

Prepared for:

City of Toronto
Engineering & Construction Services
Tel: 416-392-8267

Newtonbrook Creek Geomorphic Systems Master Plan Report



Submitted by:

Aquafor Beech Limited

Published: December 2025

Contact:

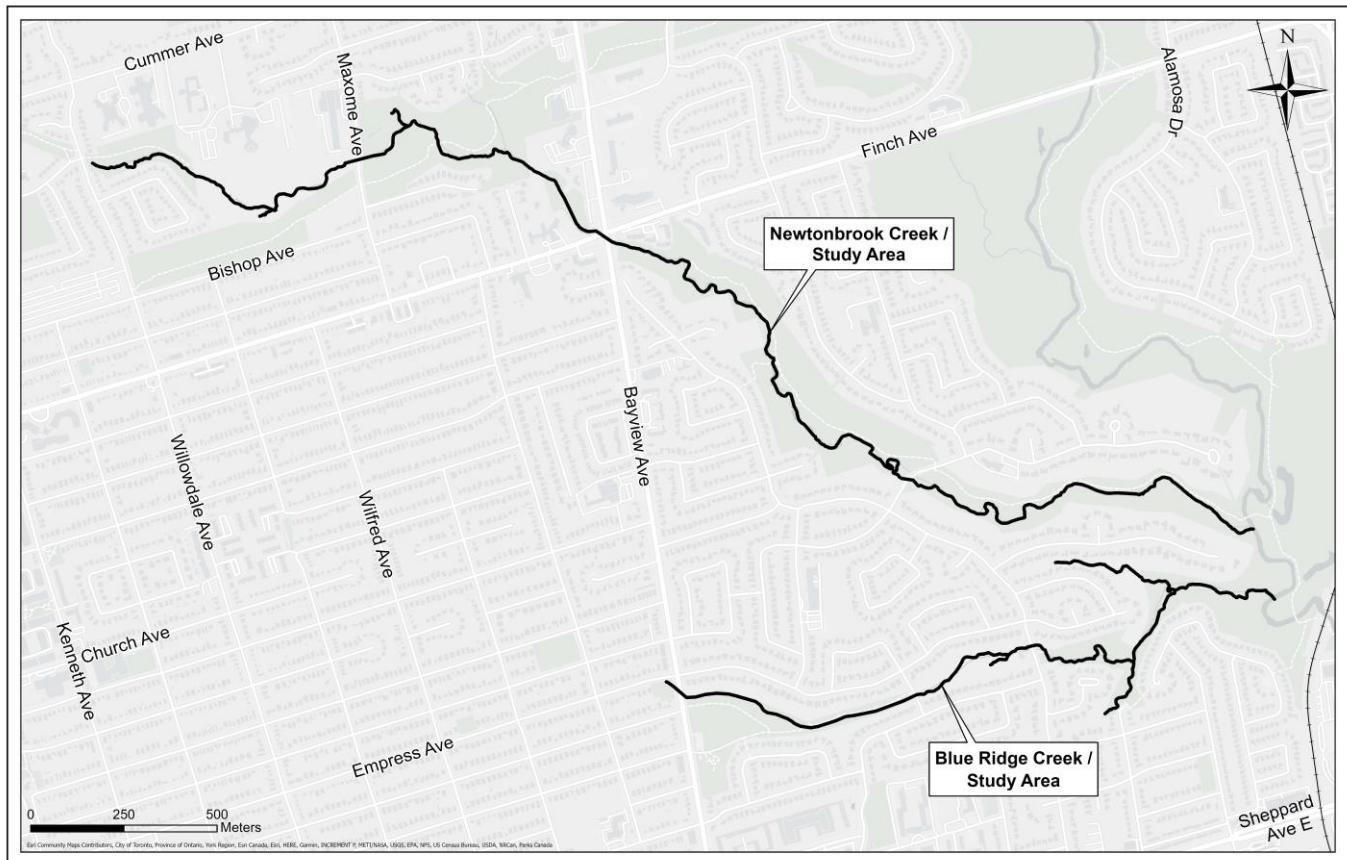
Robert Amos, MSc, P. Eng.
Aquafor Beech Limited
5405 Eglinton Avenue West,
Suite 106, Etobicoke, ON M9C 5K6
Tel. 416.705.2367
Email: Amos.R@aquaforbeech.com
Aquafor Beech Reference: 66847

Alternate formats are available as per the Accessibility for Ontarians with Disabilities Act by contacting Robert Amos at 416-705-2367

EXECUTIVE SUMMARY

Overview

The City of Toronto (City) has commissioned Aquafor Beech Limited to undertake the Geomorphic Systems Master Plan Study for Newtonbrook Creek and Blue Ridge Creek (NCGSMP), in North York. The emphasis of the NCGSMP is on systematically locating and prioritizing erosion related risks to Toronto Water (TW) infrastructure within the Don Valley corridor, including: sanitary sewers, storm sewers, outfalls, watermains and any associated erosion protection works. The study area was found to contain **seventy-two (x72) distinct erosion risks** to Toronto Water infrastructure, including nineteen (x19) vertical erosion risks to watermain and sanitary infrastructure, twenty-two (x22) horizontal erosion risks to watermain and sanitary infrastructure, and thirty-one (x31) erosion risks to storm sewer and outfall infrastructure. The extent of the NCGSMP study area is illustrated in the figure below.



Newtonbrook Creek Geomorphic Systems Master Plan Study Area

Study Objectives

The objective of the NCGSMP is to investigate the geomorphic processes which have contributed to the physical degradation of Newtonbrook and Blue Ridge Creeks, and develop a long-term plan to strategically rehabilitate the watercourses to protect Toronto Water infrastructure that is at risk of damage due to erosion. The NCGSMP study is intended to follow the Municipal Class Environmental Assessment process, in conjunction with applying the Adaptive Management of Stream Corridors principles.

Establishment of Twenty-Four (x24) High Priority Sites

In order to achieve these stated objectives, a series of technical studies and assessments were completed to characterize the study area, and identify the highest priority erosion sites to be rehabilitated. These technical

studies included fluvial geomorphology, terrestrial ecology, aquatic ecology, utility conflict, hydrologic, hydraulic, and climate change assessments. Following the completion of these studies, the level of risk at each identified erosion site was evaluated based on a series of factors taking into account the depth of cover, level of protection, and condition of the asset. Using this evaluation system, the twenty-four (x24) highest priority sites were established. Within these twenty-four priority sites, there are **fourteen (x14) sites** where there is an **immediate risk of infrastructure failure** (i.e., exposed sewer crossing or a failed outfall), as listed in the following table.

Top Fourteen Priority Sites, with Immediate Risk of Infrastructure Failure

Priority Site Rank	Erosion Site Description	Risk ID
1	Exposed Sanitary Sewer Maintenance Hole and Lateral Risk to Sanitary Sewer Near Pedestrian Trail	Lateral Risk #1 and Crossing #2
2	Exposed Sanitary Sewer Crossing at Restwell Crescent	Crossing #3
3	Failed Storm Water Outfall at Forest Grove Drive	Outfall #3
4	Failed Storm Water Outfall at Canary Crescent	Outfall #7
5	Exposed Sanitary Sewer Crossing at Farmingdale Road	Crossing #5
6	Exposed Sanitary Sewer Crossing upstream of Farmingdale Road	Crossing #6
7	Exposed Sanitary Sewer Crossing Downstream of Finch Avenue and Bayview Avenue	Crossing #7
8	Exposed Sanitary Sewer Maintenance Hole and Lateral Risk to Sanitary Sewer Downstream of Finch and Bayview Avenue	Lateral Risk #10
9	Exposed Sanitary Sewer Crossing at Finch and Bayview Avenue	Crossing #8
10	Exposed Watermain Chamber at Manorcrest Drive	Crossing #10
11	Exposed Sanitary Sewer Crossing upstream of Blessed Trinity Parish	Crossing #13
12	Failed Storm Sewer Outfall at Hi Mount Drive	Outfall #25
13	Failed Storm Sewer Outfall at Citation Drive	Outfall #26
14	Exposed Sanitary Sewer Crossing at Sifton Court	Crossing #19

The remaining **ten (x10) high priority sites** are locations where unmitigated erosion processes are expected to create an immediate risk to municipal infrastructure within the next **five to fifty (5 - 50) years**, as shown in the table below.

Ten Additional High Priority Sites

Priority Site Rank	Erosion Site Description	Risk ID
15	Lateral Risk to Sanitary Sewer downstream of Sifton Court	Lateral Risk #22
16	Lateral Risk to Sanitary Sewer at Heathview and Page Avenue	Lateral Risk #6
17	Lateral Risk to Sanitary Sewer upstream of Maxome Avenue	Lateral Risk #12
18	Lateral Risk to Sanitary Sewer upstream of Forest Grove Drive	Lateral Risk #5
19	Lateral Risk to Sanitary Sewer at Finchgate Court	Lateral Risk #7
20	Lateral Risk to Sanitary Sewer at Brucedale Crescent	Lateral Risk #9
21	Lateral Risk to Sanitary Sewer at Ambrose Road	Lateral Risk #20
22	Lateral Risk to Sanitary Sewer Downstream of Finch Avenue and Bayview Avenue	Lateral Risk #11
23	Lateral Risk to Sanitary Sewer at Hi Mount Drive	Lateral Risk #17
24	Lateral Risk to Sanitary Sewer downstream of Forest Grove Drive	Lateral Risk #4

Development and Evaluation of Alternatives

After the twenty-four (x24) highest priority sites were established, watercourse restoration alternatives were developed for each of the sites. In general, three (x3) alternatives were considered, including “Do Nothing”, “Local Works”, and “Sub-Reach Based Works”. A description of each alternative is provided below:

- **Alternative 1: Do Nothing** – This alternative involves leaving the site as it is and allowing erosional processes to continue within the watercourse corridor. Under this alternative, it should be expected that maintenance, or possibly emergency works, may have to be undertaken to address damage to infrastructure caused by continued erosion. Damage from erosion may occur gradually over time or suddenly due to a high magnitude flood event.
- **Alternative 2: Local Works** – This alternative consists of localized channel bank and/or bed work to address erosion issues within the immediate vicinity of the site. While it is understood that local erosion protection works may require ongoing maintenance, occasional repairs, or eventual replacement, this alternative is often still preferred to limit the economic cost and the environmental damage associated with construction of large-scale channel engineering and stream restoration works.
- **Alternative 3: Sub-Reach Based Works** – This alternative consists of a reach-based approach to address erosion issues, potentially incorporating multiple locations of risk to infrastructure. Reach-scale engineering focuses on minimizing the risks of erosion in highly constrained urban watercourses and can also include opportunities to ameliorate flood conditions and geomorphic processes. This alternative primarily applies “hard” channel engineering approaches for erosion control, but may incorporate some environmentally sensitive materials and features in the channel.

After establishing three (x3) candidate alternatives for each of the twenty-four (x24) risk sites, these alternatives were evaluated using a series of criteria accounting for a combination of environmental, social, economic and technical criteria, consistent with EA standard practice and City of Toronto Standards for their geomorphic system master plan projects. Particular importance was given towards an alternative’s ability to provide long-term protection to at-risk Toronto Water infrastructure. The evaluation process yielded **twenty (x20) sites with the sub-reach-based solution preferred**, and **four (x4) sites with the local works solution preferred**.

Grouping of Sites into Projects

Given the spatial density of the twenty-four (x24) priority sites, and the expansive nature of some of the proposed sub reach based solutions, several priority sites can be addressed through a single capital works project. Through this bundling process, the **twenty-four (x24) priority sites** were grouped into **eleven (x11) capital works** projects which will address not only the top twenty-four (24) priority sites, but will also address several other lower priority sites with medium to long-term erosion related risks to Toronto Water infrastructure.

Priority Ranking and Estimated Costs

After the establishment of the eleven (x11) projects, a prioritization methodology was developed to rank projects based on each project’s associated failure risk. The basis of the failure risk framework is the principal that failure risk is the product of failure likelihood and failure impact. Failure risk was calculated for each of the risk sites that constitute each project. The maximum failure risk of all the risk sites that constitute a project was considered to be the overall project failure risk. Based on these results, the **eleven (x11) projects** were grouped into **four (x4) priority groups**. Furthermore, cost estimates were established for each of the proposed projects to assist with budgetary planning. The priority groups, and project cost estimates, are provided in the following summary table.

Project Priority and Cost Summary Table

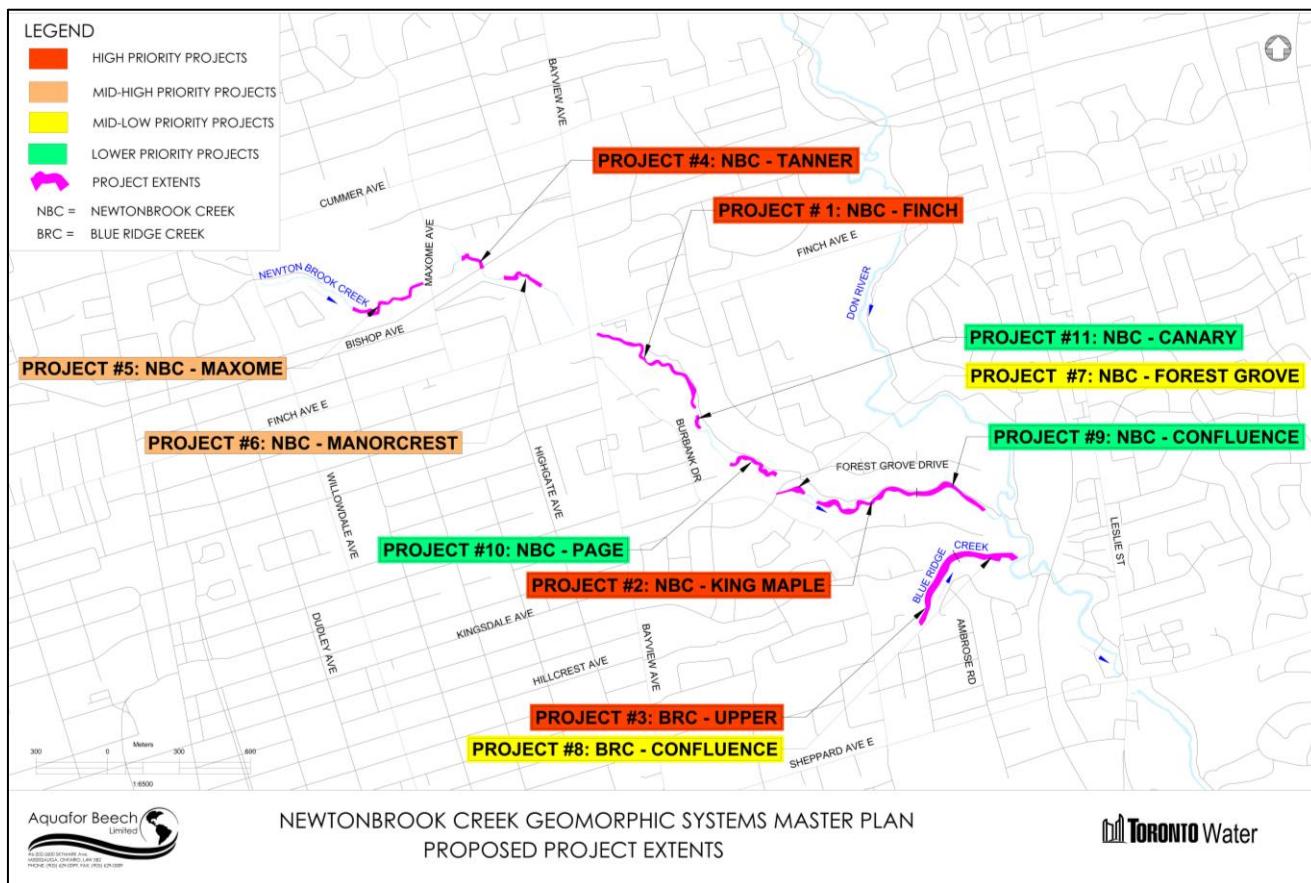
Project Name	Priority Grouping	Project Description	Project Cost Estimates
Project #1: NBC - Finch	High	Multiple Sanitary Assets Downstream of Bayview and Finch	\$8,207,000
Project #2: NBC - King Maple	High	Exposed Sanitary Sewer Downstream of Forest Grove Near King Maple Place	\$5,959,000
Project #3: BRC - Upper	High	Upper Blue Ridge Creek near Sifton Court	\$4,834,000
Project #4: NBC - Tanner	High	Exposed Sanitary Crossing Downstream of Maxome Avenue Near Tanner Court	\$2,434,000
Project #5: NBC - Maxome	Mid-High	Multiple Sanitary Risks Directly Upstream of Maxome Avenue	\$5,757,000
Project #6: NBC - Manorcrest	Mid-High	Watermain Infrastructure Upstream of Bayview and Finch Near Manorcrest Drive	\$3,271,000
Project #7: NBC - Forest Grove	Mid-Low	Failed Stormwater Outfall Downstream of Forest Grove Drive	\$1,733,000
Project #8: BRC - Confluence	Mid-Low	Lower Blue Ridge Creek near Confluence with the Don River	\$4,971,000
Project #9: NBC - Confluence	Lower	Previously Exposed Sanitary Maintenance Hole near Confluence with the Don River	\$4,449,000
Project #10: NBC - Page	Lower	Multiple Sanitary Assets Upstream of Forest Grove Drive Near Page Avenue	\$4,848,000
Project #11: NBC - Canary	Lower	Failed Stormwater Outfall at Burbank Drive Near Canary Crescent	\$875,000
Total Cost			\$47,338,000

It is acknowledged that the ultimate prioritization of capital works projects will be at the discretion of the City of Toronto and will need to take into consideration a multitude of factors in addition to project failure risk. The recommended implementation timeline for each priority group is show in the following table.

Recommended Implementation Timeline for Each Priority Group

Priority Group	Implementation Timeline
High	2025-2030
Mid-High	2030-2035
Mid-Low	2035-2040
Lower	2040-2045

The spatial distribution of the eleven (x11) projects is illustrated in the following figure.



Spatial Distribution of the Eleven NCGSMP Projects

Public and First Nations Consultation

The City of Toronto has undergone comprehensive public consultation in support of the NCGSMP, consistent with the Schedule B Municipal Class Environmental Assessment process. A Notice of Study Commencement was issued in September 2022. A Notice of Public Consultation was issued on October 2nd, 2023, in advance of the Public Information Centre (PIC) on October 18th, 2023. The PIC was conducted in both an outdoor open house and site walk format, where participants were taken on a guided walk through the study area. Comments, concerns and questions were accepted in person, and by mail, email and phone until November 1st, 2023.

The City of Toronto has undertaken First Nations consultation activities, consistent with the Schedule B Municipal Class Environmental Assessment process. The following First Nations were included in the consultation process:

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

The following information was provided to these First Nations:

- Notice of Commencement (October 2022)
- Notice of Public Consultation / recommended solutions (October 2023)
- Stage 1 Archaeology Report (December 2023)
- Overview of Key Study Findings (July 2025)

Conclusions and Recommendations

The City of Toronto has completed the Newtonbrook Creek Geomorphic Systems Master Plan to guide the future rehabilitation of Newtonbrook Creek and Blue Ridge Creek, with the aim of protecting Toronto Water infrastructure that is at risk of damage due to erosion. Ultimately, eleven (x11) future capital works projects are proposed which will address erosion related risks to:

- 8x Exposed Sanitary Sewer Crossings;
- 1x Exposed Sanitary Sewer Maintenance Hole;
- 1x Previously Exposed Sanitary Sewer Maintenance Hole (Protected through Emergency Works);
- 7x Sanitary Sewer Crossings with Minimal Cover;
- 17x Lateral Risks to Sanitary Sewer Infrastructure;
- 1x Watermain Crossing with Minimal Cover;
- 1x Exposed Watermain Chamber;
- 4x Failed Storm Sewer Outfalls;
- 4x Storm Sewer Outfalls that are Functional but in a Degraded Condition;
- Multiple risks to Private Property;
- Multiple risks to the Local Multi-Use Trail System; and
- 3x Private Oil Pipeline Crossings (Trans-Northern, Imperial Oil and Sun-Canadian).

Moving forward, the City will schedule each of the aforementioned projects for detailed design and construction. Scheduling of projects will give consideration to City-wide priorities, taking into account the findings from the other four geomorphic systems master plans the City is currently undertaking for the West Humber River, Mimico Creek, German Mills Creek and Yellow Creek. Budgetary constraints, as well as the timing of construction projects being undertaken by other City departments may also dictate construction timing on a project-by-project basis. Prior to construction, all required regulatory approvals will be procured and further targeted consultation efforts undertaken.

Table of Contents

EXECUTIVE SUMMARY	i
1 INTRODUCTION	1-1
1.1 Goals and Objectives: Statement of Environmental Assessment	1-1
2 PHASE 1: ISSUE ASSESSMENT AND PROBLEM CONFIRMATION	2-2
2.1 TRCA Background Information on Risks To Private Property & Toronto Water Infrastructure	2-3
2.2 Background Information Provided by Private Utility Owners.....	2-5
2.2.1 Telephone and Communication Cables	2-5
2.2.2 Oil and Gas Pipelines.....	2-5
2.3 Toronto Water Infrastructure - Existing Conditions	2-6
2.4 Review of Engineering Drawings Provided by City of Toronto	2-6
2.5 Data Gap Analysis.....	2-7
2.6 Issues Assessment and Problem Confirmation	2-7
3 PHASE 2: TECHNICAL ASSESSMENTS AND INFRASTRUCTURE RISK ASSESSMENT	3-8
3.1 Technical Assessments.....	3-8
3.1.1 Fluvial Geomorphic Assessments.....	3-8
3.1.1.1 Reach Delineation	3-8
3.1.1.1.1 Newtonbrook Creek Reach Delineation	3-8
3.1.1.1.2 Blue Ridge Creek Reach Delineation.....	3-12
3.1.1.2 Geomorphic Stability.....	3-15
3.1.1.2.1 Geomorphic Evaluation Results.....	3-16
3.1.1.3 Rates of Erosion	3-18
3.1.1.4 Historic Assessment of Newtonbrook Creek and Blue Ridge Creek	3-18
3.1.1.5 Scour Hazard Limit	3-18
3.1.1.6 Lateral Erosion Hazard Limit	3-22
3.1.1.7 Meander Belt Assessment	3-23
3.1.2 Terrestrial Ecology.....	3-27
3.1.3 Aquatic Ecology	3-29
3.1.3.1 Aquatic Habitat	3-29
3.1.3.2 Fish Community Assessment	3-31
3.1.3.3 DFO Self-Assessment.....	3-31
3.1.4 Utility Conflicts	3-31
3.1.4.1 Privately Owned Watermain.....	3-32
3.1.4.2 Additional Risks to Infrastructure and Private Property	3-32

3.1.5	Hydrologic And Hydraulic Conditions	3-32
3.1.5.1	Streamflow Assessment.....	3-32
3.1.5.2	Hydraulic Assessment	3-35
3.1.5.2.1	Regional Floodline Analysis	3-36
3.1.5.3	Analysis of Modelled Streamflow Velocities.....	3-38
3.1.6	Climate Change Assessment	3-42
3.1.6.1	Climate Change Assessment Part 1: Monthly and Seasonal Assessment.....	3-43
3.1.6.1.1	Available Resources.....	3-43
3.1.6.1.2	Approach to Part 1 Climate Change Assessment	3-44
3.1.6.1.3	Projected Future Climates	3-45
3.1.6.1.4	Hydrologic Impacts	3-55
3.1.6.2	Climate Change Assessment Part 2: Climate Change and Storms	3-64
3.1.6.2.1	Approach	3-64
3.1.6.2.2	Design Storms.....	3-65
3.1.6.2.3	Hydrologic Impacts of Climate Warming Storms	3-68
3.1.6.3	Summary of Hydrologic Impacts and Implications.	3-70
3.1.6.3.1	Monthly and Seasonal Impacts.....	3-70
3.1.6.3.2	Storms Impacts	3-71
3.1.6.3.3	Climate Change Recommendations.....	3-72
3.1.7	Archaeological & Heritage Resources Assessment	3-73
3.1.7.1	Indigenous Land Use and Settlement	3-73
3.1.7.2	Treaties.....	3-74
3.1.7.3	Post Contact Settlement	3-74
3.1.7.4	Previous Archaeological Research and Archaeological Potential	3-74
3.2	Site-Based Risk Assessment of Toronto Water Infrastructure.....	3-78
3.2.1	Assessment of Toronto Water Infrastructure and Erosion Control Structures	3-78
3.2.1.1	Sanitary Sewer & Watermain Crossings.....	3-80
3.2.1.2	Lateral Risks to Sanitary Sewer Infrastructure	3-83
3.2.1.3	Storm Sewer Outfalls	86
3.2.1.3.1	Condition Assessment	86
3.2.1.3.2	Erosion Protection Works.....	86
3.2.1.4	Erosion Control Structures & Erosion Hazard Sites.....	3-88
3.2.2	Geomorphic Risk Assessment Of Toronto Water Infrastructure	3-88
3.2.2.1	Vertical Risk Assessment (Sanitary Sewer and Watermain Crossings)	3-88
3.2.2.1.1	Time to Contact	3-89

3.2.2.1.2	Downstream Bed Level Change.....	3-90
3.2.2.1.3	Susceptibility of Bed Armour to Erosion.....	3-90
3.2.2.1.4	Vertical Risk Assessment Results.....	3-90
3.2.2.2	Horizontal Risk Assessment (Lateral Risks to Sanitary Sewers and Watermains)	3-91
3.2.2.2.1	Time to Contact	3-91
3.2.2.2.2	Radius of Curvature to Width Ratio (Rc/w)	3-92
3.2.2.2.3	Lateral Infrastructure Condition	3-92
3.2.2.2.4	Horizontal Risk Assessment Results	3-92
3.2.2.3	Storm Sewer Outfall Risk Assessment.....	3-92
3.2.2.3.1	Outfall Condition	3-93
3.2.2.3.2	Setback from Main Channel	3-93
3.2.2.3.3	Erosion Protection Works Condition	3-93
3.2.2.3.4	Storm Sewer Outfall Risk Assessment Results.....	3-93
3.2.3	Geomorphic Risk Assessment Results.....	3-94
4	PHASE 3: DEVELOPMENT AND EVALUATION OF ALTERNATIVES.....	4-97
4.1	List of Alternatives	4-97
4.1.1	Infrastructure Relocation Consideration.....	4-97
4.2	Evaluation of Alternatives Methodology	4-99
4.3	Priority Site #1: Exposed Sanitary Sewer Crossing, Maintenance Hole, and Lateral Risk to Sanitary Sewer 4-101	
4.3.1	Priority Site #1 – Description of Restoration Alternatives	4-102
4.3.2	Priority Site #1 – Evaluation of Restoration Alternatives.....	4-105
4.3.3	Priority Site #1 – Selection of the Preferred Alternative	4-105
4.4	Priority Site #2: Exposed Sanitary Sewer Crossing at Restwell Crescent.....	4-106
4.4.1	Priority Site #2 – Description of Restoration Alternatives	4-107
4.4.2	Priority Site #2 – Evaluation of Restoration Alternatives.....	4-110
4.4.3	Priority Site #2 – Selection of the Preferred Alternative	4-110
4.5	Priority Site #3: Detached Storm Sewer Outfall and Exposed Maintenance Hole at Forest Grove Drive 4-111	
4.5.1	Priority Site #3 – Description of Restoration Alternatives	4-112
4.5.2	Priority Site #3 – Evaluation of Restoration Alternatives.....	4-115
4.5.3	Priority Site #3 – Selection of the Preferred Alternative	4-115
4.6	Priority Site #4: Exposed Storm Water Outfall at Canary Crescent	4-116
4.6.1	Priority Site #4 – Description of Restoration Alternatives	4-117
4.6.2	Priority Site #4 – Evaluation of Restoration Alternatives.....	4-120
4.6.3	Priority Site #4 – Selection of the Preferred Alternative	4-120

4.7	Priority Site #5: Exposed Sanitary Sewer Crossing at Farmingdale Road	4-121
4.7.1	Priority Site #5 – Description of Restoration Alternatives	4-122
4.7.2	Priority Site #5 – Evaluation of Restoration Alternatives.....	4-125
4.7.3	Priority Site #5 – Selection of the Preferred Alternative	4-125
4.8	Priority Site #6: Exposed Sanitary Sewer Crossing upstream of Farmingdale Road	4-126
4.8.1	Priority Site #6 – Description of Restoration Alternatives	4-127
4.8.2	Priority Site #6 – Evaluation of Restoration Alternatives.....	4-130
4.8.3	Priority Site #6 – Selection of the Preferred Alternative	4-130
4.9	Priority Site #7: Exposed Sanitary Sewer Crossing Downstream of Finch Avenue and Bayview Avenue	
	4-131	
4.9.1	Priority Site #7 – Description of Restoration Alternatives	4-132
4.9.2	Priority Site #7 – Evaluation of Restoration Alternatives.....	4-135
4.9.3	Priority Site #7 – Selection of the Preferred Alternative	4-135
4.10	Priority Site #8: Exposed Sanitary Sewer Maintenance Hole and Lateral Risk to Sanitary Sewer Downstream of Finch Avenue and Bayview Avenue	4-136
4.10.1	Priority Site #8 – Description of Restoration Alternatives	4-137
4.10.2	Priority Site #8 – Evaluation of Restoration Alternatives.....	4-140
4.10.3	Priority Site #8 – Selection of the Preferred Alternative	4-140
4.11	Priority Site #9: Exposed Sanitary Sewer Crossing at Finch Avenue and Bayview Avenue	4-141
4.11.1	Priority Site #9 – Description of Restoration Alternatives	4-142
4.11.2	Priority Site #9 – Evaluation of Restoration Alternatives.....	4-145
4.11.3	Priority Site #9 – Selection of the Preferred Alternative	4-145
4.12	Priority Site #10: Exposed Watermain Chamber at Manorcrest Drive	4-146
4.12.1	Priority Site #10 – Description of Restoration Alternatives	4-147
4.12.2	Priority Site #10 – Evaluation of Restoration Alternatives.....	4-150
4.12.3	Priority Site #10 – Selection of the Preferred Alternative	4-150
4.13	Priority Site #11: Exposed Sanitary Sewer Crossing Upstream of Blessed Trinity Parish	4-151
4.13.1	Priority Site #11 – Description of Restoration Alternatives	4-152
4.13.2	Priority Site #11 – Evaluation of Restoration Alternatives.....	4-155
4.13.3	Priority Site #11 – Selection of the Preferred Alternative	4-155
4.14	Priority Site #12: Failed Storm Sewer Outfall at Hi Mount Drive.....	4-156
4.14.1	Priority Site #12 – Description of Restoration Alternatives	4-157
4.14.2	Priority Site #12 – Evaluation of Restoration Alternatives.....	4-160
4.14.3	Priority Site #12 – Selection of the Preferred Alternative	4-160
4.15	Priority Site #13: Failed Storm Sewer Outfall at Citation Drive	4-161
4.15.1	Priority Site #13 – Description of Restoration Alternatives	4-162
4.15.2	Priority Site #13 – Evaluation of Restoration Alternatives.....	4-165

4.15.3	Priority Site #13 – Selection of the Preferred Alternative	4-165
4.16	Priority Site #14 – Exposed Sanitary Crossing at Sifton Court	4-166
4.16.1	Priority Site #14 – Description of Restoration Alternatives	4-167
4.16.2	Priority Site #14 – Evaluation of Restoration Alternatives.....	4-170
4.16.3	Priority Site #14 – Selection of the Preferred Alternative	4-170
4.17	Priority Site #15 – Lateral Risk to Sanitary Sewer Downstream of Sifton Court.....	4-171
4.17.1	Priority Site #15 – Description of Restoration Alternatives	4-172
4.17.2	Priority Site #15 – Evaluation of Restoration Alternatives.....	4-175
4.17.3	Priority Site #15 – Selection of the Preferred Alternative	4-175
4.18	Priority Site #16 – Lateral Risk to Sanitary Sewer at Heathview and Page Avenue	4-176
4.18.1	Priority Site #16 – Description of Restoration Alternatives	4-177
4.18.2	Priority Site #16 – Evaluation of Restoration Alternatives.....	4-180
4.18.3	Priority Site #16 – Selection of the Preferred Alternative	4-180
4.19	Priority Site #17 – Lateral Risk to Sanitary Sewer Upstream of Maxome Avenue.....	4-181
4.19.1	Priority Site #17 – Description of Restoration Alternatives	4-182
4.19.2	Priority Site #17 – Evaluation of Restoration Alternatives.....	4-185
4.19.3	Priority Site #17 – Selection of the Preferred Alternative	4-185
4.20	Priority Site #18 – Lateral Risk to Sanitary Sewer Upstream of Forest Grove Drive.....	4-186
4.20.1	Priority Site #18 – Description of Restoration Alternatives	4-187
4.20.2	Priority Site #18 – Evaluation of Restoration Alternatives.....	4-190
4.20.3	Priority Site #18 – Selection of the Preferred Alternative	4-190
4.21	Priority Site #19 – Lateral Risk to Sanitary Sewer at Finchgate Court	4-191
4.21.1	Priority Site #19 – Description of Restoration Alternatives	4-192
4.21.2	Priority Site #19 – Evaluation of Restoration Alternatives.....	4-195
4.21.3	Priority Site #19 – Selection of the Preferred Alternative	4-195
4.22	Priority Site #20 – Lateral Risk to Sanitary Sewer at Brucedale Crescent.....	4-196
4.22.1	Priority Site #20 – Description of Restoration Alternatives	4-197
4.22.2	Priority Site #20 – Evaluation of Restoration Alternatives.....	4-200
4.22.3	Priority Site #20 – Selection of the Preferred Alternative	4-200
4.23	Priority Site #21 – Lateral Risk to Sanitary Sewer at Ambrose Road	4-201
4.23.1	Priority Site #21 – Description of Restoration Alternatives	4-202
4.23.2	Priority Site #21 – Evaluation of Restoration Alternatives.....	4-205
4.23.3	Priority Site #21 – Selection of the Preferred Alternative	4-205
4.24	Priority Site #22 – Lateral Risk to Sanitary Sewer Downstream of Finch Avenue and Bayview Avenue	
	4-206	
4.24.1	Priority Site #22 – Description of Restoration Alternatives	4-207
4.24.2	Priority Site #22 – Evaluation of Restoration Alternatives.....	4-210

4.24.3	Priority Site #22 – Selection of the Preferred Alternative	4-210
4.25	Priority Site #23 – Lateral Risk to Sanitary Sewer at Hi Mount Drive.	4-211
4.25.1	Priority Site #23 – Description of Restoration Alternatives	4-212
4.25.2	Priority Site #23 – Evaluation of Restoration Alternatives.....	4-215
4.25.3	Priority Site #23 – Selection of the Preferred Alternative	4-215
4.26	Priority Site #24 – Lateral Risk to Sanitary Sewer Downstream of Forest Grove Drive	4-216
4.26.1	Priority Site #24 – Description of Restoration Alternatives	4-217
4.26.2	Priority Site #24 – Evaluation of Restoration Alternatives.....	4-220
4.26.3	Priority Site #24 – Selection of the Preferred Alternative	4-220
5	PHASE 4: PRIORITIZATION AND PHASING OF PREFERRED SOLUTIONS	5-221
5.1	Grouping of Priority Sites into Projects.....	5-221
5.2	Project Risk Prioritization Methodology	5-225
5.2.1	Failure Likelihood Methodology	5-225
5.2.1.1	Emergency Works at NBC - Confluence	5-225
5.3	Failure Impact Methodology.....	5-226
5.3.1	Sanitary Infrastructure Failure Impact Methodology	5-226
5.3.2	Stormwater Infrastructure Failure Impact Methodology	5-226
5.3.3	Watermain Infrastructure Failure Impact Methodology	5-226
5.4	Risk Impact Methodology	5-227
5.5	Additional Project Prioritization Factors	5-231
5.6	Internal GSMP Prioritization Factors.....	5-231
5.6.1	Shared Construction Access.....	5-231
5.6.2	Property Access Permissions.....	5-231
5.6.3	Applicable Timing Windows.....	5-231
5.7	External GSMP Prioritization Factors	5-231
5.7.1	Priorities of Other Geomorphic System Master Plan Projects.....	5-231
5.7.2	Additional Nearby Projects	5-231
5.8	Prioritization Summary and Cost Estimates.....	5-232
5.8.1	Project #1: NBC - Finch - Multiple Sanitary Assets Downstream of Bayview and Finch	5-233
5.8.2	Project #2: NBC - King Maple - Exposed Sanitary Sewer Downstream of Forest Grove near King Maple Place.....	5-234
5.8.3	Project #3: BRC - Upper - Upper Blue Ridge Creek near Sifton Court.....	5-235
5.8.4	Project #4: NBC - Tanner - Exposed Sanitary Crossing Downstream of Maxome Avenue near Tanner Court	5-236
5.8.5	Project #5: NBC - Maxome - Multiple Sanitary Risks Directly Upstream of Maxome Avenue	5-237

5.8.6	Project #6: NBC - Manorcrest - Watermain Infrastructure Upstream of Bayview and Finch near Manorcrest Drive	5-238
5.8.7	Project #7: NBC - Forest Grove - Failed Stormwater Outfall Downstream of Forest Grove Drive	5-239
5.8.8	Project #8: BRC - Confluence - Lower Blue Ridge Creek near Confluence with the Don River....	5-240
5.8.9	Project #9: NBC - Confluence - Previously Exposed Sanitary Maintenance Hole near Confluence with the Don River	5-241
5.8.10	Project #10: NBC - Page - Multiple Sanitary Assets Upstream of Forest Grove Drive Near Page Avenue	5-242
5.8.11	Project #11: NBC - Canary - Failed Stormwater Outfall at Burbank Drive Near Canary Crescent	5-243
6	PUBLIC AND FIRST NATIONS CONSULTATION.....	6-244
6.1	Notification.....	6-244
6.2	First Nations	6-244
6.2.1	What We Heard.....	6-244
6.3	Agencies and Utilities	6-245
6.3.1	What We Heard.....	6-245
6.4	Private Property Impacts	6-245
6.5	Public Consultation Feedback	6-245
6.5.1	What We Heard.....	6-246
7	CONCLUSION & NEXT STEPS	7-247
7.1	Summary of Eleven Projects	7-247
7.2	Detailed Design and Investigations.....	7-248
7.2.1	Topographic Survey and Supporting Investigations.....	7-249
7.2.2	Hydraulic Assessment	7-249
7.2.3	Hydrogeological Assessment	7-250
7.2.4	Geomorphic Assessment.....	7-250
7.2.5	Geotechnical Investigation.....	7-250
7.2.6	Utilities Confirmation	7-250
7.2.7	Tree Inventory.....	7-250
7.2.8	Natural System Enhancement Opportunities	7-250
7.2.9	Coordination with Basement Flood Protection Projects	7-250
7.2.10	General Mitigation Measures	7-251
7.2.10.1	Erosion and Sediment Control	7-251
7.2.10.2	Fuel Spills.....	7-251
7.2.10.3	Environmental Disturbance.....	7-251

7.2.10.4	Stage 2 Archaeological Assessment	7-251
7.2.10.5	Property Access Agreements	7-252
7.3	Permits and Approvals	7-252
7.3.1	Toronto and Region Conservation Authority Permit	7-252
7.3.2	Provincial Species at Risk	7-252
7.3.3	Department of Fisheries and Oceans (DFO) Request for Regulatory Review.....	7-253
7.3.4	Urban Forestry Ravine & Natural Feature Protection Permit.....	7-253
7.4	Qualified Persons for Stream Restoration Design.....	7-253
7.5	Construction Services.....	7-253
7.6	As-Constructed Drawings and Analysis.....	7-254
7.7	Monitoring Program.....	7-254
8	SIGNATURES	8-255
9	REFERENCES	9-256

List of Figures

Figure 2-1: Photo of Trans-Northern Pipeline Exposure in Channel Bed of Newtonbrook Creek	2-6
Figure 2-2: Photo of Sun-Canadian Pipeline Exposure in Bank of Newtonbrook Creek	2-6
Figure 3-1: Gabion Lined Channel in Reach N1	3-9
Figure 3-2: Gravel and Cobble Substrate with Sandy Banks in Reach N1	3-9
Figure 3-3: Mature Point Bar Development.....	3-10
Figure 3-4: Washed-Out Angular Stone and Boulder Treatments in Reach N2.....	3-10
Figure 3-5: Clay and Silt Rich Sand and Gravel in Exposed Banks in Reach N3	3-11
Figure 3-6 Failed Gabion Baskets Through Reach N3	3-11
Figure 3-7: Confined Lower Segment Upstream of Maxome Avenue in Reach N4.....	3-12
Figure 3-8: Partially Emptied Gabion Baskets Line the Upper Portion of Reach N4.....	3-12
Figure 3-9: Incised Channel Near the Don Confluence Exposing Buried Pipes and Bank Erosion.	3-13
Figure 3-10: Steep Valley Confined Upstream Segment in Reach Br1.....	3-13
Figure 3-11: Steep Valley Confined Tributary Channel in Reach Br2.....	3-13
Figure 3-12: Debris from Fallen and Cut Trees in Reach Br2	3-13
Figure 3-13: Armourstone and Concrete Lined Channel Upstream of the Confluence with Br1	3-14
Figure 3-14: Cablecrete and Armourstone Through Bayview Village Park.....	3-14
Figure 3-15 Steep Valley Confined Tributary Channel in Reach Br4	3-15
Figure 3-16: Failed Gabion Baskets and Channel Angular Stone in Reach Br4	3-15
Figure 3-17: Stability Regime of Creek Reaches from RGA Results	3-17
Figure 3-18: Graphical Definition of the Scour Hazard Limit for Three Cases,	3-19
Figure 3-19: Historical Scour Depths within Urban Creek Systems in Toronto	3-19
Figure 3-20: Examples of Vertical Scour Depth and Lateral Bank Migration Offset	3-20
Figure 3-21: Generic models for the Scour Hazard Limit based on A) channel gradient and B) bankfull depth, including the SHL x 2 for Factor of Safety (modified from: CVC, 2020)	3-21
Figure 3-22: Theoretical Scour Potential Estimates.....	3-22
Figure 3-23: Meander Belt Mapping for Reach N1	3-26
Figure 3-24: Existing Terrestrial Natural Habitat Quality (source: Don River Watershed Plan: Terrestrial Natural Heritage, TRCA 2009)	3-28
Figure 3-25: Provincially Significant Wetlands in Study Area (source: Queens Printer for Ontario, 2019)	3-29
Figure 3-26: Fish Barriers Along Newtonbrook Creek and Blue Ridge Creek (TRCA, 2009).....	3-30
Figure 3-27: Hydrograph of Modelled Hourly Streamflow for Reach N1 from January 2012 – December 2016	3-33
Figure 3-28: Hydrograph of Modelled Hourly Streamflow for Reach Br-1 from January 2012 – December 2016	3-33
Figure 3-29: Isolated Baseflow Values Relative to the Rest of the Modelled Hydrograph for Reach N1.....	3-35
Figure 3-30: Isolated Baseflow Values Relative to the Rest of the Modelled Hydrograph for Reach Br1.....	3-35
Figure 3-31: Regional Floodplain Mapping for NCGSMP Study Area.....	3-37

Figure 3-32: Box and Whisker Plot Illustrating Variations in Channel Velocities by Design Storm for Newtonbrook Creek. Permissible Minimum Velocities for Varying Materials as per Fischenich (2001) Shown on the Right. ... 3-38

Figure 3-33: Box and Whisker Plot Illustrating Variations in Channel Velocities by Design Storm for Blue Ridge Creek. Permissible Minimum Velocities for Varying Materials as per Fischenich (2001) Shown on the Right. ... 3-39

Figure 3-34: Ontario Summer Average Temperature Increases for Four RCPs from 1981 through 2100 (LAMPS, York University)..... 3-46

Figure 3-35: Hydrology Model Calibration Period (2011 to 2013) Average Monthly and Annual Temperatures 3-47

Figure 3-36: Annual and Monthly Average Temperatures for RCP2.6, RCP4.5 and RCP 8.5 in the 2050s Compared to Current Temperatures 3-48

Figure 3-37: Annual and Monthly Average Temperatures for RCP2.6, RCP4.5 and RCP 8.5 in the 2080s Compared to Current Temperatures 3-48

Figure 3-38: Annual and Monthly Average Temperature Increases for RCP2.6, RCP4.5 and RCP 8.5 from the Present to the 2050s..... 3-49

Figure 3-39: Annual and Monthly Average Temperature Increases for RCP2.6, RCP4.5 and RCP 8.5 from the Present to the 2080s..... 3-49

Figure 3-40: Annual and Monthly Average Minimum Daily Temperature Increases for RCP2.6, RCP4.5 and RCP 8.5 from the Present to the 2050s 3-50

Figure 3-41: Annual and Monthly Average Minimum Daily Temperature Increases for RCP2.6, RCP4.5 and RCP 8.5 from the Present to the 2080s 3-51

Figure 3-42: Annual and Monthly Average Maximum Daily Temperature Increases for RCP2.6, RCP4.5 and RCP 8.5 from the Present to the 2050s 3-51

Figure 3-43: Annual and Monthly Average Maximum Daily Temperature Increases for RCP2.6, RCP4.5 and RCP 8.5 from the Present to the 2080s 3-52

Figure 3-44: Monthly Average Precipitation Volumes in the 2003-2022 (Present Day) Reference Period.... 3-52

Figure 3-45: Monthly Average Precipitation Volumes in the 2050s Compared with the Present Day for RCP2.6, RCP4.5 and RCP 8.5 3-53

Figure 3-46: Monthly Average Precipitation Volumes in the 2080s Compared with the Present Day for RCP2.6, RCP4.5 and RCP 8.5 3-53

Figure 3-47: Annual Total Precipitation Volumes in the 2050s and 2080s Compared with the Present-Day Reference Period (2003-2022) for RCP2.6, RCP4.5 and RCP 8.5..... 3-54

Figure 3-48: Six Year Average Annual Potential Evapotranspiration Calculated for Each Scenario 3-55

Figure 3-49: Six Year Total Study Area Streamflow Volume, 3 GHG Scenarios and 2 Timeframes 3-59

Figure 3-50: Six Year Streamflow Volume by Month, 3 GHG Scenarios and 2 Timeframes 3-59

Figure 3-51: Six Year Streamflow Volume by Season, 3 Climate Scenarios and 2 Timeframes 3-60

Figure 3-52: Six Year Streamflow Frequency Distribution, 3 Climate Scenarios and 2 Timeframes..... 3-61

Figure 3-53: Six Year Streamflow Low Flow Frequency Distribution, 3 Climate Scenarios and 2 Timeframes 3-62

Figure 3-54: Simulated Streamflow in the Study Area in March of 2014 with Existing and Five Future Climates 3-63

Figure 3-55: Simulated Streamflow in the Study Area in March of 2015 with Existing and Five Future Climates	3-63
Figure 3-56: Logarithmic View of Simulated Streamflow in the Study Area in March of 2015 with Existing and Five Future Climates.....	3-64
Figure 3-57: IDF Curve from Lester B. Pearson International Airport based on data from 1950 – 2017 (Sourced from ClimateData.ca)	3-66
Figure 3-58: Total Event Precipitation for 7 Design Storms and 3 Historical Events	3-67
Figure 3-59: Study Area Simulated Total Event Streamflow Volumes for Design and Historical Storms	3-68
Figure 3-60: The Ratios of the Total Stormwater Volumes (Future/Present) for 10 Storms.....	3-69
Figure 3-61: Study Area Simulated Streamflow Peaks for Design and Historical Storms	3-69
Figure 3-62: The ratios of the peak storm event flow rates (future/present) for ten storms	3-70
Figure 3-63: Archaeological Potential from the City of Toronto Archaeological Management Plan	3-76
Figure 3-64: Detailed Site Location of AkGu-88	3-77
Figure 3-65: Spatial Distribution of Toronto Water Infrastructure Crossing Newtonbrook and Blue Ridge Creeks.	3-79
Figure 3-66: Vertical Depth of Cover (m) Categorization of Infrastructure Crossings	3-81
Figure 3-67: Horizontal Offsets (m) Categorization for Infrastructure Crossings	3-81
Figure 3-68: Sample Existing Conditions Drawing Based on Topographic Survey Results for Crossing #12 ...	3-82
Figure 3-69: Sample Existing Conditions Drawing Based on Lateral Risk Site #6.....	3-84
Figure 3-70: Horizontal Offset (m) Categorization for Lateral Risk Sites	3-85
Figure 3-71: Spatial Distribution of Storm Sewer Outfalls in Newtonbrook and Blue Ridge Creek Study Area ..	3-87
Figure 3-72: As-built drawing of Crossing #10, Reach N3, showing the existing mean substrate elevation (green), the as-built ground cover (blue)	3-90
Figure 3-73: Spatial Distribution of Twenty-Four (x24) High-Priority Sites.....	3-96
Figure 4-1: Exposed Sanitary Maintenance Hole in Bank	4-101
Figure 4-2: Erosion along the Outer Meander Bend Encroaching Towards the Pedestrian Trail	4-101
Figure 4-3: Significant Bank Erosion Between the Exposed Sewer Crossing and Downstream Maintenance Hole	4-101
Figure 4-4: Upstream of the Exposure. Note gravel Island to the Right of the Photograph.	4-101
Figure 4-5: Existing Conditions - Priority Site #1	4-103
Figure 4-6: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #1	4-104
Figure 4-7: Narrowed Channel due to Gabion Basket Slumping and Woody Debris, Upstream of Crossing	4-106
Figure 4-8: Undercut Gabion Basket Retaining Walls Slumping Downwards into Channel	4-106
Figure 4-9: Broken Gabion Wire Mesh Leading to the Deposition of Dislodged Gabion Stone in Newtonbrook Creek	4-106
Figure 4-10: Failed Gabion Basket Retaining Wall and Widened Channel due to Unprotected Eroding Banks Downstream of the Exposed Sewer Crossing	4-106
Figure 4-11: Existing Conditions - Priority Site #2	4-108

Figure 4-12: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #2	4-109
Figure 4-13: Stormwater Outlet Clogged with Organic Debris	4-111
Figure 4-14: Degraded Outfall Channel with Loose Angular Stone	4-111
Figure 4-15: Location of Visible Pipe Detachment Upslope of the Outlet	4-111
Figure 4-16: Exposed Maintenance Hole in the Slope of Forest Grove Drive Road Embankment	4-111
Figure 4-17: Existing Conditions - Priority Site #3	4-113
Figure 4-18: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #3	4-114
Figure 4-19: Storm Sewer Outfall Setback Approximately	4-116
Figure 4-20: Eroded and Down-cut Outfall Channel Contributing to the Slumping of the Upstream Concrete Headwall Structure	4-116
Figure 4-21: Detachment of Headwall From Inlet Pipe	4-116
Figure 4-22: Obstructions and Detachments Within Upstream Pipe Segment	4-116
Figure 4-23: Existing Conditions - Priority Site #4	4-118
Figure 4-24: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #4	4-119
Figure 4-25: Exposed Concrete Encasement Surrounding 675 mm Ø Sanitary Trunk Sewer	4-121
Figure 4-26: Armourstone Grade Control Structure Downstream of Exposed Sanitary Sewer Crossing	4-121
Figure 4-27: Northern Storm Sewer Outfall at Edge of Pedestrian Trail	4-121
Figure 4-28: Southern Storm Sewer Outfall at Top of Slope and Associated Outfall Channel	4-121
Figure 4-29: Existing Conditions - Priority Site #5	4-123
Figure 4-30: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #5	4-124
Figure 4-31: Armourstone Grade Control Structure and Armourstone Bank Protection	4-126
Figure 4-32: Armourstone Bank Protection along Outer Downstream Bank	4-126
Figure 4-33: Exposed Encasement with Upstream Scour Pool	4-126
Figure 4-34: Armourstone Bank Protection and Grade Control Downstream of Exposed Encasement	4-126
Figure 4-35: Existing Conditions - Priority Site #6	4-128
Figure 4-36: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #6	4-129
Figure 4-37: Erosion Scar Along Outer Bank Immediately Upstream of Exposed Sewer Encasement	4-131
Figure 4-38: Exposed Concrete Encasement Exhibiting Degradation and Spalling	4-131
Figure 4-39: Armourstone Grade Control Structure Downstream of the Exposed Encasement	4-131
Figure 4-40: Channel Conditions Downstream of the Armourstone Grade Control Structure	4-131
Figure 4-41: Existing Conditions - Priority Site #7	4-133
Figure 4-42: Preliminary Concepts Alternative 2 & 3 – Priority Site #7	4-134
Figure 4-43: Exposed Sanitary Maintenance Hole and Angular Stone Material	4-136
Figure 4-44: Extents of Angular Stone Protection Around Sanitary Maintenance Hole	4-136
Figure 4-45: Exposed Sanitary Sewer Maintenance Hole Circa 2010	4-136
Figure 4-46: Hole in the Maintenance Hole Chimney, Circa 2010. Emergency Works Have Since Been Undertaken to Retrofit the Maintenance Hole Structure	4-136

Figure 4-47: Existing Conditions - Priority Site #8	4-138
Figure 4-48: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #8	4-139
Figure 4-49: Arched Culvert conveying Flows under the Intersection of Bayview Avenue and Finch Avenue ...	4-141
Figure 4-50: Armourstone Bed works over the 675 mm Sanitary Sewer Crossing, Constructed as a Series of Cascades.....	4-141
Figure 4-51: Degraded Armourstone Bed and Bank Treatments	4-141
Figure 4-52: Exposed Sanitary Sewer Maintenance Hole Downstream of the Engineered Channel Works .	4-141
Figure 4-53: Existing Conditions - Priority Site #9	4-143
Figure 4-54: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #9	4-144
Figure 4-55: Failed Gabion Basket Bank Protection.....	4-146
Figure 4-56: Exposed Watermain Chamber.....	4-146
Figure 4-57: Channel Conditions Upstream of Watermain Crossing	4-146
Figure 4-58: Undermined and Emptied Gabion Baskets Upstream of Watermain Crossing	4-146
Figure 4-59: Existing Conditions - Priority Site #10	4-148
Figure 4-60: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #10	4-149
Figure 4-61: Exposed Sewer in Channel Bed Without Visible Encasement	4-151
Figure 4-62; Bank Subject to Erosion with Degraded Geotextile Fabric.....	4-151
Figure 4-63: Gabion Basket Bank with Storm Outfall Circled in Red	4-151
Figure 4-64: Channel Conditions in Close Proximity to Exposed Sewer	4-151
Figure 4-65: Existing Conditions - Priority Site #11	4-153
Figure 4-66: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #11	4-154
Figure 4-67: Storm Outfall Failure in the Slope of the Valley	4-156
Figure 4-68: Degraded Outfall Channel	4-156
Figure 4-69: Two Failed Pipes Upslope of Headwall	4-156
Figure 4-70: Sinkhole Observed Upstream of Headwall Structure	4-156
Figure 4-71: Existing Conditions - Priority Site #12	4-158
Figure 4-72: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #12	4-159
Figure 4-73: Channel Conditions Upstream of Confluence with Tributary BR-2	4-161
Figure 4-74: Channel Conditions Downstream of Confluence with Tributary BR-2	4-161
Figure 4-75: Highly Degraded Maintenance Hole Covered By Tarp	4-161
Figure 4-76: Detached Pipe Upstream of Storm Outfall, Located Adjacent to Degraded Maintenance Hole	4-161
Figure 4-77: Existing Conditions - Priority Site #13	4-163
Figure 4-78: Existing Conditions - Priority Site #13	4-164
Figure 4-79: Exposure of the Concrete Encasement with Water Flowing into the Crack of the Encasement	4-166
Figure 4-80: View of the Engineered Channel Upstream of the Encasement Exposure	4-166

Figure 4-81: Large Drop Downstream of Encasement Exposure with Boulders Providing Grade Control	4-166
Figure 4-82: Blue Ridge Creek and Valley Setting Downstream of Boulder Pile.....	4-166
Figure 4-83: Existing Conditions - Priority Site #14.....	4-168
Figure 4-84: Preliminary Design Concepts Alternative 2 & 3 – Priority Site #14	4-169
Figure 4-85: Degraded Channel Conditions at Priority Site #15. The Actively Eroding Westerly Bank has Created a Lateral Risk to a 300 mm Diameter Sanitary Sewer.....	4-171
Figure 4-86: Existing Conditions – Priority Site #15	4-173
Figure 4-87: Preliminary Design Concepts Alternatives 2 & 3 – Priority Site #15.....	4-174
Figure 4-88: Degraded Channel Conditions at Priority Site #16. The Actively Eroding Bank has Created a Lateral Risk to the Adjacent 675 mm Sanitary Sewer	4-176
Figure 4-89: Existing Conditions – Priority Site #16	4-178
Figure 4-90: Preliminary Design Concepts Alternatives 2 & 3 – Priority Site #16.....	4-179
Figure 4-91: Degraded Channel Conditions at Priority Site #17. The Actively Eroding Bank has Created a Lateral Risk to a 675 mm Diameter Sanitary Sewer.....	4-181
Figure 4-92: Existing Conditions – Priority Site #17	4-183
Figure 4-93: Preliminary Design Concepts Alternatives 2 & 3 – Priority Site #17.....	4-184
Figure 4-94: Degraded Channel Conditions at Priority Site #18. The Actively Eroding Bank has Created a Lateral Risk to a 675 mm Diameter Sanitary Sewer.....	4-186
Figure 4-95: Existing Conditions – Priority Site #18	4-188
Figure 4-96: Preliminary Design Concepts Alternatives 2 & 3 – Priority Site #18.....	4-189
Figure 4-97: Degraded Channel Conditions at Priority Site #19. The Actively Eroding Bank has Created a Lateral Risk to a 675 mm diameter Sanitary Sewer	4-191
Figure 4-98: Existing Conditions – Priority Site #19	4-193
Figure 4-99: Preliminary Design Concepts Alternatives 2 & 3 – Priority Site #19.....	4-194
Figure 4-100: Degraded Channel Conditions at Priority Site #20. The Actively Eroding Bank has Created a Lateral Risk to a 675 mm Diameter Sanitary Sewer.....	4-196
Figure 4-101: Existing Conditions – Priority Site #20	4-198
Figure 4-102: Preliminary Design Concepts Alternatives 2 & 3 – Priority Site #20.....	4-199
Figure 4-103: Degraded Channel Conditions at Priority Site #21, Where Actively Eroding Bank has Created a Lateral Risk to a 300 mm Diameter Sanitary Sewer.....	4-201
Figure 4-104: Existing Conditions – Priority Site #21	4-203
Figure 4-105: Preliminary Design Concepts Alternatives 2 & 3 – Priority Site #21.....	4-204
Figure 4-106: Outflanked and Failing Armourstone Retaining Wall Posing Lateral Erosion Risk to 675 mm Diameter Sanitary Sewer, Partial Exposure of Sanitary Sewer Maintenance Hole Present.....	4-206
Figure 4-107: Existing Conditions – Priority Site #22	4-208
Figure 4-108: Preliminary Design Concepts Alternatives 2 & 3 – Priority Site #22.....	4-209
Figure 4-109: Representative Site conditions Near Priority Site #23.....	4-211
Figure 4-110: Existing Conditions – Priority Site #23	4-213
Figure 4-111: Preliminary Design Concepts Alternatives 2 & 3 – Priority Site #23.....	4-214

Figure 4-112: Representative Site Conditions Near Priority Site #24.....	4-216
Figure 4-113: Existing Conditions – Priority Site #24.....	4-218
Figure 4-114: Preliminary Design Concepts Alternatives 2 & 3 – Priority Site #24.....	4-219
Figure 5-1: Spatial Distribution of the Eleven NCGSMP Capital Works Projects	5-224
Figure 5-2: Spatial Distribution of Eleven Prioritized NCGSMP Capital Works Projects	5-230
Figure 5-3: Project #1: NBC - Finch Preliminary Conceptual Drawing	5-233
Figure 5-4: Project #2: NBC - King Maple - Preliminary Conceptual Drawing.....	5-234
Figure 5-5: Project #3: BRC - Upper - Preliminary Conceptual Drawing	5-235
Figure 5-6: Project #4: NBC - Tanner - Preliminary Conceptual Drawing.....	5-236
Figure 5-7: Project #5: NBC - Maxome - Preliminary Conceptual Drawing.....	5-237
Figure 5-8: Project #6: NBC - Manorcrest - Preliminary Conceptual Drawing	5-238
Figure 5-9: Project #7: NBC – Forest Grove - Preliminary Conceptual Drawing	5-239
Figure 5-10: Project #8: BRC - Confluence - Preliminary Conceptual Drawing	5-240
Figure 5-11: Project #9: NBC - Confluence - Preliminary Conceptual Drawing.....	5-241
Figure 5-12: Project #10: NBC - Page - Preliminary Conceptual Drawing	5-242
Figure 5-13: Project #11: NBC - Canary - Preliminary Conceptual Drawing.....	5-243

List of Tables

Table 2-1: List of Background Data Received as part of Phase 1	2-2
Table 2-2: Summary of Erosion Control and Erosion Hazard Data received from TRCA	2-3
Table 2-3: Erosion Control Structures in Newtonbrook Creek	2-4
Table 2-4: Selected Water Erosion Risk Monitoring sites, with Correlated Sanitary Sewer Crossings.....	2-5
Table 2-5: Summary of Received Engineering Drawings	2-6
Table 3-1: Summary of Reach Delineations in Newtonbrook Creek (N) and Blue Ridge Creek (Br).....	3-8
Table 3-2: Relevant Fluvial Geomorphic Parameters for Reach N1.....	3-9
Table 3-3: Relevant Fluvial Geomorphic Parameters for Reach N2.....	3-10
Table 3-4: Relevant Fluvial Geomorphic Parameters for Reach N3.....	3-11
Table 3-5: Relevant Fluvial Geomorphic Parameters for Reach N4.....	3-12
Table 3-6: Relevant Fluvial Geomorphic Parameters for Reach Br1.....	3-13
Table 3-7: Relevant Fluvial Geomorphic Parameters for Reach Br2.....	3-14
Table 3-8: Relevant Fluvial Geomorphic Parameters for Reach Br3.....	3-14
Table 3-9: Relevant Fluvial Geomorphic Parameters for Reach Br4.....	3-15
Table 3-10: Rapid Geomorphic Assessment (RGA) Descriptions Based on Index Value.....	3-16
Table 3-11: RGA Stability Classification for All Reaches in the Study	3-16
Table 3-12: Reach averaged scour rates and their associated 100-yr Scour Hazard Limit	3-22
Table 3-13: Reach averaged lateral erosion rates and their associated 100-yr Erosion Hazard Limit.	3-23
Table 3-14: Summary of Meander Belt Widths by Reach	3-25
Table 3-15: Reach by Reach Variability in Modelled Hourly Streamflow from 2012-2016	3-34
Table 3-16: Newtonbrook and Blue Ridge Creeks Flow Regime Summary – Design Storm Events as Defined in TRCA Don River HEC-RAS Model.....	3-34
Table 3-17: Newtonbrook and Blue Ridge Creek Flow Regime Summary - Baseflow (m ³ /s)	3-35
Table 3-18: Permissible Shear and Velocity Thresholds for Various Channel Lining Materials (Adapted from Fischenich, 2001).....	3-41
Table 3-19: Six Year (2011-2016) Monthly Total Streamflow Volumes (Mm ³) in the Study Area and Extreme Rates for the Existing Climate, 3 RCP Scenarios and 2 Timeframes (2050 and 2080)	3-57
Table 3-20: Six Year Seasonal Total Streamflow Volumes (Mm ³) in the Study Area and Extreme Rates for the Existing Climate, 3 RCP Scenarios and 2 Timeframes (2050 and 2080)	3-58
Table 3-21: Six Year Annual Total Streamflow Volumes (Mm ³) in the Study Area and Extreme Rates for the Existing Climate, 3 RCP Scenarios and 2 Timeframes (2050 and 2080)	3-58
Table 3-22: Six Year (2011-2016) and Annual Total Streamflow Summary for the Whole Study Area and the Two Contributing Creeks	3-58
Table 3-23: Registered Sites within one Kilometer of the study area.	3-75
Table 3-24: Vertical Risk Scoring – Detailed Evaluation Criteria.....	3-89
Table 3-25: Lateral Risk Scoring – Detailed Evaluation Criteria	3-91
Table 3-26: Storm Sewer Outfall Risk Scoring – Detailed Evaluation Criteria.....	3-93

Table 3-27: Summary of Priority Sites with Exposed Assets at Immediate Risk of Failure	3-94
Table 3-28: Summary of Priority Sites with Secondary (Non-Immediate) Risks	3-95
Table 4-1: NCGSMP Evaluation Criteria	4-99
Table 4-2: NCGSMP Scoring Scale for Criteria Evaluation	4-100
Table 4-3: NCGSMP Weighting Factors	4-100
Table 4-4: Summary of Priority Site #1 Maintenance Hole and Sanitary Sewer Parameters	4-102
Table 4-5: Summary of Priority Site #2: Sanitary Sewer Parameters	4-107
Table 4-6: Summary of Priority Site #3 Outfall and Maintenance Hole Parameters	4-112
Table 4-7: Summary of Priority Site #4 Outfall Parameters	4-117
Table 4-8: Summary of Priority Site #5 Sanitary Sewer and Outfall Parameters	4-122
Table 4-9: Summary of Priority Site #6 Sanitary Sewer Parameters	4-127
Table 4-10: Summary of Priority Site #7 Sanitary Sewer Parameters	4-132
Table 4-11: Summary of Priority Site #8 Maintenance Hole Parameters	4-137
Table 4-12: Summary of Priority Site #9 Sanitary Sewer Parameters	4-142
Table 4-13: Summary of Priority Site #10 Watermain Parameters	4-147
Table 4-14: Summary of Priority Site #11 Sanitary Sewer Parameters	4-152
Table 4-15: Summary of Priority Site #12 Outfall Parameters	4-157
Table 4-16: Summary of Priority Site #13 Sanitary Sewer Parameters	4-162
Table 4-17: Summary of Priority Site #14 Sanitary Sewer Parameters	4-167
Table 4-18: Summary of Priority Site #15 Sanitary Sewer Parameters	4-172
Table 4-19: Summary of Priority Site #16 Sanitary Sewer Parameters	4-177
Table 4-20: Summary of Priority Site #17 Sanitary Sewer Parameters	4-182
Table 4-21: Summary of Priority Site #18 Sanitary Sewer Parameters	4-187
Table 4-22: Summary of Priority Site #19 Sanitary Sewer Parameters	4-192
Table 4-23: Summary of Priority Site #20 Sanitary Sewer Parameters	4-197
Table 4-24: Summary of Priority Site #21 Sanitary Sewer Parameters	4-202
Table 4-25: Summary of Priority Site #22 Sanitary Sewer Parameters	4-207
Table 4-26: Summary of Priority Site #23 Sanitary Sewer Parameters	4-212
Table 4-27: Summary of Priority Site #24 Sanitary Sewer Parameters	4-217
Table 5-1: Project Risk Sites Summary	5-221
Table 5-2: Updated Risk Score for Exposed Maintenance Hole within NBC - Confluence project	5-225
Table 5-3: Sanitary Infrastructure Failure Impact	5-226
Table 5-4: Stormwater Infrastructure Failure Impact	5-226
Table 5-5: Watermain Infrastructure Failure Impact	5-227
Table 5-6: Project Failure Risk Evaluation for Project #1: NBC - Finch	5-227
Table 5-7: Driving Priority Sites for Each of the Capital Works Projects	5-227
Table 5-8: Project Prioritization Based on Failure Risk Assessment	5-228

Table 5-9: Recommended Implementation Timeline for Each Priority Tier	5-229
Table 5-10: Project Cost Summary.....	5-232

List of Appendices

Appendix A: TRCA Erosion Monitoring Information

Appendix B: TRCA Erosion Site Locations

Appendix C: Infrastructure Crossing Locations

Appendix D: Infrastructure Crossing Information

Appendix E: Meander Belt Maps by Reach

Appendix F: HEC RAS Model Results

Appendix G: Stage 1 Archaeological Report

Appendix H: Existing Conditions Drawings

Appendix I: Sanitary and Watermain Crossing Assessment Tables

Appendix J: Summary Sheets for Sanitary Sewer Lateral Risk Sites

Appendix K: Additional Lateral Risk Sites Assessment Tables

Appendix L: Outfall Assessment Tables

Appendix M: Erosion Control Structures

Appendix N: Erosion Hazard Sites

Appendix O: Recent and Ongoing TRCA Projects

Appendix P: Vertical Risk Scoring Results

Appendix Q: Horizontal Risk Scoring Results

Appendix R: Outfall Risk Scoring Results

Appendix S: Existing Conditions for High Priority Sites

Appendix T: Proposed Alternatives for High Priority Sites

Appendix U: Evaluation of Alternatives for High Priority Sites

Appendix V: Project Failure Risk Evaluation

Appendix W: Planform Drawings for Eleven Projects

Appendix X: Summary of Public and First Nations Consultation Activities

Appendix Y: Hydrologic Model Calibration