4 PHASE 3: DEVELOPMENT AND EVALUATION OF ALTERNATIVES

As part of **Phase 3** of the NCGSMP, three (x3) alternatives were developed for each of the twenty-four (x24) high priority risk sites. These restoration alternatives were evaluated using a series of evaluation criteria, considering a combination of environmental, social, economic and technical criteria, consistent with EA standard practice and City of Toronto Standards. Particular importance was given towards an alternative's ability to provide long-term protection to at-risk Toronto Water infrastructure. This evaluation process yielded a preferred restoration alternative for each of the sites.

4.1 List of Alternatives

To address erosion related risks to Toronto Water Infrastructure at each of the twenty-four (x24) priority sites listed above, a series of preliminary alternative restoration strategies were developed for each priority site. In general, three (x3) alternatives were developed for each site and can be broadly described as listed below, acknowledging that all proposed restoration strategies will be site-specific.

- **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. For risk sites associated with sanitary sewer crossings, this alternative typically involves the design of armourstone ribs adjacent to the sewer crossing for grade control, and adjustments to the grade of the channel to provide a minor increase to the depth of cover over the sewer crossing. On the other hand, for storm sewer outfalls this alternative is typically a combination of outfall restoration coupled with minor bank protection 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. For risk sites associated with sanitary sewer crossings, this alternative typically involves the implementation of riffle-pool morphology applied to an extended channel segment to gradually adjust the longitudinal profile of the channel, increase depth of cover over the sewer crossing and enhance aquatic habitat. For storm sewer outfall sites, sub-reach-based works typical encompass recessing and realigning the outfall, development of an engineered outlet channel and local bed/bank works to prevent scouring and outflanking.

4.1.1 Infrastructure Relocation Consideration

As part of the NCGSMP study, high level consideration was given to the relocation of Toronto-water infrastructure. For sanitary infrastructure, given the NCGSMP reflects an approximate 20-year planning horizon, the City has reviewed plans for the sanitary infrastructure within NCGSMP. Toronto Water has advised that any works on these systems will involve rehabilitation with sewer lining techniques, to extend their life for another 50 to 100 years. In addition, there are not currently any defined projects which would require expansion of STS capacity that would be triggered by population growth. Additionally, Toronto Water is developing a strategy to reduce inflow and infiltration (I&I) to sanitary sewers to maintain the existing sewers and improve their capacity. This is a long-term effort to increase dry weather sanitary sewer capacity by reducing the amount of I&I originating from tableland

streets and private properties. Accordingly, Toronto Water has advised that the valley-based Newtonbrook Creek and Blue Ridge Creek systems, and its associated local collector sanitary sewer system, will be remaining in place for this current planning horizon.

For storm sewer infrastructure, the major erosion risk to storm sewers is stream erosion at outfalls or erosion caused by the segmenting of pipes connected to the storm outfall. Toronto has approximately 3,600 Toronto Water outfalls over its 63,000 ha with an average storm sewer catchment area of 24 ha. Removal of storm sewers and outfalls from the stream corridor, defined as a warm water corridor of 15 metres on either side of Newtonbrook and Blue Ridge Creek's centerline, is not advised. For example, a significant number of outfalls discharge at the top of tablelands, or part way down the valley wall or ravine slope and cause significant erosion downstream of the outfall. This erosion is caused by concentrated flow and leads to significant downcutting of the intermittent channel and also causes water quality degradation in the receiving waters due to the increased total suspended solids (TSS) loadings to the creek or river.

Given the City's as-built condition is largely outfalls at the creek channel, the City is not, in its GSMPs, exploring universal reconstruction of outfalls to be outside of the creek corridor. Rather, the City is simply attempting to return priority storm outfalls, that have been impacted by stream erosion processes, like channel incision causing outfall downcutting and undermining, or bend migration and bank erosion causing outfall channel erosion, to a state of good repair. Wherever feasible, the alignment of the storm sewer outfalls with the watercourse settings will be adjusted in the direction of flow, to improve functionality and reduce future erosion.

The following subsections provide an overview of the alternative evaluation methodology, followed by an overview of the existing conditions and erosion-related risks to Toronto Water infrastructure at each priority site. Preliminary design concepts for local and sub-reach-based works solutions are also presented. High-resolution existing conditions drawings for the twenty-four priority sites are provided in **Appendix S**, with the alternatives for each of the sites presented in **Appendix T**.

4.2 Evaluation of Alternatives Methodology

To select a preferred restoration alternative for each of the top twenty-four (x24) priority sites, a multi-objective evaluation process was applied. This included considering 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. A description of the standardized criteria used to evaluate each alternative is provided in **Table 4-1.**

Table 4-1: NCGSMP Evaluation Criteria

Evaluation Criteria	Description
Toronto Water Infrastructure Risk Criteria	
Risk Reduction	Ability to reduce the risk to Toronto Water infrastructure caused by watercourse erosion.
Physical and Natural Environment Criteria	
Geomorphic Form and Function	Ability to improve geomorphic stability and physical components of watercourse function; including mitigating rates of erosion and loss of public and private lands
Slope Stability	Ability to improve slope stability of known, or potential, valley wall erosion
Aquatic Habitat	Ability to improve bedload, floodplain connectivity and aquatic benthic invertebrates, aquatic habitat and aquatic species. As well, the ability to limit temporary or permanent loss of aquatic features or categorical loss of functions by type – including provincially significant wetland, locally significant wetland and watercourses.
Water Quality	Ability to improve surface water quality through erosion reduction and floodplain connectivity.
Groundwater	Ability to improve groundwater resources through floodplain connectivity
Terrestrial Habitat	Ability to improve connectivity, diversity and sustainability; including limiting temporary or permanent loss of terrestrial species.
Terrestrial Vegetation	Ability to limit disturbance to existing woodlots and natural heritage features and vegetation by type – including ESAs, ANSIs, wildlife corridors, and others.
Flood Hazard	Ability of alternative to meet legislated criteria for flooding and reduce adverse impacts of flooding in an urban environment
Species at Risk	Ability to improve suitability of terrestrial and aquatic environment for Species at Risk, potentially affected temporarily or permanently.
Climate Change	Ability to adapt to, and be resilient to, climate change
Social and Cultural Environment Criteria	
Long-term Impacts to Private Property	Potential to positively or negatively impact private property in the long-term.
Short-term Impacts to Community	Ability to limit short-term 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, amenities and aesthetics, on the community. Impacts relate to doing nothing or following construction.
Cultural Heritage	Ability to protect built heritage resources, cultural heritage landscapes and archaeological resources

Evaluation Criteria	Description
Economic Environment Criteria	
Capital Cost	Estimated capital costs for implementing the alternative solution
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 thirty years.
Cost Effectiveness	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.
Technical and Engineering Considerations Criteria	
Regulatory Agency Acceptance	Ability to satisfy Regulatory Agency (City, TRCA, DFO, Urban Forestry, Provincial) mandates
Resource Maximization	Ability to provide multiple improvements, such as more infrastructure protection, using less 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.
Natural Infrastructure Alignment	Ability to enhance engineered grey infrastructure through the improvement of ecosystem processes in keeping with the Government of Canada's natural and hybrid infrastructure initiative.

The evaluation criteria described above were used to score each of the three (3) alternatives outlined earlier for each of the twenty-four (24) priority sites selected as part of the NCGSMP Risk Assessment. For each evaluation criteria a score was applied from 1 to 5 as per **Table 4-2**.

Table 4-2: NCGSMP Scoring Scale for Criteria Evaluation

Scoring Scale				
1	2	3	4	5
Least Preferred	Less Preferred	Neutral	More Preferred	Most Preferred

During the evaluation process, criteria scores were summed for each category and a weighting factor applied to ensure that each evaluation category was valued appropriately regardless of the number of sub-criteria within the category. Based on discussions with the City of Toronto, it was determined that for the purposes of the NCGSMP, each category would be given equal weighting. The weighting factors used for this evaluation are summarized in **Table 4-3**.

Table 4-3: NCGSMP Weighting Factors

Category	Weighting Factor	Maximum Points for Category
Toronto Water Infrastructure Risk Criteria	0.2	20
Physical and Natural Environment Criteria	0.2	20
Social and Cultural Environment Criteria	0.2	20
Economic Environment Criteria	0.2	20
Technical and Engineering Considerations Criteria	0.2	20
Total	**1**	**100**

The results of the evaluation of alternatives process, on a site-by-site basis, are presented in the following sub-sections. The evaluation matrices for all priority sites are provided in **Appendix U**.