Therme Canada

THERME CANADA | ONTARIO PLACE
SHORELINE SUMMARY REPORT
2023.09.13 Issued for OPA/ZBA Resubmission

SSR-OPL-ED-P1

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CHAPTER 1. INTRODUCTION

1.1 Report Purpose

The purpose of this report is to provide a summary of the planning and effects assessment for the shoreline works for the West Island of Ontario Place. To rehabilitate and enhance the West Island's existing shoreline protection, facilitate the creation of more than 12 new acres of public parkland plus more than 3 acres of publicly accessed green roof on top of Therme building Therme will construct shoreline works (including lake-fill activities) on the West Island.

Therme is committed and obligated to design and construct the shoreline works in full compliance with environmental laws. While the shoreline works are not subject to the provincial or federal environmental assessment regimes, Therme has, on a voluntary basis, conducted an 'Environmental Review' of the construction and establishment of the shoreline works in general accordance with the spirit of the Environmental Assessment Act (the "EAA"). Therme Canada has conducted an analysis of potential environmental effects and mitigation measures to determine the net environmental effects to water quality and aquatic habitat to demonstrate that these effects can be minimized. This will be confirmed in more detail through the relevant permits and approvals. Effects from the construction and establishment of shore protection works and lakefilling are well understood, expected to be minor in nature, and are anticipated to result in overwhelming positive benefits to the ecosystem. Potential mitigation measures are also well understood, and effects are mitigable. Thus, Therme has taken all reasonable steps to ensure that water quality and aquatic habitat are protected in accordance with the spirit of the City's Official Plan and other relevant permits and approvals.

The Environmental Review of the shoreline works is a voluntary process that generally consists of the following key elements:

- The Environmental Review assesses the potential environmental effects of the construction and establishment of the shoreline works, however, given that the environmental effects of the Undertaking are minor in nature and well understood:
    - The Environment Review is not a full study but has been completed to a level of detail that ensures proper environmental protection. Accordingly, the Environmental Review of the shoreline works for the West Island includes a site-specific analysis of existing environmental conditions, potential environmental effects and mitigation, with an emphasis on effects and mitigation measures with respect to water quality and aquatic habitat. Socio-economic effects are not considered within the scope of the Environmental Review as they are being dealt with through Planning Act applications.
    - The Environmental Review does not identify and evaluate alternatives to the Undertaking or alternative methods of carrying out the Undertaking given that the proposal is limited to the West Island site and Therme is a private sector proponent without the ability to consider alternatives. The process undertaken to determine the shoreline protection works proposed has been described in this Environmental Review. The Undertaking will be carried out in compliance with the requirements of the applicable provincial/federal permitting processes.
    - The Environmental Review is being documented in this Shoreline Summary Report which describes existing environmental conditions, potential environmental effects and mitigation, including the standard mitigation measures to be employed and any potential contributions to rehabilitating and enhancing existing degraded conditions.

- Consultations have been conducted as part of the broader Ontario Place Redevelopment Planning Act application requirements, and shoreline specific consultations have been limited to interested agencies and potentially impacted Indigenous communities. The Report summarizes the consultation program, including a brief description of the issues and concerns raised and how these were addressed or resolved and any required changes to the information documented as a result of consultations. The Report will be submitted to the City of Toronto as part of the *Planning Act* process, to regulatory agencies as part of the relevant permit application processes, will be shared with Indigenous communities, and will be made available for public review on the Therme website and on the City of Toronto website as part of the Official Plan Amendment Application (OPA). Comments will be collected and responded to as appropriate. No formal provincial review will occur. The Report (or parts thereof) may be used to support permit applications.

This Environmental Review presents a holistic planning and decision-making process and builds upon the Infrastructure Ontario (IO) reports addressing the overall Ontario Place Natural Heritage Existing Conditions (NHEC) and Natural Heritage Impact Assessment (NHIS). Further, the Report provides the City of Toronto with transparency regarding the description of the environmental effects and Therme's conclusions with respect to mitigation, including in response to agency review and comment with respect to the shoreline works. This includes descriptions of the mitigation measures employed including any contributions to rehabilitating/enhancing existing degraded conditions. The recommended monitoring programs and Adaptive Environmental Management (AEM) Framework is documented for the City of Toronto in the Report.

1.2 Project Overview

1.2.1 Ontario Place Redevelopment

Since its opening, Ontario Place has changed and evolved with the times. Throughout the 1980s and 1990s, the site saw updates that included:

- Lakefilling on the eastern side of Ontario Place
- Replacement of the original Forum with the Amphitheatre (now Budweiser Stage) — raising seating capacity from 12,000 to 16,000
- Updating and expanding the waterpark

The 2000s saw further changes to Ontario Place with a number of significant capital improvements including:

- Updates to the waterpark and the Cinesphere.
- Construction of a new outdoor entertainment venue, Echo Beach

In 2012, portions of the park were closed, including the waterpark, amusement rides and the Cinesphere. In 2017, the opening of the newly built Trillium Park and William G. Davis Trail signaled the reopening of the site on a year-round basis, and improvements were made to the iconic Cinesphere, including the installation of a new projection system and repairs to the bridge leading from the west entrance. In 2019, the Government of Ontario announced the future vision for the Ontario Place site that will bring this iconic destination back to life, both as a tourism destination and as a display of Ontario's unique cultural identity. The first step to making the future vision for Ontario Place a reality was a Call for Development launched in 2019. The government sought development concepts that could propose a single use, or a cluster of complementary uses, including family-friendly entertainment, recreation, sports, hospitality, and retail. The Call for Development was designed to provide flexibility for interested parties to propose unique — yet financially viable and sustainable — development concepts.

Therme was the winning proponent in the Government of Ontario's Call for Development of the Western gate of Ontario Place. Therme Canada | Ontario Place will be an affordable all-season entertainment and well-being destination that has something for everyone. It will be a family-friendly experience with indoor and outdoor pools, waterslides, restaurants, natural spaces to relax, surrounded by nearly 16 acres of free public space including parkland, a beach and festival gathering spaces. The Provincial government's decision to enter into an agreement with Therme to develop the West Island is not subject to an Environmental Assessment.

1.2.2 West Island – Therme Canada Ontario Place

As noted above, Therme was the winning proponent in the Government of Ontario's Call for Development of the Western gate of Ontario Place. Therme Canada | Ontario Place will be an affordable all-season entertainment and wellbeing destination that has something for everyone.

Therme recognizes the intrinsic value of the West Island to the citizens of Ontario, and the importance of the landscape as a component of a connected system of park elements that define Ontario Place. The planning for the Therme well-being facility on the West Island has been guided by the following overarching principals:

1. To honor the land stewardship of the First Nations and the importance of a common cultural goal of public access to water and land with a meaningful engagement with the site design.
2. As a man-made environment, to respect the heritage value of the original vision for Ontario Place and the innovative landscape design of Michael Hough. The Therme vision preserves the integrity of the original modernist approach to the landscape and recognizes the contextual nature of changing technologies and evolved public uses with improvements focused on:
    - Design of localized micro-climates for comfort through plantings and structures such as shaded shelters.
    - Naturalized environments that represent the native landscape of Ontario.
    - Water as an organizing element.
    - Creation of playful landforms with strong view corridors and desire lines of sights to the heritage assets.
    - Integration of landscape architecture with innovative technologies that blend the natural and built environments.
    - Creation of a gateway to the West Island as a link between the City and Lake Ontario.
3. To address impacts of climate change functionally and aesthetically armoring and enhancing the shoreline for long term sustainable preservation of the West Island.
4. The management of stormwater through innovative wetland landscape systems that function as an ecological and landscape amenity.
5. To celebrate the multicultural mosaic of the province through an innovate and creative landscaped environment.

6. Creating continuous public access to the lakefront with an enhanced experience that connects to the existing Toronto trail network (e.g., connecting Trillium Park and the Martin Goodman Trail to the William Davis Trail).
7. To have ecological sustainability, as well create terrestrial and aquatic habitats, at the core of the landscape vision.
8. To provide diverse and unique public open space experiences with a focus on passive recreation.
9. To provide a landscape that promotes engagement with nature in all four-seasons.
10. To provide a landscape that is fully accessible to people of all ages and abilities.

The proposed redevelopment work associated with the Therme revitalization includes the following:

- Construction of a new main entrance building on the west mainland, the Therme Welcome Pavilion, as well as a new public bridge to the West Island.
- Construction of a state-of-the-art water recreation and leisure attraction featuring a waterpark, pools, wellness and sauna facilities, sports recreation, gardens, and thermal baths with indoor and outdoor spaces, the Therme Building, on the West Island.
- Creation of over 12 acres of Public Realm plus over 3 acres of publicly accessed green roof on top of the Therme Welcome Pavilion, The Bridge, and The Main Building designed with programable spaces and year-round attractions; the ones relevant to Shoreline works are mentioned below.
- Creation of a new Public Swimming Pier and plaza area in the northwest section of the West Island, with washrooms, changerooms and food and beverage concession, and a new canoe and kayak docking area.
- Creation of a new sand beach along the west side of the West Island that will deliver a wading and swimming experience not currently available at Ontario Place. The west side provides an opportunity for reducing wave action at the beach by both the west headland and the artificial reef (see next point regarding reef), furthermore, swimming will remain accessible on the east and west headlands of the south shore of the West Island via steps to the water for both seating and for water access (see next point regarding stepped terraces).
- Installation of new shoreline protections around the West Island including a sand beach, armour stone, and stepped terraces, as well as construction of a submerged stone reef to improve habitat diversity and shelter the new beach area from wave action.
- Raising the shoreline elevations to mitigate flooding hazards due to high water levels including allowance for future increases due to climate change in line with the design of other waterfront parks throughout the Toronto waterfront.
- Inclusion of a large, multi-use pathway around the entire West Island perimeter with associated benches, lighting, and other user amenities.
- Lake in-filling to the extent required to expand the West Island footprint to accommodate the work and to provide full access for emergency response vehicles around the perimeter.
- Establishment of green roofs on the main Therme Building, as well as elsewhere where feasible, such as on the Gateway Bridge, on shade shelter structures, and on washrooms.
- Installation of green spaces containing native species within Therme Public Landscape spaces to create different eco-zones, as well as additional green space associated with Therme Facility Landscape areas.

1.3 Who is Therme?

Therme Group is driven by the belief that wellbeing should be accessible to all. Therme Group's vision is to create the world's most advanced wellbeing resorts, achieved by harnessing the complex interplay of nature, technology, and culture. We combine global thermal spa traditions with an indoor tropical ecosystem, creating an essential piece of social infrastructure to enhance the mind, body, and soul.

Therme Group is a group of companies with a primary focus on supporting and contributing to the development, construction, and operation of our future resorts.

Therme Group's wellbeing resort concept originated in Germany and over the course of 20 years developed into vital pieces of social infrastructure. Providing entertainment, water-based activities, and wellbeing for all, they are now an essential element of life for people throughout the country.

Our approach challenges the preconception of wellbeing as only for the privileged few. Scale, technology, and mass customization combine to create a unique experience – affordable luxury for all. Therme Group currently operates four large-scale facilities in Germany and Romania. These resorts collectively welcome over 3 million guests annually.

Therme Group is building Therme Canada | Ontario Place, a family-friendly, all-season destination offering something for all ages, including pools, waterslides, botanical spaces to relax, as well as sports performance and recovery services. Outside, people will enjoy approximately 16 acres of free, publicly accessible gathering spaces, parkland, gardens, and a beach.

1.4 Other Approvals

Therme Canada has identified the following approvals specific to the shoreline works on the West Island:

- Municipal
  - OPA and ZBA are being pursued by Infrastructure Ontario on a site-wide basis.
- Provincial
  - Endangered Species Act Authorization.
- Federal
  - Federal Fisheries Act Authorization
  - Navigable Waters Protection Act Authorization

1.5 Overview of Report

The report is organized in a similar fashion to an EA pursuant to the Ontario Environmental Assessment Act. The chapters are summarized as follows:

CHAPTER 1 is the introduction and outlines the nature of this report, the project (shoreline works component only) and the proponent.

CHAPTER 2 discusses the problems and opportunities the shoreline works are addressing, the planning and environmental management context the project is considerate of, and the study areas and time frames used for the assessment.

CHAPTER 3 describes the relevant environmental components that will either be affected by the shoreline works or affect the shoreline works. It should be noted that socio-economic components of the environment are assessed as part of the Planning Act approvals.

CHAPTER 4 describes how the extent of shoreline works was developed, the preliminary design of the shoreline works and a description of how the shoreline works will be constructed.

CHAPTER 5 is a detailed assessment of the effects of the construction and establishment of the shoreline works on water quality and aquatic ecology.

CHAPTER 6 describes the monitoring and adaptive management that will be undertaken to ensure that the shoreline works are functioning as anticipated.

CHAPTER 7 summarizes the consultation activities undertaken by Therme to discuss the shoreline works.

CHAPTER 2. PROBLEM AND OPPORTUNITY ASSESSMENT

2.1 Existing Shoreline Condition

Ontario Place was created from 1969 to 1971 by lakefilling using construction rubble and excavated soil material from construction sites. The outer shoreline of the West Island lakefill, directly exposed to Lake Ontario on the south and west sides, was protected by stone and grouted-stone revetments, stacked stone, and rubble. The sheltered shorelines on the north and east sides of the West Island are protected with vertical bulkhead walls (steel sheet pile or timber pile walls) and rip rap stone revetments.

The existing outer structures were designed based on experimental techniques developed by the Toronto Harbour Commissioners (THC, now Ports Toronto) and in accordance with engineering design practices common 50 years ago. Continuous exposure to waves, ice and high-water levels over the past 50 years has deteriorated the protection works on the south and west shorelines at the West Island to the point that they have effectively reached the end of their design life.

Previous condition assessments (Shoreplan, 2012[1]; Shoreplan, 2022[2]; Jacobs, 2020[3]) reported on the condition of the various shoreline sections at Ontario Place; their findings, along with more recent observations of the shoreline at the West Island, are summarized here in this section.

The existing shoreline at Ontario Place is subject to flooding and inundation. The 100-year flood hazard at the existing Ontario Place shore, as determined by Shoreplan (2022)[2], is presented in Figure 2.1. Additional numerical modelling confirms that the shoreline at the West Island is inundated by wave uprush and overtopping at high water level; wave action at high water results in severe wave overtopping and flooding of the narrow rubble beach at the south shore and the shoreline revetments. Higher design water levels due to the Lake Ontario regulation plan and climate change impacts increase the risk of future erosion and flooding damage at the West Island shoreline.

2.1.1 West Shore

The west shore is protected with a stacked armour stone seawall and random armour stone. Previous condition assessments did not identify specific defects with the stacked wall. However recent site visits by Baird and a further assessment by Shoreplan (2022)[2] have revealed that a section of the stacked wall has collapsed (see Figure 2.2). At design high water levels, the shoreline is overtopped by waves, and the backshore is flooded. The nearly vertical shorewall does not offer public access to the water's edge. The width of the existing walkway behind the shorewall is narrow, crowding pedestrians, strollers, and cyclists. There are no intentional aquatic habitat features incorporated into the shoreline.

[1] Shoreplan Engineering Limited, 2012. Ontario Place Preliminary Coastal Assessment, Technical Memorandum, November 30.
[2] Shoreplan Engineering Limited, 2022. Final Report Ontario Place Existing Shoreline Conditions Report Prepared for Urban Strategies Inc. and Infrastructure Ontario, Version 2, November 18, 2022
[3] Jacobs, 2020. Ontario Place Coastal Assessment, Technical Memorandum No. 1, December 18.

Figure 2.1: Existing flood hazard limit at Ontario Place (ref. Shoreplan, 2022)

Figure 2.2: Collapsed portion of stacked armour stone seawall at west shore

2.1.2 West Headland

The west headland is protected with a grouted stone revetment with additional armour stone on the lower part of the slope. Significant damage to the armour layer at the west headland was noted during a site visit on April 29, 2022, including loss of armour cover, exposure of underlying smaller stone material, and cracking of the grouted slope (see Figure 2.3). Shoreplan (2022) reported that there was significant toe damage near the tip of the western most portion of the revetment and that the grouted revetment has collapsed in some areas exposing the underside of the revetment and the rip rap bedding. Deterioration of the armoured slopes at older lakefill sites is not an uncommon occurrence in Toronto.

Figure 2.3: Deteriorated grouted armour revetment protection at west headland (Baird 2022-04-29)

2.1.3 East Headland

The east headland is protected with a grouted stone revetment with additional armour stone on the lower part of the slope. Baird noted significant damage to the grouted armour layer at the east headland during a site visit on April 29, 2022. Jacobs (2020) reported that several cracks were observed in the grouted stone revetment, and some undercutting and loss of material was observed near the waterline (see Figure 2.4). Jacobs also identified that there is the possibility of additional undercutting below the waterline, which could eventually cause the revetment to collapse; however, they did not assess the damage below the waterline. Jacobs (2020) assessed the overall condition of the east headland revetment as "poor to serious." Shoreplan (2012) also reported that the grout between the armour stones at the east headland was broken up and that there were large voids in the structure. Shoreplan concluded that the east headland was in poor condition and in need of repair. Shoreplan (2022) notes:

> "*A sizeable portion of the east side of the revetment is collapsed likely due to undermining the grouted armour stone surface. The collapsed area extends more than halfway up the slope. The revetment above the collapsed area is also undermined, exposing grout bags that were placed underneath the revetment and the underside of the grouted armour stone and rip rap. The toe of the revetment is consistently undermined across the whole sub-reach. Voids extend more than 1.5m up the slope from the toe with some areas extending to more than halfway up the revetment.*"

The crest elevation of the east headland is low relative to the design high water level and is subject to significant wave overtopping and flooding.

Figure 2.4: Deterioration of grouted stone revetment at east headland (from Jacobs, 2020)

2.1.4 South Shore

The south shore, between the west and east headlands, consists of a relatively small, narrow perched beach (see Figure 2.5 and Figure 2.6). Above the waterline, remnants of the imported stone veneer that had been placed on the underlying rubble fill and worn-down pieces of the original construction rubble (e.g., concrete, brick, and asphalt) and material from the eroding lakefill are visible. Larger lakefill rubble material is exposed at the back of the beach by the walkway (see Figure 2.5 and Figure 2.6). Exposed lakefill rubble material is also evident in the nearshore area below the water (see Figure 2.5). Since the original construction of Ontario Place, the length south beach has decreased from about 120 m in 1972 to about 85 m at present due to the placement of additional armouring material at the ends of the beach to protect the backshore lakefill from erosion (e.g., see Figure 2.7 and Figure 2.8).

Due to the narrow width and relatively low elevation of the beach, it is inundated at high water levels allowing waves to directly attack the backshore fill (see Figure 2.8). Ongoing erosion of the lakefill perimeter is evident at the shore. The width of the existing walkway along the south shore is narrow and subject to flooding and wave overtopping. The overall condition of the beach area was assessed by Jacobs (2020)[4] as “fair to poor”; Shoreplan (2012)[5] reported similar findings. Higher design water levels due to the Lake Ontario regulation plan and climate change impacts increase the risk of future flooding and erosion damage at the south shoreline.

[4] Jacobs, 2020. Ontario Place Coastal Assessment, Technical Memorandum No. 1, December 18.
[5] Shoreplan Engineering Limited, 2012. Ontario Place Preliminary Coastal Assessment, Technical Memorandum, November 30.

Figure 2.5: Narrow south shore (beach area above water approximately 320 m^2); additional armour placed at west end; erosion of lakefill at east side; and rubble in nearshore (ref. Google Earth 2019/6/22)

Figure 2.6: South shore with exposed lakefill rubble at the back of the beach (Baird 2023-05-06)

Figure 2.7: Additional armour stone placed at the west headland and at the west end of the beach to provide erosion protection to perimeter of lakefill (Baird 2023-5-06)

Figure 2.8: Narrow south shore and significant erosion of lakefill perimeter (Baird 2023-05-06)

2.1.5 North Wall

The north side of the West Island consists of a timber crib with a concrete cap that formed the original breakwater that existed prior to the construction of Ontario Place; the lakefill was placed on the south side of the crib breakwater (see Figure 2.9). The crib structure is now protected with a rip rap stone revetment that was installed in 2014 to 2015 for the PanAm Games (see Figure 2.9). The revetment is made up of a 100 mm to 300 mm diameter rip rap placed with a crest elevation of 75.5 m; the revetment slopes at 3:1 (horizontal: vertical) down to meet the bottom of the north channel (Shoreplan, 2022).

The revetment appears to be in good condition, but the walkway is in poor condition. The crest elevation of the north wall is lower than the 100-year flood level, and the walkway and backshore area are subject to flooding. Jacobs (2020) assessed the overall condition of the flood defence as “fair.” The width of the walkway is narrow, crowding pedestrians and cyclists; it does not provide adequate space for emergency vehicle access.

Past the westerly end of the West Island, the lakeside of the existing breakwater is exposed to wave action (see Figure 2.11), and the inner side is protected from overtopping waves with armour stone (Figure 2.12) that was installed at the same time as the rip rap revetment, described above.

Figure 2.9: View looking west of the north wall of West Island (left-hand side of photo) with rip rap revetment protection.

Figure 2.10: Rip rap revetment along the north wall of West Island

Figure 2.11: View to the west of exposed existing breakwater extending westward from the West Island

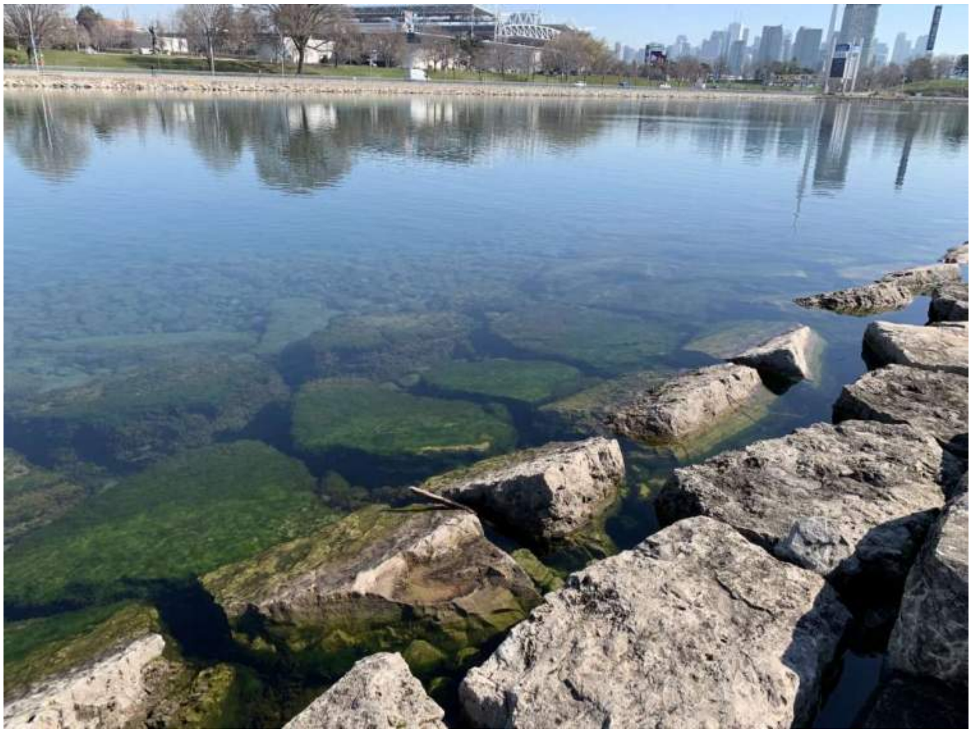

Figure 2.12: Armour stone along the inner side (north side) of the westerly portion of the existing breakwater

2.1.6 East Shore

The east shore of the West Island is protected with various structures, including steel sheet piling (see Figure 2.13), timber piling, stacked armour stone walls and rip rap revetments. Jacobs (2020) assessed the steel sheet piling, armour stone units wall and riprap conditions as “satisfactory to fair”; Shoreplan (2022) assessed the SSP conditions as “fair” and the armour stone as mostly “good” with some sections in a bit of disarray. Both Jacobs (2020) and Shoreplan (2022) noted that the area protected by timber piling showed signs of decay and some damage to the anchorages; the overall condition of the timber piling flood defence was assessed by Jacobs and Shoreplan as “poor”. The shoreline elevation is lower than the 100-year flood level and is subject to flooding at high water levels. There are no intentional aquatic habitat features incorporated into the shoreline.

Figure 2.13: Steel sheet pile wall and timber pile wall at the east shore of West Island

2.2 Public Space and Connectivity to Water

The current public realm on the West Island consists of narrow trails and eroding shoreline areas providing limited access and connection to the water's edge. There is an existing ad hoc, narrow rubble beach on the south shore, which is inundated at higher water levels restricting the space available for public use. Remnants of the west shore beach protections are visible beneath the water and within the vegetated lake edge, but no evidence of the initial beach appears to exist. Both the west and south shore are subject to erosion. Public amenities along the lake edge and within the lagoon areas are very limited and not accessible to individuals with physical limitations. A remnant boardwalk is visible along the north channel, but it has degraded and shows signs of inundation during periods of high water. Overall, public accessibility to the shore may be limited by physical and visible hazards above and below the water.

2.3 Aquatic Habitat

When Ontario Place was developed, no attention was paid to designing the new shorelines to provide habitat for fish species and aquatic life. Over time, some efforts have been made to enhance aquatic habitat features along limited parts of the West Island shoreline. However, the design of the shore itself lacks the integration of intentional fish habitat features as would be the case if the West Island was being designed today. Currently, there is a lack of habitat supporting reproduction, cover, feeding and growth for fish species. The proposed modifications and enhancements to the West Island shoreline provide the opportunity to integrate intentional features and reduce the less desirable elements such as vertical walls.

2.4 Summary

Table 2.1 summarizes the problems and opportunities associated with the West Island shoreline.

Table 2.1: Shoreline Problems and Opportunities

	Problems	Opportunities
Shoreline Protection	Existing protection around original artificial islands past its initial 50-year design life; Island perimeter shoreline protection is damaged and deteriorated and in need of replacement/rehabilitation.	Rehabilitate/replace shoreline protection to meet modern shoreline engineering design standards at the 100-year storm and provide further 50-year design life, preserve the integrity of artificial islands, allow terraced section for improved public access.
	Higher design water levels due to the Lake Ontario regulation plan and climate change impacts increase the risk of future erosion and flooding damage.	The new shoreline protection design will include an updated 100-year flood level based on recent scientific advances and resiliency measures for climate change for erosion and flooding hazards.
Public Space and Connectivity to Water	Narrow public space around the perimeter of the artificial island with only limited access and connection to the water's edge.	Increase the width of the perimeter public realm for pedestrians, cyclists, and emergency vehicles; provide waterfront park amenities and canoe/kayak docking.
	The existing ad hoc rubble beach on the south shore is narrow and inundated at higher water levels, which further restricts space available for public use. The existing beach is insufficient to protect the fill from serious erosion.	Provide a wider beach at the west shore with higher crest elevation to provide more public space and improve shoreline protection even at higher water levels; submerged reef at west headland helps shelter beach. Provide armouring to protect the south shore and the west and east headlands with stepped access to the water's edge at multiple locations.
Aquatic Habitat	Lack of intentional aquatic habitat features along the shoreline.	Enhance aquatic habitat features consistent with TWARS[6], including submerged reef and surcharged open coast revetments.
	The internal shoreline has hard, vertical edges (e.g., timber pilings, steel sheet piles); water is stagnant.	Provide a softer, greener shoreline edge at the east shore and improve the function of the lagoon as a wetland.

[6] TWARS: Toronto Waterfront Aquatic Habitat Restoration Strategy.

2.5 Environmental Management Context

There are three policy or strategy documents described below that have guided the efforts to incorporate aquatic habitat features within the shoreline works proposed for the West Island.

2.5.1 Lake Ontario Fish Community Objectives

The Great Lake Fisheries Commission, in conjunction with the Ontario Ministry of Natural Resources and Forestry, established a series of guidelines, goals and indicators for the aquatic habitat zones of Lake Ontario (GLFC 2017). Ontario Place is found within the nearshore zone and has three objectives to improve the overall fisheries quality of the lake. The goals of the Fish Community Objectives for Lake Ontario (GLFC 2017) for the nearshore zone are to:

- Maintain healthy, diverse fisheries - maintain, enhance, and restore self-sustaining local populations of Walleye, Yellow Perch, Smallmouth Bass, Largemouth Bass, sunfish, Muskellunge, and Northern Pike to provide high-quality, diverse fisheries.
- Restore American Eel abundance - increase abundance (recruitment and escapement) of naturally produced American Eel to levels that would support sustainable fisheries.
- Maintain and restore native fish communities - maintain and restore native nearshore fish communities, including species that rely on nearshore habitat for part of their life cycle.

These goals are measured by a series of status, trend, or restoration indicators that include the increase of population size and reproductive success of popular sport fish, increased numbers of mature species at risk, and the restoration of native fish communities that provide the underlying support for the food web. The proposed additional habitat for Ontario Place will incorporate the focus on a healthy, diverse, and native fish community, incorporating the protection of both at-risk and abundant species in a holistic approach.

2.5.2 Urban Recreational Fisheries Strategy

The Toronto Regional Conservation Authority, along with numerous other conservation authorities and government agencies, has prepared a strategy for the management of the public recreational fisheries along the shore of Lake Ontario (TRCA 2016). The guide outlines six strategies to help improve the quality and accessibility of the fisheries resource.

- Maintain public access with no net loss of existing public fishing areas
- Expand fishing opportunities with improved access
- Improve the quality of the fishery
- Strengthen partnerships
- Promote angling in the Strategy area
- Improve signage

Improving the safety and reliability of the access to the waterfront will support the TRCA's goals for the urban fishery. Developing robust and productive near-shore habitats will support the growth of the fishery for a long time to come. The trails and boardwalks proposed for these areas will help improve the engagement of the public with Ontario Place and the surrounding aquatic ecosystem.

2.5.3 Toronto Waterfront Aquatic Habitat Restoration Strategy

The Toronto Waterfront Aquatic Habitat Restoration Strategy (TWAHRS) was developed by representatives from the Toronto and Region Remedial Action Plan, including Environment and Climate

Change Canada, Ministry of Environment, Conservation, and Parks, Ministry of Natural Resources and Forestry, City of Toronto, and TRCA staff (TRCA 2020). The report outlines four main objectives to achieve their goal to "develop and achieve consensus on an aquatic habitat restoration strategy that will maximize the potential ecological integrity of the Toronto waterfront."

These objectives are:

- Identify the potential for self-sustaining aquatic communities in open coast, sheltered embayment's, coastal wetlands and estuaries.
- Identify limiting factors, evaluate opportunities and propose actions to protect and enhance nearshore habitats and restore ecological integrity.
- Develop sustainability indices to evaluate the success of the strategy, taking into account changes in land use and policy context.
- Develop an implementation plan to restore aquatic habitats on the Toronto waterfront, including targets, actions, roles and responsibilities, public education, regular reporting and plan review.

Habitat development and restoration strategies developed by TWAHRS will be incorporated into the design of the West Island of Ontario Place. Features such as surcharged revetements, underwater reefs, and vegetation zones have shown great success elsewhere along Toronto's waterfront and will be the foundations of the habitat compensation at Ontario Place. Improving the resiliency and diversity of the aquatic habitat will support the TWAHRS goal of developing an ecologically connected waterfront for the city and the province to enjoy.

2.6 Study Areas

The description of existing conditions is focussed on the West Island of the Ontario Place site and the waters surrounding it. The waters around the West Island are particularly important as the assessment is focused on impacts on water quality and aquatic habitat.

2.7 Project Time Frames

For similar shoreline projects, two timeframes are examined. The construction phase of the project is anticipated to commence following receipt of approvals and permits. The construction phase for the shoreline works is part of the larger construction period for the Therme facility and the redevelopment of Ontario Place. The establishment phase will commence once construction is complete. The new shoreline works, and associated park space will exist indefinitely into the future; however, monitoring and adaptive management will occur for 10 years after construction.

CHAPTER 3. DESCRIPTION OF THE EXISTING ENVIRONMENT

Unless otherwise stated, topographic elevations presented in this report are in metres (m) referenced by the Canadian Geodetic Vertical Datum CGVD1928: pre-1978 adjustment; this is the City of Toronto vertical datum. For brevity, topographic elevations are referred to as “m CGVD” in this report. Water levels presented in this report are in metres referenced to International Great Lakes Datum IGLD1985; for brevity, water levels are referred to as “m IGLD). CGVD28: pre1978 elevations are 0.045 m higher than International Great Lakes Datum 1985 (IGLD85) elevations, i.e., CGVD1928: pre1978 elevation = IGLD1985 elevation + 0.045 m. Water depths are reported relative to chart datum; chart datum for Lake Ontario is 74.2 m IGLD and is the elevation that water levels infrequently go below.

3.1 Physical Environment

3.1.1 Bathymetry

A high-resolution multibeam bathymetric survey was completed offshore of the West Island in September 2022. Depths to the west of the West Island are typically 4 m to 5 m below chart datum, while at the south shore, the depths quickly reach 8 m to 9 m below chart datum. Figure 3.1 presents an oblique image of the bathymetry using an exaggerated vertical scale.

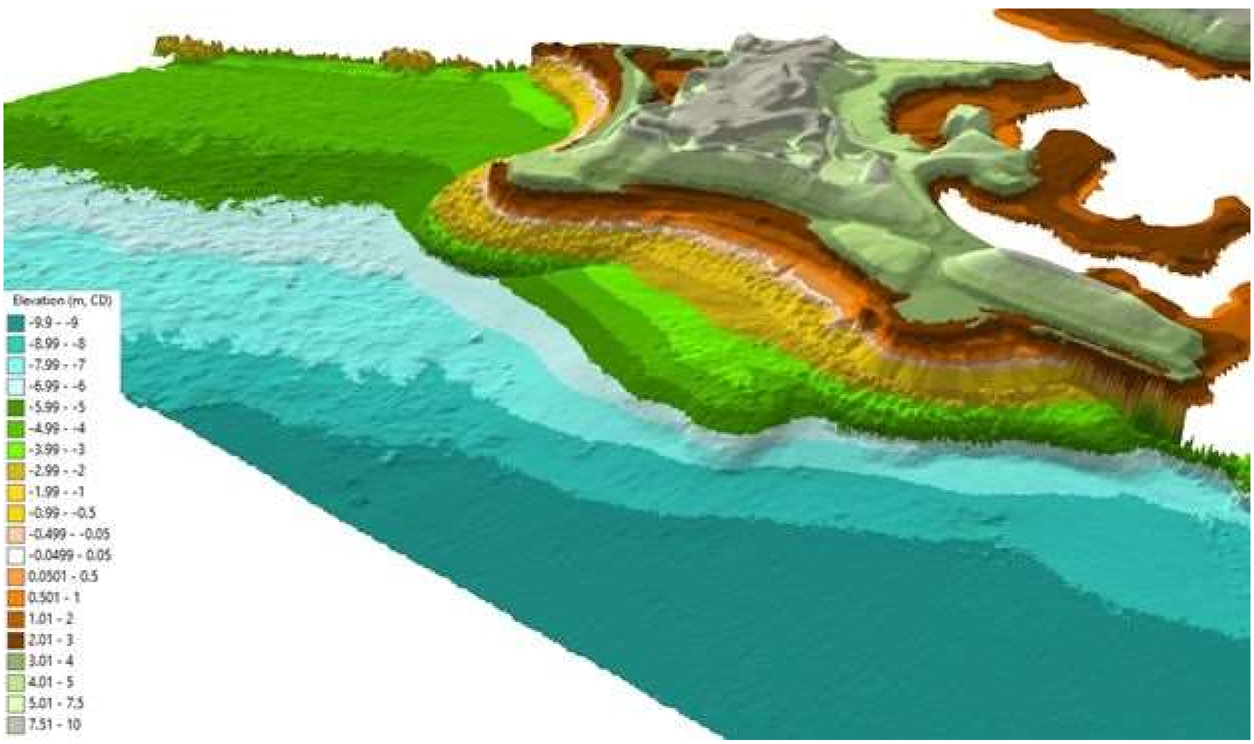

Figure 3.1: Bathymetry at West Island (note vertical scale is exaggerated x3)

3.1.2 Lakebed Substrate and Surficial Sediments

The lakebed substrate and surficial sediments around Ontario Place within Humber Bay are comprised of both glacial and post-glacial deposits over bedrock.

Bedrock

The bedrock topographic contours show a deep bedrock valley extending offshore from the Humber River into Humber Bay. Bedrock elevation contours at Ontario Place indicate that bedrock is found at or near the lakebed surface.

Surficial Sediments

Surficial sediments in Humber Bay are comprised of muddy sands and sandy muds. Areas in Humber Bay where mud deposition exceeds 1 m in thickness were found to occur primarily within an east-west band around the 10-15 m water depth contour. Glacial deposits (glaciolacustrine sediments or till) outcrop in the western area of Humber Bay and just offshore of Ontario Place. Bedrock outcrops are found to the east and west of Ontario Place. To the east, on the west side of Toronto Islands, the sediment is described as sand and gravel.

The surficial substrate offshore of the West Island at Ontario Place was mapped. The interpreted surficial geology and lakebed features are presented in Figure 3.2. Bedrock at or near the surface with local glacial till was identified offshore of the western portion of West Island, and silt and sand and glacial till with bedrock at or near the surface was found offshore of the eastern portion. The rubble perimeter slope of the lakefill was identified as rip rap and boulders, and cobbles.

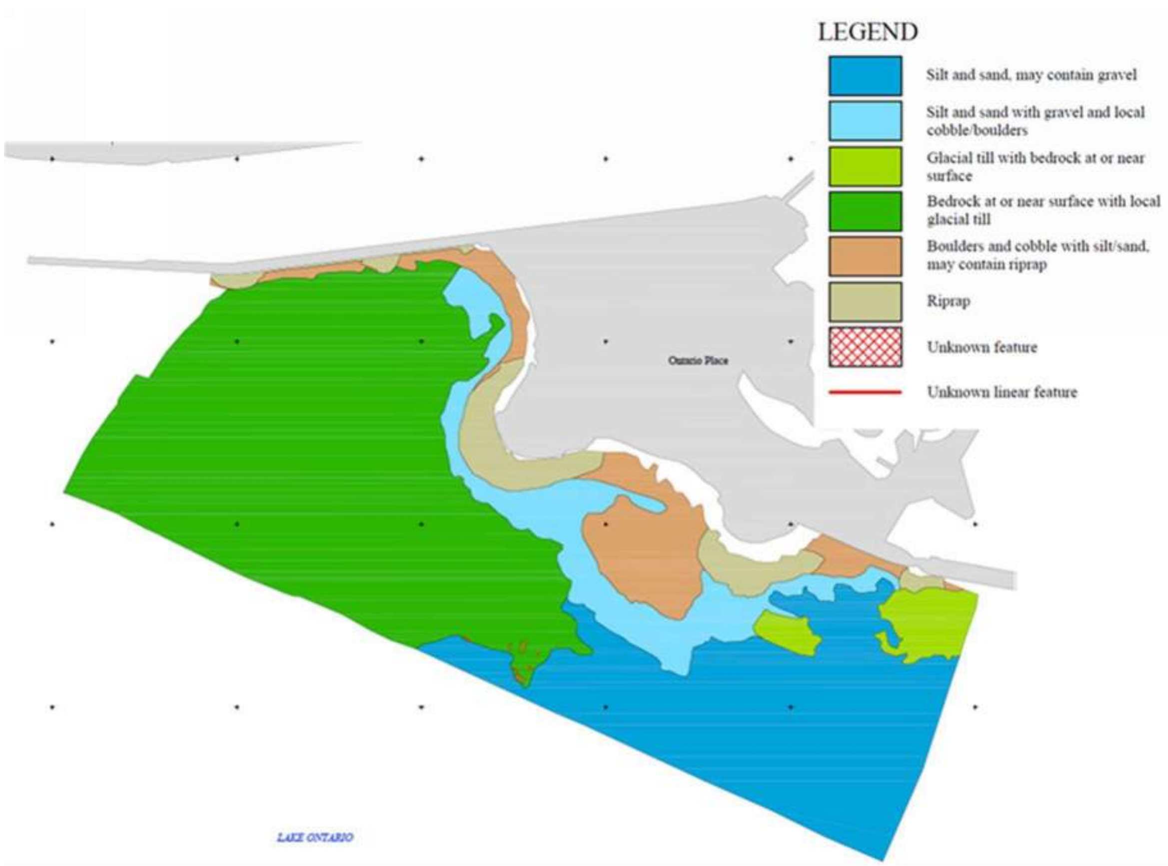

Figure 3.2: Mapped surficial substrate offshore of West Island (ref. CSR, 2022)

3.1.3 Littoral Processes

Ontario Place is located within a large littoral cell that includes approximately 9.5 km of shoreline extending from the west limit at Humber Bay Park East to the east limit at Gibraltar Point at the west end of the Toronto Islands (Figure 3.3). A littoral cell is a shoreline compartment that contains all sediment sources, transport paths and sinks. The littoral cell boundaries delineate the geographical area within which the budget of sediment is balanced and thus provide the limits for assessing impacts.

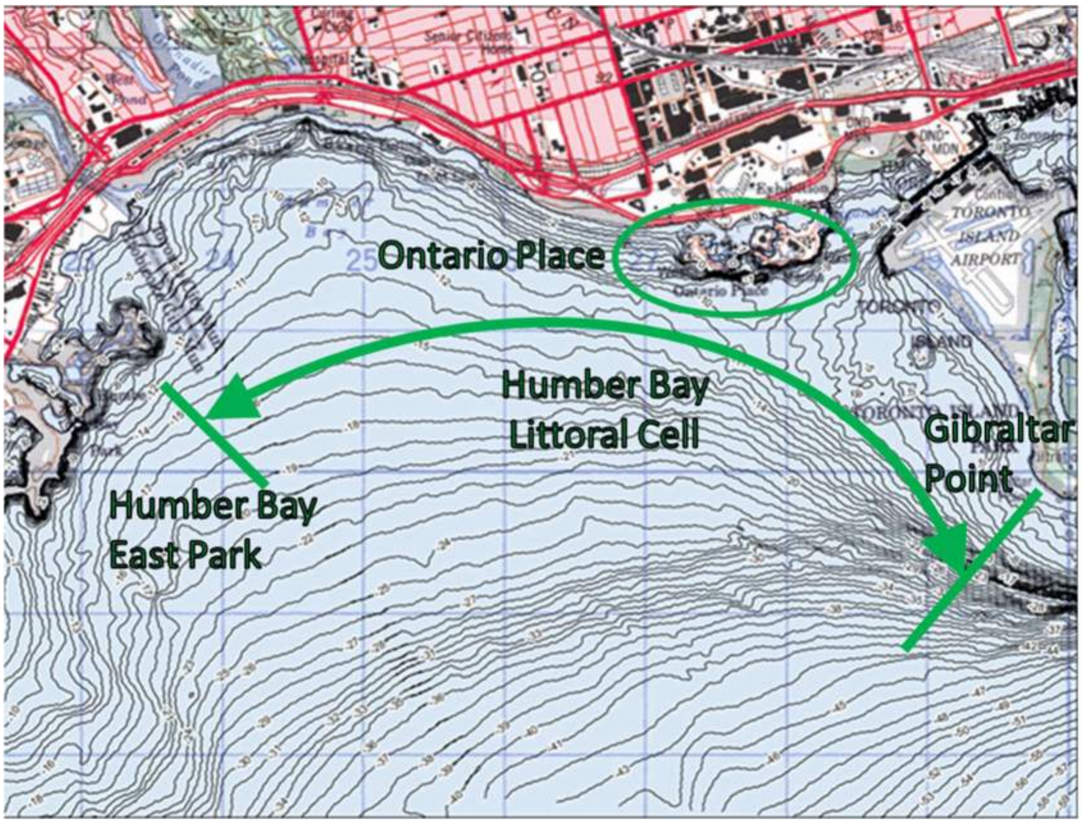

Figure 3.3: Ontario Place located within Humber Bay littoral cell

The shoreline from Humber Bay Park East to the Humber River is protected with armouring and constructed headland/beach structures. From the Humber River to Ontario Place, the 4 km length of the shoreline is protected by offshore breakwaters. Ontario Place, constructed by lakefilling, comprises about 1.5 km of shoreline, including the West Island, which is about 0.5 km of shoreline. East of Ontario Place is about 0.5 km of breakwater structures; then the littoral cell shoreline is interrupted by the Western Gap entrance to Toronto Harbour. The remainder of the littoral cell extends from the Western Gap to Gibraltar Point on the Toronto Islands, including about 2 km of beach and beach and reef shoreline.

For more than 50 years, there has been minimal longshore sediment transport within Humber Bay due to the littoral barriers formed by the Western Gap to the east and Humber Bay Park to the west and the presence of almost continuous offshore breakwaters both to the east and west of Ontario Place.

3.1.4 Wind

Figure 3.4 is a wind rose to show the distribution of speed and direction at Toronto Island / City Centre airport. The most frequent winds come from the east and west and vary by season. The distribution of winds by direction follows a similar pattern for all periods during the year.

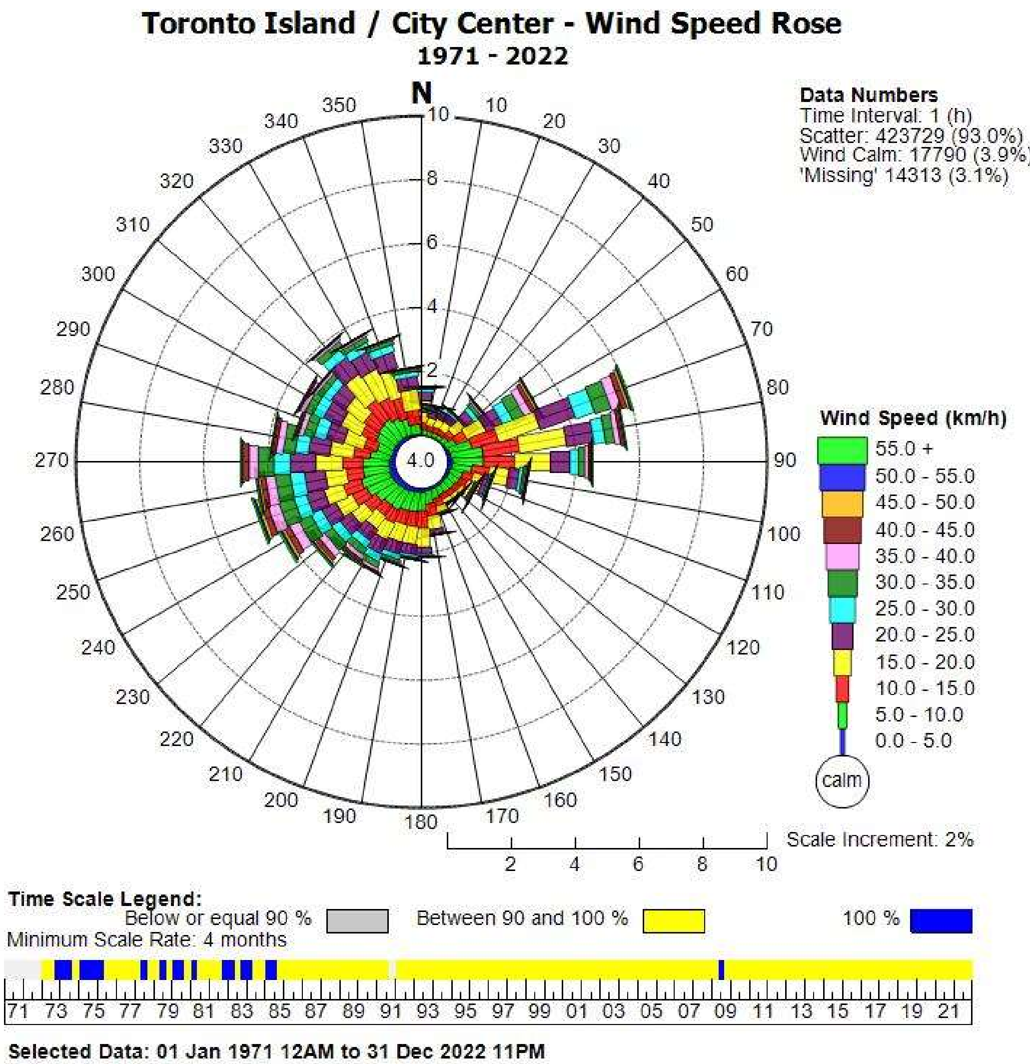

Figure 3.4: Wind rose 1971 – 2022, Toronto Island / City Centre airport

Potential Effects of Climate Change on Storms

There is concern that the frequency and intensity of severe storms will increase as a result of climate change (http://glisa.umich.edu/media/files/GLISA_climate_change_summary.pdf , 2014). It is uncertain how climate change will quantitatively impact the frequency and intensity of storms in the area. Increased temperatures (both in air and in water) may cause wind speeds to increase due to the lower stability of the atmosphere and higher turbulence (McDermid et al., 2015). Variability is also expected to increase. While model projections of average wind speeds seem to conflict with each other (some projecting increases and others projecting decreases), extreme events are likely to become more frequent and have higher intensity. However, there is low evidence and low agreement among projections. Climate models are often too coarse to capture small-scale land and atmospheric processes that generate wind and gusts. Some studies have downscaled these models and made inferences about future conditions, but there is low confidence in their conclusions.

Baird evaluated the potential impacts of climate change on future wave heights and storm surges for Lake Ontario as part of an NRCan-supported study, *Adapting to the Future Storm and Ice Regime in the Great Lakes Lake Erie and Ontario Nearshore Wave and Surge Modelling* (2019c). The analysis showed no obvious trend with respect to wave and surge levels, as the model predicted both larger and smaller wave and surge conditions in the future. This suggests that wind events in the future may not cause a significant change in wave and surge conditions on Lake Ontario based on the future emission scenario used for the study. Baird 2019a and Baird 2019c did not identify an increase in storm surge magnitude due to climate change.

3.1.5 Lake Currents

The hydrodynamics (or current climate) of Lake Ontario is largely driven by winds generating lake-wide currents and/or circulations through the Lake. Wind-driven currents are created by the wind exerting stress on the lake's surface. This stress causes the surface water to move, and this movement is transmitted through vertical mixing in the underlying water to a depth that is dependent mainly on the strength and persistence of the wind. In a large lake, such as Lake Ontario, the combination of persistent winds, the earth's rotation, and restrictions on lateral movements of water caused by shorelines and shallow bottoms induces upward (upwelling) and downward (downwelling) water movements. Wind-driven currents enhance vertical mixing that strongly influences the water quality of the shallow water areas. As discussed later in Section 3.1.8, winds can also cause wind surge (also known as wind setup) events at the down-wind end of the lake resulting in a hydraulic gradient that is then levelled in a process called a seiche.

Lakewide (or synoptic scale) currents are significantly smaller in magnitude. These general currents act as a cyclonic (anticlockwise) motion during summer with a reversal (anti-cyclonic eddy) in the northwest corner, including near Toronto (see Figure 3.5). A current rose at mid-depth is presented in Figure 3.6, showing the predominance of the currents moving from the southwest to northeast. Thermal stratification in the Lake accounts for a component of the cyclonic current when warm water moves offshore and is deflected by Coriolis forces. Current (synoptic scale) annual velocities average 1 - 2 cm/s with maximum values of 3 - 4 cm/s (Beletsky et al., 1999).

The strongest currents in Lake Ontario occur because of prevailing winds and waves near the shoreline. Waves breaking in the nearshore (i.e., the surf zone) generate strong longshore currents.

On a local scale, rivers and creeks, bathymetric features, intakes, and outfalls may introduce currents that may exceed the wind-driven currents, particularly in the vicinity of shorelines. Near outfalls and rivers, there are also density-driven currents related to warmer or cooler discharges relative to the local lake temperature.

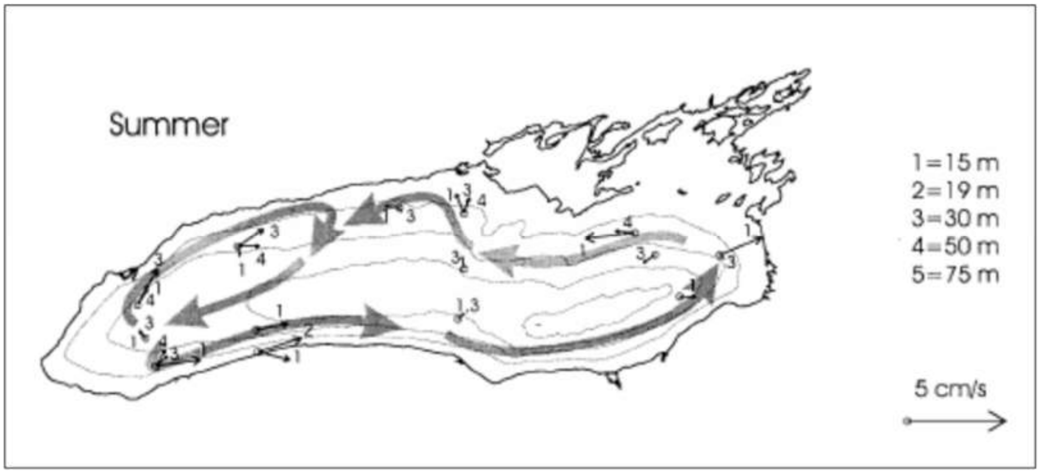

Figure 3.5: Lake Ontario average summer circulation pattern (Beletsky et al., 1999)

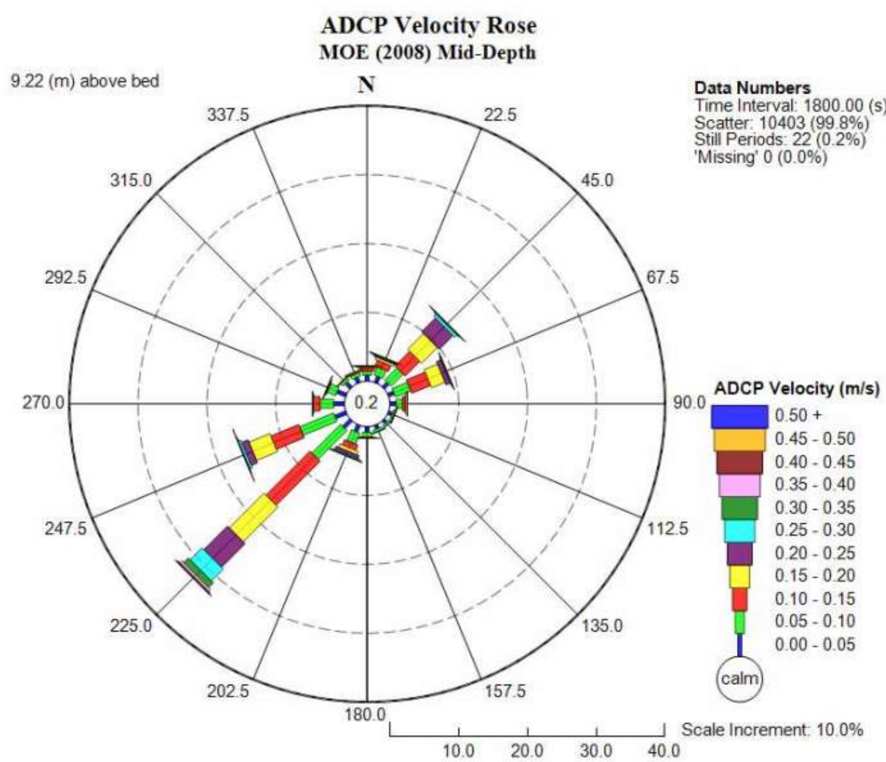

Figure 3.6: Current rose at mid-depth, east of Toronto Harbour

3.1.6 Lake Water Temperature

In the summer, the surface water temperatures in Lake Ontario peak around 12° - 20° Celsius (see Figure 3.7), while temperatures below the thermocline (20 - 45 m depth) are around 4° - 7°. During the winter, there is no thermocline, and the water temperature is about 0 - 4° with the possibility of ice cover at the surface.

The presence of the thermocline influences the nutrient mixing. In the transitional months (i.e., spring and fall), the thermocline disappears, allowing a partial turnover of the nutrients in the Lake between the deep waters and the surface waters.

Lake temperatures in Humber Bay will vary from the average lake temperature due to its limited depth, local currents, and the influence of upwelling and downwelling. Upwelling can occur when southwesterly winds blow along the lake, pushing the warmer surface water away from the north shore towards the south shore due to the Coriolis effect and Ekman transport. As the surface water moves away from the shore, the displaced water is replaced by a return flow, or upwelling, of cooler water from below the surface to the north shore. Downwelling occurs when winds northeasterly winds blow along the lake, pushing the surface water towards the north shore, causing it to sink down to deeper waters. Water temperatures at the shore can rapidly decrease by 4 to 10 °C.

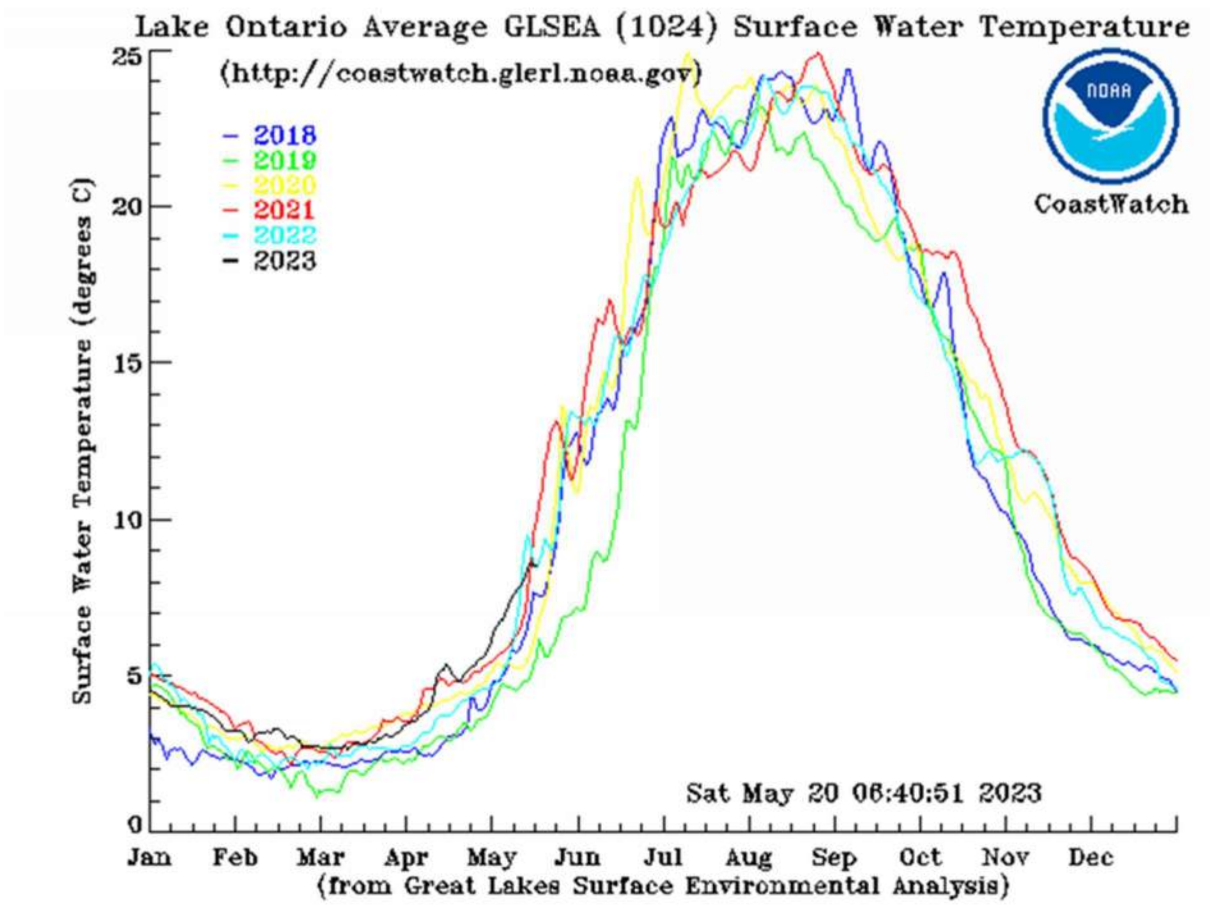

Figure 3.7: Lake Ontario's average surface water temperature

3.1.7 Ice

The formation of ice on the lake during winter months affects the shoreline climate at the project location in two ways. First, the formation of shorefast ice, in combination with an “ice foot,” protects the shoreline area from wave action even when the main body of the lake is relatively ice-free. The second factor is that ice formed within the greater water body has the effect of reducing wave generation during winter months, thereby limiting the wave climate at the site.

Ice forces must also be considered in the design of the perimeter protection of the lakefill structure. Localized damage to the perimeter protection structure can occur because of ice effects (e.g., bulldozing, plucking of stone protection), but ice piled onshore by wind and wave action does not, in general, cause serious damage to sloped rubble-mound structures. Typically, the net effects of ice formation are beneficial, as spray from wind and waves freezes on the structures and covers them with a protective layer of ice. Accepted practice for exposed shorelines of the Great Lakes is to size the primary armour layer to resist wave forces and accept some level of risk that ice damage could occur and that repairs may be required.

On Lake Ontario, ice usually originates (and is most prevalent) at the east end of the lake next to the entrance to the St. Lawrence River. However, in cold winters, it is not uncommon for ice cover to extend west along the north shore of the Lake, where it may occasionally affect Humber Bay. Ice coverage on Lake Ontario varies; typical winter coverage on Lake Ontario peaks around 17%. Ice coverage data refers to the concentration of ice, that is, the fraction of a unit of lake surface area that is completely covered with ice. The Lake is divided into grid cells, and each grid cell is coded with a number between 0 and 100, representing the percentage of that cell that is covered by ice. Mild winters may only have 10% coverage, while severe winters reach 65% coverage. For example, three such extreme events occurred in the winters of 1973, 1979, and 1994; in 1979, there was near-total ice coverage on the Lake. However, when it does occasionally develop, the ice cover is not very thick, and the ice foot is usually less than 2 m deep.

Ice coverage data from 1973 to 2000 was previously extracted for Humber Bay. On average, there are 10 days per year of ice coverage. The maximum was 35 days of ice coverage in 1990; the minimum is zero days. January and February have the greatest numbers of days of ice coverage, with just over 4 days per month on average. There are relatively few days of ice coverage in December (less than 0.5 days/month on average) and March (less than 1 days/month on average).

Consideration has also been given to the potential effects of climate change on the ice conditions in Lake Ontario. Ice at the shoreline protects the shoreline from erosive wave energy. Ice cover on the lake reduces the fetch distance across which the wind blows, effectively reducing wave generation in the winter. Significant winter warming is projected. Available evidence indicates that Lake Ontario's[7]Figure 3.8). The potential absence of lake ice in the future will increase the amount of wave energy that the shoreline is exposed to during the winter months, regardless of whether the wind fields change. It is likely that ice cover will have a higher frequency of a “no ice” condition in the future if global warming continues (Lofgren et al., 2002).

The impacts of climate change on the winds (and resulting waves) will be accounted for in the final design by conducting a sensitivity analysis for a range of wave conditions.

[7]NOAA, 2021. https://research.noaa.gov/article/ArtMID/587/ArticleID/2706/NOAA-projects-30-percent-average-Great-Lakes-ice-cover-for-2021-winter.

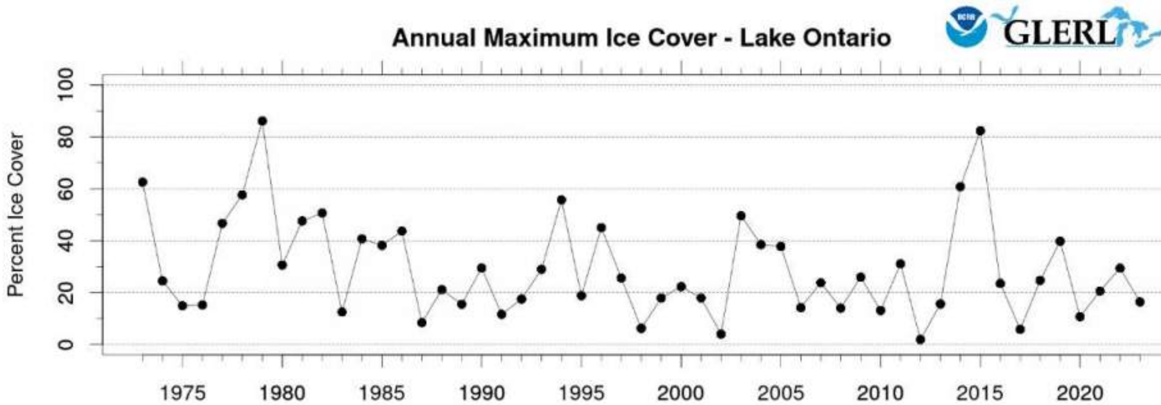

Figure 3.8: Annual maximum ice cover, Lake Ontario (https://www.glerl.noaa.gov/data/ice/#historical)

3.1.8 Water Levels

Water levels on Lake Ontario vary in the long term (i.e., years) and seasonally in response to climatic conditions over the Great Lakes drainage basin (principally precipitation and evaporation), as well as lake level regulation. Future levels may be affected by climate change. Water levels can also vary in the short term (i.e., hours) in response to wind-generated storm surge events.

The water levels of Lake Ontario have been regulated by the outflow of the Moses-Saunders Power Dam located on the St. Lawrence River at Cornwall-Massena since 1960. The previous operation plan for the dam attempted to balance the water needs for multiple stakeholders (e.g., riparian owners, natural habitat, shipping, hydroelectric power generation, recreation) while keeping Lake Ontario water levels within a 1.22 m range, from elevation 74.15 m to 75.37 m IGLD. In December 2016, the International Joint Commission announced implementation of a new regulation plan ("Plan 2014") for Lake Ontario. Under Plan 2014, the most extreme high monthly mean water level on Lake Ontario is expected to be about 6 cm higher than under the previous plan.

A plot of the hourly variations in lake level from 1960 to 2021 at Toronto is provided in Figure 3.9. The typical seasonal variation in lake level (based on monthly mean averages) is approximately 0.5 m, with the average seasonal low occurring in December and the average seasonal high occurring in June.

100-year Flood Level

Water levels were analyzed for this study to define the 100-year flood level, which is the still-water level (or peak instantaneous water level) having a 1% annual chance of being equalled or exceeded. The year-round 100-year flood level (still-water level with return period of 100 years) used in this study is 76.26 m IGLD, which corresponds to a level of 76.3 m CGVD.

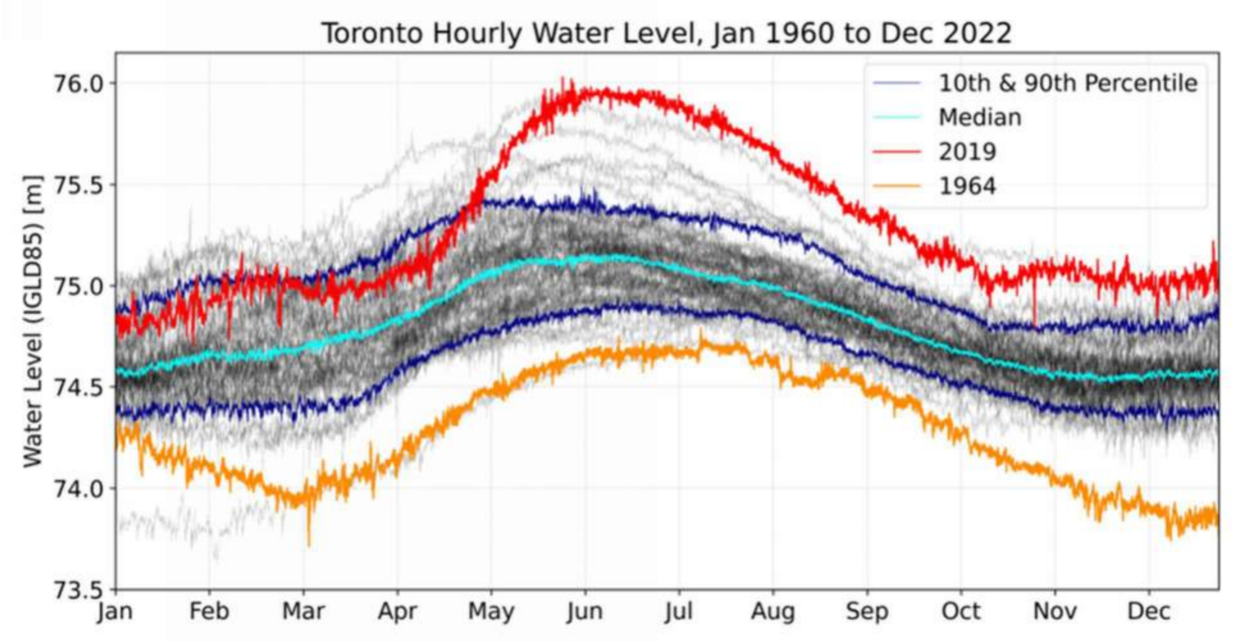

Figure 3.9: Water levels (m IGLD) recorded at Toronto from January to December (1960 to 2021)

Impact of Climate Change on Lake Levels

Environment Canada (2022) has provided estimates of projected lake levels under representative emission scenarios. According to Environment Canada, an increase in Global Mean Temperature will likely result in an increase in the range of lake levels, resulting in higher extreme high and lower extreme low water levels.

For the present Project design and to assess the potential requirement to raise the shoreline protection crest elevation in response to climate change, it has been assumed that mean lake levels will increase at a uniform rate of 5.5 mm/year over the planning horizon. This assumed rate is consistent with Environment Canada (2022) projected increase in Lake Ontario water level of 33 cm over 60 years at the 50% exceedance level.

3.1.9 Wave Climate

Wind is the primary forcing mechanism to generate waves on the Great Lakes. A state-of-the-art wave model called WAVEWATCH III was used to simulate historical wind-wave events on Lake Ontario over the last 41 years; this is known as a wave hindcast. Wave conditions just offshore of the West Island at Ontario Place were characterized by extracting hourly timeseries of simulated wave height, period, and direction from the WAVEWATCH III hindcast at various locations around the property.

A summary of the wave climate is presented in Figure 3.10 in the form of a wave rose. A wave rose is a graphical plot that illustrates the distribution of wave height and direction for the duration of the hindcast. The plot uses a polar coordinate system with wave height frequency plotted by direction. Note that the wave rose uses a meteorological convention for wave direction, which shows the direction the waves are "coming from." The frequency of waves from each direction on the rose is represented by the length of the spoke, with each spoke featuring colour bands indicating wave height and frequency of occurrence.

The directions of the longest spokes, therefore, show the dominant directions of the waves. The percentage of time waves that are calm is shown at the centre of the plot. A review of Figure 3.10 shows that just offshore of the West Island the dominant wave directions are from the south-southwest (202.5°) and southeast (135°), although the largest waves occur from the south-southwest. The highest hindcast wave height was 2.9 m from the south-southwest, with a wave period of 8 seconds.

Extreme value analysis (EVA) was completed separately for the winter months (October to April) waves and the summer months (May to September) waves. The 25-year return period wave height for the winter months is 2.7 m, and the 25-year wave height for the summer months is 2.0 m.

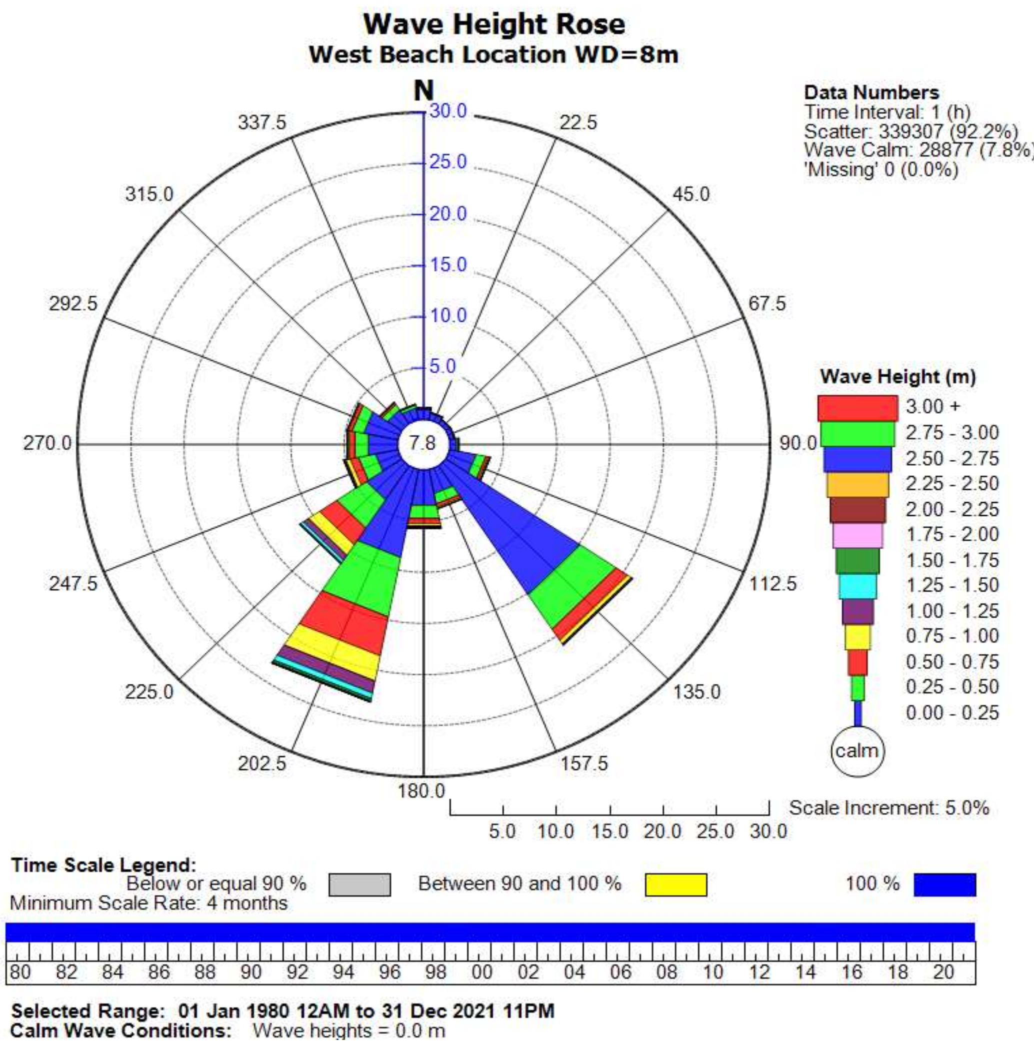

Figure 3.10: Wave rose at point just offshore of West Island, Ontario Place (Jan 1980 to Dec 2020)

3.1.10 Natural Flood and Erosion Hazards

For determining the shoreline hazards, Ontario Place is classified as an "artificial shoreline" in accordance with the Ontario Ministry of Natural Resources Technical Guide (2001) [8]. The flood and erosion hazards for the artificial shoreline enhancements at Ontario Place will be addressed through site-specific coastal engineering studies during final design in accordance with accepted engineering and scientific practice.

Existing Flood Hazard Limit

The existing shoreline at Ontario Place is subject to flooding and inundation. The flood hazard limit is defined as the 100-year flood level plus an allowance for wave uprush and other water-related hazards.

The extent of wave uprush and overtopping along the shoreline is variable as it is dependent on the nearshore wave conditions at the site and the various types of protection structures (e.g., toe elevation, permeability and roughness of slope, crest elevation and detail). The flood hazard limit for the existing shoreline at the West Island is presented in Figure 2.1.

Existing Erosion Hazard Limit

Generally, the erosion hazard limit consists of an erosion allowance plus a stable slope allowance. The Toronto and Region Conservation Authority (TRCA) Lake Ontario Shoreline Flooding and Erosion Hazards map delineates the existing shoreline erosion hazard limit at Ontario Place. The 2022 TRCA mapping for the existing shore applies the standard default erosion rate of 0.3 metres per year and the stable slope allowance of 3.0 horizontal: 1.0 vertical, which are consistent with the Ontario Ministry of Natural Resources (OMNR) Technical Guide for natural shorelines. For the purpose of determining the erosion hazards, Ontario Place is classified as an “artificial shoreline.” The erosion hazards for the artificial shoreline enhancements at the West Island will be addressed through site-specific coastal engineering studies during final design in accordance with accepted engineering and scientific practice.

3.1.11 Water Quality

Water quality is a significant challenge at the Western Toronto Waterfront, including at Ontario Place. The beaches along this stretch of shoreline are impacted by sewage-contaminated discharge from the Humber River, outflows from the City of Toronto combined sewer outfalls (CSOs) and other sources such as bird feces. Figure 3.11shows the proximity of the Humber River discharge and major CSOs to Ontario Place. The Humber River discharges into Lake Ontario 3.9 km west of Ontario Place. The Glendale CSO (“CSO-A”) and the Cowan Avenue CSO (“CSO-B”) are located approximately 2.7 km and 0.8 km west of Ontario Place, respectively. The Strachan / Battery Park CSO (“CSO-C”) is located at the east side of Ontario Place. Other smaller CSOs, or overflow outlets (e.g., Dufferin Street CSO, “CSO-1”) are also present. A schematic of existing CSOs at Ontario Place is presented in Figure 3.12(ref. TYLin, 2023); the City of Toronto confirmed that CSO-1, CSO-2, CSO-3, and CSO-4 are all presently functional, active, and not only for maintenance (pers. comm. K. Tudhope, Toronto Water, 2023-06-15).

[8] Ontario Ministry of Natural Resources (2001). Technical Guide for Great Lakes – St. Lawrence River Shorelines.

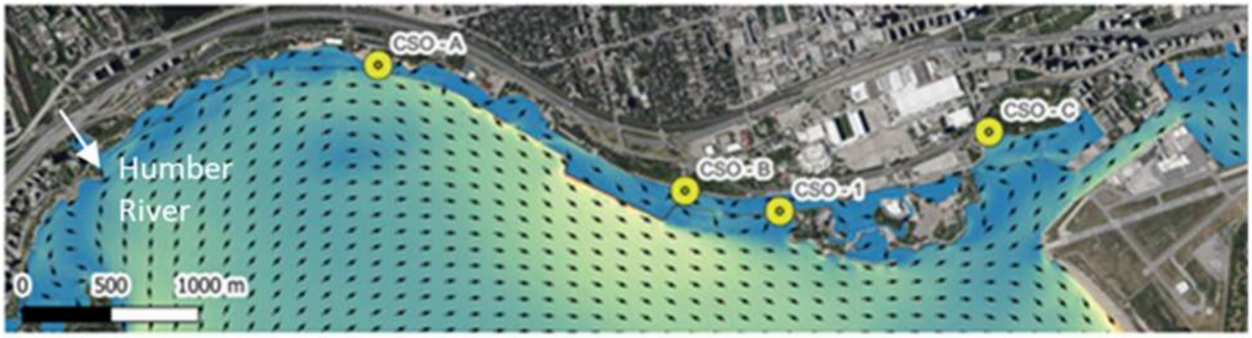

Figure 3.11: Proximity of Humber River and major CSOs to Ontario Place

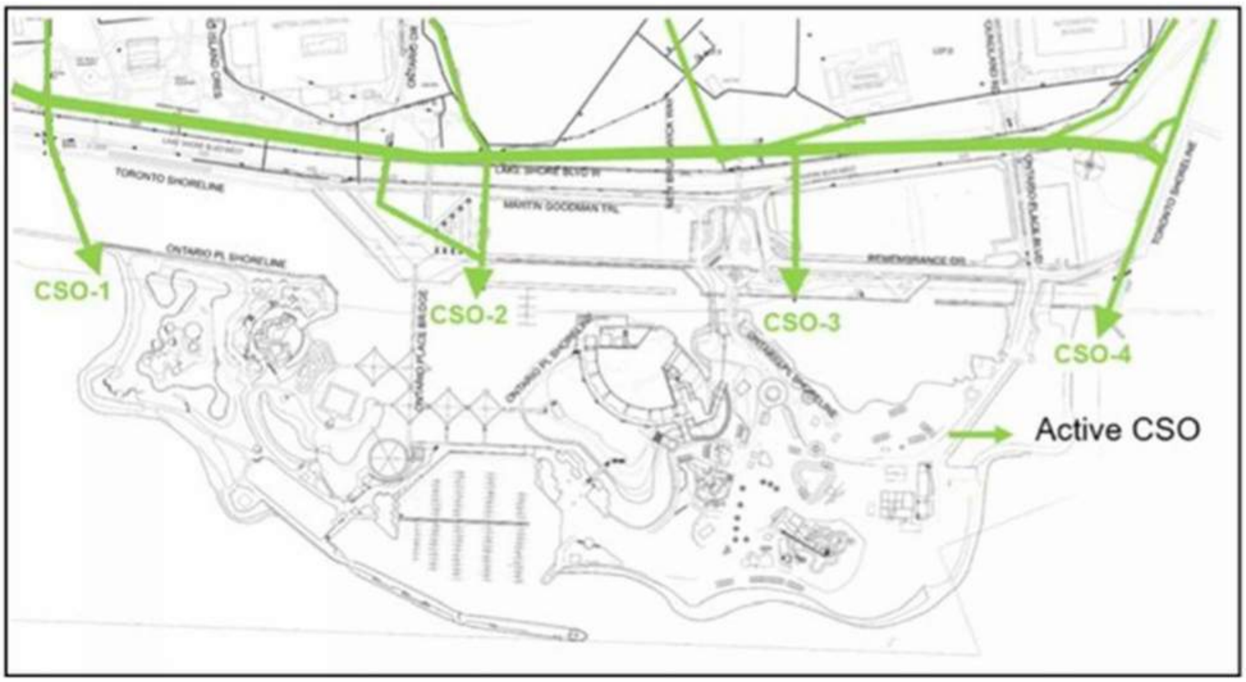

Figure 3.12: Combined sewer outfalls (CSOs) at Ontario Place (ref. TYLin, 2023)

The CSOs are linked to the Western Beaches Tunnel (WBT) system. As described in the City of Toronto Report for Action IE17.1 (October 22, 2020), the Western Beaches Tunnel (WBT) system intercepts and treats combined sewer overflows (CSO) and stormwater from ten previously existing CSO and storm outfalls. Constructed in the late 1990's, the system consists of a 3-metre diameter, 3.6-kilometre long storage tunnel that runs parallel to Lake Ontario, from approximately Parkside Drive to Strachan Avenue, with three main storage shafts (approximately 25 m diameter by 35 m to 40 m deep) located at Glendale, Cowan Avenue and Strachan / Battery Park, six drop shafts, ten sewer interception chambers, and nine lake isolation chambers with overflow outlets to the lake. The WBT was designed to improve water quality conditions at the City's nearby swimming beaches and along Toronto's waterfront, which was degraded due to the continued discharge of untreated sewage combined with stormwater during heavy rains. Since the commissioning of the WBT in the late 1990s, Toronto Water has experienced several operational issues associated with lake water isolation and the pumping and sediment management systems (ref.

City of Toronto Report for Action IE17.1, October 22, 2020). Commencing in 2019, the City has undertaken measures to mitigate the operational issues and improve performance.

The total effluent volumes discharged annually between April – October from CSO-A, CSO-B and CSO-B are shown in Figure 3.13. This data comes from the Wastewater Effluent Systems Regulation (WSER) open data portal reports submitted to Environment and Climate Change Canada by the City of Toronto. Of the three CSOs, CSO-A contributes about 70% of the effluent volume; CSO-B and CSO-C contribute the remaining 22% and 8%, respectively. The volume of effluent discharged from CSO-1 is not known but is expected to be less than all these three. Work is underway to obtain the necessary information from Toronto Water to further assess the risks posed by the CSOs.

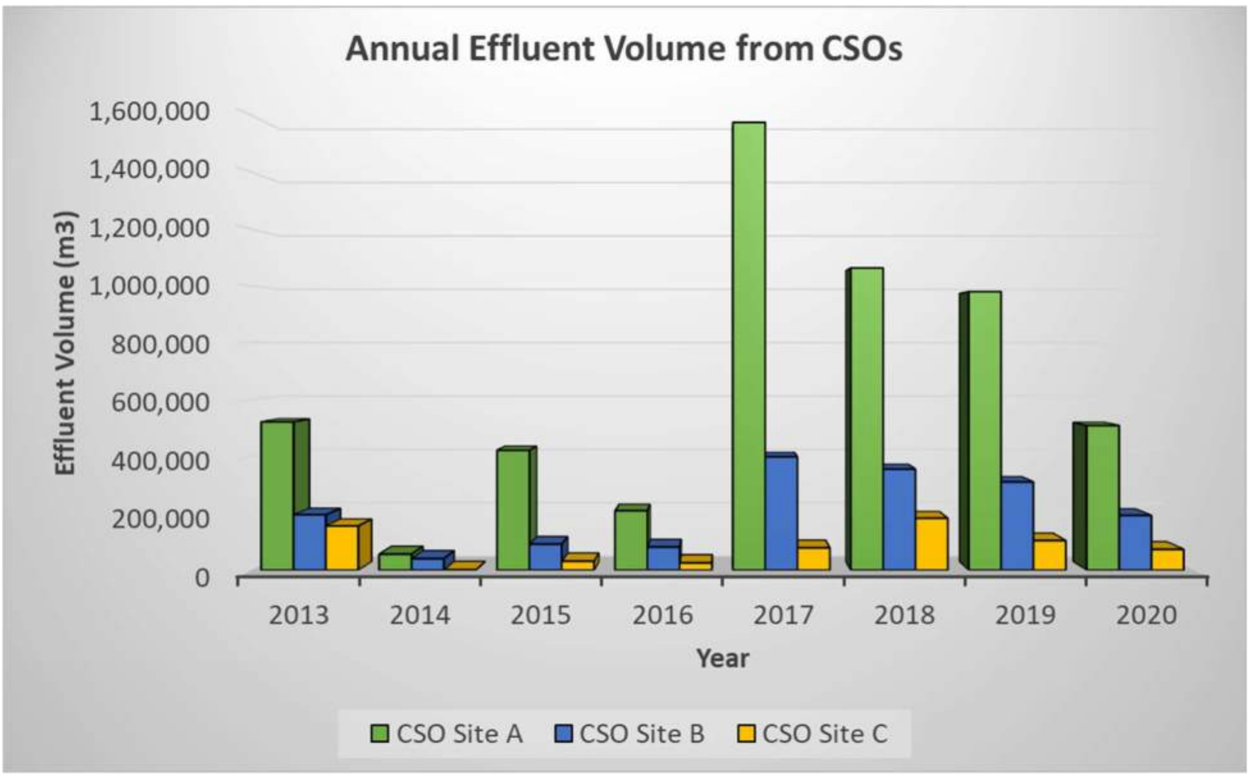

Figure 3.13: Annual effluent volumes from CSOs A, B and C

Escherichia coli (*E. coli*) bacteria is an indicator organism that identifies when other disease-causing organisms are likely present in the water and may pose a risk to swimmer's health. A measure of *E. coli* levels is provided by data collected to monitor beach water quality. Water quality monitoring data compiled by The Swim Guide[9] for Sunnyside Beach (monitored by Toronto Public Health) and Ontario Place south shore and west shore (monitored by Swim Drink Fish as part of their community-based water monitoring program) is presented in Figure 3.14. This figure compares the percentage of time collected water samples are below (i.e., "pass") the Toronto recreational standard of 100 mpn/100 mL E. coli, indicating the beach is considered safe for water contact. In the seventeen months when data for both West Island south shore and Sunnyside Beach are available, Ontario Place south shore had a higher pass rate than Sunnyside for the month about 65% of the time, a lower pass rate about 23% of the time,

[9] (https://www.theswimguide.org)

and was approximately the same about 12% of the time. At Ontario Place West Island south shore the pass rate was 90% and 85% in 2019 and 2021 respectively but was much lower at 33% in 2020. In comparison, Sunnyside Beach met the recreational water quality standards (passed) 68% and 65% of the time in 2019 and 2021 respectively, but like Ontario Place West Island south shore it was also much lower in 2020, with a pass rate of 28%. Based on the available data, the pass rate trend at Sunnyside Beach appears to be reflected in the pass trend at Ontario Place West Island south shore. The reasons for lower pass rates in 2020 at both sites may be related to overall releases from the Humber River and CSO-A and CSO-B.

Concerns have been identified regarding the water quality at the west shore of Ontario Place due to floating debris (branches, trash, etc.) becoming "trapped" in the embayment and the overall lake water quality (e.g., elevated *E. coli* counts) due to the combined sewer outfalls (CSO) in the area, and the direct discharge from CSO-1. Swim Drink Fish added the west shore at Ontario Place to their monitoring program. Figure 3.14 presents the available monthly pass rates for Ontario Place west and south shores for June, July and August 2023[10], the south shore had pass rates of 88%, 50% and 71% respectively, while the west shore had pass rates of 50%, 67% and 83% and Sunnyside had pass rates of 86%, 67% and 61%.

The large CSOs at Cowan, Glendale, and Strachan / Battery Park, as well as the substantial discharge from the Humber River are major factors with respect to the overall degraded water quality within Humber Bay and at the swimming beaches. CSO-1 discharging directly at the west shore likely contributes to the degraded water quality at the west shore.

Birds (e.g., seagulls, cormorants, ducks, geese) are another source of fecal contamination at swimming beaches. Algae may also support the growth of *E. coli* (Byappanahalli et al 2003). Cladophora offers the proper environment for survival of *E. coli* and other indicator bacteria to persist in natural environments for an extended period.

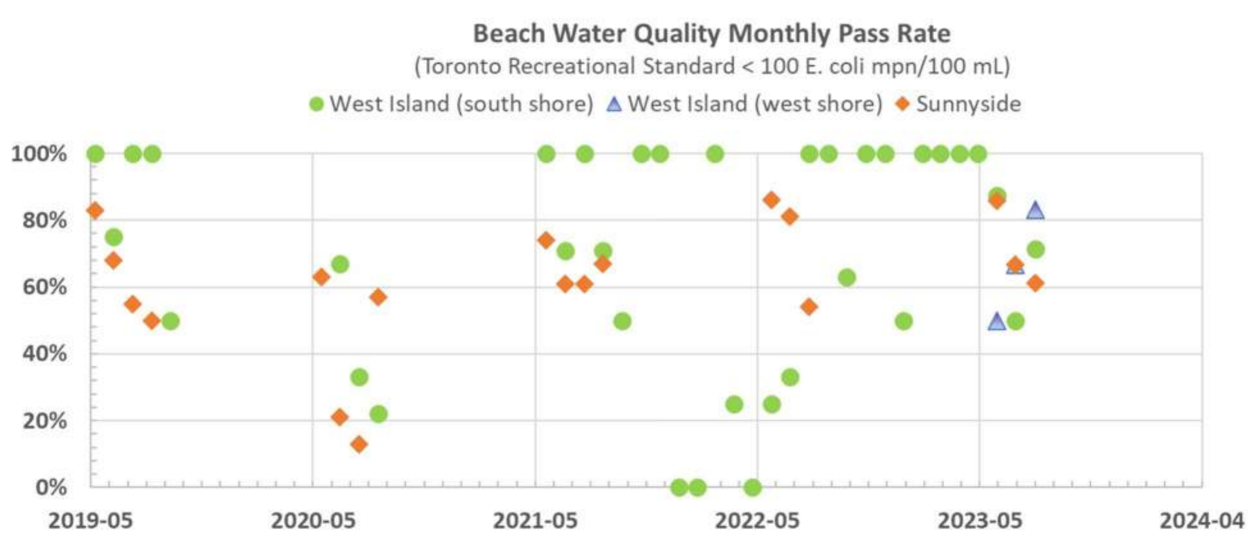

Figure 3.14: Beach water quality monitoring monthly pass rate at south shore and west shore West Island, Ontario Place (ref.theswimguide.org), and at Sunnyside

[10] theswimguide.org

3.1.12 Soils and Geology

The data summarized below was collected by Conestoga-Rover & Associates and Jacobs Consulting Canada Inc. as part of the geological investigations conducted at the Site. Further details and specifications can be found in the respective publications, CRA (2013) and Jacobs (2022).

Ground surface elevation ranged between 75.6 m CGVD and 78.45 m CGVD across the Site. Ground surface extends beneath Lake Ontario, to a minimum elevation of 73.6 m CGVD.

The surface cover at the site is thin (75 to 125 mm thick), and varies across the site (asphalt, interlocking pavers, topsoil etc.). The cover material is underlain by coarse granular fill over sand, silty sand, and clayey silt (CRA, 2013, Jacobs, 2022).

Based on the understanding of the soil quality and possible contamination of the mainland and the East Island, it can be assumed that there are impacts to the West Island as well (Jacobs 2022). As the Site was created from fill materials, the impacts are randomly dispersed throughout the subsurface (Jacobs 2022). Impacts are predominantly associated with metals, PAHs, and PHCs, with additional VOC impacts present across the Site. Prior to any major earth works associated with the shoreline work, assumed soil conditions should be confirmed to reduce the risk of unnecessary exposure and potential release of contaminated sediment to Lake Ontario.

3.2 Biological Environment

The following is a summary of the existing biological environment for the West Island derived from the Natural Heritage Impact Study (NHIS) by MH August 2023. Data on the existing aquatic and terrestrial habitat was reviewed and compiled from photographs, species inventory databases, and existing reports to provide a holistic summary of the state of the shoreline habitat.

3.2.1 Aquatic Habitat

Figure 3.15: North Shore Looking West

Shoreline habitat surrounding Ontario Place's West Island has largely been described as heavily altered by human development and disturbance. Historical lakefilling to create Ontario Place and the subsequent stabilization efforts have focused more on engineering and structural objectives over aquatic habitat function and species. Nevertheless, numerous fish species have been collected at Ontario Place during monitoring events over the past 20 years or so (MH 2023). The nearshore and offshore areas provide little diversity and few opportunities for reproduction, feeding and growth for aquatic species. Nearshore habitat and water quality parameters are likely to be compromised under existing conditions because of a number of human influences including combined storm sewer inlets, which during overflow events introduce phosphorus into the basin habitats. This nutrient input further accelerates algal growth which was observed to be dominant in the interior basin and embayments. Aquatic macrophytic vegetation, where present, may act as a buffer to moderate the negative impact of the algal blooms on water quality parameters. Algal mats are common along the Lake Ontario Waterfront, as are Zebra Mussels (*Dreissena polymorpha*) which also contribute negatively to water quality and the aquatic community.

The North and East shores (see Figure 3.15 and Figure 3.16) of the island are generally more sheltered and protected from the wave action of Lake Ontario, when compared to the South and West Shores. The North and East shores provide cover, nutrient input, foraging opportunities and may support limited spawning for warmwater species that build nests such as Pumpkinseed (Lepomis gibbosus) and Northern Pike (Esox lucius), which deposit eggs that stick to submerged aquatic vegetation. The presence of fine sediments along larger cobbles on the shore, provide habit types for some species in the calmer back-channel areas. The South and West Shores receive greater wave action and disturbance from Lake Ontario and therefore have larger sized substrate and minimal vegetation along the shoreline habitat.

Figure 3.16: East Shore Looking North

Figure 3.17: South Shore Looking West

Figure 3.18: South Shore Looking South

While more than 35 species of fish have been identified in waters surrounding the west island, few types of aquatic habitat are observed, providing minimal habitat functions supporting limited spawning and reproduction, rearing young, and adult cover and growth to a subset of observed fish species (MH 2023).

A description of the shoreline habitat in and around Ontario Place is characterized by the following features.

Open Water Beach Shoreline

A south facing gravel beach occurs on the west island (Figure 3.17). This feature is subject to wave action from the open waters of Lake Ontario. Wave action and general lack of shelter limits opportunities for aquatic vegetation to establish and grow, thus limiting feeding and refuge areas for fish along this part of the shoreline.

Open Water Vertical Walled Shoreline

On land developments and shoreline protection efforts have produced vertical walls of either concrete, steel pilings, or wood pilings that form the shoreline along many sections of Ontario Place (Figure 3.18). Vertical shorelines eliminate depth gradients and reduce establishment of submergent and emergent vegetation that could provide cover and habitat for fish and food sources. Thus, these structures provide minimal opportunities for aquatic species to utilize these features for refuge spaces, foraging habitat, or spawning locations. The water depth is approximately 6-8 m at the shoreline and increases with distance from the shore.

Figure 3.19: Back Channel West Island Looking North

Open Water Protected Sloped Shoreline

Combinations of boulders, riprap, and armour stone make up the dominant class of substrate for these areas. Below water slopes likely comprise rubble fill in the majority. The large substrate comprising the banks provide moderate habitat for fish relative to other features by providing refuge spaces, nutrient collection, or potential spawning locations. This shoreline habitat is suitable to function as refuge habitat for the American Eel, an aquatic species at risk. The water depth is approximately 2 to 4 m at the shoreline, increasing with distance from the shore.

East Shore Vertical Walled Shoreline

Land based developments and shoreline protection efforts have produced vertical walls of either concrete, steel pilings, or wood pilings that form the shoreline along many sections of Ontario Place. These features provide minimal habitat functions including refuge spaces, foraging habitat, or spawning locations for aquatic species. This shoreline habitat is adjacent to sheltered, depositional habitat. Fine sediment and undisturbed vegetation growth are more likely to occur in these areas than the Open Water Vertical Walled Shoreline areas. Water depths are generally deeper than sloped shoreline habitat communities, yet the average water depths are shallower than the open water lake habitat.

East Shore Protected Sloped Shoreline

This habitat community is defined by banks composed of boulder, riprap, or armour stone. These banks provide moderate habitat for fish through refuge spaces, nutrient collection, or potential spawning locations. This shoreline habitat is adjacent to sheltered habitat with relatively shallow depths are shallower than the open water lake habitat.

Figure 3.20: Back Channel West Island Looking North

Back Channel Vertical Walled Shoreline

Land based developments and shoreline protection efforts have produced vertical walls of either concrete, steel pilings, or wood pilings that form the shoreline along many sections of Ontario Place (Figure 3.19). These features provide minimal opportunities for aquatic species to utilize them for refuge spaces, foraging habitat, or spawning locations. This shoreline habitat is adjacent to back-channel habitat within Ontario Place, which is defined by shallow slow-moving water generally confined to narrower banks and more protected from wind and wave action. Soft substrates such as muck, silt, sand, and detritus.

Back Channel Protected Sloped Shoreline

Combinations of boulders, riprap, and armour stone make up the dominant class of substrate for these areas (Figure 3.20). The large substrate comprising the banks provide moderate habitat for fish through refuge spaces, nutrient collection, or potential spawning locations, relative to other features. This shoreline habitat is adjacent to back-channel habitat within Ontario Place, which is defined by shallow slow-moving water and soft substrates such as muck, silt, sand, and detritus.

3.2.2 Fish

Annual electrofishing surveys of Ontario Place have been completed by TRCA and have provided a robust characterization of the aquatic species present. The fish community recorded in and around Ontario Place is diverse with 37 species of fish captured by TRCA since 1990. These species are:

- Alewife (Alosa pseudoharengus)
- American Eel (Anguilla rostrata)
- Black Crappie (Pomoxis nigromaculatus)
- Bluegill
- Bluntnose Minnow (Pimephales notatus)
- Bowfin (Amia calva)
- Brook Stickleback (Culaea inconstans)
- Brown Bullhead (Ameiurus nebulosus)
- Brown Trout (Salmo trutta)
- Common Carp (Cyprinus carpio)
- Common Shiner (Luxilus cornutus)
- Common Logperch (Percina caprodes)
- Emerald Shiner (Notropis atherinoides)
- Fathead Minnow (Pimephales promelas)
- Freshwater Drum (Aplodinotus grunniens)
- Gizzard Shad (Dorosoma cepedianum)
- Golden Shiner (Notemigonus crysoleucas)
- Goldfish (Carassius auratus)
- Green Sunfish (Lepomis cyanellus)
- Lake Chub (Couesius plumbeus)
- Largemouth Bass (Micropterus salmoides)
- Lepomis sp.
- Mottled Sculpin (Cottus bairdii)
- Northern Pearl Dace (Margariscus nachtriebi)
- Northern Pike
- Pumpkinseed (Lepomis gibbosus)
- Rainbow Smelt (Osmerus mordax)
- Rainbow Trout (Oncorhynchus mykiss)
- Rock Bass (Ambloplites rupestris)
- Round Goby (Neogobius melanostomus)
- Mallmouth Bass (Micropterus dolomieu)
- Spotfin Shiner (Cyprinella spiloptera)
- Spottail Shiner (Notropis hudsonius)
- Threespine Stickleback (Gasterosteus aculeatus)
- Walleye (Sander vitreus)
- White Sucker (Catostomus commersonii)
- Yellow Perch (Perca flavescens)

While the number of fish species observed in the waters surrounding Ontario Place may appear diverse, as mentioned in Section 3.2.1, the surrounding waters provide limited habitat for reproduction and growth and many of the observed fishes may not be able to compete their life cycle in the area. The fish community surrounding the west island of Ontario Place has species that prefer warm-, cool- and cold-water habitats and a wide diversity of substrate and vegetation cover. The marginal habitat currently available at Ontario Place limits the habitat use of these species. A greater diversity and availability of habitat could potentially improve overall productivity of the ecosystem. A review of the provincial and federal Species at Risk (SAR) databases indicated that there were three protected species in proximity to Ontario Place in Lake Ontario; American Eel, Shortnose Cisco (Coregonus reighardi) and Deepwater Sculpin (Myoxocephalus thompsonii). Only American Eel have ever been captured in the Ontario Place electrofishing effort. The existing habitat of Ontario Place is not suitable to support life histories for Shortnose Cisco and Deepwater Sculpin. Neither Shortnose Cisco nor Deepwater Sculpin are expected to inhabit the waters surrounding Ontario Place.

3.2.3 Vegetation

Minimal shoreline vegetation was observed along much of the West Island of Ontario Place. Aquatic vegetation was present in less than half of the aquatic habitat survey locations conducted by MH. There was no evidence of emergent or floating aquatic vegetation at any of the survey locations. Minimal submergent vegetation was observed during the shoreline habitat assessments. Curly-leafed Pondweed (*Potamogeton crispus*), Elodea (*Elodea* spp.) and *Potamogetan* spp were the only identified taxa. Curly-leafed pondweed is a non-native species introduced to several locations throughout the property. No aquatic vegetation was observed in the open water areas, likely due to the wave action. The more protected waters of the marina and back channels allow for vegetative growth due to softer, unconsolidated substrates. Fine substrate and water clarity allow for plants to establish in the deeper areas. These finer substrates are more likely to accumulate in these areas due to the protected nature of the confined habitats as they are less subject to wind and wave action as otherwise present in the open water habitat component of Lake Ontario. Algae was present and abundant at all sampling locations within the Marina and Back Channel habitats, including growth on top of the submerged aquatic vegetation observed.

3.2.4 Birds

Waterfowl and shorebird surveys were used to identify the avifauna communities along the shoreline of Ontario Place. Additional incidental observations of birds along the shoreline of the west island of Ontario Place have been noted and support the formalized surveys. In total, 113 bird species were observed at Ontario Place during the avian surveys conducted by MH. A small proportion of avian species use Ontario Place as breeding habitat. Most bird species observed were utilizing Ontario Place for feeding and foraging during the summer, or for stopover and staging during migrations in spring and fall. Barn Swallow (Hirundo rustica), Horned Grebe (Podiceps auritus) were the only two species with provincial species at risk classifications, special, observed during the waterfowl and shorebird surveys. There were no species described as regionally scarce or extremely sensitive to anthropogenic impacts observed in the waterfowl and shorebird surveys of Ontario Place (Rank L1) and one species observed is ranked as L2, a species of regional conservation concern, the Ring-necked Duck.

3.2.5 Amphibians

Amphibian breeding habitat was assessed for the numerous bays, channels, and areas of slowing moving water around the west island of Ontario Place. Evening surveys collected community composition data based on auditory and visual observations. One species of amphibian (American Toad [*Anaxyrus americanus])* was detected on the East Island of Ontario Place over the course of the breeding surveys. American Toad is considered a Species of Conservation Concern in Urban Areas by the TRCA. While not detected on the West Island the species may be present, and potentially using the shoreline habitat currently available.

3.2.6 Reptiles

Reptile Hibernaculum and Turtle Wintering Area assessment and surveys were completed for snakes and turtles on the west island of Ontario Place. These surveys consisted of walking a single transect covering all potential snake hibernaculum (rock piles, and foundations / abutments) and turtle wintering area sites (shoreline areas and sheltered bays). Additionally, turtle nesting areas (close to water, loose substrate, away from roads, and away from predators) were surveyed for potential spawning habitat. Three unique species of turtles were observed at Ontario Place on the East Island, Midland Painted Turtle (*Chrysemys picta marginata*), Northern Map Turtle (*Graptemys geographica*), and Red-eared Slider (*Trachemys* *scripta elegans*). Of these, Painted and Map Turtles are considered Species of Regional Conservation Concern (L2-L3) by the TRCA. While the observations of the turtles were exclusively on the East Island, these species may also access waters around the West Island, and occasionally use habitat during different life history phases.

3.2.7 Mammals

There were no targeted surveys for mammals (excluding bats) completed at Ontario Place given the limited available habitat. The surveys completed to identify potential bat habitat on site identified 33 potential maternity roost trees, however none of the bat species detected during the acoustic surveys were classified as a species at risk. Any incidental observations of mammals, or evidence of their presence were recorded. No SAR mammals were recorded at Ontario Place during the surveys. Seven mammals were observed incidentally on both islands, and they include American Mink (*Mustela vison*), Beaver (C*astor canadensis*), Eastern Cottontail (*Sylvilagus floridanus*), Eastern Grey Squirrel (*Sciurus carolinensis*), Raccoon, Red Squirrel (*Tamiasciurus hudsonicus*), Striped Skunk, and an unidentifiable species of vole (Microtus sp.). Additionally, evidence of Red Fox (*Vulpes Vulpes*) was noted at Ontario Place. While these animals may or may not use the specific habitats along the shoreline of the West Island of Ontario Place, they have been noted in the vicinity and have the potential to be impacted, both positively and negatively, by the proposed development.

CHAPTER 4. PROJECT DESCRIPTION

4.1 Rationale for Nature and Extent of Shoreline Protection Works

The proposed shoreline enhancements for the West Island at Ontario Place were identified using a holistic approach to resolving the problems and opportunities described in Section 2.1. With an understanding of the existing shoreline conditions, the desire for an enhanced public realm, and taking advantage of opportunities to provide enhanced fish habitat; the shoreline engineering team worked with the landscape architects and aquatic ecologists to optimize the repairs and enhancements of the shoreline works.

From the landscape architectural perspective, the team reflected on Michael Hough's original vision and how it had been altered over time. The team chose to return to Hough's original vision as it was delivered initially and extend it and build upon it so that the new shore works would respond to 21st century engineering and changing coastal conditions. For example, the design water level has increased about 1 m. Higher design water levels due to climate change impacts increases the risk of future erosion and flooding damage at the West Island shoreline. Furthermore, the team sought to taper the edges of the extended shoreline to make slope viable, programable, and plantable. Finally, the landscape and the building have been integrated to create a system which functions as one creating something that is more sustainable and more resilient.

The problems and the opportunities with the existing West Island shoreline with respect to shoreline protection, public space and connectivity to the water, and aquatic habitat were described in Section 2.0 and are summarized in Table 2.1. Additional rationale for the extent of shoreline works and modifications is provided in Section 1.2.2. To address these issues, the proposed shoreline enhancements including lakefilling at the West Island are intended to serve three key purposes:

- Rehabilitate the shoreline protection to meet present day coastal engineering design standards for erosion and flooding hazards at the 100-year storm, including resiliency measures for climate change, and an updated 100-year flood level based on recent scientific advances provide a further 50-year design life for the West Island
- Provide enhanced public space and connectivity to the water
- Improve aquatic habitat.

4.2 Conceptual Design

4.2.1 Shoreline Works

Primary Elements

The primary elements of the proposed shoreline improvements by Therme at the West Island are presented in Figure 4.1 and include the west shore beach and submerged reef, north peninsula, north wall, east shore, east headland, south shore, and west headland.

Typical concept cross-sections for the primary outer shoreline improvements, showing the armour stone primary protection and toe berm, core stone, beach, stone reef, and clean fill, are presented in Figure 4.2

- West shore beach (Section A; Station -0+075)
- West headland and submerged reef (Section B; Station 0+095)
- West headland (Section C; Station 0+200)
- South shore revetment (Section D; Station 0+325)
- East headland (Section E; Station 0+500)

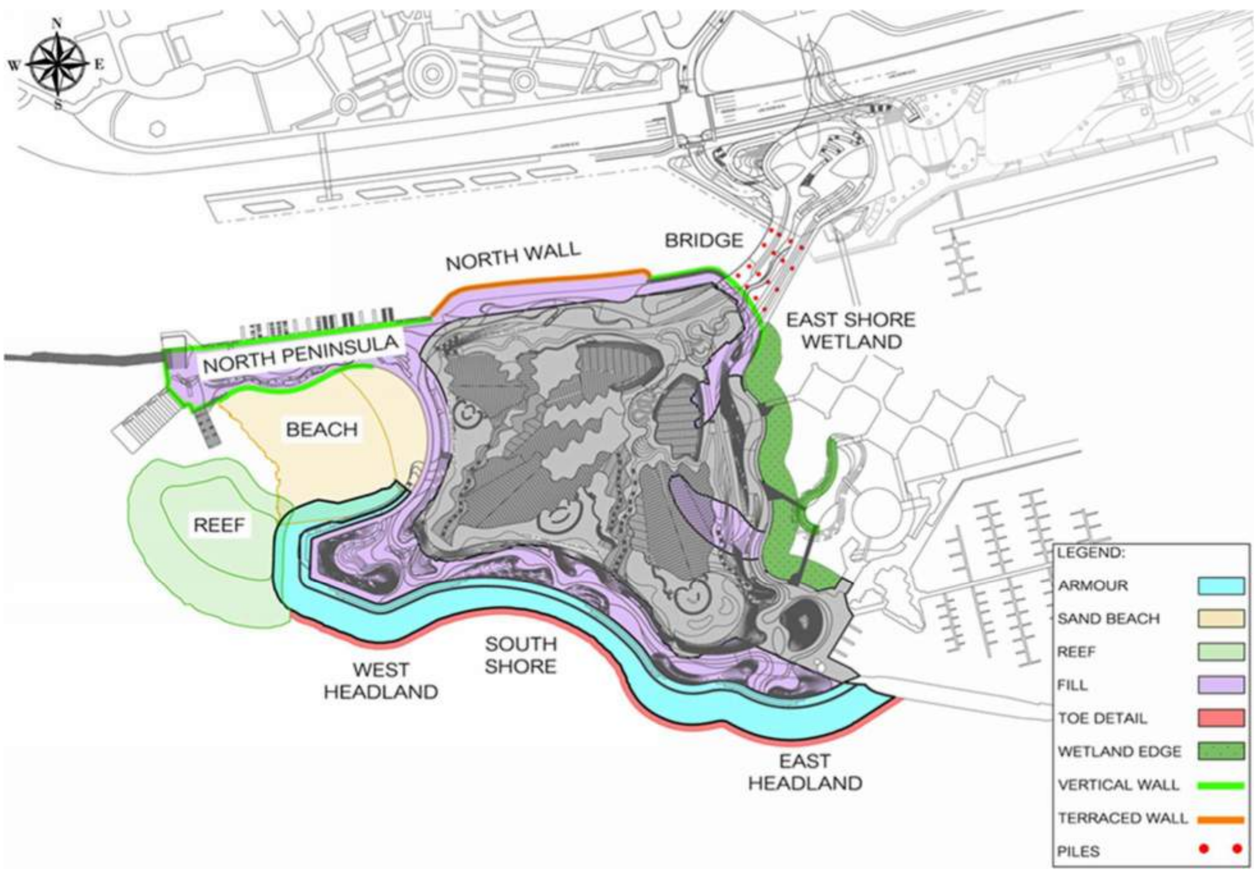

Figure 4.1: Primary elements of proposed shoreline enhancements, West Island Ontario Place

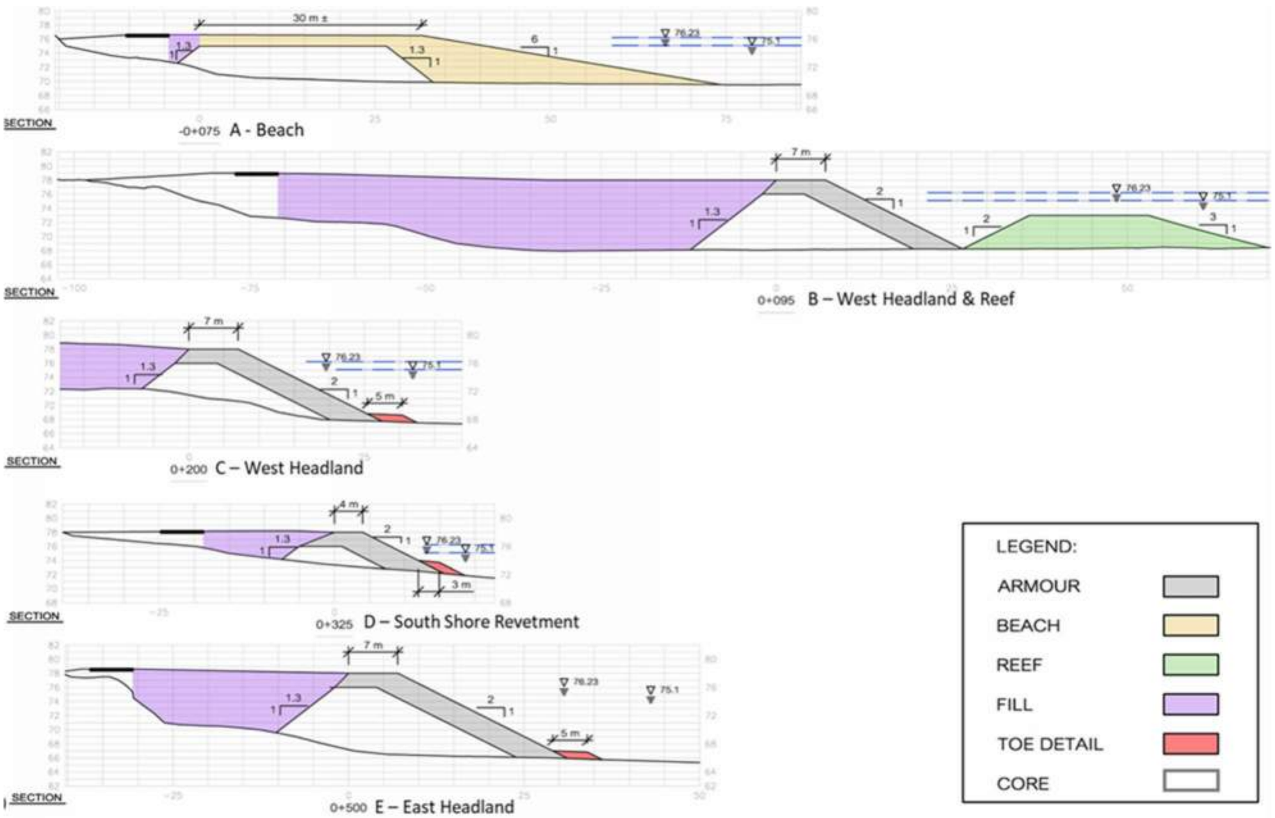

Figure 4.2: Schematic cross-sections of proposed outer shoreline, West Island Ontario Place Proposed Lakefill Areas

The enhanced shoreline at the West Island will be achieved by additional lakefilling around the perimeter of the existing lakefill that created the original West Island. The proposed lakefill areas at the West Island are shown in Figure 4.3. The various lakefill area classifications are defined in Figure 4.4.

The estimated surface area of land created by lakefill at the West Island is 37,800 m^2, including at the outer shore (Area A), the north wall, and the east shore (Area B). The new lakefill area under the water supporting the land is 28,100 m^2, including the shore works (Area C) and the submerged reef (Area D). At the east shore of the West Island, about 1100 m^2 of new water area is created (Area E) where it is now existing land. The lakefill areas are summarized in Table 4.1. The distance along the shoreline, from the east headland at the ship breakwater to the west end of the north peninsula is 580 m.

Proposed Lakefill Volumes

A preliminary estimate of the shoreline lakefill volume, including stone protection material, stone core, beach material, reef material, and clean fill is approximately 320,000 m^3; a breakdown of the lakefill volume is provided in Table 4.2. The swim pier is pile-supported above the water and does not require significant filling in the lake. The fill material will be clean and meet the requirements of the Ontario Fill Quality Guide for Shore Filling.

Figure 4.3: West Island lakefill areas (see Figure 4.4 for further definition of areas)

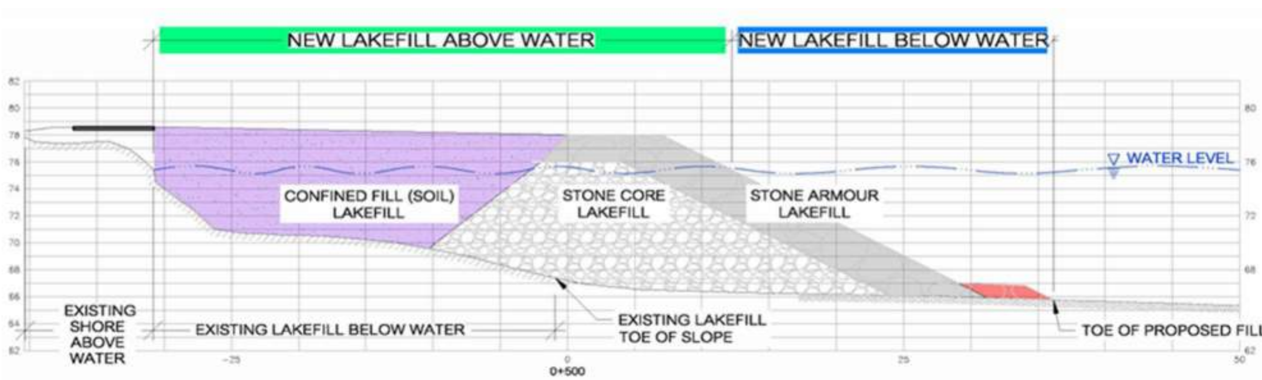

Figure 4.4: Definition sketch of new lakefill area above water and new lakefill area below water

Table 4.1: Summary of Lakefill Areas, West Island Ontario Place

Lakefill Area Designation (Figure 4.3)	Lakefill Area Description	Lakefill Area (m2)	
A	New Lakefill Above Water	33,500 m^2	
B	New Lakefill Above Water (East Shore)	4,300 m^2	
	Total Area of New Lakefill Above Water		*37,800 m^2*
C	New Lakefill Below Water	16,100 m^2	
D	New Submerged Reef (Lakefill Below Water)	12,000 m^2	
	Total Area of New Lakefill Below Water		*28,100 m^2*
E	New Water Area Created from Existing Lakefill	1100 m^2	

Table 4.2: Preliminary Lakefilling Volumes at West Island, Ontario Place

	Armour & Core Stone Material (m^3)	Beach Material (m^3)	Clean Fill (m^3)	Reef Stone (m^3)
West Shore (Beach and North Peninsula)	16,000	37,000	36,000	N/A
Submerged Reef	N/A	N/A	N/A	45,000
West Headland	51,000	N/A	29,000	N/A
South Shore	15,000	N/A	10,000	N/A
East Headland	37,000	N/A	20,000	N/A
North Wall	7000	N/A	4,000	N/A
East Shore	N/A	N/A	13,000	N/A
Total Material Type	126,000 m^3	37,000 m^3	112,000 m^3	45,000 m^3
		Total Lakefill Volume	**320,000 m^3**	

Shoreline Design

The shoreline design will rehabilitate the shoreline protection to meet present day coastal engineering design standards for erosion and flooding at 100-year storm and will include resiliency measures for climate change including an updated 100-year flood level based on recent scientific advances. The shoreline design will be in accordance with accepted coastal engineering design practice with a design life of 50 years.

The design life for the shoreline protection works at the West Island will be 50 years. Structure design life is the length of time that a structure, with routine maintenance, can safely and adequately perform its function. Structure design life differs from the planning horizon of the project. Structures requiring replacement or significant rehabilitation have reached the end of their useful design life.

The allowance for wave uprush and overtopping depends on the wave exposure, the type of shoreline protection, the crest elevation of the shoreline, the backshore elevation, the slope of the backshore away from the shoreline, the protection of the area behind the shoreline structure, the use of the shoreline immediately behind the crest of the protection, and the proximity of the development to the shoreline. For example, with a higher shoreline crest elevation, the wave overtopping, and the inland extent of the water inundation will be reduced; however, if the crest of the shoreline is lowered, the wave overtopping, and inland extent of water inundation will increase. Sufficient distance is required between the shoreline crest and any buildings to allow facilities for proper drainage of overtopping waves. In addition, wind can drive the wave overtopping spray inland. The design of the shoreline protection will be in accordance with current accepted practice guidelines with respect to tolerable limits for average wave overtopping rates and maximum wave overtopping volumes for pedestrians and structures.

West Headland

The existing west headland is being extended about 80 m in length by lakefilling to provide wave sheltering for the proposed beach at the west shore. At the same time, the expanded headland provides increased public space for programming and emergency access.

The expanded headland will be protected with a new armour stone structure (Figure 4.5), that will provide an appropriate level of protection at the 100-year storm and will have a design life of 50 years. The proposed concept level design of the headland protection is a multiple layer armour stone structure with a crest elevation of about 78.0 m.

The proposed armouring will have greater porosity (i.e., more interstitial spaces) than the existing structure; this will improve aquatic habitat conditions. At selected areas of the headland, the armouring at the crest and upper slope will incorporate stepped terracing for public access. The existing armour stone at the west headland will be salvaged and reused in the new protection. Aquatic habitat features will be incorporated at select locations along the toe of the armouring.

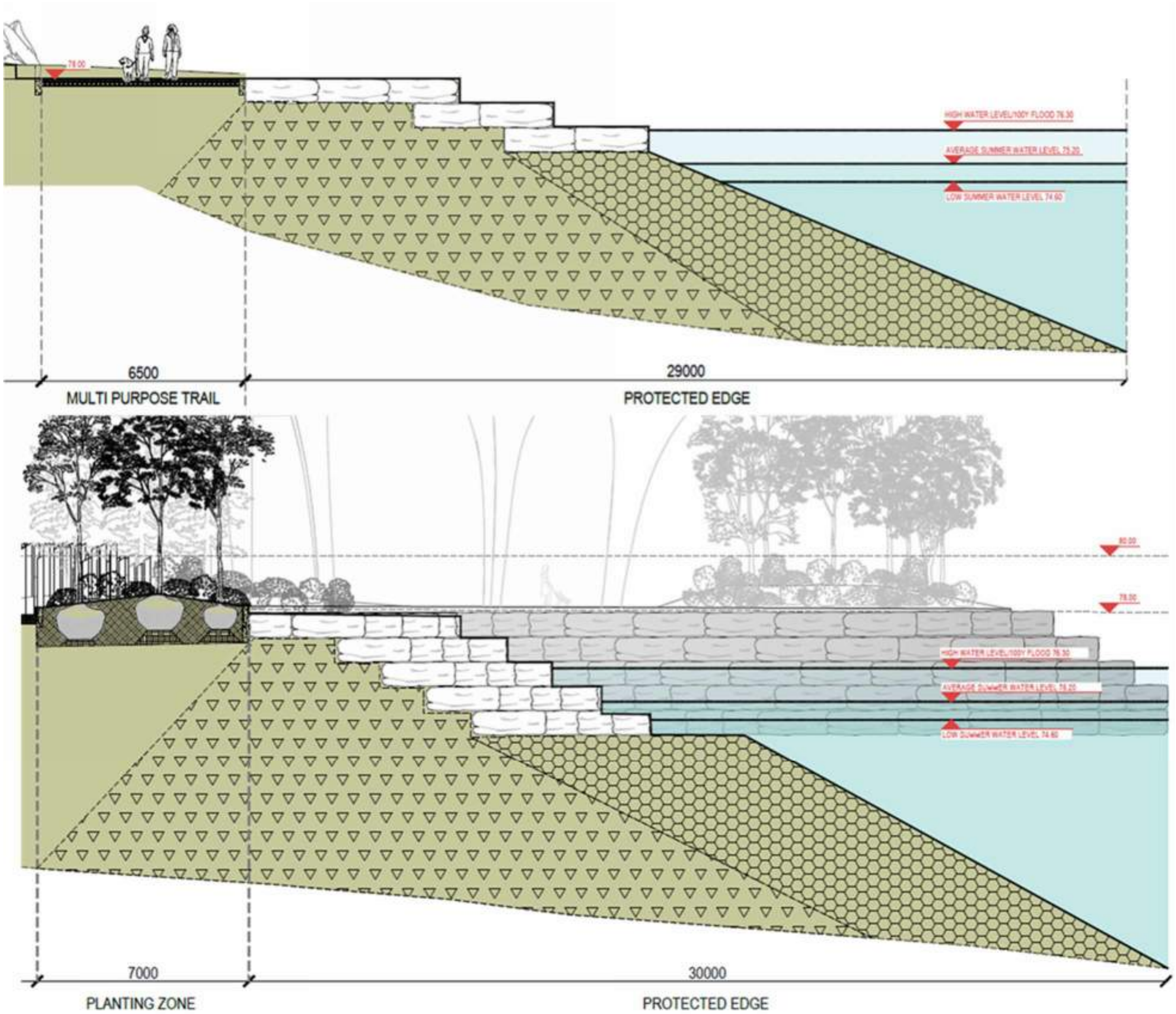

Figure 4.5: Proposed armouring at west headland (top frame) and east headland (bottom frame)

East Headland

The damaged east headland is being replaced with an expanded headland and a new armour stone revetment structure to provide a proper level of erosion and flood protection with a design life of 50 years. The armour protection will be like the proposed armour protection for the west headland. At selected locations, the east headland will incorporate stepped terracing for public access, A typical section of the proposed structure is presented in Figure 4.5. The existing armour stone at the east headland will be salvaged and reused in the new protection.

The proposed armouring will have greater porosity than the existing structure; this will improve aquatic habitat conditions. Aquatic habitat features will be incorporated along the toe of the armouring.

The expanded east headland will increase public realm area to provide enhanced programming space and emergency access. The proposed expansion of the east headland will extend along the lakeside face of the westerly portion of the ship breakwater, providing improved protection (see Figure 4.1).

South Shore

The proposed approach to protect the south shore is to provide a sloped armour stone revetment structure with a proper level of erosion and flood protection and a design life of 50 years. The expanded south shore provides increased public space for programming, a wider multi-purpose trail and emergency access. A typical section of the proposed south shore structure is presented inFigure 4.6.The armour protection will be like the proposed armour stone protection for the west headland. Aquatic habitat features will be incorporated along the toe of the armouring.

The feasibility of constructing a pebble beach at the new location of the south shore was considered. To create a viable artificial pebble beach fully resilient for 50 years considering the higher 100-year flood level and increasing future water levels due to climate change impacts requires substantial additional lakefilling intervention to construct a supporting reef in the deep water at the south shore.

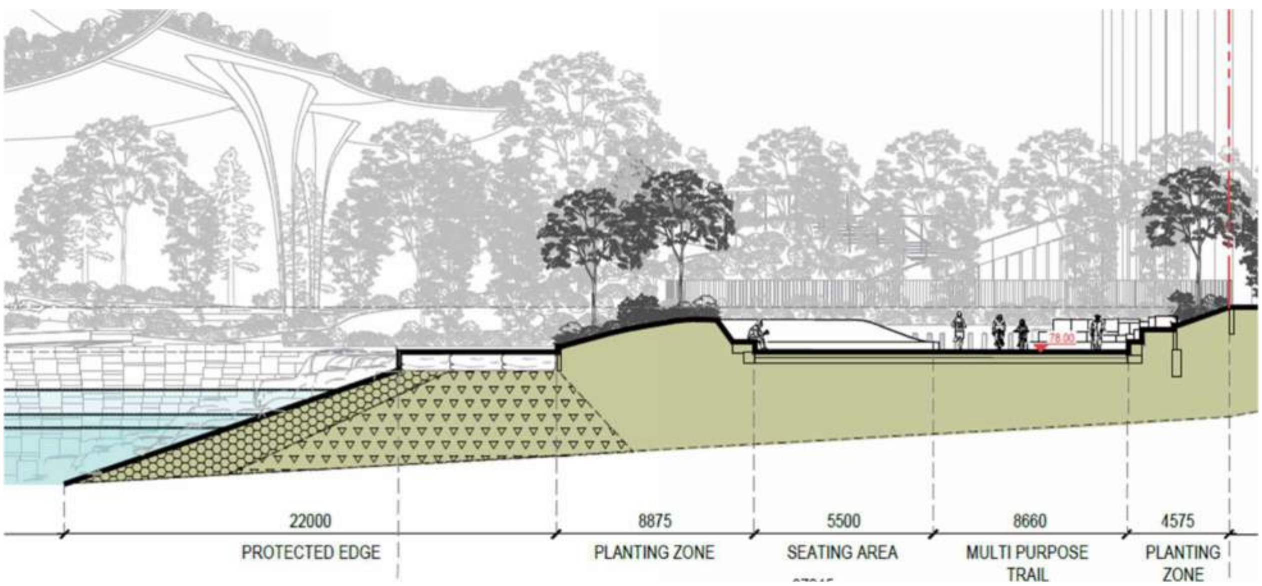

Figure 4.6: Proposed shoreline enhancements at south shore, West Island

Proposed West Beach

A public sand beach is proposed at the west shore to replace the existing stacked armour stone seawall. Creation of the new sand beach will provide a safe wading and swimming experience. The beach will be integrated with a nearshore reef; the reef will reduce wave action at the shore and provide valuable aquatic habitat. The beach will significantly reduce wave uprush and flooding at the backshore that presently occurs. The concept for the beach and reef is shown in Figure 4.7. The beach location at the west shore is favourable because the beach can be contained between the existing north breakwater and the expanded west headland, reducing the potential for longshore loss of new beach material, and the nearshore depth of water is shallower than off the south shore which makes the volume of material required more manageable.

Figure 4.7: Concept for west beach and west headland. The lower inset image indicates the concept reef structure (shown in green) extending off the end of the proposed west headland. The upper inset shows the west headland and west shore as it was originally constructed in 1971.

The characteristics and dimensions of west beach are summarized in Table 4.3.

The inner portion of the beach structure will be constructed with stone core material. The existing stacked armour stone at the west shore will be salvaged and reused in the armour stone protection elsewhere at the project. The proposed beach will enhance the public realm as it will have an area about 3000 m2 at the 100-year flood level which is substantially larger in area than the present ad hoc rubble beach on the south shore. The walkway width will be increased to provide improved public space and emergency access.

Reef

A submerged stone reef structure will be installed off the southwesterly end of the new expanded west headland (Figure 4.7). The reef will be constructed with stone material. The characteristics and dimensions of reef are summarized in Table 2.1. The proposed nearshore reef is a key innovative component of the project in the design of the West Beach and will serve two purposes: the first is to provide additional wave sheltering for the west beach protection; and the second is to enhance the aquatic habitat and compensate for habitat areas lost by the lakefilling above the water. Additional off-site aquatic habitat measures may be required; this will be determined through discussions with Aquatic Habitat Toronto.

Table 4.3: Characteristics and Dimensions of West Beach / Reef

Element	Dimensions
Beach Material	Coarse sand
Beach Crest Elevation (at boardwalk)	77.0 m
Beach Crest Width (at midpoint)	30 m
Beach Slope (into water)	1:12 (vertical: horizontal)
Reef Material	Stone (rip rap to small armour; sizes to be determined)
Reef Crest Width	74.2
Reef Crest Elevation	73.7 m
Reef Front Slope and Rear Slope	1:5 and 1:3 (vertical: horizontal)

North Peninsula

A concept section through the north peninsula is presented in Figure 4.8. At the north side of the north peninsula a floating walkway will run parallel to the existing breakwater wall; floating canoe/kayak finger docks will extend perpendicular to floating walkway. The pier that extends to the north of the north peninsula at the west end of the site will extend out over the existing shore and will be pile-supported. Along the north wall a retaining wall structure will be required to accommodate the increased elevation and width of the public multipurpose trail and access. The north peninsula itself will be a filled structure enclosed with vertical walls around the perimeter of the south side. The piers that extend to the south will be pile-supported. Aquatic habitat features will be incorporated along the walls.

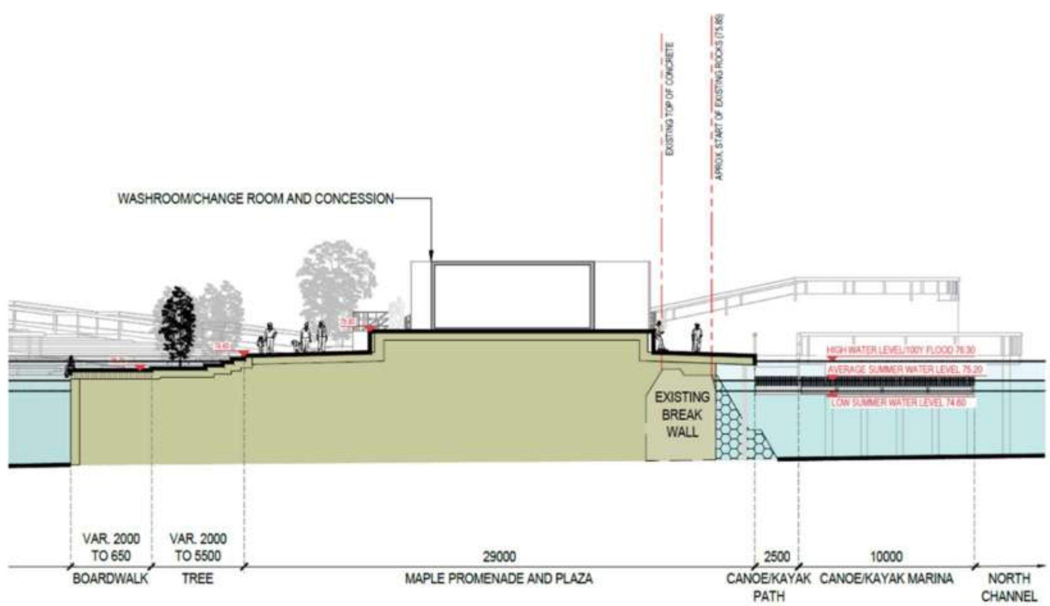

Figure 4.8: Concept section at north peninsula (south side on left side of figure; north side with canoe/kayak area on right hand side of figure; swim pier beyond)

North Wall

The north wall is presently protected with an existing stone revetment that is in good condition. The walkway along the north wall is too narrow for public and emergency access and is in poor condition. While the area is sheltered from wave action, the crest elevation of the north wall and shoreline is still subject to flooding at high water levels. The public realm walkway will be expanded at the north wall to provide a safe width for emergency vehicle access and the top elevation will be increased to protect against flooding. To accommodate the increased width and elevation of the public walkway and access along the north wall, a terraced retaining wall structure and some lakefill will be required (see Figure 4.9) Aquatic habitat features will be incorporated at the wall.

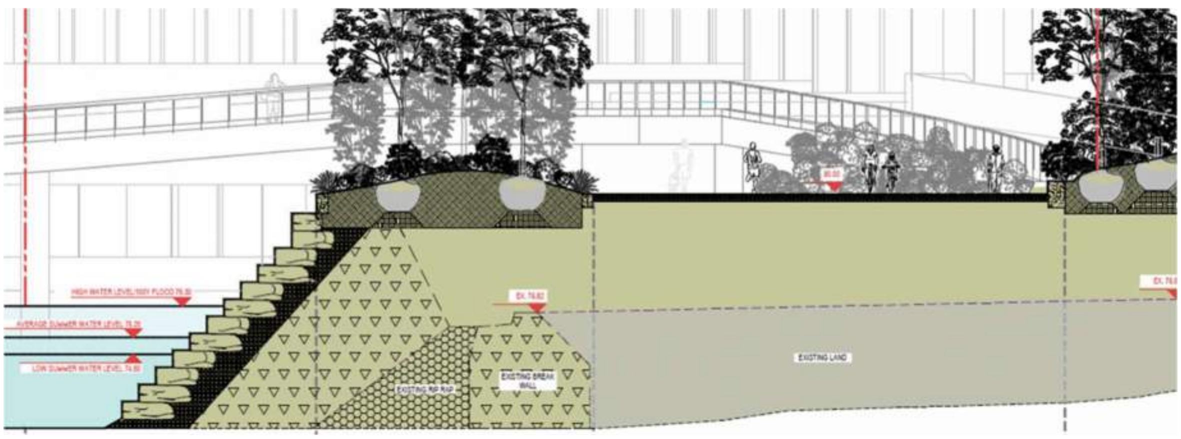

Figure 4.9: Concept section at north wall

East Shore

The existing hard-edge treatment of the east shore (e.g., steel sheet piling, timber piling, armour stone walls and rip rap revetments) will be replaced with a naturalized, green wetland edge that will enhance the aquatic habitat. The shoreline level will raised provide greater flood protection for the backshore areas. The design of the wetland area is ongoing in consultation with stakeholders (e.g., Aquatic Habitat Toronto) and Mississaugas of the Credit First Nation (see Figure 4.10).

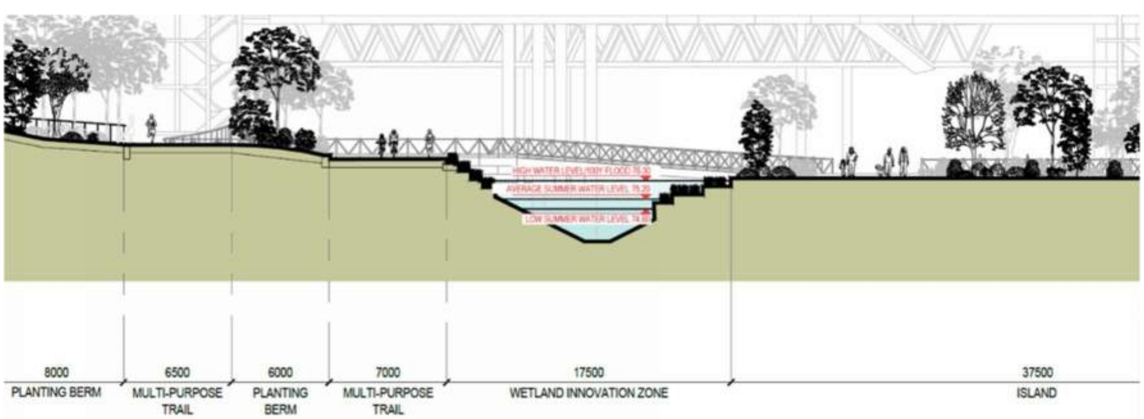

Figure 4.10: Concept section at east shore

Floodproofing Standard

TRCA's Living Cities Policies (TRCA, 2014) defines floodproofing as "the combination of measures incorporated into the basic design and/or construction of buildings and structures or properties to reduce or eliminate flood hazards, wave uprush and other water-related hazards along the shoreline of Lake Ontario, and flood hazards along the watercourses". OMNR Technical Guide states that development shall be protected from flooding to the "floodproofing standard", which is an elevation equal to, as a minimum, the sum of the 100-year monthly mean lake level plus the 100-year storm surge plus an allowance for wave uprush and other water-related hazards. It should be noted that "floodproofing" does not mean that there is no risk of flooding, only that the risk of flooding has been reduced. For the project site, the minimum floodproofing elevation is established as the sum of the 100-year static level, regulation plan adjustment corresponding to the same return period, the 100-year storm surge, a climate change allowance of 0.28 m based on a 5.5 mm/year uniform rate of lake level rise over a 50-year period, and 0.20 m freeboard allowance. At the locations of the Project where floodproofing is considered critical, such as building openings, the building is well setback and wave runup and overtopping is not significant. Table 4.2 provides a summary of the various components of the recommended floodproofing elevation. The recommended floodproofing standard elevation is 77.0 m CGVD for the critical infrastructure at the West Island where flooding is not acceptable and could potentially be dangerous. This floodproofing elevation does not apply to other designs at Ontario Place where overtopping and flooding can be tolerated.

TRCA permits certain uses within the flood hazard. For example, shoreline walkways could be placed at a level below the floodproofing standard elevation, while recognizing that they may be flooded during storm events at higher water levels.

Table 4.4: Components of Floodproofing Standard Elevation for Critical Infrastructure (building openings)

Water Level Component	Value	Unit
100-year static water level	76.05	m IGLD
100-year storm surge	0.28	m
Regulation plan adjustment at 1% exceedance level	0.12	m
Climate change allowance (50 years at 5.5 mm/year)	0.28	m
Freeboard Allowance	0.20	0.20
Floodproofing elevation (sum of the above)	76.93	m IGLD
Floodproofing elevation	77.0	m CGVD

4.2.2 Other Shore Works

The existing west access bridge will be reconstructed and will provide both public realm access and access to the Therme facility. The design of the new bridge structure is still evolving however, it is anticipated that new piles will be required to support the bridge structure. Currently, 18 piles are anticipated; pile diameter is estimated to be 1 to 2 m. Further details will be developed through the DFO permitting process.

4.3 Construction

4.3.1 Construction of Shoreline Works

The shoreline works are one part of the larger Therme project which is part of the much larger Ontario Place Redevelopment Project. Only the construction activities associated with the shoreline works are discussed in this section. Commencement of construction activities is subject to obtaining the necessary permits and approvals including the Fisheries Act Authorization.

Prior to Therme commencing construction activities on site, site readiness work must be completed by IO, including:

- Cap and decommission existing services on the West Island (electrical, gas, water & sanitary)
- Demolition & removal of existing structures within the lease limits.
- Cut and remove selected trees and vegetation in compliance with all pertinent mitigation.
- Provide interim utilities (power, gas, water) to the lease boundary.

Work by Therme will commence with site setup activities which include:

- Install erosion and sedimentation controls in accordance with Erosion and Sediment Control Plan, including:
  - Mud mat/rumble mats
  - Silt fencing around site perimeter
  - Turbidity curtains
  - Filter cloth installed on existing catch basins.
- Mobilize equipment to the island
- Perform site grading on the island
- Install temporary site offices and safety trailers
- Establish temporary ring road on the island
- Establish laydown areas on the island
- On-Site and excess soil will be managed in accordance with regulation O.Reg 406/19.
- On-site soil may be subject to risk management measures (if contaminants of concern are present and are to remain on-site). As such, site preparation and planning will adhere to the risk management objectives[11], where applicable.

Once the site setup activities are complete, lakefilling operations will commence. Lakefill materials will arrive at site by both barge and truck. Materials arriving by barge will be placed immediately while materials arriving by truck may be stockpiled on the West Island prior to use. It is anticipated that the bulk of materials will arrive by truck, supplemented by barge delivery when weather permits. Lakefilling will commence at the North Wall and West Headland then move to the South Shore, East Headland and East Shore. Lakefilling at the beach and placement of the submerged reef will occur last. All lakefilling activities will commence with the construction of a berm using core material and armouring likely from barges followed by the placement of fill material behind the berm using shore-based earth moving equipment. Once the lakefilling is complete the building foundations and structural work will commence.

[11] Prior to any major earth works associated with the shoreline work, assumed soil conditions should be confirmed, and where applicable risk management measures should be developed.

It is anticipated that lakefilling will take approximately 24 months weather permitting and exclusive of fish timing windows.

Construction equipment used for the lakefilling work will be typical earthmoving machines such as dump trucks, compactors, bulldozers, backhoes, and graders.

The public swimming pier will be constructed with steel pipe piles drilled & anchored into bedrock, structural steel, and reinforced concrete. Equipment will include barge, mobile cranes, and loaders.

The north peninsula will be built with sheet piles, pipe piles & backfilled with granular material. Reinforced concrete deck will be installed with land-based work force.

The reef will be constructed with a barge using small armour stone and rip-rap stone.

The beach will be built with a land-based core. Then sand will be placed with land-based dump and push equipment. Some sloping and grading of beach may be done with an excavator.

The north wall will be built with precast concrete blocks and/or select armour stone all placed from land with an excavator. The east shore will be built with land-based excavators.

4.3.2 Bridge Piers/Foundations

The existing west access bridge will be reconstructed and will provide both public realm access and access to the Therme facility. The design of the new bridge structure is still evolving however, it is anticipated that new piers will be required to support the bridge structure. At this time, 18 piers are anticipated, and it is anticipated that the piers will be constructed with the aid of cofferdams and that the cofferdam will be in place for approximately six months. Further details will be developed through the DFO permitting process.

CHAPTER 5. EFFECTS ASSESSMENT

5.1 Permanent Impacts to Water Quality

Within the regional study area of Humber Bay, the water quality is degraded due to sewage-contaminated discharge from the Humber River and outflows from City of Toronto combined sewer outfalls (CSOs); presently, beach closures occur when *E. coli* in collected water samples exceed the City of Toronto recreational standard. The proposed shoreline enhancements at the West Island are not expected to have a measurable impact on the regional water quality within Humber Bay. The expanded landform of the proposed West Island is similar in configuration to the existing West Island, and it is estimated that the general currents and circulation past the perimeter of the proposed design will be like the existing conditions; within the west embayment, the currents will be reduced due to the sheltering effect of the reef. At the west shore, work is underway to confirm the operations of CSO-1, and this work will identify and assess options for mitigating impacts of the CSO on the proposed West Beach. The water quality at the proposed West Beach is estimated to be like Sunnyside Beach.

An advanced 3D hydrodynamic model supported assessment of the potential impact of the proposed design. The model included tracer concentration loadings from the three primary CSOs (e.g., CSO-A, CSO-B, and CSO-C) to assess the West Island design's relative impact on currents and water quality. The model is driven by temporally and spatially varying wind, pressure and temperature fields derived from the global climate models. A sample of the model output is presented in Figure 5.1, showing current velocities (speed and direction) and tracer concentrations at a single time step for both the existing conditions and the proposed shoreline conditions at the West Island. The modelling results are preliminary based on available information on the discharges from CSOs. The modelling image presented is a snapshot in time; the concentrations vary over time depending on the wind conditions and the currents. In the image presented, the concentration at the west shore is similar for both existing and proposed conditions; at the reef area, the concentrations are higher than the existing condition where there is no reef.

5.2 Temporary Impacts on Water Quality

Construction of the shoreline enhancements at the West Island will include lakefilling. The perimeter of the lakefill consists of the placement of clean, inert, quarried stone and concrete material for the core and armouring and reef, and sand for the beach. Placement of these materials may result in a slight increase in turbidity; however, the increase in turbidity is expected to be low, short-lived, and limited to close proximity to the structure. Construction-related effects are temporary, and no residual impacts are expected. Experience with the construction of the Western Beaches breakwater in 2005-2006 was similar, and no adverse effects from turbidity were encountered.

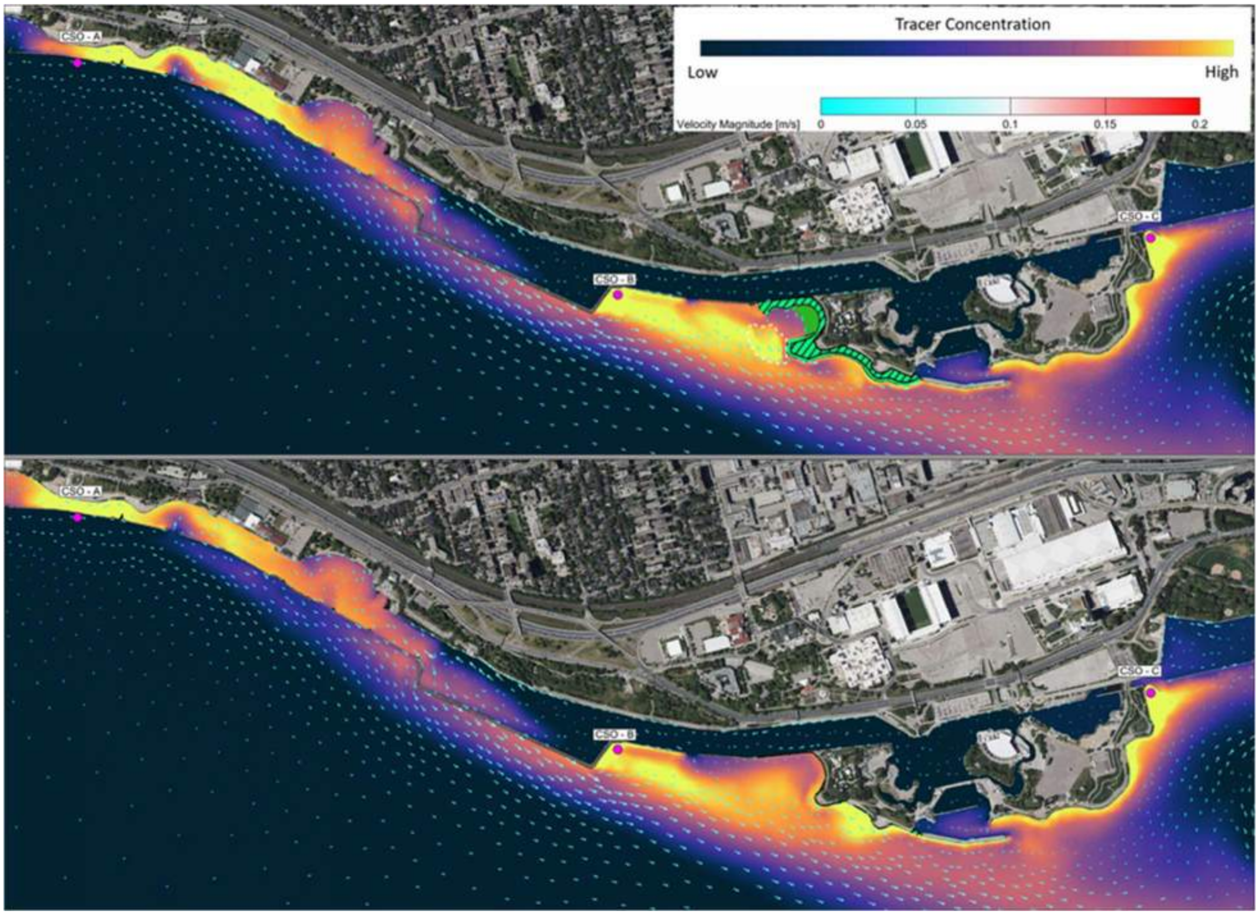

Figure 5.1: Sample output from 3D hydrodynamic model showing currents and tracer concentrations under proposed conditions (top frame) and existing conditions (bottom frame). Arrows represent current vectors (velocity and direction).

5.3 Permanent Impacts on Coastal Processes

The site was created over fifty years ago by lakefilling out from the original shoreline and is now part of an artificial shoreline complex extending for 5 km along the shore. There is minimal alongshore littoral transport at the shoreline. The overall general configuration of the shoreline at Ontario Place will be maintained, and the modifications to the shoreline will not create adverse environmental impacts on the coastal processes and will not adversely impact erosion, sedimentation, littoral transport, water levels, wave action, and ice action at other locations within the Humber Bay littoral cell. The proposed shoreline changes will not create new shoreline hazards or aggravate existing hazards at adjacent properties and will not result in a measurable and unacceptable cumulative effect on the control of flooding and erosion. Modifications to the shoreline will enhance the aquatic environment and provide improved public access.

5.4 Temporary and Permanent Impacts on Fish and Aquatic Habitat

The most prominent impact on the West Island shoreline during the Ontario Place redevelopment will be the infilling of Lake Ontario surrounding the island and will have permanent impacts that will require mitigation and monitoring (Table 5.1). The infilling will lead to temporary construction impacts that include risks to water quality, aquatic habitat, and fish community (Table 5.2). The shoreline of the West Island of Ontario Place will be modified and enhanced to provide fish habitat that is consistent with the goals and objectives established by the Fish Community Objectives for Lake Ontario, Urban Recreational Fisheries Strategy, and Toronto Waterfront Aquatic Habitat Restoration Strategy documents (GLFC 2017, TRCA 2016, TRCA 2020).

Table 5.1: Potential Permanent Effects on the Environmental Components of Ontario Place

Environmental Component	Potential Effects	Mitigation Measures / Compensation	Net Effects
Water Quality	• Increased surface water runoff	• Incorporate permeable walkway surfaces into the design to manage surface runoff. • Utilize bioswales to improve surface water runoff quality	• Minimal effects if turbidity is managed appropriately. • Minimal effects if no lasting contaminants enter the waterbody. • Improved surface water runoff management
Aquatic Habitat	• Shading of underwater habitat can produce offsetting effects, i.e., reduce primary and secondary productivity as well as moderate water temperatures. • Loss of existing aquatic habitat • Longshore loss of substrate along the southern shore	• Deploy clean rock fill. • Dock design and incorporation of appropriate materials to allow natural light penetration to the bottom. • Supplemental stone of various sizes to provide habitat complexity adjacent to docks and over armour stone. • Creation of habitat with lakefill areas • Shoreline protection • Installation of large wood debris and wooden structures • Protect new beach habitat by using offshore reefs	• Minimal extent (spatial and temporal) of shading under docks allows the growth of aquatic vegetation and benthic invertebrates. • Shade will moderate nearshore water temperatures. • Permanent placement of appropriately sized rock creates increased diversity of habitat functions with a diverse range of coarse rock to fine sediments providing reproductive, rearing young and adult growth functions to a broader range of fish species. • Increased overall habitat quantity and quality. • Increased habitat complexity • Improved resilience of habitat • Increase suitable habitat for American Eel
Fish Community	• Loss of existing resources used for reproduction, feeding and growth	• Introduce submergent and emergent aquatic vegetation and variety of substrates increases habitat diversity.	• New wetland niches, increasing habitat features and functions. • Depth gradients favour species suited to a range of feeding and reproduction

Environmental Component	Potential Effects	Mitigation Measures / Compensation	Net Effects
		• Incorporate a range of substrate sizes overtop the armour stone to increase opportunities for reproduction, feeding and growth. • Create a range of habitat opportunities along depth gradients	modes. • Habitat functions and opportunities currently not available at this location are provided
Terrestrial Habitat	• Non-native species removals throughout the West Island (both inland and along the shoreline) • Removal of existing limited habitat opportunities • Wetland creation along the East Shore of the West Island	• Provides a better opportunity area for biodiversity and additional habitat (fruit and nut-bearing trees, selection of species with large canopies, etc.) • Strategic placement of structures (bat/bird boxes) across the West Island	• Reduction of non-native species in the area • Increased biodiversity and variability in increased habitat throughout the west island (inland and shoreline) • Wetlands can help mitigate potential impacts for stormwater management from new buildings and hard surfaces that increase the risk of sediment transport. • Structures allow for a transition between cleared/removed habitat and re-establishment of new vegetation but add to long term habitat diversity
Terrestrial Wildlife	• New nesting/habitat structures	• Installation during tree planting or when compensation is implemented	• Provides an opportunity for additional/alternate habitat

Table 5.2: Potential Temporary Effects on the Environmental Components of Ontario Place

Environmental Component	Potential Effects	Mitigation Measures / Compensation	Net Effects
Water Quality	• Increased sedimentation events leading to elevated TSS and turbidity during construction. • Contamination due to spills from increased vehicle traffic on the West Island • Contamination due to spills from construction equipment	• ESC Methods to minimize sedimentation. • Implement best practices when working around water. • Utilize bioswales to improve surface water runoff quality	• Minimal effects if turbidity is managed appropriately during construction. • Minimal effects if no lasting contaminants enter the waterbody while the bridge is in operation. • Minimal negative effects associated with construction if effective sediment and erosion control occurs
Aquatic Habitat	• Loss of existing aquatic habitat • Temporary sedimentation during construction	• Use clean rock fill for all in-water applications. • Divert sediment and construction contact water away from fish habitat. • Implement best practices when working around water	• Access to suitable habitat outside work areas will minimize potential effects associated with temporary restrictions of movement. • Minimized potential harmful effects on habitat
Fish Community	• Temporarily blocked movement by construction • Loss of access to habitat • Entrapment in work area • Most fish will avoid the area of disturbance during construction. • Temporary noise-induced behaviour changes	• Salvage operation in isolated areas and release captured fish in appropriate areas for freedom of movement. • Deploy noise curtains and other mitigation measures, such as timing windows to protect fish from noise.	• Minimized loss of aquatic life • Minimal loss of life stage opportunities for fish because key habitat functions are largely absent in existing conditions. • Fish will move to adjacent areas with similar habitat function as the construction area
Terrestrial Habitat	• Tree removals with DBH >30cm throughout the west island, both	• Compensation plantings and nesting and bat structures to decrease the amount of time the habitat is unavailable	• Removal of non-native species • Provides a better opportunity area for habitat creation.

Environmental Component	Potential Effects	Mitigation Measures / Compensation	Net Effects
	inland and along the shoreline	• Include areas for amphibian and terrestrial breeding and nesting habitat (wetlands)	
Terrestrial Wildlife	• Removal of migratory bird and bat habitat • Barn Swallow nests potential impacted • Removal of food source for pollinator species	• Avoid breeding bird and bat roosting timing windows. • Provide alternate habitat opportunities (i.e., native trees, pollinator gardens, migratory bird, bat boxes, boxes/houses) • Installation of barn swallow nesting structures • Wetlands provide increased habitat for species of special concern (reptiles and amphibians)	• Minimal effects on nesting and roosting opportunities based on a limited number of trees removals. • Improvement to currently limited habitat for reptiles and amphibians on the West Island • Provides better opportunities area for habitat creation.

Several docks, piers, and walkways will need to be constructed for long-term access by pedestrians. Walking surfaces will encircle the West Island and allow for pedestrians to view and access the various riparian habitats on the inner and outer shores. Installing infrastructure directly adjacent to or in contact with the lake water poses its own potential impacts, including shading habitat and increased surface runoff. Some fish, such as Smallmouth Bass, Northern Pike, and other ambush predators, may benefit from moderate shade cover. Proper storm run-off management, planning and installation should prevent long-term impacts and the need for most mitigation or compensation measures. During construction, measures to control erosion and sediment releases into the water will help mitigate impacts on the nearshore fish community and associated habitat.

Minimal shoreline vegetation and limited aquatic habitat were incorporated into the existing design. Currently, steel sheet pile walls, rock cribs, and armoured riprap make up most of the shoreline and provide little habitat value to the aquatic ecosystem. One of the key features of the proposed West Island will be the Wetland Innovation Zone, which should increase the near shore and littoral habitat available for the aquatic community when constructed. TWAHRS identified self-sustaining native fish communities as one of their primary objectives along the Toronto Waterfront (TRCA 2020). The introduction of shallow habitats, including submergent and emergent vegetation along the littoral zones of Ontario Place, is designed to support the reproduction and growth of the fish species found here. The Wetland Innovation Zone is located where there is shallow, sheltered waters conducive to wetland habitats and isolated from most marina traffic.

The Wetland Innovation Zone creates 2.1 acres of ecologically flourishing environment that only receives treated stormwater from the public realm and functions as a final polishing step in a nature-based system. The Wetland Innovation Zone receives overflows of stormwater runoff from the upstream site area by way of permeable pavement, underdrains, and catch basins, which are then treated before final release to the wetland. A closed-loop water recycling system helps minimize the amount of municipally supplied potable water used for park maintenance by promoting passive irrigation and providing additional storage for an active irrigation system. The park's stormwater management system manages its stormwater on-site, promoting nature-based solutions through managing water where it lands, which results in a significant reduction of discharge volumes and outperforms the required stormwater criteria.

Functionally, the Wetland Innovation Zone is designed to incorporate natural wetland processes to improve habitat and water quality, with multi-use pathways running along the East Shoreline. Short-term losses of habitat will be required during the isolation of the construction areas. Long-term habitat gains will be made with the increase in the complexity of the habitat, providing additional spawning and growth opportunities for warm water fish such as Rock Bass, Pumpkinseeds, and Bluegills already found in these locales throughout their life histories. Vegetation adapted to the local conditions will be planted along the in-water wetland to the upland gradient.

The proposed redesign of the southern shoreline will incorporate additional lakefilling to protect the area from flooding and develop a regraded shoreline which provides intentional aquatic habitat and safe and reliable access for pedestrians. Cobble and gravel sized substrates will be placed at the toe of the proposed southern shoreline. The range of substrate sizes will be selected to provide spawning and refuge habitat for species, including American Eel, Alewife, and Lake Trout, consistent with Lake Ontario fish community objectives for promoting healthy and diverse communities (see Section 2.5.1). During the construction period, the entrapment of fish is a possibility in the isolated work areas. Salvage and construction best practices will be used to maintain access to appropriate habitats in the short term, mitigating impacts on the aquatic habitat. A temporary ring road will be established on the island for the construction phase, increasing the potential risk of spills and contamination from vehicles.

The proposed west beach will replace the existing stacked armour stone seawall and be protected by the elongation of the north peninsula and west headland to reduce the long-term effects of wave action and longshore erosion.

Underwater noise can be a serious issue to fish and fish habitat if unmanaged. Underwater noise can be generated from various construction processes such as sheet piling or post-driving. Sound that is significantly above underwater ambient sound levels (natural background) is considered noise and can trigger responses in fish. The in-water construction activities are expected to temporarily increase underwater noise levels near the project area.

There is the potential for the following temporary impacts to the aquatic community:

- Fish could potentially be impacted by the in-water construction noise emissions.
- Impulsive noise, due to impact piling, is the sole in-water construction method projected to potentially cause physical injury to some fish species at very close ranges.
- Non-impulsive noise activities such as vibratory piling, drilling, and dredging may cause temporary behavioral responses in some fish species throughout the project area.

Where the potential for physical injury to fish exists, the application of mitigation methods (i.e., timing windows, bubble curtains) or exclusion zones will prevent harmful impacts beyond temporary changes in behaviors from occurring.

The confined nature of the combined bathymetry that makes up Lake Ontario in the vicinity of Ontario Place and the existing infrastructure in the proposed project area does not allow sound to travel freely through the water. Shallow waters and the proximity of the project to the shoreline, combined with lakebed sediments comprised primarily of sand, mud and clay, can significantly reduce underwater noise levels and, in some cases, present a physical barrier to sound propagation.

The creation and improvement of aquatic habitat surrounding Ontario Place's West Island will result in the permanent habitat compensation required to satisfy the anticipated Fisheries Act Authorization. The existing habitat lost to lakefilling will require compensation and will be achieved through the proposed habitat gains or improvements listed in Table 5.3. The new habitat created is intended to be more productive and better suited to the aquatic community of Ontario Place. Appropriate substrate type, increased vegetation, and a greater diversity of depths will help to improve the overall habitat quality surrounding Ontario Place. The habitat compensation areas are designed and will be constructed to provide diverse habitat functions including reproduction and feeding opportunities to help enrich the species biodiversity of Ontario Place. Fills above the water level will be considered habitat loss (Table 5.3) as the existing lake and shoreline habitat will be overprinted by fill, and other materials but, lakefill below water and the submerged reef will be considered habitat gains (Table 5.3). The gains are being made through habitat enhancement or creation incorporated into the proposed shoreline design. Lakefill below water along the south shore will employ specifically sized stone substrates to provide greater resources for the fish community. The reef will overprint the existing lakebed habitat but will provide additional rocky substrate for reproduction and complex cover; this does not create a measurable loss. Habitat resources such as cover, forage, spawning substrate, and nursery habitat are limited in this area. The additional large rocky substrate and habitat improvement measures will help supplement the limited resources and bolster productivity. The improved habitat will have a greater value to the aquatic ecosystem than what is currently present. The existing habitat is degraded or of poor quality for the local biotic community. The created and improved habitats will be of higher quality and will be designed to meet the needs of the aquatic ecosystem, now and into the future. To create a gain in quality of habitat around Ontario Place, there are losses that must occur.

Table 5.3: Summary of Lakefill and Aquatic Habitat Alteration

Locations (Fig 4.3)	**Lakefill Description**	**Lakefill Area (m^2)**	**Gain / Loss**	**Habitat Condition**
A	New Lakefill Above Water (South Shore)	33,500	Loss	Existing armour stone on the shoreline. Lakebed substrate comprised of sands, glacial till, and gravel with outcrops of bedrock (Figure 3.2). Little habitat function providing opportunities for reproduction, shelter, or refuge.
B	New Lakefill Above Water (East Shore)	4,300	Loss	Vertical walls of either concrete, steel pilings, or wood pilings on the shoreline. Sheltered, depositional habitat with fine sediments and undisturbed vegetation growth. Vertical walls provide little depth gradients and limited surfaces for aquatic vegetation. While species such as Pumpkinseed and Rock Bass that prefer relatively warm water in sheltered areas have been collected along the east shore, opportunities for spawning and rearing young are limited in this locale.
C	New Lakefill Below Water	16,100	Gain	Proposed armouring will provide depth gradients instead of vertical walls in some locations. Parts of amoured areas and the toe of slope will be surcharged with gravel to cobble sized rocky substrate. These substrates will provide increased surface area for vegetation (where sufficiently sheltered) and benthic invertebrate production. Substrates will be sized appropriately to provide opportunities for open water species of Lake Ontario.
D	New Submerged Reef	12,000	Gain	A submerged stone reef structure constructed with rip rap to small armour. Substrate sizing will be dependent on fish community requirements for species such as Lake Trout, which spawned on nearshore reefs historically.
E	New Water Area Created from Existing Lakefill	1,100	Gain	A naturalized, green wetland incorporating a tiered shoreline to allow natural water level fluctuations and vegetation communities. The design of the wetland area is ongoing in consultation with stakeholders. Habitat features would be designed to support submergent and emergent aquatic vegetation with opportunities for spawning and reproduction, rearing young and adult refuge and growth for species such as Rock Bass, Pumpkinseed, Northern Pike and Yellow Perch and other suitable forage species, thus supporting habitat and fisheries objectives of TWAHRS and the Fish Community Objectives for Lake Ontario.

The following provide some examples of the proposed habitat enhancements associated with shoreline protection. A submerged stone reef structure will be installed off the southwesterly end of the newly expanded west headland. The proposed nearshore reef is a key innovative component of the project in the design of the West Beach, as it will help protect the beach from wave action and provide complex offshore habitat for a wide variety of aquatic organisms. Historically Lake Trout spawned on nearshore reefs along the Toronto Waterfront, but these have been lost or degraded over time due to dredging, aggregate extraction, and increased sedimentation. Suitable substrate will be placed at appropriate depths to promote Lake Trout spawning. This will support the Fish Community Objectives for Lake Ontario by providing critical spawning habitat for native species of sport fish (GLFC 2017). Offshore habitat is limited around Ontario Place. New access to a wide range of offshore depth gradients provides habitat that was once scarce to these species. Complex, diverse habitats support the feeding and reproduction modes of many important fish species.

5.5 Temporary and Permanent Impacts on Terrestrial Habitat

Terrestrial habitat and wildlife impacts will be limited during shoreline works to isolated locations. Removal of some trees greater than 30cm dbh (diameter at breast height) will be required along the north wall and peninsula, east and west shore, and east and west headlands. The trees proposed for removal currently providing limited habitat for migratory birds and bats and are mostly non-native species. Removal of these trees will provide the opportunity to improve available habitat on site for the long term. Short term impacts will include removal of all terrestrial habitat and vegetation; however, the removal represents an opportunity to enhance the habitat with multi-story vegetation which should attract the return of tolerant species presently using Ontario Place while also attracting sensitive species with more specific habitat requirements.

New plantings of native species can provide biodiversity and species that better support wildlife habitat (i.e., fruit and nut bearing, large canopy, etc.). Opportunities to provide understory vegetation and associated habitat functions will be exercised. Trees requiring removal to accommodate construction and/or soil remediation will be removed. Erosion and sediment control plans will be required for areas where the removal of trees increases the risk of erosion and release of sediment into Lake Ontario.

To reduce the short-term impacts, the removal of all trees that would provide habitat (i.e., >30cm dbh) must occur outside of the timing window for migratory birds and bats (April 1st to September 30th). Any vegetation removed during the timing window will require that no harm or harassment of migratory birds or species at risk bats occur.

The long-term impacts of the project are all beneficial in the sense that non-native species management can occur by removing species not native to the area and replacing them with species that will improve biodiversity and create a habitat that supports native species. Proposed wetland creation will further improve diversity, habitat and stormwater quality entering Lake Ontario. Plantings can improve pollinator habitat that can encourage more species at risk to inhabit and use the island (i.e., bees, butterflies). Improvements to the shoreline will provide opportunities for reptiles and amphibians for breeding and nesting.

CHAPTER 6. MONITORING AND ADAPTIVE MANAGEMENT

The monitoring and adaptive environmental management (AEM) process presented in this Section will ensure that the aquatic habitat modified and enhanced by the shoreline works is maintained through a set of performance indicators to be developed during permitting.

Environmental performance monitoring can measure if the aquatic habitat functions as intended. TRCA already undertakes monitoring activities throughout the Toronto Waterfront in conjunction with other partner agencies. Therme Canada will seek to collaborate with TRCA to understand the existing monitoring program and how it may be used to measure how well the shoreline works are functioning to provide aquatic habitat. As part of the permitting process, Therme Canada will develop a monitoring plan in collaboration with TRCA, AHT and other relevant agencies. Monitoring will occur for at least 10 years after the completion of construction. As this work evolves subsequent iterations of this report will be updated.

Should the monitoring identify areas where the shoreline works are not performing as anticipated, Therme Canada will work with other agencies, such as AHT and TRCA, to identify how the design may be modified to achieve desired results.

CHAPTER 7. SUMMARY OF CONSULTATION ACTIVITIES

As discussed earlier, the shoreline works at the West Island are one part of the Therme proposal, which is one component of the much larger Ontario Place site-wide redevelopment. Considerable consultation has been undertaken by IO and the City of Toronto with respect to the site-wide redevelopment and particularly the Official Plan Amendment and the Zoning By-Law Amendment. Therme has participated in many of the site-wide consultation events in addition to undertaking consultation on the Therme proposal and specifically with respect to the shoreline works on the West Island as follows.

- Therme Canada has a website Toronto's Landmark Destination | Therme Canada, which describes the company and links to the broader organization and to the Ontario Place-specific website. This website also has a link to a survey Therme has been conducting.
- Therme Ontario Place has a website, A Place for Everyone | Revitalizing Ontario Place (thermecanada.com). The website details the Therme proposal for Ontario Place West Island and provides responses to Frequently Asked Questions. The website also has a feedback button which provides an opportunity for questions and concerns to be sent directly to Therme.
- Aquatic Habitat Toronto (AHT) is made up of representatives of approval authorities and organizations with an interest in aquatic habitat on the Toronto waterfront. It is a collaborative forum to discuss projects proposed along the waterfront, monitoring of aquatic habitat and fish populations and a sounding board for discussing opportunities to enhance and restore fish habitat. Given membership from the federal Department of Fisheries and Oceans, the Ministry of Natural Resources and Forestry, TRCA, and the City and Waterfront Toronto, AHT is traditionally who is consulted with during the planning stages of project development. Representatives of Therme met with AHT on a number of occasions throughout project planning and will continue to meet through permitting, construction and establishment.
- Therme Canada, both individually and in association with IO, has met with City of Toronto staff to discuss the planning applications on a number of occasions.
- The development plans for Therme Canada Ontario Place have been publicly shared and widely discussed among media since Therme was announced as a successful proponent in July 2021. From November 2022 to May 2023, the total potential reach of all articles, news coverage, and Twitter mentions was 994 million. Media coverage has mostly originated from Toronto and GTA-based outlets, including the Toronto Star, CTV News, the Niagara Falls Review, and the Peterborough Examiner. The Toronto Star has written about the project more than any other outlet. Coverage of Therme Canada's plans has remained mostly positive or balanced.
- Therme Canada hosted a virtual webinar to present the project to interested participants.
- Therme Canada established engagement with the Mississaugas of the Credit First Nation early in the project development process. Meetings have been held on a variety of topics, including the shoreline works. Representatives of MCFN have met with Therme to discuss this report, and they have reviewed the draft report.
- Therme Canada has participated in City-led public meetings and information sessions with respect to the OPA and ZBA applications pursuant to the Planning Act.

While a number of comments have been received on the Therme Ontario Place proposal and the overall redevelopment of Ontario Place, very few comments specific to the shoreline works on the West Island have been received. Many of the regulatory agencies are supportive of efforts to mitigate flooding and erosion risk on the West Island and of the enhancements to fish habitat. Some stakeholders have raised concerns about water quality at the west beach and provision of access for lake swimming.

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