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Review of Potential Future Safety Zones at Billy Bishop Toronto City Airport with Bombardier CS100 Jets

EXECUTIVE SUMMARY

Porter Airlines has proposed to introduce Bombardier CS100 jets to Billy Bishop Toronto City Airport (BBTCA), necessitating a runway extension of at least 168 meters at each end. Porter's current proposal increased this extension to 200 meters at each end. We anticipate that the new jet aircraft will be classified at Category C (versus B for today's turboprops) and the runway will need to be upgraded to a Code 3 (versus Code 2 today).

The introduction of these jets, which are larger, faster and less maneuverable than the current turboprop aircraft, will require an expansion of the safety zones around the airport. Unless exemptions are granted, Transport Canada's (TC) standards and specifications would result in Obstacle Limitation Surfaces (OLS) that would restrict boat movements between 780 and 1140 meters from the threshold of the extended runway, versus about 340 - 430 m today. The range in the future marine restrictions is due to uncertainty on which OLS slope will be permitted by TC, and whether a non-precision (visual landings only) or precision (instrument all-weather landings) approach will be mandated.

In addition to marine restrictions, the OLS surfaces may also severely impede development of the Toronto Port lands. Waterfront Toronto has developed various mixed use proposals for a large new downtown in this area, including concepts with tall buildings. Depending on the OLS surface that is mandated, many of the proposed tall buildings would not be permitted. The current uncertainty means that Waterfront Toronto cannot proceed with zoning bylaws governing building heights. In the worst case, introduction of jets at BBTCA could significantly curtail development in the Port lands worth billions of dollars.

Jet blast is another important area of concern. Preliminary estimates by Porter's consultant, Airbiz, indicates a high velocity blast well outside the current Marine Exclusion Zone (MEZ), which would be wholly unsafe for the thousands of sailboats, canoes and kayaks which constantly use the area. These concerns cannot be addressed by deflectors beside the runway. This is just one example where this particular airport expansion raises different and more pressing safety issues than those at other airports. Most airports are not meters from sensitive recreational activities.

Runway approach lighting is another important area requiring further study. Virtually all jet airports in the world comparable to BBTCA have approach lighting and buffers extending well beyond the end of the runway. Using TC standards, these facilities at BBTCA would extend 360 - 630 meters into the lake (depending on which lighting system is mandated).

The current Marine Exclusion Zone (MEZ) extends 305 m beyond the current end of the island. Based on the above analyses of OLS and lighting, we anticipate that the future MEZ would extend 830-1190 meters into the lake from the current end of the island, depending again on which OLS slope and approach is mandated. These would result in severe impediments to recreational boating, Toronto Island ferry routes and lake shipping.

Some parties have argued that new navigation technology systems will eliminate the need for reducing building heights due to OLS or eliminate the need for approach lighting systems. This will not be the case. These systems do not eliminate the need for manual pilot backups using analog instruments, or for approach lighting.

In conclusion, if Transport Canada mandated standards and specifications are followed, there will be huge impacts in Marine Exclusion Zones, approach lighting and Port Lands development. These impacts are large enough that the City should say “no” to the expansion proposal.

If exemptions from safety standards and specifications are provided, this will significantly increase safety and liability risk at BBTCA.

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1. Background

Billy Bishop Toronto City Airport (BBTCA), located on the Toronto Island directly south of Bathurst St, serves as a small commercial and general aviation airport. The main runway (08-26), which is used by the larger aircraft using the facility, is 1216 m (3988 ft.) long and is 77 m or 252 ft. above sea level. Presently, jets are banned from using the airport except for very special circumstances. The airport is governed by a tripartite agreement between the Toronto Port Authority, the City of Toronto and the Government of Canada.

In April, 2013, Porter Airlines, the main commercial tenant at BBTCA, decided to purchase Bombardier CS100 jets to fly out of this airport. This will require changes to the tripartite agreement as well as requiring runway extensions of at least 168 m (400 feet) at each end. Porter's current proposal involves extending the runway by 200 m (656 ft).

The public reports provided to date are listed below:

Billy Bishop Toronto City Airport: Porter Airlines Proposal Review: Interim Results Findings by Airbiz, (27 November 2013)
TP 308 Impact Study Toronto Bully Bishop/Toronto City Airport for Porter by Air Navigation Data (May 2013)
Porter Airline Runway 08-26 Extension Study Billy Bishop Toronto City Centre Airport by LPS Avia Consulting (24 May 2013)
Runway Extension Presentation by Porter Airlines (May 2013)

Transport Action Ontario (TAO) has many concerns about the expansion of BBTCA. We released a position paper summarizing these concerns in July, 2013:

- Increased pollution and different noise profile than today’s turboprops
- Uncertainty about property development and land values
- Increased marine exclusion zones, impacting both navigation and Ontario Place
- Expansion will enable other aircraft to use BBTCA
- Need to expand the land side of the airport to provide better access
- Increased fuel demands, leading to spill and odour issues
- Noise levels during engine maintenance

We noted that there are two viable alternatives to meet the transportation needs that allegedly require a BBTCA expansion:

- Use of the Union Pearson Express to access long-distance routes
- Use of Higher Speed Rail to serve cities within about 800 km

Many other countries are now moving towards such rail alternatives.

Since the CS100 is a new aircraft with newly designed engines that feature some very new technology, TAO cannot accurately estimate either the noise produced by the aircraft nor the amount of pollution

produced by it. When reliable numbers, not related to the marketing of the aircraft, are released, we may revisit these concerns.

The balance of this document will concentrate on the safety zones and constructability associated with the expanded runway and the use of CS100 jets.

2. Runway Construction Concerns

Transport Canada has raised a concern of how the construction of the expanded runway will be handled. TAO would like to see this concern fully examined. Not only are we worried about the impacts it may have on airport operations, we are concerned about construction noise and pollution. Pile driving will have to be done for an extensive time period and will be highly disruptive.

These are several approaches used to expand runways:

1) Building a new temporary relief runway. If such a runway gets built what becomes of it after the main runway is completed?
2) Closing one end of the runway and building. This would only allow for operations in one direction at BBTCA, if it is possible at all.
3) Moving operations to another airport, for example going to Pearson temporarily while construction is underway.

TAO also would like assurances that the Toronto Port Authority can afford to complete the construction. We would also like to see what the financial burden for paying for the expansion will be on a per passenger basis.

3. Classification of Bombardier CS100 Jets

Appendix A gives published specifications for this aircraft. Appendix B summarizes aircraft classification standards. In summary, a variety of lines of evidence indicate that the CS100 will likely be classified as Approach Category C aircraft. In contrast, the turboprop aircraft used today, Bombardier Q400s, by Porter Airlines are classified as Category B as their typical approach speed is 115 knots.

This change in aircraft will necessitate the runway being upgraded from being a code 2 to a code 3.

The consequence of introducing a larger jet aircraft to BBTCA is that larger airport safety zones are required under Transport Canada standards and specifications.

4. Safety Zones around BBTCA

Both Transport Canada and the Federal Aviation Administration (FAA) have requirements for safety zones around airport and especially near the ends of runways. These safety zones have been mandated to handle aircraft that undershoot or overshoot when landing, and also for aircraft that have an engine failures. The Obstacle Limitation Surfaces(OLS) specified by Transport Canada and the Runway Protection Zones (RPZ) as defined by the FAA are designed to mitigate the impacts of a disabled aircraft using an airport and/or the impacts of poor weather.

Airplane crashes like Lion Air at Bali on April 13, 2013, British Airways Flight 38[1] at Heathrow, London U.K. on 17th January 2008, Asiana Airlines Flight 214[2] on July 6th, 2013 at San Francisco International, Air France Flight 358[3] at Toronto's Pearson on 2 August 2005, China Airlines Flight 605[4] at Kai Tak Airport in Hong Kong on the 4th November 1993, and Air Ontario Flight 1363[5] at Dryden, Ontario on the 10th March 1989 all indicate the value of the safety zones for the traveling public and people who work or live near an airport. All of these crashes took place immediately around the airport and many of the aircraft ended up in the protected zones around the airport.

4.1 Transport Canada's Obstacle Restriction and Removal Requirements

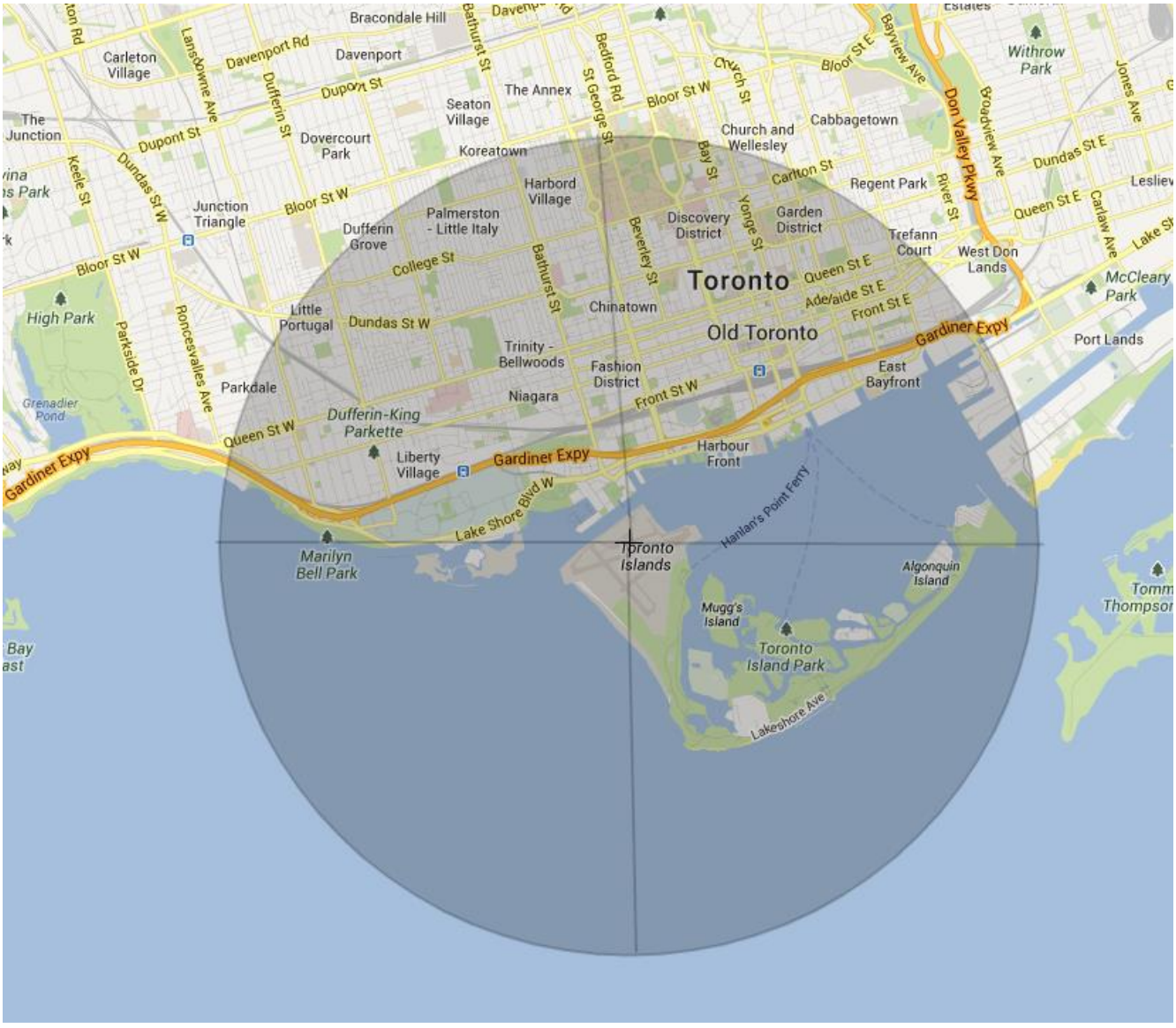
Transport Canada has defined a set of surfaces, known collectively as the Obstacle Limitation Surfaces (OLS) that should be kept clear around airports for the safe operation of aircraft. These surfaces are defined in the document Aerodrome Standards and Recommended Practices (document TP 312E) by Transport Canada (see Appendix C). The examples below come from chapter 4 of the document.

1 http://en.wikipedia.org/wiki/British_Airways_Flight_38
2 http://en.wikipedia.org/wiki/Asiana_Airlines_Flight_214
3 http://en.wikipedia.org/wiki/Air_France_Flight_358
4 http://en.wikipedia.org/wiki/China_Airlines_Flight_605
5 http://en.wikipedia.org/wiki/Air_Ontario_Flight_1363

4.1.1 Outer Surface

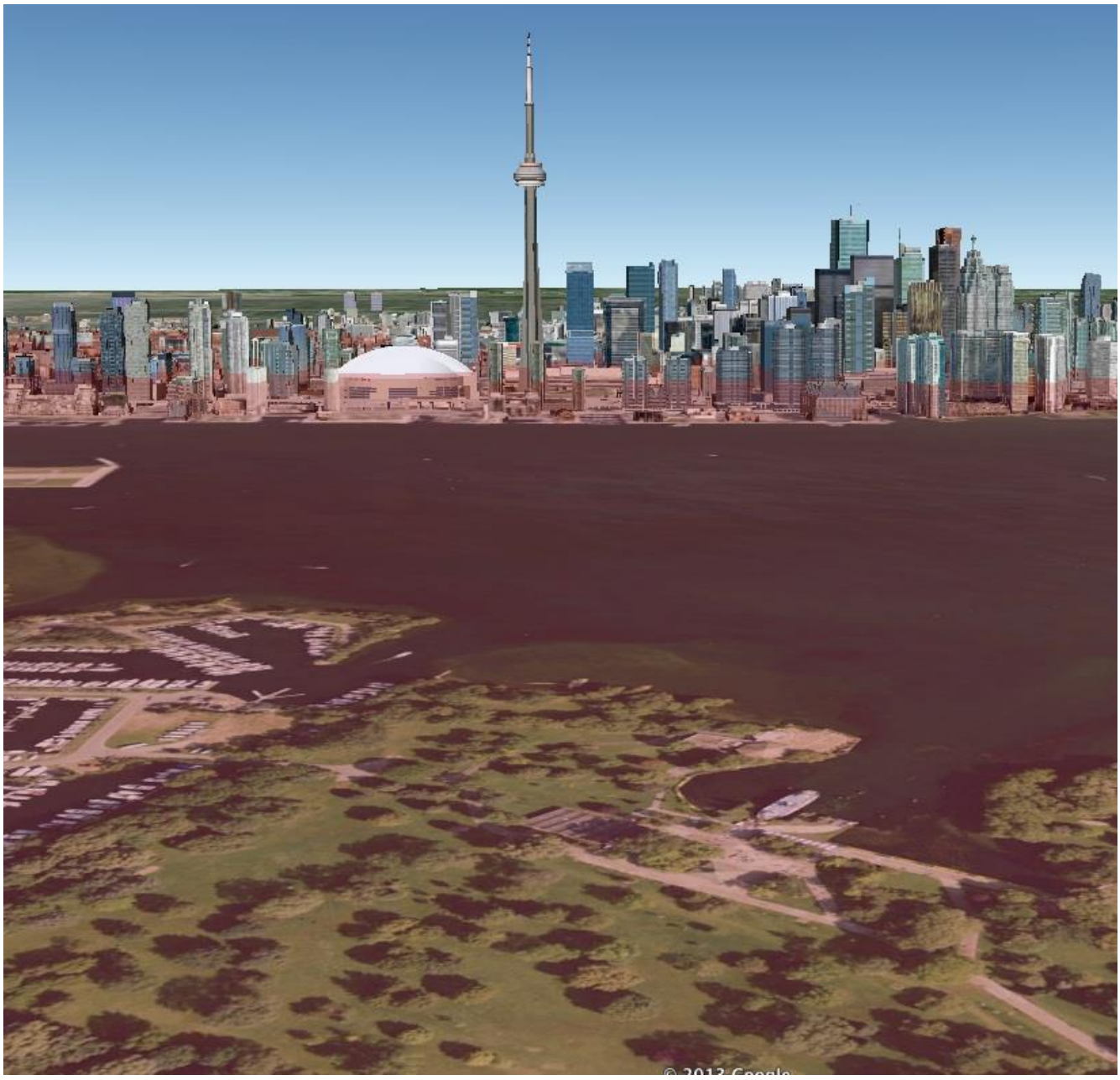
Transport Canada defines the Outer Surface as circle with a radius of 4000 m, parallel to the ground 45 m above the surface of the runway. This is the area in which aircraft doing a go-around when in trouble are expected to use. Transport Canada ideally wants the full circular region, but the minimum is a half circle where the cut runs parallel to the runway's centre line.

Within this surface are other areas that get closer to the ground, that are related to aircraft approach and departure. They will be discussed shortly. Anything penetrating this surface would be classified as an obstacle to aircraft operations. Ideally Transport Canada would like the penetrating Obstacle removed to increase aircraft operating safety. This is the surface for the BBTCA (45 m above runway surface):



The grey circle is the Outer Surface as defined by Transport Canada, centred on BBTCA runway 08-26.

The surface can be divided in half along the centre line of the runway, if required, which is what has happened in the case of BBTCA. All the buildings north of the line can penetrate into the Outer Surface, whilst those south cannot. From above Centre Island this looks like the image below:



The buildings above the red surface penetrate the Outer Limit surface.

As can be seen from the image and the map, the outer surface takes in the greater part of Downtown Toronto, Ontario Place and the entire Inner Harbour. It is quite obvious that quite a few structures penetrate the north half of the surface - the CN Tower, many of the office buildings downtown and condos along the waterfront. Most buildings with 15 or more floors will be higher than 45 m. The Richard L. Hearn Generating Station is just out of the range of the outer surface. Under these standards, no tall ships would be allowed in the Inner Harbour as their masts can be as high as 60 m tall. However the Toronto Port Authority has regulations governing the movement of ships over 18 m in height going through the Western Gap. This regulation is:

V*essels in excess of 18 metres overall height, truck to waterline, are required to notify Toronto City Centre Airport, Control Tower (VHF 12) prior to transiting the Western Gap*.

(Toronto Port Authority Practices and Procedures[6], Regulation 34)

The necessity for having a regulation like this is concerning. The regulation exists to give a plane in trouble room to manoeuvre. When an engine on a plane fails, or some other glitch occurs, the pilot(s) are informed by electronic voices and noise makers in the cockpit. Often when these incidents happen, the cockpit is thrown into a minor or major state of confusion. On take-off the pilot(s) must decide to proceed or not, and on landing they also have to decide how to proceed. At the same time they must diagnose the problem, its severity and the impact it will have on the attempted operation. It is at this point that minor things like left & right, port & starboard, north & south can get mixed up. A pilot experiencing an engine failure due to mechanical problems or a bird strike might get confused and fly northbound into the forest of buildings north of the airport[7].

Transport Canada obviously allows the airport to exist and allows Porter and other airlines to fly commercial passenger flights into the airport despite the restriction on structures penetrating the outer surface. It should also be noted that there is a north south runway for general aviation that can still be used. Runway 15-33 is almost at right angles to 08-26 and forces the Outer Surface to be a full circle.

Transport Canada TP 312 regulation 4.1.1.1 allows tall buildings development north of BBTCA line, when operations on 15-33 are discounted. The FAA takes this issue very seriously - in San Diego California, a building in the equivalent of the Outer Surface had 2 floors removed[8] near Montgomery Field in 2007. The building was not directly in line with any of the runways. Here is a map of the vicinity:

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6 http://www.torontoport.com/Port/About-Us/Practices-and-Procedures.aspx

7 These crashes are related to navigation failures near airports: http://en.wikipedia.org/wiki/Garuda_Indonesia_Flight_152, http://en.wikipedia.org/wiki/Air_China_Flight_129, http://en.wikipedia.org/wiki/Airblue_Flight_202

8 http://www.aviationpros.com/news/10383920/faa-affirms-office-tower-not-a-hazard & http://www.sdairfields.org/Portals/0/Sunroad/20070910-SDBJ-The%20Walls%20Come%20Down%20on%20Sunroad's%20Centrum.pdf

The green pin is the centre of the main runway and the red pin is the decapitated building. The red line has a length of 1.22 km. There are no structures of significant height south of the airport. The building is now 48 m tall.

4.1.2 Take-off / Approach Surface

Transport Canada defines the Take-off / Approach Surface as a surface that starts a distance away from the end of the runway and then slopes away from the runway at an angle into the sky. The surface parallels the path that the aircraft would fly up when departing and fly down when arriving. Nothing should penetrate this surface, however exceptions can be made. There are a few exceptions already in place around BBTCA.

Note that on September 7th, 2013 Porter suggested that the runways be lengthened at both ends to 200 m from the current proposed 168 m extensions. TAO has tried to add this change into this report to the best of our ability.

Currently, the main runway at BBTCA 08-28, is classified as a Code 2[9] runway. According to Airbiz, BBTCA is running under Code 3 Airport Zoning Regulations. But the airport currently operates with an exemption from Transport Canada in regards to the OLS approach surfaces. According to the AirBiz report, for runway 08 (landings toward the east), the exemption allows the OLS at 4.8%, while for runway 26 (landings towards the west), the exemption allows the OLS at 6.38%.

The Airbiz report dismisses the potential changes to the Obstacle Limitation Surfaces too quickly:

> The proposed layout as set-out in the Porter Airlines proposal retains the approach surfaces at their existing locations which would ensure the integrity of the Marine Exclusion Zone (MEZ) subject to approach exemption being confirmed by Transport Canada. 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.[10]

TAO believes that these surfaces should be fully examined and reviewed before any decision on the runway expansion can be made. We are not confident that Transport Canada will grant exceptions to this project. The risk of making many exceptions for this airport is that BBTCA could become like the former Kai Tak (Hong Kong) where the pilots needed special training to use the facility and it was known as a dangerous place to fly in and out of. The CS100 is a larger, faster and less manoeuvrable aircraft than the current aircraft using the facility. Having larger jet aircraft weave their way into BBTCA would not be beneficial to the current users of the Inner Harbour, nor the residents around the harbour.

4.1.3 Current Obstacle Limitation Surfaces (OLS) at BBTCA

There is sometimes confusion between OLS and Glide Slopes. See Appendix E for definitions.

[9] Porter Airlines Proposal Review – Interim Results/Findings, Airbiz, pg 36

[10] Porter Airlines proposal Review – Interim Results/Findings, AirBiz, pg 36

BBTCA's Dash 8's and other large prop aircraft operate with a Transport Canada exception, such that the OLS to the west is at 4.8% and to the east, over the inner harbour it is 6.38%. To help visualize it, here is a table:

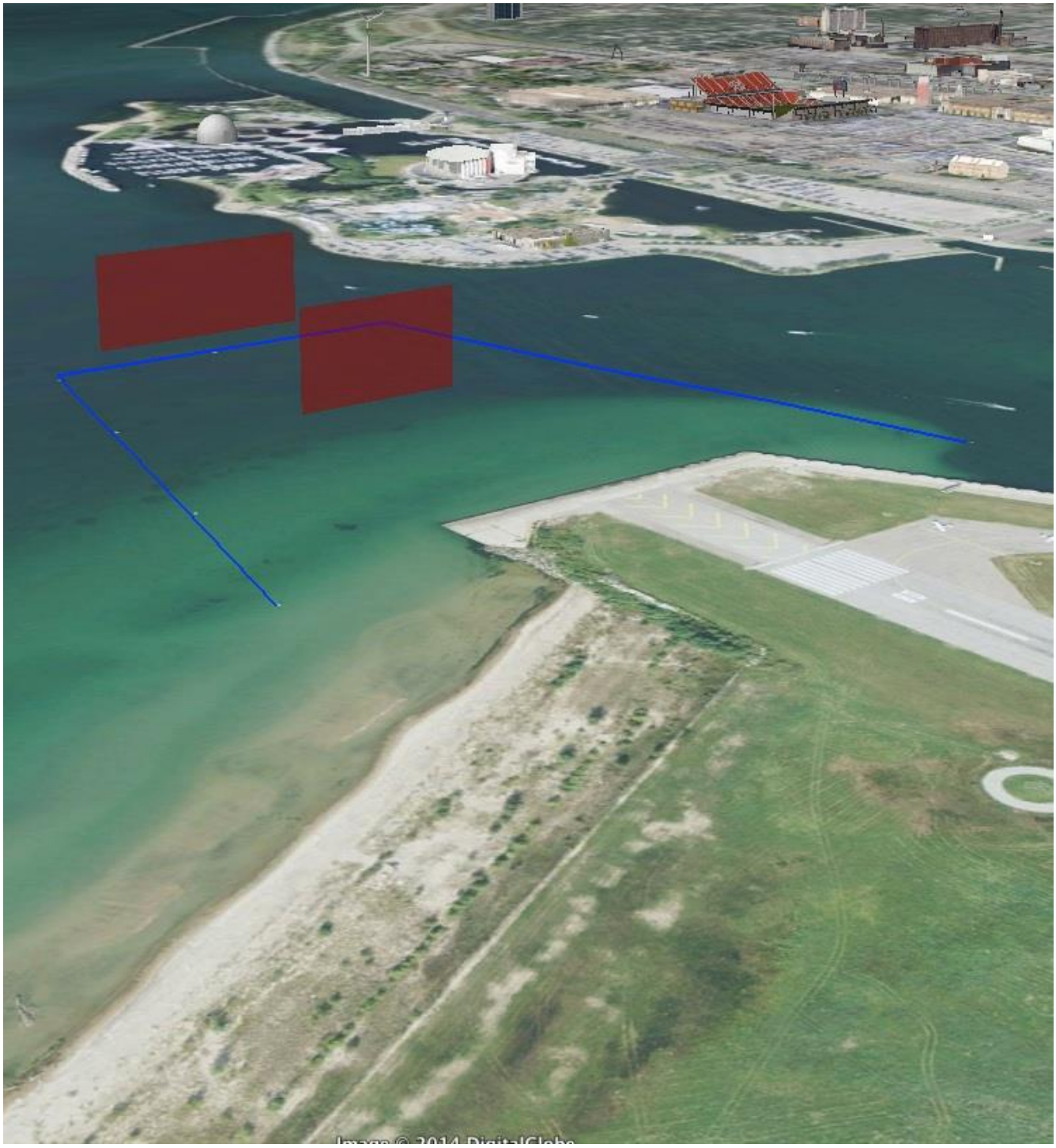
	Slope as % and (Rise : Run))	Closest Approach by a 25 ft. (7.6 m) Sailboat	Closest Approach by a 50 ft. (15.2 m) Sailboat
West End	4.8 % (1:20.833)	268 m (from runway threshold)	435 m (from runway threshold)
East End	6.38 % (1:15.674)	217 m (from runway threshold)	342 m (from runway threshold)

The calculation method for the sailboats is provided in Appendix D.

Below are some images to establish what the current situation looks like. This will aid in reading the sections that follow:

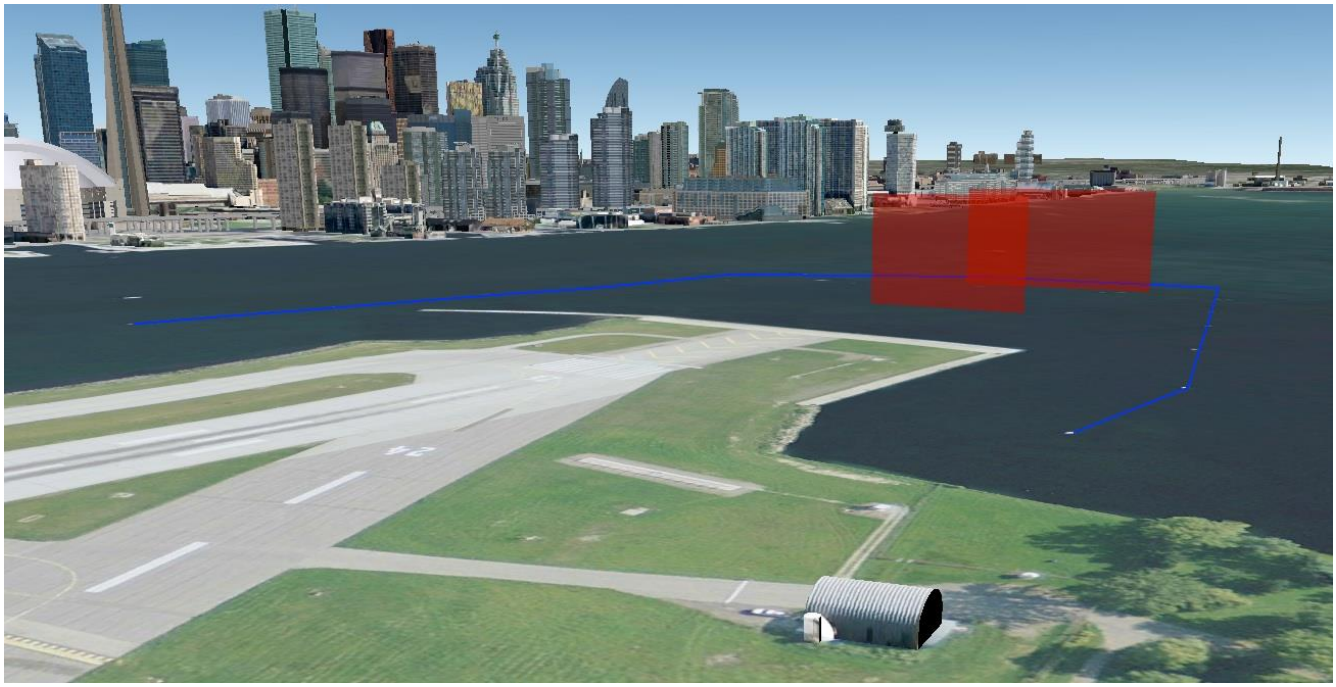
The blue line is the existing MEZ. The red rectangle closest to the runway is the point that a boat 10 m high (a 25 foot long sail boat (7.6 m), or large Toronto Ferry) should not cross and the outer one is for a boat with a 18 m tall mast (a 50 foot long sail boat, 15.2 m).

An easier view to understand is of the western end of the runway:



The image indicates that the current MEZ zone is quite safe for 10 m tall boats, but 18 m tall boats should not sail right up to the edge of the Western MEZ. The red rectangles are 50 m tall for visibility.

On the Eastern end we see this:



As can be seen, both zones are inside the MEZ so it is safe to sail right up to the end of the MEZ in a boat with an 18 m tall mast.

These views will be used throughout the rest of the document to demonstrate the size and attributes of features about the airport.

4.1.4 Potential Future Obstacle Limitation Surfaces at BBTCA

There are a number of potential future OLS depending on final Transport Canada decisions.

According to Transport Canada's document TP 312E, these are the permitted maximum Obstacle Limitation Surfaces (slopes) for BBTCA if it was upgraded to handle Category C aircraft on a Code 3 runway.

	Slope	Closest Approach by a 25 ft. (7.6 m) Sailboat	Closest Approach by a 50 ft. (15.2 m) Sailboat
Runway 08-26 Non-precision	2.5% (1:40)	460 m (from threshold)	780 m (from threshold)
Runway 08-26 Precision	2.0% (1:50)	560 m (from threshold)	960 m (from threshold)

The calculation method for the sailboats is provided in Appendix D.

From Porter's report *Current Flight Paths* (no date), both runways 08 and 26 allow ILS landings but they do not state what Category they fall into. TAO suspects that they are some modified version of

Category I, which is why the table above quotes both precision and non-precision OLS numbers.

“Non precision” runways are those where landings are only permitted if visibility is adequate (ie no fog), while “precision” runways permit instrument-based lower visibility landings.

Unless exemptions are granted, Transport Canada’s minimum requirements for a Category C jet using a Code 3 runway are OLS slopes of 2.5% for non-precision approach and 2.0% for a precision approach (Cat I).

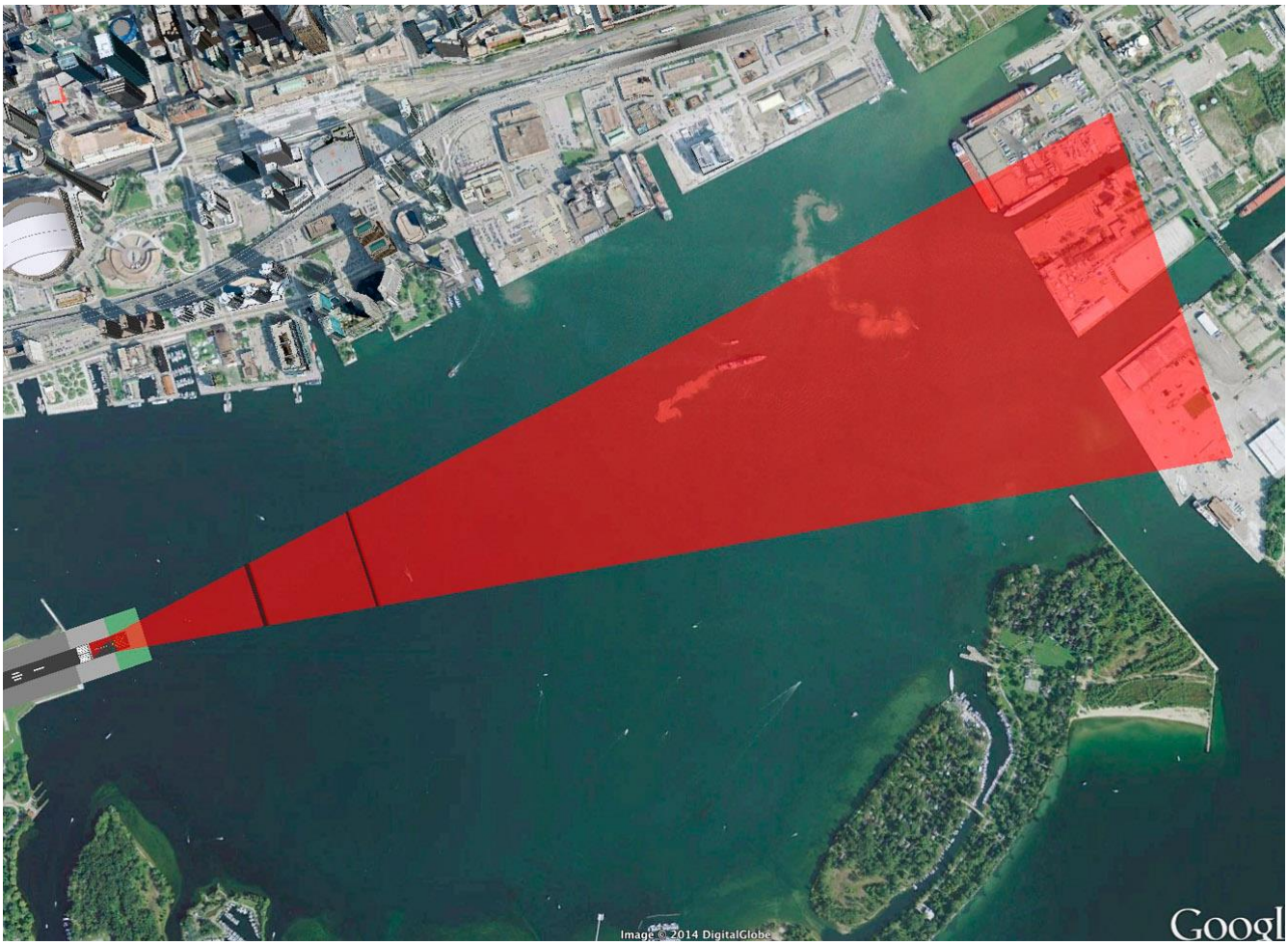
4.1.4(a) Non-Precision Approaches at BBTCA as a Code 3 Airport

Below is an overview of what the new OLS would look like under the Non-precision Code 3 slopes[11]:

As can be seen this surface extends over the Port lands development area, while the previous one did not. When it gets over the Port lands it is about 75 m above ground, which would allow for buildings of approximately 25 floors.

[11] This map/image was created with Google Earth, without a datum.

OLS for Eastern End of the Main Runway (Runway 26)



The red polygon is the obstacle limitation surface defined by Transport Canada for a Code 3 runway using non-precision approach. The first dark red line east of the runway is the no go zone for an average 25 foot (7.6 m) recreational sailing boat, with a mast height of 10 m. A sail boat of this size must stay 460 m away from runway threshold. For details on the sailboat height calculation, see Appendix D. Toronto's largest ferries must also stay approximately the same distance away. The second red line east of runway is the exclusion zone for an average 50 foot (15.2 m) recreational sailing boat, with a mast height of 18 m. A sail boat of this size must stay 780 m away from runway threshold.

Ideally Transport Canada would like this slope to be 2.0% (TP 312E clause 4.2.3.3) and not 2.5%, which would place the 25 foot boat 560 m out and the 50 foot sail boat 960 m out.

This Obstacle Limitation Surface would also influence the route of some of the Toronto ferries. The members of the Island Yacht Club, located on Mugg's Island, would have to make an extensive diversion around the OLS to use the Western Gap.

OLS for Western End of Main Runway (Runway 08)

The OLS surface going west looks like this:

This map is similar to the previous one, with similar distances.

Zooming in on the gap between Ontario Place and the OLS we see this:

The length of the yellow line is about 55 m long where it meets the 18 m high mark. This is a narrow gap for boaters.

TAO is also concerned that an inexperienced boater will turn into one of the OLS areas and an aircraft experiencing trouble will clip the boat. The Bombardier Q400, having turboprop engines, can turn on power quickly and manoeuvre out of danger quickly. The CS100, due to its jet engines, has to deal with spool up[12] time which will hamper its manoeuvrability.

4.1.4(b) Precision Approaches At BBTCA as a Code 3 Airport

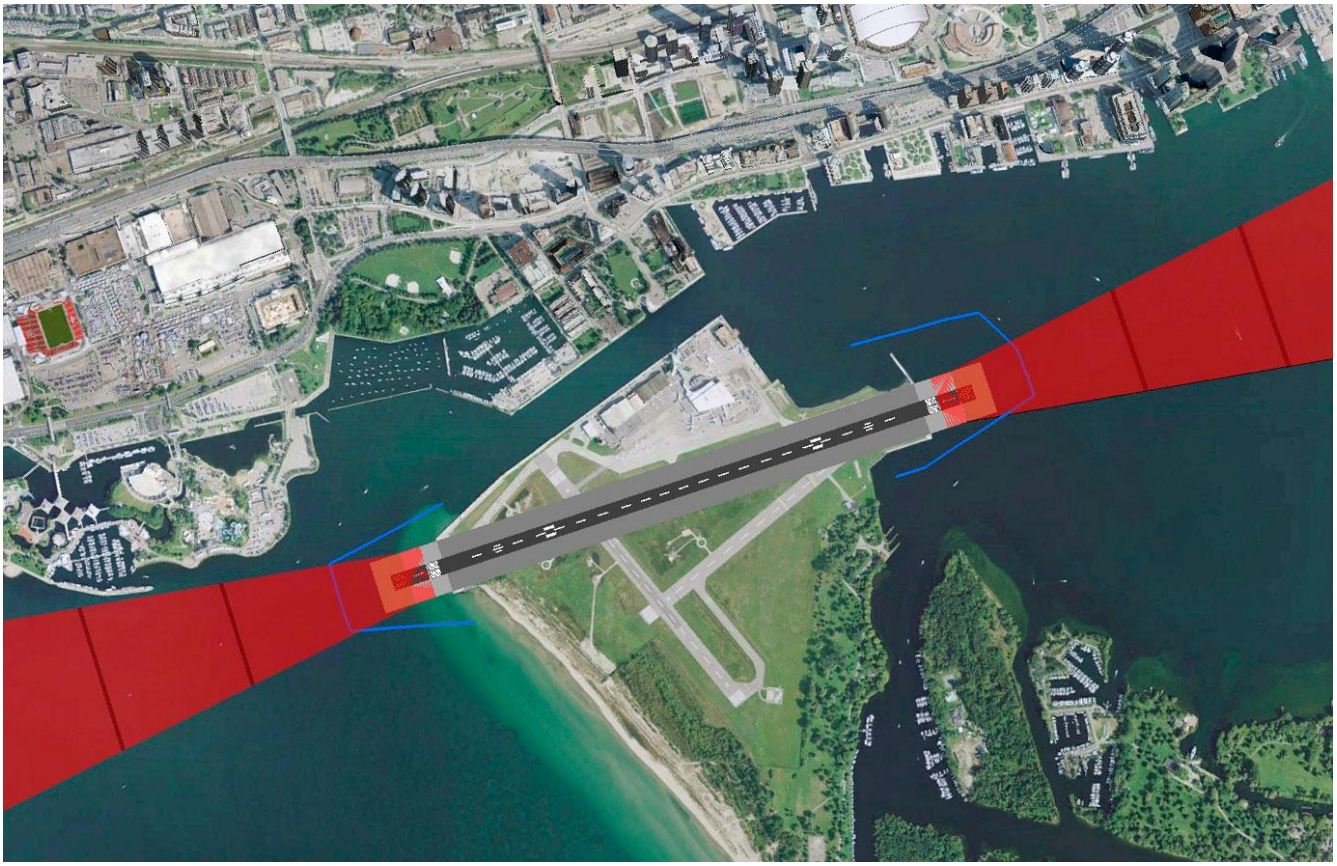
Due to the characteristics of the new jets and the airport, Transport Canada could demand a full Category I precision approach system. This has implications on for the OLS. Here is what these implications look like.

This is what the OLS looks like from above:

[12] Approximately 6 seconds. As the CS100's engines are a new design TAO does not have any information on this aircraft's engine spool up time.

It goes over 15 km from each end of the runway, and at its end points is 300 m above the ground.

Here is a close up of the Inner Harbour portion of the surface:



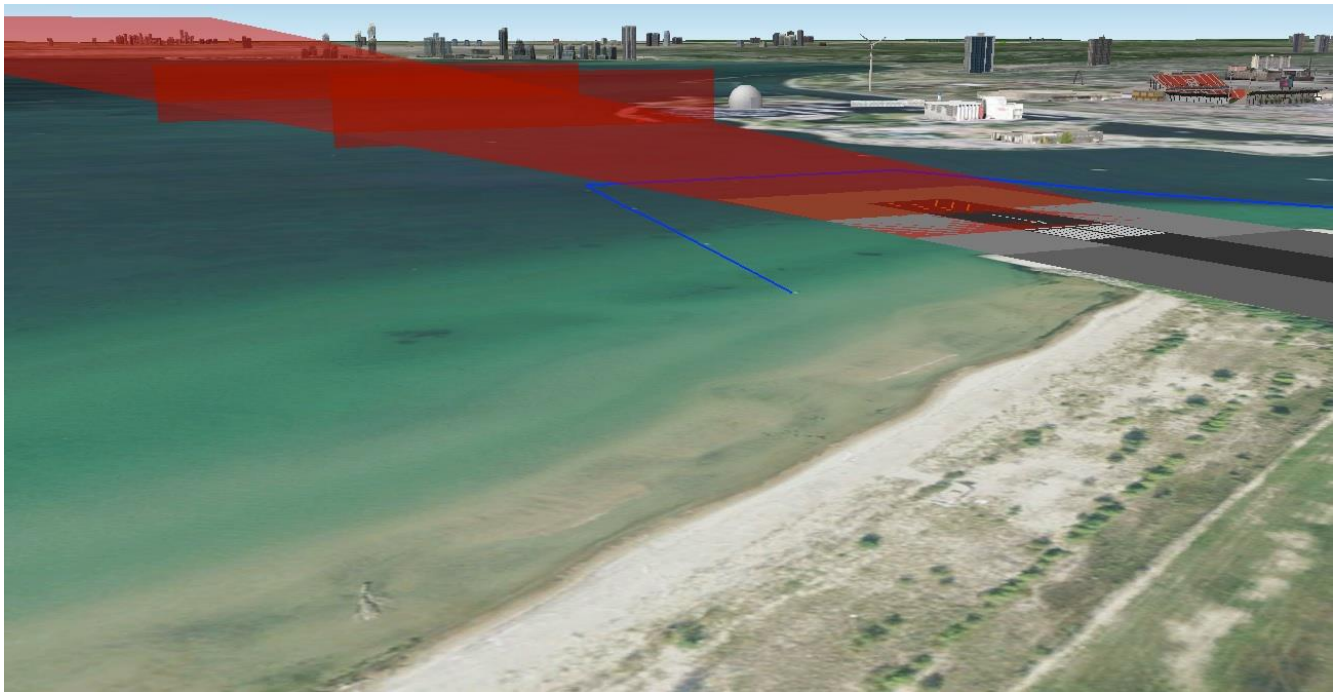
As can be seen, the boating limits move out considerably from the existing MEZ zones depicted by the blue line. The line for 18 m tall boats is a long way down the frontage of Ontario Place. The gap between the Sunken Ships Promenade and the OLS is very narrow. Expanding the view of that zone shows:

Notice the tiny yellow line, which is approximately 10 m long. That is the gap between the OLS and the Sunken Ships Promenade. It falls between the gap for 10 m tall and 18 m tall boats. Boats of 10 m in height or less at this point could make a turn to port when leaving the harbour, but the taller boats would be forced through that narrow gap for aviation safety.

It is also likely that there would be insufficient lake depth to accommodate the below-surface draft of many boats in this area, rendering the Western Gap effectively unavailable to larger boats unless the shoreline was extensively excavated and reconfigured. This would impact the redevelopment of Ontario Place and the Ontario Place Marina.

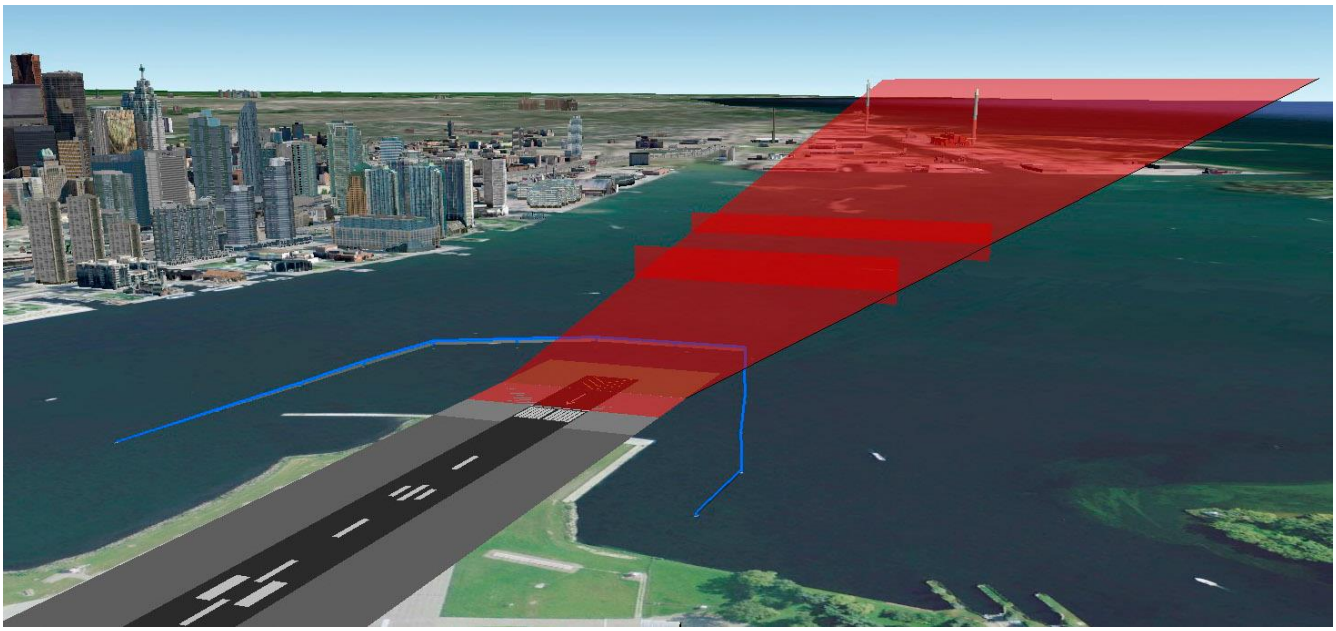
For oblique overviews of this, see below.

The west end of the runway:



As can be seen from the image, the cut off points for boats is a long way out. The 10 m boats get cut off at the nearer vertical surface. The surface further out is for the 18 m boats.

To the east this is the view:



The off limits to boating is pushed a long way out. The OLS cuts right over the proposed Portland development area and cuts off the stacks of the Hearn Station and the Ashbridges Bay Treatment Plant.

4.1.5 Summary of Slopes and Distances

These are the new slopes and distances for both Precision and Non-precision OLS for BBTCA.

	Current Transport Canada Exemption	Transport Canada Code 3 Runway – Non Precision	Transport Canada Code 3 Runway - Precision
Transport Canada Max. Slope (%, rise:run, degree)	West: 4.80% Slope East: 6.38% Slope	2.5, 1:40, 1.432	2.0, 1:50, 1.146
Transport Canada Recommended Slope (%, rise:run, degree)	n/a	2.0, 1:50, 1.146	1.66, 1:60, 0.955
Exclusion zone for 25 foot (7.6 m) sailboat Maximum Slope	East End: 217 m West End: 268 m (from threshold)	460 m (from extended runway threshold)	560 m(from extended runway threshold)
Exclusion zone for 50 foot (15.2 m) sailboat Maximum Slope	East End: 342 m West End: 435 m (from threshold)	780 m (from extended runway threshold)	960 m (from extended runway threshold)
Exclusion zone for 25 foot (7.6 m) sailboat Recommended Slope	n/a	560 m (from extended runway threshold)	660 m (from extended runway threshold)
Exclusion zone for 50 foot (15.2 m) sailboat Recommended Slope	n/a	960 m (from extended runway threshold)	1140 m (from extended runway threshold)

In conclusion, it is extremely difficult to see a credible runway expansion scenario in which TC could approve OLS that would permit the MEZ to remain in their current locations, without creating serious safety concerns and violating the intent of its own safety standards and specifications.

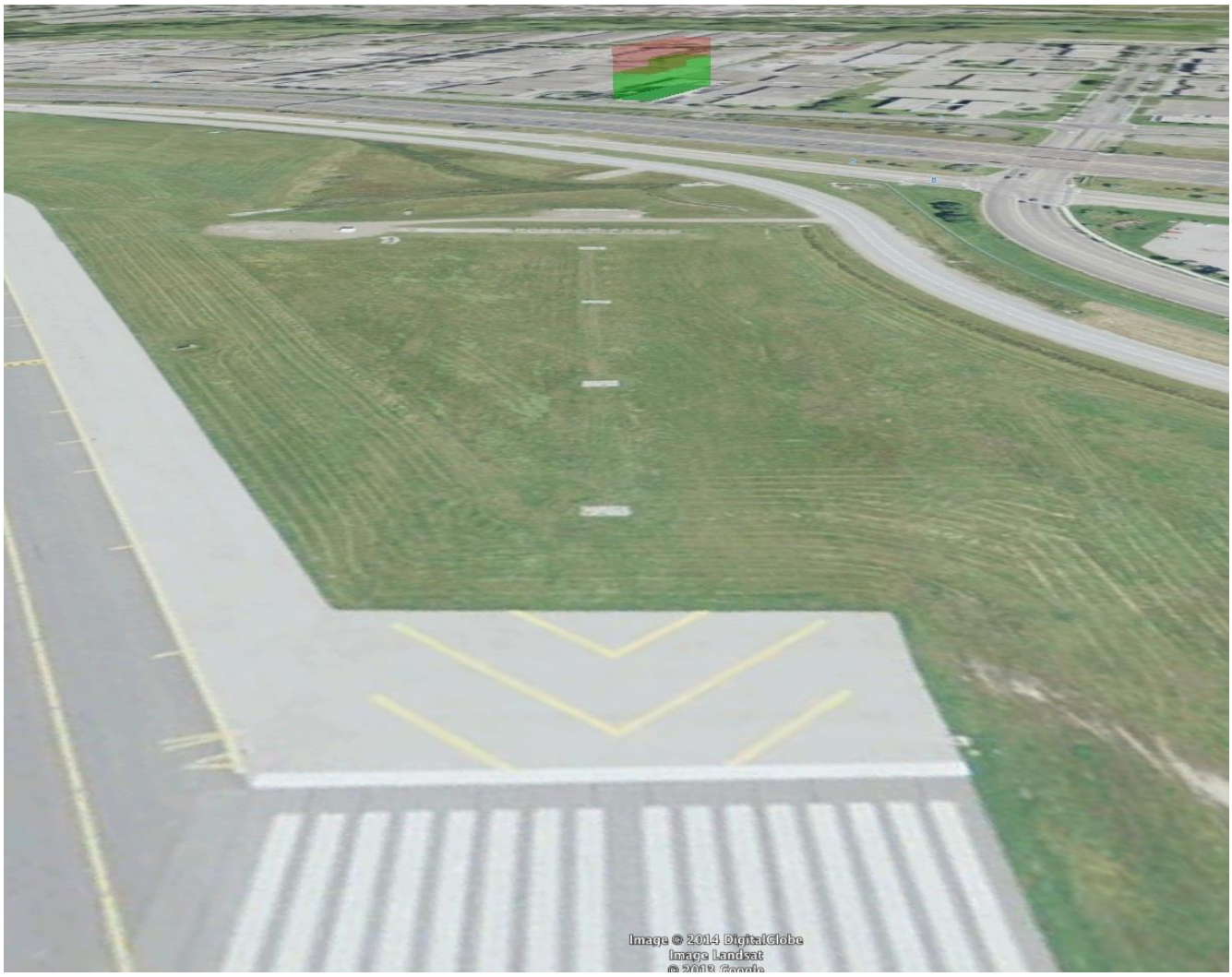
4.1.6 Obstacle Limitation Surfaces and a Decapitated Hotel

What happens to Obstacles that penetrate into the OLS? Transport Canada has the right, in the interest of safety, to have the offending Obstacle removed.

In May of 1991 a new Novotel Hotel opened at 135 Carlingview Dr., Toronto, right beside Pearson Airport. When the Airport planned a new east west runway called 24L, the hotel, which had just been completed, was found to be in the OLS. Transport Canada demanded the removal of 4 floors of the hotel at the front of the building and 3 at the back[13]. Our research indicates that this decapitation exactly fits into Transport Canada's recommended OLS slope for a Precision approach Category I Code 4 runway.

This image, taken above the eastern end of 24L, shows the location of the hotel.

[13] The Toronto Star, August 9, 1991 & December 11, 1991 (pg E7).



The green part of the building is what remains. The red section was removed.

The hotel was sold at a large loss and resulted in a large lawsuit. It is now known as Hotel Indigo Toronto Airport.

4.1.7 Impacts on the Toronto Port Lands Development

Waterfront Toronto has published a few alternative proposals for the redevelopment of the area around the mouth of the Don River and Keating Channel, called the Port Lands[14]. Much of this development (Lower Don Lands) lies underneath or close to the flight paths, glide slopes and OLS of BBTCA.

The Waterfront Toronto mixed use proposals include a number of tall condo/office towers, bordering the new Don River. This development is designed as a new dynamic downtown; it will be larger than

[14] http://www.waterfrontoronto.ca/explore_projects2/port_lands & http://www.tplc.ca/

both the Distillery District and Liberty Village. The area is equivalent in size to the downtown block bordering Front St. to Queen St, and University Ave to Jarvis St.

Waterfront Toronto's development of the Port Lands faces one major problem arising from the Porter proposal: they have to wait for the final decision on BBTCA's expansion, and Transport Canada's and NAV Canada's design decisions before they can set zoning bylaws governing building heights. Transport Canada has indicated if a decision for expansion has been made, it may take 2 to 3 years to finalize and approve the new Master Plan design of BBTCA. At this stage in planning, Waterfront Toronto have no idea what their air rights are. This could vastly change the value of any future development in the Port Lands.

The BBTCA's Draft Master Plan has this to say about the Obstacle Limitation Surfaces around the airport:

> BBTCA is located within close proximity to a number of major developments along the City of Toronto waterfront. As a result, the protection surfaces associated with the Airport's certification and Instrument Approach Procedures are at risk of penetration, which could impact the Airport's certification, operational usability and economic viability.
>
> As a result, the TPA has initiated studies to work with Transport Canada, NAV Canada and the City of Toronto to ensure that future developments located on the shores of Lake Ontario do not impact the airport. These studies include comprehensive analysis of aeronautical protection surfaces outside of those protected under existing Federal Airport Zoning Regulations (SOR 85-515).
>
> Once finalized, these revised aeronautical protection surfaces will be used by the TPA, NAV Canada, Transport Canada and the City of Toronto to identify and discourage developments that are incompatible with the current and future operation of BBTCA[15].

On February 2, 2014, when questioned about the statement above, Geoffrey A. Wilson, President and CEO of the Toronto Port Authority, stated that once the protection surfaces are established, the TPA will work with the City to protect them.

4.1.7(a) Present-Day OLS

The present-day OLS cuts through the Port Lands like this:

[15] Billy Bishop Toronto Centre Airport: Airport Master Plan, DRAFT, pg. 46.

The image indicates that the current OLS doesn't reach the Port Lands. At the end of the OLS it is 159 m above the harbour. The Outer Surface cut would cut through any building above 45 m, but any building north of the centre line of the runway would probably be fine.

It should also be noted that runway 06-24, which is at an angle to the main runway, also has a OLS zone that doesn't reach the proposed development at the Port Lands. It does mean the Outer Surface rule needs to be imposed north of this runway's centre line.

4.1.7(b) OLS with Expanded Airport – Non Precision Approach

For the expanded airport, if Transport Canada enforces the OLS surfaces for non-precision approaches using the maximum slope (2.5%), the end result would look like this:

In the upper figure, the Outer Surface would cut through building higher than 45 m.. Removing the Outer Surface from the image, the lower figure shows the OLS from the same point.

This surface will cut through buildings higher than 75 m at the end point.

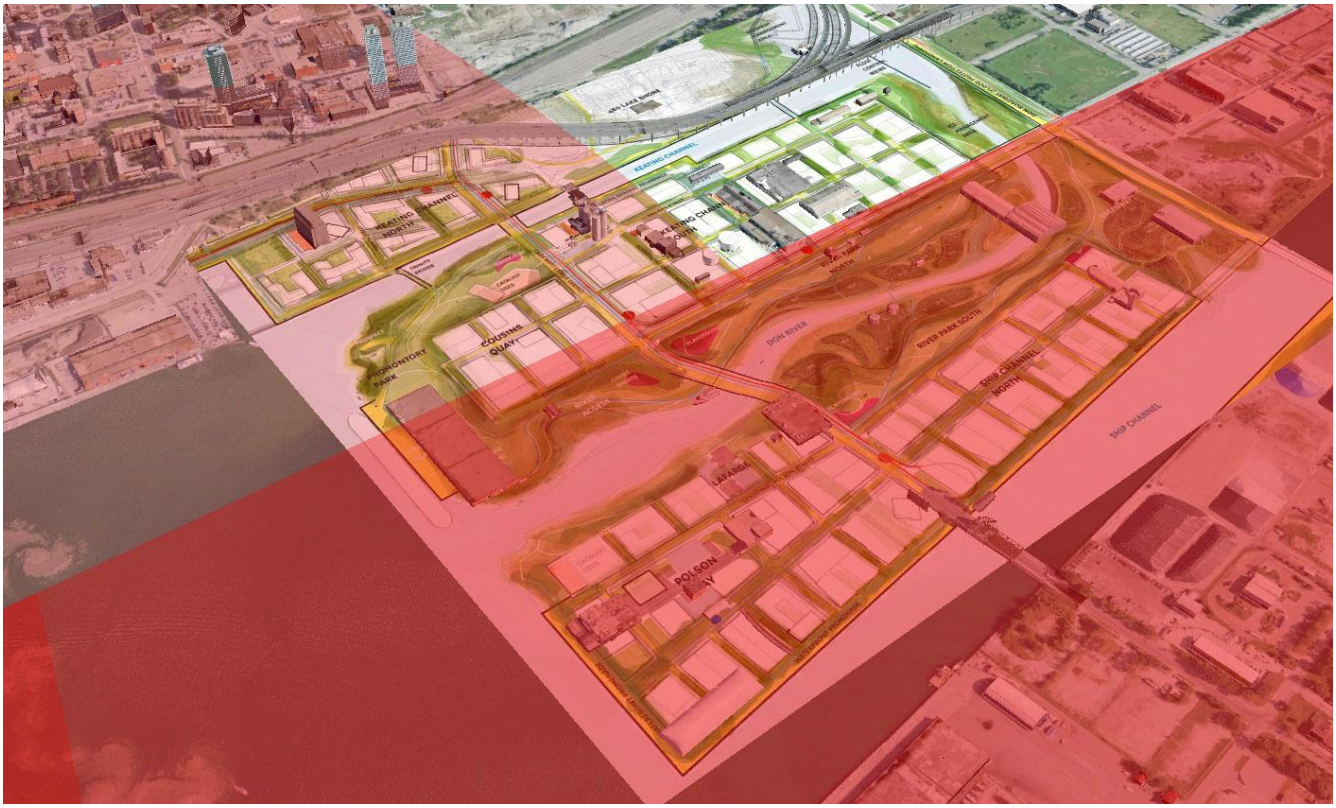
Taking a different perspective, this time from above:

As the image indicates, the brighter red surface would cut through any structures that would rise above it. At this point Transport Canada would have the ability and right to control building heights and air rights. Although the OLS stops only a short distance into the Lower Don Lands, Transport Canada would likely control the heights of structures right through the development. The height at the end of the OLS is 75 meters, which, depending on design, would allow 15 to 20 story tall buildings.

4.1.7(c) OLS with Expanded Airport – Precision Approach

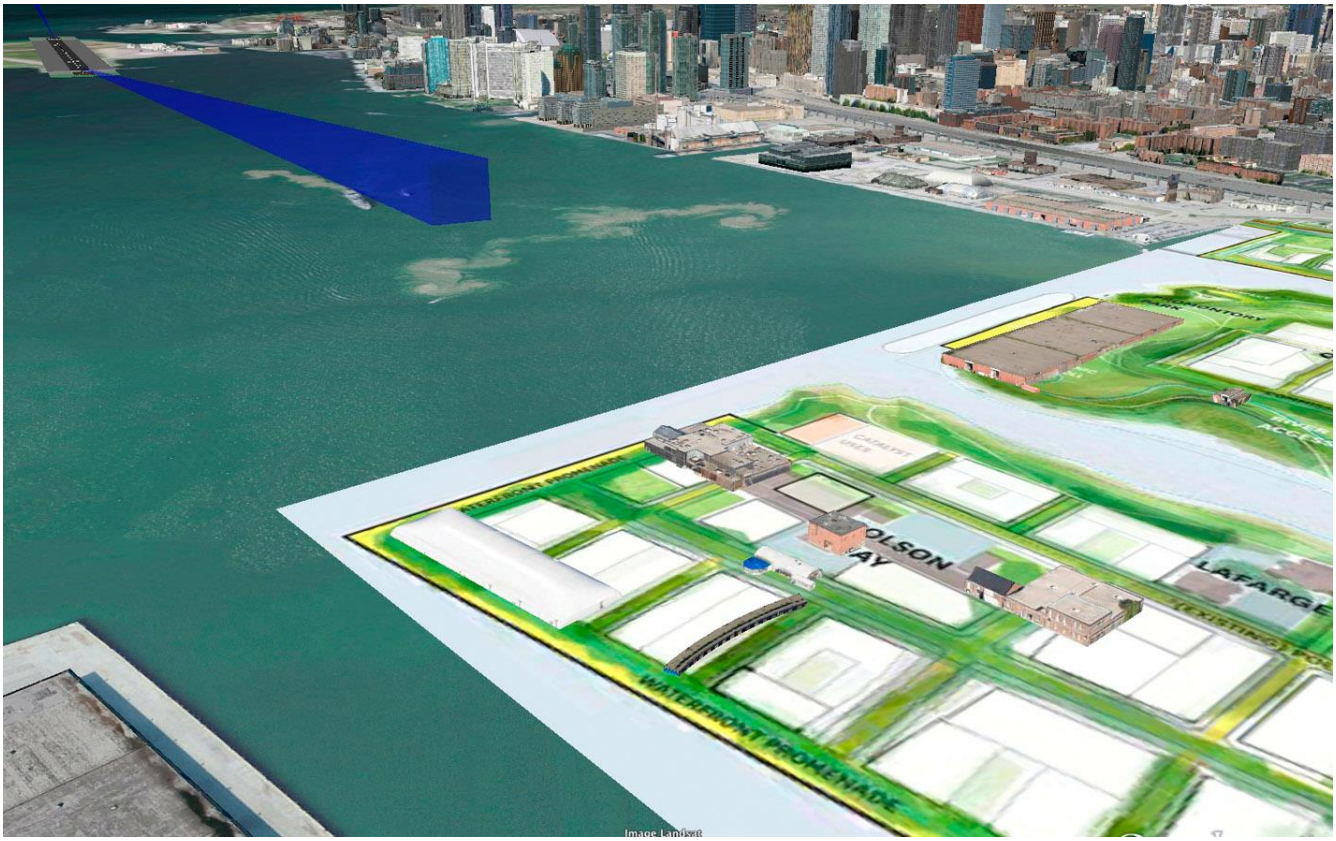
If Transport Canada or NAV Canada insisted on Precision Approaches to BBTCA, which could be the case considering the nature of the proposed traffic and local features of the airport, Transport Canada's requirements would look like this:

Here you can distinctly see two surfaces, the lower light red one is the Outer Surface and the darker one over the left half of the image is the OLS, which would limit building heights to 60 m at the west and 80 m south of the Don River. From above it looks like this:



Looking at the overall picture of OLS from the sections above, one can see that this surface would blanket the southern portion of the Port lands, putting building heights under the control of Transport Canada.

And where will the jets be relative to these surfaces? A typical jet, flying along a typical glide slope would end up flying along the blue zone (the safe 3 degree slope) presented in the image below:



Based on the centre line of the runway, this slope places planes 145 m from ground level at the water edge.

4.1.7(d) Discussion

It should be noted that in TP312E the recommended OLS slope is 2.0% for a non-precision slope, which is the same as the maximum slope of the precision slope used in the images above. When Transport Canada removed the floors from the Novotel near Pearson in the early 90's, they cut the building down to the recommended OLS slope and precisely removed 4 floors of the front of the building and 3 off the back. Transport Canada should be equally vigilant at BBTCA due to the number of people traveling through the airport and the many more thousands living and working around the BBTCA. One should also consider the decision made by the FAA (based on safety grounds) to reduce the height of a building near Montgomery Field in San Diego California. That building was only in the equivalent of the Outer Surface, not anywhere near an OLS.

Observing the activity around BBTCA over this winter, it has been noted that the airplanes coming into BBTCA are following the 3 degree glide slope shown above. Possibly they stick to the special requirements required by this Airport only during boating season? Regardless, the pilots seemingly like to fly along the 3 degree slope which is very close to the proposed buildings.

Transport Action cannot predict what NAV Canada and Transport Canada will permit. They may accept the current OLS and not require additional lighting and development and the Port Lands can proceed

without having to consult with Transport Canada. However, this is unlikely. The present situation leads to uncertainty. One would be ill advised to make plans or proceed with any development plans until such time as the plans for BBTCA are finalized and all the OLS are known. If expansion was to proceed, at the very least one can safely assume that Waterfront Toronto's Port Lands developments have no guaranteed air rights over 50 metres above lake level, until told otherwise from Transport Canada.

Hence a stark contrast appears: does the City allow the expansion of a small airport that duplicates the services provided by Pearson, or does the City allow a downtown sized residential, commercial, and retail brown field development that could bring billions of dollars of value to the city?

4.1.8 Conclusions on Obstacle Limitation Surfaces

As the images and maps above indicate, the runway expansion and switch to jets will impact marine navigation, and development around the airport.

If the runway expansion goes ahead and Transport Canada enforces their OLS standards without making any exceptions, a recreational boater would have a long sail around the OLS. This distance would now increase to over 3 km from 2 km, increasing the time through the gap at 5 knots[16] (10 km/hr) from a minimum time of 12 minutes to 18 minutes. Many boaters will be annoyed by this additional delay.

TAO is also concerned that an inexperienced boater will turn into one of the OLS areas and an aircraft experiencing trouble will clip the boat. The Bombardier Q400 is a turboprop aircraft, which can put on power quickly and manoeuvre out of danger quickly. The Bombardier CS100, being a jet aircraft, has to wait for its engines to spool up, which takes about 6 seconds. This might prevent the aircraft from climbing over an obstacle in its path, such as a sail boat cutting into the OLS.

TAO believes that Transport Canada should not grant an OLS exemption for the BBTCA. TAO has always been on the side of safety; the maintenance and stiff enforcement of rigorous safety requirements has been a long standing priority of our organization.

TAO is also concerned about future development in the Port Lands, and would not like to see development constrained by activities at BBTCA and dictated by Transport Canada.

4.2 United States Federal Aviation Administration (FAA) Requirements

TAO has also explored FAA requirements for airport design and Obstacle Clearances around airports. Their standards are slightly different from Transport Canada's requirements but overall they turn out to be fairly similar. Presently the FAA is issuing updates on Runway Protection Zones at the ends of runways. The requirements are being tightened up. Transport Canada is having the same debate, which is discussed on their website[17].

[16] http://www.torontoport.com/Port/About-Us/Practices-and-Procedures.aspx

[17] http://www.bst-tsb.gc.ca/eng/recommandations-recommendations/aviation/2007/rec_a0706.asp

5. Jet Blast

Airbiz, in their final report of November 27, 2013, addressed the issue of jet blast. This is a major improvement in their report, as it begins to address a significant issue. However, AirBiz was prevented from doing a full analysis because of a lack of time and suitable research to review. The jet blast research done by the major airline manufactures has been done to establish safety at airports[18]. The tests were designed to establish the danger zones for airport vehicles and airport ground staff, and typically consider winds of 40 to 60 km/hr. Consideration of kayakers, motor boaters and sailors was not a priority, although for boaters the study should probably look at winds down to 20 km/h.

To the north of runway 08-26 are the taxiways servicing it. Aircraft arriving or departing from the airport will need to turn on and off of these taxiways. To make the turns, the aircraft will have to provide a short blast of power to accelerate the aircraft to make the turn. This burst of power could have adverse problems for boaters near the end of the runway. These jet blasts may be sufficient to damage the sails of a sail boat, cause it to have a sudden and unplanned change of course, or even knock it down. They might be loud enough to prevent communication between a boat's crew, etc. Smaller boats could be swamped.

The Airbiz report superimposes images of the blast plume based on comparable existing planes on an image of the proposed runway expansion and current MEZ. The blast plumes appear to extend well over a hundred meters past the current MEZ, with velocities in excess of 60 km/hr outside the MEZ. Such velocities would be wholly unsafe for thousands of sailboats, canoes and kayaks which constantly used the area, and would potentially be life threatening.

As is apparent from the above, the jet blast issue is not confined to the blast as planes round the corner from the taxiing to the runway. In other words, jet blast concerns cannot be addressed by deflectors beside the runway.

In conclusion, the question of whether jet blast from the runway expansion will create imminent physical danger to those nearby, including children, for generations to come, should be regarded as a priority concern. This is just one example where this particular airport expansion raises different and more pressing safety and regulatory issues than those at other airports. Most airports are not meters from sensitive recreational activities.

[18] http://asrs.arc.nasa.gov/publications/directline/dl6_blast.htm

6. Approach Lighting

Approach lighting makes landing at any airport in the dark or inclement weather much safer. Here is what the FAA states about it:

> Approach Lighting Systems provide the basic means to transition from instrument flight to visual flight for landing. Operational requirements dictate the sophistication and configuration of the approach light system for a particular runway.[19]

Approach lighting has not been discussed in any of the reports published so far. Porter has not requested approach lighting for the expansion. However, TAO feels that approach lighting will be required at the airport for the following reasons:

1) Transport Canada or Nav. Canada may impose lighting at BBTCA for safety reasons.
2) Porter, having spent a great deal of money on new aircraft, will need to recoup their money quickly. This means expanding the operational envelope of BBTCA. Considering that the airport is in a marine environment, subject to weather that often can close the faculty, Porter will want approach lighting so that they can remain open in inclement weather.
3) Porter's and other airlines' insurance companies may require enhanced safety equipment at the airport.
4) Despite any special arrangements for BBTCA, a foreign carrier, under any of our international agreements that relate to air travel, may demand the additional infrastructure so they can fly to BBTCA.

What would these lighting systems look like?

6.1 ODALS System

From TP312, TAO has established that the minimum system that would be installed at a typical Code 3 airport in Canada would be an ODALS system. From section 5.3.5 of TP312:

1) The lights would extend from the threshold of the runway out to 450 m.
2) Any lights over water would have a 60 m buffer around them, as defined by clause 5.3.5.6b in TP312E.
3) They should be visible for any direction, but cannot be blocked in the direction that the planes approach.
4) They must be all-weather accessible by land. This means that the lights require a catwalk back to the land.

Below is Transport Canada's diagram of an ODALS system:

[19] https://www.faa.gov/air_traffic/publications/atpubs/aim/aim0201.html

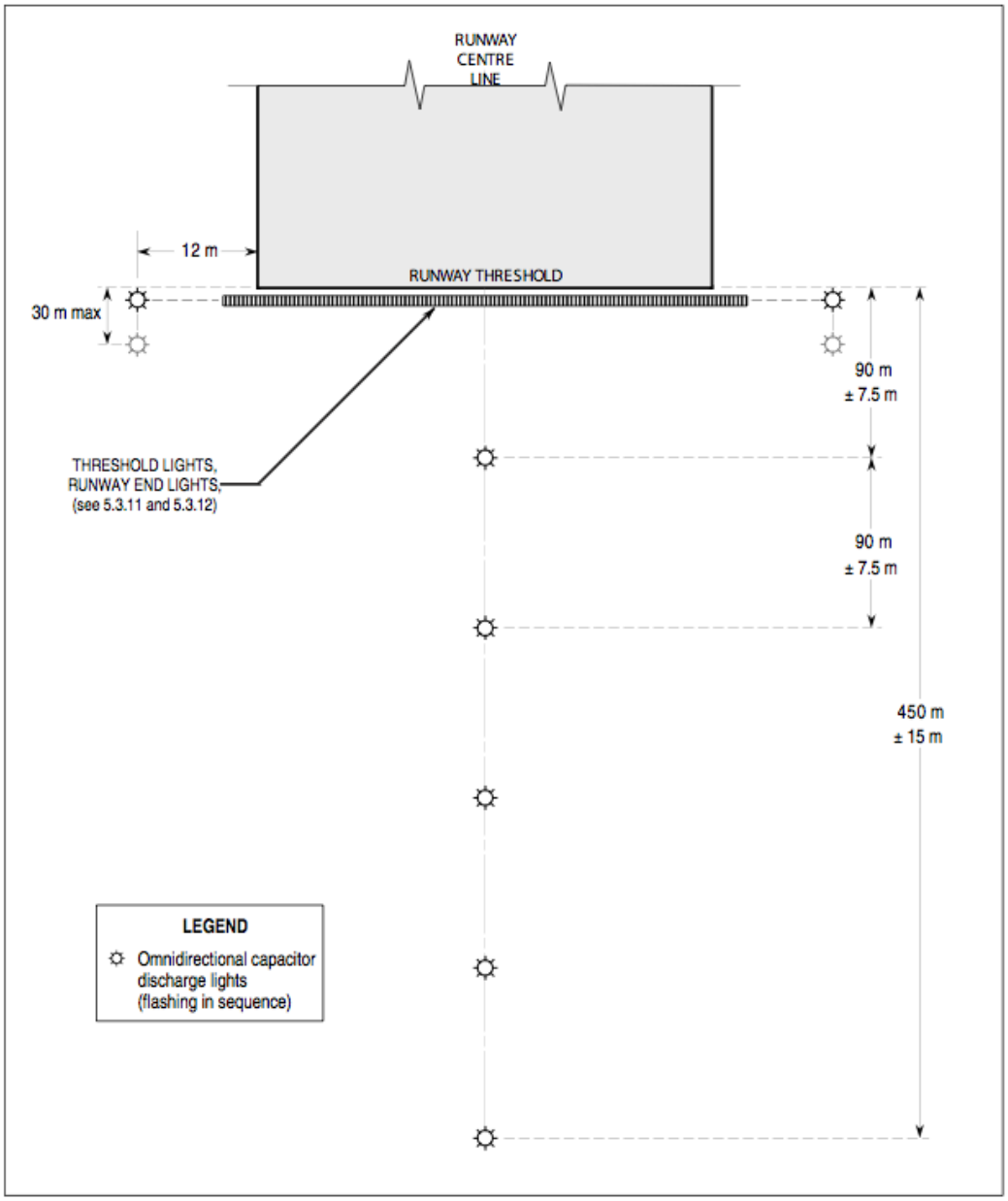
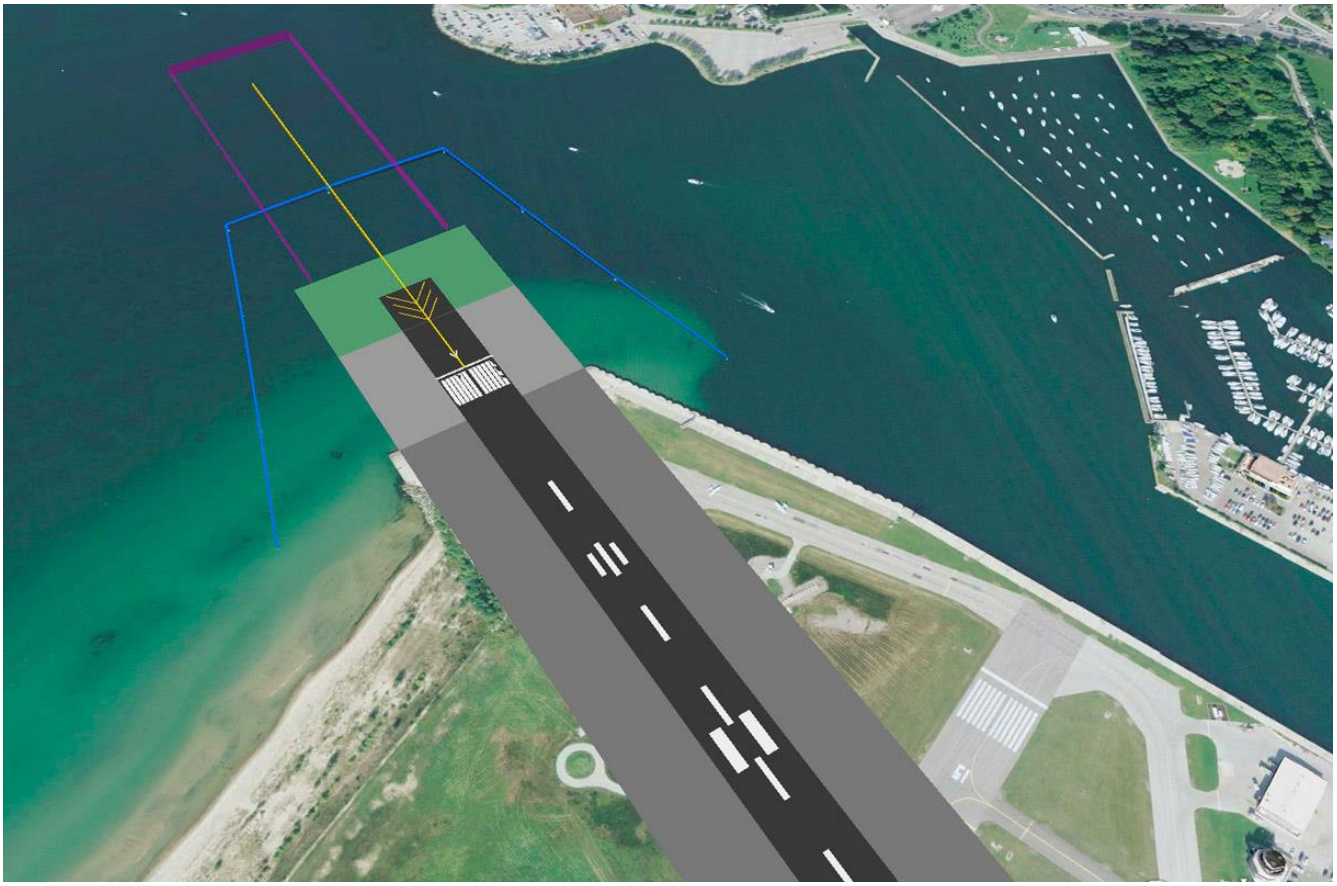


Figure 5-9. Simple approach lighting system (ODALS)

This system, if installed at the 200 m expanded BBTCA 08-26 runway, would extend 300 m [450 m of lights – (90 m Runway End Safety Area (RESA) + 60 m Runway Strip)] into the lake at both ends of the runway. This is what it would look like at the east end of BBTCA's runway 08-26:

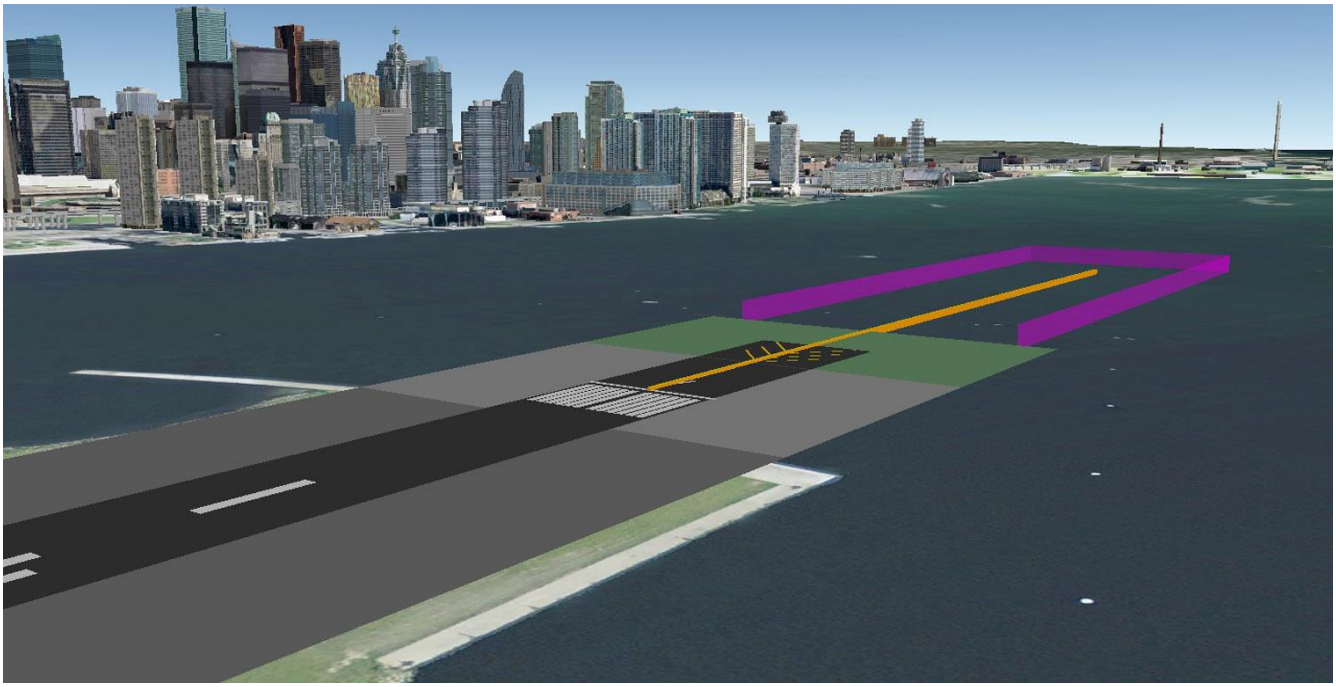
The width of the yellow line is an approximation and includes a 1 m wide catwalk.

And at the west:

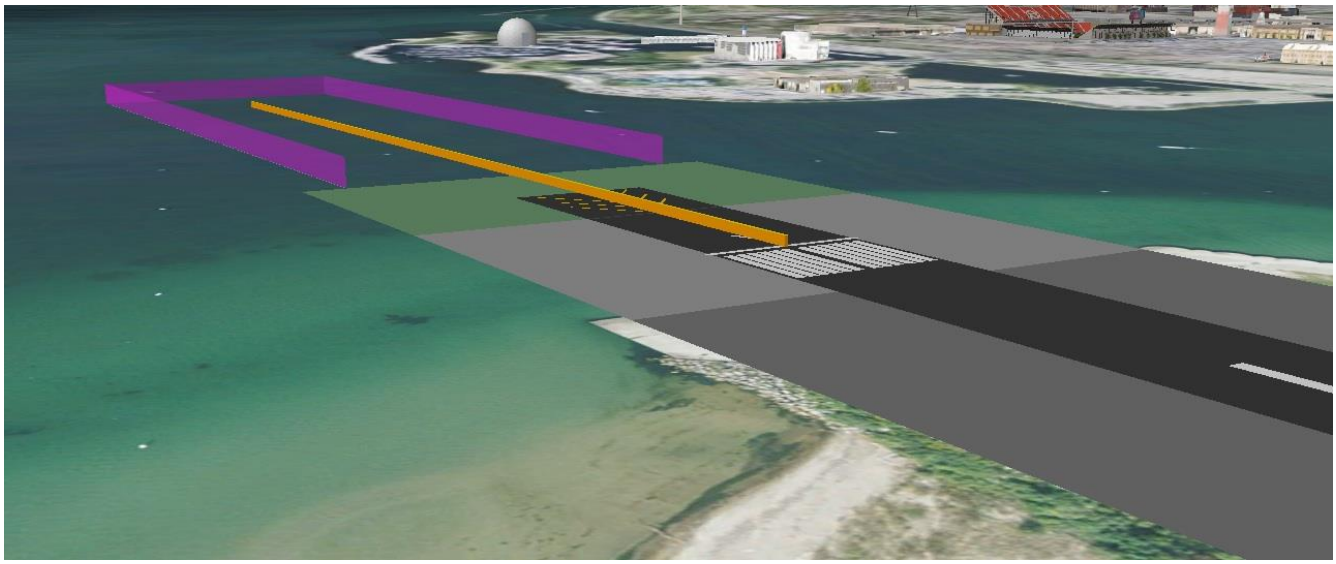


The blue line is the current MEZ, the yellow line is the lighting system (450 m long) and the purple is the 60 m buffer near the lights.

To make it clearer about what these elements would look like, here is an oblique view of both east and west with the same colour scheme:



The purple fence is the 60 m buffer around the lights. For the west we have:



6.2 SSALR System

Considering that this airport could potentially be handling more than 4 million passengers a year and handling midsized jet aircraft, Transport Canada or NAV Canada might require a full sized Precision Approach Category I Lighting System, commonly referred to as a SSALR.

The prime difference between the ODALS mentioned above and the SSALR is the length of the lighting system. A SSALR is a minimum of 720 m long. It has more lights and shares all the other characteristics with the ODALS system. Below is a diagram of one from TP312:

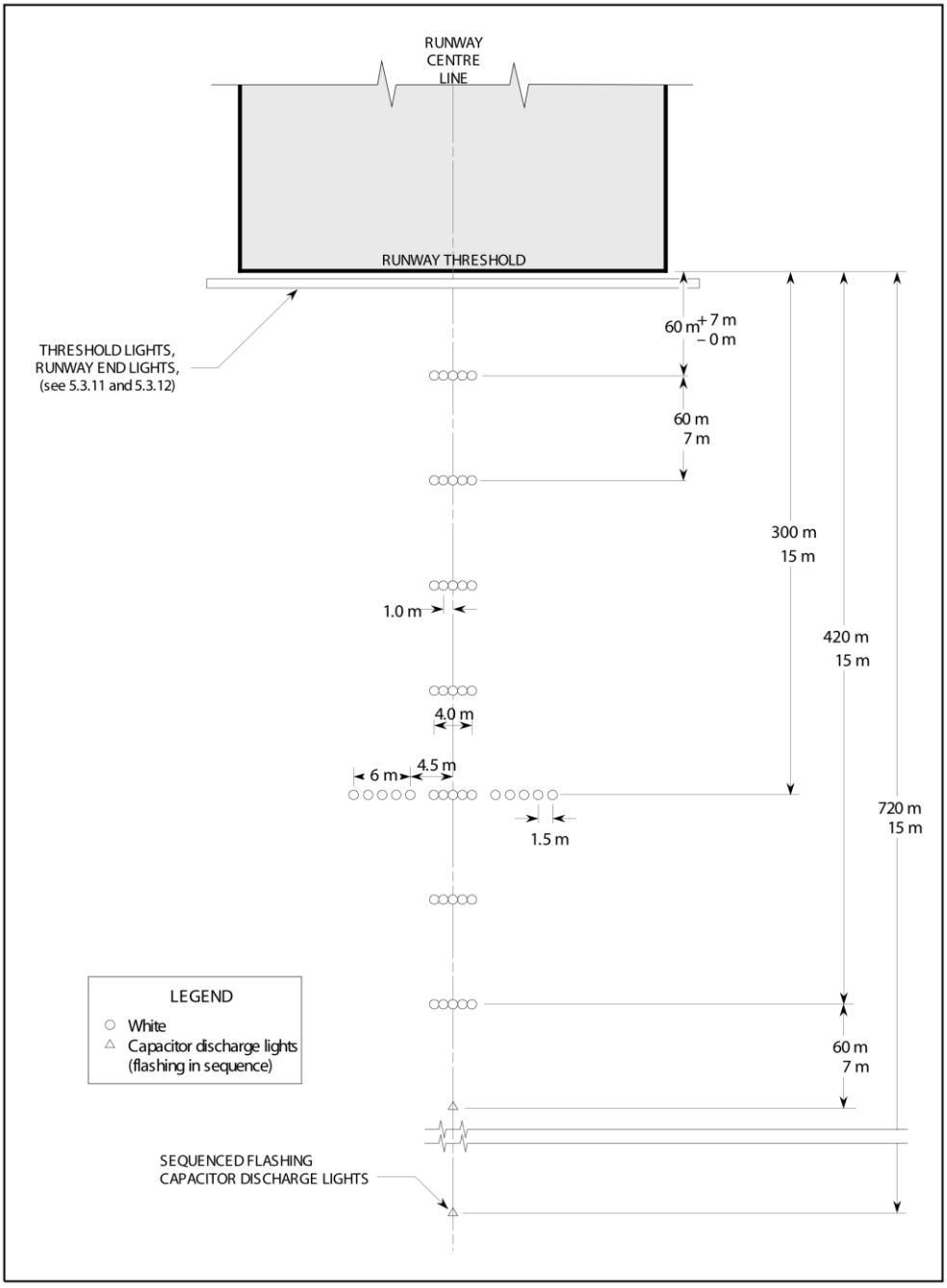
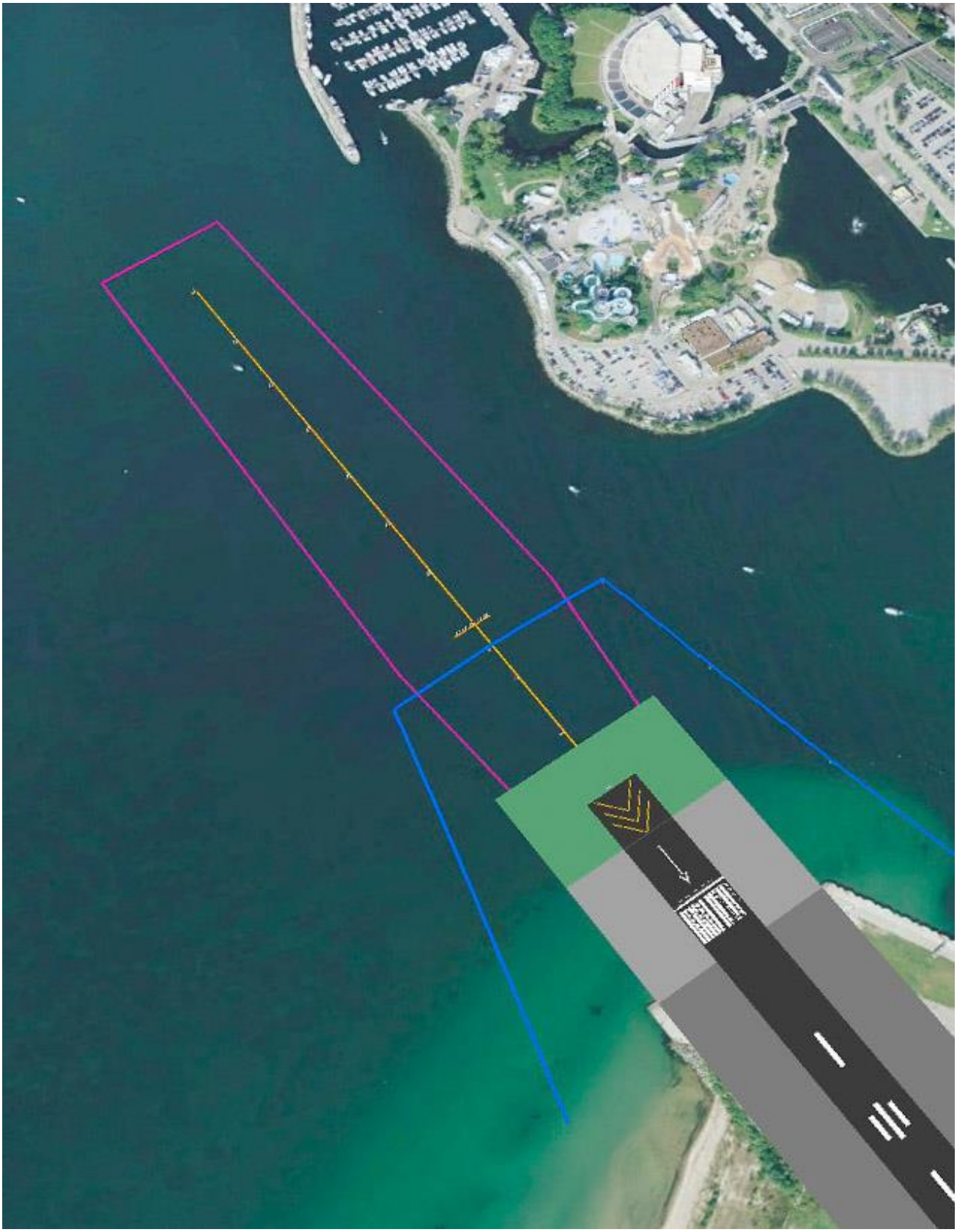


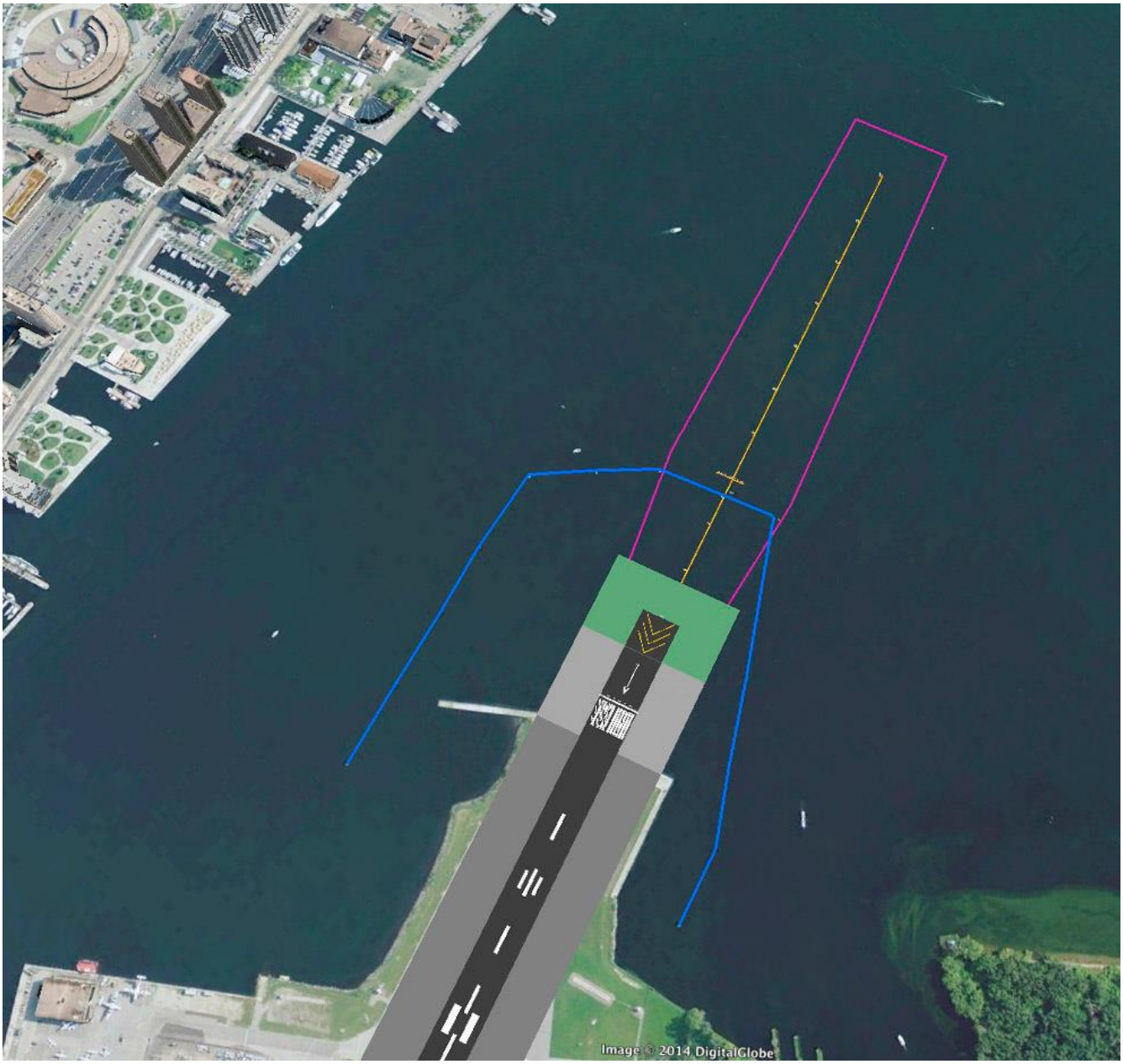
Figure 5-10. Precision Approach Category I lighting system

After the 200 m expansion of the runway, if such a system was put in, it would extend 570 m into the water at both ends of the runway. Mapped it would look like this:

Below is an oblique view of the western end:



For the eastern end of the runway we see:



Note the purplish surface is the 60 m buffer zone required for the lights.

Both of these lighting systems go far beyond the current MEZ's and would demand a complete redesign of the MEZ's.

6.3 Summary of Approach Lights Distances

Here is a summary of these distances:

System	ODALS	SSALR
Requirement per TC	450 m (from extended runway threshold)	720 m (from extended runway threshold)
Available on-land portion (RESA + Runway Strip)	150 m	150 m
Required buffer in lake	60 m	60 m
Extent into lake (lights + buffer)	360 m	630 m

6.4 Lighting at Other Airports

In addition to the requirements for lights in TP312E, Google Maps was used to study 9 Canadian airports[20]. Thinking that that sample size wasn't robust enough, a group of land based but beside water airports were also examined[21]. In addition, some airports of compatible size were examined, those being London City (falls in two groups – near water and compatible in size to BBTCA), Belfast (EGAC), and Stockholm (ESSB). All of these airports had lighting systems, and most had at least one runway with the full SSALR. The only airport with just the shorter lighting system was London City and the only airport without an approach lighting system at all was BBTCA.

If Transport Canada or Nav. Canada does not require either of these lighting systems, a full comprehensive rationale should be provided before a final decision to expand the airport is made.

7. Marine Exclusion Zones (MEZ)

Presently at the west and east ends of runway 08-26 there are Marine Exclusion Zones (MEZ) that are for preventing boats from getting too close to the airport, and to prevent aircraft overruns from running into boat traffic. From air-photos, TAO discovered that the current MEZ extends 305 m (1000 ft) beyond the end of the land into the lake (about 410 m from runway threshold) and about 80 m from each projected side of the runway.

This MEZ was partly designed based on the special OLS that Transport Canada has given BBTCA. Between possible changes to the OLS and lighting systems, we have created new MEZ's based on two scenarios: (a) a non-precision approach with ODALS lighting going 450 m out, or (b) a precision approach with SSALR lighting going out at least 720 m. Other scenarios are possible but were not studied.

[20] Toronto, Vancouver. Montreal, Calgary, Edmonton, Ottawa, Halifax, Winnipeg, BBTCA.

[21] 16 more airports: San Francisco (KSFO), Oakland (KOAK), La Guardia (KLGA), New York, Washington (KDCA), Boston (KBOS) New Orleans, Liverpool, Kobe, Kansai, Haneda, Bali, Kingston, Jamaica, Hong Kong, London City.

Design criteria for the new MEZ:

1) Cannot be smaller than the current MEZ.
2) For lighting-based MEZ, assume this clause from TP312E:

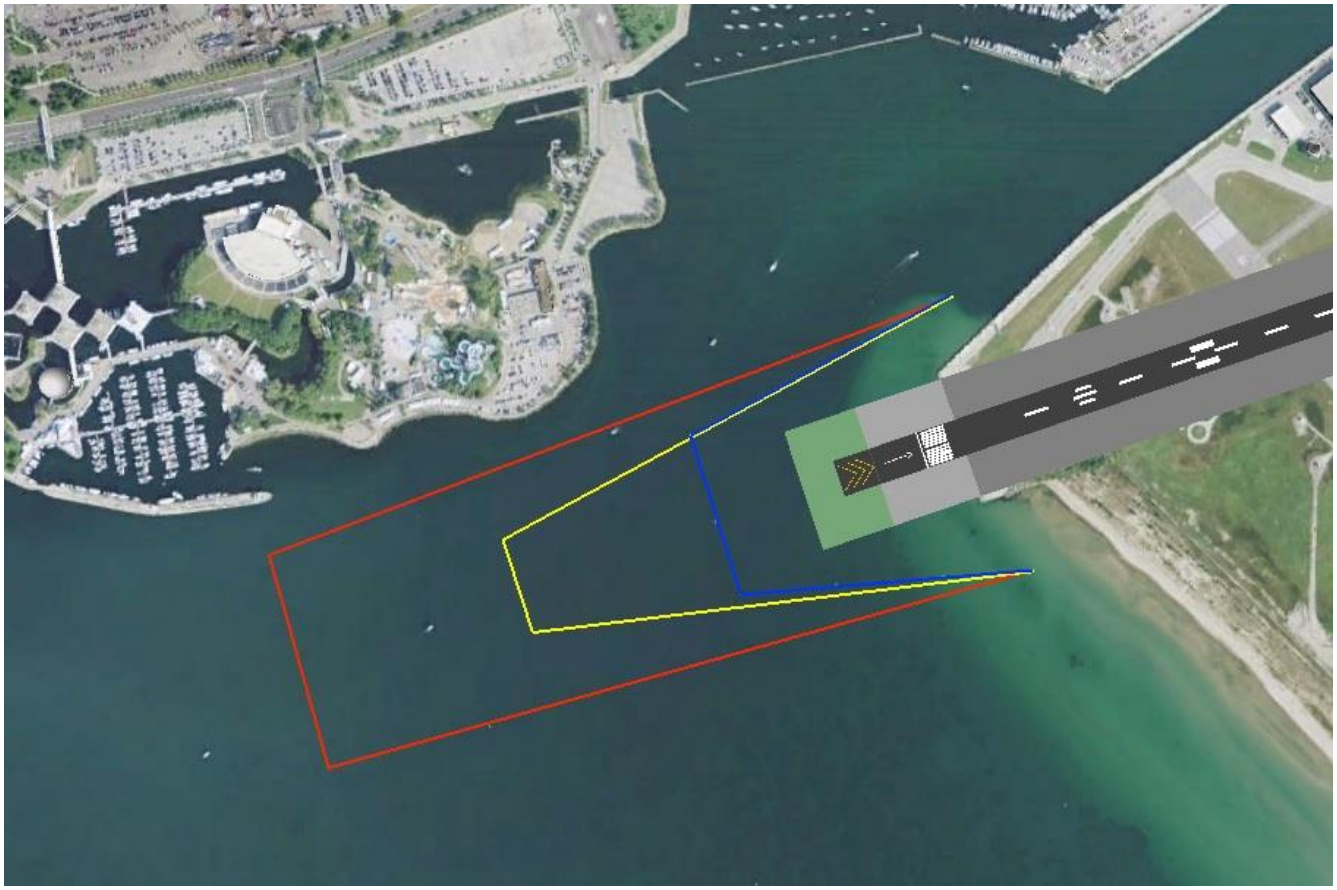
> *5.3.5.6 Standard.— The system shall lie*
> *as nearly as practicable in the horizontal plane*
> *passing through the threshold, provided that:*
> *a) no light shall be screened from an approaching aircraft; and*
> *b) as far as possible, no Obstacle shall protrude through the plane of lights within a distance of 60 m from the centre line of the system. Where this is unavoidable, as in the case of a single isolated Obstacle protruding through the plane of lights the Obstacle shall be treated as an obstacle and marked and lighted accordingly.*

   This means that no boats will be allowed within 60 m of the lights.
3) For boats, the OLS consistent with either TC maximum slopes or recommended slopes will be used. The figures will show the OLS based on maximum slopes. As noted above, based on the existing OLS surfaces, a boat with an 18 m high mast can get right up to the OLS at the east end of the airport, and almost right to the MEZ at the west end. Therefore an OLS for an 18 m tall boat was used.
4) Transport Canada will enforce their current OLS standards.

What would these MEZ's look like?

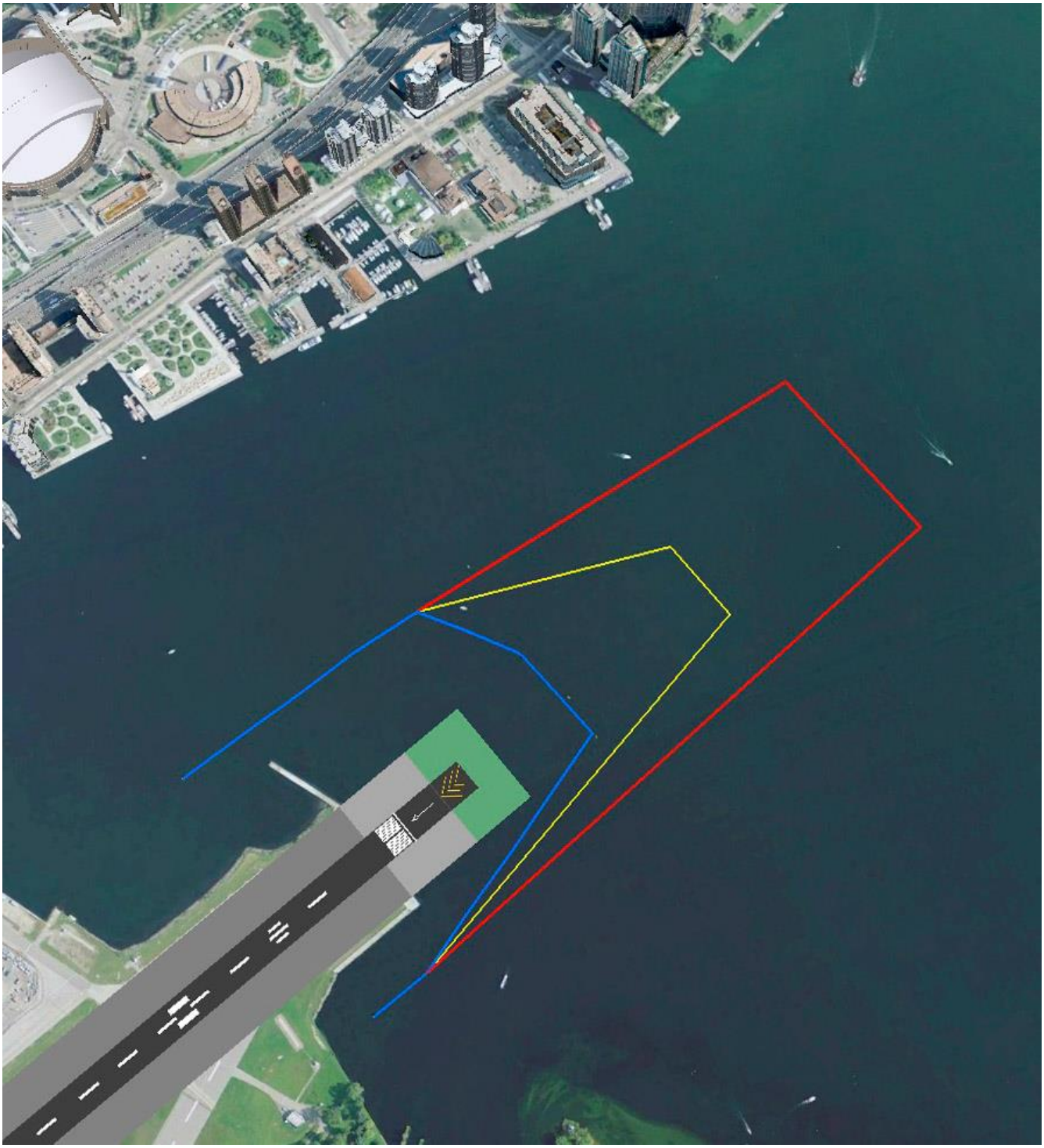
7.1 Non-Precision Approach Based MEZ (assumes ODALS Lighting)

For a non-precision approach from the west we get this:



The blue line is the existing MEZ. The yellow is based on the lighting system, which in this case is a ODALS system. The red line shows the MEZ based on boating limits, as with today's MEZ.

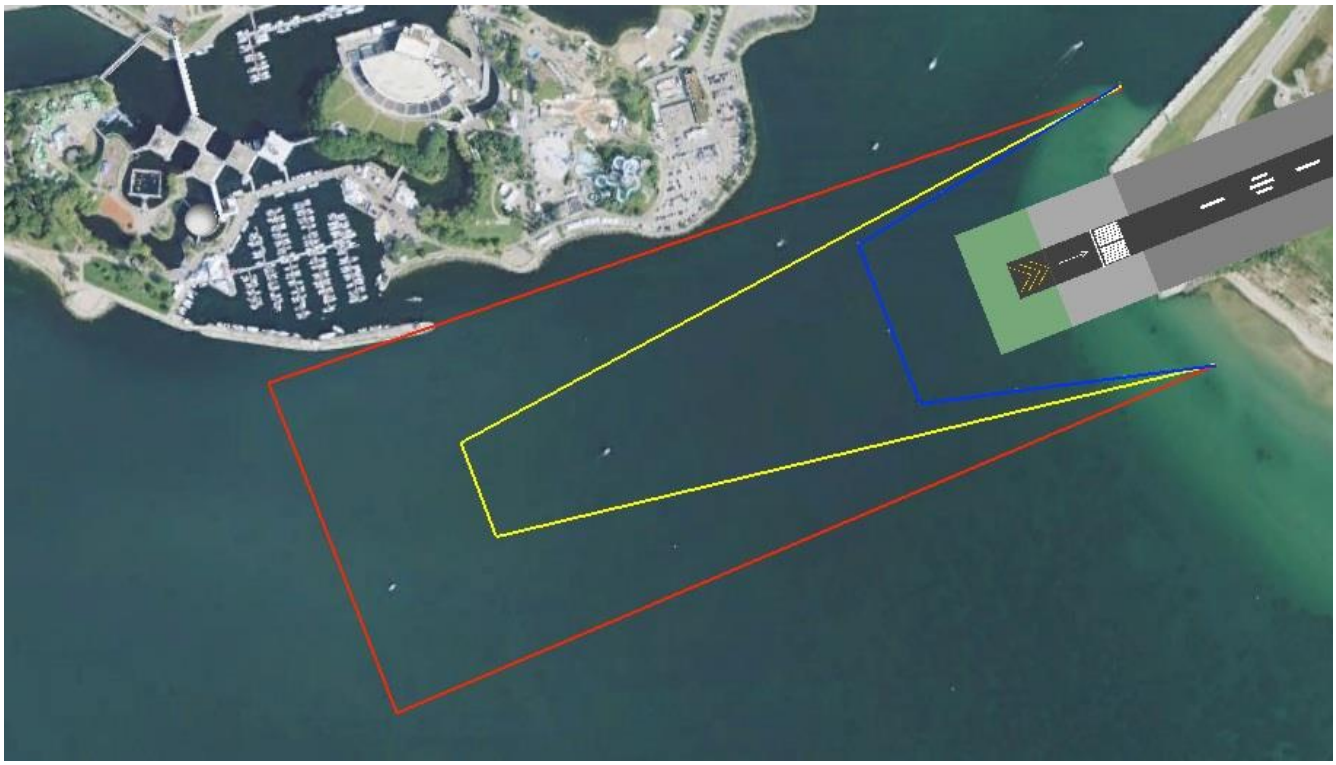
To the east we see the following:



The colour scheme is identical to the previous image. Note how the lighting MEZ lines up with Simcoe St, and the OLS MEZ goes to over to about York Street.

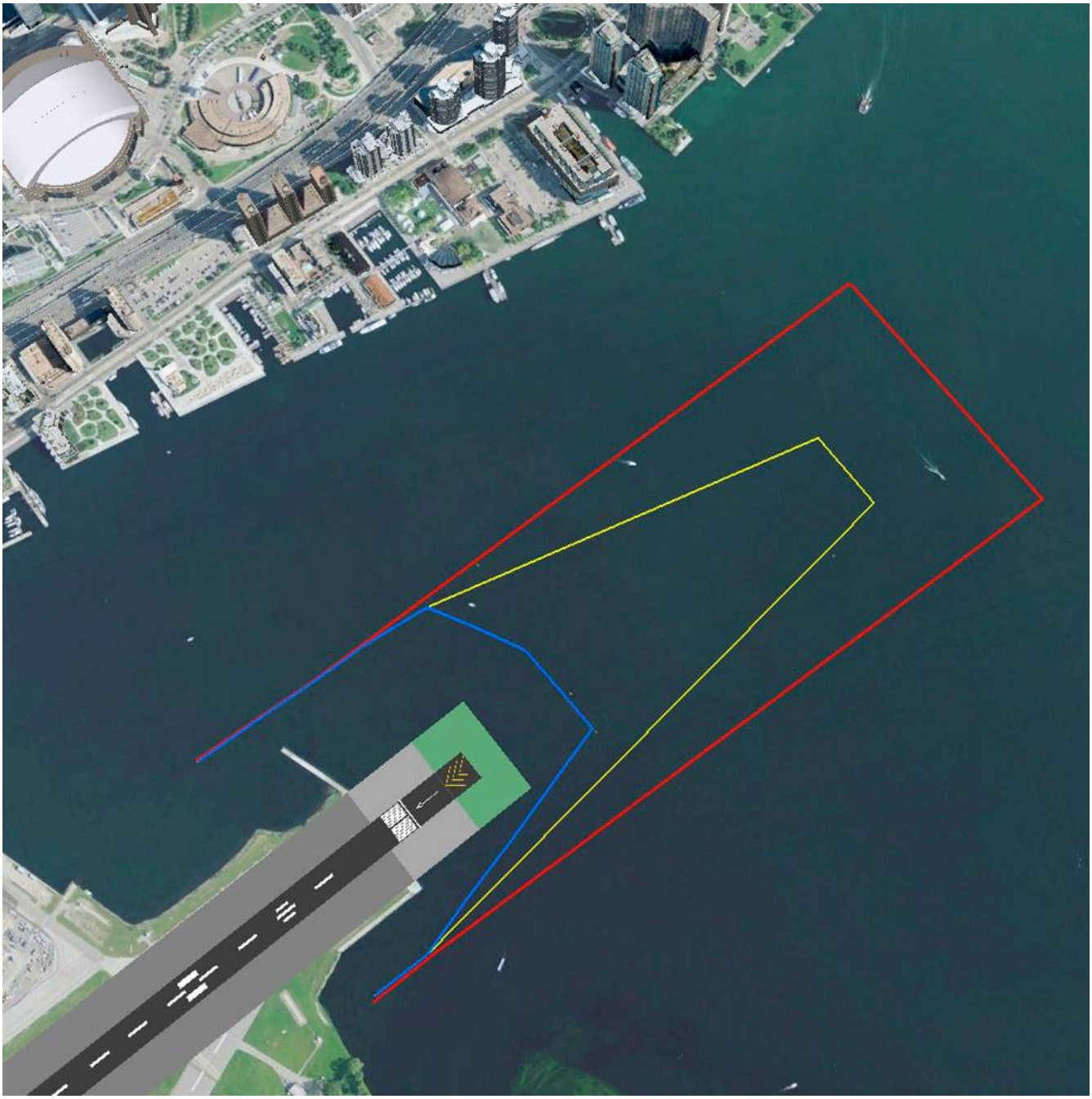
7.2 Precision Approach Based MEZ (assumes SSALR Lighting)

For the precision approaches, even larger MEZ's are created. For the west end of the airport the MEZ mapped as below:



The MEZ based on lighting reaches a point nearly due south of the end of the Sunken Ships Promenade. There is enough room to sail and manoeuvre around this MEZ. However, examining the one created by the OLS, the Western Gap is completely cut off.

To the east we have:



Now the lighting MEZ goes to York St. and York Quay. The OLS based MEZ goes all the way to Harbour Square and the ferry docks. This would really close up the Inner Harbour.

7.3 Conclusions on MEZ

Our MEZ design has not considered jet blast (from both take-off and taxing), overruns, undershoots, veer-offs etc.

The proposed Runway End Safety Area (RESA) and runway strip (paved area at the end of a runway strong enough for taxiing but not for landings) do not remove the need for an expanded or moved MEZ. Aircraft still run the risk, especially with Canadian lakeside weather, of sliding off the ends of runways. It should be noted that the proposed 90 m RESA in Porter's 168 m extension proposal is the bare minimum accepted by Transport Canada.

Transport Canada's guidelines and recommendations are derived from the ICAO's Annex 14, which can be summarized as:

> *RESA SARPs were revised in 1999 when the then Recommended Practice of a 90 metre RESA was converted into a Standard. The current Requirement is that Code 3 and 4 runways have a RESA which extends a minimum of 90 metres beyond the runway strip and be a minimum of twice the width of the defined runway width. The additional Recommended Practice for these runway codes is that the RESA length is 240 metres or as near to this length as is practicable at a width equal to that of the graded strip. For Code 1 and 2 Runways, the Recommended Practice is for a RESA length of 120 metres with a width equal to the graded strip.*[22]

It would seem that to make the MEZ really effective for aircraft safety, it will, at the very least, need to be moved further out into the lake and harbour. The OLS distances are greater than the approach lighting distances and would presumably govern the MEZ.

The table below summarizes the relevant MEZ distances if TC **maximum slopes** are used for OLS.

	Current	**Non-Precision Approach with ODALS Lighting**	**Precision Approach with SSALR Lighting**
Lighting+ Buffer	n/a	510 m from extended threshold	770 m from extended threshold
Future OLS	n/a	780 m from extended threshold	960 m from extended threshold
MEZ Distance from future land end	n/a	630 m (assumes 150 m RESA and runway strip)	810 m (assumes 150 m RESA and runway strip)
MEZ distance from current land end	305 m	830 m (assumes 200 m land extension)	1010 m (assumes 200 m land extension)

[22] http://www.skybrary.aero/index.php/Runway_End_Safety_Area

This next table summarizes the relevant MEZ distances if TC **recommended slopes** are used for OLS.

	Current	Non-Precision Approach with ODALS Lighting	Precision Approach with SSALR Lighting
Lighting+ Buffer	n/a	510 m from extended threshold	770 m from extended threshold
Future OLS	n/a	960 m from extended threshold	1140 m from extended threshold
MEZ Distance from future land end	n/a	810 m (assumes 150 m RESA and runway strip)	990 m (assumes 150 m RESA and runway strip)
MEZ distance from current land end	305 m	1010 m (assumes 200 m land extension)	1190 m (assumes 200 m land extension)

If Transport Canada does not require an MEZ expansion, a full comprehensive rationale should be provided.

8. Impacts of New Navigation Technology

Some have suggested that new navigation technology systems will eliminate the need for reducing the height of buildings due to OLS, or eliminate the need for approach lighting systems. This will not be the case.

Systems such as Wide Area Augmentation Systems (WAAS) and Ground Based Augmentation Systems (GBAS)[23] and Required Navigation Performance (RNP)[24] are extremely useful augmentations to the crew's navigation tool kit, but they are not a replacement. TAO endorses the use of such systems as they enhance the efficiency of flying and increase safety, but they do not eliminate the need for a pilot looking out the window and flying manually.

Today, new aircraft continue to have analog back up instruments. Approach lighting, OLS etc. are a continuation of the necessary backups and redundancy that safe flight requires. The very recent expansion of runway 33L at Boston Logan also included a brand new 730 m approach lighting system.

[23] http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/hill/

[24] http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/afs400/afs470/rnp/ & https://www.aea.net/AvionicsNews/ANArchives/RNPJan08.pdf & http://www.navcanada.ca/EN/media/Publications/In%20the%20News/Rounding-The-Corners-EN.pdf

9. Conclusions

In the interests of safety in this busy part of Toronto, TAO strongly encourages Transport Canada and NAV Canada to follow mandated standards and specifications. In this case, our best estimates indicate that the expansion and introduction of jets will have very large impacts on recreational boating, tourism and residents in the vicinity of the airport. It will also impose changes on the Toronto Island ferry routes and could prevent the use of the Western Gap for lake shipping. Development in the Port lands may be adversely impacted. These impacts are large enough that the City of Toronto should say "no" to the expansion.

If Transport Canada, the City of Toronto and the Port Authority approve this expansion with exceptions from standards and specifications regarding safety, are they willing to take on the liability issues that go with it?

As cited in our earlier position paper, there are viable 21st century rail alternatives that should be utilized in lieu of BBTCA expansion, as many other countries have done.

Disclaimer

Transport Action Ontario (TAO) is a Canadian non-government organization advocating for sustainable transportation. This report was written by a non-professional TAO researcher with some experience in airport and aircraft operations. While best efforts were made to provide quality research and analysis, no data or content in this report is guaranteed to be accurate or representative, and is intended for information purposes only. No responsibility or liability will be borne by TAO under any circumstances for any consequences of any actions or decisions taken by any person using this report.

Dimensions are accurate within approximately 3 meters. Projection of maps is unknown. Datum is unknown. Open source software used to create 3D images, maps, models etc. [Google Earth, Trimble SketchUp, Scribble Maps, etc.]

Appendix A: The Bombardier CS100

	Metric	Imperial
Length	35 m	114.8 ft
Wingspan	35.1 m	115 ft
Tail Height	11.5 m	38 ft
Max Takeoff Weight (normal)	58 967 kg	130,000 lb
Max Takeoff Weight (urban)	53 060 kg	117,000 lb
Takeoff at Max Takeoff Weight(MTOW) (normal)	1463 m	4,800 ft
Takeoff at Max Takeoff Weight (MTOW) (urban)	1219 m	3,999 ft
Landing Field Length ~ Maximum Landing Weight (normal)	1356 m	4,449 ft
Landing Field Length ~ Maximum Landing Weight (urban)	1341m	4,400 ft

The urban mode is for short take-off and landing operations at certain airports, like London City Airport in the U.K.

Appendix B: Aircraft Classification

Aircraft Design Groups[25]

Category	Approach Speed (Knots)
A	< 91
B	91 - 120
C	121 - 140
D	141 -166
E	> 166

Aircraft Group Number[26]

Group Number	Tail Height (ft)	Wingspan (ft)
I	< 20	< 49
II	20 <= 30	49 <= 79
III	20 <= 45	79 <= 118
IV	45 <= 60	118 <= 171
V	60 <= 66	171 <= 214
V1	66 <= 80	214 <= 262

ICAO Aerodrome Reference Codes[27]

Code	Reference Field Length (m)	Code Letter	Wingspan (m)	Distance Between Edges of Main Landing Gear (m)
1	< 800	A	< 15	< 4.5
2	800 <= 1200	B	15 <= 25	4.5 <= 6
3	1200 <= 1800	C	24 <= 36	6 <= 9
4	> 1800	D	36 <= 52	9 <= 14
		E	52 <= 65	9 <= 14
		F	65 <= 80	14 <= 16

From the tables above we can calculate what class of aircraft the CS100 belongs to and from that information we can make inferences about what the future Island Airport will look like.

Aircraft Design Group

Bombardier hasn't published the design group for this aircraft, partly because the aircraft has only started its test flights (September 2013). Instead of just guessing at the class, TAO looked at other aircraft in the same size, weight and passenger caring range. To do this, the following aircraft certified for London City Airport[28] were used.

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25 Planning & Design of Airports, 5ed, Mc Graw Hill, 2010, pg 174
26 Planning & Design of Airports, 5ed, Mc Graw Hill, 2010, pg 175
27 Planning & Design of Airports, 5ed, Mc Graw Hill, 2010, pg 176
28 http://www.lcacc.org/aircraft/

Aircraft	Length (m)	Wingspan (m)	MTOW (t)	Takeoff MTOW (m)	FAA Design Group	Aircraft Approach Category	IACO Aerodrome Reference Code
Airbus A318	31.45	34.1	68	1828	III[29]	C	3C
Embraer E170	29.9	26	35.99	1644	III[30]	C	3C[31]
Embraer E190	36.24	28.72	47.79	2056	III	C	3C[32]
Bombardier CS100	35	35.1	58.97	1463			

As we can see the three known aircraft in this group are all in Aircraft Approach Category C, and baring some very good aerodynamic design the CS100 will also fall in this group.

The Airbiz report of May, 2013 assumes that the CS100 is in Aircraft Approach Category 'C' class for designing the airport.

29 http://www.airbus.com/fileadmin/media_gallery/files/tech_data/General_information/Airbus_ICAO-ARC_FAA-ADG_App-Cat-Feb2013.pdf

30 http://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5300_13A.pdf, page 222

31 http://www.embraercommercialaviation.com/AMPS/APM_170.pdf

32 http://www.embraercommercialaviation.com/AMPS/APM_190.pdf

Appendix C: Transport Canada TP 312E – Aerodrome Standards and Recommended Practices

Below are the details of the table (abridged) that was used to study and create the images detailing the Obstacle Limitation Surfaces. Copied from table 4-1, page 4-5:

Surface and Dimensions	Non-precision approach		Precision approach (Cat 1)	
Code Number	1 & 2	3	1 & 2	3 & 4
Outer Surface				
Height (m)	45	45	45	45
Radius (m)	4000	4000	4000	400
Take-off /Approach Surface				
Length of Inner Edge (m)	45	75	75	150
Distance from Threshold	60	60	60	60
Divergence [minimum each side] (%)	10	15	15	15
Length [minimum](m)	2500	3000	15000	1500
Slope [maximum](%)	3.33 (1:30)	2.5 (1:40)	2.5 (1:40)	2.0 (1:50)
Transition Surface Slope [maximum](%)	14.3 (1:7)	14.3 (1:7)	14.3 (1:7)	14.3% (1:7)

Runway 08-26 is defined by the IACO and Transport Canada as a category 2 runway. The runway will have to be considered a category 3 runway for the CS100.

Runway 08 is defined as instrument precision, and runway 26 is defined as instrument non-precision runway.[33]

It should be noted that this document does not provide any recommendation for clearances over marine traffic. It does have recommendations for land transportation corridors (clause 4.3.1.3):

Corridor	Clearance (m)	Actual Maximum Height of Vehicle
Road	4.3	4.5[34]
Railway	6	6.15[35]

It would seem that both heights are a bit low and need to be updated. The road clearance fails to consider street signage and lighting. The railway code fails to cover things like overhead electrification.

[33] Need Assessment Study Pickering Lands Final Report, The Greater Toronto Airpots Authority, March 2010, Section 5.3.1, pg. 50

[34] http://www.mto.gov.on.ca/english/trucks/oversize/guide.shtml#weight

[35] http://en.wikipedia.org/wiki/Loading_gauge#North_America

It should be noted that this document does not have a section on short take-off and landing airports, thus TAO assumed that this document applies to all airports.

Appendix D: Sailboat Calculations

The sail boat calculations were done in the following manner[36]:

> Selected sail boat types from the Toronto International Boat shows website[37], and some that are common around Toronto Harbour.
> Visited Mauri Pro Sailing[38] and found the dimensions for the selected boats. Mauri Pro Sailing provides the mast height but does not include the freeboard of the hull and deck. Since this is usually over a meter and the airport's runway is about 2 meters above the water lever I assumed the numbers would wash out.
> Found the height of the masts for the selected boats and averaged the result.
> For a 25 foot (7.6 m) boat, it works out to:
>
> > Mast height of 9.6 m, round up to 10 m.
> > Multiply by slope of 1:40 and add 60 m away from the runway threshold:
> >
> > Distance = 40 * 10 + 60 = 460 m

Places us 460 m away from the runway threshold for an average 25 foot sail boat.

Toronto Ferries

For Toronto's larger ferries, like the Thomas Rennie, assume 1 m for freeboard and decks of 3 m high and 3 decks to the top of the bridge, for a total height of approximately 10 m.

[36] Transport Canada, TP 312E, Table 4.1, page 4-1
[37] http://www.torontoboatshow.com/splash.php, selected boats C&C, Hunter, Tartan, Beneteau
[38] http://www.mauriprosailing.com/us/Rig-Dimensions.html

Appendix E: Glide Slopes and Obstacle Limitation Surfaces

When reading through the various reports published on BBTCA and discussing this issue, TAO has continually found that people are confused about glide slopes and Obstacle Limitation Surfaces.

They are:

Obstacle Limitation Surface (OLS)[39]. A surface that establishes the limit to which Obstacles may project into the airspace associated with an aerodrome so that aircraft operations at the aerodrome may be conducted safely. Obstacle limitation surfaces consist of the following:

Outer surface. A surface located in a horizontal plane above an aerodrome and its environs.

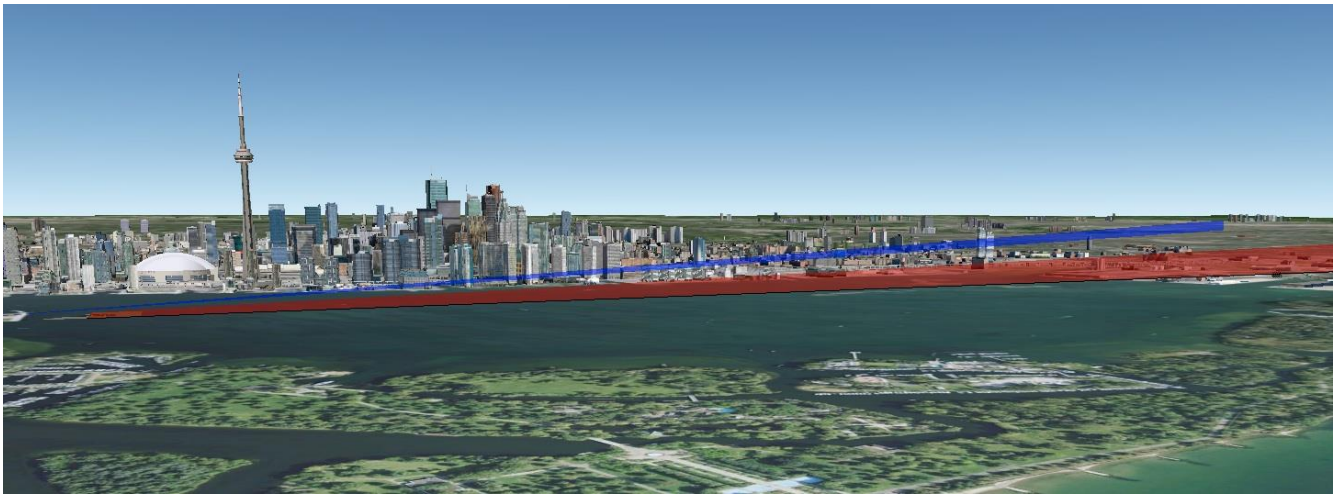
Take-off/Approach surface. An inclined plane beyond the end of a runway and preceding the threshold of a runway.

Transitional surface. A complex surface along the side of the strip and part of the side of the approach surface, that slopes upwards and outwards to the outer surface, when provided.

Glide Slope[40]: the proper path of descent for an aircraft preparing to land; especially such a path indicated by a radio beam.

The glide slope for most commercial jet aircraft is a 3 degrees slope from the horizontal. Obstacle Limitation Surfaces are defined by the runway's code type and type of approach. See Appendix C for details. Obstacle Limitation Surfaces are measured as rise:run or percentage slopes.

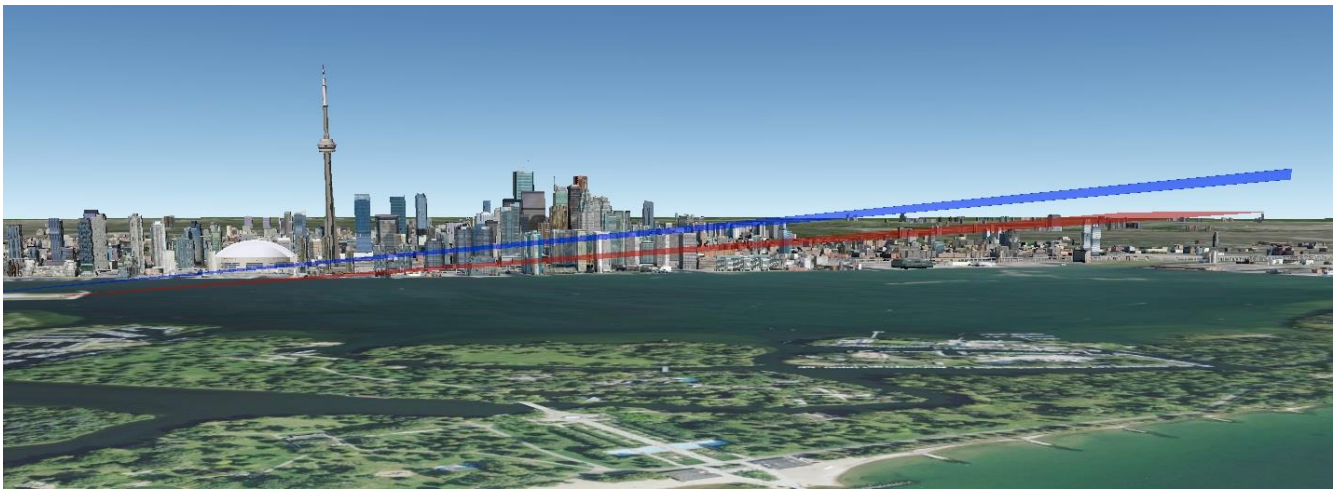
An example of the Transport Canada mandated OLS and glide slopes for BBTCA using a precision approach for a Code 3 runway looks like this:



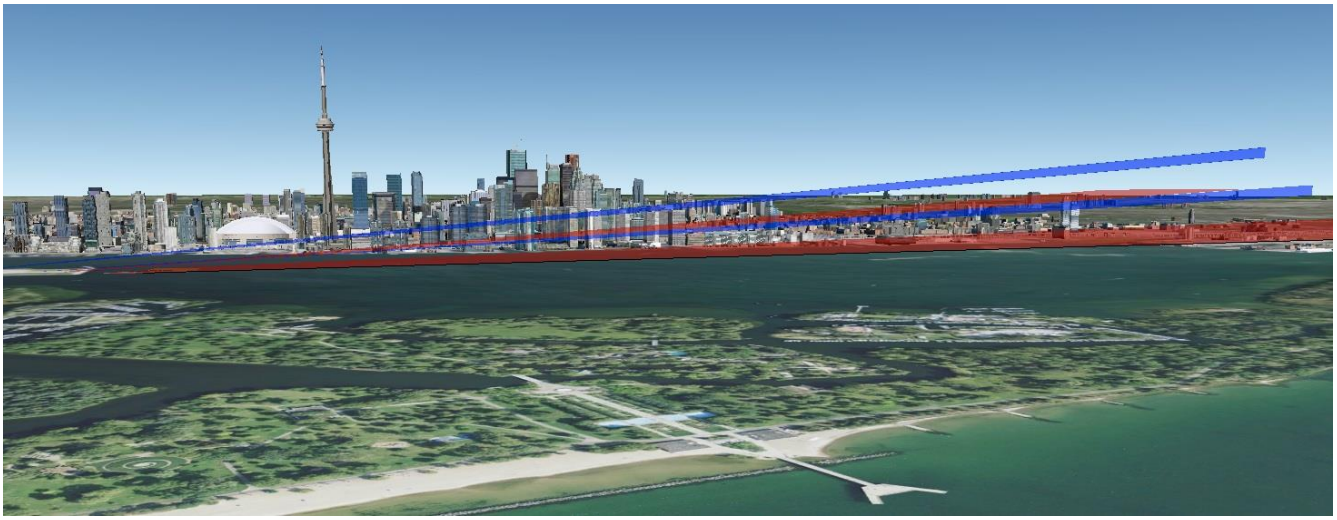
[39] http://www.tc.gc.ca/eng/civilaviation/publications/tp312-chapter1-1-1-4793.htm
[40] http://www.merriam-webster.com/dictionary/glide%20slope

The glide slope is set to 3 degrees and the OLS is at 2.5%.

BBTCA has special slopes and they look like:



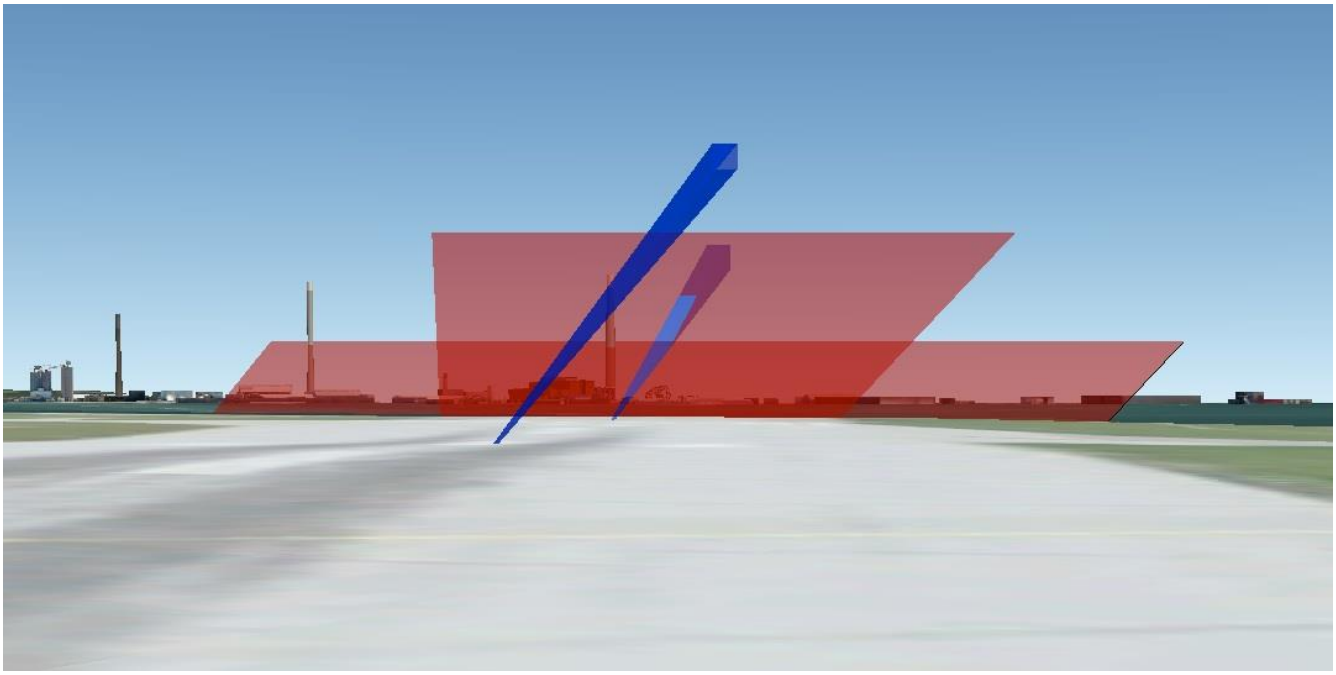
This is an OLS slope of 6.38% on the east end, and a glide slope of 4.8 degrees[41].
Superimposed on each other:



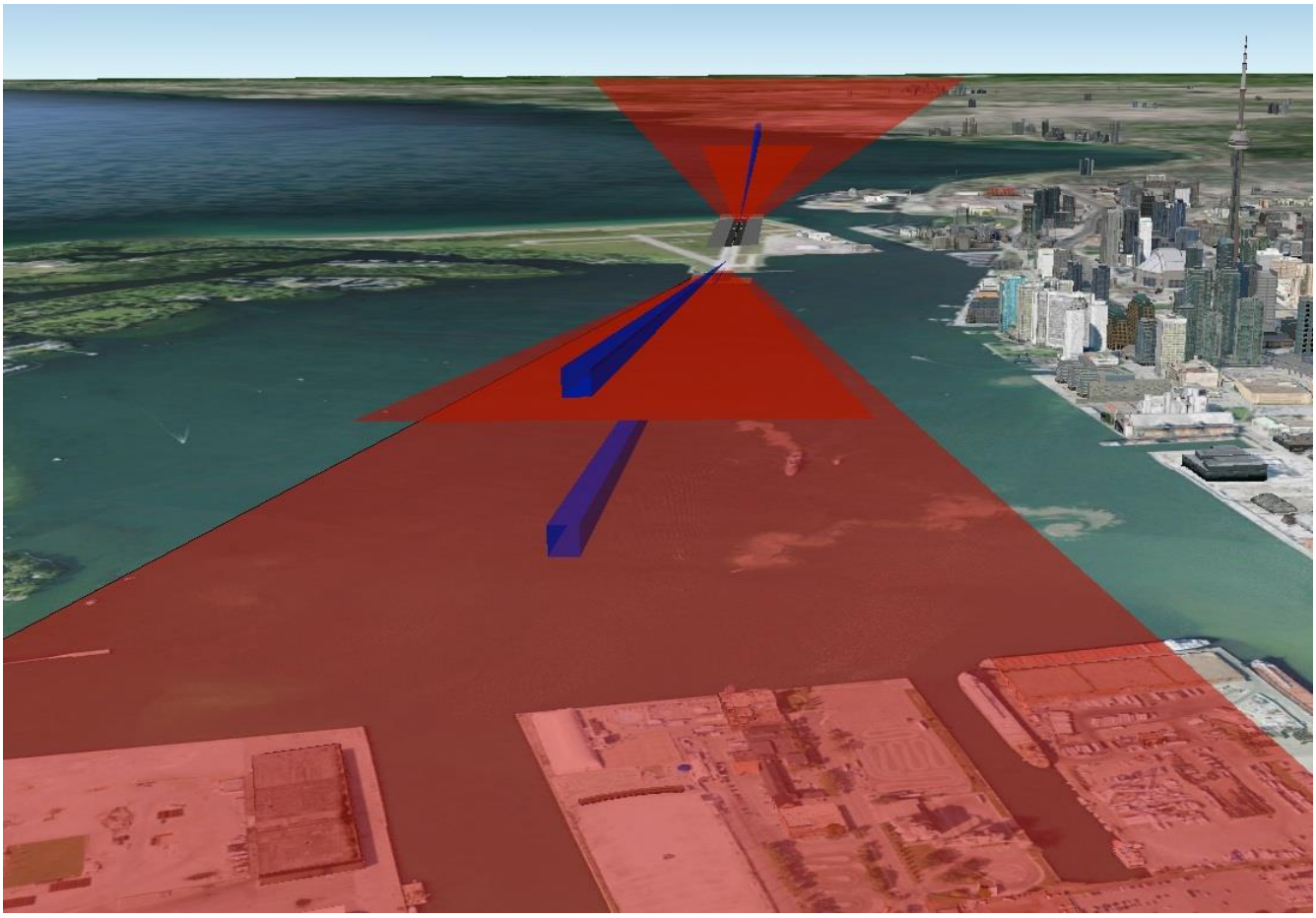
As one can see the current BBTCA slope is much steeper than the standard. Pilots generally like to fly the 3 degree slope. Observations over the winter of 2013/2014 indicate that many of Porter's pilots fly much closer to the 3 degree line than the 4.8 degree slope.

To further understanding, here are some other views of the two glide slopes and OLS surfaces:

[41] Canada Air Pilot, Billy Bishop Toronto City Airport, CYTZ, 5 April 2012, NAV Canada



Above, looking from the east end of runway 08-26 looking east.



This image shows slopes from near the end of the 3000 m long modelled glide slopes. The upper one is BBTCA existing situation and the lower is Transport Canada's Code 3 precision approach.