APPENDIX B: Detailed Evaluation of Alternative Solutions

Appendix B - EVALUATION OF BREAKWATER ALTERNATIVE SOLUTIONS

Objective	Evaluation Criteria	Alternative 1 New Fixed Breakwater	Alternative 2 New Floating Breakwater	Alternative 3 Combination Fixed and Floating Breakwater
Improvement to Habitat *This objective encompasses both potential positive and negative impacts to aquatic and terrestrial habitat as a result of the proposed breakwater. However, this objective is considered to have been achieved when a net benefit to or improvement of habitat is realized.*	Potential to create a Harmful Alteration, Disruption or Destruction (HADD) of fish habitat	***Ranked Third*** • A fixed breakwater will result in a HADD. • It is noted that the depth of water at the breakwater location suggests that the quality of habitat to be removed will be low.	***Ranked First*** • No HADD resulting from replacement of existing breakwater with a new structure.	***Ranked Second*** • HADD will result from installation of the fixed portion of the breakwater; no HADD for portion to be installed as floating breakwater. • It is noted that the depth of water at the breakwater location suggests that the quality of habitat to be removed will be low.
	Opportunity to improve fish habitat	***Ranked First*** • Potential to increase quantity and quality of fish habitat on side slopes of fixed breakwater.	***Ranked Third*** • Limited to no opportunity to improve fish habitat beyond what currently exists	***Ranked Second*** • Potential to increase quantity and quality of fish habitat on side slopes of fixed portion of the breakwater. Floating breakwater portion will have limited habitat value.
	Potential for impact to terrestrial habitat	***Ranked Equal*** • None of the alternatives will involve significant shore work. No impacts are anticipated.	***Ranked Equal*** • None of the alternatives will involve significant shore work. No impacts are anticipated.	***Ranked Equal*** • None of the alternatives will involve significant shore work. No impacts are anticipated.
	Potential for impacts to aquatic habitat based on water quality	***Ranked Third*** • Fixed breakwater requires a longest in-water construction period. • Potential for impact to water quality during construction resulting from sedimentation (it is noted that there is limited sediment in the area and fill will be clean). • Fixed breakwater has the potential to influence water circulation pattern in harbour. • No long-term negative water quality impact in the harbour is anticipated.	***Ranked First*** • Involves some in-water construction to install anchors. • Some potential for impact to water quality during construction. • Low potential for impact to water circulation, since only the anchors would be fixed to the lakebed. • No long-term negative water quality impact in the harbour is anticipated.	***Ranked Second*** • Length of in-water construction period within water is less than Alternative 1. • Potential for impact to water quality during construction resulting from sedimentation (it is noted that there is limited sediment in the area and fill will be clean). • Reduced influence on water circulation than Alternative 1. • No long-term negative water quality impact in the harbour is anticipated.
	Potential for impacts to Species at Risk (aquatic and terrestrial)	***Ranked First*** • No impacts to Species at Risk. • May have a positive effect by creating some habitat for American Eel (Endangered).	***Ranked Third*** • No impacts to Species at Risk.	***Ranked Second*** • No impacts to Species at Risk. • May have a positive effect by creating some habitat for American Eel (Endangered). The extent of habitat created would be less than for Alternative 1.
	Potential to improve colonial bird nesting habitat	***Ranked First*** • Potential to provide habitat for Herring Gulls and Common Terns (locally significant birds).	***Ranked Third*** • No potential to improve bird nesting habitat.	***Ranked Second*** • Potential to provide habitat for Herring Gulls and Common Terns (locally significant birds) on the fixed portion of the breakwater. The extent of habitat created would be less than for Alternative 1.
	Potential to impact Trumpeter Swan wintering habitat	***Ranked Third*** • May impact wintering swans as a result of change/extend ice-on period. This can be managed through the use of a bubbler in the water, or through mechanical ice break-up. No long term negative impact on swan wintering habitat anticipated.	***Ranked First*** • No impact anticipated during swan wintering period as floating breakwater would be removed during this time.	***Ranked Second*** • Fixed breakwater portions may change/extend ice-on period but less potential than for Alternative 1. No long term negative impact on swan wintering habitat anticipated.
Overall Ranking for Improvement to Habitat Objective		***Ranked First*** • The fixed breakwater provides the greatest opportunity for long term fish and wildlife habitat improvement. The impact created by the footprint of the breakwater and associated disruption to the water column is outweighed by the potential for overall improvement in habitat diversity and creation of habitat for fish species targeted by the Hamilton Harbour RAP and the MNR Hamilton Harbour	***Ranked Third*** • The floating breakwater will not have a significant negative impact to habitat in the short term; however, it does not provide the opportunity for new habitat to be created.	***Ranked Second*** • The combination breakwater provides some opportunity for improvement to habitat and habitat creation (i.e. at the fixed portion of the breakwater), but not as much as an entirely fixed breakwater since it is combined with a floating portion. The potential negative effects of this breakwater option are fewer than that of a fixed breakwater, but greater than that of a floating breakwater.

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Objective	**Evaluation Criteria**	**Alternative 1** **New Fixed Breakwater**	**Alternative 2** **New Floating Breakwater**	**Alternative 3** **Combination Fixed and Floating Breakwater**
		Fisheries Management Plan.		
Improvement to Marina Protection *This objective encompasses opportunities to improve protection to the marina by reducing damages from wind and wave action, improving the level of safety provided to marina users, and offering the potential to enhance operational activities as a result.*	Ability to manage wave conditions	***Ranked First*** • Provides the greatest reduction in wave action and can be designed to meet specific criteria.	***Ranked Third*** • Provides improvement over existing conditions and can be designed to meet specific criteria.	***Ranked Second*** • Provides substantial improvement over existing conditions and can be designed to meet specific criteria.
	Potential for impacts on waterfront recreational facilities during construction	***Ranked Equal*** • All alternatives have minimal impact on existing shoreline and on-shore facilities. • Construction is not anticipated to significantly impact marina operations as it can be staged to minimize overlap with the boating season.	***Ranked Equal*** • All alternatives have minimal impact on existing shoreline and on-shore facilities. • Construction is not anticipated to significantly impact marina operations as it can be staged to minimize overlap with boating season.	***Ranked Equal*** • All alternatives have minimal impact on existing shoreline and on-shore facilities. • Construction is not anticipated to significantly impact marina operations as it can be staged to minimize overlap with boating season.
	Opportunity for enhancement of waterfront recreational facilities/ amenities	***Ranked First*** • Represents the most significant improvement to protection of the marina. • New fixed breakwater may provide opportunity for improved protection of transient mooring.	***Ranked Third*** • Will provide improvement to the protection of the marina. • New floating breakwater may provide opportunity for improved protection of transient mooring.	***Ranked Second*** • Will provide substantial improvement to the protection of the marina. • Sections of this Alternative may provide opportunity for improved protection of transient mooring.
	Potential for impact on public safety	***Ranked First*** • All alternatives involve improvement to protection of land and/or water. • This alternative provides the greatest reduction in wave action and increases safety.	***Ranked Third*** • All alternatives involve improvement to protection of land and/or water. • This alternative provides improvement in wave protection and increases safety.	***Ranked Second*** • All alternatives involve improvement to protection of land and/or water. • This alternative provides substantial improvement in wave protection and increases safety
Overall Ranking for Improvement to Marina Protection Objective		***Ranked First*** • A fixed breakwater provides the greatest certainty of protection for the Marina. It also protects public safety and provides opportunity for expansion.	***Ranked Second*** • A floating breakwater provides some certainty of protection for the Marina but is not as effective as a fixed breakwater.	***Ranked Second*** • A combination breakwater provides some certainty of protection for the Marina and is considered to provide the same level of protection as a floating breakwater.
Limit impact on community *This objective encompasses the potential for both positive and negative effects to the community during the construction and operation phases of the proposed breakwater. This objective is considered to have been achieved if negative impacts to the community during construction are limited, while improving the potential for positive impacts during operations.*	Potential to impact cultural heritage (archaeological resources or built heritage and cultural landscapes) and/or treaty rights	***Ranked Second*** • May result in an impact to the lakebed and an archaeological assessment may be required.	***Ranked First*** • Minimal impact on cultural heritage or treaty rights anticipated as there is no fill required.	***Ranked Second*** • May result in an impact to the lakebed and an archaeological assessment may be required.
	Potential to attract undesirable nesting birds (e.g. cormorants)	***Ranked Equal*** • May provide surface for nesting. The width of the surface provided may vary depending on the breakwater. • Nature of rocky material is not considered desirable by cormorants. • Opportunities to attract desired species and deter undesirable species are available.	***Ranked Equal*** • May provide surface for roosting. The width of the surface provided may vary depending on the breakwater. • Little opportunity for plantings or other means to discourage nesting.	***Ranked Equal*** • May provide surface for roosting and nesting. The width of the surface provided may vary between the fixed and floating portions of the breakwater. • Nature of rocky material in fixed sections is not considered desirable by cormorants. • Opportunities to attract desired species and deter undesirable species are available.
	Potential for construction impacts on park users and/or neighbourhood	***Ranked Third*** • Some potential for construction impacts on park users and/or neighbourhood. A “self-unloader” is assumed for most of the construction but a small portion of the breakwater material will likely be delivered by road (approximately 3-4 trucks per day over approximately 2.5 months). The construction period for a fixed breakwater is approximately 3 months.	***Ranked First*** • Minimal potential for construction impacts on park users and/or neighbourhood as sections are constructed off-site and moved to the location. The construction period for a floating breakwater is approximately 2 months. • The annual installation/removal of the floating system and marina docks is similar	***Ranked Second*** • Limited potential for construction impacts on park users and/or neighbourhood as a “self-unloader” is assumed. Construction is likely longer than a floating system but only a small portion of the breakwater material will likely be delivered by road. The construction period for a combination breakwater is approximately 2 to 3 months. • The annual installation/removal of the floating portion

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			to what occurs presently.	of the system and marina docks is similar to what occurs presently.
	Potential operational impact on park users and/or neighbourhood	***Ranked First*** • This alternative improves the visual aesthetics and the ability to enjoy the marina pier in all seasons as it is anticipated that the docks would no longer need to be stored on the marina pier during the off-season.[1] • A fixed breakwater has a higher visual profile. On average it will sit approximately 1.2-1.5 m above the water. • No other operational impacts from the breakwater on the community are anticipated.	***Ranked Second*** • This alternative does not facilitate the use of the marina pier as docks will need to be stored on the marina pier during the off season. • A floating breakwater has a relatively low visual profile. On average it will sit approximately 0.6 -0.8 m above the water. • No other operational impacts from the breakwater on the community are anticipated.	***Ranked Second*** • This alternative does not improve the visual aesthetics or year round use of the pier as it is likely that docks will need to be stored on the marina pier during the off season. • The visual profile of the structure will vary. • No other operational impacts from the breakwater on the community are anticipated.
Overall Ranking for Limit Impact on Community Objective		***Ranked Second*** • This alternative has the potential for the greatest construction related impacts due to construction traffic to accommodate the placement of armour stone (approximately 3-4 trucks per day over approximately 2.5 months). • The advantage of this alternative is the ability for the community to use the marina pier during all seasons as the docks will stay in the water. It is noted that there is potential for some visual impact, as this structure has the highest visual profile sitting an average of 1.2 -1.5 metres out of the water. • There is potential for archaeological impact associated with placement of fill on the lakebed.	***Ranked First*** This alternative would require a shorter construction period to bring in and anchor the floating system, and thus limited impact on the community is expected during construction. Storage of the docks on the marina pier will continue to limit use of the pier during the off-season and create a visual nuisance. There is no potential for archaeological impact associated with anchoring needed for the floating breakwater.	***Ranked Third*** This alternative has a construction period slightly shorter than a full fixed breakwater so some construction related traffic will occur and has the potential to impact the community. There will likely still be a need to store docks on the pier which will continue to limit use of the pier during the off-season and create a visual nuisance. There is potential for archaeological impact associated with placement of fill on the lakebed and anchoring needed for the floating portion of the breakwater.
Limit impact on navigability *This objective encompasses the desire to ensure that all requirements of the Navigable Waters Protection Act and Navigation Act are met during the construction and operation of the proposed breakwater,*	Impact on Navigability	***Ranked Equal*** • All new alternatives have potential to impact navigability. • Care will be taken to minimize potential for negative impact through NWPA review and approval.	***Ranked Equal*** • All new alternatives have potential to impact navigability. • Care will be taken to minimize potential for negative impact through NWPA review and approval.	***Ranked Equal*** • All new alternatives have potential to impact navigability. • Care will be taken to minimize potential for negative impact through NWPA review and approval.
Overall Ranking for Limit Impact on Navigability Objective		***Ranked Equal*** All alternatives have potential to impact navigability. Care will be taken to minimize potential for negative impact through NWPA review and approval by Transport Canada.		
Low maintenance operation and constructability *This objective encompasses both potential positive and negative impacts arising from the ease of constructability and maintenance for each of the proposed alternatives. This objective is considered to have been achieved if the construction provides structural integrity, and the maintenance requirements over the expected design life are minimal.*	Structural integrity for waves	***Ranked Equal*** • New fixed breakwater can be designed to provide structural integrity with respect to waves.	***Ranked Equal*** • New floating breakwater can be designed to provide structural integrity with respect to waves.	***Ranked Equal*** • New combination breakwater can be designed to provide structural integrity with respect to waves.
	Design life/ Maintenance requirements	***Ranked First*** • New fixed breakwater may have a design life of approximately 50 years. • Minimal maintenance is required.	***Ranked Third*** • New floating breakwater may have a design life of approximately 25-50 years. • Annual maintenance involves the seasonal	***Ranked Second*** • Design life of a combination breakwater will be different for the fixed and floating sections, however it is expected the design life for each will be similar to what

[1] It is noted that the expectation that the docks will be able to stay in place in the off season is based on common practice in Lake Ontario. The ability for the docks to withstand ice can not be fully assessed or guaranteed.

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Objective	**Evaluation Criteria**	**Alternative 1 New Fixed Breakwater**	**Alternative 2 New Floating Breakwater**	**Alternative 3 Combination Fixed and Floating Breakwater**
			relocation of the breakwater and docks. Movement of the breakwater will be more difficult than currently as the structure would be larger. • Other maintenance requirements may include regular anchor chain recovery/repair and removal of zebra mussels.	is stated for Alternative 1 and 2. • The floating sections and docks will likely require seasonal relocation but may be able to be stored in the water rather than on the pier. • Other maintenance requirements are minimal for the fixed portions and include anchor/chain maintenance and zebra mussel removal for the floating portion.
	Potential for contamination issues	***Ranked Third*** • Core will be placed by self unloader. A floating curtain will be used (as necessary) to contain any disturbed sediments. • There is some potential to encounter contamination issues.	***Ranked First*** • Minimal potential to encounter contamination issues as only anchors on the lake bottom.	***Ranked Second*** • Core will be placed by self unloader. A floating curtain will be used (as necessary) to contain any disturbed sediments. • Minimal potential to encounter contamination issues.
	Operational Flexibility	***Ranked Third*** • A fixed breakwater is the least flexible, as the structure cannot be moved.	***Ranked First*** • A floating breakwater provides most flexibility. • Can be moved to accommodate changes to docks.	***Ranked Second*** • Fixed breakwater sections will not be able to be moved.
	Ability to withstand winter Ice	***Ranked First*** • Fixed breakwater will stay in place during the winter and can withstand ice forces. • Armour stone breakwaters may suffer minimal and infrequent damage by ice movement.	***Ranked Third*** • Floating breakwater will likely need to be removed from water or relocated to a sheltered area in the winter or other precautions taken (e.g. installation of bubblers) depending of manufacturer's recommendations.[2]	***Ranked Second*** • Fixed breakwater sections will stay in place during the winter. • May be opportunity to move floating sections and docks behind fixed portions so that they can stay in-water during winter.
	Potential impacts on utilities	***Ranked Equal*** • Will not be located on top of any utilities.	***Ranked Equal*** • Anchors can easily be located away from any utilities.	***Ranked Equal*** • Fixed portions will not be located on top of any utilities. • Anchors can easily be located away from utilities.
	Constructability	***Ranked Equal*** • Relatively easy to construct. • On-site activities will include placement of stone.	***Ranked Equal*** • Relatively easy to construct. • On site activities generally limited to placement of anchors and preparing a retrieval system to allow removal of breakwater during winter.	***Ranked Equal*** • Relatively easy to construct. • On-site activity to include both placement of stone and anchors.
Overall Ranking for Low Maintenance, Operation and Constructability Objective		***Ranked First*** The fixed breakwater system has the longest design life and is the only alternative that remains in the water all year and is able to allow docks to remain in water during ice conditions, thus is has the least amount of maintenance. However, since it is a fixed structure, it would be the most difficult to change in the future.	***Ranked Third*** The floating breakwater system has a shorter design life and requires the breakwater to be relocated seasonally, or for other precautions to be taken depending on manufacturer's recommendations. The docks would continue to require seasonal removal and storage.	***Ranked Second*** The combination system will likely require floating breakwater sections and docks to be removed/relocated but they may be able to remain in the water, which would reduce the seasonal maintenance that would be required.
Reasonable cost *This objective encompasses the overall cost of each alternative, considering both capital and maintenance and operation costs. This objective is considered to have been achieved when relative costs for both are minimized.*	Relative cost differences (capital cost only)	***Ranked Third*** • Highest capital Cost (approximately $20,000 per m). • Estimated 400 m total length required. • Construction costs associated with aquatic habitat are not included.	***Ranked First*** • Moderate capital cost (approximately $6,500 to 8,500 per m). • Estimated 440 m total length required.	***Ranked Second*** • Moderately high capital cost depending on the length of fixed and floating in the final design. • It is anticipated that approximately ½ will be floating and ½ will be fixed in this Alternative.
	Relative cost differences (operation, design life, and	***Ranked First*** • Low maintenance requirements. Marina infrastructure	***Ranked Second*** • Relatively high annual maintenance costs	***Ranked Third*** • Relatively high annual maintenance costs due

[2] Manufacturer contacted cannot guarantee that floating wave break can withstand ice at this location, but believes the breakwaters will work in ice. Manufacturer does not recommend annual movement of some types of floating wave breaks.

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	maintenance)	would remain in situ (Limited cycles of refurbishment because of lower frequency of handling necessary when removing/installing). • Design life anticipated to be 50 years.	due to need to relocate breakwater and remove docks in the winter. • Dock relocation/removal cost estimated to be $40,000 annually. • Floating breakwater relocation expected to be $150,000 to $200,000 annually, if required. • Design life anticipated to be 25-50 years.	potential need to relocate floating sections of the breakwater and remove docks in the winter. • Design life anticipated to be 50 years for fixed section and 25-50 years for floating section.
Overall Ranking for Reasonable Cost Objective		***Ranked Third*** The fixed breakwater option has the highest capital cost (approximately $20,000 per metre) but limited to no maintenance costs. It is noted that over the life of the breakwater infrastructure when the combination of capital and maintenance costs are considered, the cost difference between alternatives is minimized.	***Ranked First*** The floating breakwater has a moderate cost (approximately $6,500 to 8,500 per metre). Annual maintenance costs for this option are expected to be in the range of approximately $190,000 to $240,000 seasonally to relocate/remove docks and relocate breakwater, if required.	***Ranked Second*** The combination breakwater option has a moderately high cost depending on the length of fixed and floating sections in the final design. It is anticipated that approximately ½ of the structure will be floating and ½ will be fixed. Maintenance costs for this option will likely include the removal/relocation of the floating breakwater sections and docks.

Design Evaluation Table – Fixed Wave Break vs. Aquatic Habitat Shelf

Objective	Evaluation Criteria	Option 1: Standard Fixed Wave Break	Option 2: Standard Fixed Wave Break with Aquatic Habitat Shelf
Improvement to Habitat	Potential to create a Harmful Alteration, Disruption or Destruction (HADD) of fish habitat	***Ranked Equal*** • The footprint of the wave break will remove fish habitat.	
	Opportunity to improve fish habitat	***Ranked Second*** • There is opportunity to increase quantity and quality of fish habitat at the toe fixed wave break.	***Ranked First*** • There is opportunity to create habitat along the toe of the structure as well as along the aquatic habitat shelf. The habitat shelf has the potential to attract fish species identified as desirable in the Hamilton RAP and MNR Fisheries Management Plan.
	Potential for impact to terrestrial habitat during construction	***Ranked Equal*** • There will be no negative impacts to terrestrial habitat during construction.	
	Potential for impacts to species at risk	***Ranked Equal*** • There will be no anticipated negative impacts to species at risk.	
	Potential to improve colonial bird nesting habitat	***Ranked Equal*** • Additional habitat for terns and gulls may be provided at the surface of the structure. These species are listed as desirable in the Hamilton RAP and Vision 2012.	
Improvement to Marina Protection	Ability to manage wave conditions	***Ranked Equal*** • Waves will be reduced below acceptable standards within the mooring basin. Boats and other marina infrastructure will be better protected.	
	Potential for impacts on waterfront recreational facilities during construction	***Ranked Equal*** • The length of the construction period for both designs is similar. Both will require some delivery of material to the site by truck, however most is planned by water to minimize disruption.	
	Opportunity for enhancement of waterfront recreational facilities/ amenities	***Ranked Equal*** • Community access to the pier during the winter months may be improved since docks would no longer need to be removed.	
	Potential for impact on public safety	***Ranked Equal*** • Both designs are expected to improve public safety by reducing wave damage.	

Design Evaluation Table – Fixed Wave Break vs. Aquatic Habitat Shelf

Objective	Evaluation Criteria	Option 1: Standard Fixed Wave Break	Option 2: Standard Fixed Wave Break with Aquatic Habitat Shelf
Limit impact on community	Potential to impact cultural heritage (archaeological resources or built heritage and cultural landscapes) and/or treaty rights.	***Ranked Equal*** • Designs have some potential to cause impacts to cultural heritage features or archaeological resources, however an archaeological assessment has not been completed and it has not been confirmed if there are archaeological or cultural heritage resources in the area.	
	Potential to attract undesirable nesting birds	***Ranked Equal*** • Both designs have equal opportunity to attract undesirable bird species along the top of the wave break.	
	Potential for construction impacts on park users and/or neighbourhood	***Ranked Equal*** • The construction period for both designs is similar and impacts are considered temporary.	
Limit impact on navigability	Impact on navigability	***Ranked Equal*** • Both designs have equal potential to limit navigability. The final design will be in accordance with the *Navigable Waters Protection Act* and approval will be sought from Transport Canada.	
Low maintenance operation and constructability	Structural integrity	***Ranked Equal*** • Both designs will have structural integrity and will reduce damage to marina infrastructure.	
	Design life/maintenance requirements	***Ranked Equal*** • The design life is anticipated to be approximately 50 years with little to no maintenance requirements.	
	Potential for contamination issues	***Ranked Equal*** • Both designs have potential for contamination issues due to infilling of the harbour during construction.	
	Operational flexibility	***Ranked Equal*** • The wave break can be sized to accommodate a marina expansion. • Once installed, the wave break cannot be moved.	
	Ability to withstand winter ice	***Ranked Equal*** • The fixed structure will provide adequate protection against ice.	
	Potential impacts on utilities	***Ranked Equal*** • The wave breaks will not be constructed over utilities.	
	Constructability	***Ranked Equal*** • The construction requirements and timelines are similar. Both designs are relatively easy to construct.	

Design Evaluation Table – Fixed Wave Break vs. Aquatic Habitat Shelf

Objective	Evaluation Criteria	Option 1: Standard Fixed Wave Break	Option 2: Standard Fixed Wave Break with Aquatic Habitat Shelf
Reasonable cost	Relative cost differences (capital cost only)	***Ranked First*** • This option represents the base capital cost.	***Ranked Second*** • It is anticipated that an additional cost of approximately $3000 per metre will be incurred to install the aquatic habitat shelf.
	Relative cost differences (operation, design life and maintenance)	***Ranked Equal*** • Both options are expected to require little maintenance and have the same design life (approximately 50 years).	