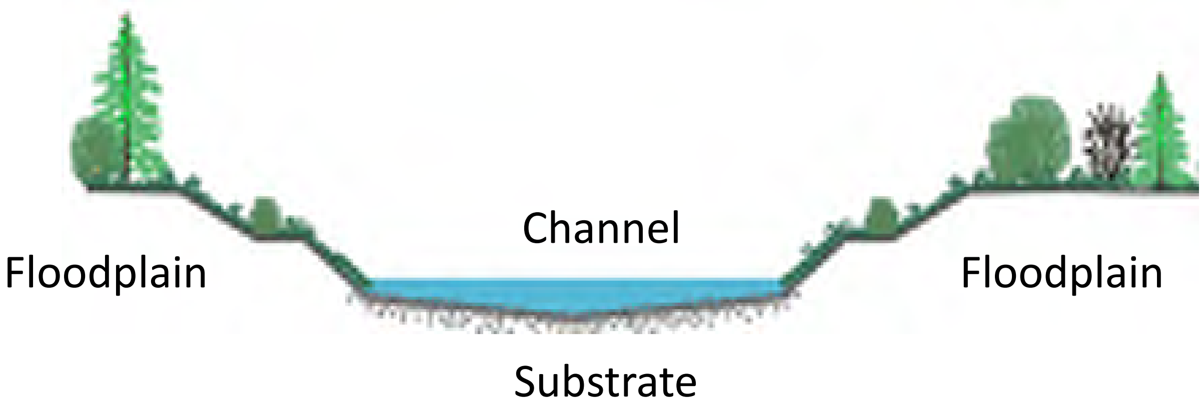
Medium Risk Priority Projects 7 to 8

Low Risk Priority Projects 10 to 11

Risk Assessment Glossary of Terms

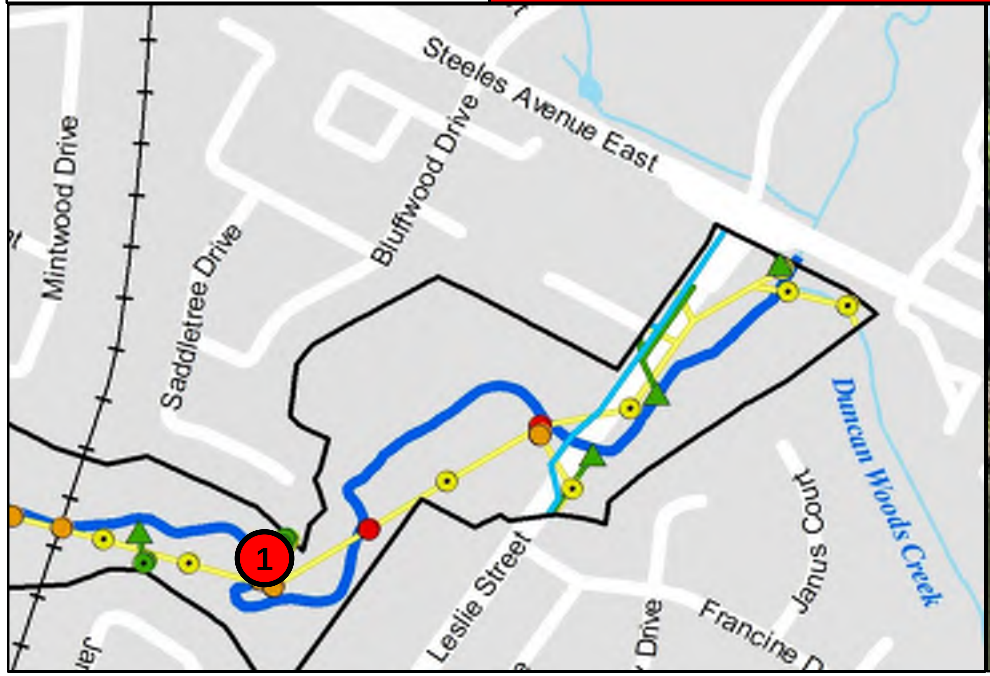
Bank:	The sides of the creek, also part of the floodplain
Channel:	The water in the creek / river / stream
Confluence:	Where 2 or more watercourses meet
Erosion:	Gradual changes to the form (path a creek follows) and function (aquatic and terrestrial habitats the stream supports) of the creek and creek bed due to increased water flow and storms
Floodplain:	The area surrounding the channel which holds increased water flow when the width of the creek expands seasonally or due to storms and snowmelt
Substrate:	The material on bottom of the bed of the creek

Cross-section of stream channel and floodplain



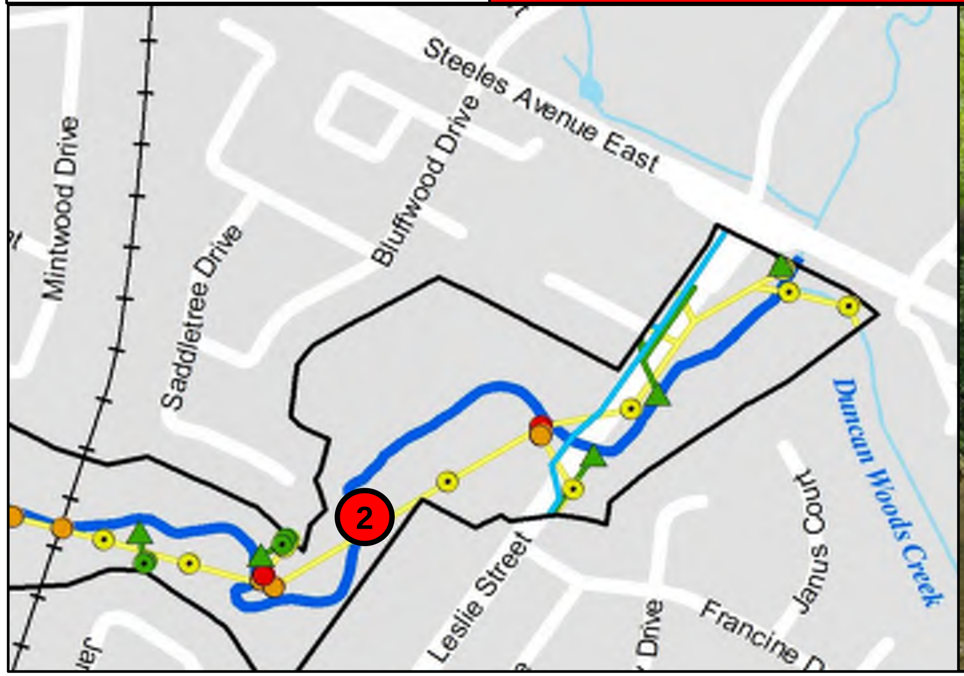
Risk Assessment: Priority Site 1

Sanitary sewer maintenance hole and lateral sewer connection	
Descriptions of conditions	• Exposed maintenance hole and pipe • Other 2 pipes 1.2 m and 0.16 m depth of cover remaining • At an actively eroding large meander
Risk level	**Imminent**



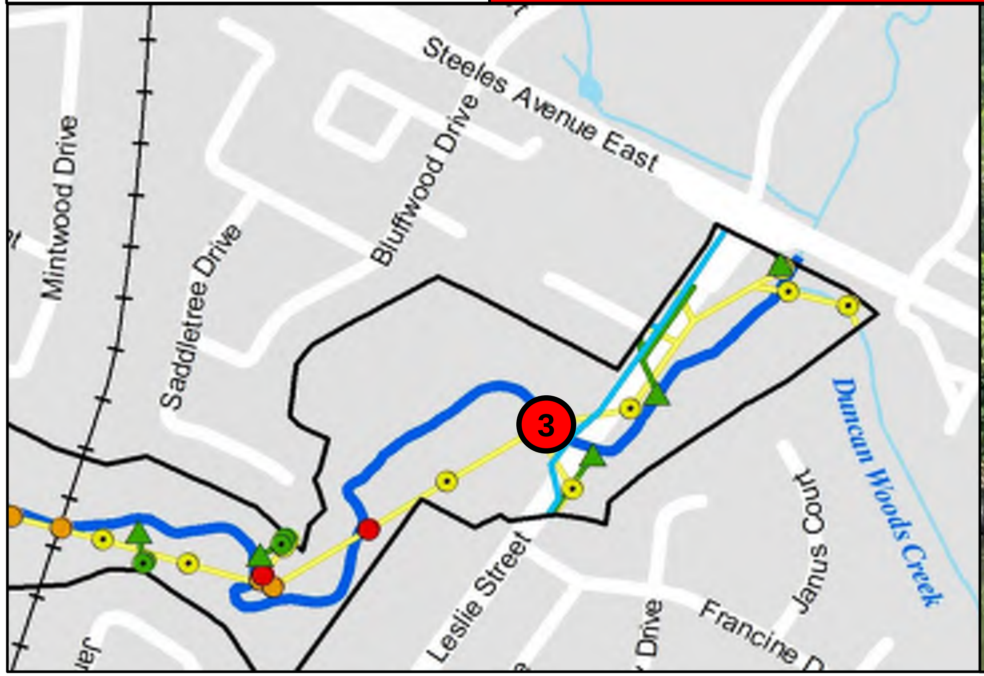
Risk Assessment: Priority Site 2

Sanitary sewer maintenance hole	
Descriptions of conditions	• 1 maintenance hole fully exposed • 1.3 m depth of cover remaining at sewer crossing • Severe and ongoing bank erosion occurring
Risk level	**Imminent**



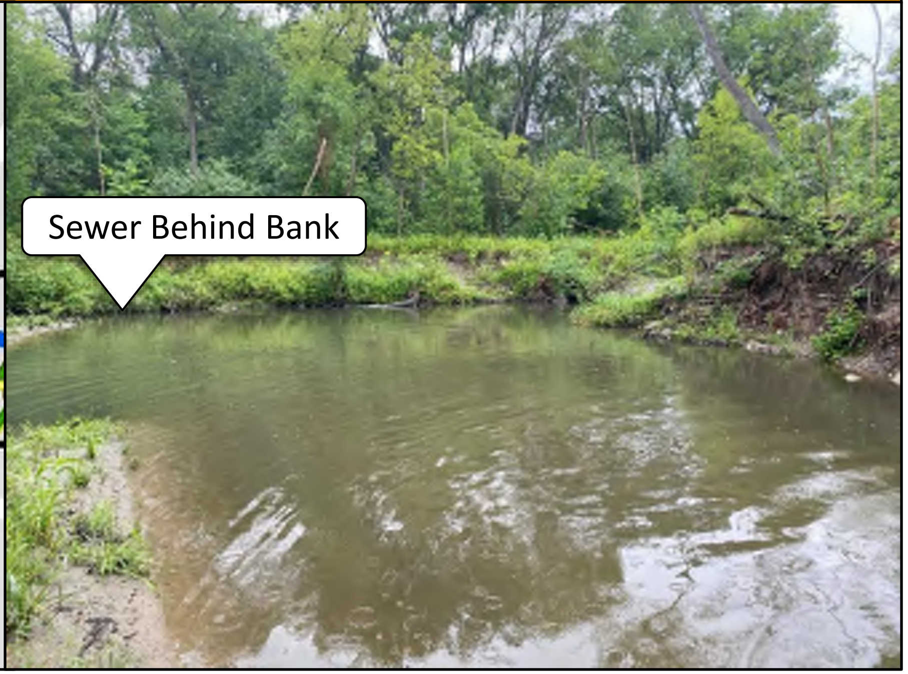
Risk Assessment: Priority Site 3

Sanitary sewer maintenance hole	
Descriptions of conditions	• 0.92 m and 1.54 m depth over nearby pipe crossings • 1 maintenance hole is fully exposed • Severe and ongoing bank erosion
Risk level	**Imminent**



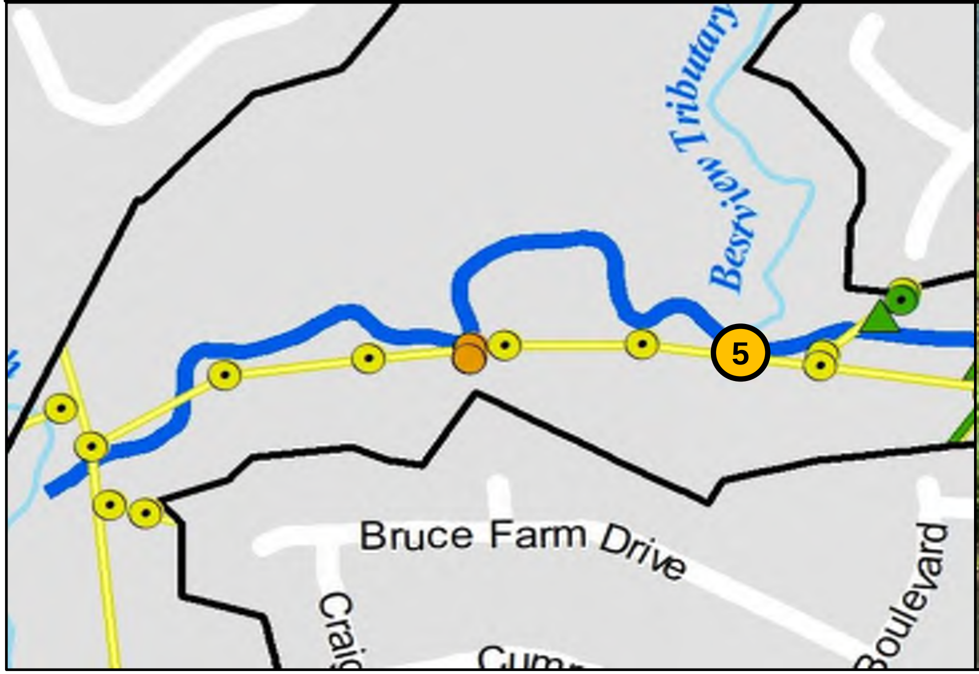
Risk Assessment: Priority Site 4

Sanitary sewer adjacent to pathway	
Descriptions of conditions	• Sewer within 1 m from edge of creek • Sewer runs parallel to pathway and creek • Vertical banks against sewer in several locations
Risk level	**High**



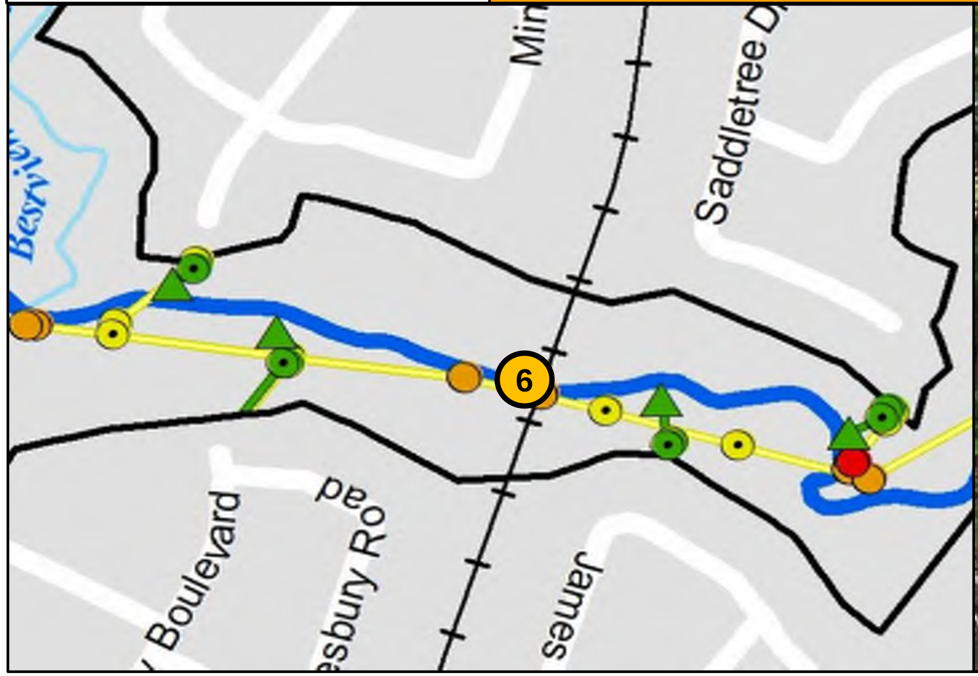
Risk Assessment: Priority Site 5

Sanitary sewer adjacent to pathway	
Descriptions of conditions	• Sewer within 1 m from edge of creek • Sewer runs parallel to pathway and creek • Bank is actively eroding and near confluence with Bestview Tributary
Risk level	**High**



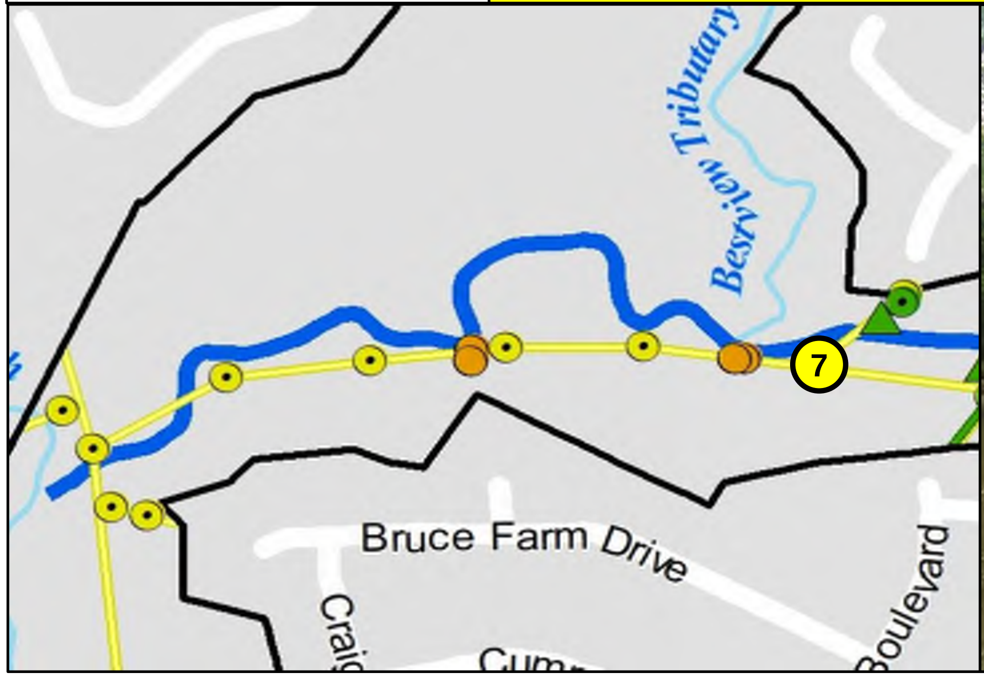
Risk Assessment: Priority Site 6

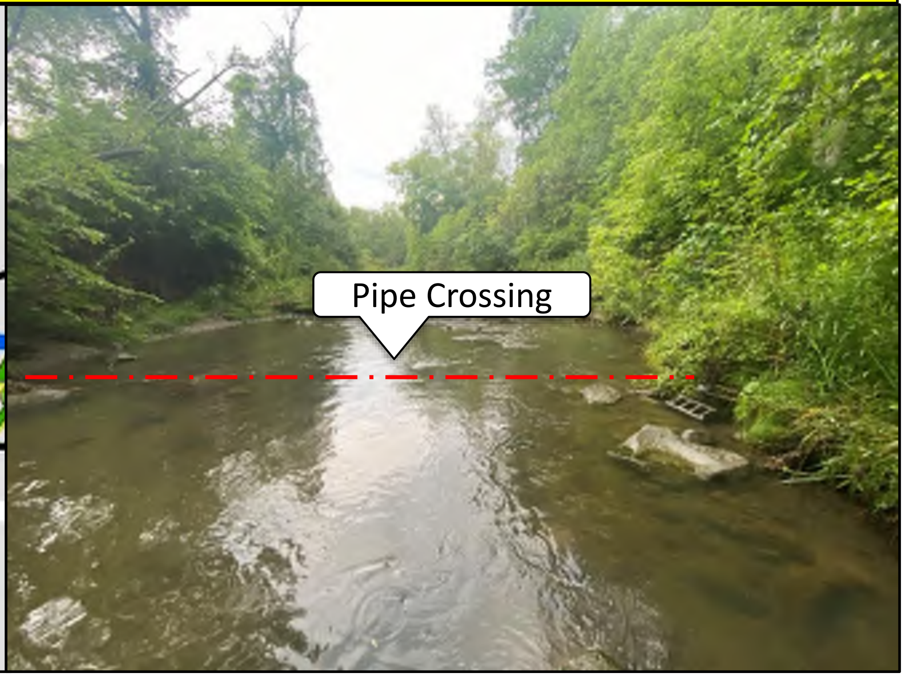
Sanitary sewer adjacent to pathway and railway	
Descriptions of conditions	• Sewer within 1 m from edge of creek • Existing erosion protection moderately stable
Risk level	**High**



Risk Assessment: Priority Site 7

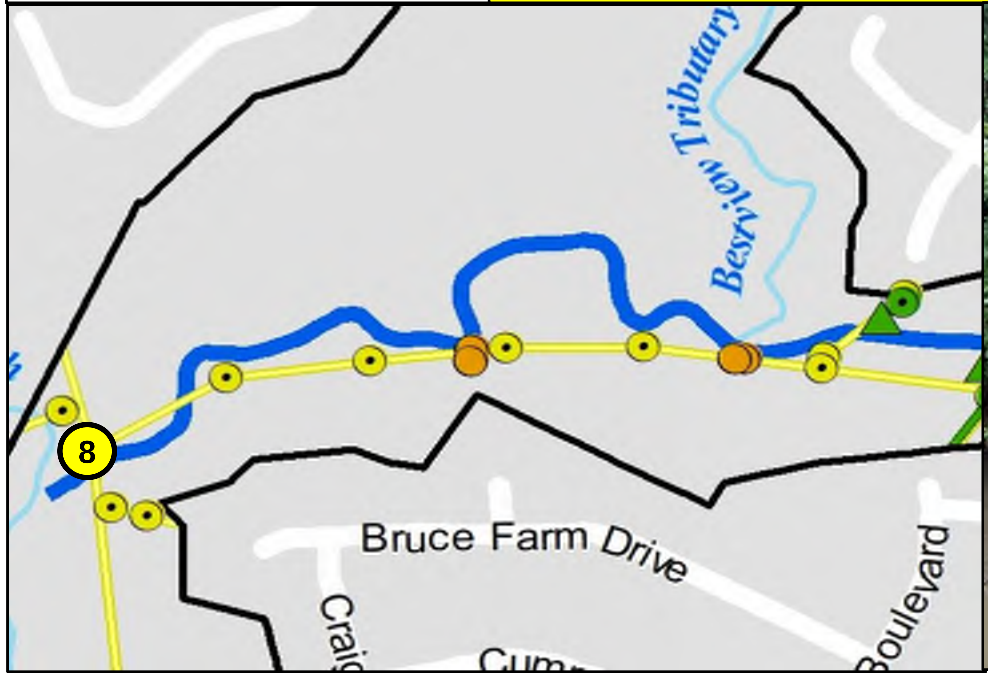
Sanitary sewer pipe crossing	
Descriptions of conditions	• 0.37 m depth of cover over existing pipe • Channel substrate is mainly sand so more susceptible to erosion
Risk level	**Medium**





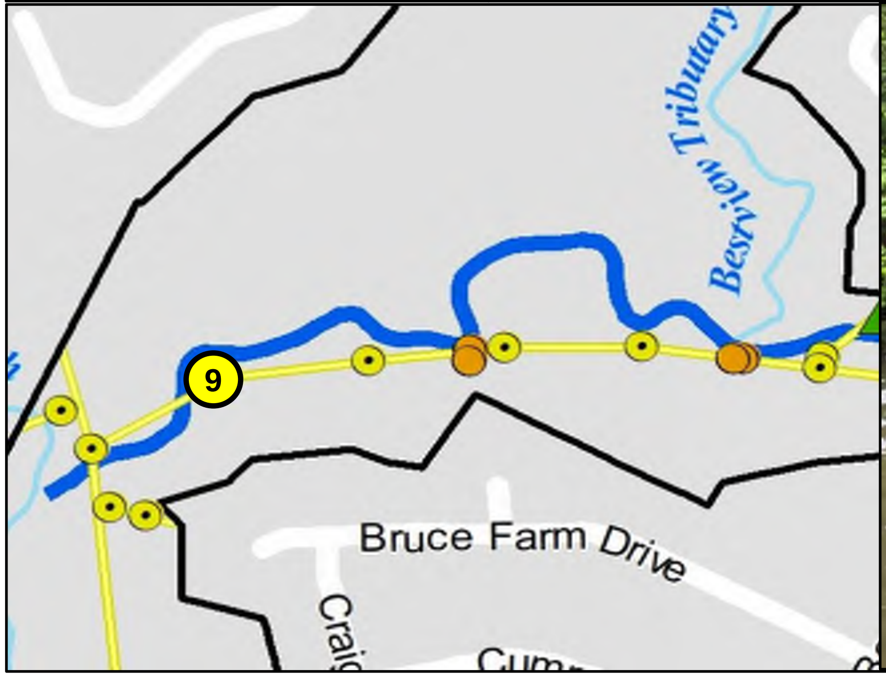
Risk Assessment: Priority Site 8

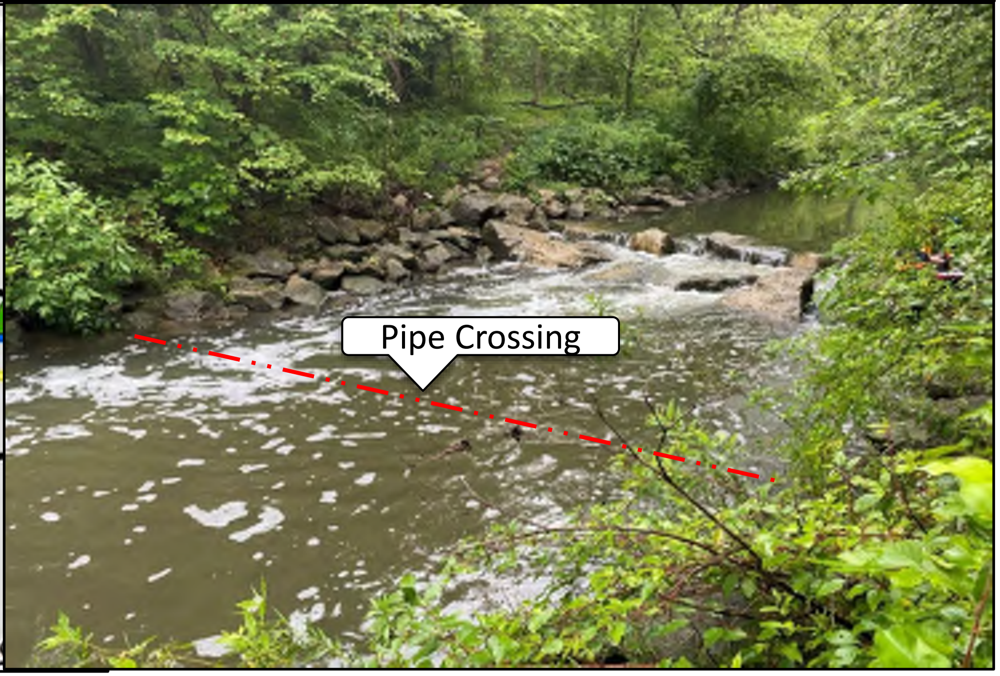
Sanitary sewer pipe crossing	
Descriptions of conditions	• 0.48 m depth of cover over existing pipe • Channel substrate is cobble and gravel so less susceptible to erosion
Risk level	**Medium**



Risk Assessment: Priority Site 9

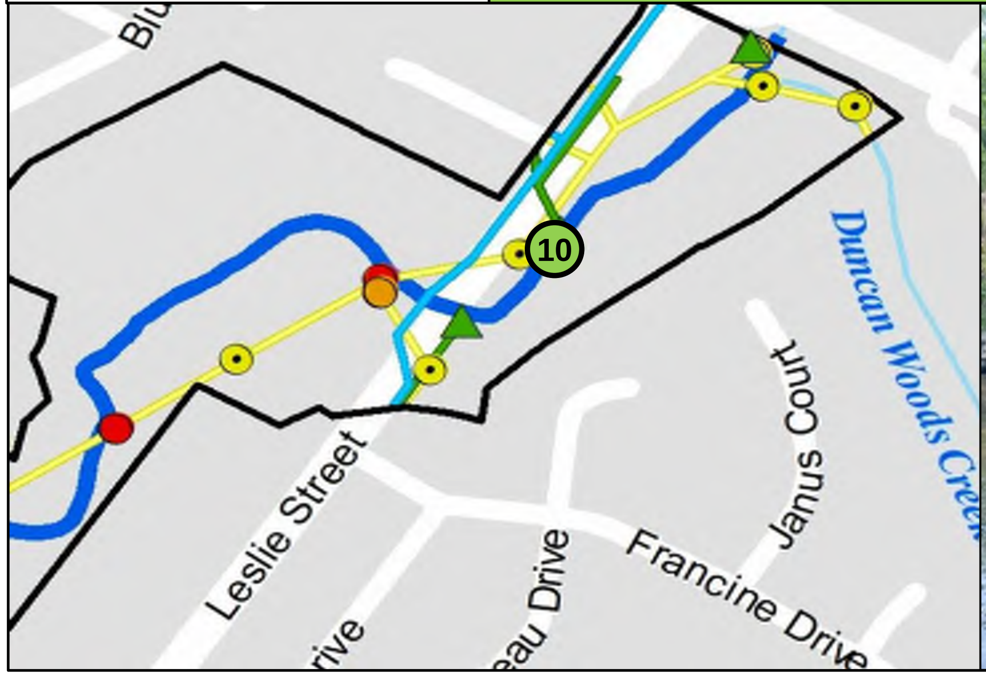
Sanitary sewer pipe crossing	
Descriptions of conditions	• 1.2 m depth of cover over existing pipe • Grade control structures (rocky ribs) to reduce channel velocities
Risk level	**Medium**





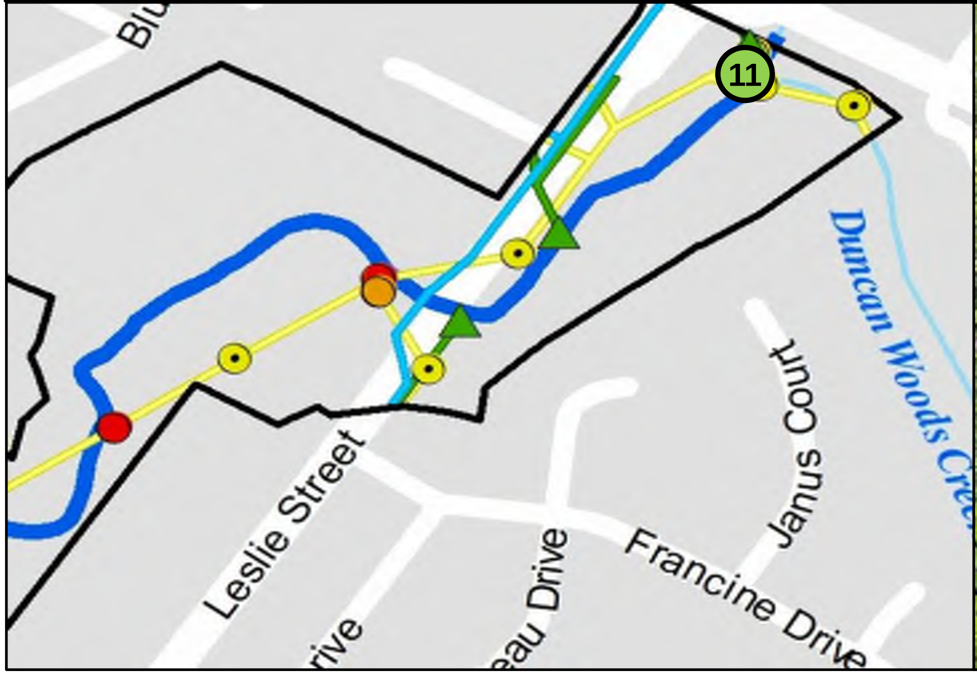
Risk Assessment: Priority Site 10

Sanitary sewer outfall	
Descriptions of conditions	• Outfall protected by armourstone and large boulders
Risk level	**Low**



Risk Assessment: Priority Site 11

Sanitary sewer maintenance hole	
Descriptions of conditions	• Maintenance hole well protected behind armourstone blocks • No sign of active erosion but maintenance hole is within 4 m of creek
Risk level	**Low**



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Alternative Solutions for Natural Channel Design

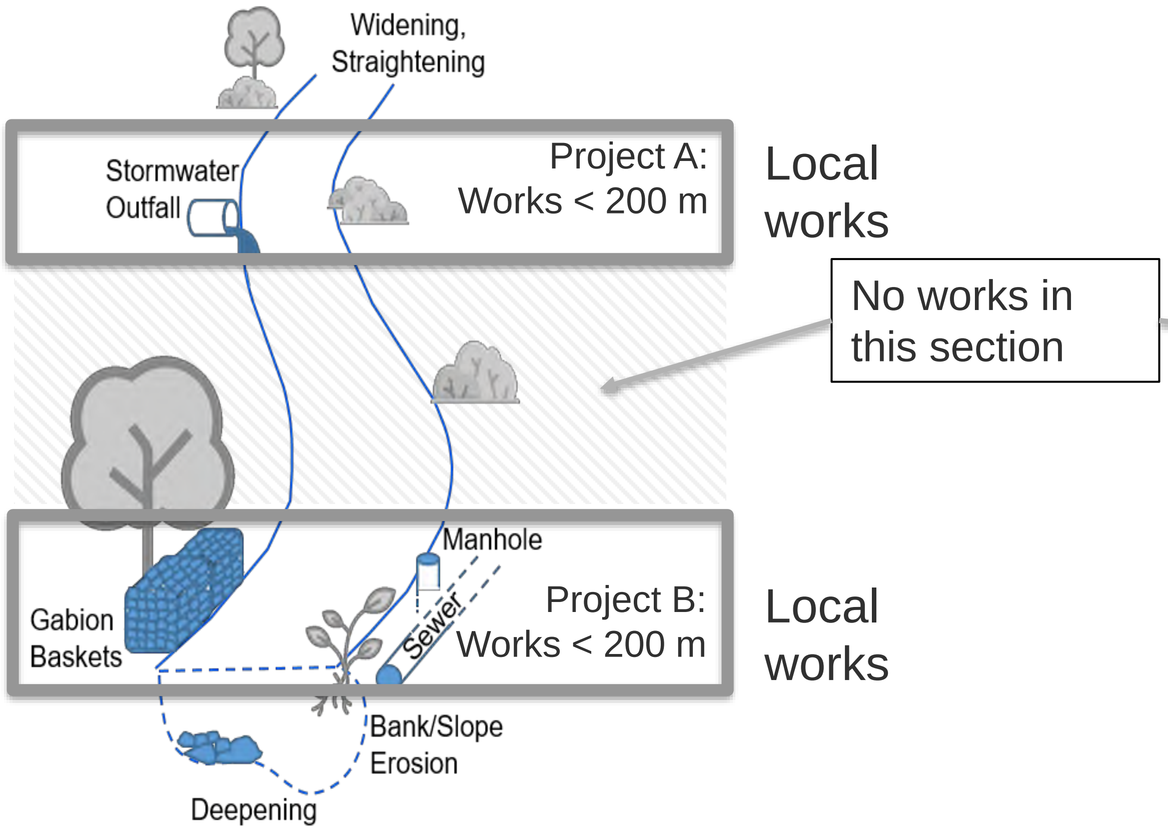
Alternative 1: Do Nothing
- No improvements

Alternative 2: Improvements through local works less than 200 metres
- Bed and bank work in the stream and floodplain
- Project site less than 200 metres
- No work between project sites

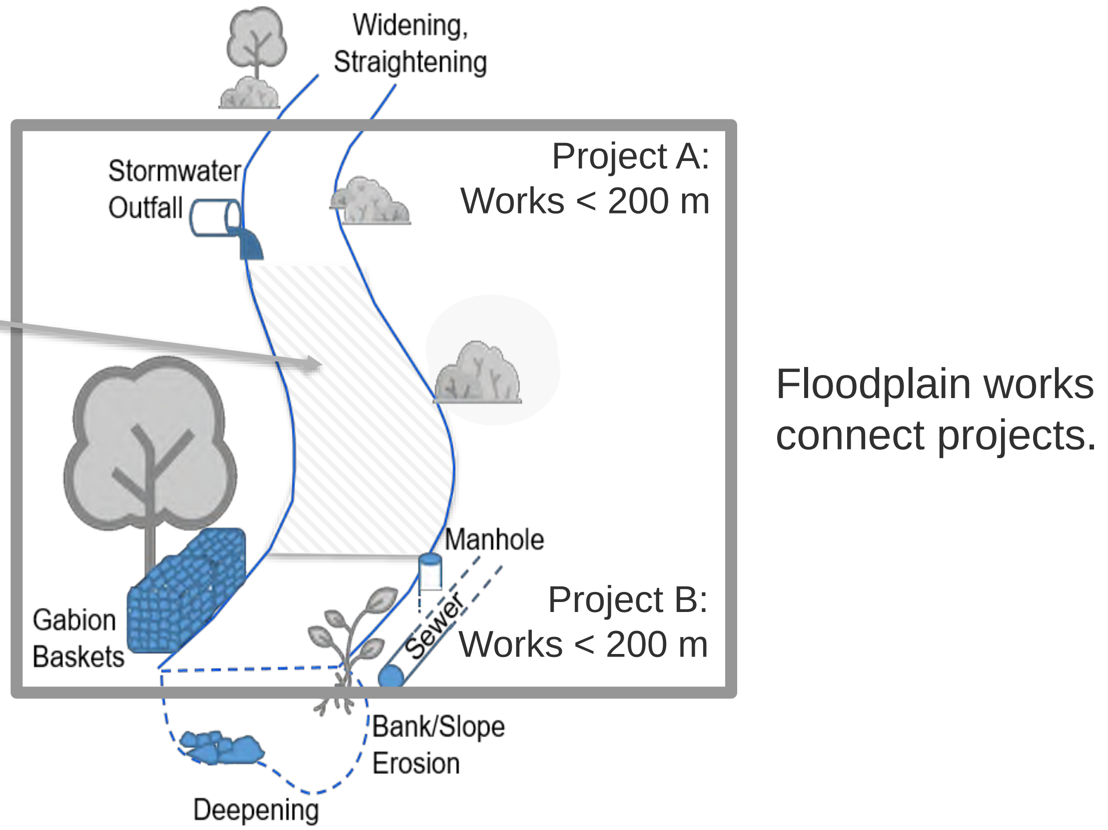
Alternative 3: Improvements through local works less that 200 metres and floodplain connections
- Bed and bank work in the stream and floodplain
- Floodplain will be widened to increase capacity for creek flow, reducing water velocities and erosion
- Project site less than 200 metres
- Where there are gaps between project sites, there is only floodplain work and no work in the creek

Alternative 4: Improvements in a segment of the creek greater than 200 metres
- Bed and bank work in the stream and floodplain
- Larger project sites greater than 200 metres
- Bed, bank, and floodplain works are continuous between project sites

Alternative Solutions for Natural Channel Design continued



Alternative 2 – Project A and B separated



Alternative 3 – Project A and B connected through works in the floodplain

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Example of Alternative 2

Improvements through local works less than 200 metres

Massey Creek - Toronto
Before Construction

Massey Creek - Toronto
After Construction

Example Alternative 4, Greater than 200 m

Improvements through local greater than 200 metres

Section of creek realigned

Highland Creek - Scarborough
After construction

Evaluation Criteria

The following 5 categories of criteria are used to evaluate alternative solutions

Physical & Natural Environment

Improves stability of stream and valley walls, flood conveyance, groundwater quality, vegetation, aquatic and terrestrial habitats including habitat for at-risk species, and minimised tree removals

Infrastructure Risk

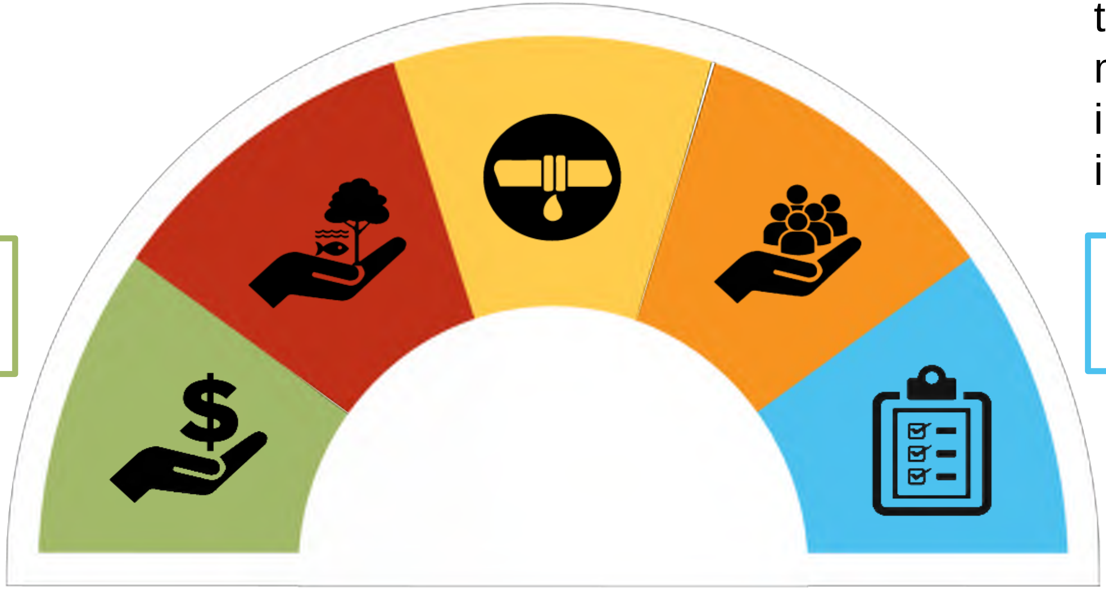
Addresses erosion and risk to City's water and sewer infrastructure

Social & Cultural Environments

Protects built and cultural heritage as we as landscape and archaeological resources, long term benefits for the community, minimum or short term negative impacts, and consideration for impacts on private property

Economic Considerations

Evaluate total capital costs against recurring costs for maximum improvements and outcomes over a span of 30 years



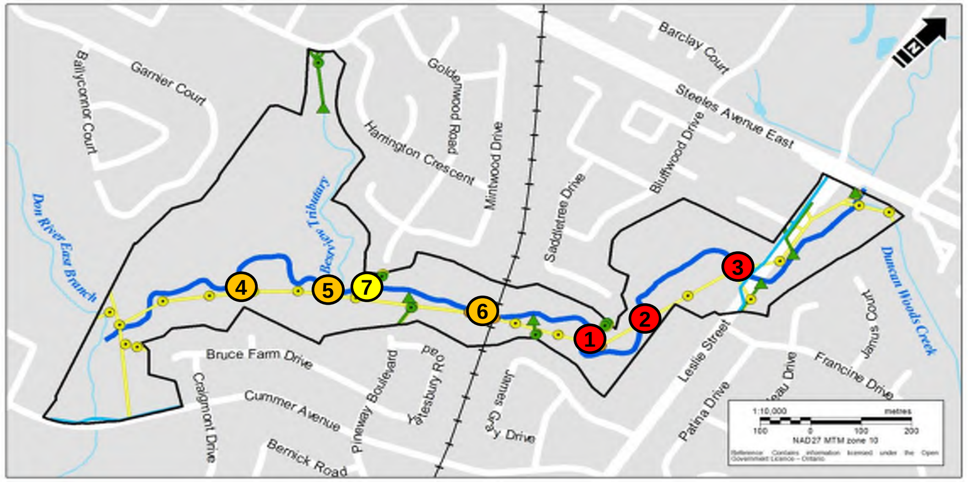
Technical & Engineering Considerations

Evaluate regulatory agency standards, availability of staff and technical resources, maximum improvement for ecosystem and infrastructure

Recommended Solutions: Imminent-risk Sites

Project were developed based on the priority risk sites. Each project will address the priority risk site along with nearby infrastructure

Project No.	Recommended Solution	Evaluation Detail
1	Local work and floodplain connection Possible realignment of the pedestrian bridge located 500 metres west of Leslie Street to allow the stream a natural course	Recommended solution: • Addresses erosion risk within existing footprint without major corridor realignment and grading • Floodplain connection not as essential in these areas as it is generally well connected • Erosion issues are less severe in these locations Future implementation of the recommended natural channel design projects requires tree removal, to be followed by restoration and replanting with native trees and shrubs.
2	Local work and floodplain connection	Same as Project No. 1 above
3	Local work and floodplain connection	Same as Project No. 1 above

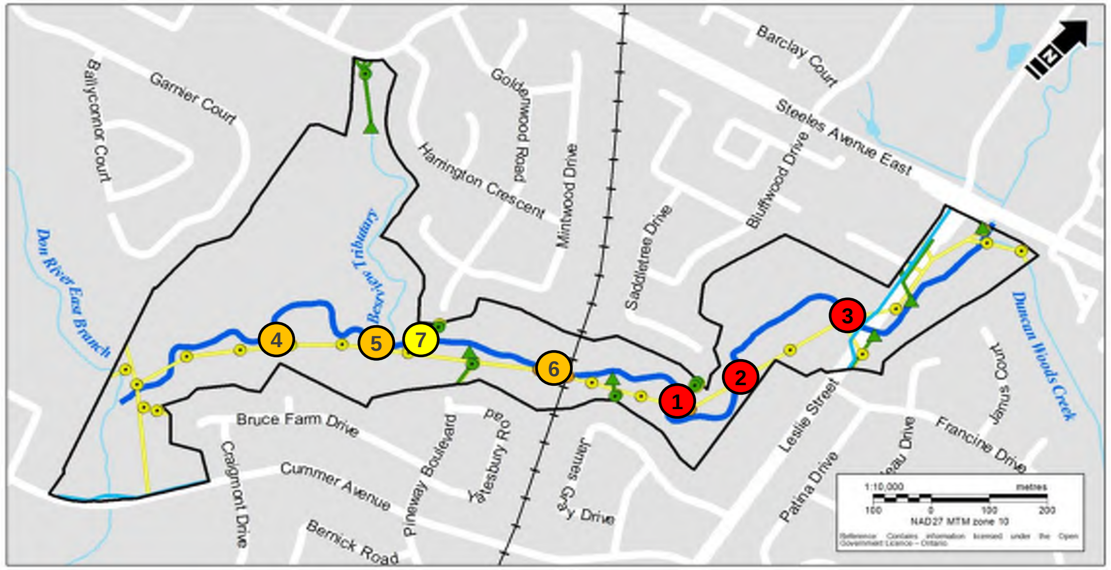


Imminent Risk Priority Projects 1 to 3

High Risk Priority Projects 4 to 6

Preferred Solutions: High-risk Sites

Project No.	Recommended Solution	Evaluation Detail
4, 5, 6, and 7	Local work less than 200 m	Recommended solution: • Addresses erosion risk within existing footprint without major corridor realignment and grading • Floodplain connection not as essential in these areas as it is generally well connected • Erosion issues are less severe in these locations Future implementation of the recommended natural channel design projects requires tree removal, to be followed by restoration and replanting with native trees and shrubs.

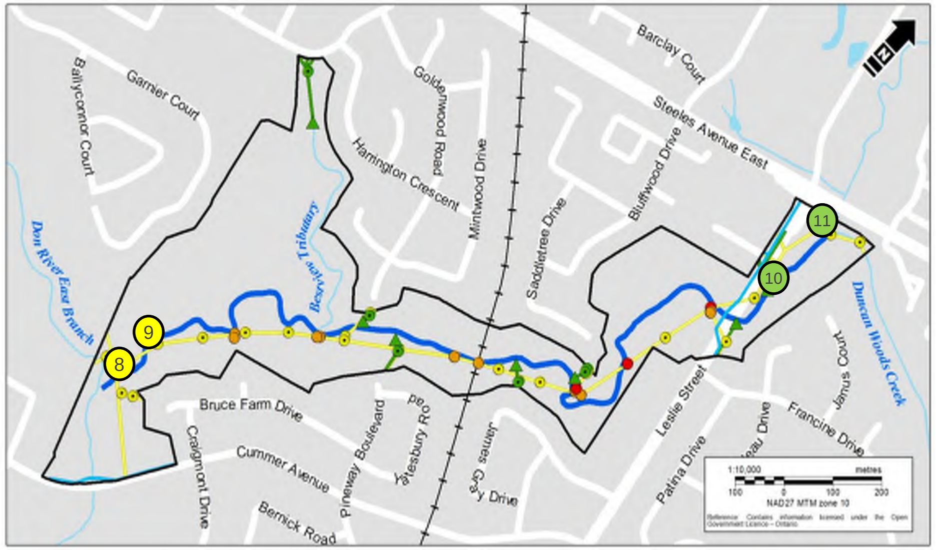


Imminent Risk Priority Projects 1 to 3

High Risk Priority Projects 4 to 6

Preferred Solutions: Medium- and Low-risk Sites

Project No.	Recommended Solution	Evaluation Detail
8	Local works less than 200 metres and floodplain connections	• Projects in close proximity to each other – addresses multiple erosion risks to infrastructure at once within one construction period as well as provides efficiencies in design costs • Balances in-stream erosion reduction and tree removals Future implementation of the recommended natural channel design projects requires tree removal, to be followed by restoration and replanting with native trees and shrubs
9	Local works less than 200 metres and floodplain connections	Same as Project No. 8 above



Medium Risk Priority Projects 7 to 8

Low Risk Priority Projects 10 to 11

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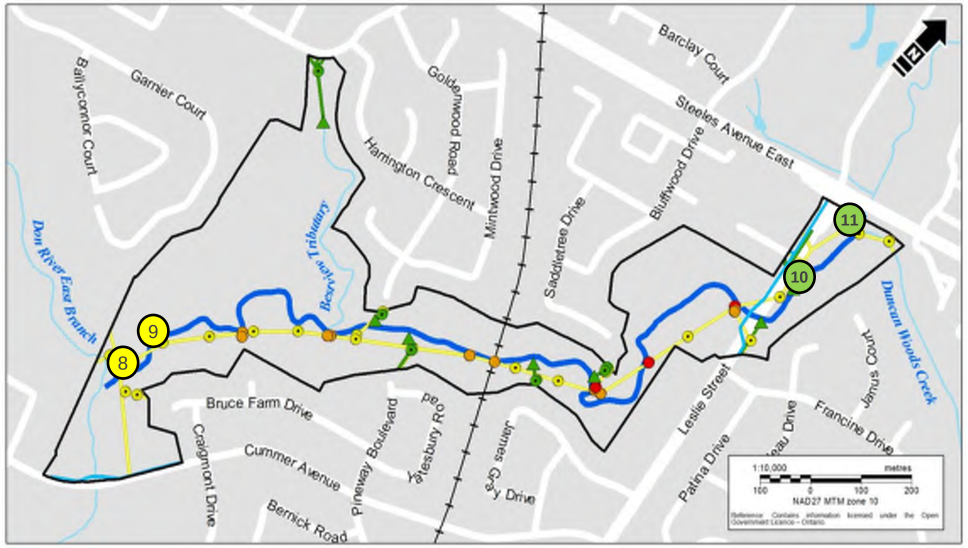
Preferred Solution: Medium- and Low-risk Sites continued

Project No.	Recommended Solution	Evaluation Detail
10	Local works less than 200 metres	• Low erosion risk, therefore local works minimize cost and impacts to surrounding infrastructure Future implementation of the recommended natural channel design projects requires tree removal, to be followed by restoration and replanting with native trees and shrubs
11	Local works less than 200 metres	Same as Project No. 10 above



Medium Risk Priority Projects 7 to 8

Low Risk Priority Projects 10 to 11

Impacts of Creek Restoration and Erosion Control Restoration Works

Future implementation of the recommended natural channel design projects requires:

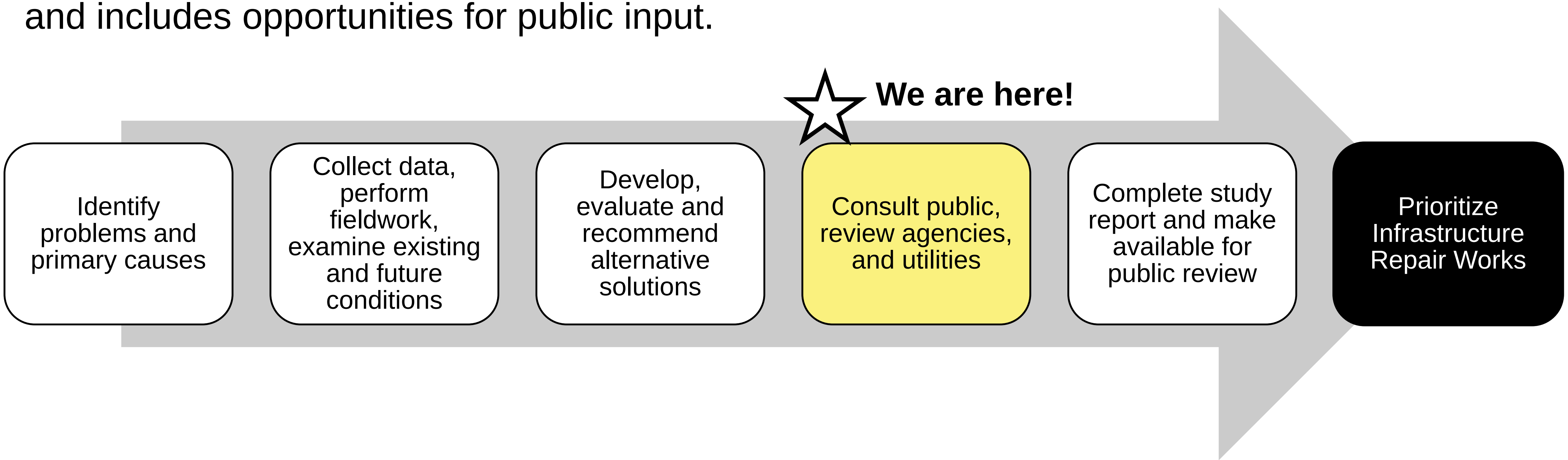
- Tree and vegetation removal – to be replaced with healthy native species, to be further analyzed during detailed design
- Potential pedestrian bridge realignment to allow the stream to have a natural course and avoid future erosion

Construction Impacts

- Residents will be notified prior to any construction
- A restoration plan will be developed prior to construction

Next Steps in Study Process

The study is following the Municipal Class Environmental Assessment study process for Master Plans, which is an approved planning process under the Ontario Environmental Assessment Act and includes opportunities for public input.



Once a GSMP is approved, recommended solutions will be included in the City’s Stream Restoration and Erosion Control Program which will prioritize and allocate budget for detail engineering design and construction.

Residents will be notified prior to any construction occurring.

Public Consultation

Public Consultation – Activities

Learn More	Attend a site walk	Provide Feedback
View project information on the website and provide feedback **toronto.ca/germanmills**	Visit the study area with the project team to discuss the study recommendations and ask questions Friday August 18, 2023 (rain or shine) Drop in 9:00 a.m. – 11:00 a.m. Site walk at 9:00 a.m.	Complete an online survey or request a printed copy. Submit comments by email, mail or phone. Comment deadline: Friday September 1, 2023

Meet at the trail entrance south of Steeles Avenue on the west side of Leslie Street.

This location is wheelchair/mobility device accessible. If you have a specific accessibility need or require accommodation, please contact us in advance.

Paid parking is available at the Canadian Memorial Chiropractic College at 6100 Leslie Street.

Staff Contacts

Project Manager
Devin Coone
Acting Senior Project Manager, Stormwater Management Infrastructure
Design & Construction - Linear Underground Infrastructure
Engineering & Construction Services

Toronto Water
Bill Snodgrass
Senior Engineer, Infrastructure Planning & Programming
Water Infrastructure Management
Toronto Water

Public Consultation Unit
Aadila Valiallah
Senior Coordinator, Public Consultation Unit
Policy, Planning, Finance & Administration

Toronto.ca/GermanMills
Email: germanmills@toronto.ca
Telephone: 416-338-2985

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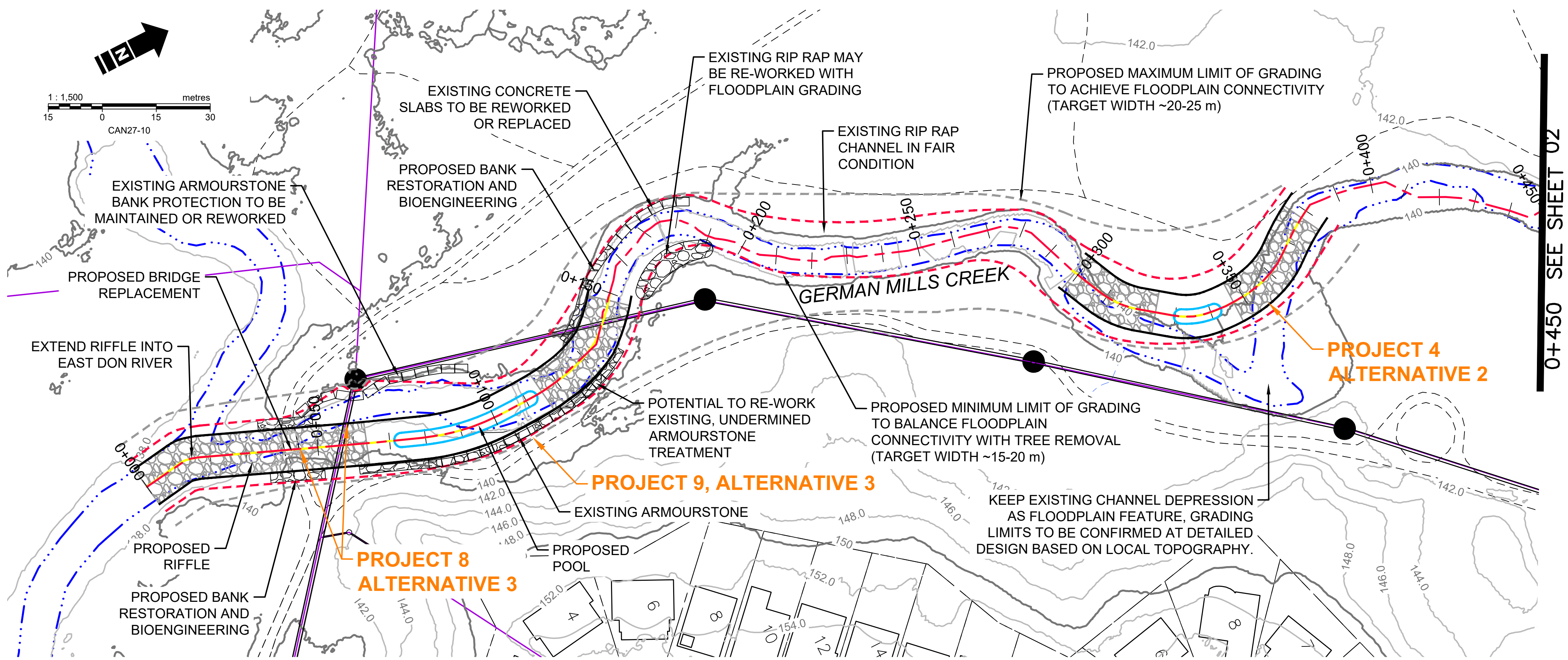
ATTACHMENT 2

Concept Drawings



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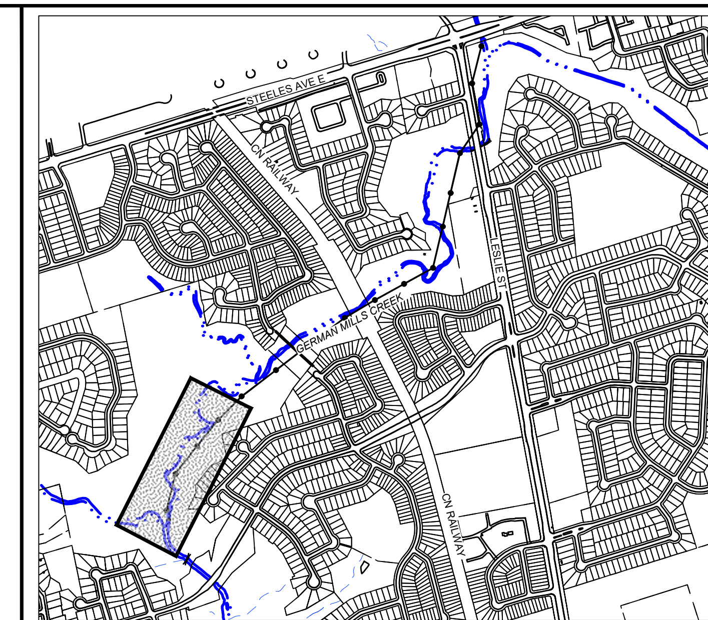
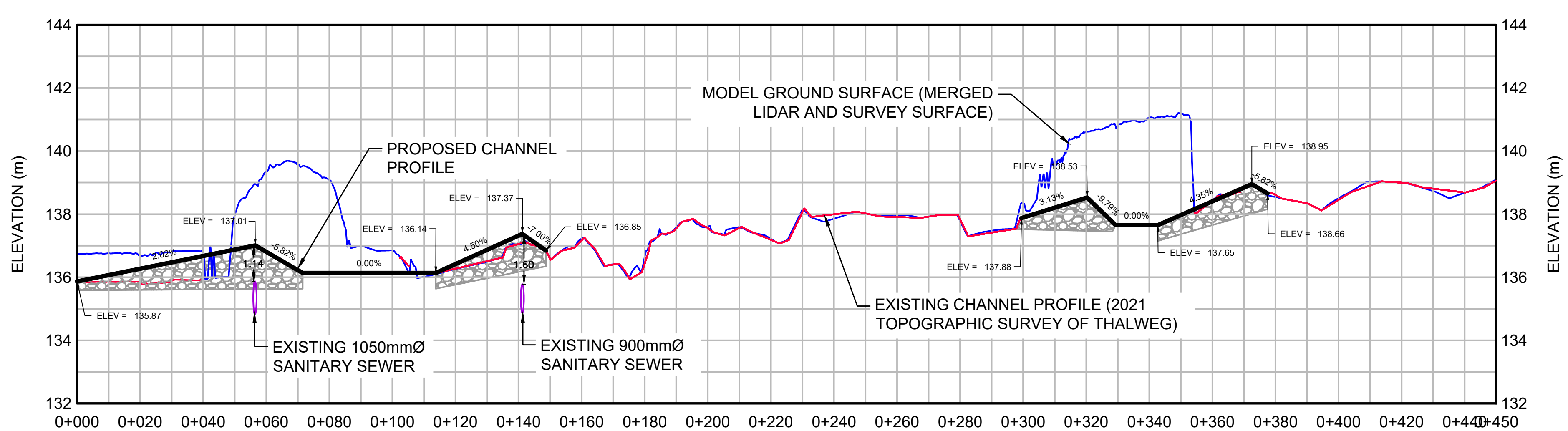


KEY MAP

NOT TO SCALE

LEGEND

	LOT LINE		CHANNEL REALIGNMENT
	RIVER SHORELINE		CHANNEL BANK
	THALWEG		MINIMUM GRADING LIMIT
	TRAIL		MAXIMUM GRADING LIMIT
	EXISTING CONTOUR (2m INTERVAL)		EXISTING ARMOURSTONE
	SANITARY SEWER		PROPOSED BANK AND TOE RESTORATION WITH EXPOSED ARMOURSTONE
	STORM SEWER		
	WATERMAIN		PROPOSED BANK AND TOE RESTORATION WITH BURIED ARMOURSTONE
	SANITARY SEWER		
	MAINTENANCE HOLE		PROPOSED BANK RESTORATION AND BIOENGINEERING
			RIFFLE
			POOL



PROFILE

HORIZONTAL SCALE 1:2000
VERTICAL SCALE 1:200

REFERENCE:
1. BASE MAP TOPOGRAPHY COMPILED FROM CITY OF TORONTO OPEN SOURCE DATA, TWAG SERVICING DATA AND DRF15170_TOPO2D.
2. MAPPED CREEK ALIGNMENT ON PLAN FROM 2018 ORTHOPHOTOGRAPHY DIGITIZED BY MATRIX SOLUTIONS.
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5. COORDINATE SYSTEM ONTARIO MTM ZONE 10 NAD27.

DRAFT

REVISION

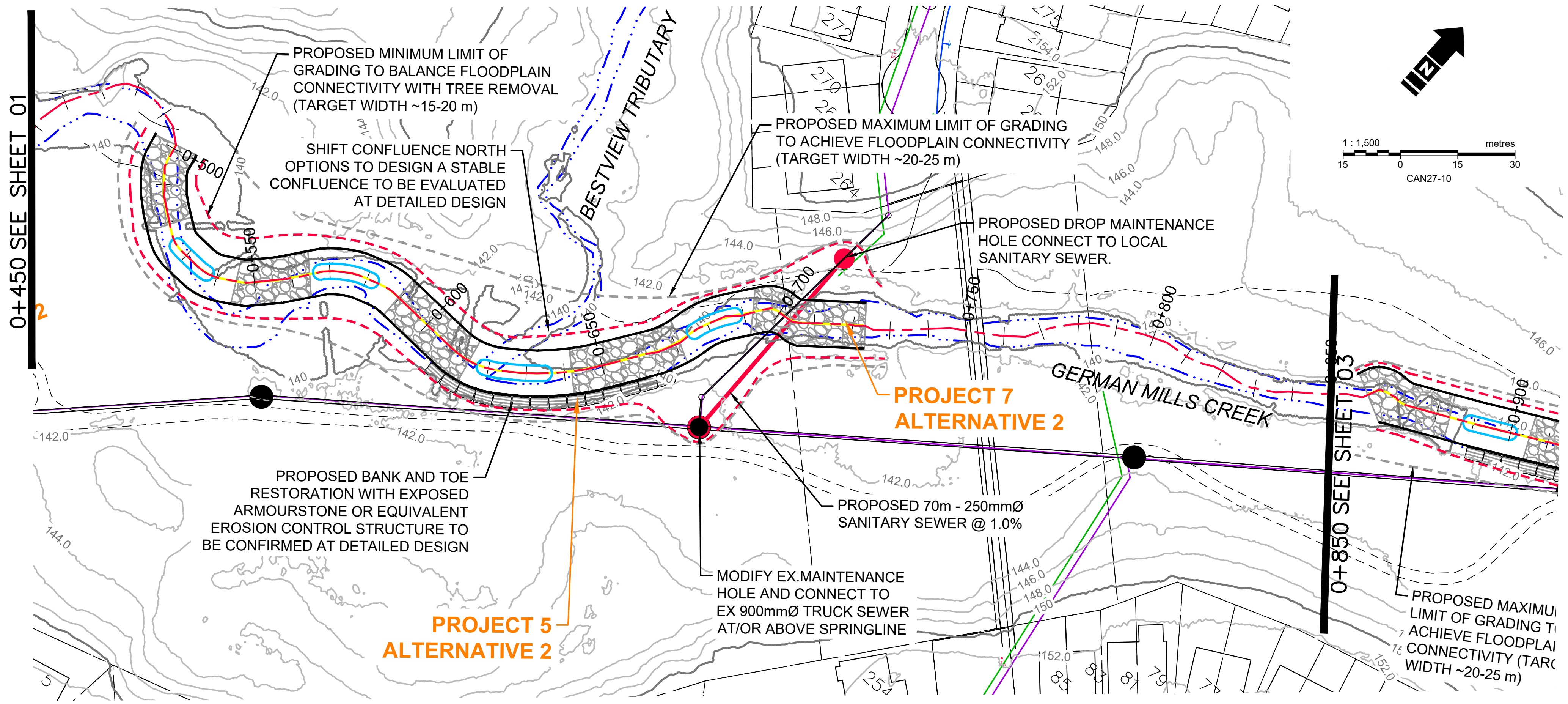
No.	DATE	DESCRIPTION	BY	CHK.	DRN.
B	2023-01-27	ISSUE FOR REVIEW	NC	RP	KW
A	2022-06-23	ISSUE FOR REVIEW	NC	RP	KW

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

CITY OF TORONTO
GERMAN MILLS GSMP EA

PREFERRED ALTERNATIVE
STA. 0+000 TO 0+450

DATE: APRIL 2022	TECHNICAL: N. CYPLES	REVIEWER: R. PHILLIPS	DRAWN: K. WEILER
PROJECT: 32227-504		REVISION: B	DRAWING: C1



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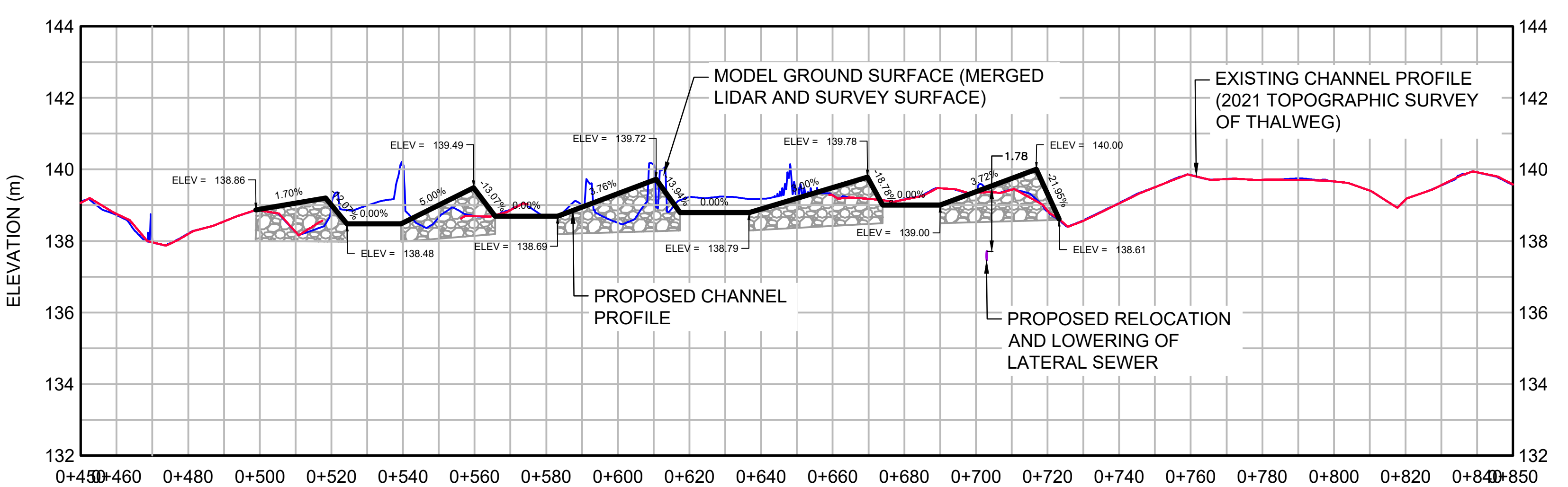

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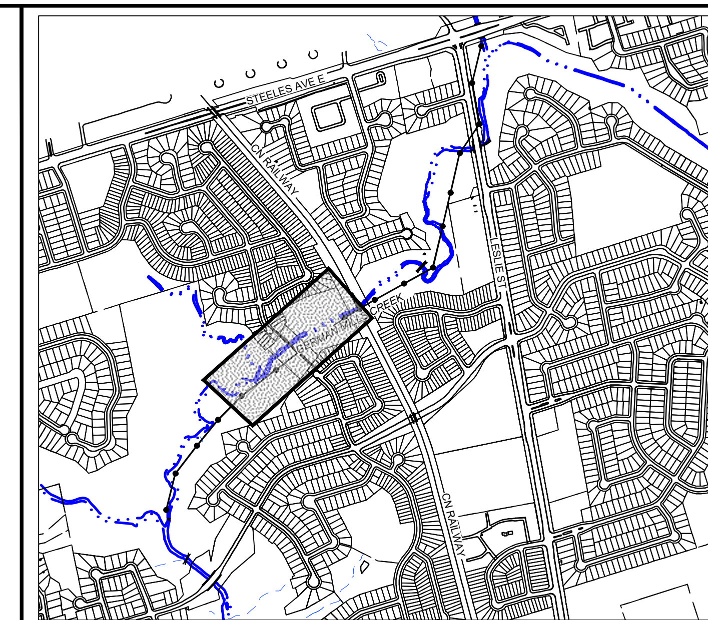

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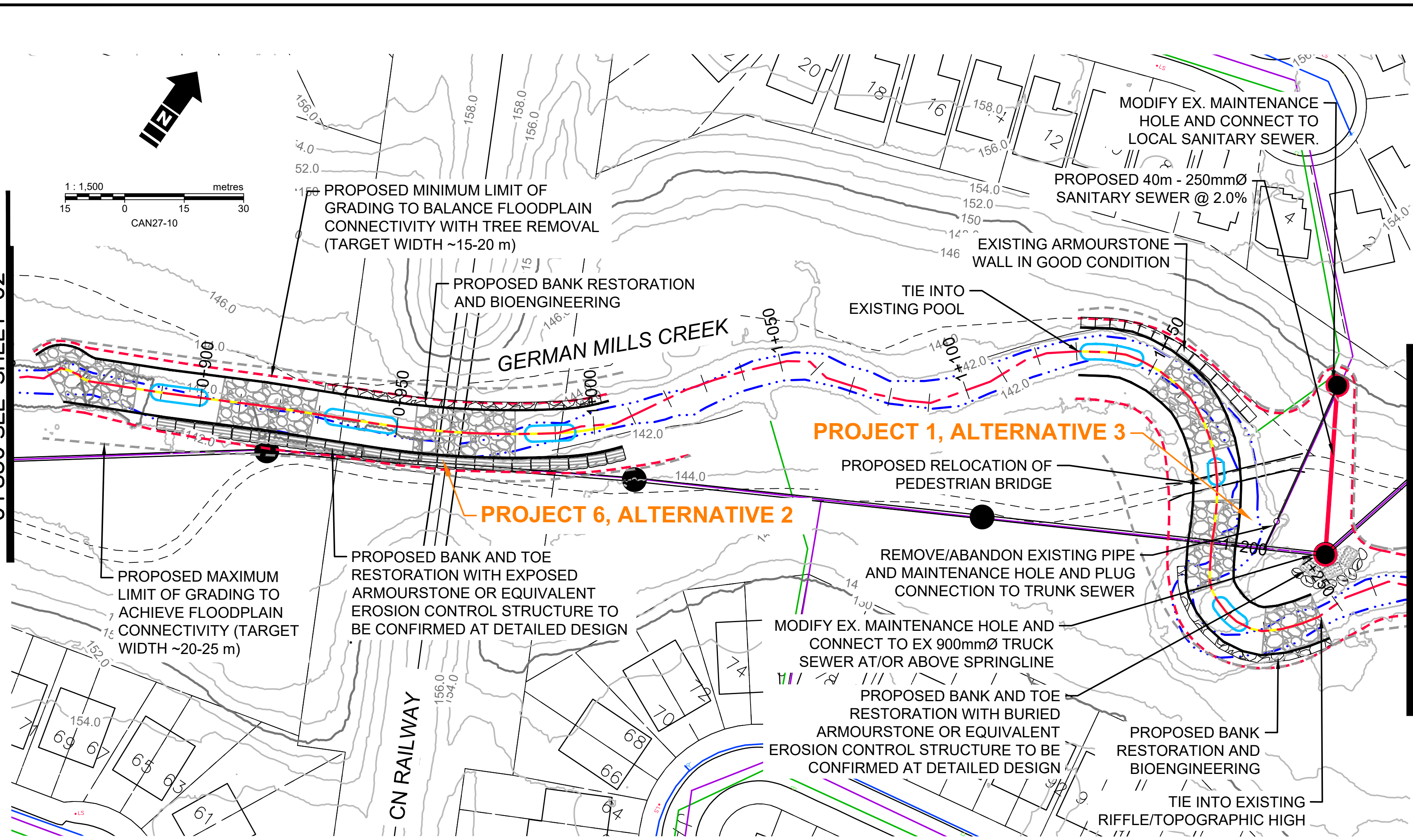
PREFERRED ALTERNATIVE
STA. 0+450 TO 0+850

DATE:	TECHNICAL:	REVIEWER:	DRAWN:
APRIL 2022	N. CYPLES	R. PHILLIPS	K. WEILER

PROJECT:	REVISION:	DRAWING:
32227-504	B	C2



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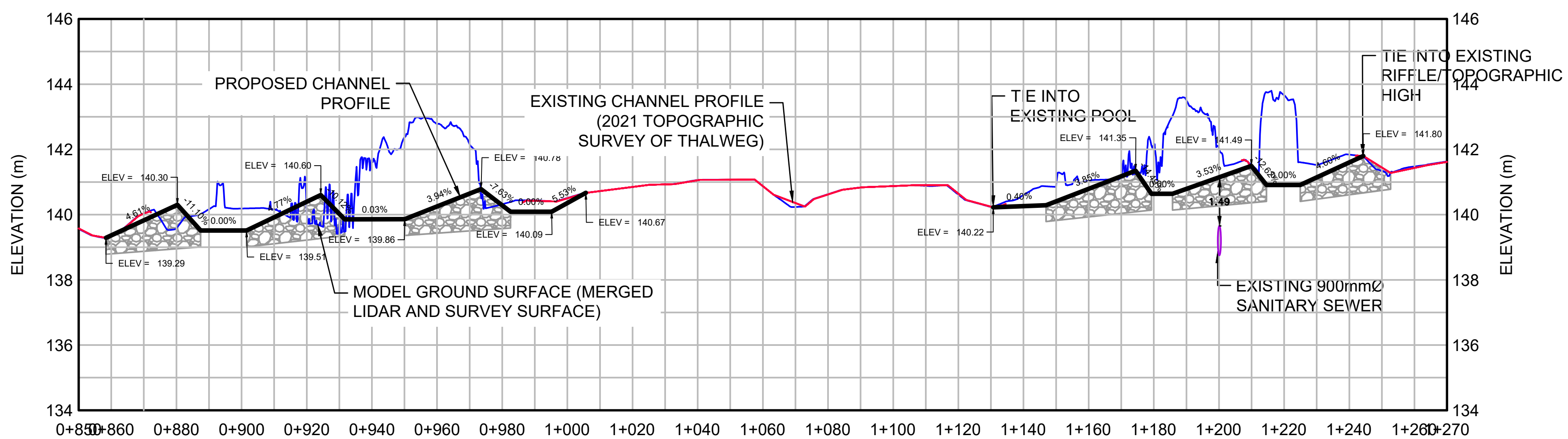

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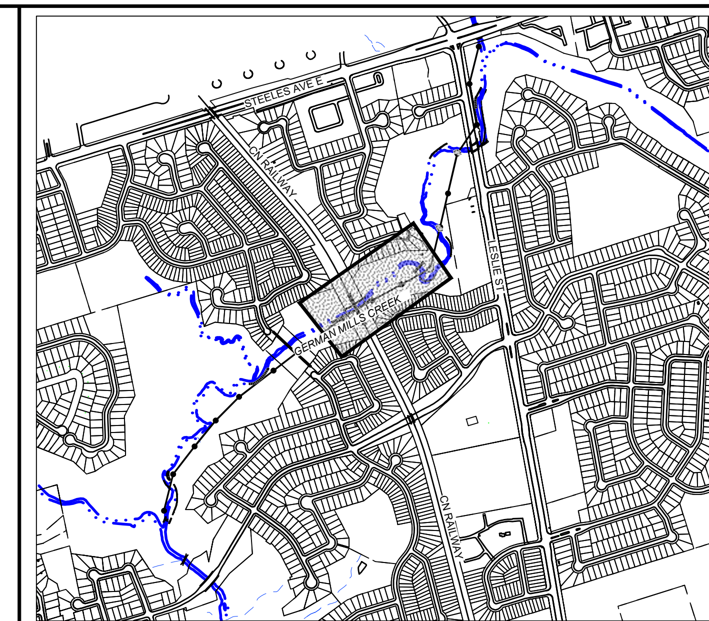

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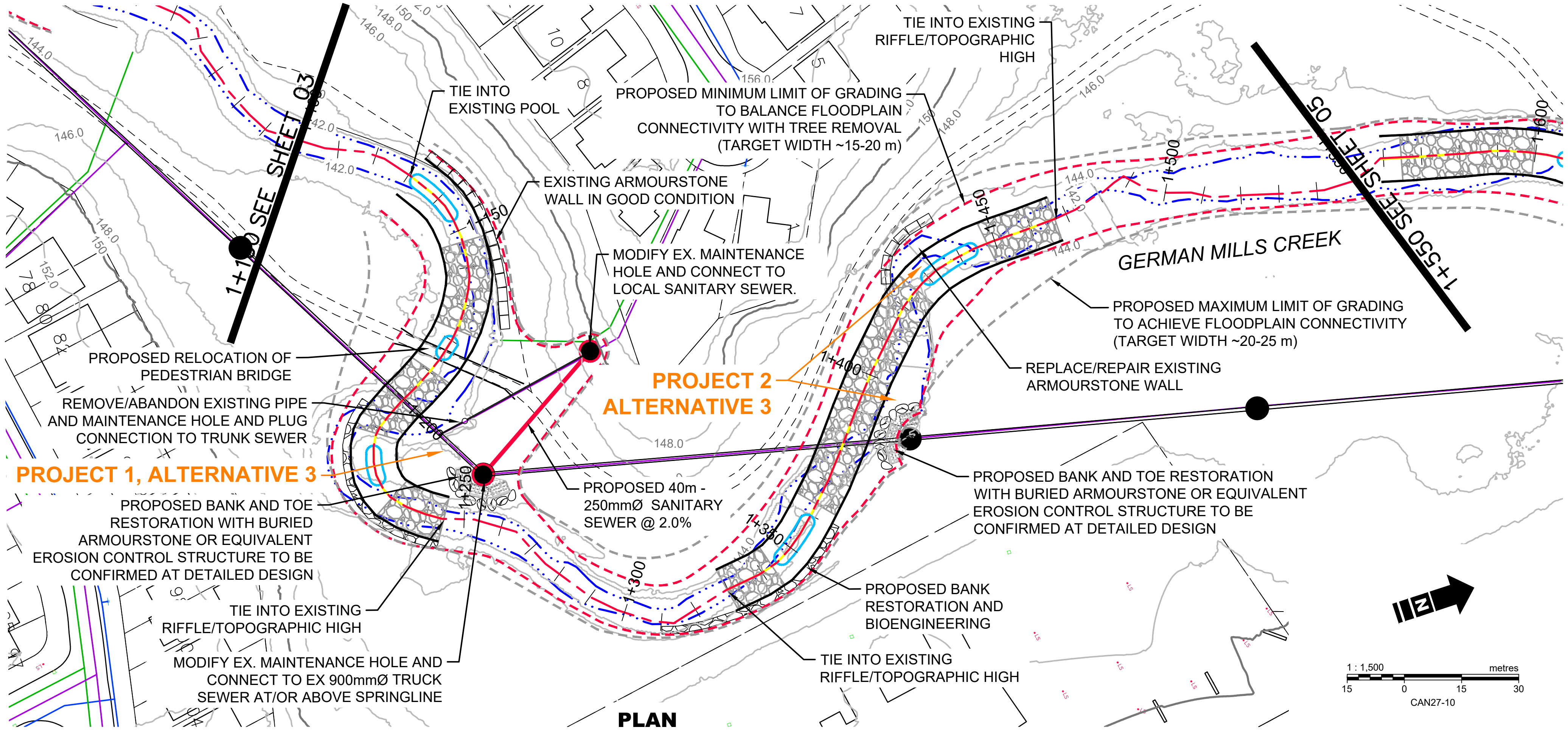
PREFERRED ALTERNATIVE
STA. 0+850 TO 1+270

DATE:	TECHNICAL:	REVIEWER:	DRAWN:
APRIL 2022	N. CYPLES	R. PHILLIPS	K. WEILER

PROJECT:	REVISION:	DRAWING:
32227-504	B	C3



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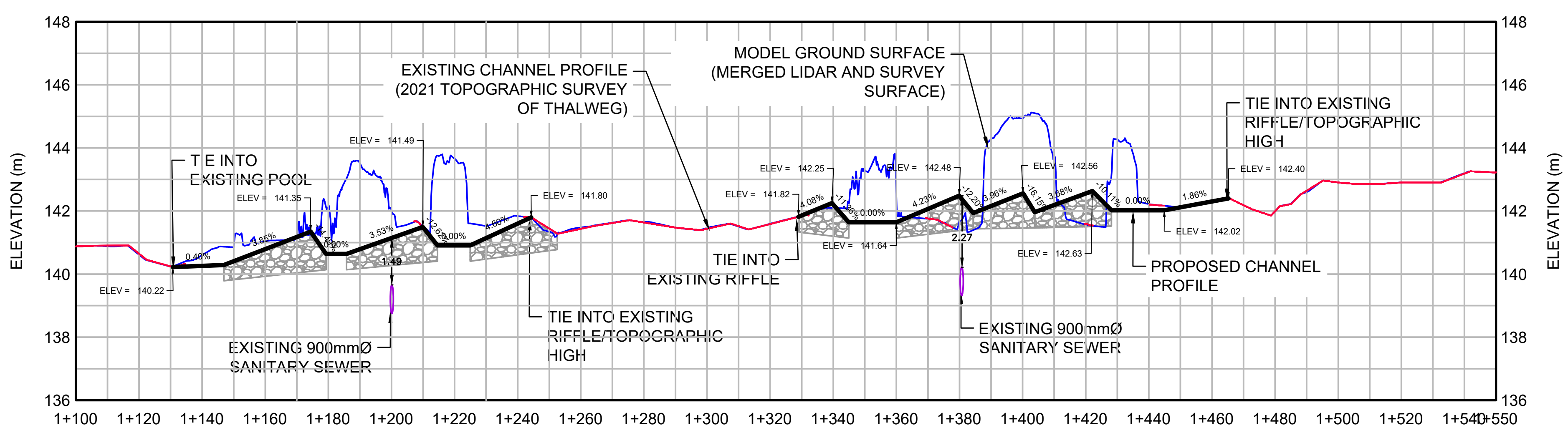

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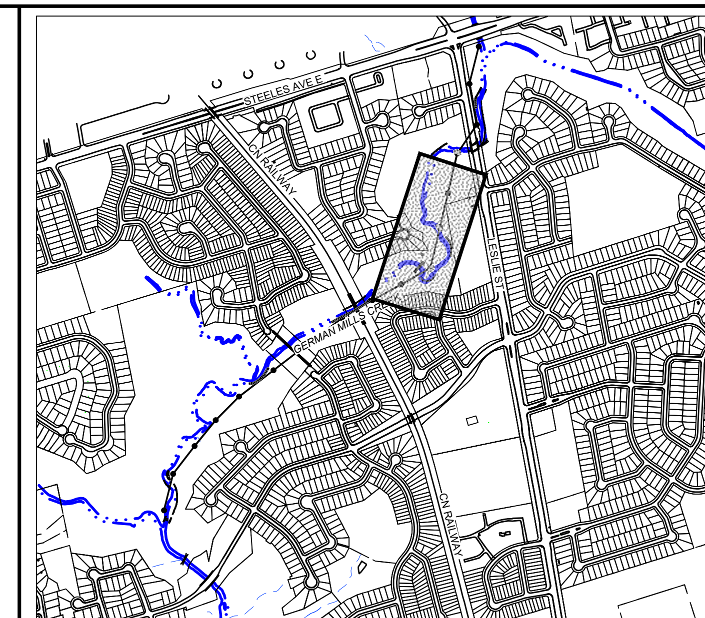

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- MAXIMUM GRADING LIMIT
- EXISTING ARMOURSTONE
- PROPOSED BANK AND TOE RESTORATION WITH EXPOSED ARMOURSTONE
- PROPOSED BANK AND TOE RESTORATION WITH BURIED ARMOURSTONE
- PROPOSED BANK RESTORATION AND BIOENGINEERING
- RIFFLE
- POOL

REVISION

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
B	2023-01-27	ISSUE FOR REVIEW	NC	RP	KW
A	2022-06-23	ISSUE FOR REVIEW	NC	RP	KW

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

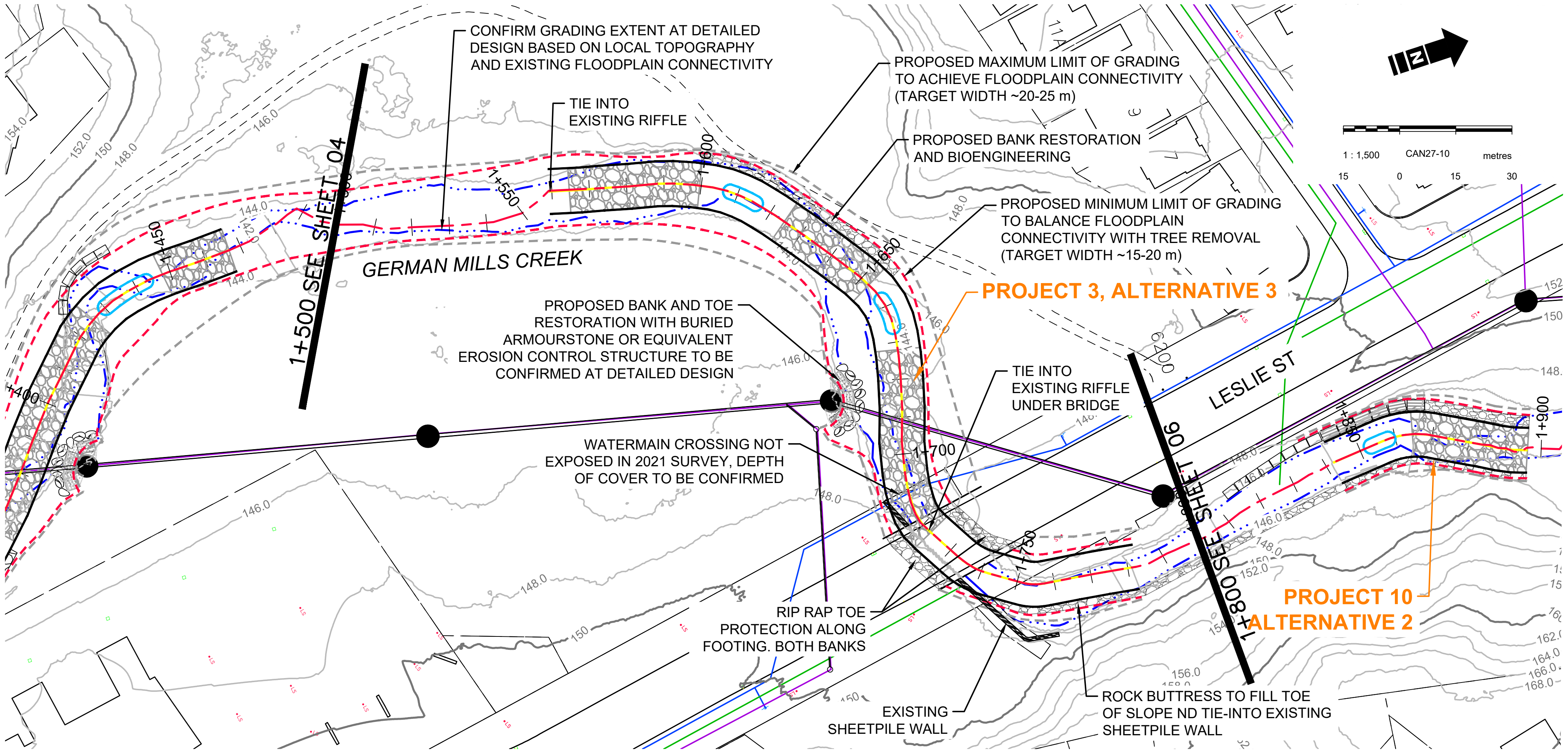
CITY OF TORONTO
GERMAN MILLS GSMP EA

PREFERRED ALTERNATIVE
STA. 1+100 TO 1+550

DATE:	TECHNICAL:	REVIEWER:	DRAWN:
APRIL 2022	N. CYPLES	R. PHILLIPS	K. WEILER

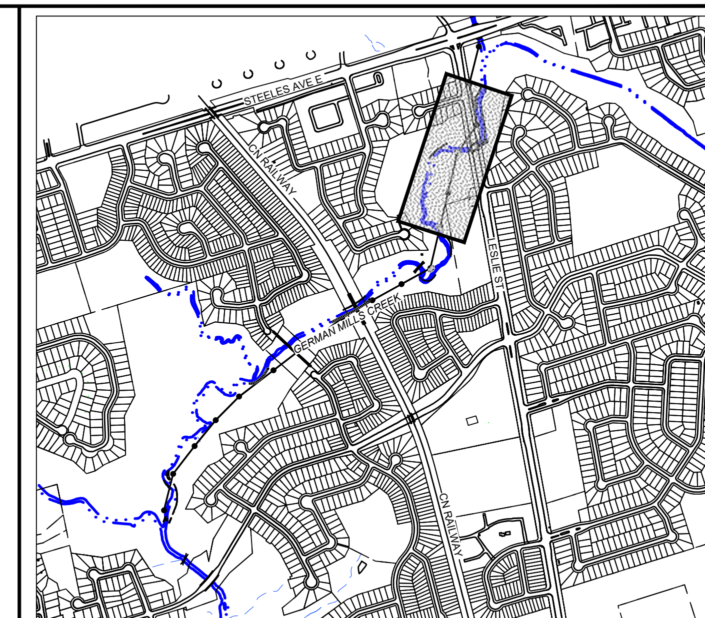
PROJECT:	REVISION:	DRAWING:
32227-504	B	C4

N:\PROJECTS\32227 - German Mills GSMP EA\05 Analysis\Drafting\C3D\EA\Production\Figs\32227-River PP Phase 3.dwg - B4 - Thursday, January 19, 2023 1:58:12 PM - Kim Weiler
Plot 1:1 = Tabloid (L)



PLAN

SCALE 1:1500

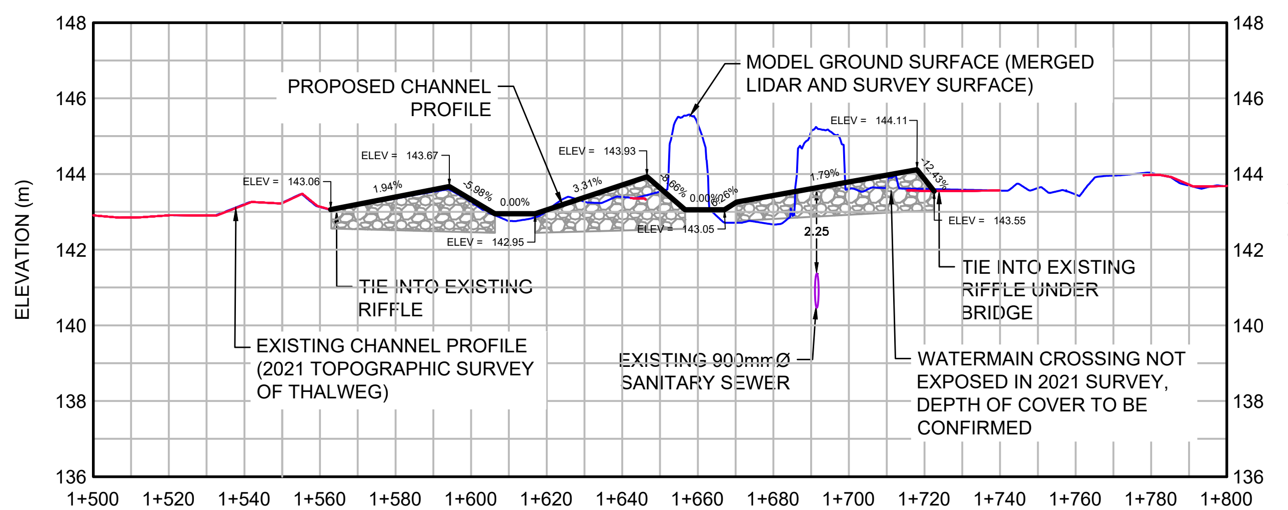


KEY MAP

NOT TO SCALE

LEGEND

LOT LINE		CHANNEL REALIGNMENT	
RIVER SHORELINE		CHANNEL BANK	
THALWEG		MINIMUM GRADING LIMIT	
TRAIL		MAXIMUM GRADING LIMIT	
EXISTING CONTOUR (2m INTERVAL)		EXISTING ARMOURSTONE	
SANITARY SEWER		PROPOSED BANK AND TOE RESTORATION WITH EXPOSED ARMOURSTONE	
STORM SEWER		PROPOSED BANK AND TOE RESTORATION WITH BURIED ARMOURSTONE	
WATERMAIN		PROPOSED BANK RESTORATION AND BIOENGINEERING	
SANITARY SEWER		RIFFLE	
MAINTENANCE HOLE		POOL	



PROFILE

HORIZONTAL SCALE 1:2000
VERTICAL SCALE 1:200

REFERENCE:
1. BASE MAP TOPOGRAPHY COMPILED FROM CITY OF TORONTO OPEN SOURCE DATA, TWAG SERVICING DATA AND DRF15170_TOPO2D.
2. MAPPED CREEK ALIGNMENT ON PLAN FROM 2018 ORTHOPHOTOGRAPHY DIGITIZED BY MATRIX SOLUTIONS.
3. TOPOGRAPHIC SURFACE BASED ON 2015 LIDAR DIGITAL ELEVATION MODEL (OPEN SOURCE) COMBINED WITH TOPOGRAPHIC AND CHANNEL PROFILE SURVEY BY MATRIX SOLUTIONS JULY TO SEPTEMBER 2021.
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5. COORDINATE SYSTEM ONTARIO MTM ZONE 10 NAD27.

DRAFT

REVISION

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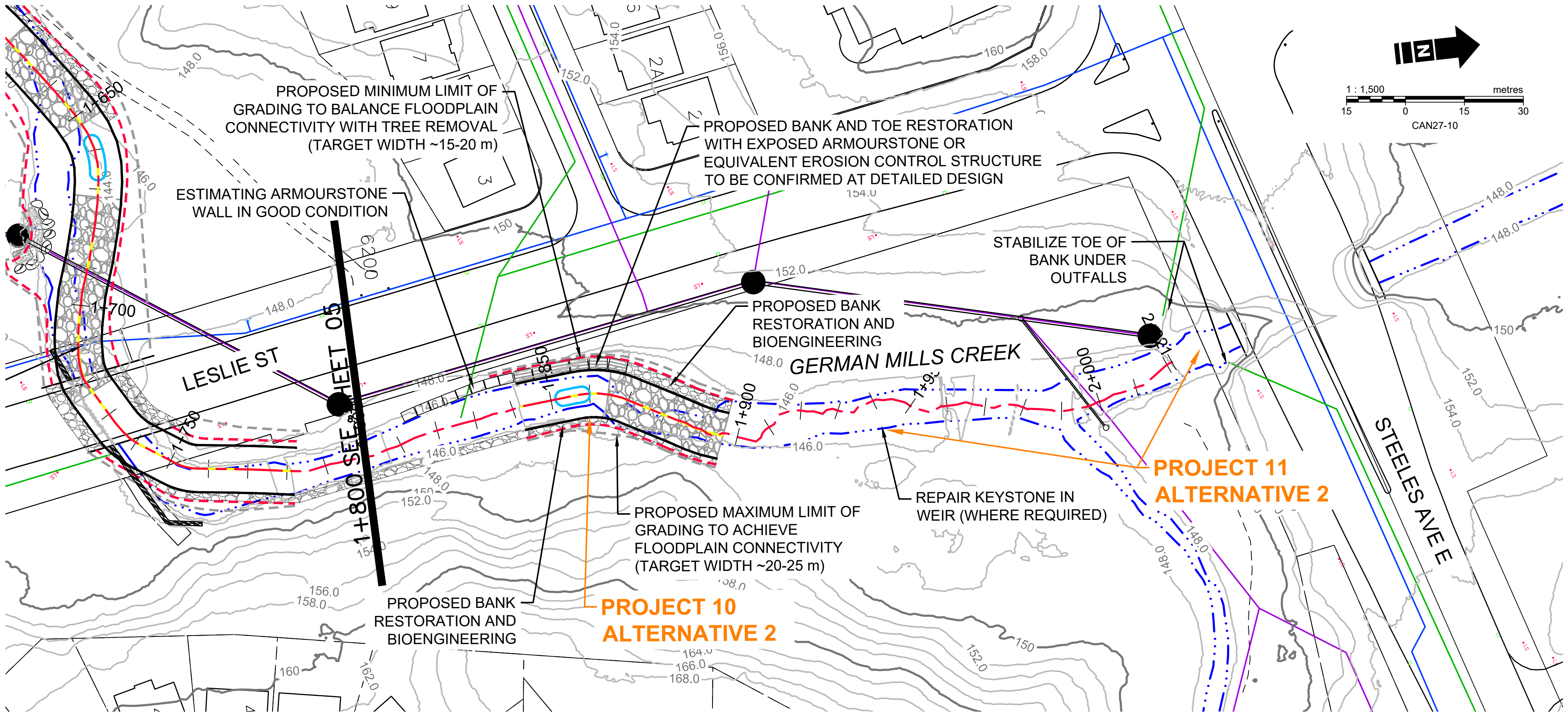
ENVIRONMENT & ENGINEERING

CITY OF TORONTO
GERMAN MILLS GSMP EA

PREFERRED ALTERNATIVE
STA. 1+500 TO 1+800

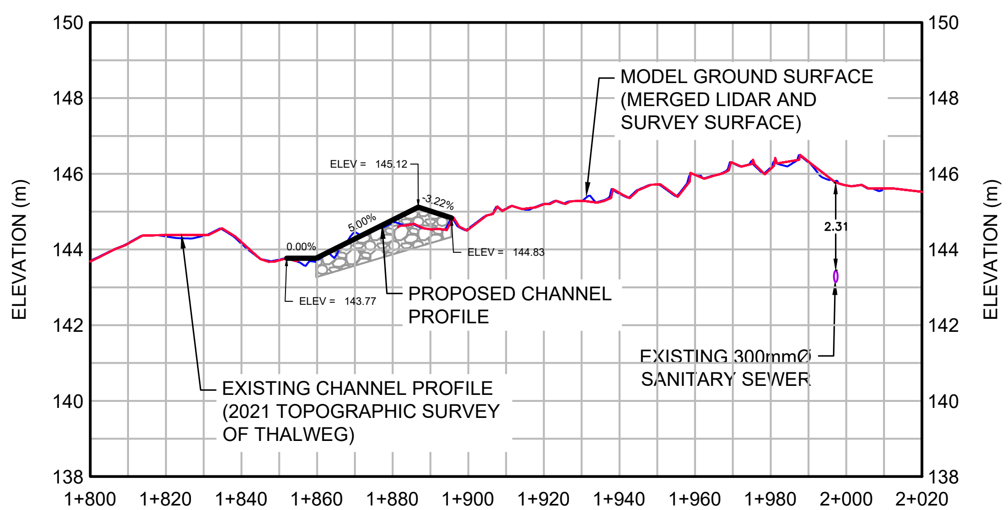
DATE:	TECHNICAL:	REVIEWER:	DRAWN:
APRIL 2022	N. CYPLES	R. PHILLIPS	K. WEILER

PROJECT:	REVISION:	DRAWING:
32227-504	B	C5



PLAN

SCALE 1:1500



PROFILE

HORIZONTAL SCALE 1:2000
VERTICAL SCALE 1:200

REFERENCE:
1. BASE MAP TOPOGRAPHY COMPILED FROM CITY OF TORONTO OPEN SOURCE DATA, TWAG SERVICING DATA AND DRF15170_TOPO2D.
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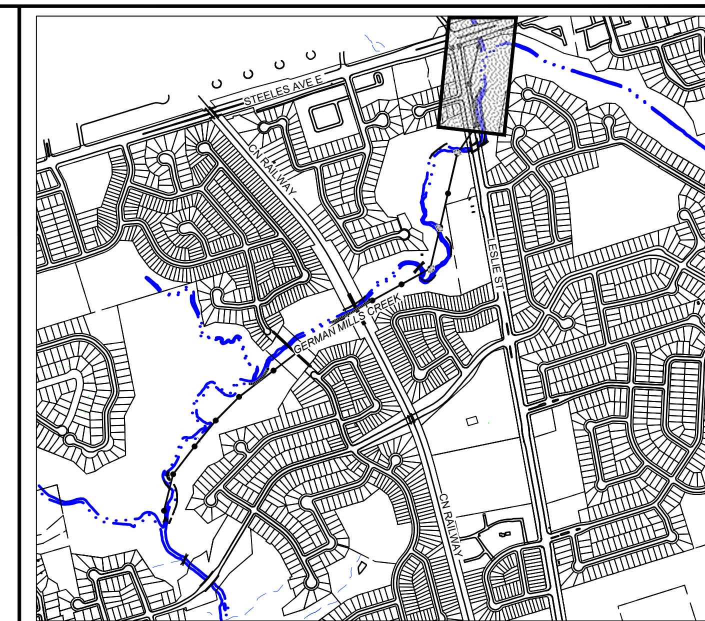
5. COORDINATE SYSTEM ONTARIO MTM ZONE 10 NAD27.

DRAFT



KEY MAP

NOT TO SCALE

LEGEND

- LOT LINE
- RIVER SHORELINE
- THALWEG
- TRAIL
- EXISTING CONTOUR (2m INTERVAL)
- SANITARY SEWER
- STORM SEWER
- WATERMAIN
- SANITARY SEWER
- MAINTENANCE HOLE
- CHANNEL REALIGNMENT
- CHANNEL BANK
- MINIMUM GRADING LIMIT
- MAXIMUM GRADING LIMIT
- EXISTING ARMOURSTONE
- PROPOSED BANK AND TOE RESTORATION WITH EXPOSED ARMOURSTONE
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- PROPOSED BANK RESTORATION AND BIOENGINEERING
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REVISION

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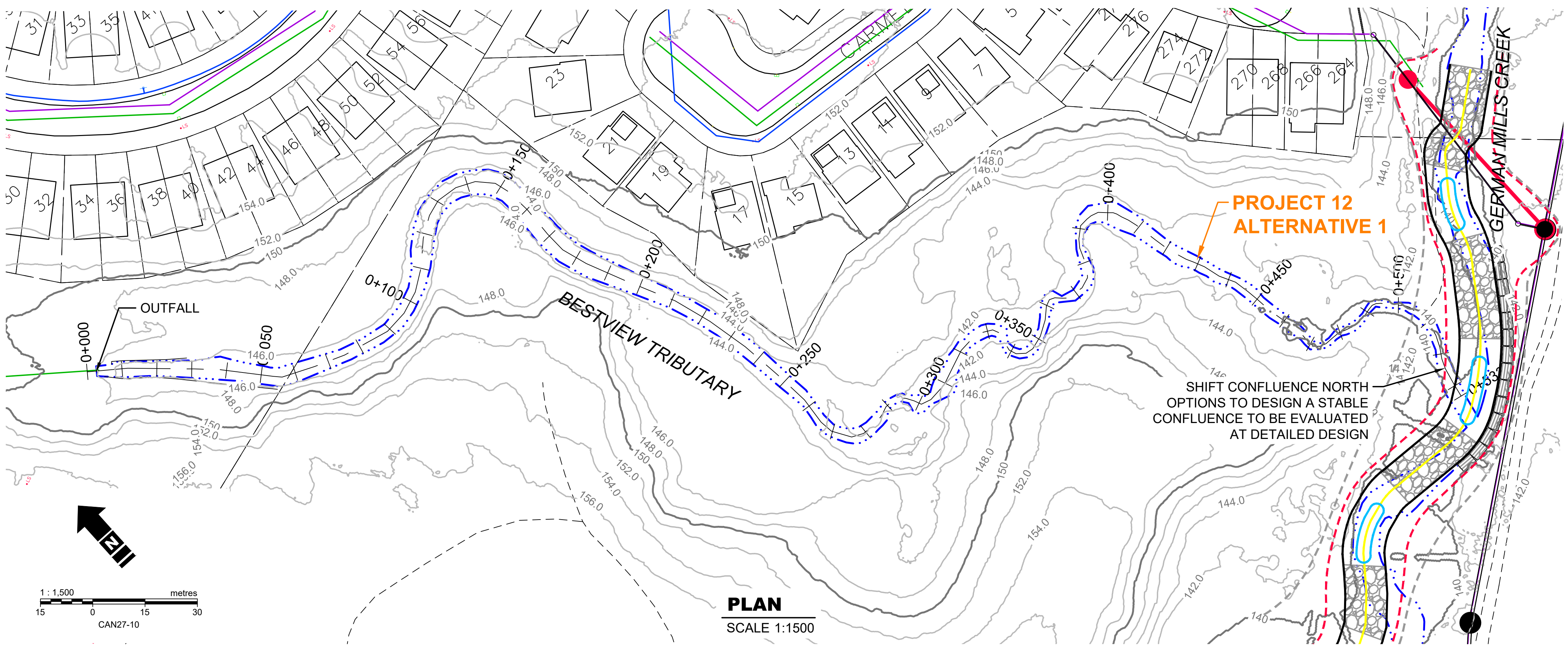
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

CITY OF TORONTO
GERMAN MILLS GSMP EA

PREFERRED ALTERNATIVE
STA. 1+800 TO 2+020

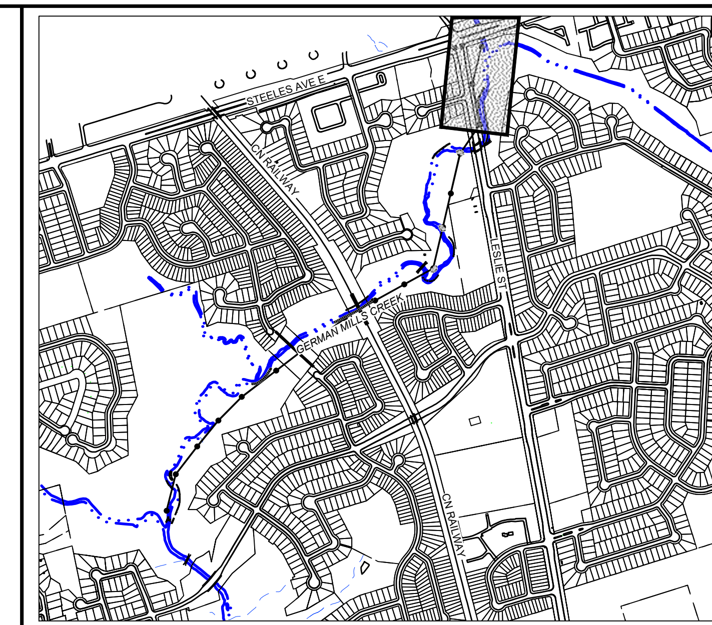
DATE:	TECHNICAL:	REVIEWER:	DRAWN:
APRIL 2022	N. CYPLES	R. PHILLIPS	K. WEILER

PROJECT:	REVISION:	DRAWING:
32227-504	B	C6



PLAN

SCALE 1:1500



KEY MAP

NOT TO SCALE

LEGEND

LOT LINE	CHANNEL REALIGNMENT
RIVER SHORELINE	CHANNEL BANK
THALWEG	MINIMUM GRADING LIMIT
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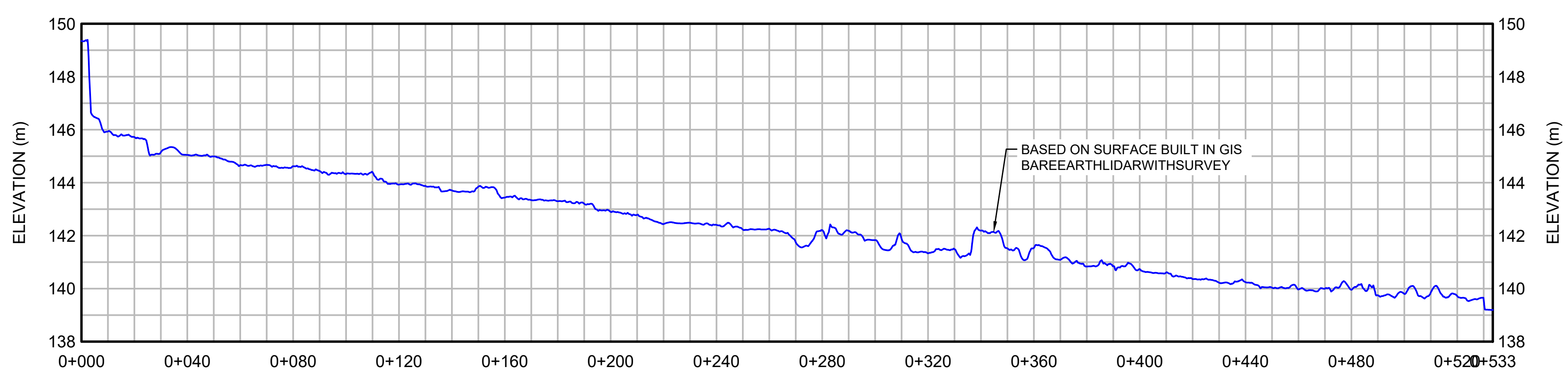
SANITARY SEWER	RIFFLE
MAINTENANCE HOLE	POOL



PROFILE

HORIZONTAL SCALE 1:2500
VERTICAL SCALE 1:250

REVISION

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
B	2023-01-27	ISSUE FOR REVIEW	NC	RP	KW
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Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

CITY OF TORONTO
GERMAN MILLS GSMP EA

PREFERRED ALTERNATIVE
STA. 0+000 TO 0+533

DATE:	TECHNICAL:	REVIEWER:	DRAWN:
APRIL 2022	N. CYPLES	R. PHILLIPS	K. WEILER

PROJECT:	REVISION:	DRAWING:
32227-504	B	C7

REFERENCE:
1. BASE MAP TOPOGRAPHY COMPILED FROM CITY OF TORONTO OPEN SOURCE DATA, TWAG SERVICING DATA AND DRF15170_TOPO2D.
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5. COORDINATE SYSTEM ONTARIO MTM ZONE 10 NAD27.

DRAFT