H_2O 2021: Extreme Water Levels – Impacts and Strategies
Webinar 2: Shorelines and Shoreline Structures – Winds, Waves and Storms
Saturday 13 November 2021, 10 am to 12 pm

SYNOPSIS

Key Takeaways

1) Waves typically originate from wind or disturbances such as boats. Fetch, depth and wind speed/duration are key factors in wave height. Bigger storms + deeper water = bigger waves closer to the shoreline. Gentler shoreline slopes and vegetation will dampen/dissipate wave energy and can be used as the basis for creating soft but stable shorelines.

2) Wake boats should be operated in sufficiently deep water to protect bottom sediments and near shore vegetation. 'Living shorelines' absorb energy through the use of softer materials and live vegetation, and help buffer wave energy before it reaches shore.

3) There is a case to be made for approaching natural assets collectively, including that they can benefit from the delivery of core services, can be managed (which is the focus of local government natural-asset management), and are often over-used and under-recognized.

4) There are significant differences in the approach to the high-water mark across Georgian Bay's coastal municipalities. Those marks that have been set are at a lower level than the 2019/20 water level, and these may need to be re-considered given higher water levels are expected in the future.

5) Water-level changes affect the many businesses that are part of our coastal infrastructure, including by increasing their capital and operating costs related to dock systems, shore-wall systems, and shoreline properties.

6) There are planning permission requirements for installing new/replacement docks and for relocating shoreline structures, as well as setback requirements, and some of these vary by municipality. Those involved in new construction or relocations should consider placing structures above the minimum setback from the high water mark required by the municipality to be prepared for higher water levels.

Welcome Messages

1) Adam Chamberlain, chair of the board of directors of Georgian Bay Forever (GBF), offered a traditional land acknowledgement and welcomed participants on behalf of the two sponsoring organizations – GBF and the Georgian Bay Association (GBA).
2) Marilyn Longlade Capreol, an elder from the Shawanaga First Nation and founding member of the Conservation through Reconciliation Partnership Elder's Lodge, provided opening comments.
3) Rolfe Jones, chair of the GBA board of directors, offered his welcome and introduced the first Topic

Topic A: Storms, wakes and waves – Natural coastal processes Naturalizing shorelines – Flooding – High-water mark Land-water interface – Municipal infrastructure

Topic A of the webinar addressed seven questions:

1) what can we expect from higher wind strengths and more frequent and intense storms increasing wave action?
2) what can be done to reduce harmful boat wakes?
3) what to do (and not do) on shorelines?
4) what erosion impacts can we expect?
5) what are the impacts on municipal infrastructure of extreme high and low water levels?
6) should the municipal high water level mark be changed?
7) how can municipalities adapt?

Each speaker typically addressed two or three questions.

A scientist from the Severn Sound Environmental Association, **Aisha Chiandet**, provided an overview of this section of the webinar and introduced Brian Majka and Alex Ray.

Brian Majka, Senior Restoration Ecologist at GEI Consultants Inc., primarily addressed questions 1, 2 and 4 (wind- and boat-driven wakes and their impacts). He offered the following summary:

- waves typically originate from wind or disturbances such as boats;
- fetch, depth, and wind speed/duration are key factors in wave height;
- bigger storms + deeper water = bigger waves, closer to the shoreline; and
- gentler shoreline slopes and vegetation will dampen/dissipate wave energy and can be used as the basis for creating soft but stable shorelines.

Much of the rest of his presentation provided the background to this summary:

Brian described a wave in the following ways:

- a swell in a body of water, typically with forward motion;
- created by energy passing through water; and
- a transfer of energy without a transfer of matter.

He noted that "wave energy is just a form of solar energy."

He provided the following definitions:

- fetch = longest uninterrupted distance across the open water from a site; and
- bathymetry = elevation of the bed in a body of water.

He noted that slope is often described as run: rise, so a 5H:1V slope has 5' of run for every 1' of rise.

Brian explained that waves can come from three sources:

- wind driven;
- disturbance driven, which includes boats (and tsunamis); and
- gravitational (tides).

With wind-driven waves, wind causes friction across the water and the energy from the wind is transferred to the water. The friction causes micro-ripples, which cause more friction, which cause larger ripples – and wave height grows. Wind-driven wave height is a function of fetch, wind speed, duration, and water depth.

Boat-driven waves arise because boats displace water as they move, and in "pushing" water, they create higher waves than wind-driven waves. The size and shape of waves are influenced by boat hull and speed. Boat-driven wave height – a function of wind speed, duration, and water depth – is reduced when boat begins planing. Boat-driven waves are periodic, but usually have longer period and greater height than wind-driven waves.

Brian explained that wave height at the shoreline comes from:

- fetch
- depth
- run-up
- site orientation
- influence of adjacent features
- presence/absence of aquatic vegetation

He noted that wave height is most often limited by either fetch or depth. He also noted that waves break over and lose energy when wave height reaches ~ 80% of water depth (so an 8" wave will start to break in 10" of water). The gentler the slope, the further offshore the wave will break.

Waves affected the shoreline in three ways:

1) soil erosion;
2) physical displacement of plants; and
3) turbidity.

Their impacts are a function of fetch, depth, slope, wind speed, and wind duration. He noted that natural Great Lakes shorelines:

- have 10:1 to 20:1 slopes;
- are dynamic and transient;
- are not always vegetated;
- often have mosaics of shrubs, grasses, and wildflowers; and
- can provide a template for understanding how to restore shorelines.

Alex Ray, owner and lead consultant a Payette Environmental Services LLC, primarily addressed questions 2, 3 and 4 (boat wakes, impacts, and mitigation strategies).

He made three observations about wake-boat surface waves:

A. a wake boat operating 300' from shore produced a wave that was 7.75" high when it reached shore;
B. complete attenuation of wake boat waves occurs at approximately 1000'; and
C. due to their greater height and wavelength, surface waves produced by motorized watercraft carry far more energy than wind waves on fetch-limited bodies of water.

Alex drew three conclusions from these observations:

1) no-wake zones for watercraft using wave-enhancing technology (WET) should be a minimum 500' from shore;
2) wake boats should be operated in sufficiently deep water to protect bottom sediments and near shore vegetation; and
3) there is no one-size-fits-all solution (each body of water will have specific limitations).

He also explained that traditional erosion-control techniques, such as rip-rap and seawalls, reflect rather than absorb energy, leading to loss of beaches and near-shore habitat. Instead, 'living shorelines' absorb energy through the use of softer materials and live vegetation. A restored aquatic habitat and aquatic plants can also help buffer wave energy before it reaches shore.

Alex showed an image of a living shoreline with toe stone, fieldstone and coir log on top of a filter layer (gravel) and then native plantings. The coir logs (or BioD Blocks) buffer and absorb rather than reflect energy, and they are low cost and easy to install. Native plants are low maintenance, and they filter runoff and provide habitat. In particular, live stakes of willow grow rapidly and create a living root mat to stabilize shorelines. Rock revetments can be used as added protection in areas with high wave energy.

He offered a list of online resources:

- Tip of the Mitt Watershed Council (https://www.watershedcouncil.org)
- Michigan Natural Shoreline Partnership (https://www.mishorelinepartnership.org)
- Living Shorelines Academy (https://www.livingshorelinesacademy.org)
- St. Anthony Falls Laboratory (https://cse.umn.edu/safl/healthy-waters-initiative).

GBF Executive Director, **David Sweetnam**, then provided some additional context before introducing Roy Brooke. He noted that evaluations of hazard existence, management and remediation are often based on two distinct and somewhat differing perspectives:

A. Flooding, erosion and dynamic beaches are naturally occurring processes, which in and of themselves are not hazards. They only become hazards when human activities and development encroach on shoreline environments influenced by these natural processes. In some cases such activities have accelerated the severity of the resulting hazards.

B. Flooding, erosion and dynamic beaches are hazards that can and must be addressed through various remediation measures such as shore protection, lake regulation, and floodproofing. The siting of development within shoreline environments is a right and should not be limited by the existence and/or susceptibility of hazards within the defined stretch of shoreline.

Roy Brooke, the Executive Director of Municipal Natural Assets Initiative, addressed questions 5 and 7 (municipal infrastructure impacts and adaptation) and talked about accelerating natural-asset management for climate-change resilience. He began by explaining that natural asset management is one approach within a broader suite of approaches:

- local home-owner actions;
- local government natural-asset management (Roy's focus);
- green infrastructure (e.g., Rain City Strategy); and
- healthy coastal wetlands to absorb run-off.

He introduced some key concepts and fundamentals. The core idea is that nature is one of our most vital assets, central to any resilient infrastructure system, and potentially an investable asset. He noted that there is a case to be made for approaching natural assets collectively, including that they can benefit from the delivery of core services, they can be managed (which is the focus of local government natural-asset management), and they are often over-used and under-recognized.

Roy provided some data about the state of our infrastructure:

- the Federation of Canadian Municipalities has estimated that one third of our infrastructure is in very poor to fair condition; and
- Statistics Canada estimated in 2017 that there were 164.3 billion litres of raw sewage overflows from combined sewers (i.e., existing systems are not handling downpours effectively).

He made the case for needing new service-delivery solutions in a changing climate, and argued that asset management is a valuable tool for managing natural assets. Natural-asset management integrates two elements:

- people's skills, expertise and activities; and
- information about a community's physical assets and finances – and can yield informed decisions to support sustainable service delivery.

Roy noted that there are growing enabling environments, including the following upcoming and ongoing opportunities:

1) Public Service Accounting Board;
2) engineering sector in B.C. and beyond;
3) other professional disciplines;
4) norms for asset management cycle;
5) norms for data; and
6) funding environment.

He recommended four key resources:

- MNAI natural asset primer
- What are municipal natural assets: Defining and scoping municipal natural assets (2019)
- Asset management for sustainable service delivery: A BC framework
- Blog on what we are valuing and not valuing in natural assets: Nature: Is it worth it?

He also recommended some optional reading:

- Dasgupta review on the economics of biodiversity (UK Treasury)
- Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) summary report.

GBF and GBA executive directors, **David Sweetnam and Rupert Kindersley**, addressed questions 6 and 7. They introduced a discussion about the high-water mark (and whether municipal marks should be changed) and the land-water interface (and how municipalities can adapt). Rupert began by reminding participants of the seven elements of resiliency described in the last webinar:

- erosion setbacks;
- relocation of dwellings;
- flood elevation and protection requirements;
- shoreline alteration requirements;
- real estate disclosure requirements;
- acquisition of high-risk properties; and
- hazard insurance.

He noted that key to a number of these elements of resiliency is the high-water mark. There are significant differences in the approach to the high-water mark across Georgian Bay's coastal municipalities. Those marks that have been set are set at a lower level than the 2019/20 water level, and these may need to be re-considered given higher water levels are expected in the future.

Municipality	High-water mark
Township of the Archipelago	176.44 metres G.S.C. above sea level
Township of Carling	176.44 metres G.S.C above sea level
Township of Georgian Bay	177.4 C.G.D
Town of Northeastern Manitoulin and the Islands	measured by Ontario Land Surveyor or controlled level by a dam
Municipality of Killarney	Flexible measurement – see below*
Town of Parry Sound	Flexible measurement – see below*
Township of Tiny	178.0 metre elevation**

** Flexible measurement: "… the mark by the action of water under natural conditions on the shore or bank of a body of water which action has been so common and usual that it has created a difference between the character of the vegetation or soil on one side of the mark and the character of the vegetation and soil on the other side of the mark."*

***Note that this value is not the high water mark but actually the "flood hazard limit" associated with Georgian Bay, which was established by the Ministry of Natural Resources.*

David then asked:

- what areas of our community are at risk?
- what is the nature and magnitude of the risk?
- what is the value of the property, buildings and infrastructure at risk?
- what is the overall community vulnerability?

He described four steps – called **PARA** to match the first letter in each step – in adapting to create resilient communities:

- **Protect** – minimize loss of land and physical capital such as infrastructure
- **Accommodate** – reduce coastal flood risks to acceptable levels in human settlements
- **Retreat** – plan an efficient retreat from areas that cannot be protected in a cost-effective manner
- **Avoid**

He also described four types of tools available to municipal governments:

- planning tools – objectives and policies, coastal-hazard mapping, risk management, and emergency planning and preparedness;
- regulatory tools – subdivision regulation, building regulation, land-use regulation, and development permit;
- land-use tools – land acquisition, transfer of development potential, ease / covenant or other, land trusts, and foreshore tenure;
- structural tools – scour protection, structural elevation, dikes, other hard protection, and wet floodproofing; and
- non-structural tools – coastal wetland protection, dune building, and beach nourishment.

David concluded with a quote from Wendy Leger, co-chair of the Great Lakes-St. Lawrence River Adaptive Management (GLAM) Committee of the binational International Joint Commission (IJC):

"What it means for the Great Lakes is that we need to be prepared for extremes. Whether it's extreme weather patterns, whether it's extreme water levels, whether it's extreme droughts and storms, we just need to be prepared for extremes."

Topic B: Coastal infrastructure – Marinas and shoreline businesses Docks and other shoreline structures Impacts and adaptation strategies – Regulations

Section 2 of the webinar addressed five questions:

1) what are the impacts on shoreline businesses (including marinas), contractors, and other services of extreme high and low water levels?
2) how can those impacted adapt?
3) what to do about shoreline cabins, sheds, docks, and boathouses?
4) how should they be reconfigured (raised or moved)?
5) what are the impacts/regulations?

GBA Executive Director, **Rupert Kindersley**, introduced this section of the webinar and Rick Layzell.

Rick Layzell, CEO of Boating Ontario, addressed questions 1 and 2 by providing an overview of the issues facing the businesses that are part of our coastal infrastructure, including how water-level changes increase their capital and operating costs related to dock systems, shore-wall systems, and shoreline properties. He noted that between Tobermory and Sault Ste. Marie there are 61 marinas and 9,983 slips (or families), which means an average of 163 slips per marina. He gave an example of Kropf as a supplier of dock systems, marine cradles and hydraulic trailers, and wave attenuators to many of these businesses and to cottagers.

For dock systems, he provided an example of a marina's capital costs ($8,000 to $10,000 per slip, which means $1.6 million for an average 163-slip marina), operating costs (which include utilities), and significantly increased maintenance costs with fluctuating water levels (adjusting floats and adding, extending and shortening chains).

Rick did the same for shore-wall systems, noting marina's capital costs, estimated at $2,000 per running foot with a minimum of 300' per marina, which means a minimum of $600,000 per marina, not including the removal of existing systems and the addition of boardwalks.

these coastal businesses also need to consider their shoreline structures, which include showrooms, parts stores, fuel buildings, roadways, parking facilities, and possibly owner and staff homes. They also need to deal with permits, inspections, and regulations from local and provincial government agencies, as well as utility operators.

He described their approach to managing their businesses as one 'bite' at a time. For example, in year 1 they may address their main finger docks, in year 2 they may address secondary docks, security systems and gangways, and in year 3 they may address their shore wall. He noted that oftentimes they have to put other capital investments on hold, including roadways, major building repairs, and storage facilities.

GBF and GBA **executive directors**, David Sweetnam and Rupert Kindersley, then moved to addressing questions 3, 4 and 5. David provided the broader context for this coastal infrastructure, beginning with the need to increase shoreline resilience by respecting natural processes and enhance terrestrial and marine habitats, while continuing to provide recreational opportunities. He noted that increasing variability in water levels, more rapid transitions between extremes, and escalating violence of storms are going to present increasing challenges in managing shoreline structures that are sensitive to water level changes and waves. He suggested that those involved in new construction or relocations should consider placing structures above the minimum setback from the high water mark required by the municipality to be prepared for higher water levels.

Rupert provided some excerpts from the natural hazards section of the Ontario Provincial Policy Statement (2020):

development shall generally be directed, in accordance with guidance developed by the provincial government (as amended from time to time), to areas outside of: a) hazardous lands adjacent to the shorelines of the Great Lakes - St. Lawrence River System and large inland lakes which are impacted by flooding hazards, erosion hazards, and/or dynamic beach hazards (3.1.1);

and

planning authorities shall prepare for the impacts of a changing climate that may increase the risk associated with natural hazards (3.1.3).

Rupert noted that there are planning permission requirements for installing new/replacement docks and for relocating shoreline structures, as well as setback requirements, and some of these vary by municipality:

	Crib docks	**Floating docks**	**Shoreline structures**
Regulatory authority	MNDMNRF*	Municipality	Municipality
Relocation along shore	Approval	Dock permit	Building permit Planning permission
Relocation up/down shore	N/A	None	Building permit Planning permission
Expansion	Approval	Dock permit	Building permit Planning permission
Removal	Approval	None (safe disposal important)	Demolition permit
Reconfiguration raising	Approval	None	Building permit

**Ministry of Northern Development, Mines, Natural Resources and Forestry is the new name for MNRF*

He offered a number of suggestions:

- raising buildings that do not have plumbing and extensive decks is usually straightforward;
- relocating is more expensive but may be the best solution if higher ground is available;
- some boathouses can be converted to floating structures (and these may be a better solution when consider a new/replacement boathouse); and
- contractors will have solutions.

David gave an example of new dock structures (e.g., with spring-loaded arms that can absorb energy and accommodate water-level changes) and of a house built on 'honeycomb' foundation (allowing it to float when the need arises because of rising water levels).

He concluded with a quotation from an article in The Conversation by Daniel Macfarlane, Senior fellow, Bill Graham Centre, University of Toronto and Associate Professor, Western Michigan University:

"If a property along the Great Lakes is getting wet now, it will almost certainly be wetter in the future. While there is some scientific uncertainty about exactly what climate change will do to water levels, the extreme highs and lows will get worse. Volatility is the new normal."

Questions and Answers

Answers to the questions posed in the Q&A session and on registration have been collected into a document that will be posted on the GBA and GBF websites.

Final observations

The webinar led to significant improvements in awareness and knowledge.

On registration:

Question	Responses
Do you understand the future uncertainty predicting a broader range of extreme high and low water levels, the potential impacts on your property shorelines and shoreline structures and what to do about it?	I don't think extreme water levels changes are an issue for the future of my property shorelines and shoreline structures: 1.0% No, I am looking for help: 11.2% Somewhat, but I would like more up-to-date information and more solutions: 85.7% Yes - I am an expert on water level fluctuations and future forecas ts and their impacts on my property shorelines and shoreline stru ctures: 2.1%

Webinar segments	**Before presentations**	**After presentations**
Topic A - Storms, wakes and waves	Do you know what to do?	Have you learned more about what to do?
What to do on your shoreline to reduce impacts from storms, waves, and wakes.	Yes: 28% Somewhat: 54% No: 18%	Yes. I will take action to reduce boat wakes and naturalize my shoreline: 36% Somewhat. I have learned a little more and will take the actions that work best for me: 55% No. I do not believe these actions will make a difference: 3% No. I already take these actions: 6%
Webinar segments	**Before presentations**	**After presentations**
Municipal infrastructure	Do you understand the challenges?	Do you have a better understanding of the challenges?
Challenges facing municipalities in addressing extreme water levels and more frequent and intense storms.	Yes: 33.3% Somewhat: 48.0% No: 18.7%	Yes: 64.4% Somewhat: 31.1% No: 4.5%

Topic B - Coastal Infrastructure and Long Term Planning			
I am concerned about the ability of service businesses like marinas to adapt to extreme water conditions.			Yes: 52.7% Somewhat: 35.9% No: 11.5%
Before presentations		**After presentations**	
Do you have one or all of the following: docks; shoreline cabins, sheds and/or boathouses?	Yes. I have one or more of these structures: 87.2% No. I don't have any of these: 12.8%	Based on the presentations about docks; shoreline cabins, sheds and/or boathouses, and high water – I feel:	I am relieved. My structures are fine where they are: 21% I will look into the suggestions and act where possible: 65% I have no shoreline structures: 8% The solutions presented do not help my situation: 6%

Exit Poll:

Question	Responses
Rate your experience of this webinar: Shorelines, Docks & Shoreline Structures Part of the Extreme Water Levels webinar series:	Met my expectations: 64% Exceeded my expectations: 22% I did not find it relevant: 3% Did not meet my expectations: 9%
Given the information you learned in the webinar about the impacts of Waves, Extreme Water Levels, and Actions that Can Reduce Damage, including Shoreline Naturalization – will you take action?	Yes. I will take action: 65% I would, but I have already taken action: 17% I don't need to take action: 15% I don't believe extreme water levels create conditions that require action: 0%