Don Mouth Naturalization And
Port Lands Flood Protection Project

Appendix L

Don Narrows

Toronto and Region Conservation for The Living City

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1. The Don Narrows

1.1 Background

The “Don Narrows” are located near the mouth of the Don River, extending approximately 2,150 metres from Riverdale Park in the north to Lake Shore Boulevard in the south, where the Don River enters the Keating Channel. The Narrows make up the northern extent of the Project Study Area (**Figure 2-3**, **Chapter 2**). Prior to the late 1880s, this section of the Don River was a highly sinuous, low gradient river channel which possessed a bed load primarily of sands and silts. During the late 1880s this portion of the Don River was straightened and widened using a series of cedar piles inserted into the ground vertically side-by-side to create new hardened river banks. These piles were installed to allow for the establishment of heavy industry along the west bank of the river, including shipping by water from the lake and by land via rail (which would later become the Belleville and Bala Subdivisions), and to mitigate flood risk in the area. As we would expect with today’s understanding of hydrology, these modifications to the river did nothing to minimize the impacts of heavy sand/silt loads from upstream or flood risk.

From the late 1940s to mid 1950s, the wooden piles were replaced by steel sheet piles to facilitate the construction of the Don Valley Parkway (DVP) on the east bank of the river, as well as up to Queen St. on the west bank. Remnants of the original cedar posts can still be seen in the “Narrows”. During this period and into the mid and late 1960s, sediment loads increased significantly (up to four times the current sediment transport rates) to the Don Narrows and Keating Channel as a result of rapid urban development in the Don Watershed which lacked any sort of sediment management controls at the time, and as a result of the construction of the DVP. From the 1970s to the 1980s, sediment loads in the lower Don began to return to loads similar to those experienced prior to the construction of the DVP. As part of the early urban development starting in the late 1800s, numerous outfalls were installed along the Don Narrows containing stormwater and combined sanitary/stormwater discharges.

Today the Don Narrows (**Figure 1-1**) are both bisected perpendicularly and bounded in parallel by transportation and utility infrastructure (**Table 1-1**). Currently, the DVP, Don Roadway, Bala/Belleville Subdivision, Lower Don Trail, and Bayview Avenue are impacted by flooding in localized areas as frequently as the two-year flood event (**Figure 1-2**).

Figure 1-1 Don Narrows (2002) Aerial Photograph

Figure 1-2 HEC-RAS Flood Lines Don Narrows (2 Year Flood Lines)

Table 1-1 Transportation and Utility Infrastructure within the Don Narrows

Location	Type of Infrastructure	Active?	Impacts or Impacted by Flood Levels
Bala Subdivision	Regional Railway (Bridge Crossing)	Yes	Yes
Bala/Belleville Subdivisions	Regional Railways (west bank of Don River)	Yes	Yes
Bayview Avenue	Regional Road (west bank of Don River)	Yes	Yes
Don Roadway	Local Road (east bank Don River connecting DVP to Lake Shore Boulevard)	Yes	Yes
Don Valley Parkway (DVP)	Regional Highway (east bank of Don River)	Yes	Yes
Lower Don Trail	Regional Trail (west bank of Don River)	Yes	Yes
Dundas Street	Local Road (Bridge Crossing)	Yes	No
	Sanitary Siphon (Underground crossing of Don River)	Yes – Hi-Level Interceptor	No, unless exposed during severe scour event
Eastern Avenue	Local Road (Bridge Crossing)	Yes	No
Eastern Avenue/ Richmond Street	Regional Road (Exit ramps to Richmond St & Eastern Ave)	Yes	Yes
Gardiner Expressway	Regional Highway (Bridge Crossing)	Yes	Yes (Pier Supports, rather than soffit elevation)
Gardiner Expressway/ DVP Ramps	Regional Highway (Access/exit ramps)	Yes	Yes
Gerrard Street	Local Road (Bridge Crossing)	Yes	No
	Sanitary Siphon (Underground crossing of Don River)	Yes – Mid-Toronto Interceptor	No, unless exposed during severe scour event
Kingston Subdivision	National and Regional Railway Linkages (Bridge Crossing)	Yes	Yes
Lake Shore Boulevard	Regional Road (Bridge Crossing – includes fibre optic, municipal and energy utilities)	Yes	Yes
	Harbour Lead Spur (Bridge Crossing)	Yes	Yes
	Overhead High Voltage Transmission Lines (Crosses over Don River)	Yes	No
Martin Goodman Trail	Regional Trail (Bridge Crossing)	Yes	Yes
Old Eastern Avenue Bridge	Local Road (Bridge Crossing)	No (Historical Bailey Bridge)	Yes
Old Eastern Avenue Utility Bridge	Conduit for Regional Natural Gas Line, watermain, and fibre optic lines	Yes	Yes
	Sanitary Siphon (Underground crossing of Don River)	Yes – for Low Level Interceptor	No, unless exposed during severe scour event
Queen Street	Local Road (Bridge Crossing)	Yes	No
Riverdale Park	Pedestrian Bridge Crossing	Yes	No
South of Kingston Subdivision Crossing	Conduit for High Voltage Cables (Bridge Crossing)	Yes	Yes (due to channel dimensions, rather than soffit elevation)

Given the extensive infrastructure along, over and under the Don Narrows area, the river is almost entirely disconnected from its floodplain from an ecological perspective, with only a narrow ribbon of vegetation observed along the top of the west bank of the river between the top of bank and the Bala/Belleville Subdivisions. This area consists primarily of invasive species such as Japanese knotweed, dog-strangling vine, Manitoba maple and crack willow, although there have been extensive efforts by local community groups led by the Task Force to Bring Back the Don, City Parks, and TRCA/Waterfront Toronto to reintroduce native vegetation to this area. Localized sediment deposition within the sheet pile banks of the Don Narrows has also allowed for the establishment of vegetation within the hardened channel confines on a local and discontinuous basis along the east bank of the river. In some areas,

the sheet pile walls have been removed and replaced with bioengineered banks to provide some improvement to the riparian areas.

Bathymetric surveys conducted in the lower Don River by TRCA in 2003 have provided evidence of the development of a thalweg (submerged low flow channel form) with some low-lying point bar development, particularly in the northerly reach of the Don Narrows. These point bars consist primarily of sand and fine gravels. However, in general, bed structure throughout the Don Narrows are relatively uniform and provides limited habitat potential for use by fish and other aquatic fauna species. Hydraulically, the river is very flashy in nature, although most of the time the hydraulic conditions are determined primarily by water levels in Lake Ontario up to Gerrard Street and beyond. Water quality in this area is typically poor with elevated turbidity, significant sediment deposition, stormsewer discharges, and frequent combined sewer overflows. The discontinuous thin band of riparian vegetation provides minimal cover for fish or other wildlife within the Don Narrows.

As depicted in **Section 3.2.4.2** (of **Chapter 3** of the DMNP EA), fish surveys conducted in the Don Narrows depict a fish community that is degraded and consists primarily of tolerant fish species, including invasive, introduced and pollution-tolerant fish species. A total of 24 fish species were observed utilizing the Don Narrows between 1991 and 2005 from May to November (**Table 3-13**, **Chapter 3**), with only 8 to 16 species observed on any given year. This is in sharp contrast to the average number of fish species typically found in other north shore rivers along Lake Ontario, which is in the order of 25 to 27 species (TRCA 2004b).

In the Don Narrows, the most common species captured every year were White Sucker (*Catostomus commersoni*), Emerald Shiner (*Notropis atherinoides*) and Spottail Shiner (*Notropis hudsonius*). These three species accounted for 88% of the fish community in spring, summer and fall. Other high order piscivorous species such as Northern Pike (*Esox lucius*) and Walleye (*Sander vitreum*) were also captured during the survey period, albeit in low numbers, but indicate that trophic interactions between predator and prey within the degraded system may be occurring. Recent fish surveys have also indicated significant localized increases in fish abundance and diversity in an area where boulders were placed in the vicinity of the Kingston Subdivision crossing of the Don River.

These boulders were placed by the TRCA as part of Waterfront Toronto's waterfront revitalization flood protection works for the West Don Lands. The implications of these findings are that similar increases in habitat structure in the Don Narrows could produce significant increases in fish usage in this critical transition area between the Don Watershed and Lake Ontario. Turtles and waterfowl have also been seen loafing on these boulders by TRCA staff, almost immediately following construction. Further details on fish communities can be found in Chapter 3 of the DMNP EA.

The Don Narrows north of the Kingston Subdivision crossing are not formally part of Waterfront Toronto's plans for revitalizing the Toronto Waterfront. However, early on it was agreed that the Don Narrows should be added to the DMNP EA. This decision was not based on a desire to develop a preferred alternative that will be implemented as part of the Waterfront Revitalization activities, but rather to develop a "toolbox" of habitat enhancement approaches that could be implemented to improve aquatic habitat in the Don Narrows by the TRCA and other agencies when specific opportunities arise through other planning and operating processes.

1.2 Objective

As part of the DMNP EA, TRCA and the AECOM consultant team examined opportunities to improve the instream habitat conditions for the Don Narrows north of the elevated railway crossing for the Kingston Subdivision. Areas south of the Kingston Subdivision within the Project Study Area have already been identified for flood conveyance and sediment/debris management purposes.

Further, a range of possible habitat improvements were identified during a community workshop held on May 24, 2008. These improvements considered ways of creating instream habitat structure and function between the east and west sheet pile banks of the river and ways of improving the narrow strip of riparian cover immediately along the river top of bank.

1.3 Potential Habitat Improvements

The range of habitat improvements developed by TRCA and the consultant team and originally presented at the May 24th community workshop can be divided into the following broader categories:

- Artificial Bed Structures
- Backwatered Wetland Areas
- Containerized Artificial Wetlands
- Long-term Replacement of Sheet piled Banks
- Continued Riparian Plantings - Community Stewardship

Workshop participants were also invited to suggest other habitat enhancement approaches that should be considered for the Don Narrows, which can be summarized in the following broad categories. It should be noted that the intent of the workshop was not to stimulate debate or agreement between participants, but rather to stimulate new ideas to be considered following the workshop:

- Adjust the trail
- Animal/wildlife corridor
- Parks/greenspace/wetlands
- Riverbanks
- Overall approach

These categories are summarized in **Table 1-2** and **Table 1-3**.

Table 1-2 Potential Habitat Improvements for the Don Narrows

Habitat Improvement	Description
Artificial Bed Structures *To increase the diversity of habitat structure for use by fish and other aquatic species, and to increase the variability in flow conditions and sediment transport within the Don Narrows.*	**Low and High Profile Estuary Hooks** • Estuary hooks are cobble and boulder placements in a "hook" configuration located along the base of vertical walls/banks. These are designed to deflect and concentrate flows, entrain sediments, encourage local establishment of vegetation, and provide small eddy pools for habitat and primary production. Spacing these estuary hooks on opposite banks in a staggered configuration simulates the function of alternating point bars within a channel. The high profile design has the stone above the water mark at baseflow conditions, while the low profile design remains submerged throughout the year. These structures must be developed in conjunction with a strong understanding of the hydraulic conditions within a project area. • The key habitat targets are to improve emergent, submergent and riparian vegetation, increase amount of area for primary production, increase the amount of essential habitat for cool and cold water species, improve forage opportunities for aquatic and terrestrial species, and add structure to improve near shore habitats.
	Artificial Point Bars • Artificially constructed alternating point bars generally provide the same function as the estuary hooks identified above. The primary difference is that the constructed point bars are in a "tear-drop" configuration along the base of a vertical wall/bank, instead of the "hook" appearance depicted by the Estuary Hooks. Like the Estuary Hooks, the artificial point bars can possess either a low or high profile, depending on the desired habitat enhancement benefits and local hydraulic conditions (i.e., if flooding is an issue, lower lying profiles would be preferred over high profiled structures). • The key habitat targets are essentially the same as the Estuary Hooks above. Where sedimentation loads are

	such that sediment deposition is anticipated to occur consistently within the "hook" area (essentially filling in the hook to create a point bar), the construction of artificial point bars may be the preferred approach to adding structure.
	Cobble – Boulder Pavements • In some instances, the hydraulic impacts of a proposed Estuary Hook or Artificial Point Bar may result in increased rates of flooding to adjacent infrastructure, such as the DVP or Bala/Belleville Subdivisions. Under such scenarios, it may be possible to still increase the diversity of habitat structure with only minor impacts on flood levels by excavating the existing sand bed to a certain depth and replacing the material with a veneer or pavement of cobbles and boulders across the bed. This is a technique more frequently used in coastal regions where past dredging activities have eliminated all large sized stones from the offshore zone. • The key habitat targets are to increase the amount of area for primary production, increase the amount of essential habitat for cool and cold water species, improve forage opportunities for aquatic and terrestrial species, and add structure to improve instream habitats. The key challenge with this approach is that in river systems with high sediment loads, this boulder pavement may be buried by sand and silts for extended periods in between larger flood events. In addition, in a low gradient, low flow velocity area (such as the Don Narrows), increasing the bed roughness with boulder pavements will likely produce less hydraulic diversity (and benefits ecologically) under baseflow conditions than those created by an artificial point bar or Estuary Hook.
	Longitudinal Rock Placements – Flow Vanes • The longitudinal placement of cobbles and boulders along a length of dockwall appears similar to the Estuary Hooks. However, this approach is more typical for extending the life of aging dockwalls by reinforcing or propping up these structures, or for increasing local flow velocities to discourage sediment deposition (in the case of rock vanes). The added benefit of these engineering techniques is that much needed structure is provided for fish habitat along the base of vertical walls. These rock placements are not typically designed to simulate nor create a more sinuous flow pattern. The benefit of these placements is that they typically cover a more extensive area of dockwall with coarse material than locally placed Estuary Hooks or point bars.
Backwatered Wetland Areas	• This habitat enhancement approach identifies where the existing channel configuration or existing instream structures (such as the remnants of the original wooden piles used to create the Don Narrows in the 1880s) have allowed for the accumulation of sediment within the confines of the sheet pile walls. The intent is then to excavate those accumulated materials and create a series of small protected emergent and submergent wetland pockets within the confines of the sheet pile walls. Small connecting channels between the river and wetland pockets would be created. • The key habitat targets are to improve emergent, submergent and riparian vegetation, increase amount of area for primary production, increase the amount of essential habitat for cool and cold water species, improve forage opportunities for aquatic and terrestrial species, and add structure to improve near shore habitats. The primary disadvantage of this approach relates to the fact that these areas are located in sediment deposition zones. As such, unless regular maintenance is undertaken (i.e., dredging), these pocket wetlands will likely fill up with sediment in a relatively short period of time.
Containerized Artificial Wetlands *These habitat enhancement approaches build upon techniques used in stormwater management ponds and canals.*	**Floating Wetland Platforms** • This form of habitat enhancement approach provides for the creation of floating mats of wetland vegetation suspended on the surface of the water by engineered floats and anchored to the river bed. Vegetation is planted on the surface of the floats in a porous medium allowing for the roots of the plants to extend directly into the water column to extract moisture and nutrients. The floating mats also provide overhead and submergent cover for fish and other aquatic species. • These structures have been applied in stormwater ponds and canals where flows can be controlled or eliminated. As such, the major disadvantage of these structures in a river environment would be their exposure to damage during the frequent flood events and due to the large volumes of floating debris and/or ice that makes its way downstream every year.
	Wetland Planters • Given the primary disadvantage of the floating wetland platforms above, the level of exposure to floods, debris and ice, TRCA staff suggested the construction of what would essentially be large planter boxes with open bottoms to be attached to the base of vertical sheet pile walls. Inside these boxes, floating wetland platforms could be secured to the planter boxes. The floating wetland platforms would have all the ecological benefits identified in the section above, but would an extra level of protection from floating debris, ice and flood flows.
Long-term Replacement of Sheet piled Banks	• This habitat enhancement approach refers mainly to an operational policy statement whereby TRCA will encourage other parties to explore alternative forms of bank protection when major maintenance/replacement

	works are being considered for the existing aging sheet pile wall sections within the Don Narrows. The City of Toronto is the primary responsible agency for maintaining the upkeep of the existing sheet pile walls. As such, TRCA will identify areas where it may be viable to consider more ecologically friendly approaches for stabilizing banks along the DVP and Lower Don Trail.
Continued Riparian Plantings - Community Stewardship	• This habitat enhancement approach reflects the existing conditions whereby Non-Governmental Agencies (NGOs) such as the Task Force to Bring Back the Don will partner with TRCA, City Parks and other members of the public to conduct native plantings and invasive species removal along the west bank of the Don River between the top of bank and the Bala/Belleville Subdivision. These activities provide some necessary green space in an otherwise infrastructure intensive environment, and provide some cover for terrestrial species such as birds and small mammals. Though highly degraded, this is the corridor linking Lake Ontario Park with Riverdale Park and the rest of the Don Watershed.

Table 1-3 Community Recommended Potential Habitat Improvements for the Don Narrows

Habitat Improvement	Description
Adjust the Trail (variation of long-term replacement of sheet pile walls)	This option was raised in one form or another by many of the participants as being a desirable consideration. In particular it was recommended that the real estate underneath the path could be shared with the river to realize additional aquatic and riparian habitat gains in the Don Narrows. This would involve the excavation under the trail to create new river and wetland habitats. The trail would then be rebuilt with a cantilever or piers to elevate the trail over the created habitats. Variations of this idea included: • Meandering the trail and the river bank in the area using elevated boardwalks, • Entirely reconstructing the western bank between the existing river and the railway tracks to redefine the function and appearance of the river and trail in this area, and • Moving the fence westward to occupy one of the railway right of ways to expand the trail system to create a bike-only trail.
Animal/Wildlife Corridor	A variation to the above was suggested to modify the eastern bank of the Don Narrows to create a wildlife-only corridor between the Don River and the DVP, connecting Lake Ontario Park with the rest of the Don Watershed. Wildlife-only bridges over the Don were also suggested to provide east-west connections for wildlife to and from the east bank wildlife corridor, as were culverts under the DVP, Bala/Belleville Subdivisions and Bayview to allow for water from the Don to connect to wetlands that could be constructed in the east and west Riverdale Park and at 777 Dundas Street East.
Parks/Greenspace/ Wetlands	Enclosed are some site specific recommendations for enhancing habitats within the Don Narrows not addressed by earlier considerations: • Do not allow lights to be installed along the Don Narrows – disturbing for wildlife at night, and • Establish more local stewardship for the area to maintain and enhance the area
Riverbanks (variation of long-term replacement of sheet pile walls)	The workshop participants reached a consensus that consideration be given to the idea of a long-term program of replacement of sheet pile walls with more functional bank stabilization materials such as rock. Sheet piles could either be removed and replaced, or simply buried by rock and large woody placements (estuary hooks, point bars, cabled logs, etc). One innovative suggestion was that the Lower Don Trail and west bank area be lowered significantly to provide more ecological connection between the river and floodplain, while at the same time, providing more hydraulic conveyance for the area. A new line of sheet pile would be required to the west of the trail to protect the Bala/Belleville Subdivision from scouring.
Overall Approach	This provided the widest divergence of opinion between workshop participants. Opinions ranged from an intensive habitat enhancement management approach (i.e., trail expansion, bank modifications, bioengineering, green walls, floating ponds, etc) to a “hands off” approach (i.e., the Don Narrows has been slowly improving on its own, allow it to proceed naturally).

1.4 Technical Criteria for Habitat Improvements

As part of the presentation on May 29, 2008, TRCA identified the following technical criteria to be used to select or reject potential habitat improvements. In general, potential improvements:

- Cannot increase the frequency of flooding to the DVP, Bayview Avenue, Bala/Belleville Subdivision and Lower Don Trail;
- Cannot increase the risk of failure to transportation and utility infrastructure adjacent to the Don Narrows;
- Must continue to accommodate trail users currently using the Lower Don Trail; and
- Must be low maintenance, meaning:
    - Resilient under the "normal" range of flows and sediment transport conditions (~35,000 to 40,000 m3/yr); and
    - Does not significantly increase the amount of garbage and debris accumulation within the Don Narrows.

1.5 Technical Review of Potential Habitat Improvements

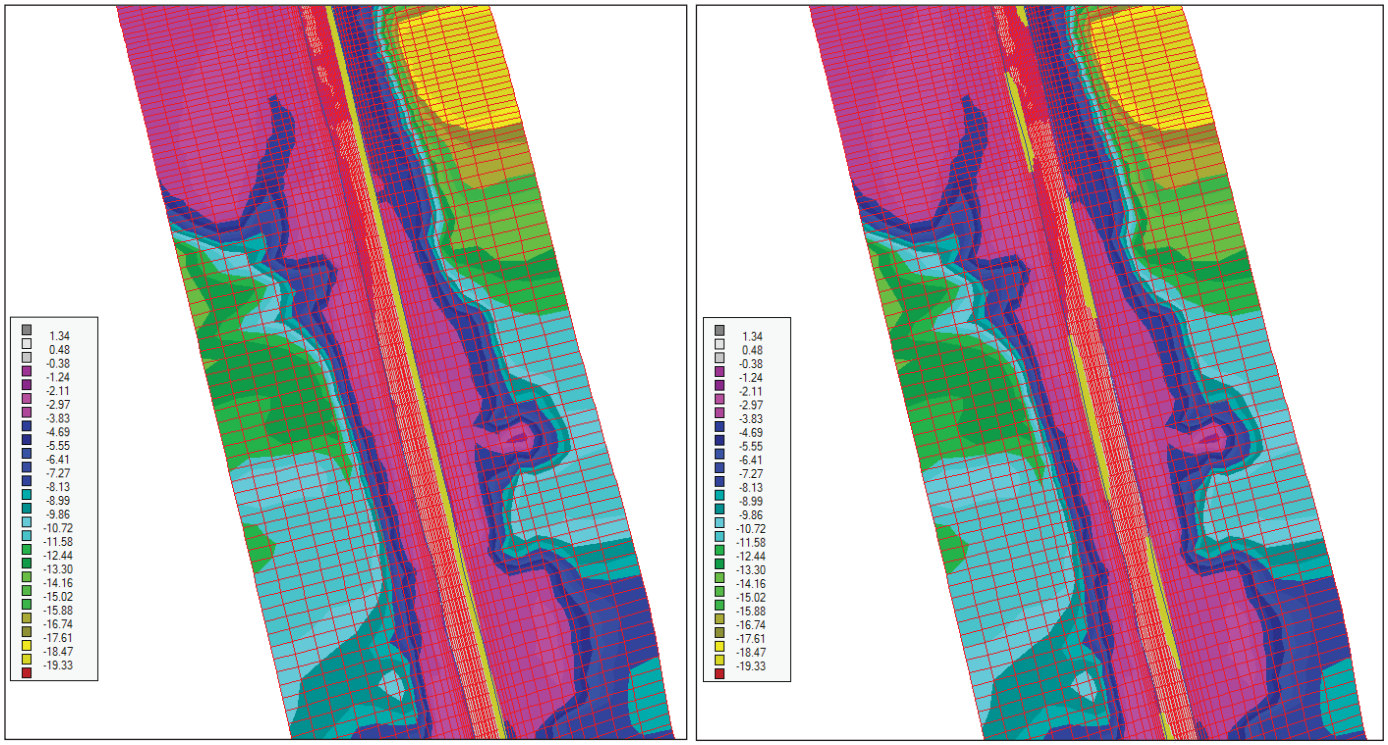
On June 22, 2009, a technical review workshop was held with TRCA and Waterfront Toronto staff and consultants from the AECOM team. Staff from Toronto Water and Toronto Parks, Forestry and Recreation were also invited to participate. The intent of the workshop was to:

- Present the intent of the Don Narrows Habitat Enhancement component of the DMNP EA;
- Present the range of habitat improvements originally presented at the May 29, 2008 public workshop;
- Present the results of the May 29, 2008 workshop;
- Present the results of preliminary hydraulic modelling runs for the Don Narrows up to the 100-year flood event showing the existing hydraulic conditions and the resulting hydraulic impacts on water levels as a result of two different bed structure orientation scenarios for the Don Narrows;
- Present the results of recent discussions led by Toronto Water, through Aquatic Habitat Toronto, to develop standardized habitat and species targets for the lower Don, and summarize Department of Fisheries and Oceans (DFO's) efforts to reverse engineer their Defensible Methods Model for use to optimize the functionality of created habitats for targeted species;
- Review and eliminate those habitat improvements deemed not viable for further consideration; and
- Devise an approach that will meet the habitat targets for the Don Narrows.

1.5.1 Preliminary Hydraulic Modelling Results

Three 2-D hydraulic model runs were conducted for the Don Narrows using the Delft Hydraulic Modelling Package. The initial model run was designed to establish the existing baseline hydraulic conditions from baseline levels to the 100-year event, for the Don Narrows from north of Riverdale Park to the Kingston Subdivision crossing of the river. The model depicted areas where water began to overtop the banks of the Don Narrows and flood the DVP, Lower Don Trail, the Bala/Belleville Subdivision, and Bayview Avenue.

Two other model runs were conducted to test the sensitivity of water level change along the Don Narrows using a similar reduction in conveyance capacity within the channel with different spatial orientations of the fill. The first scenario assumed a uniform reduction in channel capacity along the eastern bank by 10%. The second scenario also decreased the channel's capacity by 10% (**Figure 1-3**); however, this reduction was in the form of alternating point bars. Both scenarios were coded such that the infill remains dry under all flow conditions.



(a) Uniform Fill **(b) Alternating Fill**

Figure 1-3 Changes in channel dimensions in Don Narrows
a) Reduction of channel width by 10% along eastern bank denoted in straight line of light army green; b) 10% reduction of channel width in the form of alternating point bars denoted in light army green. These were established as "dry cells" in the model and as such did not truly function as point bars

Water levels were plotted for both infilling scenarios and compared against the existing conditions. **Figure 1-4** depicts water levels at the typical summer storm flow condition (42 centimetres). The results indicate that water levels increase by approximately 10 cm in the upper to mid sections of the Narrows under both infilling scenarios. At the mid to downstream end of the Narrows, there was essentially no change in water level resulting from the infilling, suggesting that the reduced hydraulic capacity in the lower portions were offset with a more rapid increase in flow velocities, likely due to the increase in head upstream. No flooding occurs onto the adjacent road and railways at this discharge level under any scenario.

Figure 1-5 depicts water levels at the 2 year flood event. Under this discharge, sections of Bayview and DVP are under water with the existing channel configuration. **Figure 1-5** also indicates that the alternating berms produced the greatest increase in flood levels, in the order of 25-30 centimetres in the upper reaches of the Narrows. From the middle to lower portions of the Narrows, the alternating infill scenario produced little to no change in water levels. For the uniform infill scenario, the upper third of the Narrows experienced minor increases in flood levels (between 5 and 10 centimetres). However, for the middle portions, water levels remained essentially the same with an actual lowering of water levels depicted in the lower third of the Narrows. It is likely that the uniform infill impedes flow less than would happen under the alternating infill scenario, and as such, creates higher flow velocities and lower water levels.

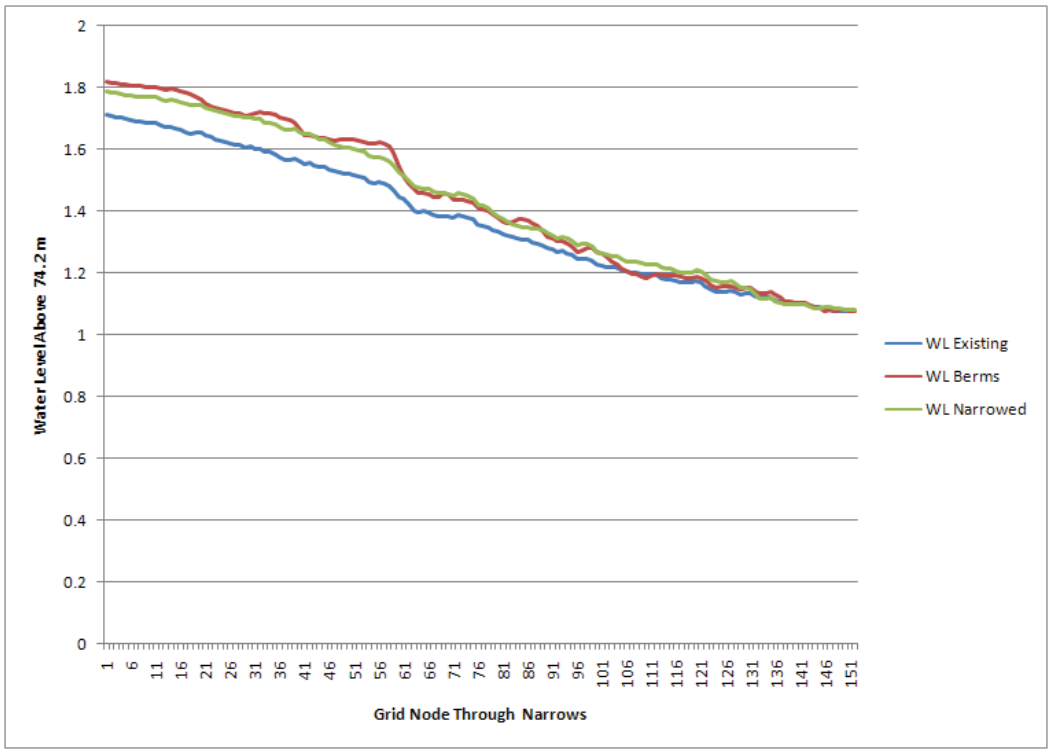


Figure 1-4 Comparing impacts of two channel infill scenarios on water levels in Don Narrows at 42cms (less than 1 year return period flows)

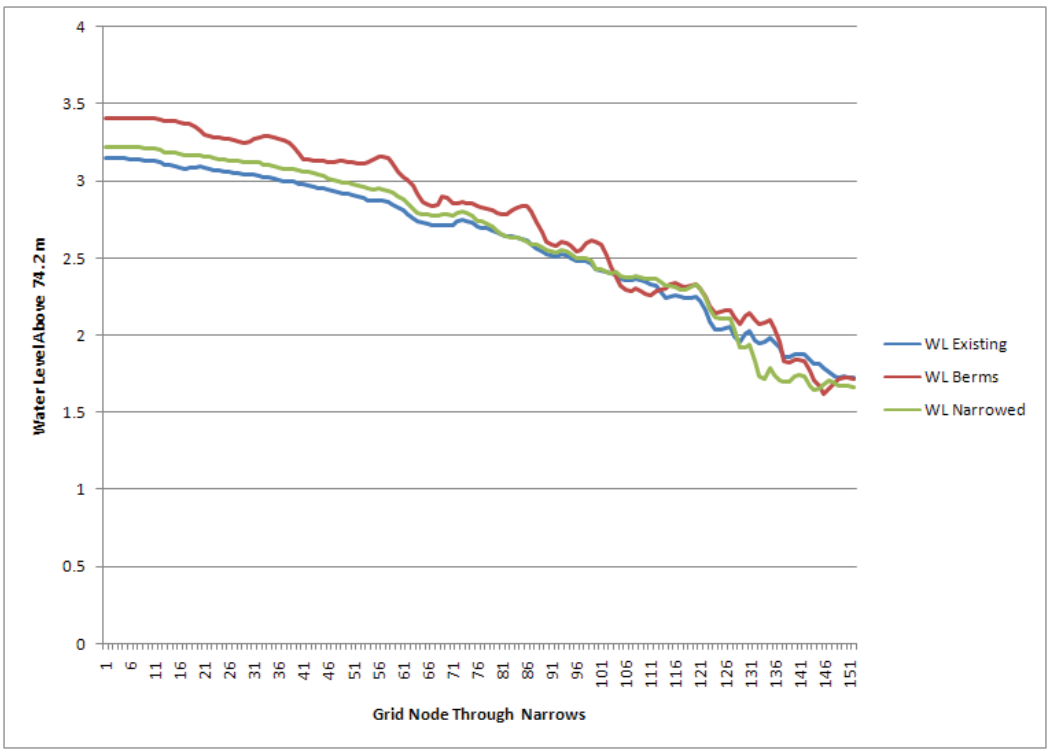


Figure 1-5 Comparing impacts of infill scenarios on water levels in Don Narrows at 2 year flood event

These results suggest that a 10% infilling of the Narrows will influence water levels during the most critical flood frequencies (between the ~0.5 to 2 year flood event) as it relates to impacts on infrastructure. These model results are more exaggerated than would occur in reality, as the infill was coded to remain dry during all flood levels, rather than gradually becoming submerged on the rising limb of the hydrograph. As such the coding eliminates more conveyance capacity from the channel than would be necessary to create fish habitat at base flow conditions. Allowing for the habitat structure infill to become submerged as water levels increase, should further reduce increases in water levels as compared to the existing condition. The results do also show that the location, size, and arrangement of structures in the Don Narrows can produce significant variability in changes in water level as compared to the existing conditions.

As a result of these preliminary findings, the original intent to create a general toolbox of habitat enhancement approaches to be implemented in an opportunistic way needs to be revisited. A more detailed concept should be developed outlining the approximate location, configuration and composition of any bed structures in the Don Narrows, in order to ensure the elimination of increased flood risk to adjacent transportation infrastructure.

1.5.2 Selecting Potential Habitat Improvements

Table 1-4 contains a list of the full range of potential habitat improvements on the left side of the table, and the five (5) key technical criteria across the top. The assessment was conducted as follows: Good (G) indicates that the anticipated impacts will be positive; Potential (P) indicates that if not planned properly, the impacts will be negative; and Negative (N) indicates the impacts will be negative, and as such this potential habitat improvement will not be considered further.

Table 1-4 Technical Assessment Results

Potential Habitat Improvements	TECHNICAL CRITERIA (G-Good, P-Potential Impact, N-Negative Impacts)					
	Increase Flooding	Increase Risk of Failure to Infrastructure	Continued Trail Use	Resilient to Flows/ Sediment Loads	Minimize Clean-up / Maintenance	Carry Forward?
Estuary Hooks	P	G	No Impact	P	P	Yes
Point Bars	P	G	No Impact	P	P	Yes
Cobble-Boulder Pavement	P	G	No Impact	P	P	Yes
Longitudinal Placements – Rock Vanes	P	No Impact	No Impact	P	P	Yes
Backwatered Areas	G	No Impact	No Impact	N	P	No
Floating Wetland Platforms	P	No Impact	No Impact	N	N	No
Wetland Planters	P	P	No Impact	P	N	No
Sheet pile Replacement	G	P	P	P	P	Yes
Continued Riparian Plantings – Stewardship	P (only at Regulatory Flood level)	P	P	P	P	Yes
Trail Adjustments – channel excavation & cantilevered / elevated trail sections	G	N	P	P	N	No
Animal / Wildlife Corridor	N	N	No Impact	No Impact	No Impact	No
Parks/Greenspace – no lighting & more stewardship	No Impact	No Impact	No Impact	No Impact	No Impact	Yes
Riverbanks – lower trail and west bank / new sheet piles along railway	G	N	P	P	P	No

1.5.2.1 Artificial Bed Structures

The overall results for estuary hooks, point bars, boulder pavements and rock vanes were essentially the same. In the absence of sound planning and detailed hydraulic modelling, each of these options would potentially create unacceptable increases in flood frequency in the area, with boulder pavements providing the least potential for this to occur. Conversely, the boulder pavements would be most prone to burial by sediment deposition, thereby, potentially eliminating any ecological benefits.

The high profile estuary hooks, high profile point bars and longitudinal rock placements (due to their higher influence in the water column and greater displacement of hydraulic capacity) pose the greatest potential for increasing flood risk. Conversely, these larger structures provide the greatest benefits for providing additional structural stability to aging dockwall infrastructure in the area.

Given the above, all of the artificial bed structure options may be considered for implementation in the Don Narrows. In sections where extra hydraulic conveyance or capacity is available within the channel, the larger profile structural elements may be considered if deemed desirable. In areas where flooding already occurs on a frequent basis, perhaps only boulder pavements can be considered, if any at all. In the areas between where flooding already occurs, low profile estuary hooks/point bars may be all that is considered appropriate. The placement of any of these structures must be confirmed by the Delft Hydraulic Model.

1.5.2.2 Backwatered Areas

The proposed excavation of existing sediment deposits within the confines of the Don Narrows to create wetland habitat would provide improvement for flood conveyance through the Don Narrows. However, given that these areas are located in active sediment deposition zones, regular dredging of these areas would be required to maintain the wetland areas. The need to regularly dredge these wetland areas negates the intended ecological benefits while resulting in high maintenance costs. As such, the establishment of backwatered areas has been eliminated from further consideration.

1.5.2.3 Containerized Wetlands

The proposed floating wetland platforms would be too exposed to damage due to flooding, debris and ice. Maintenance requirements would be high and ongoing. The ecological benefits would be questionable given the anticipated frequency of damage to the structure.

Conversely, the wetland planters provide an interesting and innovative way to protect these artificial floating platforms to an extent. The negative impacts of these planters are that they could potentially negatively impact flood conveyance, and would very likely impact the structural stability of the sheet pile walls to which they are fastened. However, despite the added protection provided by the planter walls, they would still require regular maintenance to avoid build up of sediment/debris following flood events and to ensure that the platforms remain floating.

Given the above maintenance considerations, these improvements have been eliminated from further consideration.

1.5.2.4 Sheet Pile Replacement

Replacement of the existing aging sheet pile is only potentially viable in locations where the DVP and other transportation infrastructure are not located in the immediate proximity of the top of bank. Similarly, only certain forms of alternative bank protection may be considered to ensure continued structural stability of the transportation infrastructure.

Orthophotos and ground-based photographs indicate that the only area where sheet pile walls are any significant distance from the west shoulder of the DVP is between the Kingston Subdivision crossing of the river and the old Eastern Avenue bailey bridge. The amount of separation between the top of sheet pile and the west side of the DVP is approximately 6 m. However, a review of the utility map for this area indicated that this area is underlain by three gas lines. As such, this area would not be considered for alternative bank protection measures.

Upon further analysis, sediment deposition was observed along the base of the east bank sheet pile wall from Riverdale Park to the Dundas Street crossing of the Don Narrows, and from the Queen Street crossing to the Eastern Avenue crossing of the Don Narrows. Sediment deposits ranged from 2 m to 6 m wide and resulted in the formation of a river bank ranging from approximately half to the entire the height of the sheet pile wall. This narrow zone of sediment deposition contains a mixture of mature trees (often leaning over the water), shrubs and herbaceous plant species. The existing condition hydraulic model is based on topographic surveys conducted by TRCA in 2003, which includes these bank formations within the sheet pile walls. As such, bank protection measures could be considered for the east bank of the Don Narrows from Riverdale Park to Dundas Street, and from Queen Street to Eastern Avenue with a new stable toe of bank located at the base of the existing bank formations, tapering back towards the DVP.

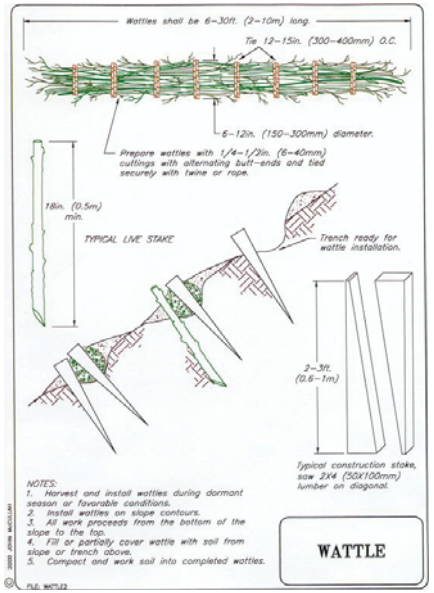
Given that these banks have formed and have become vegetated naturally, no modifications to their structure would be recommended unless these banks are to be disturbed as part of future major maintenance works on the existing sheet pile walls along the DVP. It would be at this time that TRCA would work with the City to consider bank protection forms that would accelerate the establishment of vegetation in this area. Some sample cross-sections of alternative bank protection works have been provided in **Figure 1-6** below.

On the west side of the river, very few opportunities are available to implement bank protection measures given the close proximity of the pedestrian path and railways in relation to the top of bank. Three scenarios for modifying the western sheet pile walls could be considered for areas north of the Low Level Interceptor crossing of the Don (sanitary siphons located at the Enbridge Gas Utility bridge crossing). These include:

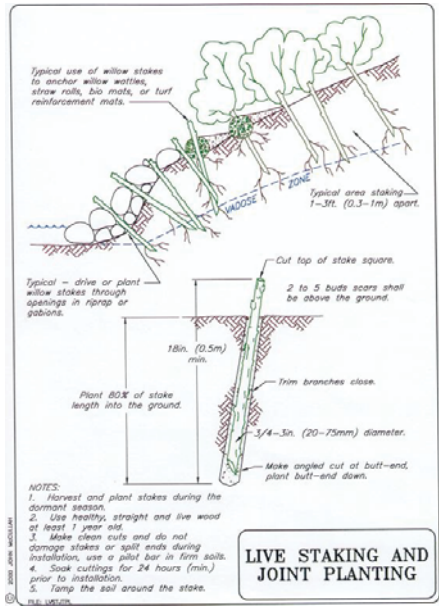
- Relocating the Lower Don Trail a few metres west to an abandoned rail right of way. Past discussions with both CN and GO Transit suggest that they are not interested in releasing their unoccupied right-of-way at this time. As such, this is not likely a viable consideration.
- Relocating the western sheet pile wall between the tracks and the Lower Don Trail. It may be possible to use alternative forms of bank protection in this area as well. Regardless of the bank protection measure utilized, this would allow for the lowering of the lands currently below the existing trail to create a more connected floodplain with the river. Then the trail could either:
    - Be constructed on an undulating boardwalk (cantilevered or on piers) above the lower, naturalized floodplain areas; or
    - Be constructed at grade on the lowered floodplain area.

Under both scenarios, a major influx of capital would be required to remove the existing sheet pile walls and install new bank protection measures to the west. Under the at-grade trail scenario, the Lower Don Trail, which currently experiences more than 1 million users a year, would be exposed to a significant increase in flood frequency, a scenario which would be undesirable for operation, maintenance and public safety. The constructed boardwalk scenario would likely be the most feasible approach for improving the ecological function along portions of the west bank, while maintaining the functionality of the existing trail. Unfortunately, the costs to construct and maintain a boardwalk (whether cantilever or on piers) would be very high as well.

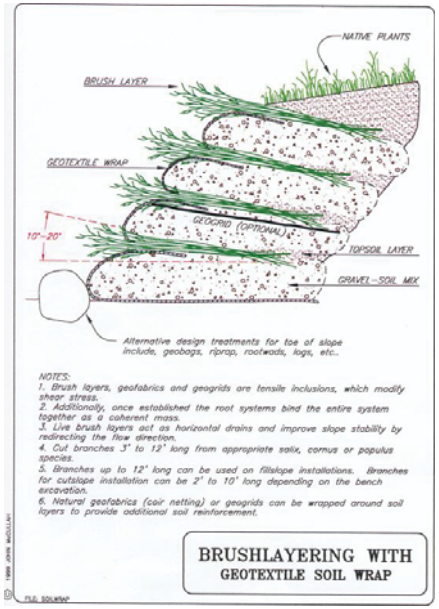
At this time, there is no source of funding available to proceed with such works along the west bank of the river.



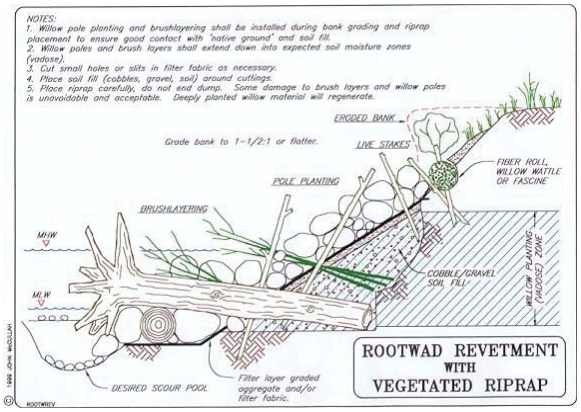
c) Willow Wattles



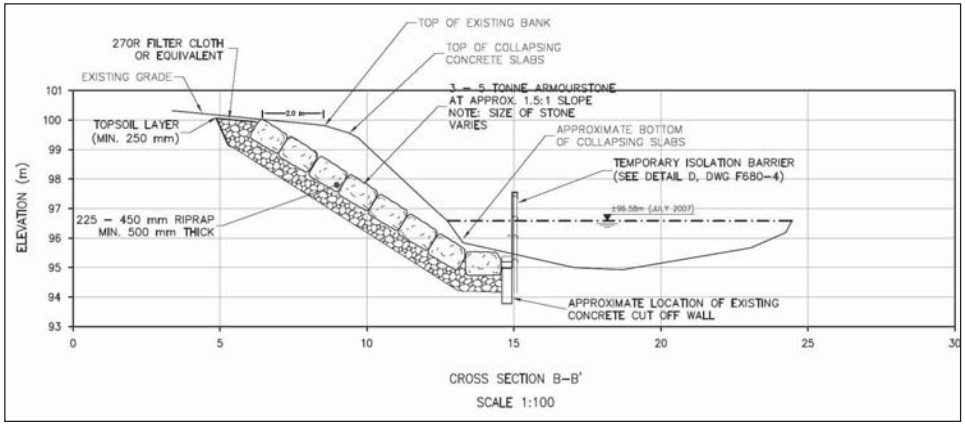
a) Live Staking and Joint Planting



b) Brushlayering with Soil Wrap



d) Rootwad Revetment with Vegetated Riprap



e) Sloped Armour Stone

Figure 1-6 Five examples of alternative bank protection works that could be considered for along the DVP

1.5.2.5 Continued Riparian Plantings

It is recommended that community stewardship involving riparian plantings, invasive control and stream clean-ups continue as part of the ongoing efforts to improve the Don River in this area. It should be noted that the planting of additional treed vegetation along the west bank of the river at the Don Landing (easternmost extent of the future Don River Park) be avoided due to flood conveyance issues and incompatibility with the underground and overhead high voltage cables.

Efforts by the Task Force to Bring Back the Don in partnership with TRCA, City of Toronto and others have contributed to the establishment of a narrow green corridor extending from the Keating Channel to the Don Watershed ravine system starting around Riverdale Park. These efforts play an important role in raising community awareness about Toronto's river systems and provide for the maintenance of this narrow corridor, which will play an even more important role following the establishment of the naturalized mouth of the Don River.

Opportunities for plantings in this area will remain on an as-required basis in response to the loss of vegetation following flood events or in areas where invasive plant species have gained a strong hold. Further naturalization in this area should be done in consultation with TRCA, Toronto Parks and Toronto Water to coordinate efforts and achieve multiple benefits where possible.

1.5.2.6 Wildlife Corridor

During the May 2008 community workshop, it was suggested that a wildlife corridor be established along the east bank of the Don River, connecting Lake Ontario with the Don Watershed ravine system. TRCA staff and consultants, in consultation with City staff, examined this suggestion and have decided that this would not be a desirable function in this area for the following reasons:

- Encouraging wildlife along a narrow strip of real estate between the river and the DVP would likely result in an unacceptable level of risk to motorists and the wildlife in this area;
- To provide a more functional corridor in this area that would mitigate the risk to motorists along the DVP would require a significant amount of fill in the Don River, which would result in increased flood risk to the DVP, railway, Lower Don Trail, and Bayview Avenue;
- A new river crossing would need to be constructed over the Don River or over the DVP in order to allow wildlife along the east bank of the river to access green space further upstream. This would result in significant costs, could further increase flood risk to the area, and it would be uncertain whether wildlife would use such an artificial crossing.

Given the above issues, this option has been eliminated from further consideration.

1.5.2.7 Parks / Green Space

Suggestions were raised during the May 2008 community workshop that were more related to the philosophy of the function of the Don Narrows green space than actual opportunities for enhancing the habitat. These suggestions included a desire to keep street lighting away from the Don Narrows (at least along the west bank) and to encourage the establishment of more stewardship teams for the area. There was some divergence between respondents regarding the level of active habitat enhancement that should be undertaken, ranging from "leave nature to fend for itself" to "expending massive amounts of resources to improve the aquatic and terrestrial habitat conditions through this area of the river".

1.5.3 Summary of Viable Habitat Enhancement Approaches

In summary, the primary approaches deemed viable for further consideration for enhancing the aquatic habitat function in the Don Narrows include:

- The development of a conceptual arrangement of new artificial bed structures such that increases in flood risk to adjacent regional transportation infrastructure will not occur. As this approach will result in further encroachments within the existing channel of the Don Narrows, additional hydraulic modelling will be undertaken to further assess the level of impact on flood levels and flood frequencies within this area. It is anticipated that TRCA would lead fundraising activities and implementation of such a plan;
- Identifying areas for possible bank modifications in the event major maintenance works are planned for the existing sheet pile planned along the DVP, or in the event funding becomes available to revisit the configuration of the west bank of the Don River. No further modelling of this approach would be required given that the overall footprint of sheet pile replacement works with more ecologically friendly materials would largely retain the existing conveyance capacity of the channel or potentially increase it.

  The main driver for such works to proceed would be based on the willingness of the City to use other techniques for bank stabilization (such as in Figure 1-6) on the east side of the River. Alternatively, a series of wetland habitat pockets overlain by short-sections of cantilevered boardwalks along the west side of the Don River could be contemplated if a significant source of funding for construction and operations becomes available and is agreed to by the City of Toronto; and
- Providing continued support for local stewardship opportunities within the Don Narrows. The impacts of additional plantings along the Don Narrows do not require further review or assessment as part of this study.

2. Conceptual Arrangement of Proposed Habitat Structures

2.1 Hydraulic Impacts of Proposed Habitat Structures

The placement of new artificial bed structures was identified as one of the preferred ways to enhance the existing habitat characteristics within the Don Narrows. As stated previously, partial in-filling of the Don Narrows could potentially increase flood frequency to the Don Valley Parkway, Bayview Avenue and adjacent railways. To assess the impacts on flood frequency to adjacent infrastructure, refinements to the proposed arrangement, size and composition of artificial habitat structures were incorporated into the Delft 3D model to assess their impacts as compared to the existing conditions.

Six alternating point bars were encoded in the Delft3D hydraulic model for the Don Narrows to determine whether the addition of these structures would increase water levels at the 2 year return period flood as compared to the existing water levels (**Figure 2-1**). The proposed structures are about 200 to 300 metres long and are raised by 0.3 to 0.5 metres above existing grades. These structures have been placed where deposition has been observed to already occur. The point bars will consist of coarser gravels held in place with cobbles and small boulders on the upstream end, which will minimize the need of frequent replacement of gravels. These structures appear similar in nature to estuary hooks but with smaller materials. Given the relatively low flow conditions, Manning's N during the 2 year flood event is assumed to be in the order of 0.035. Manning's N is an empirical formula used to calculate the roughness of a river channel based on the physical configuration of the channel, and the materials and vegetation located within the channel. This is essentially a value used to calculate how much friction the river channel will exert on flowing water in the channel. Smaller values represent "smoother" channels, which allows for faster flow conditions. For the Don Narrows, a value of 0.035 has been assigned and is typical of larger channels with some weeds and stones.

Figure 2-1 depicts the change in depth along the Don Narrows between existing and the proposed conditions. The location and extent of the proposed structures are readily apparent in the image as areas within the channel where the depth of flow is less than the existing conditions. Three main spills are apparent in the image:

- West bank at Riverdale Park: flooding occurs over the railways and Bayview Avenue;
- East bank between Gerard and Dundas Streets: flooding covers western lanes of the DVP; and
- West bank north of Queen Street: flooding occurs over the railways and Bayview Avenue.

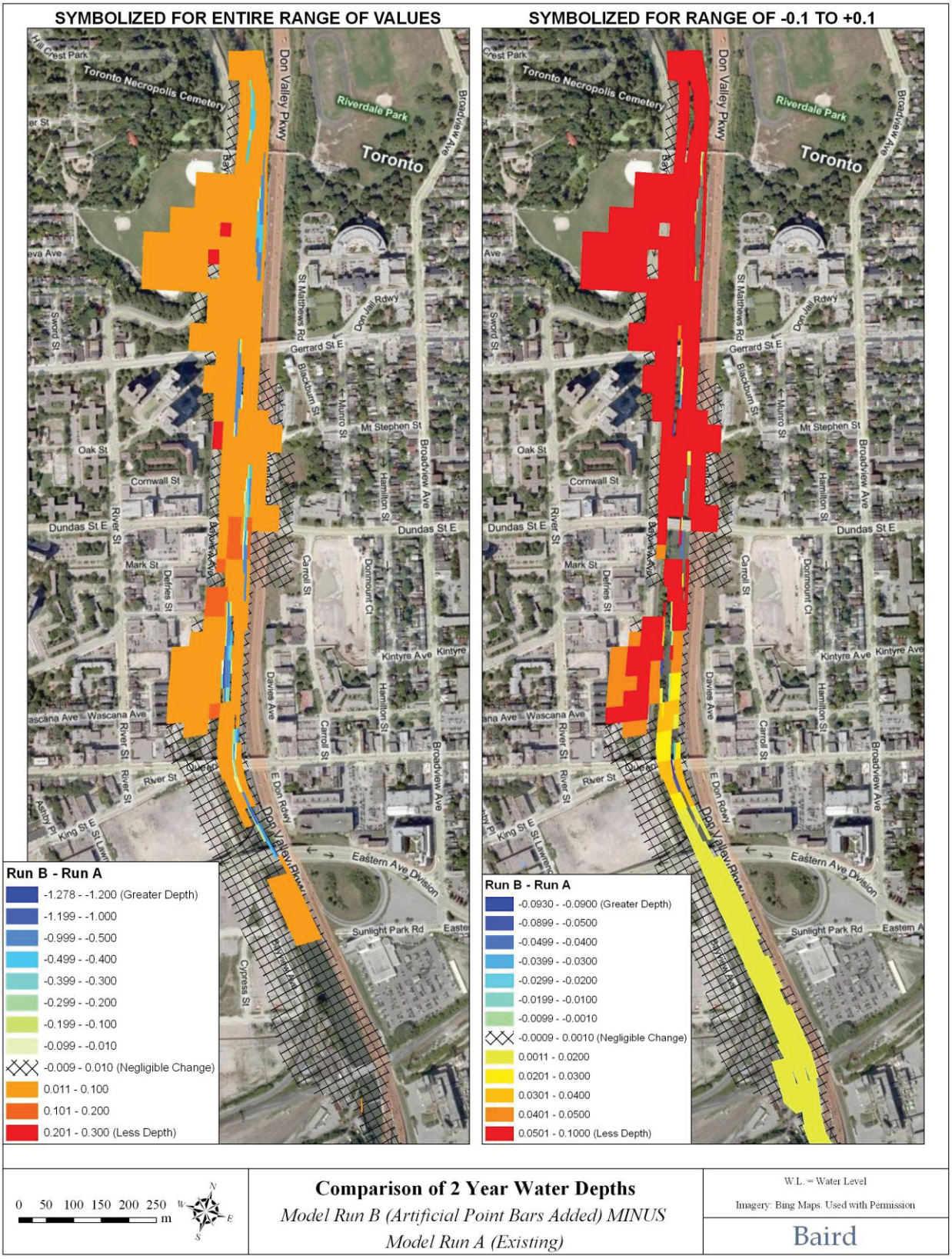


Figure 2-1 **Location of alternating point bars and magnitude of change in water level within Don Narrows due to placement of alternating point bars**

Figure 2-1 also indicates that water levels have increased between 0.06m and 0.09m throughout most of the Don Narrows, other than over the new point bars. The current hydraulic model output also assumes a "static" river bed configuration. Given the alternating point bar configuration, it is possible that deeper pools would develop opposite to the point bars on the rising limb of the flood hydrograph, providing additional channel capacity to offset losses incurred by the placement of these structures. However, it would be difficult to assess whether enhanced scour would occur soon enough in the rising limb to scour out the pools, or whether enough scour can occur to accommodate displaced flows. As such, the assessment of impacts will rely on the conservative approach, a static bed up to the 2 year event.

It is also anticipated that further refinements to the proposed arrangement of structures could be undertaken to reduce their footprint and constituent grain sizes. This should allow for minimizing the increase in water levels to about 0.05m, however, it is not anticipated that these modifications can be undertaken to a sufficient level to entirely eliminate their hydraulic impacts, while at the same time, providing significant improvements to fish habitat. As this configuration of habitat features is unable to meet the first objective for this study, "ensure that flood frequency does not increase on adjacent infrastructure", the proposed placement of six alternating point bars throughout the Don Narrows does not appear to be a viable solution. The results also indicate that the use of material intensive artificial bed features (i.e. "high profile estuary hooks") are not likely to be deemed suitable for the Don Narrows.

Further investigation of **Figure 2-1** does suggest that the most significant impacts on flood levels occur south of the pedestrian flyover at Riverdale Park and north of Queen Street, while flooding to adjacent infrastructure does not occur in the area of the most northerly and most southerly of the point bars. As such, placing habitat structures (i.e. low profile estuary hooks and/or artificial point bars) in these two locations appear to be viable from a flood risk perspective within the Narrows. There is still some opportunity to place small groupings of boulders together throughout the reach to improve habitat function without impacting hydraulics. However, based on the predominant sand composition of the bed, and the volume of sediment load on an annual basis, it is likely these smaller groupings of boulders would be buried within a short period of time, limiting their ecological value.

2.2 Fish Habitat Benefits of Proposed Structures

As stated in **Section 1.1** (**Appendix J**), the Don Narrows are likely used by fish primarily for migration to and from the lake. However, the overall lack of cover for forage species results in limited forage opportunities for predators even in a diurnal or transitory way. TRCA's recent observed increase in fish diversity and abundance adjacent to and within the recently placed boulders at the CN crossing seems to support this assumption. If this assumption is correct, then the placement of rocky material elsewhere in the Don Narrows (i.e. the artificial point bars) may indeed have a positive and measurable effect on species abundance and distribution, and provide extended periods of habitat usage within the Narrows.

The Department of Fisheries and Oceans (DFO) is currently developing a riverine version of their lake-based Habitat Alteration Assessment Tool (or HAAT model). The utility of this model would be to quantify the magnitude of net change in fish habitat productivity resulting from small-scale infilling projects; in this case, to quantify the net increase in fish habitat productivity resulting from the placement of rocky material in the two proposed locations in the Don Narrows. The intent is to utilize this modified HAAT model when it becomes available for use in riverine systems. However, it was not available at the time that this report was drafted.

It is recognized that there may be many other factors limiting fish usage in the Don Narrows. These can include water quality, low flow velocities, temperature, turbidity, high suspended and bed sediment loads, to name but a few variables. A strong unknown relates to the response of sediment loads on the proposed artificial point bars. Given that approximately 35,000 to 40,000 m^3 of sediment are deposited in the Keating Channel annually, this same

volume of sediment must pass through the Don Narrows as well, since there is no evidence of long-term bed aggradation or degradation occurring in the Narrows. Although there is no evidence of a net change in sediment accumulation in the Narrows over time, there has been evidence of a transient thalweg throughout the Narrows and significant changes in bed elevation (of up to 0.5m variation) from a year to year basis near the elevated CN crossing of the Don River.

The implications of this is that finer sediment (sand) may accumulate and bury the proposed artificial point bars or individual boulder groupings for periods of time, thereby removing their ecological value, until such time that larger floods occur and flush away the sand. Given the possible cyclical burial or shifting of placed material, it is likely that any quantified net gains in habitat usage would be greatly mimimized overall. TRCA would not advocate management practices that require ongoing sediment removal to maintain these habitat structures.

One of the monitoring needs for the detailed design stage for the DMNP EA is to undertake detailed sediment load sampling to help calibrate the sediment trap function proposed in Reach 1 of the EA. This same sediment transport modelling program could be used to help define the anticipated frequency and extent of burial of the proposed habitat structures. Depending on which project proceeds first to the detailed design stage, the Don Narrows work or the Reach 1 sediment trap work for the DMNP EA, this sediment monitoring program could be utilized to support both project components.

Regardless of the outcomes of that modelling, there remains the evidence showing that the rocks placed in 2007 at the CN Bridge did provide improved localized habitat usage. There could be value in providing additional habitat structures further upstream, even if it is transitory in nature.

3. Conclusions

This study sought to identify viable solutions to improve instream habitat conditions within the Don Narrows. The Don Narrows are a straight, channelized portion of the Don River between the elevated CN railway crossing over the Don, up to Riverdale Park. Generally speaking, the channel is wide with vertical banks, and has a relatively uniform bed structure consisting primarily of sand, silt and some fine gravel. Some low-lying bed features are observed throughout the reach with evidence of some thalweg development that migrates within the channel walls.

The Don Narrows are bounded by the Don Valley Parkway to the east, and railway tracks and Bayview Avenue to the west. Localized flooding from the Don currently overtops its banks and floods the DVP, the rail lines and Bayview Avenue around the 2 year return period event. Given the importance of these transportation arteries for the City of Toronto, any proposed works designed to improve fish habitat can only be considered viable if they do not increase the frequency of flooding to this infrastructure, do not require a significant maintenance or operational component, do not result in an increased risk to failure of infrastructure, nor impact the use of the Lower Don Trail.

Generally speaking, three broad habitat enhancement approaches were deemed viable, if incorporated properly. The first two approaches rely heavily upon other agencies or NGOs to implement, and generally meet the conditions of this study:

1. Replacement of existing sheet pile walls to more naturalized armoured banks: These works would be undertaken likely by the City of Toronto, if deemed appropriate, as part of major retrofits or maintenance/replacement of the existing banks along the DVP. These efforts would largely be limited to those areas where sediment deposition has largely occurred already, which would allow the creation of tapered bioengineered banks to be constructed. Use of these channel modification works would be assessed by the City as part of their major works planning efforts.

Similar works could be considered for short distances of the west bank of the river, whereby a combination of bioengineered shorelines could extend west from the existing toe of bank to near the railway Right-Of-Way, with trail access possibly maintained by constructing a cantilever or boardwalk system over the constructed habitat. However, this solution would be very expensive to build and maintain. Further, such a boardwalk would be subject to significant shear stresses during a large flood event, and would be subject to regular damage due to ice and debris. Currently, there are no plans or funding to undertake such works and further discussions with Toronto Parks would be required.

2. Continued plantings of natural vegetation along the top of the banks of the Don Narrows: The Task Force to Bring Back the Don and other groups and agencies have undertake vegetation plantings for years along the west bank of the Don Narrows. This area is highly stressed by frequent high flows, heavy usage by people, and limited rooting conditions given the amount of infrastructure in the area. However, continued stewardship opportunities to replace lost vegetation and community education initiatives may continue on a limited basis.

3. The third potentially viable enhancement approach is the strategic placement of artificial bed structures, essentially coarse rock material, to form artificial point bars or low-profile estuary hooks. It is anticipated that these works would most likely be undertaken by the TRCA.

The hydraulic analysis indicates that when several low-lying habitat structures are proposed throughout the Don Narrows, this additional placement of material will produce measurable increases in flood frequency with the Don Narrows. However, the modelling suggests that these negative impacts can be avoided if two such rocky habitat structures are placed in the Narrows: one north of the Riverdale Park pedestrian flyover (on the west bank), and one south of the Queen Street flyover (on the east bank).

However, a more detailed study would be required to refine the proposed works as part of the detailed design process. Some of the key elements of that study process would be to:

1. Conduct HAAT modelling using DFO's river model (currently under development),to maximize the fish habitat potential of these two structures;
2. Revise the 3D hydraulic model results to confirm that the habitat structures that have been refined to maximize habitat potential continue to have no impact on flood frequency to adjacent infrastructure. Anticipate several iterations between the habitat model and hydraulic models to reach an idealized structure for both;
3. Examine opportunities using the 3D hydraulic model to determine whether individually placed larger rocks or small groupings of rocks can be placed between the two larger artificial bed structures without impacting flood frequencies within the Don Narrows;
4. OPTIONAL: Depending on whether the detailed design process for the DMNP EA or the Don Narrows habitat enhancement works proceed first, there would be value in undertaking detailed sediment load field studies to quantify sediment grain size distributions of suspended and bedload entering and leaving the Don Narrows. This study would serve a dual purpose for calibrating sediment transport models used in the detailed design refinements for the Reach 1 sediment trap in the DMNP EA, and for conducting sediment transport model runs for the Don Narrows to assess the frequency at which sand buries artifical habitat structures. NOTE: Costs for such field work are high, in the order of $100 to $200K.
5. Develop detailed designs for the proposed large-scale and small-scale habitat structures in the Don Narrows;
6. Obtain appropriate permits and approvals from applicable agencies which is not limited to, but may include, NWPA, Transport Canada, DFO, Environment Canada, Ministry of Natural Resources, Ministry of the Environment, City Transportation, City Water, City Parks, GO Transit, and CP / CN Rail.