Revised Review Report

Porter Airlines Runway Extension Proposal Review Coastal Processes and Environments

Prepared for

City of Toronto

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Prepared by

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Statement of Limitations and Assumptions

This report outlines the estimated effects of the proposed extension of runway 08-26 at the Billy Bishop Toronto City Airport (BBTCA), as submitted to the City of Toronto by Porter Airlines, to the natural and social environments in the immediate vicinity of the proposed extension. The assessment of effects has been based on data previously gathered for other studies or under other data gathering exercises, and is therefore limited to the information available. This report assesses only the effects of the proposed runway extension, in a cursory and preliminary manner, and does not assess the effects of any works or activities facilitated by the proposed extension, including the usage of additional or different airplanes at the BBTCA.

Further study and modelling exercises are required to quantify the full effects of the proposed runway extension prior to finalizing design details, and CH2M HILL Canada Limited accepts no liability for decisions made based on the information presented herein. The work is prepared for the benefit of the City of Toronto and there are no third party beneficiaries. All work product is prepared for the sole and exclusive use of the City of Toronto for specific application to the property described in the report and is not for the benefit of any third party. The report may not be distributed, disclosed in any form to, used by, or relied upon by any third party without the prior written consent of CH2M HILL.

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1. Introduction and Background

1.1 Background

In 1939 the City of Toronto (City) opened the Toronto City Centre Airport as the Port George VI Airport. In 1983 the Toronto Harbour Commission, the City of Toronto and Transport Canada signed the Tripartite Agreement outlining terms and conditions for the airport's operation. This Agreement imposed noise controls on flights to and from the airport, banned jet aircraft from using the airport, and disallowed runway extensions. In 2011, City Council granted an easement to the Toronto Port Authority that allowed for the construction of the fixed link pedestrian tunnel beneath the Western Gap to the airport terminal, which is currently under construction (City of Toronto, n.d.). The airport is currently known as the Billy Bishop Toronto City Airport (BBTCA).

In April of 2013, one of two commercial operators at the BBTCA, Porter Airlines Inc. ("Porter Airlines") announced the conditional purchase of Bombardier CS-100 jet-powered aircraft subject to the amendment of two provisions of the 1983 Tripartite Agreement (AirBiz, 2013):

1. The lift of the current prohibition of jet aircraft operations at the airport, and
2. An authorization to lengthen the runway by 168m at both ends of the airfield.

The announcement of the deal between Porter Airlines and Bombardier was followed by a request by Porter Airlines to the City to review the above-two items. In response to this request, the City has sought review from a number of technical experts of the impacts of the proposed runway extensions and impacts on social, environmental, and technical aspects of the Toronto Harbour and Central Waterfront. The City has commissioned CH2M HILL Canada Ltd. (CH2M HILL) to review the runway extension concept submitted by Porter Airlines to determine, at a conceptual level, the potential effects of the proposed runway extension on the aquatic and terrestrial environments, including:

- Document the existing shoreline and coastal environment including bathymetry, marine structures, lake levels, wave climate, currents, ice conditions, nearshore sediments, and regional shoreline characteristics;
- Conduct a cursory level assessment of the shoreline based on site observations, available aerial imagery, bathymetry, geotechnical data, and other available information to provide an understanding of sediment processes and aquatic habitat at the project location and potential impacts of the proposed works on the coastal environment; and
- Evaluate the impacts of the proposed runway extension on the surrounding coastal areas and comment on the regulatory implications of the proposal.

1.2 Purpose of the Study

CH2M HILL will examine the aquatic and terrestrial environment in the immediate vicinity of the proposed runway extensions and estimate the likely impacts of those extensions on coastal processes, aquatic and terrestrial habitat, flora and fauna. The aim of this investigation is not to recommend a course of action to the City of Toronto, but to present a factual outline of the existing conditions in the immediate vicinity of both ends of runway 08-26, and an estimate of the changes that may be caused by, and the regulatory requirements for the construction of a 168m extension to both ends of runway 08-26.

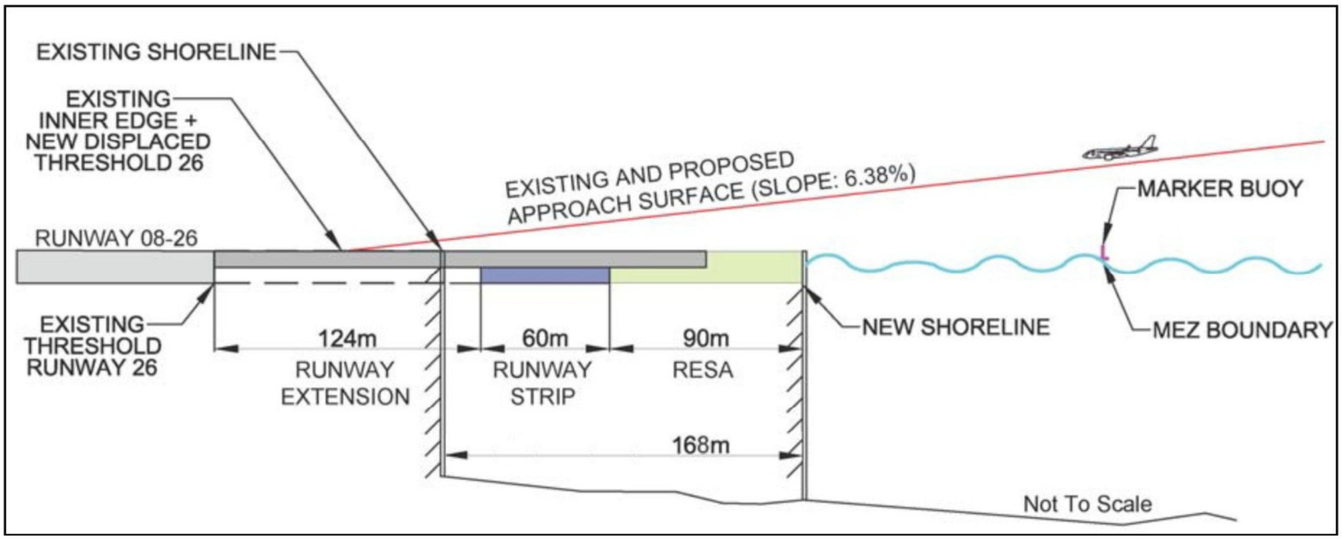
1.2.1 Aboveground and Belowground Fuel Storage Tanks

From discussions with City representatives, CH2M HILL have also been directed to examine the implications of the potential need for additional fuel storage tanks on the site to supply fuel for proposed new aircraft. The proposed new CS100 Jets have a higher fuel usage capacity than the propeller planes that currently use the BBTCA. Should it be determined that additional fuel storage capacity is required at BBTCA to accommodate the new aircraft, if approved, new fuel storage tanks will be required at or near the airport.

1.3 Study Area and Proposed Runway Extension

The City of Toronto is currently reviewing a request from Porter Airlines to permit jet-powered aircraft at the BBTCA. If permitted, extensions of at least 168 metres on both ends of the existing runway, encroaching into the lake waters, will be required. The extension will accommodate a 124 m runway extension from the threshold of the existing runway, all of which, save 18m, can be accommodated on the existing land, plus a 60m runway safety strip and a 90m Runway End Safety Area (RESA). A further request for review of a 200m runway extension, although not contemplated in this report, is unlikely to cause major changes to the opinions provided in this study.

Figure 1-1 **Profile of Proposed Runway Extension**
Adapted from: LPS Aviation, 2013

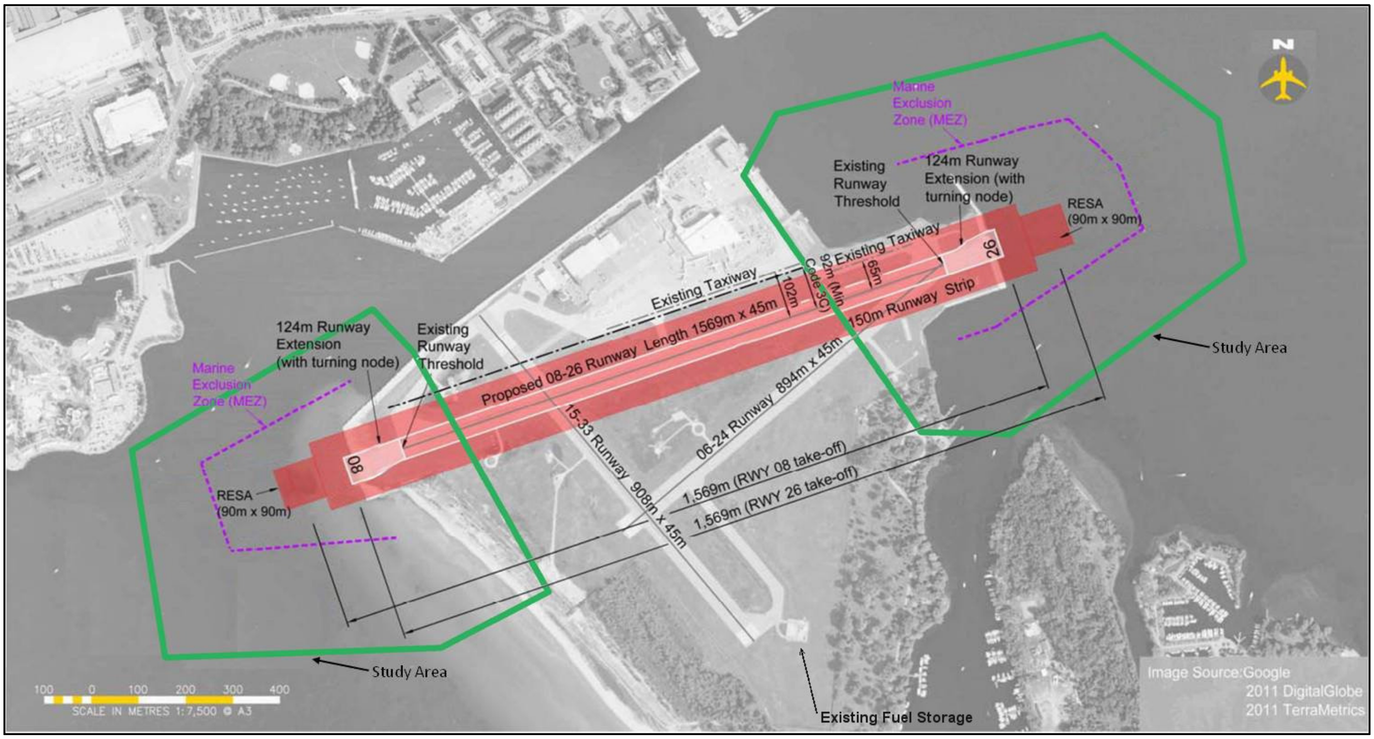


The BBTCA is located near Hanlan's Point on the northwest end of Centre Island, the largest of a group of islands that form the Toronto Islands, just offshore of the city's downtown business and tourism districts. To the east, the airport is bounded by the Inner Harbour, to the west by Lake Ontario, and to the north by the Western Gap, a 120 m wide, 700 m long, NE-SE waterway that connects the Inner Harbour with Lake Ontario.

The project site is located within the Marine Exclusion Zone (MEZ) in Toronto Harbour, east and west of the extremities of the BBTCA as shown in Figure 1-2. The footprint of the runway is proposed to extend 168 m into the lake waters on both ends along the 111°-291° N bearing. The total area of the harbour bed to be occupied by the proposed extension would be approximately 38,700m^2.

The runway extension may be constructed on lakefill or on a pile-supported deck structure. To determine the impacts of the proposed runway extension, as described above, CH2M HILL has examined the area of the proposed extension and its immediate vicinity. For appropriate context, existing conditions in the vicinity of the entire BBTCA have been examined as well, were required.

Figure 1-2 **Study Area**
Image adapted from Airbiz, 2013



1.4 Project Team

CH2M HILL has worked closely with the City of Toronto to gather background information, previous studies and reports to facilitate the review of the potential impacts of the proposed BBTCA runway extension. In addition, information was gathered from the Toronto and Region Conservation Authority (TRCA) and the Toronto Port Authority (TPA).

2. Existing Conditions and Effects of Proposed Runway Extension on the Aquatic Environment

2.1 Aquatic Habitat

Water quality in the Inner Harbour and around the Toronto Islands has improved greatly in the past three decades, with the Ontario Ministry of the Environment (MNR) noting a "much healthier open water aquatic community" around the islands (MNR, 2007, p. 4). Populations of aquatic species are strengthening and diversifying, with Tape-grass communities, commonly considered an indicator of relatively clear waters with low disturbance, returning to the open water and coastal regions of the Toronto Islands after declining substantially in the early 1900s. According to the MNR (2007, p. 4) "this species was last recorded on the Islands in 1894, and was not present in [a] 1978 survey... Other aquatic species which have returned include Flat-stemmed Pondweed (last collected in 1899), Perfoliate and Richardson's Pondweed (last collected in 1897), Star Duckweed (last collected in 1947), Common Coontail (last collected in 1926) and Canada Waterweed (last collected in 1913)."

Nonetheless, many other aquatic plants have not returned to the area (MNR, 2007), indicating that the open and coastal waters in the vicinity of the BBTCA may still be in a stressed condition. Although the exact extent of current aquatic vegetation is unknown, if vegetation is located within the footprint of a proposed lakefill runway extension, it will be destroyed by the extension. A deck on piles will reduce the amount of vegetation destroyed in the short term, however it will reduce light penetration through the water column, and may result in longer-term decline of aquatic vegetation in its vicinity.

2.2 Fish and Fish Habitat

A number of fish are present in the vicinity of the BBTCA, spawning and nursing in the coastal marshes of the Toronto Islands. The Coastal marshes of the Toronto Islands are considered significant in the ecodistrict 7E-4, in which they are located (MNR, 2007). According to the Ministry of Natural Resources (MNR, 2007), the fish present at and in the vicinity of the Toronto Islands include Common Carp, Brown Bullhead, Pumpkinseed, Bluegill, Northern Pike, Black Crappie, Longnose Gar, White Sucker, Freshwater Drum, Largemouth Bass, Smallmouth Bass, Rock Bass, American Eel, Bowfin, White Perch, Yellow Perch, White Bass, Walleye, Rainbow Trout, Chinook Salmon, Gizzard Shad, Rainbow Smelt, Alewife, Goldfish, Brook Silverside, Brook Stickleback, Threespine Stickleback, Bluntnose Minnow, Fathead Minnow, Common Shiner, Golden Shiner, Spottail Shiner, Emerald Shiner and Johnny Darter (MNR, 2007). The American Eel is considered endangered by the Ontario Ministry of Natural Resources, and is listed as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Figure 2-1 The American Eel Inhabits the Waters of Lake Ontario, amongst other fresh and saltwater habitats, and is listed as endangered under Ontario's *Species at Risk Act*

According to a 2013 Environmental Assessment for the TPA, three aquatic species at risk have the potential to inhabit the area of the runway extension: American Eel, Silver Lamprey, and Eastern Pondmussel (Dillon, 2013).

In the immediate vicinity of runway 08-26, fish habitat is very limited due to the extensive hard surfaces of the cellular and sheet pile walls, and limited submergent and emergent vegetation (Aquatic Habitat Toronto, n.d.). Nonetheless, at both ends of the runway localized shoreline revetments provide limited structural habitat for area aquatic life. Further underwater surveys are required to determine if additional structural habitat is located within the study area. Runway extensions offer an opportunity to improve habitat through the placement of submerged and emergent structures such as rip rap or root balls to provide cover for foraging fish. The wall of a lakefill runway extension offers more opportunities to place structures such as a shoreline revetment to create habitat than the construction of a deck on piles does. A deck on piles will reduce light penetration below it, affecting vegetation growth.

Submerged, rooted aquatic plants can create good habitat conditions for fish and other aquatic organisms, improve water quality, and stabilize the substrate. A study undertaken by Aquatic Habitat Toronto (AHT) in the summer of 2002 showed submergent vegetation located immediately to the south of the eastern end of the runway (Aquatic Habitat Toronto, n.d.); however, further study should locate the extent of current submergent vegetation. At the time of visiting the site, in early August, when aquatic vegetation usually peaks, no emergent vegetation was visible in the vicinity of the vertical walls or revetment coastline at either end of the runway, and no submergent vegetation was visible in the shallow, sandy lake bed to the south of the eastern end of the runway, or south of the western end of the runway, along Hanlan’s Point Beach. Fish will forage and spawn in areas where food and cover are available. While foraging by area fish may be reduced in areas with limited vegetation, a detailed survey of underwater vegetation and structures (boulders, submerged logs, and other sunken debris) is required to ascertain habitat quality and fish activity within the study area.

Figure 2-2 South of the Western End of the BBTCA Runway, Riprap and Floating Woody Debris Forms Structural Cover for Fish Species and Protection from Predators

2.3 Resident/Breeding and Migratory Birds

The BBTCA runway does not host meaningful habitat or nesting grounds for resident and breeding bird populations, nor is it particularly welcoming to migrating birds during stopovers on the way to nesting or overwintering grounds. And although the grassed areas of the airport property can be used by Canada Geese for foraging, and even nesting, the TPA actively manages goose and other bird populations on the site through deterrents and annual removals in cooperation with the Canadian Wildlife Services (Lundy, Personal communication, 2013) as bird populations represent a nuisance to airport operations. Despite the poor habitat found within the BBTCA, very high-quality habitat for resident and migratory birds is found nearby, on Mugg’s Island (see Figure 2-3) and other parts of the Toronto Islands and at the Leslie Street Spit/Tommy Thompson Park (TTP). TTP is a globally significant “important bird area” (IBA Canada, n.d.), hosts 316 different recorded species of birds, and contains the largest breeding colonies of colonial waterbirds on the Great Lakes with an estimated population of over 170,000

Figure 2-3 Mugg's Island is Located Immediately to the South of the East End of the BBTCA Runway

individual birds located less than 4km away from the BBTCA (McDonald, Personal Communication, 2013). As a result of the nearby habitat, some of these birds tend to loaf in the waters of the Inner Harbour (MNR, 2007), including in the vicinity of the proposed runway extension.

Unlike resident and overwintering bird populations, which tend to make homes in the vicinity of the BBTCA on a long-term basis, migratory birds stop in the vicinity of the BBTCA to feed, rest, and sometimes wait out inclement weather (City of Toronto, 2009) on a seasonal basis. The greatest diversity of species of migratory birds stopping in the vicinity of the BBTCA can be found in TTP, on the Toronto Islands, and along natural patches of the shoreline (City of Toronto, 2009). Stopovers are typically made in the spring and fall months as migratory birds travel between nesting grounds and overwintering grounds (City of Toronto, 2009). In addition, birds that stopover at TTP, the Toronto Island, and other lakeshore and lakeside locations, may seek food such as water insects and fish in the waters around the BBTCA property. In the Toronto area, of all the threats to migrating birds during migration, the greatest threat is considered to be habitat loss. (City of Toronto, 2009). Although a number of different types of migratory birds stopover in TTP and on the Toronto islands, the birds most likely to be found in the immediate vicinity of the BBTCA runways are those birds that loaf and feed in coastal and wetland environments. The most commonly-observed birds loafing in the vicinity of the BBTCA runways are ducks, geese, and cormorants, of various varieties (see Figure 2-4), however according to the MNR (2007), a number of species of birds can be observed at various times of the year in the waters around the Toronto Islands, including waterfowl, herons and other waders, pelicans, rails, Rusty Blackbirds (a species at risk), Yellowheaded Blackbirds, swallows (many of which are listed as a species at risk), other shorebirds, and American Pipit. The wetlands and open waters of the Toronto Islands and TTP provide stopover for migrating waterfowl such as Gadwall, Bufflehead, Redhead, Canvasback, Green-winged Teal, Blue-winged Teal, Hooded Merganser, Ruddy Duck, American Widgeon, Wood Duck, Mute Swan, Canada Goose, Mallard and Gadwall, many of which also breed at the Toronto Islands (MNR, 2007) and at Tommy Thompson Park (McDonald, Personal Communication, 2013).

A runway extension is unlikely to displace loafing birds, once constructed (using lakefill or a deck on piles), and if habitat improvements are incorporated into the design, may result in more bird feeding and loafing activity. An updated birdstrike assessment should be conducted to detail the effects of existing and increased bird populations on airplane take-off and landing activities.

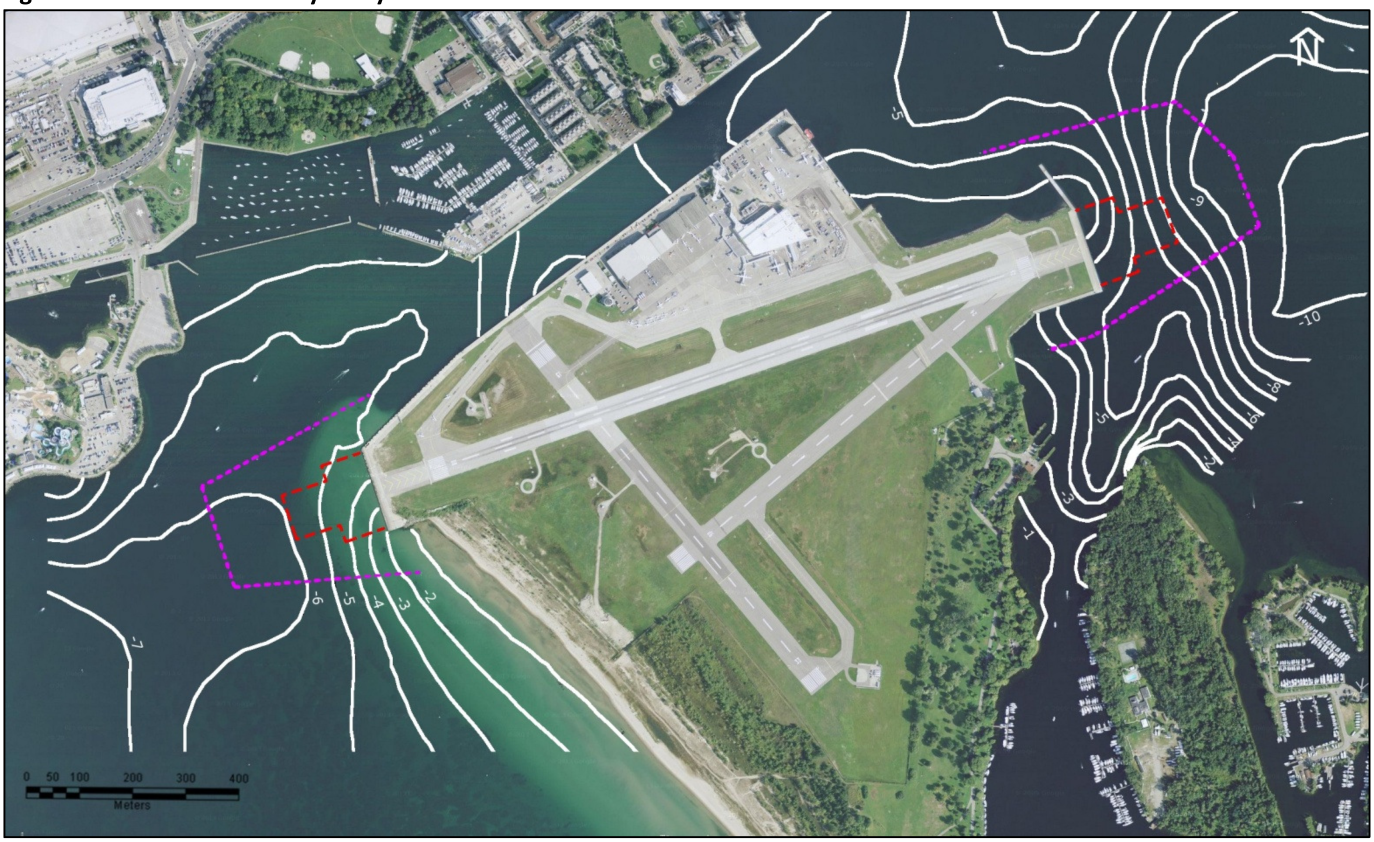
Figure 2-4 Cormorants and Ring-billed Gulls Sun Themselves on the Eastern BBTCA Breakwater and Loaf in Nearby Waters in Early August 2013

2.4 Bathymetric Conditions

Depths in the Toronto Inner Harbour vary from 12m in the deepest area, offshore of the eastern side of the runway, to less than 1m along the shores of the Toronto Island. Water depths in the Western Gap are in the order of 7.6 m. To the west of the BBTCA, beyond the MEZ the water depth is approximately 6.7m deep, and reaches 15m in depth within 500m further offshore. All depths are referenced to chart datum, which is 74.2m International Great Lakes Datum (IGLD) 1985.

Figure 2-5 shows bathymetric contours in the vicinity of the BBTCA, created using MIKE 21 CMAP (DHI, 2012a). Contours are plotted on an aerial image from 2009 (Google, 2013). The water depths at the toe of the steel sheet pile wall are 4.5 m and 4.0 m below chart datum at the eastern and western end of the runway, respectively.

Figure 2-5 Local Bathymetry Around the BBTCA



If a deck structure is selected to extend the runway it will not affect the adjacent bathymetry. If the extension is constructed as lakefill, it is anticipated that the extension will result in decreased depths at the western runway extension where sediments will accumulate along the south side of the extension. No impact is expected on the eastern runway extension if constructed with lakefill or as a deck on piles.

2.5 Seabed Characteristics

As an integral part of the Gibraltar Point Erosion Control project (TRCA, 2008) sediment samples were collected at thirty seven locations in the nearshore area of the Toronto Islands by the TRCA, as shown in Figure 2-6. The sediment samples have been analyzed for grain size distribution in the laboratory. The sample sites 1, 32, and 33 are in close proximity to the western end of the runway in Lake Ontario and these samples are considered herein.

Figure 2-6 **Sediment Grab-Sample Locations (Agat Laboratories, 2009)**
Derived from Agat Laboratories, 2009

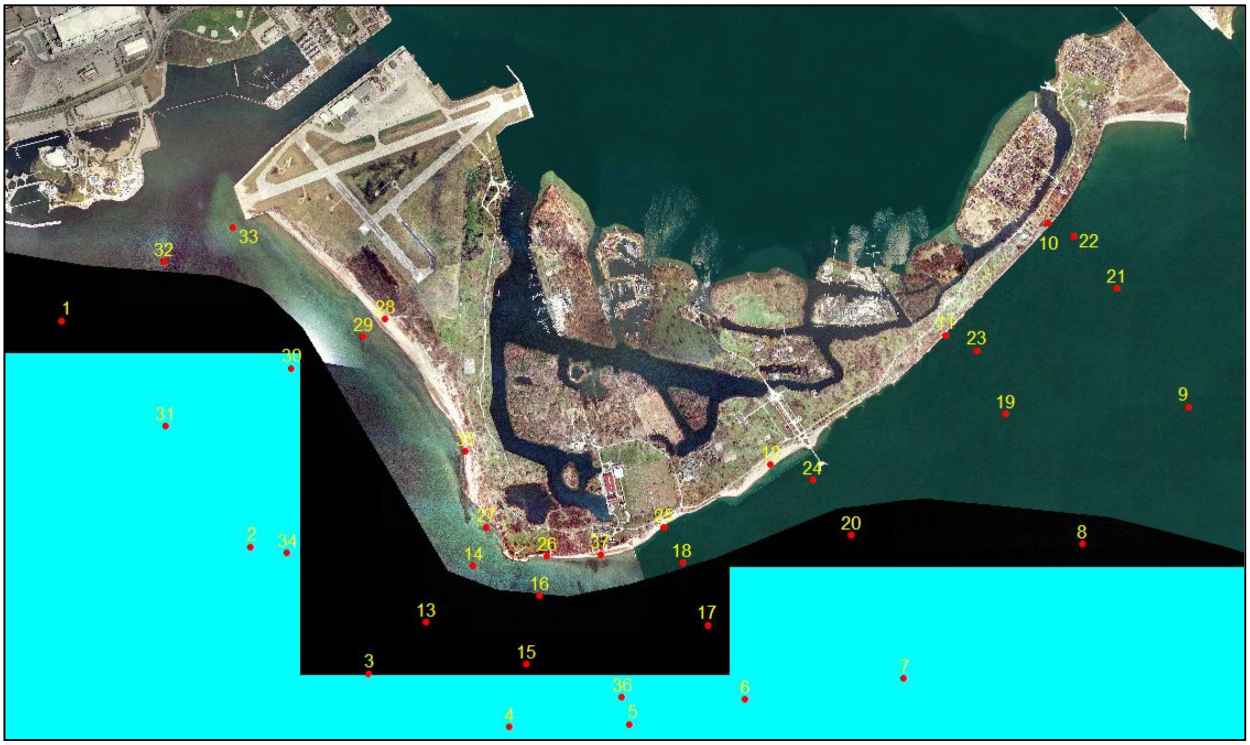


Table 2-1 summarizes grain size characteristics such as D16 (diameter for which 16% of sediment by weight is finer), D84 (diameter for which 84% of sediment by weight is finer) and median grain size D50. The average median grain size for samples collected from the stations 1, 32 and 33 is 0.23mm. Thus the sediment in this region is predominantly fine sand. Figure 2-7depicts the grain size distribution of each sample in front of the proposed western runway extension.

Table 2-1 **Summary of Sand Samples in Front of Western Runway**

Station ID	Sample Location (WGS84 UTM Zone 17)		D_{50} (mm)	D_{84} (mm)	D_{16} (mm)	σ_g(=$\sqrt{D_{84}/D_{16}}$)	σ_ϕ=(D_{84}-D_{16})/2
	Easting (m)	Northing (m)					
1	627883	4831149	0.27	0.68	0.05	3.58	1.98
32	628359	4831422	0.22	0.63	0.16	1.97	1.15
33	628684	4831586	0.20	0.24	0.16	1.22	0.80
Average			0.23	0.52	0.13	2.26	1.31

An indication of the sample's gradation and sorting, which refers to the range of grain sizes present, was also investigated for each sample. A numerical measure of sorting is the standard deviation, σ_ϕ, which is defined by Dean and Dalyrmple (2002) as

$$\sigma_\phi=(\phi_{16}-\phi_{84}/2)$$

The ϕ size is related to grain size by

$$\phi = -\log_2(D)$$

where D is measured in millimetres. A perfectly sorted sand (homogeneous in size) would have the same values for ϕ_{84} and ϕ_{16} where σ_ϕ =0.For realistic sand size distributions on a beach, a $\sigma_\phi \leq 0.5$ is considered well sorted (i.e. poorly graded), whereas a sample with $\sigma_\phi \geq 1$ is considered poorly sorted. The standard deviation σ_ϕ was calculated for each sample (Table 2-1). It was found that average standard deviation σ_ϕ is 1.31 which means the sand is poorly sorted, or very heterogenous in size, at stations 1, 32 and 33.

The geometric standard deviation, σ_g is determined by

$$\text{sqrt[D84/D16]}= 2^{\sigma_\phi}$$

and was calculated for each of these samples (Table 2-1). The average geometric standard deviation σ_g was found to be 2.26 for the three stations.

Recent borehole samples taken in the Inner Harbour show that the lakebed in the harbour consists of sand and silt deposits, varying in thickness from approximately 1m to 10m, overlying bedrock (Ministry of the Environment Canada, 1997). At the eastern end of the proposed runway extension the seabed is characterized by 75% silt and clay and 25 % sand, as shown in Figure 2-8.

Figure 2-7 Grain Size Distribution at Station 1, 32, 33
Derived from Agat Laboratories, 2009

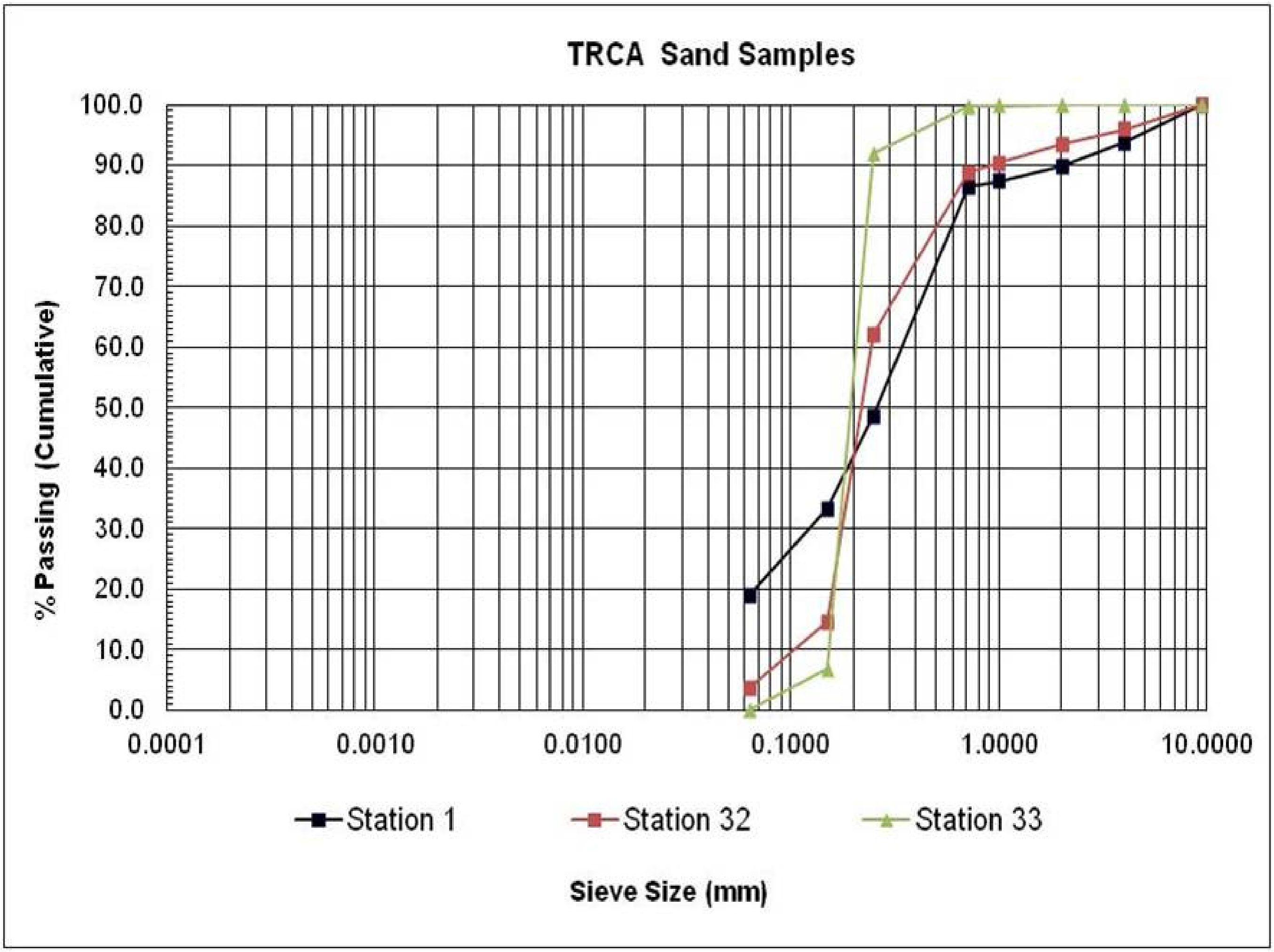
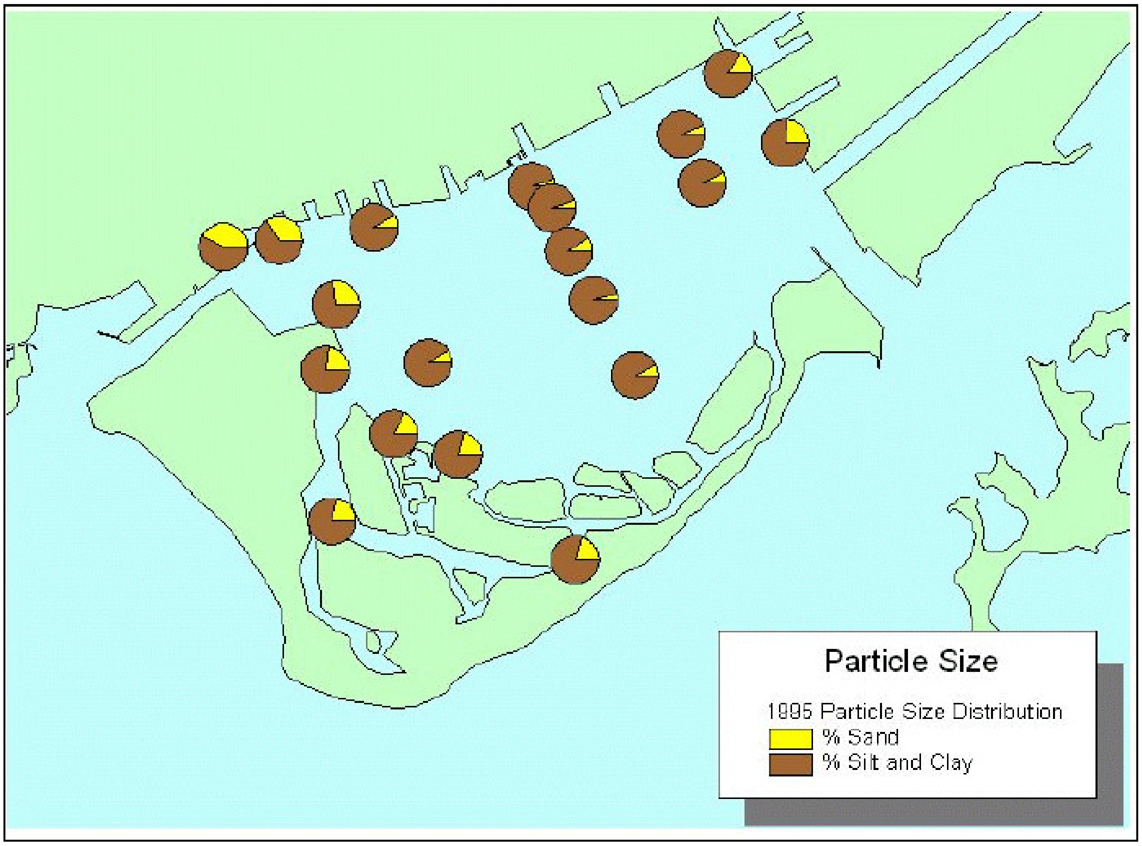


Figure 2-8 Sediment Particle Size Distribution within the Toronto Harbour (MNR, 1997)



Silt/clay can be easily mobilized by construction activities, and will require mitigation measures such as silt curtains to avoid sediment release into the water column outside of the construction area. Bedrock beneath the sediment is unlikely to be negatively affected by the construction of an extension constructed either with lakefill or on piles.

3. Existing Conditions and Effects of Proposed Runway Extension on the Terrestrial Environment

The terrestrial environment within the BBTCA is dominated by paved surfaces and manicured lawns and, as noted in the previous section, offers little habitat for bird species. The property is fenced and generally inaccessible to terrestrial species such as mammals or rodents. This condition will remain unchanged if the proposed BBTCA runway extension is implemented. Beyond the BBTCA, however, dynamic and static shorelines represent existing and potential habitat opportunities, are subject to physical processes, and must be accounted for in the design of a proposed runway extension.

3.1 Historic Shoreline Changes

The coastline to the south of the western end of runway 08-26 features a dynamic dune environment, known as Hanlan's Point Beach. Shoreline changes on the Hanlan's Point Beach were assessed using available aerial images. Historical aerial images with full coverage over the Hanlan's Point Beach were extracted from Google Earth Pro (Google, 2013). Although the exact time stamps of the images used are not known, the historical shoreline positions were digitized from aerial images from the years 2002, 2003, 2005, 2007 and 2009.

Figure 3-1 Historic Shorelines at Hanlan's Point Beach Overlaid onto Aerial Image 2009
Adapted from Google, 2013

The shoreline positions were inferred by distinguishing the difference between wet and dry sand. Figure 3-1 shows the digitized shorelines from year 2002 through 2009. The total error due to image placement and shoreline digitization is estimated to be 1.0 m in all images. This error margin should be considered when interpreting the shoreline change results.

Gridlines with 20 m grid intervals, originating from a specified baseline between 630453.87m E, 4830547.97m N, and 629192.24m E, 4831995.27m N (UTM 17) were drawn and perpendicular distances from baseline to the shoreline were measured for all digitized shorelines. Based on measured perpendicular distances to the baseline, shoreline change rates were calculated for approximately a 2km section of the Hanlan's Point Beach between the western end of the runway and Gibraltar Point.

There are several possible methods for calculating an average rate of change within a selected time segment having more than two measurement points. The multiple method approach, first introduced by Foster and Savage (1989) ensures the calculated error is not method-dependent. The first method is called 'the end-point method' which takes the difference between the first shoreline position and the end shoreline position divided by the time between surveys to give an approximate shoreline change per year. The second method applies the least square method to fit a linear trend to the shoreline positions versus time. The slope of the fitted line indicates the rate of shoreline change. The third method, rate averaging, determines the shoreline change rate for each possible survey combination with enough time separation to eliminate possible effects due to digitization error.

The shoreline change rates were calculated using the three methods, based on traced shoreline from aerial images 2002, 2003, 2005, 2007 and 2009 and the average result from the three methods was calculated as the representative shoreline erosion rate for Hanlan's Point Beach. It was found that the shoreline extended into the water through the process of accretion at an average rate of 1.70m/yr between 2002 and 2009 due to northerly longshore sediment transport.

3.2 Present-Day Shoreline Description

A visual reconnaissance of the site was undertaken by CH2M HILL on August 9, 2013. The water level at the time of the visit was approximately 0.84 m above the CD. The description of the shoreline condition is based on the visual reconnaissance only. Geotechnical studies, surveying, sediment sampling, or other detail investigations were not conducted during this visit, but may be required during the detailed design phase of the work, should the runway extension be approved.

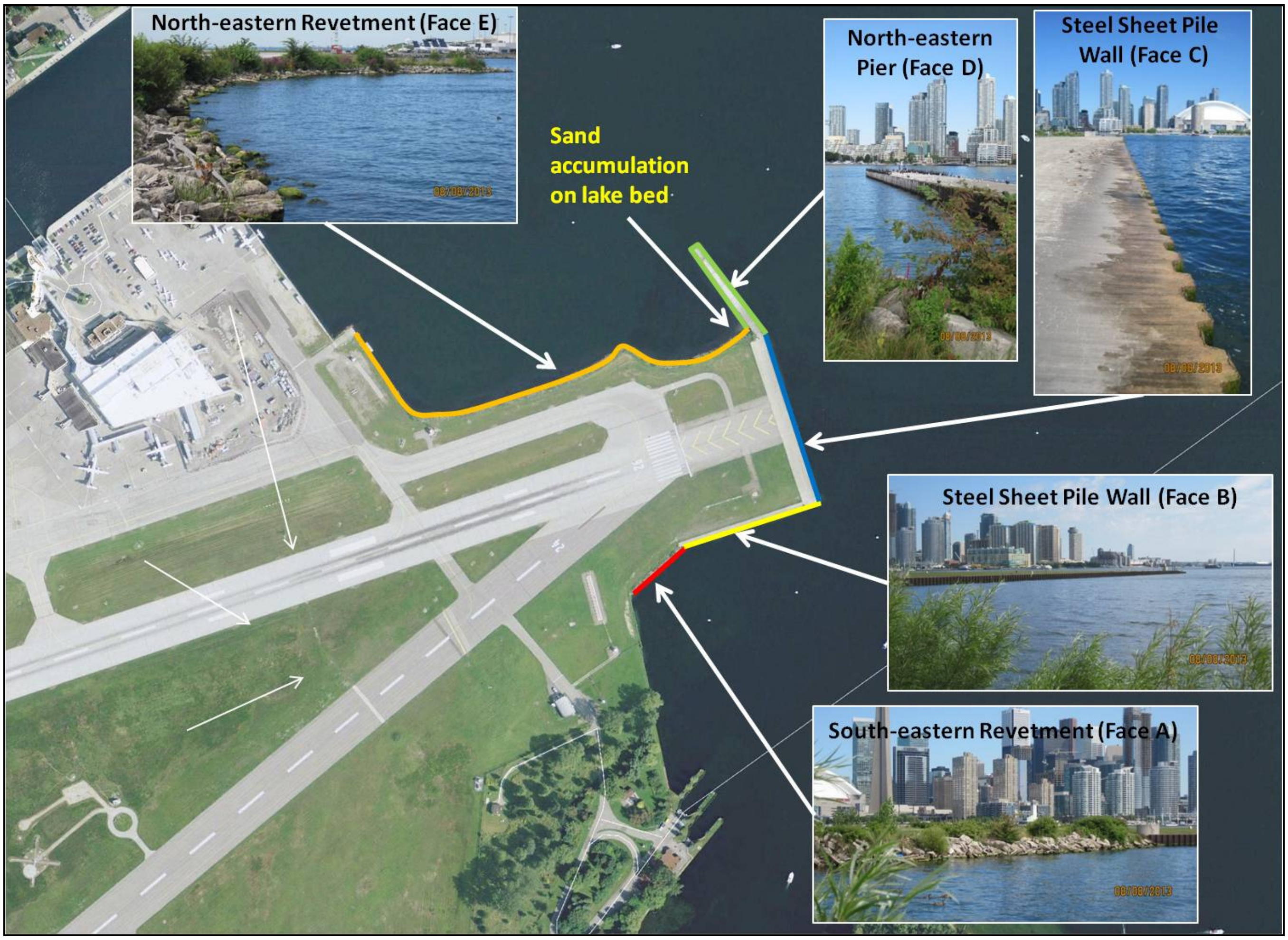
The length of shoreline observed on the eastern and western runway by CH2M HILL are shown in Figure 3-2 and Figure 3-6, respectively. It was observed that the shoreline has been stabilized with shore protection structures including rock revetment (approximately 490 m around the eastern runway and 50 m on the western runway) and steel sheet piles. A revetment is a hard treatment used to stabilize shorelines. For discussion purposes, the shoreline has been divided into two reaches, namely the eastern runway and western runway sections.

3.2.1 Eastern Runway

3.2.1.1 Southeastern Revetment (Face A)

The southwestern revetment extends from a steel sheet pile wall along the City of Toronto's Hanlan's Ferry docks at the south up to the STEEL SHEET PILE wall (Face B), as shown in Figure 3-2. The southwestern revetment is a rock armor structure with a front face slope of 1V:1.5H. It is observed that floating debris have accumulated amongst the revetment armor and shrubs and willow whips are growing above and out of the front face, as shown in Figure 3-3. Based on visual inspection revetment appears to be performing and no sign of erosion in the vicinity was observed.

Figure 3-2 Existing Shoreline Conditions on the Eastern Runway



3.2.1.2 Steel Sheet Pile Wall (Face B)

The steel sheet pile wall extends from southern revetment to the next steel sheet pile. Its crest elevations seem slightly higher than the southern revetment crest. There are a few localized cracks on the concrete deck of the wall, but it appears the sheet pile wall is in very good condition.

3.2.1.3 Steel Sheet Pile Wall (Face C)

This steel sheet pile protection extends from STEEL SHEET PILE Face B to the eastern pier. It consists of a steel sheet pile wall with sloping concrete deck in the central portion and a flat concrete deck in the northern and southern portions. The sloping concrete deck slopes down towards the inner port, and occurs over the width of the eastern end of Runway 08-26. The water level was almost at the same level as the crest height of the sheet pile wall during the visit. It is anticipated that this wall shall be overtopped by waves during the higher lake water levels. It is noted that there are few localized cracks between the concrete deck and STEEL SHEET PILE at the edge of the wall.

Figure 3-3 The Southeastern Revetment (Face A)

3.2.1.4 Northeastern Pier (Face D)

The northeastern pier is a steel sheet pile pier with a concrete deck that extends from the northeast limit of steel sheet pile Face C as shown in Figure 3-2. It is simply built as a double sheet pile wall connected with tie-rods and capped with a concrete deck. Similar to STEEL SHEET PILE wall at the end of the eastern end of the runway, some localized deterioration on the concrete surface was observed on the deck. At the time of the site visit on August 9, 2013, the deck was also hosting moss and lichen in several locations as shown in Figure 3-4.

Figure 3-4 Moss and Lichen on the Northeastern Pier

3.2.1.5 Northeastern Revetment (Face E)

The northeastern revetment extends from the eastern pier at the east end of the runway to the TPA float plane docks on the west end. It consists of dumped stone of various size, but ranging from approximately 2.5 tonne stones to small rip rap arranged on an approximately 1:4 slope. The revetment is overgrown with shrubs and small trees. At the eastern limit of the revetment, next to the Eastern Pier, an appreciable volume of sand has accumulated in front of the revetment against the pier as shown in Figure 3-5, in the relatively well sheltered embayment area.

Figure 3-5 Sand Accumulation at the Eastern End of the Northeastern Revetment

3.2.2 Western Runway

3.2.2.1 Eireann Quay (Face F)

The Eireann Quay extends east to west along the Western Channel. It is constructed as a steel sheet pile wall with a flat concrete deck as shown in Figure 3-7. Mooring tools such as bollards and a rub-rail have also been installed on the pier. Based on visual assessments, the sheet pile wall is in good condition and functions well. In the central portion of the wall a sound barrier wall was constructed on the decks to attenuate noise and vibrations from landing and ascending planes.

3.2.2.2 Northwestern Cellular Steel Sheet Pile (Face G)

The northwestern steel sheet pile protection extends from Eireann Quay to the Western pier. The structure consists of a cellular sheet pile wall with a concrete deck. Its crest elevation is slightly higher than the Eireann Quay. Localized deterioration on the concrete decking was observed during an August 9, 2013 site inspection. Nonetheless, the sheet pile wall is generally in good condition (Figure 3-8).

3.2.2.3 Western Steel Sheet Pile (Face H)

This steel sheet pile protection extends from the northwestern cellular STEEL SHEET PILE face (Face G) to the southwestern revetment. It consists of a steel sheet pile wall with a sloping concrete deck in the central portion and a flat concrete deck in the northern and southern portions. The sloping concrete deck slopes down towards Lake Ontario, and extends across the width of the western end of Runway 08/26. The water level was almost at the same level as the crest height of the sheet pile wall during the August 9, 2013 site inspection. It is anticipated that this wall is occasionally overtopped by waves during periods of higher lake water levels. A few localized cracks between the concrete deck and STEEL SHEET PILE at the edge of the wall were observed.

3.2.2.4 Southwestern Revetment (Face I)

The southwestern revetment extends from the western STEEL SHEET PILE wall (Face H) to Hanlan’s Point Beach. It consists of dumped stone, ranging in size from approximately 3.0 tonne stones to small rip rap arranged on approximately a 1:1.5 slope. At the eastern limit of the revetment an appreciable volume of sand has accumulated due to the northerly longshore drift of sediments from Gibraltar Point and Hanlan’s Point Beach. In addition to the sand, floating debris has accumulated on the beach and revetment as shown in Figure 3-9.

Figure 3-6 Existing Shoreline Conditions on the Western Runway

3.2.3 Overall Shoreline Condition

The shoreline in the project area is currently protected by a combination of armourstone, rip rap revetments, and steel sheet piling. The existing shore protection has hardened the shoreline and prevents natural shoreline responses to wave action. Based on visual reconnaissance, overall the shoreline protection appears to be in good condition and appears to have prevented shoreline change since its installation.

The proposed runway extension is located in an area with a heavily armored shoreline that is resistant to wave action and shoreline change. The proposed extension works are not expected to have an impact upon the steel or concrete shoreline, however may affect the movement of sediment northward into the Western Gap. Beach and dune impacts are detailed in Section 3.2.5. It is noted that there is an intake tunnel in the immediate vicinity of the eastern runway extension which supplies the John Street Pumping Station , located at 23m to 28m below International Great Lakes Datum 1985 (Dillon Consulting Ltd, 2013). It is recommended that a detailed site survey and sounding be carried out to determine its exact location with respect to the proposed extension and construction activity near the eastern runway.

Figure 3-7 View Eastward of Eireann Quay and the BBTCA Sound Barrier

Figure 3-8 View South of the Northeastern Cellular Quay

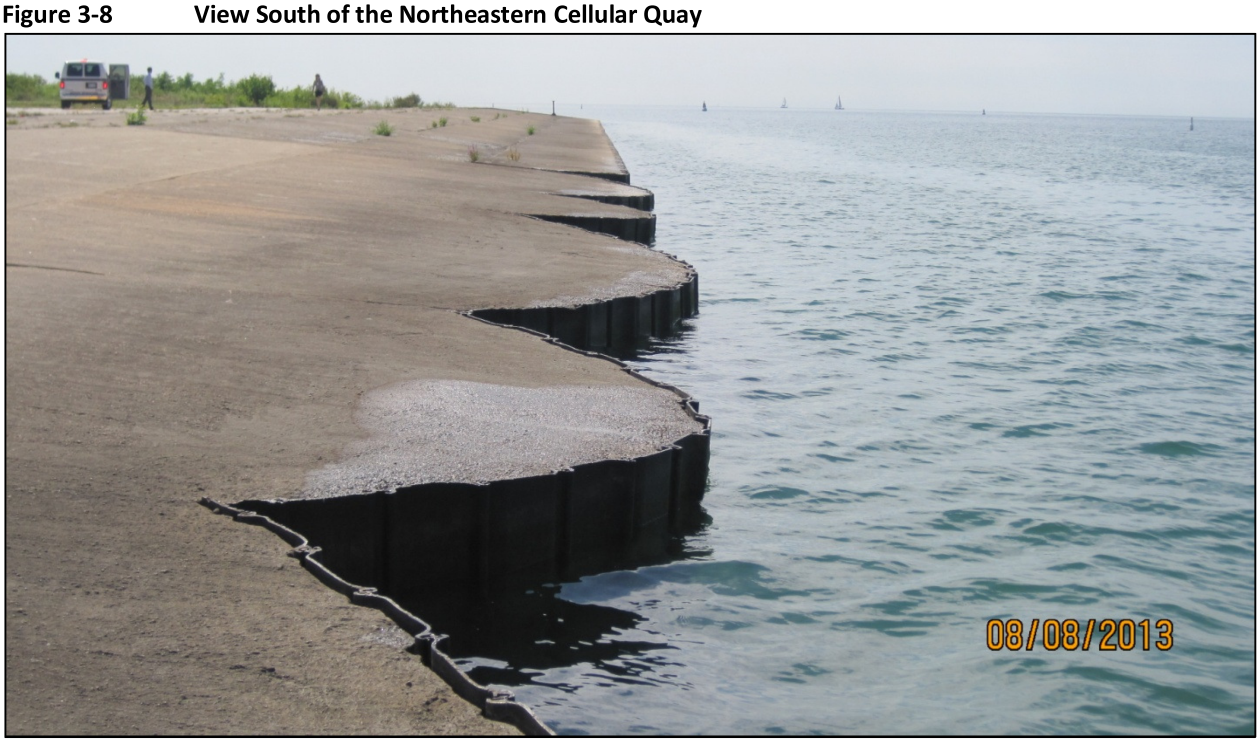
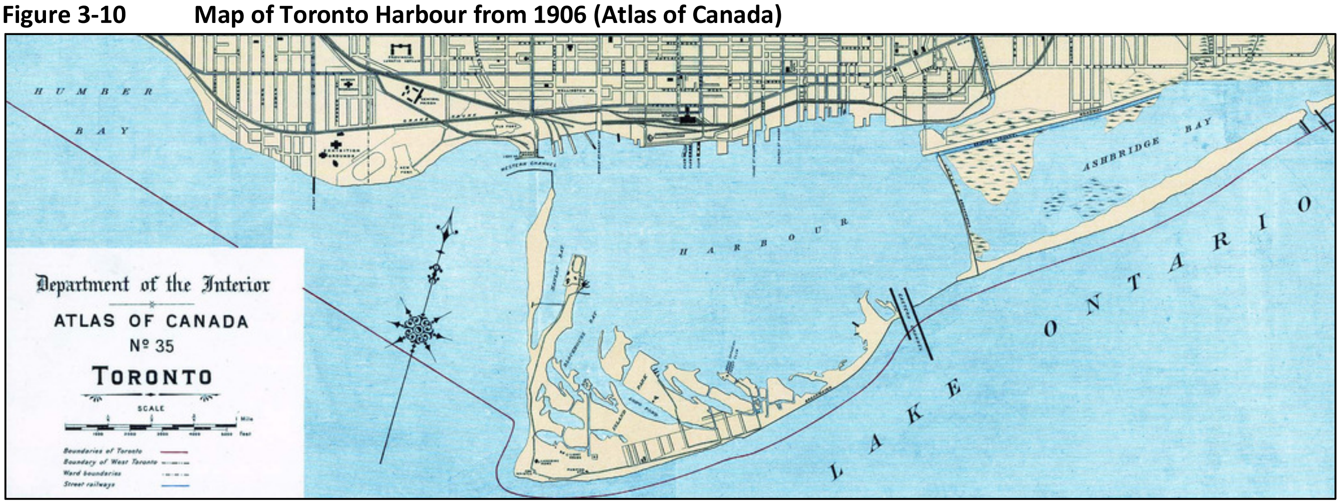


Figure 3-9 The Southwestern Revetment and Hanlan's Point Beach

3.2.4 Sediment Transport and Future Shoreline Changes

The Toronto Islands were formed in the late glacial and post glacial periods by sediment supplied to Lake Ontario via rivers and bluff erosion along the Scarborough Bluffs (Sharpe, 1980). This resulted in the formation of a sand spit that extended from Ashbridge's Bay, to the Toronto Islands. Figure 3-10 shows the Toronto shoreline in 1906. Considerable fill has been added to the islands and waterfront since the turn of the 20th century, most notably in the central waterfront, Ashbridge's Bay and Buffer's Park. This was followed by further lake filling at the west end of the Toronto Islands in the 1930s, to create the present day BBTCA. Construction of the Leslie Street Spit started in the 1950s and today, the Leslie Street Spit forms a complete barrier to littoral transport from the east. The net direction of sediment transport was in a westerly direction and the spit now forms an area of deposition.

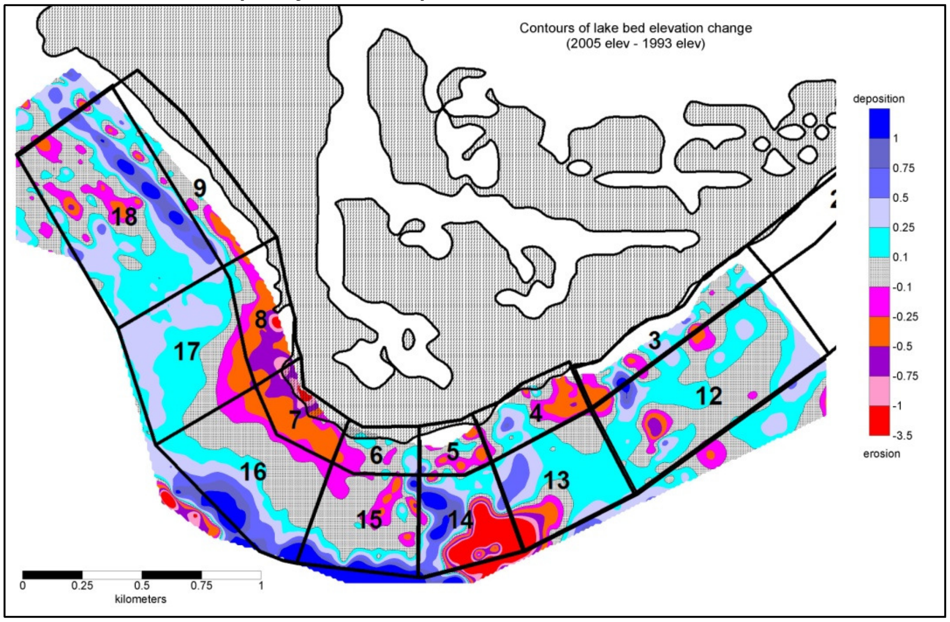
Figure 3-10 Map of Toronto Harbour from 1906 (Atlas of Canada)



The present day harbour is isolated from sediment sources. There is virtually no sediment transport into the Harbour through the Eastern and Western Gaps. The Don River, once a source of sediment to the area, now empties into the Keating Channel, which is regularly dredged.

Within Toronto Harbour, the north, east and west shores of the Harbour consist of lakefill, protected by timber cribs, concrete walls and steel sheet piling. The south shore, which is the sheltered shoreline of the Toronto Islands, consists of sand deposits, also largely protected with revetments and seawalls. As a result, the shoreline does not erode in response to wave action, and it does not represent a sediment supply within the Harbour.

Figure 3-11 Lakebed Elevation Change Contours from 1993 to 2005
Adapted from Shoreplan, 2005

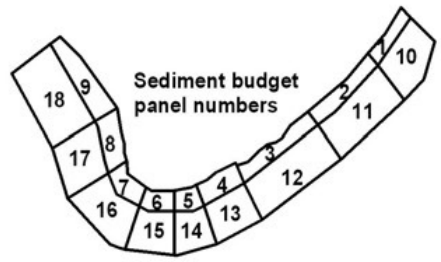


As part of a 2007 Class Environmental Assessment for Remedial Flood and Erosion Control Projects completed for the TRCA, Shoreplan Engineering completed a coastal analysis study to determine the regional processes around Gibraltar Point and assist with the development of alternative long-term solutions to the shoreline erosion (Shoreplan, 2007). Shoreplan investigated sediment transport characteristics around Gibraltar Point using numerical models and survey comparisons as well as previous studies. Based on a 1994 Baird sediment transport modeling study which covers the 35 year period from 1958 to 1993, Shoreplan developed a sediment budget analysis for Gibraltar Point and Hanlan's Point Beach using profile surveys from 1993 and a nearshore bathymetry survey conducted at the end of 2005. Figure 3-11shows the contour map of the lakebed elevation changes that occurred within the 1993-2005 timeframe. Table 3-1 shows the lakebed volume changes calculated as part of the sediment budget analysis. Negative volume changes indicate erosion and positive volume changes indicate accretion. It may be noted that Panel 18 is near the proposed runway extension on the western end of the island, where sand accumulates in the nearshore. Based on these analyses it is anticipated that the alongshore sediment transport rate in front of the western end of Runway 08-26 is approximately 7,400 m^3/year.

If a deck on piles is constructed to extend the runway, changes to the sediment transport will be minor and limited to the immediate area of the proposed extension on the western gap. As for the lakefill, it is anticipated that northerly-directed alongshore sediment transport will be partly blocked by the extension at the western end and sand may accumulate against the lakefill. On the eastern end of the runway it is anticipated that a runway extension constructed with either lakefill or a deck on piles will result in no impact to the sediment process in the Inner Harbour. However, during the construction there is a potential for increased suspended sediment concentration and the resulting turbidity plume at both ends of the runway. The potential impact would largely be related to fisheries. It is recommended that a silt curtain/barrier be used during the construction to reduce these impacts. To quantify the impacts on sediment movement that will result from the proposed runway extension, a detailed numerical sediment transport modeling study is recommended to determine the transport path around the island with and without the proposed extension.

Table 3-1 Annual Sediment Volume Changes at Gibraltar Point and Hanlan's Point Beach (Shoreplan, 2007)

Average Annual Volume Changes Values (m^3/yr)						
Panel	1913 to 1993	1951 to 1993	1951 to 1967	1967 to 1981	1981 to 1993	1993 to 2005
1	-1,300	800	1,700	-700	-1,700	
2	-1,800	700	1,600	-4,700	400	
3	-600	-400	-3,700	-500	0	2,100
4	-1,400	-100	-200	4,400	-5,300	-100
5	-1,200	-200	-200	-1,300		-300
6	-2,700	-3,200	-1,900	-5,400	-2,300	100
7	-1,900			-4,900	-5,800	-2,800
8	400				-1,800	-2,600
9	5,600			14,100	4,800	
10	-4,800	0				
11	-6,700	-3,600				
12	-2,900	-4,600				4,400
13	-1,300	-900				900
14	-2,400	1,500			-1,800	-3,100
15	-1,100	-2,900			-6,300	3,000
16	-3,000				-5,700	5,500
17	400					2,700
18	6,400					7,400



3.2.5 Beach and Dune Environment

Beach and Dune environments are limited to the section of the coast extending south from the western end of the runway, known as Hanlan's Point Beach. Significant restoration efforts have been ongoing along this section of coastline, slowing erosion and improving dune species diversity. A study by the TRCA (currently on hold) is examining the feasibility and design of a dune replenishment program that will replace beach sand with lost sand dredged from the Western Gap. As the greatest threat to this dune environment is the movement of sand northwards into the Western Gap, it is not anticipated that the proposed runway extension, at the northernmost end of Hanlan's Point Beach will negatively affect the dune environment. The design of a proposed BBTCA runway extension at the western end of the runway can be optimized to capture beach substrate and sediments before they enter the Western Gap, potentially facilitating or reducing the costs associated with mechanical sand replenishment activities on Hanlans' Point Beach and Gibraltar Point, the southernmost tip of the beach. Accretion at the proposed runway extension will also extend the dune environment, potentially creating additional dune habitat, as shown conceptually in Figure 3-12, below.

Figure 3-12 Potential Conceptual Dune Accretion Resulting from Proposed Runway Extension

3.3 Environmental Risks and Mitigation Associated with New Storage Tanks for Jet Fuel

The most common environmental risk associated with the storage of liquid petroleum products, such as jet fuel, is the potential for leaks or spills from either above ground or underground storage tanks and associated piping and equipment. Historically, underground storage tanks and in particular single walled steel tanks have posed a much greater risk to the environment due to the greater potential for leakage associated with corroding or rusting tanks or piping. In instances where leaks may be occurring, they may go undetected without appropriate leak detection monitoring equipment or inventory control procedures in place, resulting in appreciable soil and groundwater impacts.

Development of more stringent regulatory requirements and improvements in fuel tank system design and construction materials such as the use of double walled fiberglass tanks and double walled steel tanks in conjunction with associated leak detection and associated monitoring equipment has helped significantly reduce although not completely eliminate the potential environmental risks associated with both underground and aboveground storage tanks systems. Even a small gasoline leak of one drop per second for example, can result in the release of about 1,520 L of gasoline per year. Preventing tank spills and leaks is especially important because jet fuel can move rapidly through surface layers and into ground water. Also, vapors from an underground leak that collect in basements, sumps or other underground structures can be a health or explosion hazard.

The primary environmental risks associated with above-ground and underground storage tanks and associated piping and equipment can be variable, however the most common risks are typically associated with or due to the following reasons:

- Potential for accidental spills during tank fueling if proper fueling procedures are not followed and appropriate spill containment equipment is not present at the tank filling locations
- Potential for leakage or spills due to equipment failure or malfunction at product dispensing equipment (pumps and hoses), fuel tanks (above or below grade), underground and aboveground piping, and piping joints etc. If not quickly detected by existing tank and monitoring equipment (where present), or identified through inventory control and reconciliation procedures, leaks or spills could migrate to the subsurface. Spill migration can result in soil, groundwater, and potentially surface water contamination if

not contained by secondary containment systems where present, or quickly recovered or cleaned up in the event of a spill or leak.

The best way to mitigate risks associated with fuel and petroleum product storage is to ensure all tanks and associated equipment are designed, installed, and operated in accordance with the applicable regulatory requirements and codes, including appropriate secondary containment and leak detection monitoring equipment. The tanks and associated equipment should also be installed and appropriately maintained by a licensed/certified petroleum equipment contractor in accordance with the manufacturer's instructions.

3.3.1 Spill Risks and Mitigation During Tank Filling

The most common risk of spills during filling are typically associated with accidental spillage or overfill due to operator error while fueling. This can and is typically mitigated by engineering controls such as tank high-level alarms, use of overfill protection at the fueling port, and the use of written fueling procedures by the fuel service providers. In Ontario, fuel service providers have to be TSSA licensed, and are bound to follow appropriate procedures and protocols that specify the appropriate procedures to try and avoid spills or leaks during re-fuelling.

3.3.2 Requirements for Rank Construction and Maintenance

Both aboveground and underground storage tanks shall be constructed and certified in accordance with approved standards i.e. ULC, API etc., in accordance with the Federal or Provincial regulatory requirements as applicable. As noted in the response to Question # 2 above, it is critical that the proposed tanks systems be designed, installed, and maintained by an appropriately licensed/certified petroleum equipment contractor and in accordance with the manufacturer's instructions. Maintenance of the equipment and any associated testing where required should be completed in accordance with the manufactures instructions and applicable regulatory requirements. Typical maintenance and monitoring requirements for the equipment or training documentation for fuel system operators that needs to be kept up to date and maintained may include but are not limited to the following examples:

- Annual dispenser inspections by an appropriately licensed/certified petroleum equipment mechanic/contractor
- Annual inspections of any electronic leak detection and fuel system monitoring equipment by an appropriately licensed/certified petroleum equipment mechanic/contractor
- Training records for employees using the fueling system
- Reference to additional emergency procedures and related spill response
- Leak detection and monitoring for double-wall tanks shall include
  a) commissioning test: precision leak detection test or secondary containment test
  b) in-service monitoring
    i) continuous: secondary containment monitoring
    ii) periodic: none required
  c) leak suspected: precision leak detection test or secondary containment test
- Leak detection and monitoring for single-wall piping shall include
  a) in-service monitoring
    i) continuous: single vertical check valve and statistical inventory reconciliation (SIR); single vertical check valve and inventory reconciliation; continuous electronic line and tank leak detection; electronic line leak detection (applicable only to single-wall pressure piping)
    ii) periodic: precision test every 2 - 5 years (annually for threaded galvanized equipment); electronic line leak detection
  c) leak suspected: confirm and replace with double-wall pipe.

3.3.3 Tank Lifespan

The useful lifetime of both underground and aboveground storage tanks can vary depending on a number of factors including but not limited to things such as tank construction materials i.e. steel or fiberglass, single or double walled, tank location i.e. underground or aboveground, and the frequency and degree of tank and system maintenance that is conducted. There are specified regulatory requirements and frequencies for tank integrity testing and upgrades for steel underground storage tanks, and for upgrading and conducting internal inspections for large above ground storage tanks. Typically steel underground storage tanks would have a life expectancy of 20-25 years, and potentially longer for fiberglass tanks provided appropriate tank leak detection monitoring is in place. It is not uncommon on the other hand to have above ground fuel storage tanks that are 30-40 years old or greater. However, there are certain requirements for tank inspections and maintenance depending on the age of the tank, with internal inspections required for example every 10 years for larger AST tanks constructed to API Standard 650.

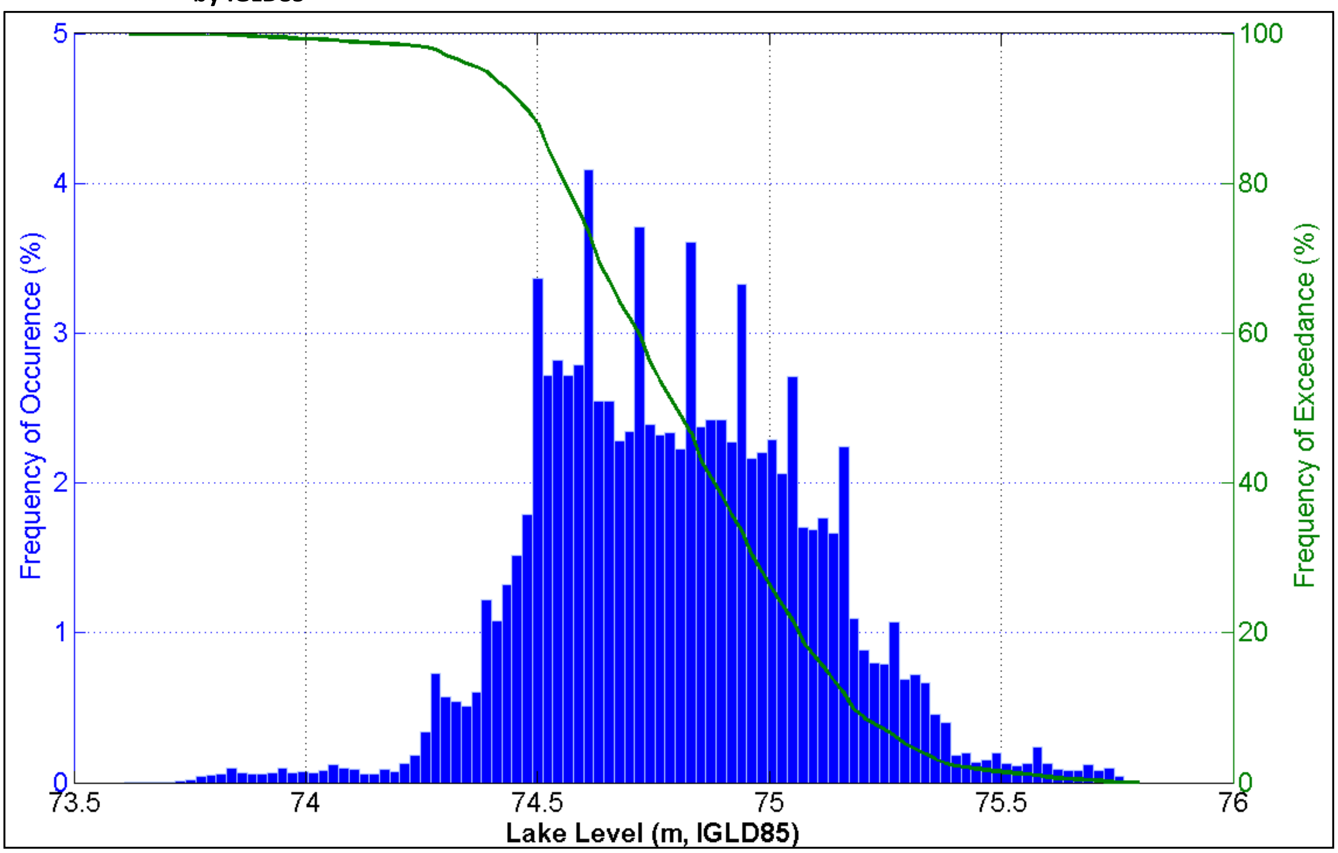
4. Physical Processes Affecting the Aquatic and Terrestrial Environment

Although much of the geography of the Toronto Islands, Inner and Outer Harbors, and the lake shore of the City have been shaped and hardened by anthropogenic means, the area is still subject to numerous dynamic processes resulting from cyclic climate and lacustrine changes. These processes and the effects they have on the BBTCA runway are described below.

4.1 Water Levels

Water levels in Lake Ontario vary annually and seasonally in response to general climatic conditions, and hourly in response to storm events. Canadian Hydrographic Service hourly digital water level data was collected from January 1962 to August 2013 and analyzed to estimate extreme high water levels as a function of various return periods. Figure 4-1 shows the frequency of occurrence and frequency of exceedance for hourly water levels over the fifty-two year period analyzed from the Toronto Gauge. Table 4-1 documents the maximum and minimum water levels over the period of record of hourly data (1962-2013).

Figure 4-1 Frequencies of Occurrence and Exceedance Statistics for Hourly Water Levels at the Toronto Island Gauge by IGLD85[1]



[1] The "datum" or elevation reference system used to define water levels within the Great Lakes-St. Lawrence River system must be adjusted every 25 to 35 years to account for movement of the earth's crust. IGLD85 is the durrent datum used when measuring water levels. The previous datum was known as the International Great Lakes Datum, 1955 or IGLD 1955.

Table 4-1 Maximum and Minimum Hourly Water Levels at Toronto Gauge (1962-2013)

Water Level	Water Level (IGLD 1985)	Date
Max.	75.81	May 28 1973
Min.	73.62	February 4, 1965
Range	2.19	-

First, storm surge events were separated out from the hourly water level by subtracting three days average mean water level from the measured water levels during the same period. Similarly, the maximum three days averaged water levels were determined from the data. A combined probability analysis was then performed in order to estimate three days mean, surge and combined water level (surge + weekly) as a function of the 1, 5, 10, 25, 50 and 100 year return periods. The results are summarized in Table 4-2 for the full year and for the boating season (May 1 to October 31).

Table 4-2 High Water Level as a Function of Return Period (m IGLD 1985)

Period	Water Level	Return Period (yrs)				
		5	10	25	50	100
Full Year	Static	75.72	75.75	75.78	75.79	75.80
	Surge	0.19	0.21	0.23	0.25	0.27
	Combined	75.75	75.79	75.82	75.84	75.86
Boating Season	Static	75.71	75.75	75.77	75.78	75.79
	Surge	0.16	0.18	0.20	0.22	0.25
	Combined	75.74	75.78	75.81	75.82	75.83

A similar analysis was also undertaken to estimate extreme low water levels as a function of same return periods as above. Again, the results are shown in Table 4-3 for the full year and for the boating season (May 1 to October 31).

Table 4-3 Low Water Level as a Function of Return Period (m IGLD 1985)

Period	Water Level	Return Period (yrs)				
		5	10	25	50	100
Full Year	Static	73.85	73.80	73.75	73.71	73.67
	Surge	-0.24	-0.26	-0.30	-0.33	-0.37
	Combined	73.78	73.72	73.64	73.59	73.55
Boating Season	Static	74.34	74.26	74.16	74.07	73.98
	Surge	-0.17	-0.18	-0.20	-0.22	-0.23
	Combined	74.25	74.18	74.09	74.02	73.95

Water levels in the harbor and Lake Ontario will not be affected by the extension.

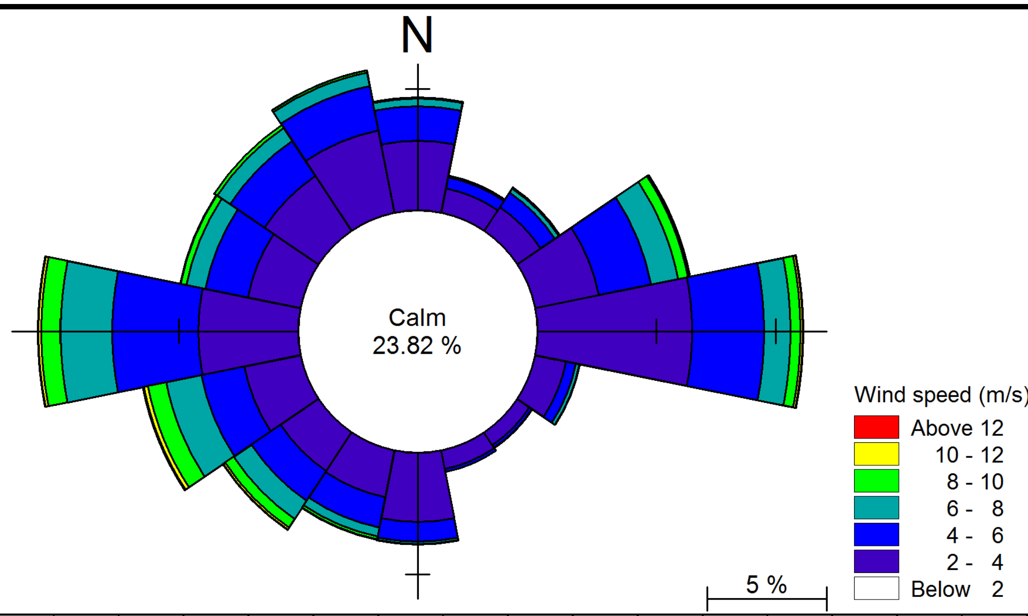
4.2 Climate Conditions

4.2.1 Wind

Wind data from the Toronto Island Airport anemometer (WMO ID code: 71265) was downloaded from the National Climate Data and Information Archive. The anemometer is located at latitude 43.6286° N and longitude 79.3950° W, at an elevation of 76.5 metres above sea level (masl).

Although the wind data record spans from February 1957 to March 2006, data prior to 1973 were not used, since measurements were not continuously taken throughout the day. The wind data was corrected to 10m anemometer elevation per U.S. Army Corps of Engineers guidelines (USACE, 2003). Following standard convention, wind data is "direction from," meaning that, for example, a northerly wind refers to wind that is coming from a northerly direction. A wind rose diagram and scatter diagram for Toronto Island wind data from 1973 to 2006 is shown in Figure 4-2. The strongest winds are mainly from the west to south-southwest sector. The wind speed rarely exceeds 14 m/s (0.03 % of the time in 24 years). The wind speed is calm, or less than 2 m/s approximately 23.8% of the time. Frequency of occurrence and exceedance frequency of the wind speed are shown in Figure 2.4.

Figure 4-2 Wind Rose and Scatter Diagram for Toronto Island Airport: Hourly Wind Speeds from 1973-2006



Wind Spd. (m/s)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	*Sum*
<2	1.02	0.39	0.43	1.11	3.10	1.08	0.78	0.78	2.03	1.62	1.72	2.33	2.96	1.34	1.62	1.52	***23.82***
2 - 4	2.85	1.02	1.19	2.73	6.51	1.34	0.63	0.78	2.83	1.96	1.91	2.41	4.21	2.25	2.72	3.46	***38.80***
4 - 6	1.40	0.47	0.72	2.25	3.00	0.42	0.11	0.12	0.82	1.27	1.47	1.84	3.60	1.81	1.75	1.87	***22.92***
6 - 8	0.32	0.07	0.19	1.14	1.11	0.13	0.02	0.01	0.10	0.38	0.90	1.50	2.16	0.83	0.63	0.55	***10.05***
8 - 10	0.03	0.01	0.06	0.43	0.42	0.04	0.00	0.00	0.02	0.11	0.43	0.79	0.80	0.23	0.14	0.09	***3.61***
10 -12	0.00	0.00	0.01	0.07	0.08	0.00	0.00	0.00	0.00	0.02	0.10	0.17	0.13	0.03	0.01	0.01	***0.64***
12 - 14	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.02	0.00	0.00	0.00	***0.13***
14 - 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	***0.02***
>16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	***0.01***
Sum	**5.63**	**1.96**	**2.60**	**7.74**	**14.25**	**3.01**	**1.54**	**1.68**	**5.79**	**5.36**	**6.56**	**9.08**	**13.89**	**6.50**	**6.88**	**7.51**	***100***

A peaks over threshold (POT) analysis was performed on the Toronto Island Airport wind data to determine extreme events in the dataset. An extreme value analysis (EVA) was then completed using MIKE 21 EVA (DHI, 2012b) on the resulting data. Wind speeds for varying return period are listed in Table 4-4. The upper and lower confidence limits are based upon the 95% confidence interval. Considering the length of the data set used in the analysis (33 years), the predicted 50 and 100 year return period wind speeds should be used with caution.

Figure 4-3 Frequency of Occurrence and Exceedance Frequency of Wind at Toronto Island Airport from 1973 to 2006

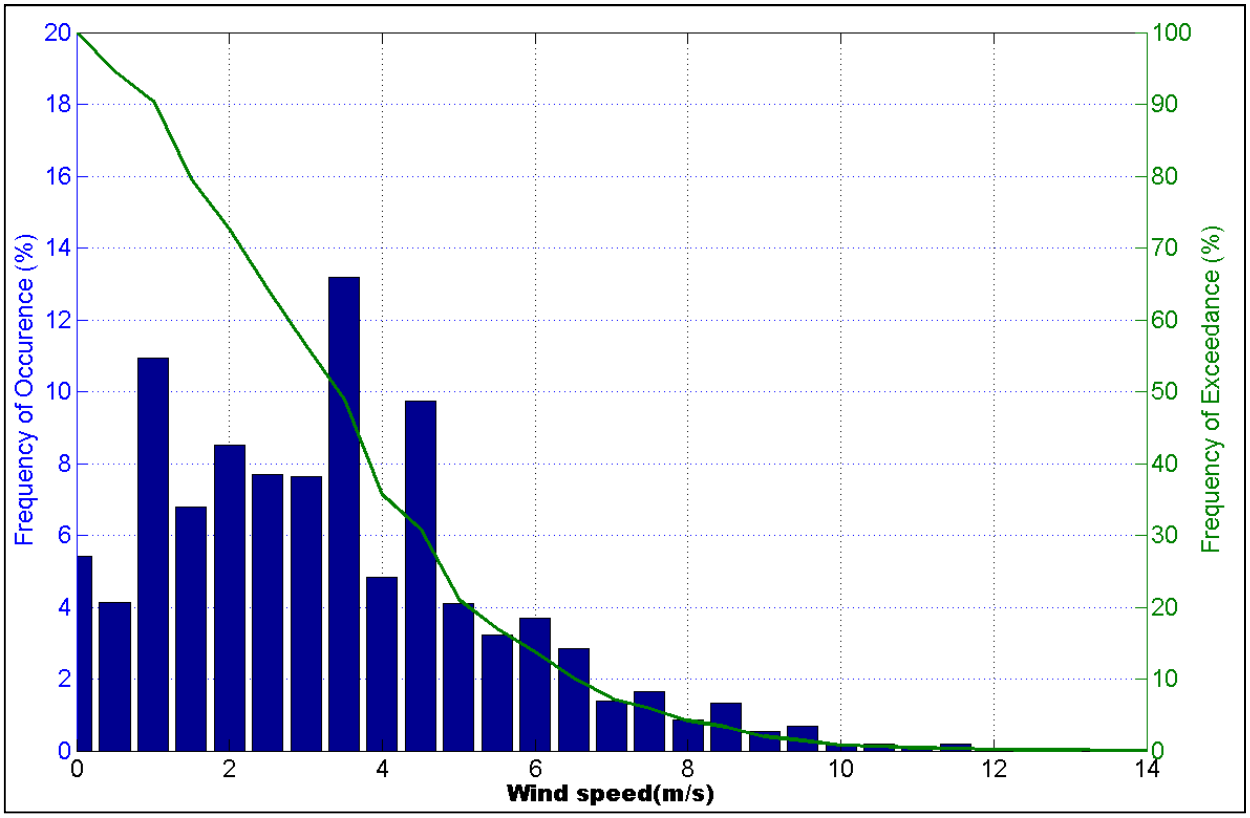


Table 4-4 Summary of Extreme Wind Speed and Confidence Limits for Toronto Island Weather Station Data

Return Period (yrs)	Wind Speed (m/s)	Upper Confidence Limit (m/s)	Lower Confidence Limit (m/s)
1	14.0	14.2	13.8
5	14.7	15.2	14.2
10	15.8	16.6	14.9
25	16.8	17.8	15.5
50	18.2	19.8	16.1
100	19.3	22.0	16.3

The wind field in the harbor and lake will not be impacted by the project.

4.2.2 Waves

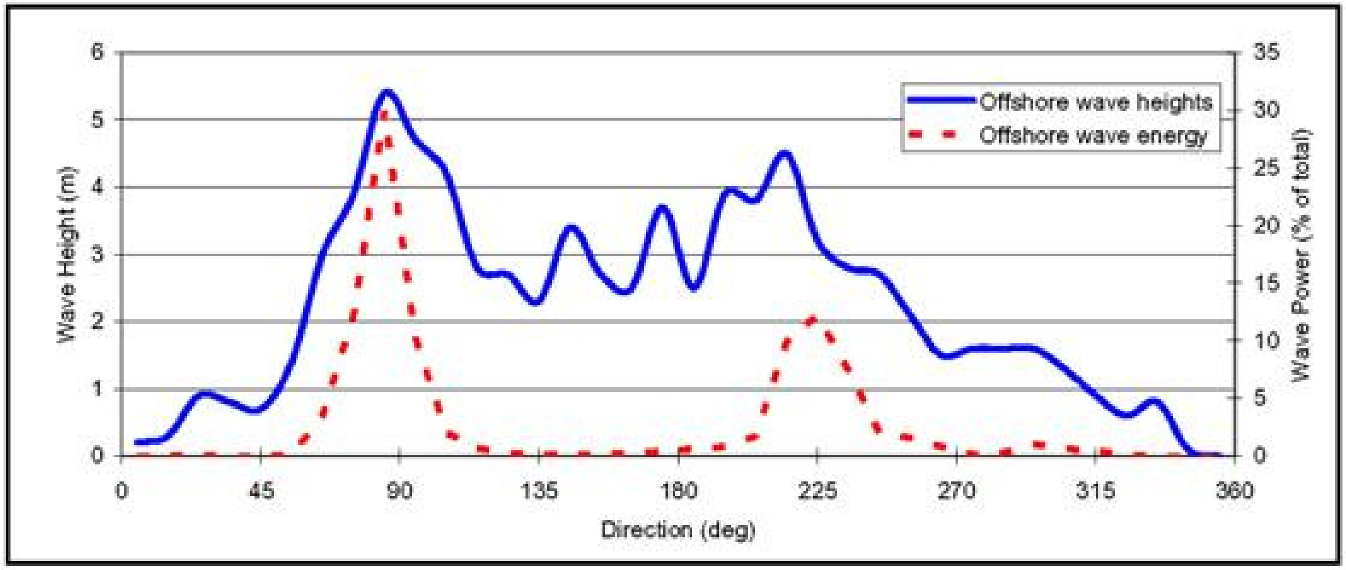
4.2.2.1 Wind Waves at the Inner Harbor

Baird and Associates (2012) carried out a one-dimensional wave hindcast using 39 years of wind data (1973-2012), measured at the Toronto Island Airport for the Inner Harbor. It is noted that wind data were not corrected for the overwater effects and assumed to be at a 10 m elevation, although the station elevation was stated as 76.5masl. Based on Baird’s analysis, significant wave heights are less than 0.4m 98% of the time. The maximum wave height is estimated to be 0.9m from the east (90^{o} N) at the eastern runway. An extreme value analysis was also carried out on the hindcast data. A 100 yr return period wave height is estimated to be 0.93m, which is slightly larger than the maximum wave height found from the hindcast.

4.2.2.2 Offshore Wave Climate

Shoreplan (2007) carried out a wave hindcast study using 33 year wind data (January 1973 to December 2005) observed at the Toronto Island Airport. Figure 4-4 shows the highest hindcast wave height and total wave energy distribution by direction from the hindcast. Both the wave height and the wave energy distributions show two distinct peaks; one from the east and one from the southwest. There is significantly more wave energy associated with the easterly peak than the southwesterly peak.

Figure 4-4 Distribution of Offshore Wave Heights and Wave Energy (Shoreplan, 2007)



4.2.2.3 Nearshore Wave Climate

Shoreplan (2007) also assessed the nearshore wave climate around Gibraltar Point at the southernmost end of Hanlan's Point Beach by transferring offshore wave hindcast date from deep water into the nearshore area using DHI's MIKE21 Parabolic Mild Slope (PMS) numerical wave transformation model. Figure 4-5 shows the location of 13 nearshore nodes where the nearshore wave climate data was estimated. Figure 4-6 shows a comparison of the nearshore wave energy distributions for nearshore nodes 3, 6 and 9 as well as the offshore distribution. Although, the closest nearshore point to the BBTCA site is node 13, wave conditions presented for node 9 are more representative of conditions near the western runway due to the predominant direction of wind and wave movement. Figure 4-6 shows that waves from the southwesterly direction are dominant near the western end of the runway. A 100 year return period southwesterly extreme significant wave is estimated to reach a height of 4.5 m with a peak period of 9 seconds in the nearshore.

4.2.2.4 Ship Generated Waves

Ship generated waves in the harbor were evaluated by Baird and Associates (2012). Vessels are limited to a speed of 5.4 knots in the Inner Harbor, and thus the wakes from vessels in the Inner Harbor are limited. The fireboat, however, is authorized to exceed this speed limit when responding to emergencies and thus potentially generates one of the largest wakes in the harbor. The fireboat is a 26 m long, all weather, 1500 horsepower, twin-screw tug. The vessel has an 8-knot hull design and is used as an icebreaker when the harbor freezes in winter months. Data collected by Baird (2012) showed that when the fireboat was travelling less than 6 knots the wake was minimal (wave height less than 0.3 m). During an emergency, when speed is a priority, the fireboat may attain speeds greater than 6 knots and wakes become more significant, however, maximum waves generated by the boats were less than the maximum wind generated waves, and wind waves (as opposed to ship generated waves) should therefore govern the design of the runway extension.

Figure 4-5 Location of Nearshore Wave Climate Nodes (Shoreplan, 2007)

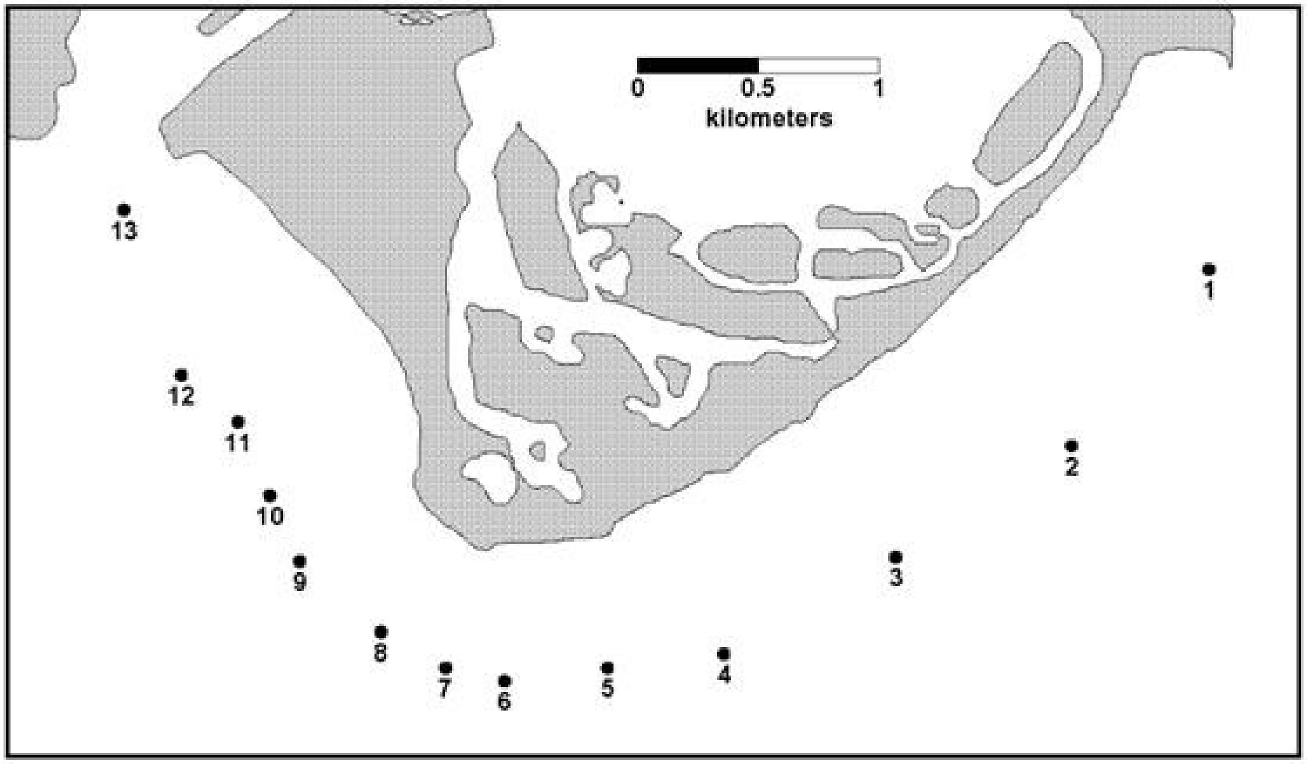
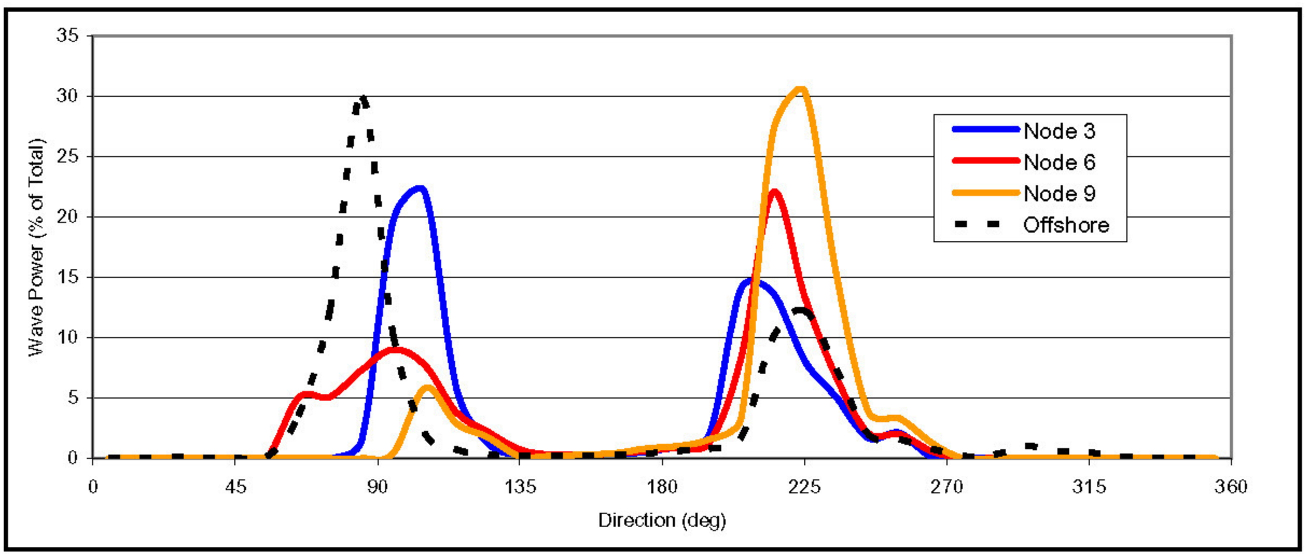


Figure 4-6 Comparison of Wave Energy Distributions



There will be minor change to the waves entering into the Western channel around the western runway due to reduction in size of wave energy window for the southwesterly waves by the expansion. It is not expected that the minor changes to wave height will increase siltation in the Western Gap. In the eastern runway extension there won't be any changes to the waves at the shoreline. However, a detail numerical wave modeling study is recommended to quantify these effects during the detail design of the project.

4.2.3 Currents

Wind generated surface currents may be estimated as about 3 percent of the wind speed (e.g., British Standards, 1984). For a typical wind speed of 3.5 m/s as shown in Figure 2.4, surface currents would be in the range of 0.1 m/s. During the 1-year return period wind speed of 14.0 m/s surface currents are estimated to be 0.4 m/s.

Changes to the currents as a result of the proposed runway extension will be minor and limited to the immediate area of the proposed extension on the western end of the runway if the extension is constructed as a deck on piles. In this case, it is anticipated that current velocities will decrease compared to the existing situation in the vicinity of the extension, as the piles will slow the speed of the water moving around them. If the extension is constructed as lakefill, it is anticipated that there won't be any changes to the current both at the western and eastern runway extension areas. Detailed hydrodynamic model of the harbor and surrounding area should be carried out to quantify the currents within the harbor and localized areas during operational and storm conditions.

4.2.4 Ice

Ice is a significant design factor for any marine construction project in Lake Ontario. Ice may impact coastal structures due to forces resulting from thermal extension, horizontal forces due to ice floes, and ice scour. Ice scour may be a consideration at this site, and must be accounted for during the detailed design of the proposed runway, should the project be approved.

Limited ice data are available for the Inner Harbor from Environment Canada's Ice Service. Previous work undertaken in a study by Baird and Associates (2012) suggests that ice thicknesses in the range of 55cm to 65cm for 30 year and 100 year return periods, respectively, may be found in the vicinity of the BBTCA. If construction occurs in the winter, ice may cause downtime and minor inconveniences. The fireboat operates as an ice breaker in the winter when required.

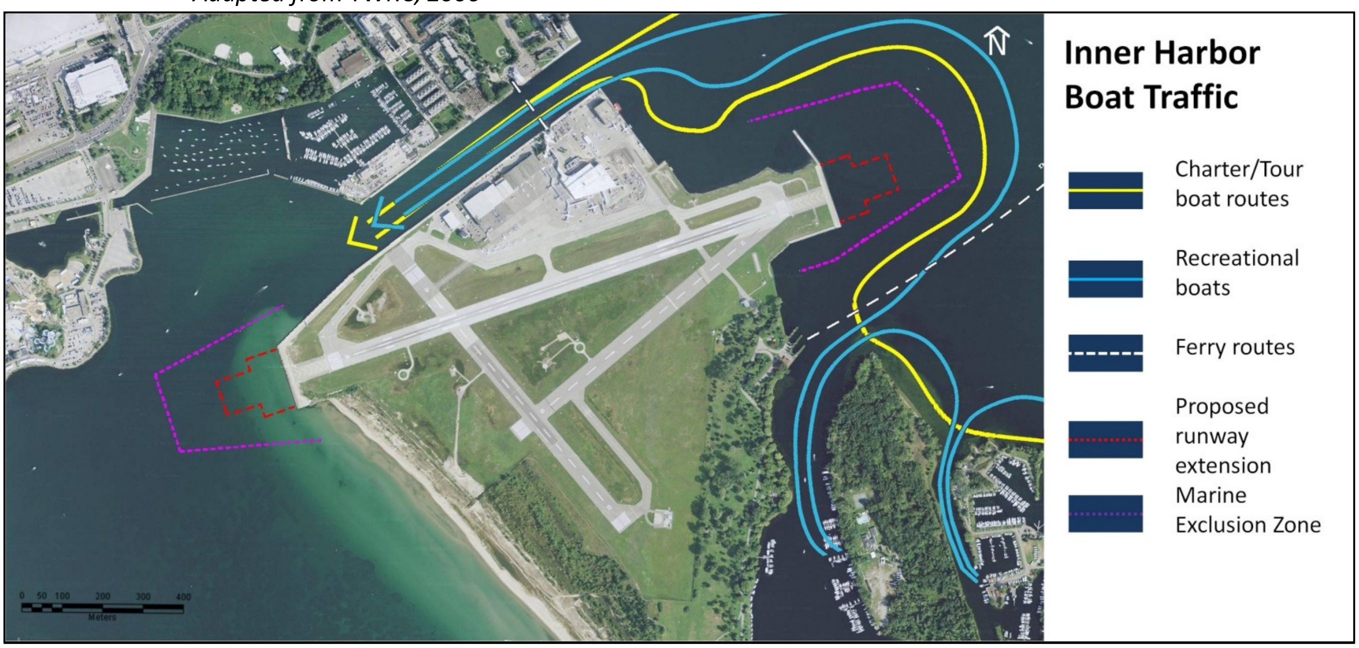
No significant changes to ice formation are anticipated in case of lakefill concept. If extension shall be decking with pile structures, ice blocks may trapped under the deck, between the piles and may impose additional forces both to the piles and to the deck slab.

5. Existing Conditions and Effects of Proposed Runway Extension on the Social/Cultural Environment

5.1 Marine Vessel Use

A 2006 marine use study of the inner and outer harbors by the Toronto Waterfront Revitalization Corporation (TWRC) – now Waterfront Toronto – mapped the routes commonly taken by commercial, recreational, sport and ferry vessels. This study found the Inner Harbor and Western Gap were heavily used by all four types of vessels (TWRC, 2006), however no marine traffic occurs in the immediate vicinity of the ends of the existing runway due to the location of buoy markers around the MEZ. The proposed extension as submitted will be accommodated entirely within the existing MEZ and does not require relocation of the MEZ buoy markers. It should be noted that City Council directed staff to exclude any consideration of either a runway or an extension of the Marine Exclusion Zone as currently configured, that would materially encroach upon the Western Gap. As the marine exclusion zone (MEZ) will not be altered as a result of the proposed BBTCA runway extension, recreational vessels, shipping routes and activities, and ferry routes will not be affected by the extension of the runway, as it is proposed within the existing MEZ[2]. Currently the Ward's Island Ferry must detour slightly around the eastern MEZ. This will remain unchanged as a result of the proposed BBTCA runway extension.

Figure 5-1 **Generalized Marine Vessel Routes in the Vicinity of the Proposed Runway Extension**
Adapted from TWRC, 2006



The impacts of the proposed runway extension to navigation and marine uses were assessed for both the construction phase and the operational phase of the runway extension. While no negative effects of the extension are anticipated after the extension is built, there may be some impacts to marine use while construction occurs. Because the BBTCA is on an island, a mix of land and marine borne equipment will be required throughout construction activities. Berthing of barges along the BBTCA's water edge perimeter for the build-up of stockpiles

[2] It should be noted that, according to a 2013 AirBiz study, although the proposed runway layout and aerial approach will ensure the integrity of the MEZ, approval will be nonetheless required from Transport Canada for exemptions to the requirements for the aerial runway approach configuration. In addition, "for take-off operations, declared distances (e.g. TORA, TODA) should be confirmed with Transport Canada to ensure that appropriate clearances from obstacles are also provided" (Airbiz, 2013, p. 36).

should not interfere with navigation through the Western Gap, if berthed outside the Western Gap, however may result in a mild increase in congestion while travelling to berthing sites. Suitable berthing locations include the dock wall to the southeast of the Western Gap (where the second BBTCA Ferry berths), and the dock wall to the north of the Hanlan's Point Ferry docks. Barges should avoid berthing in sensitive dune environments, and within the MEZ.

5.1.1 Jet Blast Impacts to Marine Vessels

The City provided CH2M HILL with figures showing the estimated area of impact (contours) associated with the jet blast from the CS100 while taking off. These contours represent the generic extent of the Bombardier CS100 jet velocity for various speeds based on information provided by Bombardier and Pratt and Whitney. This information shows the distances that various wind speed velocities will extend from the rear of the engines during breakaway and take-off as follows (illustrated for a 168m runway extension and a 200m runway extension in and , below):

Table 5-1: Engine Jet Blast Profile (Velocity/Distance on Engine Centreline)

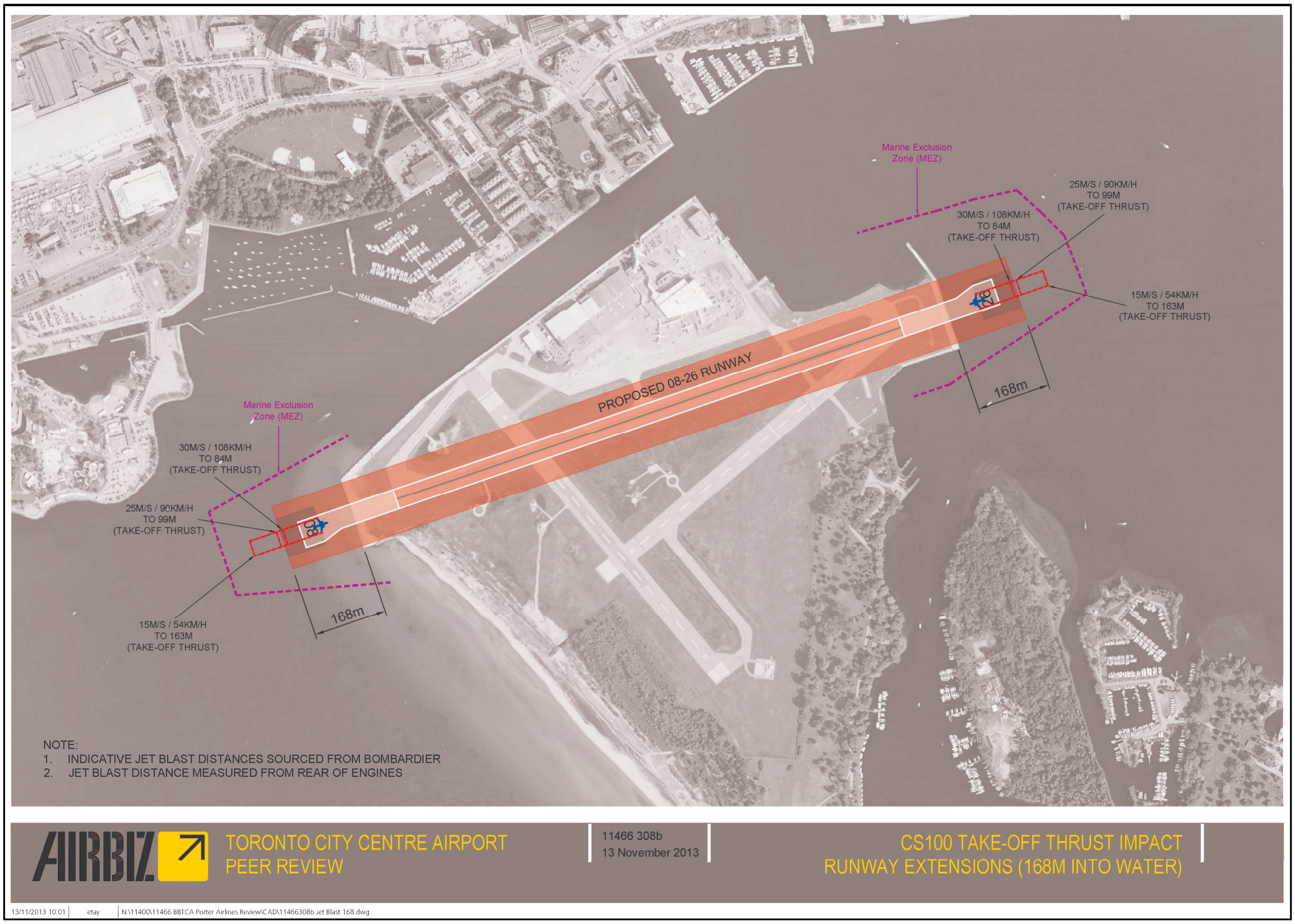
Velocity (m/sec)	Distance (m)
Breakaway	
10	99
25	44
Take-off	
15	163
25	99
30	84

It is possible to calculate the effect of the jet blast on a passing sailboat, but only in terms of dynamic stability. Dynamic stability is a vessel property that characterizes its capacity to resist the sudden application of a force, in this case, the force on the sails due to the jet blast. A boat with a high dynamic stability will heel less under the effects of the jet blast than others with a low dynamic stability. To properly calculate the effects of the potential jet blast on the dynamic stability of passing sailboats, an understanding of the range of typical sailboats that could sail the area must be outlined in order to compute their dynamic stability and estimate the consequence of the sudden heel angle induced by the potential jet blast. However, given that the greatest extent of jet blast felt seaward of the runway will not extend past the existing MEZ, the impacts of jet blast on the dynamic stability of a vessel may be imperceptible as compared to background conditions.

The 2006 TWRC study outlines the importance of a pleasant marine environment to the success of recreational and charter/tour boat activities, and it is recommended that further assessment is done on the effects of heat, noise, and airborne particulate resulting from the potential jet blast associated with the take off of the CS100. In addition, an updated survey of vessel traffic, coupled with an anticipated flight schedule for the CS100, can help to predict the likelihood of the occurrence of any impacts of the potential jet blast on passing vessels. It is important to note the impacts would only occur if a boat was passing behind the runway at the exact time of which a jet might be cleared for take-off.

The potential effects of jet blast can be mitigated by the installation of a jet blast deflector at the BBTCA. A deflector can be designed to direct air upwards, away from boat traffic, and also to deflect heat and dampen noise that may also be of concern to stakeholders. The cost of installing a jet blast deflector should be contrasted with the likelihood of occurrence, and negative effects of the potential jet blast.

Table 5-2: Extent of Measurable Jet Blast for CS100 Take-off from a 168m Runway Extension



5.2 Archaeological and Cultural Heritage Conditions

According to the Archaeological Master Plan for the Central Waterfront (City of Toronto, 2003), areas of the Toronto Islands have the potential for archaeological discoveries, however the ends of the runway have been constructed out of lake fill, and therefore do not feature archaeological potential. According to Dillon (2013) the TPA is not aware of any marine archaeological resources in the vicinity of the proposed runway extension in the Inner Harbor. It is anticipated that no artifacts are submerged at the western end of the runway either.

The Mississaugas of the New Credit First Nation settled a land claim in 2010 that included the lands within the study area. The land claim and agreement, known as the Toronto Purchase and Brant Tract Specific Claim Settlement Agreement and Trust Agreement, do not affect the ownership of any of the land for the proposed Project (Dillon, 2013), and do not affect the future use of the Inner Harbor.

5.3 Designated Natural and Recreational Areas

A number of cultural amenities are located in the immediate vicinity of the proposed runway extension, including Hanlan's Point Beach, the Hanlan's Point ferry docks, and the parkland in between. Although the proposed runway extension will not affect these amenities once construction is complete, construction activities may result in temporary and slight increases to noise levels, which could scare away wildlife. Adequate notice should be given to users of Hanlan's Point Beach of planned construction activities in the vicinity of the proposed western runway extension.

The Toronto Islands are used heavily by amateur and professional field naturalists and by the general public for recreational nature observation (see Kidd, n.d.). Construction activities may temporarily limit opportunities for observation of bird and other wildlife species in the vicinity of the proposed works, however if aquatic habitat features are enhanced, nature observation opportunities could improve as a result.

Recreational boaters are prohibited from entering the MEZ; however, there are multiple marinas to the south of the BBTCA on the Toronto Islands and on the mainland to the north of the Western Gap. Construction activities may have impacts on boating, as described in Section 5.1.

6. Permitting and Approvals Requirements

6.1 Provincial Requirements

6.1.1 Toronto and Region Conservation Authority

Although the jurisdiction of the TRCA does not extend into Lake Ontario, this regional organization has been heavily involved in habitat and hazard management on the Toronto Islands, the Toronto shore line, and in TTP for many years. Their knowledge of are ecology is broad and in-depth and they should be consulted throughout the conceptual and detailed design of the proposed runway extension, if approved to move forward.

6.1.2 Ministry of Natural Resources

Because the proposed works are located in an area that has the potential to provide habitat for the American Eel, a provincially-listed endangered species under the *Endangered Species Act (ESA)*, further habitat and species assessments must be done to determine the presence of habitat or individuals from this species within the area that will be affected by the proposed runway extension. If American Eel habitat or individuals are found, an ESA permit may be required from the Ministry of Natural Resources (MNR).

6.2 Federal Requirements

6.2.1 Environment Canada

According to the *Migratory Birds Convention Act* (MBCA) it is illegal to harass or harm a migratory bird or destroy migratory bird habitat. Although the area of the proposed runway extension does not represent good bird habitat, it is regularly frequented by migratory birds for loafing and sometimes for feeding. Construction activities must take place within appropriate timing windows and with appropriate mitigation measures to avoid negative impacts to migrating bird populations.

If it is determined that construction activities will negatively affect any federally-listed species or their habitat, a permit under the *Species at Risk Act* will be required. Conditions such as construction timing windows and habitat enhancement will likely be applied to the proposed works.

6.2.2 Department of Fisheries and Oceans

The Fisheries Act regulates against the harmful alteration, disruption or destruction (HADD) of fish habitat. A permit for causing a HADD to fish habitat may be obtained from the Department of Fisheries and Oceans (DFO) if the proposed works will result in a net benefit to fish habitat. A detailed assessment of the aquatic environment in the vicinity of the proposed works must quantify the condition of the fish habitat and determine the impacts of the proposed works on that habitat and if a permit will be required.

6.2.3 Transport Canada

Under the *Navigable Waters Protection Act* (NWPA), activities that could temporarily or permanently affect navigation must be reviewed and approved by Transport Canada (TC). Although the proposed runway extension is located entirely within the MEZ, nonetheless, a NWPA Permit screening submission is recommended.

6.3 Regulations Affecting Fuel Tanks

The storage and handling of petroleum products is regulated at both the federal and provincial levels of government. The regulation and management of Fuel Storage Tank Systems located on provincial, municipal, or private lands within Ontario are primarily within provincial jurisdiction which is governed by the Technical Standards and Safety Authority (TSSA).

The TSSA, Fuels Safety Division (FSD) has primary responsibility for tank licensing, decommissioning, installation and fuel distribution systems in Ontario. The TSSA also regulates the storage of petroleum products and their associated distribution systems and related environmental issues under the *TSS Act*, as well as associated regulations and codes and the Environmental Management Protocol (EMP) (August 2012).

At the federal level and at facilities that are federally owned, operated, or regulated, fuel storage is regulated under the *Canadian Environmental Protection Act* (CEPA). Based on our current understanding of the potential purpose and use of the subject tanks, irrespective of them potentially being located on City of Toronto lands, it is our preliminary opinion that the Federal requirements would take precedence over the TSSA regulatory requirements given the intended use of the fuel for fueling aircraft at a federally-regulated airport. This preliminary interpretation should be confirmed with the applicable federal and provincial authorities and it is suggested that a formal written request be prepared and submitted to the TSSA and applicable Federal authorities to confirm this. Should it be confirmed that the Federal requirements apply, the following regulations and CEPA guidelines for aboveground storage tanks (AST) or underground storage tank (UST) systems should be considered for regulatory purposes as well as for reference purposes with respect to Best Management Practices (BMPs), as summarized below.

6.3.1 Federal Regulations/Guidance Documents

Registration of Storage Tank Systems for Petroleum Products and Allied Petroleum Products on Federal or Aboriginal Lands Regulations (SOR/2008-197 — November 30, 2011) – This regulation requires that all outside AST systems with a capacity greater than or equal to 4000 L, and all UST systems containing petroleum products that are located on federal or aboriginal land, be registered with the appropriate federal department which in turn, reports yearly to Environment Canada. The regulation outlines the required registration information to be updated on an annual basis. The requirements of this regulation will apply in federal jurisdiction for petroleum storage tank installations, management and associated issues.

CCME Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products published by the Canadian Council of Ministers of the Environment in 2003 (Updated January 2013). The code presents a model set of technical requirements to protect the environment from existing, new, or proposed storage tank systems that contain petroleum and allied petroleum products. Its primary purpose is the promotion of environmentally sound management of petroleum and allied petroleum product storage tank systems through the application of uniform performance standards throughout Canada. It has been prepared for owners of storage tank systems, the petroleum marketing and distribution industry, and federal, provincial, and territorial departments which have the authority to regulate storage tanks containing petroleum or allied petroleum products. The Code is a model set of technical requirements and only comes into effect if adopted, in whole or in part, by an authority having jurisdiction. It provides technical requirements for registration and approval of storage tank systems, design and installation of new storage tanks and piping, monitoring and leak detection, upgrading of existing systems, operation and maintenance, and the withdrawal from service of storage tank systems.

Technical Guidelines for Aboveground Storage Tank Systems Containing Petroleum Products (1996) – This guideline adopts the tank management guidelines for aboveground storage tanks set out in the CCME *Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products* (1994). This document applies to outdoor ASTs and outlines the requirements for tank registration, new installations, upgrading of existing installations, operations, maintenance, and removal of systems.

Technical Guidelines for Underground Storage Tank Systems Containing Petroleum Products and Allied Petroleum Products (1995) – This guideline adopts the tank management guidelines for USTs set out in the Canadian Council of Ministers of the Environment (CCME) *Environmental Code of Practice for Underground Storage Tank Systems Containing Petroleum Products and Allied Petroleum Products* (1993). These documents outline the requirements for tank registration, new installations, upgrading of existing installations, operations, maintenance, and removal of systems.

6.3.2 Provincial (TSSA) Regulations/Guidance Documents

Although presently not anticipated to be the applicable regulatory guidance documents for the proposed tank installations based on presently available information, for reference purposes and in the event it is determined that TSSA requirements were to apply or considered as best management practice, the following summary of TSSA regulatory guidance documents and regulations with respect to fuel tanks is provided.

The storage and handling of petroleum products is regulated at both the federal and provincial levels of government, although Fuel Storage Tank Systems located on private lands within Ontario are primarily within provincial jurisdiction. A brief overview of fuel-related legislation and regulations is provided in the following paragraphs.

The TSSA, Fuels Safety Division (FSD) has primary responsibility for tank licensing, decommissioning, installation and fuel distribution systems in Ontario. The TSSA also regulates the storage of petroleum products and their associated distribution systems and related environmental issues under the *TSS Act*, as well as associated regulations and codes and the Environmental Management Protocol (EMP) (August 2012).

O. Reg. 217/01 and the associated liquid fuel handling code (LFHC) apply to gasoline and other petroleum products used as fuel for motive applications, i.e. in vehicles that travel on roads/highways, while O. Reg. 213/01 and the Fuel Oil Code apply to all stationary and portable oil-burning equipment. O. Reg. 217/01 and the LFHC are applicable to the fuel systems assessed as part of this evaluation.

The Fuel Oil (O. Reg. 213/01) and Liquid Fuels (O. Reg. 217/01) regulations require that personnel who install, repair, or perform maintenance on fuel tanks and associated systems be appropriately qualified and certified with the TSSA. The TSSA regulations and associated codes state that no person shall install, alter, purge, activate, repair, service, or remove any appliance or equipment that handles or uses fuel oil or liquid fuels unless the person is a holder of a certificate for that purpose under the Ontario Fuel Industry Certificates Regulation and/or the Certification of Petroleum Equipment Mechanics Regulation, as required under TSSA Regulation 216.

In the event that petroleum contamination is discovered at a facility that continues to handle fuel, or during permanent closure of such facilities in Ontario, environmental assessment activities must follow the EMP for Fuel Handling Sites in Ontario, August 2012, established by TSSA FSD. The EMP provides direction for the reporting, assessment and management of petroleum products that have escaped to the environment at operational fuel handling facilities in Ontario. Soil and groundwater cleanup standards in the EMP adopted the standards in O. Reg. 153/04, as amended. In cases where subsurface investigation or assessment is required as a result of a leak or a spill at a fuel handling facility, it is noted for reference purposes that the cleanup and management of contaminated sites is set out in O. Reg. 153/04, as amended (Record of Site Condition [RSC] regulation).

6.3.3 Other Regulatory Considerations

In addition to the above noted Federal and Provincial regulations and guidelines, the Ontario Fire Code (OFC), established in law by the Fire Protection and Prevention Act, also provides legislation on the storage, handling, processing, and use of flammable or combustible liquids that should be considered and adhered to for any new proposed tank installations as well as any local municipal building code requirements.

6.3.4 Comparison of Regulatory Considerations for Underground and Aboveground Fuel Storage Tanks

The regulatory requirements for both the Federal and Provincial TSSA jurisdiction and requirements do vary somewhat between underground storage tanks and aboveground storage tanks. The primary differences relate to things like maximum allowable tanks size which as far as we are aware is restricted to 100,000L for USTs, and tank design and containment system features that vary between the two types of tanks as underground tanks require additional protective measures with respect to protecting tank integrity and the environment due to the increased potential leaks or spills going undetected in the subsurface. As such, although tank design, leak detection, and secondary containment features are important and required in some form for both types of tanks systems, the requirements vary between both types with additional protective measures required for USTs such as double walled tanks, interstitial monitoring, double-walled piping. Despite their being some differences, there are also many requirements that are common to both aboveground and underground storage tanks. One example is that all tanks have to be manufactured in accordance with approved design standards such as Underwriters Laboratory of Canada (ULC), American Petroleum Institute (API), as specified in the applicable regulatory guidance documents and installed and operated in accordance with the manufacturers' instructions. Typical regulatory consideration items and requirements that need to be addressed for both during the initial design, installation, and operation and maintenance of fuel tanks and associated systems that are specified in both the above referenced Federal and Provincial legislation and guidance documents typically include but are not limited to the following:

- Tank construction standards.
- Tanks opening requirements.
- Tank design and operating pressure requirements (atmospheric pressure for most fuel storage tanks).
- Repair and maintenance requirements.
- Tank supports or anchoring requirements.
- Tank clearances from adjacent structures/site features.
- Tank piping requirements and associated systems.
- Protection from vehicles.
- Secondary containment (double walled tanks, tank containment dyking, double walled piping etc.).
- Secondary containment maintenance and monitoring.
- Filling of tanks.
- Tank venting requirements.
- Gauging and monitoring of tanks and inventory control and reconciliation records.
- Corrosion protection and cathodic protection in the case of steel underground storage tanks.
- Use of appropriately certified petroleum equipment contractors and mechanics for tank system installations, upgrades, and maintenance as per regulatory requirements.
- Tank system removal and decommissioning when no longer in use.

In summary, although there are some variations between the regulatory requirements for both UST and AST systems, many of the requirements are common to both. It is critical that the proposed tanks systems be designed, installed, and maintained by an appropriately licensed/certified petroleum equipment contractor in accordance with the manufacturer's instructions.

7. Summary and Further Research Recommendations

The City of Toronto is currently reviewing a request from Porter Airlines to permit jet-powered aircraft at the Billy Bishop Toronto City Airport (BBTCA). If permitted, extensions of at least 168 meters on both ends of the existing runway, encroaching into the lake waters within the Marine Exclusion Zone, will be required.

The effects of the proposed runway extension on the coastal conditions in the area of impact were estimated. The existing shoreline and coastal environment assessed includes: bathymetry, water levels, wind, waves, currents, ice, coastal processes, fish and bird habitat, marine use and cultural heritage. The assessment was performed in a preliminary and cursory manner, and was based on information collected from key stakeholders and in the public domain. Information gaps were filled, to the best of the ability of CH2M HILL with assumptions based on sound engineering judgment and standard engineering practice.

Based on the assessment, it appears that the proposed runway extension will have a minimal and limited affect on the physical coastal and marine processes, however will affect existing aquatic habitat.

Advantages associated with a runway extension constructed by filling portions of the lake include lower costs, natural dune accretion, and greater habitat improvement opportunities. Disadvantages include greater habitat disruption and more strenuous permitting requirements. Advantages associated with a runway extension constructed by placing decking on piles include reduced habitat disruption (although some disruption will still occur) and possibly reduced permitting requirements. Disadvantages include greater costs, fewer habitat creation opportunities, and no dune accretion.

It is not anticipated that the proposed extension will negatively affect archaeological heritage or marine use, and may result in a greater species diversity in the area if habitat features are built in to the proposed design.

Although many studies have assessed the conditions in the Inner and Outer Harbours, detailed numerical modelling is required to fully quantify the impacts of the proposed runway extension on wave heights, currents and sediment transport, and a detailed natural heritage survey must quantify the aquatic habitat features that will be affected by the proposed works.

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