Integrated Assessment on Water Level Variability and Coastal Bluffs and Shores in Northern Milwaukee County and Southern Ozaukee County, Wisconsin
Response Options
Phase 2 Report to the Graham Sustainability Institute at the University of Michigan
November 11, 2016

EXECUTIVE SUMMARY

The Lake Michigan coast from Shorewood to Port Washington in southeastern Wisconsin is characterized by coastal bluffs ranging from 70 to 140 feet in height. Lake Michigan water levels were below the long-term average from 1999 to 2014, but have risen approximately four feet from the record low monthly average in January 2013. This rapid rise in Lake Michigan water levels is causing concern among property owners and local officials about impacts to beaches and the stability of coastal bluffs.

In March 2015, a team of investigators representing disciplines including coastal engineering, geology, urban and regional planning, law, policy studies, ecology, landscape architecture, and social science led by the University of Wisconsin Sea Grant Institute received a planning grant from the Graham Sustainability Institute at the University of Michigan to explore the impact of changing water levels on coastal bluffs in northern Milwaukee County and southern Ozaukee County. In November 2015, Wisconsin Sea Grant received word that it was one of four teams to receive funding from the University of Michigan to collaborate in a full Integrated Assessment lasting 18 months and building on the findings of the planning grants.

The full Integrated Assessment consists of three phases: synthesis of existing data and information, identification and assessment of a range of response options, and integration of local findings into a regional report. This Phase 2 report utilized extensive community engagement to identify and prioritize structural options for property owners, policy options for local government and outreach and tools to guide decisions. This engagement was led by a pair of experienced community facilitators and the Social Science Outreach Specialist at Wisconsin Sea Grant. It included three community conversations attended by over 140 people during the summer of 2016 to provide background on water levels and coastal bluff processes and resources to address coastal erosion, as well as listening to hopes, wishes, concerns and issues for a healthy and vital future for coastal bluffs and shores. Project staff reviewed the results of a brainstorming exercise to capture hope, wishes, concerns and issues and interviewed investigators and partners to develop 29 response options to analyze and prioritize. This was accomplished using an audience polling system at a three-hour evening meeting on October 27, 2016 and was presented to local officials and project partners the following morning.

In general, there was very strong support for education, outreach and decision support tools. Policy options receiving strong support included collaboration among neighbors, updated bluff-top construction ordinances, easing approval for offshore structures and establishing a trigger mechanism for policy review when water levels or erosion rates exceed a threshold. Review of structural options showed that, "greening" of conventional gray infrastructure shore protection approaches was viewed most favorably.

INTRODUCTION

Location

The location covered by this integrated assessment covers approximately 28 miles of the Lake Michigan coast from the Town of Port Washington on the north to the Village of Shorewood on the south (see Figure 1). This stretch of coast is characterized by bluffs ranging from 70 to 140 feet in height that are prone to episodic erosion – red areas along the shore indicate unstable bluff conditions in 2007-08, while green areas indicate more stable bluff conditions. Local governments include two cities (Port Washington and Mequon) and two townships (Port Washington and Grafton) in southern Ozaukee County and four villages (Bayside, Fox Point, Whitefish Bay, and Shorewood) in northern Milwaukee County.

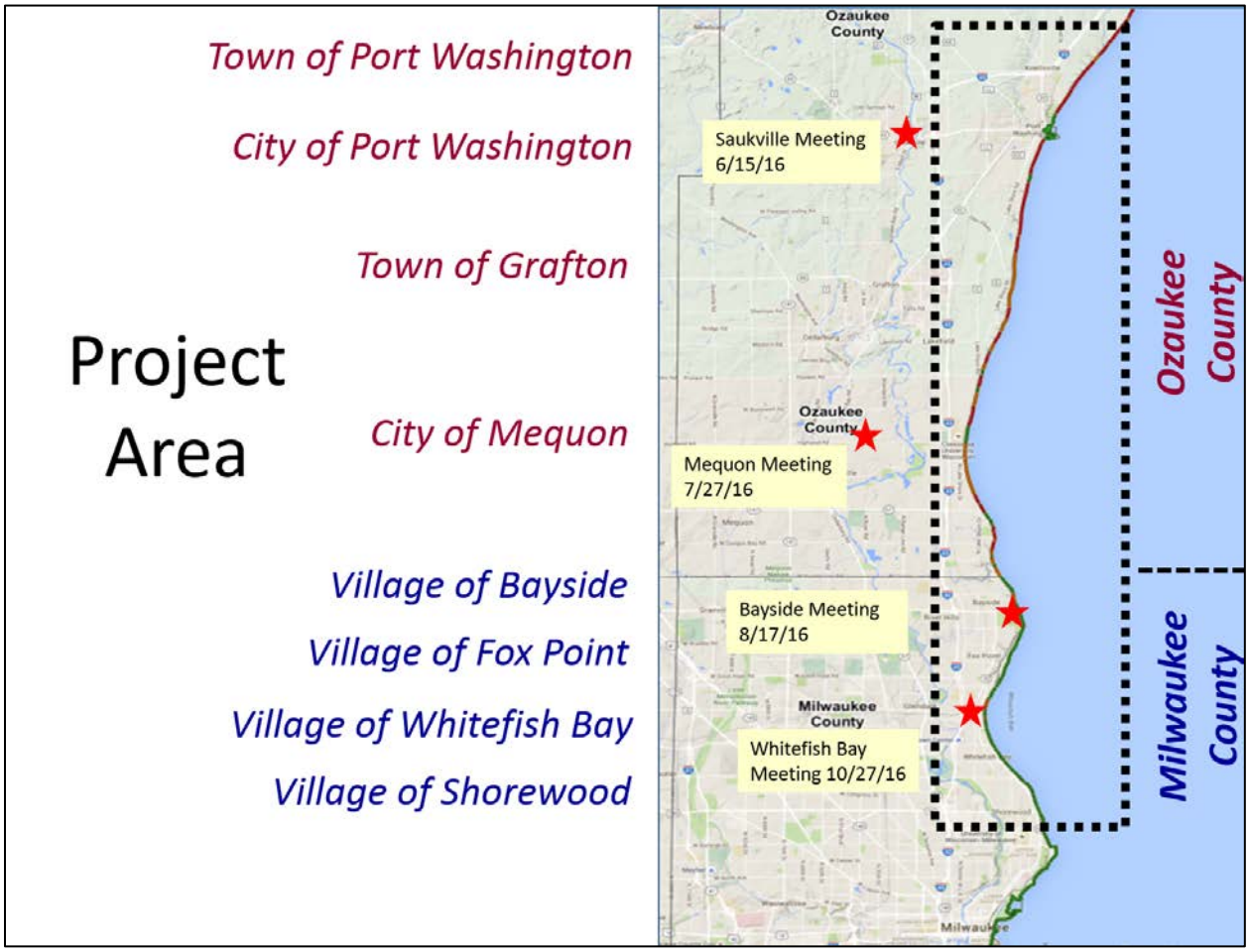


Figure 1. Project Area Including Locations of Community Meetings

Water Level Challenges and Phase 1 Findings

The primary impact areas that are addressed by the integrated assessment reflect the influence of changing Lake Michigan water levels on coastal bluff erosion. Impact areas discussed in this report include: 1) changes to beach and bluff toes due to higher water levels; 2) impacts of shore protection structures; and, 3) changes to the lake bed, bluff face and bluff top. The following section presents a brief summary of the status and trends concerning changing water levels and

coastal bluff erosion between Shorewood and Port Washington, Wisconsin and the corresponding consequences of those trends.

Summary of status and trends:

- Water levels have been increasing during the last four years. Lake Michigan water levels were below the long-term average from 1999 to 2014 and quickly jumped above that average in spring 2014.
- From 1976 to 2012, there was a trend towards more stable coastal bluffs in the study area. Despite the general trend, new bluff failures continue to appear in the study area.
- There has been an increase in shoreline structures in the study area built since high water levels in 1976. Specifically, from 1976 to 2007, armoring of the Lake Michigan shore increased from 9.6% to 27.3% in Ozaukee County and from 44.6% to 62.7% in Milwaukee County.
- In recent years, waves are causing new bluff toe failures influenced by decreased beach widths.
- Lakebed downcutting has been observed at one location within the study region.
- In recent years, there have been legislative changes in Wisconsin that favor an increase in private property rights.
- The rapid rise in Lake Michigan water levels since January 2013 is causing concern among property owners and local officials.

Consequences of these trends:

- New single-property shoreline protection structures are designed and constructed with little planning for potential regional impacts.
- Properties with shoreline structures had bluffs with higher factors of safety than those with no structures.
- Water levels will remain high in the near term. Water levels will probably fluctuate in the longer term, but are not likely to go down and stay down.
- New bluffs are failing which were initially stable, especially those adjacent to newly built shoreline/bluff protection structures.
- Lakebed downcutting is expected to continue due to the prolonged low water level period.
- Beaches are likely to continue to lessen in width and/or disappear. It is anticipated that the current higher water levels above long-term averages in Lake Michigan coming after the extended period of low levels could have an impact on nearshore bathymetry and beaches and correspondingly affect the stability of coastal bluffs.
- Waves will continue to cause bluff toe erosion if no shore protection is present.
- The increase in shoreline structures will occur on a piecemeal basis.
- The increase in shoreline armoring will decrease the amounts of regional littoral material in reach with the structures. The significance of this increase in percentage of armored shoreline not only in just the study area, but also in the Wisconsin Lake Michigan shoreline region-wide is that there are significant changes in the historical availability of littoral sediment supply. That change being a regional starvation of previously available sediment, as it has been removed from what would have been natural littoral drift. The result of this starvation would mean greater regional erosion potential such that the

impacts of individual shoreline structures should be considered within a regional sediment analysis.

- The presence of a structure at the toe of the bluff showed a large increase to the bluffs factor of safety when compared to bluffs with no type of shoreline protection. It is important to note that this result looks only at the bluff immediately behind the shoreline protection and not adjacent bluffs which may be impacted by the neighboring structure (regional sediment management).
- Lakebed downcutting will continue to occur and influence wave energy at bluff toe as well as changes to regional sediment budgets. The lakebed study concluded that "for future coastal development and management in the Great Lakes, the local geomorphologic and hydrodynamic conditions have to be taken into consideration in the planning and designing stages to provide a more thorough picture on the consequences of coastal structures."

Phase 2 Overview

Phase 2 of the Wisconsin Great Lakes Water Levels Integrated Assessment included extensive community engagement to identify and prioritize a range of adaptive actions, policy alternatives, education and outreach options, and decision tools. This engagement was led by a pair of experienced community facilitators and the Social Science Outreach Specialist at Wisconsin Sea Grant. It included three community conversations attended by over 140 people during the summer of 2016 to provide background on water levels and coastal bluff processes and resources to address coastal erosion, as well as listening to hopes, wishes, concerns and issues for a healthy and vital future for coastal bluffs and shores. Project staff reviewed the results of a brainstorming exercise to capture hopes, wishes, concerns and issues and interviewed investigators and partners to develop 29 response options to analyze and prioritize. This was accomplished using an audience polling system at a three-hour evening meeting at the Jewish Community Center in Whitefish Bay on October 27, 2016 and was presented to local officials and project partners the following morning.

IDENTIFICATION OF RESPONSE OPTIONS

Identification of adaptive actions, policy alternatives, education and outreach options, and decision tools to address variable water levels and coastal bluff erosion in the study area involved a two-step process: listening to and recording the hopes and wishes, concerns and issues for a healthy and vital future for coastal bluffs and shores at a series of three community conversations and interviewing investigators and partners to build on community feedback and identify a wide range of options for addressing their hopes and wishes, concerns and issues. Development of response options was also influenced by review of interviews conducted during the planning grant in 2015 and ideas presented in the research synthesis during Phase 1 of the integrated assessment.

Structure of Community Conversations

This section focuses on preparing for, attending, recording and summarizing three community meetings held in the project area during the summer of 2016. The first meeting covered the Town and City of Port Washington and the Town of Grafton in the northern part of the project

area. It was held at the American Legion Hall in Saukville on June 15th with an attendance of 45. The second meeting covered the City of Mequon in the middle of the project area. It was held at the North Reuter Pavilion in Mequon on July 27th with an attendance of 55. The third meeting covered the four villages of Bayside, Fox Point, Whitefish Bay and Shorewood in the southern part of the project area in northern Milwaukee County. It was held at the Schlitz Audubon Nature Center in Bayside on August 17th with an attendance of 43.

The meetings were conducted by community engagement specialists Bert and Linda Stitt and each followed a similar format: The meetings began with initial introductions, giving everyone in the room (not just the presenting team) a chance to provide their name, area of residence and general purpose for attending the meeting. Introductions were followed by a presentation, given by David Hart, discussing the origins and purpose of the Great Lakes Water Levels Integrated Assessment, the drivers of lake level variability, the role of these community meetings and the upcoming stages of the project. The presentation was followed by a quick round of questions and comments from the audience and then by a brainstorming exercise that was the central component of the meetings. Once this exercise was concluded, each member of the room was asked to give their thoughts on the meeting. Each component of the format served a purpose, both for the audience for the members of the Integrated Assessment team. The following is a reflection on each component, including its purpose and effectiveness.

Introductions

For the audience, the initial introductions were an opportunity to know who was in the room, to speak their mind and lay out any ideas that they felt were critical to the agenda. For the project team, they were a snapshot of the concerns of this group as well as an opportunity to see the social structure of the room. Every meeting had groups of friends and couples that attended and at the first meeting there was a large contingent of neighbors. From the standpoint of the project team, the introductions revealed community leaders and social networks that could be important for enacting any ideas or actions that come out of the Integrated Assessment.

Presentation

While the presentation provided some good background information on the science behind the rising water levels of the Great Lakes, the project team felt that its true purpose was to clarify roles. The researchers were there to listen to the hopes and wished, concerns and issues of the audience. The input from these meetings would be used by the researchers to generate a list of options and solutions. In a subsequent meeting, the community members would be the ones to prioritize those options into recommendations. The researchers were not there to provide the solutions, but to facilitate their formation by the communities themselves.

Q&A Session

The question and answer session immediately following the presentation was important as a space for the audience to verbally process the message from the presentation. A common statement during the introductions was some form of “I’m here because I want answers about what to do or what’s going to be done.” Accepting that the purpose of the meeting was not to provide a range of solutions took some adjustment. The question and answer session gave everyone a chance to relieve some of their own anxiety by asking specific questions or making

specific comments. They knew they might not get an immediate answer, but at least they could ask and know that their questions were helping to inform the project.

Brainstorming Exercise

From the perspective of the project team, the centerpiece of the meetings was the brainstorming exercise that followed the question/answer session. This was a simple exercise that involved having the audience members write down hopes/wishes and concerns/issues on sticky notes. The team members gathered those notes and then began to group them into general themes. By taking this approach, the communities generated ideas for solutions and gave the project team several directions to focus on when developing options.

In its full form, this exercise was supposed to include two steps, with the brainstorming followed by a group analysis in which the audience read the comments and made some kind of mark (marker, pen, red sticker-dot) to indicate which ones strongly resonated with them. Because of the length of the presentation and Q&A session, the project team did not have the time needed to fully complete that exercise and so stuck with the brainstorming. This was an important lesson in terms of trying to schedule adequate time for this kind of exercise into a community engagement meeting. The brainstorming exercise alone was very useful, but adding a group analysis component to it would certainly have enhanced it by highlighting the ideas around which consensus is likely to form. To a certain extent, that analysis occurred in the final Reflection component of the meeting and gave a hint of the power of a full version of this exercise. It is important to note that the group analysis of the sticky notes from the three meetings did occur at the prioritization meeting in late October.

Reflection

The final component of the meetings was a reflection. Every person in the room was asked "What happened here tonight?" or "How did we do?" In the opinion of the project team, this was the part of the community meetings that varied the most in terms of efficacy. The reflection was lengthy and extremely valuable in Saukville, shorter and less powerful in Mequon and almost non-existent at the meeting in the Schlitz Audubon Nature Center. What the project team took away from that spread was the impact of the space the meeting was held in and the format that the reflection took.

The Saukville meeting was held in the Saukville American Legion Hall. The space was comfortable (well-lit and well air-conditioned) and nicely finished on the interior without being overly formal. For the final reflection round, the project team pulled the audience into a circle for the exercise. Everyone participated and what started initially as a commentary on the meeting and assessment turned into a group conversation about what the community needed and could do. The project team saw consensus form around certain topics like a desire for clearer guidelines on regulations and the need for a collective approach to solving the erosion problems. The Brainstorming exercise was not as fruitful at the Saukville meeting as it was at the other two, so this reflection round turned out to be extremely valuable.

In Mequon, the meeting was held in a facility at one of the local parks. The structure was well-lit, but quite warm and the interior was mostly concrete and cinder-blocks and was the least formal of the spaces we used for meetings. The audience was larger in Mequon and rather than

pull everyone into a circle, the reflections just went around the room. The reflection here was still effective in that people spoke their minds and made some closing statements but the conversation among the members was more limited. In Saukville, the audience was talking to each other, while in Mequon they were mostly addressing the project team.

The meeting at the Schlitz-Audubon Center had the weakest reflection round. Most audience members simply said "thank you" or nothing at all or left during the discussion. The Nature Center was the smallest space we were in and by far the nicest in terms of interior finishing. The physical aspects of the room as well as the fact that it was located in a Nature Center gave it more formality than at the previous meetings. As in Mequon, the audience remained in their place during the reflection, rather than forming a circle.

How important was the reflection component of these community meetings? The answer to that depends on whether or not the brainstorming exercise used would include the group analysis or not. However, even if the group analysis had occurred at the summer meetings, the project team feels a reflection component like the one in Saukville would still be extremely useful. It gives the audience a chance to process all of the ideas and discussion, engage with each other to begin to reach some consensus and to address the community rather than the researchers with any outstanding concerns. Given that ultimately any solutions that are enacted will have to involve some level of political and/or financial commitment from the communities, giving them a chance to address each other as a group in that manner is extremely important. To foster that kind of interaction, a certain set of conditions is necessary. The space needs to be comfortable enough to want to stay in but shouldn't be so formal that people feel like they have to be on their best behaviors. In New England, where a town hall tradition remains vigorous, many communities use a local Grange Hall, as these were comfortable spaces already used for community meetings by the local dairy farmers and yet were not as formal as the local churches or administrative buildings. The American Legion Hall in Saukville had a similar feeling to it, whereas the Schlitz-Audubon Nature Center in Bayside was too formal and the structure in Mequon was not formal enough. However, physical conditions of the space are definitely secondary to the formation of a circle. Pulling people away from their initial tables and groups and having them face each other rather than the researchers was critical to fostering a genuine group conversation.

Outcomes of the Community Meetings: Themes, Needs, Opportunities

Themes

The questions and comments that occurred in each component of the meeting were identified and grouped into general themes as shown below. Figure 2 shows the number of times this theme came up in each meeting and in total.

- Beaches, Not Bluffs: This category includes comments or questions that focused specifically on beaches, either to include them in the discussion or to distinguish them from the issues with bluffs. Common questions focused on whether or not the erosion processes for beaches were different than for bluffs and required different approaches for stabilization. This topic was minor overall but most important in the Saukville meeting where many of the members came from low-lying areas north of the bluffs in the project area.

- Education about Legislation and Legislative Changes: This topic covers a range of questions and concerns related to policy. Many people expressed the need for clearer guidelines pertaining to getting permits for individual action. There was also a great interest in recent changes to legislation that have occurred at the state level. There was a consistent expression of the need for some type of legislative changes to be made. However, the nature of the changes varied, from much tighter and more consistent controls at the state level to looser controls and quicker permitting processes from those folks who felt they didn't have time to wait. This topic also includes calls for greater education of the town or city planners, required education of homeowners on bluff properties. Finally, at the first meeting there was an expression of disappointment in the low attendance of representatives from any state, county or federal agencies or even from the municipal governments, though in fact the mayor of Port Washington and a member of the Ozaukee County Parks and Planning department were in attendance. The last two meetings both had a more visible presence of various officials, so this issue did not come up again.
- Education about Stabilization Solutions: This was one of the most frequently occurring topics and it came up at every meeting. People want to know what they can do. Some people wanted a range of options to choose from and some wanted clear guidance from the government on what to do. In the Schlitz-Audubon meeting, there were more questions about best management practices and greener approaches to stabilization, while the first two meetings mostly focused on engineered solutions. This is perhaps not surprising given the extent of shoreline armoring that has already occurred in the coastal villages north of Milwaukee where most attendants to the third meeting live. Whether or not people wanted a range of options or clear guidance, engineered or green solutions, the most common desire was that any options they chose carried no risk of violating some regulation or requirement resulting in the property owner having to pay fines and pay for more work to be done. This topic also includes interests in the solutions employed by other regions. At every meeting, members were curious about how other lakeshore communities were handling the problems.
- Collective Action, Legal and Financial Solutions: At every meeting, there was a clear call for collective action, with two clear motivators. Many people have seen how individual actions had consequences for surrounding properties. This was an especially hot topic in the Mequon meeting, where many of the audience members had been involved in an unsuccessful legal action against Concordia University, claiming that the University's bluff stabilization plan was causing faster and more dramatic erosion to properties on both sides of the project. So one motivation behind collective action was the desire to have a coordinated plan that everyone was committed to with the purpose of avoiding those kinds of problems. The other motivation was financial. Many people simply do not have the resources to have stabilization structures built on their properties. These two motivators clearly reinforce each other. If an engineered design is proposed that is large enough to protect several miles of bluff, then it will absolutely have to be paid for by a group. By contrast, if each person is left to their own devices, the effectiveness of structures could be compromised by the piecemeal nature of implementation. However, while it was clear at each meeting that there is a lot of consensus and enthusiasm for collective action, it is equally clear that people do not know how or where to begin.

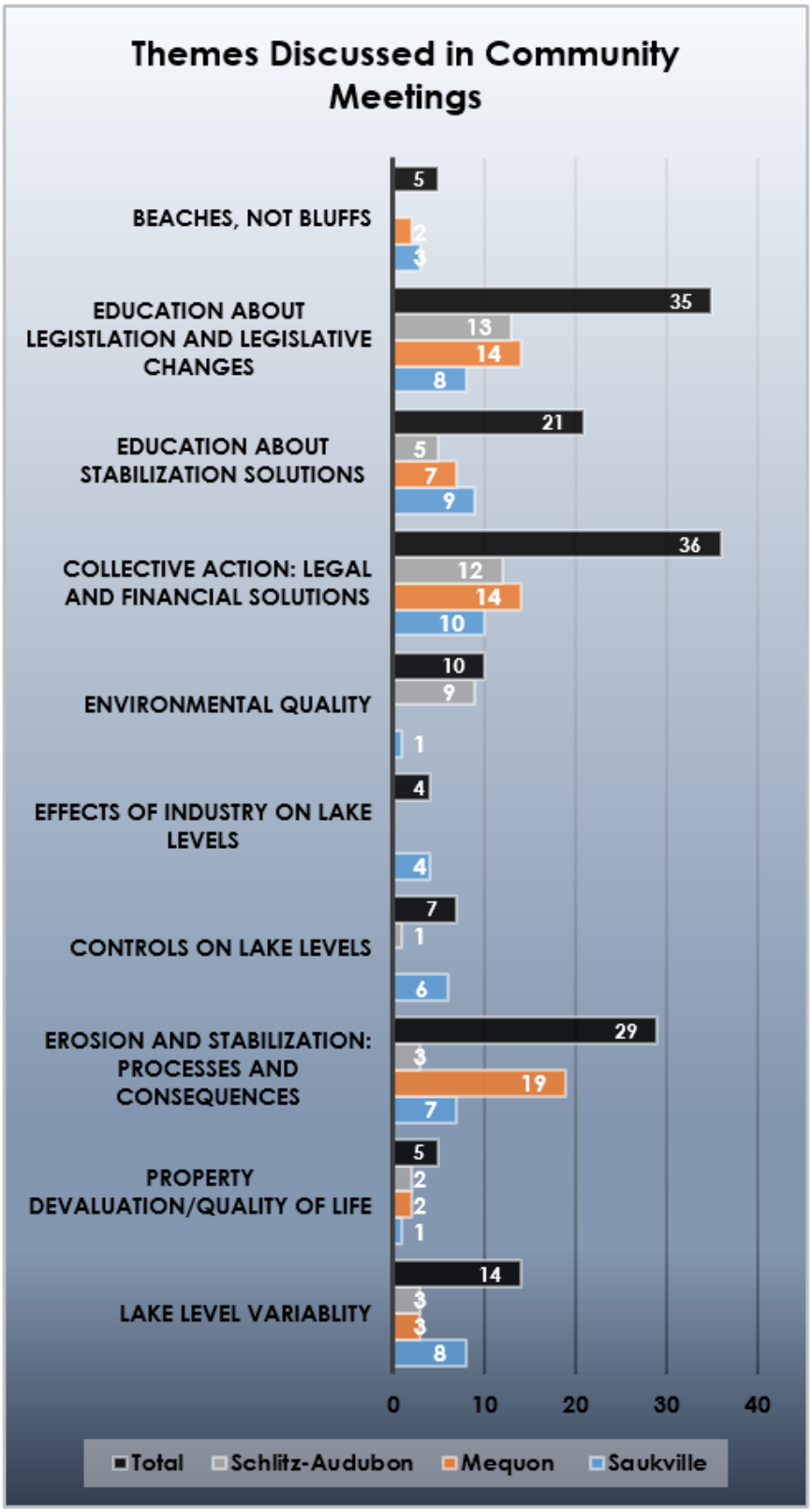


Figure 2. The frequency in which comments or questions pertaining to a particular topic came up in the three community conversations during summer 2016.

- Environmental Quality: This was a fairly minor topic that was most important in the final meeting held at (unsurprisingly) the Schlitz-Audubon Nature Center. Communities closer to Milwaukee are more intimately familiar with water quality issues as well due to a large waterborne disease outbreak in the city in 1993 and ongoing beach contamination issues. Again, it is important to note that the more extensive armoring in the coastal villages and associated reduction of immediate concerns about bluff failure and houses tumbling into the lake, the community seems to have shifted focus to interest in greener approaches, increased access to shoreline and stronger regulations against cutting down trees to improve the view.
- Effects of Industry on Lake Levels: This topic only came up in the Saukville meeting and was focused on the idea that influence from shipping and fishing interests drove abnormal operation of the control structures linking the lakes, tailoring lake levels to their respective needs.
- Erosion and Stabilization Processes and Consequences: This was the third most frequent topic and reflects the general confusion and concern about the bluffs. This topic mostly includes questions and concerns focused on getting more information about erosion processes along bluffs and beaches and also (quite frequently) how new structures can impact surrounding properties. Some of this, especially in Mequon, may relate to confusion over why some bluffs seem more stable than others, why beaches seem to appear and disappear and what the long term consequences of particular actions might be.
- Property Devaluation/Quality of Life: This topic appears minor but that's only because questions explicitly concerning property values or loss of nice community resources were relatively rare. However, those issues were absolutely tied up in the more common questions about solutions, consequences and collective action. For many, the issue of property devaluation was so obvious that it didn't really need to be stated.
- Lake Level Variability: This was a common theme that mostly consisted of calls for explanations on what drives changes in lake levels. These were most frequent at the Saukville meeting and skepticism was prevalent that lake level variability was natural. In the second and third meetings, we added some material to the presentation specifically addressing the climatological drivers of the sudden increase in lake levels and in those meetings there were far fewer questions about what was causing the variability. It should be noted however, that some curiosity about the extent of human control over the lake levels existed at each meeting and points to an information need.

Needs and Opportunities

When it comes to solutions to the problems resulting from lake level variability and bluff erosion, the purpose of the Great Lakes Water Levels Integrated Assessment in Wisconsin is not to make a series of specific recommendations. The purpose, instead, is to present options for various solutions, tools and resources to community members and stakeholders and gather their response. The community will determine which options presented are the most appealing and worth implementing. The three meetings discussed here were intended to provide some sense of what types of solutions, tools and resources to present to the community.

The most important areas of concern were focused on collective action, legislation, erosion processes and the consequences of various stabilization efforts. Each of these areas point to information needs that could be addressed by tools and resources. A comment that came up in

the Mequon meeting was that communities should form Lake Management Districts as a legal and financial framework for addressing the problems as a group. Currently, it doesn't seem that state and federal legislation supports a coastal version of a lake management district. However, there are other methods of banding together and sharing costs and responsibility that are supported, such as Neighborhood Improvement Districts. Tools and resources that could be useful could include case studies and how-to guides for taking advantage of existing methods for collective action, or guides on how to drive adoption of new legislation at various levels of government. If there seems to be strong interest in a particular type of solution, a resource might be a series of community workshops on that topic. This topic offers many potential opportunities for community members and government representatives at all levels. These issues could drive the development of entirely new legal frameworks for resource and property management or simply adaptation of existing frameworks to a new situation.

When it comes to legislation, the initial need is for clarity. People are confused about different ordinances, regulations and permitting procedures and there is an opportunity for either the production or consolidation of any number of resources helping to educate people about existing legislation. Increased awareness and clarity of these rules will also lead to many opportunities for policy revision. At one meeting, there was discussion of designing a new setback ordinance based on hard science about erosion rates and risk rather than a one-size-fits all number.

The topic of erosion processes is closely linked to the topics of stabilization consequences and solutions. While there was certainly some general scientific interest about erosion, the majority of interest in erosion was specifically concerned with identifying long term solutions to it and understanding how those solutions might affect other areas. There was also some concern specifically about how beaches might be affected by bluff stabilization. This topic presents many opportunities for regional comparisons. Specifically, there might be some perspectives that have come out of the heavy shore armoring around Milwaukee that should be shared with residents in Ozaukee County. A comment from the brainstorming exercise at the Schlitz-Audubon meeting is particularly telling: "I worry that your groups are merely managing the gradual destruction of the natural shoreline." From that comment, as well as individual discussions with members of the audience, I got a sense that many people felt that they gained bluff stability at the cost of being able to enjoy the shoreline. One woman in particular spoke of long walks she used to take along the shore that are now completely inaccessible because she has to climb over rocky structures shoring up the bluffs. The reason these viewpoints might be important to share with Ozaukee County residents is that there was a single-minded focus on engineered solutions in the Saukville and Mequon meetings. It appears there is a lack of knowledge about and confidence in non-structural solutions to bluff erosion in these areas. Some examples of where and how those approaches are effective, presented in conjunction with perspectives from Milwaukee County could help communities develop a strategy with a range of solutions that strike a balance between bluff stabilization and shore access.

Identification of Response Options

As described above, identification of adaptive actions, policy alternatives, education and outreach options, and decision tools to address variable water levels and coastal bluff erosion in southeastern Wisconsin evolved from 19 interviews conducted for the Planning Grant in 2015, synthesis of research conducted in Phase 1 of the Integrated Assessment, listening and recording

the hopes, wishes, concerns and issues for a healthy and vital future for coastal bluffs and shores at a series of three community conversations.

With that knowledge in mind, the project team began developing response options through a series of one-on-one interviews with our investigators and partners (see Table 1). All of the interviews followed the same general format, beginning with a review of the existing options and a review of the themes that came out of the summer meetings. Each interviewee was asked a similar series of questions. First, they were asked for any options that they felt were strongly needed and were missing from the current version of the list. This was a multi-purpose question. It not only gave each interviewee an immediate chance to leave their mark on the list of options, but also gave them a chance to voice their opinion about what issues they felt were integral to a healthy and resilient coast. For those interviewees who were part of a partner organization, a common follow-up question was to ask what they felt was the biggest barrier to implementing what they considered were the most important options. This often helped to generate ideas for tools or data to increase understanding. For example, a challenge to implementing a risk-based setback ordinance was the need for up-to-date estimates of erosion rates and groundwater flow and a framework in which the risk of bluff collapse based on criteria such as bluff slope, recession rates and bluff-toe erosion could be calculated.

Table 1. Interviews to Guide Development of Response Options

Name	Title and Organization	Date
Brian Ohm	Professor, Department of Urban and Regional Planning, University of Wisconsin-Madison	September 7, 2016
Kathi Kramasz	Water Regulations and Zoning Specialist, Wisconsin Department of Natural Resources	September 15, 2016
Chin Wu	Professor, Department of Civil and Environmental Engineering, University of Wisconsin-Madison	September 16, 2016
David Mickelson	Professor Emeritus, Department of Geosciences, University of Wisconsin-Madison	September 17, 2016
Adam Bechle	J. Philip Keillor Science-Policy Fellow, Wisconsin Coastal Management Program and University of Wisconsin Sea Grant Institute	September 20, 2016
Jenny Kehl	Professor, School of Freshwater Sciences,	September 22, 2016

	University of Wisconsin-Milwaukee	
Deidre Peroff	Social Science Outreach Specialist, University of Wisconsin Sea Grant Institute	September 23, 2016
Bert Stitt	Principal, Stitt and Associates	September 23, 2016
Kathleen Angel	Federal Consistency and Coastal Hazards Coordinator, Wisconsin Coastal Management Program	September 27, 2016
Gene Clark	Coastal Engineering Outreach Specialist, University of Wisconsin Sea Grant Institute	September 28, 2016
Michael Hahn	Deputy Director, Southeastern Wisconsin Regional Planning Commission	September 28, 2016

The conversations then moved on to considering the themes that came out of the summer community engagement meetings. In the broadest terms, the public voiced a desire for collective action to address erosion control measures, support, either financial or technical, from the government and finally a desire for tools or resources to help them understand the science behind lake level variability, coastal engineering techniques and the relationship between bluff and beach erosion. Each interviewee was asked to consider options that would specifically respond to or support these themes. This was often the richest part of the interviews and frequently led to interdisciplinary questions. An investigator whose academic background was focused on urban and regional planning would discuss various options for collective action but also bring up the need for better decision support tools, stating that any discussion of collective action to implement a project could only come after an appropriate project had been selected. Similarly, an investigator focused on coastal engineering would state that to really support some innovative approaches to erosion control along the Wisconsin coast of Lake Michigan, changes were required to permitting and approval guidelines. Finally, each interview wrapped up with a verbal summary of the discussion by the interviewer, ensuring that ideas were accurately captured. Frequently, it was fruitful to restate the original call for new options as most conversations inspired new ideas for the interviewees.

Every interview resulted in either new options or refinements of existing options for the list. The project team shared written summaries of the interviews with the investigators and partners and invited questions and comments. At first, no idea was left out of consideration, but as the team moved forward with developing the list that would be presented to the public, larger collections of ideas were condensed into specific options. Some of the ideas were well established, while others were very preliminary and would require much future vetting. Since the ideas were generated by a diverse team of investigators and partners representing a range of disciplines, it is important to note that differing views could exist on any given response option. The process was designed to generate a full range of possible ideas to consider. It was expected that only a subset

of the options would generate enough interest for further implementation. It will be up to property owners and/or local communities to decide whether to implement any of the ideas.

In the end, a total of 29 options were developed for presentation to the public at a three-hour evening meeting at the Harry and Rose Samson Family Jewish Community Center in Whitefish Bay on October 27, 2016. The options were grouped into three topics: structural options that could be taken by the property owners; policies to be considered by local governments in the project area; and outreach and education activities that could be performed by the institutions involved in the assessment. They are presented in Tables 2 through 4.

Table 2. Structural Options: Physical Modifications to Coastal Property

Option	**Definition**
Gray Infrastructure	*Common interventions using earth, rock or concrete.*
Revetment	A protective structure of stone/concrete/sandbags parallel to the shore with a sloping face designed to protect against wave erosion.
Sea Wall	A vertical or sloping wall running parallel to the shoreline typically at base of bluff made of stone, concrete, steel/vinyl sheets.
Breakwater	Offshore structure made of stone/concrete blocks. Can be floating or built on lake bed. Can be submerged. Can be continuous wall or series of segments.
Groin	Perpendicular structures jutting into the lake from shoreline. Made of stone or concrete rubble or steel sheet pile. Most often used on beaches to prevent beach loss, by replenishing sediment.
Bluff Regrading	Cutting into face of bluff to create shallower, more stable slope.
Groundwater Drainage	Groundwater seeping through face of bluffs can compromise stability. Drainage systems can be added to drain the groundwater and stabilize the bluffs.
Green Infrastructure	*Approaches with less alteration of the bluffs/shoreline.*
Managed Retreat	Moving structure back from edge of bluff. Can be a last resort or can be performed pre-emptively in combination with bluff regrading for long-term solutions.
Artificial Beaches	Adding sand/sediment to shoreline to restore beaches washed away by erosion.
Living Shoreline	Using native plants and stones to resist shoreline erosion.
Greening of Gray Infrastructure	*Using a combination of hard construction and vegetation approaches.*
Breakwater with Living Shoreline	Offshore breakwater built using common gray construction techniques to reduce wave energy. Lower wave energy allows use of green approaches on shoreline for additional protection.
Living Breakwater or Artificial Reef	Offshore structure built with porous material, often includes vegetation and sand on exposed portions.

Living Revetment/Sea Wall	Use of native vegetation to improve stability of shoreline/bluff face behind an existing revetment or seawall.

Table 3. Policy Options: Revised or New Authorities Regarding Management of the Coast

Option	Definition
Collective Action/Funding	Ideas for neighbors, municipalities, and states to collaborate and address Coastal Erosion Issues, including funding projects, sharing information and regulating practices.
Collaborating with neighbors	Work together to share the costs of a larger project that benefits multiple properties.
Neighborhood Improvement District	Using Wisconsin ACT 186 (2005), neighborhoods of residential or mixed residential and business properties can form a NID Board to develop and contribute to improvement projects.
Create aid fund for bluff and shore properties	Formation of a fund for use in erosion control, bluff stabilization or managed retreats by properties along bluffs and shores.
Form a Great Lakes Regional authority	The issues faced by residents along the Great Lakes are as big as the lakes themselves. Should an inter-state or international authority be formed to coordinate, regulate and fund a big-picture, regional approach to management of the lakes?
Permitting Guidelines	*Ideas for alterations to current permitting guidelines for shoreline structures.*
Include sediment study/impacts in site plans	Require site plans to include study of sediment flow in site and potential impacts on sediment flow from new structure.
Include funds for monitoring in permit	Add fee to permit to create funds for monitoring of new structures for a set period of time.
Incentives for living shorelines	Allow reduction of permit cost if site includes green practices (e.g. vegetation).
Easing approval for offshore structures	Approving permits for offshore structures is complicated by impacts to navigation and effectiveness in variable lake levels. Promote new guidelines easing approval by allowing impacts to navigation to be offset by reduction in shoreline erosion and/or implementation of Living Shoreline practices.
Policies and Ordinances	*Options for policies and ordinances at various levels of government.*
Coordinated ordinances between municipalities	Municipalities along coastline collaborate to create/maintain consistent ordinances.

Establishing a policy review mechanism	Establish a condition that results in an immediate review/revision of ordinances and policies (e.g. water level change of 6ft in one year).
Including stability/erosion in insurance rates	Include assessments of Bluff Stability/Erosion Rates in Housing Insurance.
Updated bluff-top construction ordinances	Include stability and erosion considerations in construction ordinances.

Table 4. Outreach and Tools: Materials and Actions to Aid Decision-making

Option	Examples
Educational Resources	Publications such as a bluff vegetation guide; Video series such as an explanation of coastal processes through a virtual tour of the coast; Enhanced website to share comprehensive information on coastal processes and engineering.
Outreach Activities	Educational boat tours of the coast; Annual workshop series on coastal erosion; K-12 curriculum activities
Maps	Maps of bluff erosion rates & stability factors; Maps of beach profiles at different possible water levels; 3D visualization of coastal erosion
Decision-Support Tools	Erosion & bluff stability self-assessment guide; Spectrum of erosion control methods
Data and Analysis	Assess impact of erosion on property values and property tax base; Update recession rate and stability analyses; Analyze and map bluffs which contribute the most sand to coastal beaches;

ANALYSIS OF RESPONSE OPTIONS

The analysis of response options developed as part of this report includes three components. The first is a reflection on five broad themes of the hopes, wishes, concerns and issues expressed during the brainstorming exercise at the summer community conversations. This was conducted as a group exercise as part of a public meeting held at the Harry and Rose Samson Jewish Community Center in Whitefish Bay on October 27, 2016. The second is the description and assessment of the 29 response options developed for presentation at the same meeting, while the third includes the results of audience polling of the options, also at the same meeting.

Reflecting on Hopes, Wishes, Concerns and Issues for Healthy Bluffs and Shores

Throughout the three summer public meetings, participants were asked to write down their hopes and wishes, concerns and issues for the bluffs. Participants were encouraged to be as open as possible in their thinking. These responses were combined across the three meetings and sorted into five overall themes: lake levels, erosion, resources and support, regulation and management, and collective action. For the October 27th public meeting, all of the hopes and wishes, concerns and issues that were collected were presented on large posters grouped in these themes. Meeting participants were provided with sticky dots to apply to the hopes and wishes, concerns and issues

that they identified with or resonated with them. To encourage participants to be judicious with their dots, participants were only given a number of dots approximately equal to one third of the total number of "hopes, wishes, concerns and issues" presented. The number of dots for each "hope, wish, concern or issue" were then tallied and are reflected below.

In the Lake Level theme, the exercise reflected concern about the factors which affected lake levels. Participants chose responses that expressed a desire for more scientific understanding about lake level changes, as well as what parties could influence lake levels such as industry, the Wisconsin Department of Natural Resources, and the U.S. Army Corps of Engineers. Desire was also expressed to control the lake levels through lock and dam or increased flow through the St. Lawrence Seaway. After presenting results in the group conversation, a discussion took place about how the lake levels of Lakes Michigan and Huron could be controlled. Project personnel explained the practical requirements for both installation of lock and dam, as well as the international agreements needed to modify how the Great Lakes are regulated. One participant suggested that costs be defrayed by pooling money they would not have to be spend on shore protection towards the lock and dam.

In the Erosion theme, the overall sentiment was concern about why erosion is occurring at the shore. Participants chose responses that indicated a desire to learn about the causes of erosion, particularly the impacts of lake levels, surface & groundwater, and adjacent shore protection structures. Interest was expressed in an online tool that would allow property owners to track erosion at their property through aerial photograph analysis, particularly to track whether erosion increased in response to newly constructed shore protection on adjacent properties. Beyond causes of erosion, there was also concern about how erosion would affect coastal property values.

In the Resources and Support theme, participants indicated a desire to see the government as having some role in providing support to property owners. Specifically, there was a strong desire for financial and technical support for projects to protect the shoreline. In lieu of financial support, participants expressed a desire for assistance in constructing shore protection through a curated set of "approved" or reliable solutions to erosion, as well as a set of reliable contractors. Further, participants indicated a desire to learn about past coastal projects to see how peers addressed erosion both successfully and unsuccessfully.

In the Regulation and Management theme, the overall response from participants expressed a desire for clear definition of both their rights to protect property and the regulations on their actions. In terms of private property, respondents both wanted to know what actions they could take on their own bluffs as well as what steps could be taken to limit others' projects that may negatively impact adjacent shorelines. In terms of ordinances, participants expressed a desire for model bluff and ravine ordinances with consistent terminology and definitions across jurisdictions.

In the Collective Action theme, the overall response indicated a wish for support for working together in an informal framework. While a strong desire was indicated for coordinated solutions among neighbors, there was less desire for a legal framework for cooperation like a Neighborhood Improvement District. Specific comments by participants indicated caution at

developing a formal framework for cooperation due to potential fees and taxes that could be imposed. In a larger, regional framework, there was a good amount of support for shoreline habitat conservation, but less interest in formal regional frameworks.

Presentation and Assessment of Response Options

In preparation for the October 27th public meeting, the project team conducted an assessment of the strengths and weaknesses of structural actions, policy alternatives, and education and outreach approaches. The assessment included a description of the option, a listing of benefits and disadvantages, and a summary of the purpose, scale, potential complications and cost. The assessment of the 29 response options is included in the appendix to this report.

Rating of Response Options

The response options were presented to the public at the October 27th meeting in Whitefish Bay. The project team utilized the Turning Point audience response system (https://www.turningtechnologies.com/) so those attending could easily and anonymously vote on the ideas. The rating protocol included four responses as listed below.

Response	Meaning
1	I *like* this option
2	I am *neutral on* this option
3	I *do not like* this option
4	I *would like to know more before I rate* this option

A total of 10 members of the public attended the October 27th meeting. One benefit of the low attendance was the ability to explore some options in greater depth. An example was a lengthy conversation on the relevance of living shorelines for the high energy coast of Lake Michigan. Typically 8 people voted on each response option. The summary of the voting is included in Tables 5-7. The number and percentage of each response is indicated. A mean score is calculated for each response based on a value of 1 for "like," 2 for neutral, and 3 for "do not like." The mean score does not factor in response 4 – "would like to know more before rating."

Table 5. Rating of Structural Options

Response Option	Rating	Mean
Gray Infrastructure		***1.93***
Revetment	Like: 63% (5) Neutral: 13% (1) Do Not Like: 0% (0) Need More Info: 25% (2)	1.17
Sea Wall	Like: 0% (0) Neutral: 25% (2) Do Not Like: 75% (6) Need More Info: 0% (0)	2.75

Breakwater	Like: 50% (4) Neutral: 25% (2) Do Not Like: 25% (2) Need More Info: 0% (0)	1.75
Groin	Like: 25% (2) Neutral: 0% (0) Do Not Like: 63% (5) Need More Info: 13% (1)	2.43
Bluff Regrading	Like: 50% (4) Neutral: 25% (2) Do Not Like: 25% (2) Need More Info: 0% (0)	1.75
Groundwater Drainage	Like: 63% (5) Neutral: 13% (1) Do Not Like: 25% (2) Need More Info: 0% (0)	1.63
Green Infrastructure		***2.09***
Managed Retreat	Like: 13% (1) Neutral: 38% (3) Do Not Like: 38% (3) Need More Info: 13% (1)	2.29
Artificial Beaches	Like: 50% (4) Neutral: 0% (0) Do Not Like: 50% (4) Need More Info: 0% (0)	2.00
Living Shoreline	Like: 50% (4) Neutral: 0% (0) Do Not Like: 50% (4) Need More Info: 0% (0)	2.00
Greening of Gray Infrastructure		***1.30***
Breakwater with Living Shoreline	Like: 75% (6) Neutral: 0% (0) Do Not Like: 13% (1) Need More Info: 13% (1)	1.29
Living Breakwater or Artificial Reef	Like: 75% (6) Neutral: 13% (1) Do Not Like: 13% (1) Need More Info: 0% (0)	1.38
Living Revetment/Sea Wall	Like: 78% (7) Neutral: 0% (0) Do Not Like: 11% (1) Need More Info: 11% (1)	1.25

Table 6. Rating of Policy Options

Response Option	Rating	Mean
Collective Action/Funding		***1.40***
Collaborating with neighbors	Like: 89% (8) Neutral: 11% (1) Do Not Like: 0% (0) Need More Info: 0% (0)	1.11
Neighborhood Improvement District	Like: 25% (2) Neutral: 25% (2) Do Not Like: 13% (1) Need More Info: 38% (3)	1.80
Create aid fund for bluff and shore properties	Like: 50% (4) Neutral: 13% (1) Do Not Like: 13% (1) Need More Info: 25% (2)	1.50
Form a Great Lakes Regional Authority	Like: 50% (4) Neutral: 0% (0) Do Not Like: 13% (1) Need More Info: 38% (3)	1.40
Permitting Guidelines		***1.48***
Include sediment study/impacts in site plans	Like: 63% (5) Neutral: 13% (1) Do Not Like: 13% (1) Need More Info: 13% (1)	1.43
Include funds for monitoring in permit	Like: 25% (2) Neutral: 25% (2) Do Not Like: 25% (2) Need More Info: 25% (2)	2.00
Incentives for living shorelines	Like: 63% (5) Neutral: 38% (3) Do Not Like: 0% (0) Need More Info: 0% (0)	1.38
Easing approval for offshore structures	Like: 88% (7) Neutral: 0% (0) Do Not Like: 13% (1) Need More Info: 0% (0)	1.25
Policies and Ordinances		***1.35***
Coordinated ordinances between municipalities	Like: 38% (3) Neutral: 13% (1) Do Not Like: 13% (1) Need More Info: 38% (3)	1.60
Establishing a policy review mechanism	Like: 75% (6) Neutral: 0% (0) Do Not Like: 13% (1) Need More Info: 13% (1)	1.29

Including stability/erosion in insurance rates	Like: 38% (3) Neutral: 0% (0) Do Not Like: 13% (1) Need More Info: 50% (4)	1.50
Updated bluff-top construction ordinances	Like: 75% (6) Neutral: 13% (1) Do Not Like: 0% (0) Need More Info: 13% (1)	1.14

Table 7. Rating of Outreach and Tool Options

Response Option	Rating	Mean
Educational Resources	Like: 100% (8) Neutral: 0% (0) Do Not Like: 0% (0) Need More Info: 0% (0)	1.00
Outreach Activities	Like: 86% (6) Neutral: 14% (1) Do Not Like: 0% (0) Need More Info: 0% (0)	1.14
Maps	Like: 88% (7) Neutral: 0% (0) Do Not Like: 13% (1) Need More Info: 0% (0)	1.25
Decision-Support Tools	Like: 100% (8) Neutral: 0% (0) Do Not Like: 0% (0) Need More Info: 0% (0)	1.00
Data and Analysis	Like: 63% (5) Neutral: 13% (1) Do Not Like: 13% (1) Need More Info: 13% (1)	1.43

Review of the structural options shows that, in general, "greening" of conventional gray infrastructure approaches was most favorable (mean rating of 1.30 for the category). The most favorable rating in that category was the living revetment/sea wall option at a score of 1.25. There was moderate interest in gray infrastructure approaches (mean rating of 1.93 for the category). Revetments were the most liked option with a rating of 1.17, while sea walls and groins were not liked with ratings of 2.75 and 2.43 respectively. Green infrastructure was the least liked as a category (mean rating of 2.09 for the category). Discussion during the polling indicated property owners were skeptical about effectiveness of green approaches along the Lake Michigan coast. Overall, the mean rating for the topic of structural options was 1.81, making it the least liked of the three topics.

Rating of the policy options showed strong support for several options, including collaboration among neighbors (1.11); updated bluff-top construction ordinances (1.14); easing approval for offshore structures (1.25); and establishing a trigger mechanism for policy review (1.29). All but

one option (including funds for monitoring in permits at 2.00) rated on the positive side of neutral. Informal collaboration was favored over the formal structure of neighborhood improvement districts (1.80). Several of the options received multiple responses for wanting more information before a rating could be given. Overall, the mean rating for the topic of policy options was 1.42.

Finally, there was strong support for outreach and tools (mean rating of 1.16 for the topic). Educational resources and decision-support tools were universally liked as options (1.00).

Review of Response Options with Local Officials and Project Partners

A meeting with local officials and project partners was held on the morning of Friday, October 28, 2016 at the Harry and Rose Samson Family Jewish Community Center in Whitefish Bay. Those who attended are identified in the Appendix (26 total) and included four elected officials, six local government staff, six partners from state government and the Southeastern Wisconsin Regional Planning Commission, one staff associated with an area nature center, one investigator, and eight project team members. Six of the eight municipalities in the project area were represented.

The meeting began with an overview of the project, the community meetings that were held during the summer in Saukville, Mequon and Bayside and then a more detailed account of the October 27th prioritization meeting, including a review of feedback on the various response options. An important feature of the October 27th meeting was the sticky dot exercise that allowed the public attendees to select the hopes and wishes, concerns and issues gathered in the summer community engagement meetings that particularly resonated with their own views. An overview of the outcomes from that exercise was presented and then there was a break to allow attendees to view and reflect on posters with the comments and sticky dots from the previous evening. This was followed by three rounds of questions and conversation. A few questions came up before presentation of the summary of the sticky dot exercise, focused on who exactly had attended the public meeting on the previous evening. There was also an expression of interest in replicating the prioritization meeting in some sort of online survey format to get more input from coastal residents.

Following the summary, another round of conversation ensued. This was a mix of several different viewpoints and questions. One attendee found the regional perspective of the both the sticky dot exercise and the prioritization meeting important and wondered if there was a way to expand on that perspective. Another brought up a challenge they perceived with a regional approach, specifically the desire from the public for technical assistance from the State in the form of a recommended plan for erosion. The attendee's view was that while such a plan would be great, the challenges of actually developing and implementing such a plan were too great to be achieved and they suggested that the focus of outreach efforts should be on educating citizens and managing expectations regarding support from the State. A third attendee asked about whether or not the water levels would remain high and what the certainty was of any of those projections – an important point to consider when thinking about supporting implementation of various options along the coast, as it was the rapid rise in water levels that renewed interest in developing solutions for the coast. Another attendee brought up the point that if there was to be a focus on opportunities rather than challenges, there needed to be a strategy for getting private

property owners to buy into plans and ideas and focus on that viewpoint rather than a focus on environmental benefits.

After the group had a chance to view and discuss the posters and sticky dots, there was a wrap-up conversation that began with a reflection on the outcomes of the public meeting held on October 27th by the various members of the project team that were in attendance. Members of the team spoke to the overall benefit of the exercise with regard to bringing people together. Each team member also touched on particular outcomes from the prioritization exercise, mentioning specifically the overwhelming support for more outreach and education activities and decision support tools. The project team then provided a final summary to express the set of opportunities they saw coming out of the community meetings during the summer and the October 27th evening meeting. They noted the focus of the attendees on the effects of high water levels on one's own property, but that there was also a strong desire to be good neighbors, as evidenced by the support for collaboration and development of projects that would not aggravate erosion on adjacent properties. They also mentioned specific comments by the audience regarding their perceptions of the issues in Mt. Pleasant (south of Milwaukee) and how they viewed Mt. Pleasant as a portrait of their future if they didn't take action.

The project team summary was followed by a general wrap-up and reflection round similar to those held at the summer community engagement meetings. The overall response from public officials was very positive. Several attendees were really pleased both by the integration of different types of options (both structural and policy) and the effectiveness of the presentation as an educational tool and a tool for bringing people together. Several other attendees, particularly the elected officials, discussed the opportunities they saw for collaboration. One official discussed the importance of more education and discussed plans to meet with a group of property owners for further action. Another talked about how beneficial the meeting with local officials was in terms of getting people with parallel roles from different communities together and mentioned that they wanted to work with several communities to develop more consistent, effective and up-to-date ordinances and regulations for the bluffs. This was a policy option presented to the public at the October 27th prioritization meeting public and was greeted with a mixture of support and a desire to know more about what such an action would actually look like before deciding whether or not it was an option they would support or not. Another attendee mentioned that the entire assessment project was a great example of what we should be doing globally – considering impacts, developing options, engaging the community and fostering collaboration. Finally, a local elected official wondered about next steps.

That final statement led the community engagement facilitators to call for a few people to lead the development of community action on some of the options and opportunities that came out of the assessment. Two local and regional planning staff members stepped up to take this role, pending more information and input from community members. That hesitancy was echoed by other attendees in public and private discussion, with expressions of interest in working with other communities and developing plans but wanted to know more about the options. This desire, as well as the generally positive reviews of the prioritization exercise, highlights the importance of getting these options out to a larger audience for more input. In both the public and public officials meetings, specific requests were made to get the presentation out in some sort of survey format and at additional meetings with public officials.

ADDITIONAL CONSIDERATIONS

Alternative Methods for Additional Rating of Response Options

Despite strong attendance at all three of the community conversations during the summer, the attendance at the October 27th response option prioritization meeting was low. The project team will explore scheduling additional public meetings for prioritization of the response options with more extensive publication, as well as developing an online survey to support prioritization of options.

Additional Assessment of Bluff Stability

Prof. David Mickelson has completed extensive analysis of oblique aerial photos of the Lake Michigan coast of Wisconsin from 1976 to 2007 to examine stability of coastal bluffs. This has provided useful information for the Phase 1 Synthesis report to identify the status and trends associated with bluffs in the study area, but represents an ending period of low water levels. An opportunity was identified to use project resources for Prof. Mickelson to fly additional oblique aerial photos in August 2016 to assess conditions during higher water levels. This work will evaluate the nature of changes on bluffs in this reach between 2012 photos taken by the U.S. Army Corps of Engineers and (USACE photos) and this August. Special attention will be paid to changes at the base of bluffs due to higher lake levels in the last few years, and areas where there has been a large impact will be highlighted as potential bluff failure sites in the future if water levels remain high. Bluff and nearshore profiles will be constructed from 2012 Lidar at a spacing more appropriate for property owners than what are now available. There are already 79 profiles in the GLWLA area. This work proposes adding approximately 50 bluff and bathymetric profiles sited at what appear from the oblique photos to be likely future slope failure sites.

Recession Rate Decision Tool Prototype

One of the outreach resources identified as useful by property owners in the project area was an online tool that would allow property owners to track erosion at their property through aerial photograph analysis. Work has commenced on a prototype that would leverage different dates of historical aerial photography and bluff feature mapping completed by the Department of Civil and Environmental Engineering at UW-Madison through a photo comparison tool titled JuxtaposeJS (https://juxtapose.knightlab.com/) developed by the Knight Lab at Northwestern University. JuxtaposeJS uses a slider bar to visually contrast photos from two different dates to show change.

Sea Grant Resilience Initiative

Wisconsin Sea Grant has proposed use of a portion of a Resilience National Strategic Initiative allocation for 2016-17 to: 1) cover travel for outreach staff to meet with local officials and coastal property owners, as well as public engagement services to facilitate conversations with local communities on implementing resilience principles; and 2) conduct boat tours next year to see the water side of high water impacts on Lake Michigan shores could prompt community conversations about resilience policy options and coastal property owner adaptive actions.

Continued Momentum of the Wisconsin Integrated Assessment
An important consideration is how best to continue momentum on the topic after the integrated assessment ends. The project team will interview staff at the Graham Sustainability Institute and Michigan Sea Grant about different approaches to continue momentum after an integrated assessment ends. This will include evaluation of the Northeast Michigan Integrated Assessment (http://www.miseagrant.umich.edu/downloads/nemia/report/NEMIA-Final-Report.pdf), viewed as an impactful project with a strong Sea Grant extension role.

LITERATURE

An on-line Wisconsin Coastal Hazards Bibliography that contains 141 bibliographic entries as of November 6, 2016 represents the literature that supports the integrated assessment (https://www.mendeley.com/groups/4020161/wisconsin-coastal-hazards-bibliography/). Several of the core documents guiding the project are searchable by the geography they cover through the OpenGeoPortal included in the Catalog of the Wisconsin Coastal Atlas (http://maps.aqua.wisc.edu/opengeoportal/).

APPENDICES

List of Events

- Meeting with Local Officials and Partners, Harry and Rose Samson Family Jewish Community Center, Whitefish Bay, WI, October 28, 2016 (17 attendees)
- Public Meeting, Harry and Rose Samson Family Jewish Community Center, Whitefish Bay, WI, October 27, 2016 (10 attendees)
- Community Conversation, Schlitz Audubon Nature Center, Bayside, WI, August 17, 2016 (~43 attendees)
- Community Conversation, North Reuter Pavilion, Mequon, WI, July 27, 2016 (~55 attendees)
- Community Conversation, American Legion Hall, Saukville, WI, June 15, 2016 (~45 attendees)
- Proceedings of the three community conversations are available in the public file sharing site for the project (https://uwmadison.box.com/v/glwlia-wi-public).

List of Participants

Meeting with Local Officials and Partners, Harry and Rose Samson Family Jewish Community Center, Whitefish Bay, WI, October 28, 2016 (26 attendees)

- Kate Angel, Coastal Resources and Community Planning, Wisconsin Coastal Management Program
- Adam Bechle, J. Philip Keillor Fellow, Wisconsin Coastal Management Program and University of Wisconsin Sea Grant Institute
- Tammy Bockhorst, Trustee, Village of Shorewood
- Gene Clark, Coastal Engineering Outreach Specialist, University of Wisconsin Sea Grant Institute, Superior Field Office
- John Edlebeck, Director of Public Works, Village of Whitefish Bay
- Mark Grams, City Administrator, City of Port Washington
- Mike Hahn, Deputy Director, Southeastern Wisconsin Regional Planning Commission
- David Hart, Assistant Director for Extension, University of Wisconsin Sea Grant Institute
- Andy Holschbach, Director, Ozaukee County Land and Water Management
- John Janssen, Professor, School of Freshwater Sciences, University of Wisconsin-Milwaukee
- Kathi Kramasz, Water Regulations and Zoning Specialist, Wisconsin Department of Natural Resources
- Kay Lutze, Water Regulations and Zoning Specialist, Wisconsin Department of Natural Resources
- Andrew Mangham, Water Resources Management Student, University of Wisconsin - Madison
- Jake Meshke, Assistant Village Manager/Director of Community & Utility Services, Village of Bayside
- Tom Mlada, Mayor, City of Port Washington
- Julia Noordyk, Coastal Storms Outreach Specialist, University of Wisconsin Sea Grant Institute, Green Bay Field Office

- Deidre Peroff, Social Science Outreach Specialist, University of Wisconsin Sea Grant Institute, Milwaukee Field Office
- Don Quintenz, Senior Ecologist, Schlitz Audubon Nature Center
- Tara Serebin, Trustee, Village of Whitefish Bay
- Caitlin Shanahan, Disaster Response & Recovery Planner, Wisconsin Emergency Management
- Bert Stitt, Stitt Facilitations
- Linda Stitt, Stitt Facilitations
- Karron Stockwell, Supervisor, Town of Grafton
- Kim Tollefson, Director of Community Development, City of Mequon
- Rob Vandennoven, City Engineer, City of Port Washington
- Margaret Zieke, Executive Staff Secretary, Wisconsin Emergency Management

Key Resources

- Project web site (http://go.wisc.edu/glwlia)
- Project newsletters delivered using Constant Contact (July – sent 7/13, August – sent 8/30, September – sent 9/30, October/November – sent 11/9)

List of Publications

Publications are available in the public file sharing site for the project (https://uwmadison.box.com/v/glwlia-wi-public).

- University of Wisconsin Sea Grant Institute. 2016. *Integrated Assessment on Water Level Variability and Coastal Bluff Erosion in Northern Milwaukee County and Southern Ozaukee County, Wisconsin – Phase 1 Report – Interdisciplinary Synthesis of Existing Research*. May 9, 2016.
- Hart, David. 2016. *Relevant Reports, Studies, Data and Resources - Integrated Assessment on Water Level Variability and Coastal Bluff Erosion in Northern Milwaukee County and Southern Ozaukee County, Wisconsin*. Project White Paper. April 3, 2016.
- Hart, David. 2015. *Finding and Organizing Existing Research, Data and Decision Tools Related to Water Level Variability and Coastal Bluffs in Northern Milwaukee County and Southern Ozaukee County, Wisconsin*. Project White Paper. June 26, 2015.

List of Presentations

Presentations are available in the public file sharing site for the project (https://uwmadison.box.com/v/glwlia-wi-public).

- David Hart gave a presentation titled “Great Lakes Water Levels and Coastal Bluffs: Northern Milwaukee County and Southern Ozaukee County, Wisconsin” at a meeting of local officials and project partners of the integrated assessment at the Harry and Rose Samson Family Jewish Community Center in Whitefish Bay, WI on October 28, 2016. 17 attended.
- David Hart gave a presentation titled “Great Lakes Water Levels and Coastal Bluffs: Northern Milwaukee County and Southern Ozaukee County, Wisconsin” at a public meeting for the integrated assessment at the Harry and Rose Samson Family Jewish Community Center in Whitefish Bay, WI on October 27, 2016. 10 attended.

- Gene Clark, Andrew Mangham, and David Hart gave a presentation titled “Great Lakes Water Levels Integrated Assessment: Prioritization Exercise” at a public meeting for the integrated assessment at the Harry and Rose Samson Family Jewish Community Center in Whitefish Bay, WI on October 27, 2016. 10 attended.
- David Hart gave a presentation titled “Water Level Variability and Coastal Bluff Erosion in Northern Milwaukee County and Southern Ozaukee County, Wisconsin” at a public meeting for the integrated assessment in Bayside, WI on August 17, 2016. 43 attended.
- David Hart gave a presentation titled “Water Level Variability and Coastal Bluff Erosion in Northern Milwaukee County and Southern Ozaukee County, Wisconsin” at a public meeting for the integrated assessment in Mequon, WI on July 27, 2016. 55 attended.
- David Hart gave a presentation titled “Water Level Variability and Coastal Bluff Erosion in Northern Milwaukee County and Southern Ozaukee County, Wisconsin” at a public meeting for the integrated assessment in Saukville, WI on June 15, 2016. 45 attended.
- David Hart gave a presentation on the integrated assessment to a team led by Wisconsin Emergency Management working on coastal bluff erosion issues centered in Mt. Pleasant, WI at the Wisconsin Emergency Management office in Madison on June 20, 2016. 10 attended.
- Gene Clark gave a presentation titled “Integrated Assessment on Water Level Variability and Coastal Bluff Erosion in Northern Milwaukee County and Southern Ozaukee County, Wisconsin” at the Great Lakes Water Level Integrated Assessment Meeting in Ann Arbor, Michigan on May 17, 2016. Approximately 30 attended – additional by webinar.
- David Hart gave a presentation titled “Integrated Assessment on Water Level Variability and Coastal Bluff Erosion in Northern Milwaukee County and Southern Ozaukee County, Wisconsin” at the project synthesis workshop in Madison on March 31, 2016. 14 attended.
- David Hart gave a presentation titled “Planning for an Integrated Assessment on Water Level Variability and Coastal Bluffs in Northern Milwaukee County and Southern Ozaukee County, Wisconsin” at the Great Lakes Water Level Integrated Assessment Summary Meeting in Ann Arbor, Michigan on September 3, 2015. 40 attended.
- David Hart gave a presentation titled “Existing Research & Decision Tools about Water Levels and Bluff Erosion” at the Great Lakes Water Level Integrated Assessment Stakeholder Workshop in Bayside on July 27, 2015. 35 attended.
- David Hart gave a presentation titled “Planning for an Integrated Assessment on Water Level Variability and Coastal Bluffs in Northern Milwaukee County and Southern Ozaukee County, Wisconsin” at the Great Lakes Water Level Integrated Assessment Stakeholder Workshop in Bayside on July 27, 2015. 35 attended.
- David Hart gave a presentation titled “Planning for an Integrated Assessment on Water Level Variability and Coastal Bluffs in Northern Milwaukee County and Southern Ozaukee County, Wisconsin” at the Great Lakes Water Level Integrated Assessment Kickoff Meeting in Ann Arbor, Michigan on April 8, 2015. 40 attended.

Timeline of Project Activities

	2016												2017			
Activity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1. Conduct interdisciplinary overview synthesis																
2. IA phase 1 report (synthesis)																
3. GLWLIA meeting 1 (Ann Arbor)																
4. Setting the context for community engagement																
5. Community conversations (3 meetings)																
6. Identify response options																
7. Community meeting - prioritize response options																
8. IA phase 2 report (response options)																
9. Mid-project evaluation																
10. GLWLIA webinars for response options																
11. Communicate select policy options																
12. IA phase 3 report (select options)																
13. Community conversations (endorsement)																
14. Phase 3 report peer review																
15. GLWLIA meeting 2 (Ann Arbor)																
16. IA final report compilation																
17. Final project evaluation																

List of Students Involved

- Andrew Mangham, Water Resources Management, Gaylord Nelson Institute for Environmental Studies, UW-Madison (Summer and Fall Semester, 2016)
- Ben Kranner, Undergraduate Student, Department of Civil and Environmental Engineering, UW-Madison (Spring Semester, 2016)

Assessment of Response Options

Revetment

Definition: A protective structure of stone/concrete/sandbags parallel to the shore with a sloping face designed to protect against wave erosion.

Benefits:

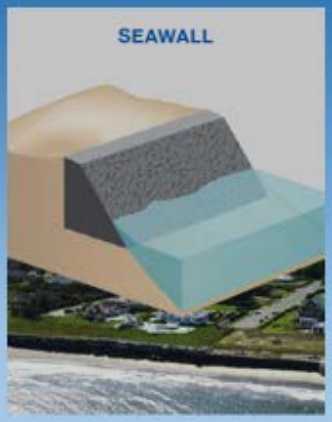
- Resists erosion of shoreline/bluff toe by waves.
- Strong and durable.

Disadvantages:

- Can result in increased erosion of adjacent natural shoreline of lakebed along the bottom edge.
- Loss of beaches and natural habitat, prevents sediment flow in lakes.
- Can limit water access due to large size and unsteady footing

Purpose	When is this necessary?	Scale	Complications	Cost
Erosion	Strong waves hitting shore and base of bluff	Individual or Group Action	Site Access (can use barge)	Medium

Sea Wall



Definition: A vertical or sloping wall running parallel to the shoreline typically at base of bluff made of stone, concrete, steel/vinyl sheets.

Benefits:

- Resists erosion of shoreline/bluffs behind structure.
- Strong and durable.
- Low maintenance costs.
- Allows for access to water from wall top.

Disadvantages:

- Higher construction costs than revetments.
- Can result in increased erosion of adjacent natural shoreline and lakebed along bottom edge.
- Can result in increased erosion of lake bed next to sea wall.
- Can result in loss of beaches by preventing natural transport of sediment from bluffs/shoreline to beaches.

Purpose	When is this necessary?	Scale	Complications	Cost
Erosion	Strong waves hitting shore	Individual or Group Action	Site Access (can use barge)	High

Breakwater

Definition: Offshore structure made of stone/concrete blocks. Can be floating or built on lake bed. Can be submerged. Can be continuous wall or series of segments.

Benefits:

- Reduces wave force and height at shore, which reduces erosion.
- Allows retention of natural shoreline.
- Strong and durable.

Disadvantages:

- Can be expensive in deep water.
- Can prevent circulation of water.
- Can create navigational hazard-permit approval challenging.
- Designing for variable lake levels is challenging.

Purpose	When is this necessary?	Scale	Complications	Cost
Erosion	Strong waves hitting shore	Group Action	Permit approval for offshore structures can be challenging.	High

7

Groin

Definition: Perpendicular structures jutting into the lake from shoreline. Made of stone or concrete rubble or steel sheet pile. Most often used on beaches to prevent beach loss, by replenishing sediment.

Benefits:

- Traps littoral drift (sediment suspended in lake currents) in front of existing beach.
- Many options for material and methods.
- Low maintenance costs.

Disadvantages:

- Reduces sediment delivery to down-drift properties, leading to increased erosion.
- Difficult to get permit.

Purpose	When is this necessary?	Scale	Complications	Cost
Erosion	To keep existing beach in place	Individual or Group Action	Site Access (can use barges). Often causes erosion to adjacent properties	Low to Medium

8

Bluff Regrading

Definition: Cutting into face of bluff to create shallower, more stable slope.

Benefits:

- Provides long term stability to bluff area.
- Can provide area for natural vegetation, habitat.

Disadvantages:

- Can be limited by existing construction (houses, roads etc.).
- Can be high cost.
- Should be paired with shoreline erosion control and drainage control to retain stable slope.

Purpose	When is this necessary?	Scale	Complications	Cost
Bluff Stability	Steep Bluffs, Bluffs with groundwater seepage	Individual or Group Action	Site Access	High

9

Groundwater Drainage

Definition: Groundwater seeping through face of bluffs can compromise stability. Drainage systems can be added to drain the groundwater and stabilize the bluffs.

Benefits:

- Can help stabilize bluff by preventing collapse through groundwater seepage.

Disadvantages:

- Doesn't address stability problems on very steep bluffs.
- Can require frequent maintenance due to drain blockage and damage from shifting bluffs.

Purpose	When is this necessary?	Scale	Complications	Cost
Bluff Stability	Bluffs with significant groundwater seepage	Individual or Group Action	Site Access, variable soils in bluff	Medium

10

Managed Retreat

Definition: Moving structure back from edge of bluff. Can be a last resort or can be performed pre-emptively in combination with bluff regrading for long-term solutions.

Benefits:

- Doesn't necessarily require shoreline/bluff construction measures.
- Can be long term solution.
- Allows natural shoreline and processes to be maintained

Disadvantages:

- Can be limited by existing construction (houses, roads etc.).
- Can be high cost-can also be less expensive than revetment.
- Allows for loss of land to erosion.

Purpose	When is this necessary?	Scale	Complications	Cost
Saving a structure	When Bluff Collapse threatens structure	Individual or Group Action	Property limits/Existing construction	Medium to High

12

Artificial Beaches

Definition: Adding sand/sediment to shoreline to restore beaches washed away by erosion.

Benefits:

- Low cost.
- Can recycle sediment displaced by other construction projects.
- Can provide natural shoreline habitat.
- Allows for larger useable beach area.

Disadvantages:

- Requires constant maintenance.

Purpose	When is this necessary?	Scale	Complications	Cost
Erosion	Areas with significant beach erosion	Individual or Group Action	Site Access	Low

13

Living Shoreline

Definition: Using native plants and stones to resist shoreline erosion.

Benefits:

- Resists erosion from low power waves.
- Promotes more natural habitat.
- Flexible approach.

Disadvantages:

- Can be difficult to establish plants depending on conditions (soil, microclimate, etc.)
- Can require frequent maintenance.
- Will not protect shoreline from high energy wave action without additional structure.
- Can be difficult to implement on steep bluffs.

Purpose	When is this necessary?	Scale	Complications	Cost
Erosion	Areas with low wave energy	Individual or Group Action	Early phases of plant growth vulnerable to climate/erosion	Low

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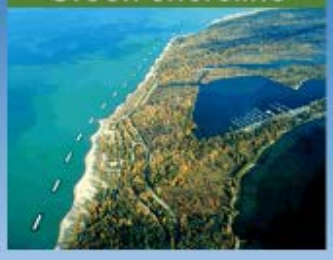
Gray Breakwater, Green Shoreline



Gray Breakwater, Green Shoreline

Definition: Offshore breakwater built using common gray construction techniques to reduce wave energy. Lower wave energy allows use of green approaches on shoreline for additional protection.

Benefits:

- Can allow for less aggressive breakwater structure by supporting it with green approaches to resist erosion
- Reduces wave force and height.
- Allows retention of natural shoreline.
- Strong and durable.

Disadvantages:

- Can be expensive in deep water.
- Design for variable lake levels is challenging.
- Can create navigational hazard-makes approval difficult.

Purpose	When is this necessary?	Scale	Complications	Cost
Erosion	Strong waves hitting shore	Group Action	Permit approval challenging. Establishing plants can be challenging.	High

16

Living Breakwater

Living Breakwater/Artificial Reef

Definition: Offshore structure built with porous material, often includes vegetation and sand on exposed portions.

Benefits:

- Reduces wave force and height.
- Allows retention of natural shoreline.
- Strong and durable.
- Provides offshore habitat.

Disadvantages:

- Can be more expensive than gray breakwater.
- Can prevent circulation of water.
- Can create navigational hazard.
- Can be difficult to establish plants.

Purpose	When is this necessary?	Scale	Complications	Cost
Erosion	Strong waves hitting shore	Group Action	Offshore permitting difficult. Establishing plants can be challenging.	High

17

Living Revetment

Living Revetment/Seawall

Definition: Use of native vegetation to improve stability of shoreline/bluff face behind an existing revetment or seawall.

Benefits:

- Reduces erosion of shoreline/bluff toe by waves.
- Strong and durable.
- Provides bluff habitat.

Disadvantages:

- Can result in faster erosion of adjacent natural shoreline.
- Can result in loss of beaches by preventing natural transport of sediment from bluffs/shoreline to beaches.
- Early phase of planting can be challenging due to climate/erosion.

Purpose	When is this necessary?	Scale	Complications	Cost
Erosion	Strong waves hitting shore	Individual or Group Action	Site Access (can use barge) / Establishing plants	Medium

18

Collaborating with Neighbors

Concept: Work together to share the costs of a larger project that benefits multiple properties.

Benefits:
- Spreads out the cost of a project.
- Promotes cooperative efforts that benefit multiple properties.
- Reduces unanticipated impacts on neighboring properties.

Challenges:
- Effectiveness depends on scale of project.
- Still requires property owners to pay out of pocket.

Purpose	Scale	Similar Models	Implementation Difficulty	Personal Impact
Share project costs	Neighborhood	Neighborhood Associations	Low	Lower Costs

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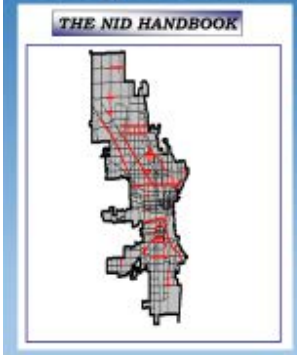
Neighborhood Improvement Districts



Concept: Using Wisconsin ACT 186 (2005), neighborhoods of residential or mixed residential and business properties can form a NID Board to develop and contribute to improvement projects.

Benefits:
- Uses existing legislation.
- Provides framework for sharing costs for erosion control measures among property owners.

Challenges:
- Building consensus between property owners.
- Approval of plans must still go through municipal and state authorities.
- Not appropriate for single property projects such as managed retreat.
- Municipality specially assesses properties-assessments can be paid separately or added to property tax.

Purpose	Scale	Similar Models	Implementation Difficulty	Personal Impact
Share project costs	Neighborhood to Municipal	NID's in Milwaukee	Medium	Shared Project Costs/Assessed Fees

22

Create Aid Fund for Bluff and Shore Properties

Concept: Formation of a fund for use in erosion control, bluff stabilization or managed retreats by properties along bluffs and shores.

Benefits:
- Provides aid for properties in peril.
- Helps preserve important source of property tax revenue.
- Could promote larger projects with multi-property benefit.

Challenges:
- Determining the source of the money.
- Defining benefits of coastline to property owners not on coastline.
- Determining process for allocation of funds.

Purpose	Scale	Similar Models	Implementation Difficulty	Personal Impact
Create funds for projects	Municipal to Federal	FEMA Funding	Medium	Financial Support/ Additional Taxes

23

Inter-State or International Great Lakes Authority

Concept: The issues faced by residents along the Great Lakes are as big as the lakes themselves. Should an inter-state or international authority be formed to coordinate, regulate and fund a big-picture, regional approach to management of the lakes?

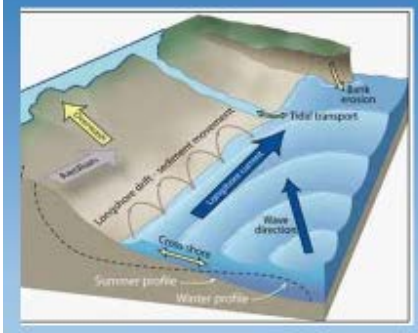
Benefits:
- Provides large-scale, regional framework within which issues faced by residents of the Great Lakes can be addressed.

Challenges:
- Would require new legislation across multiple states.
- Would impact power of states and individuals.
- Distinction between this idea and existing agreements would require additional powers.

Purpose	Scale	Similar Models	Implementation Difficulty	Personal Impact
Regional Coordination	State to International	TVA, Great Lakes Compact	High	Varies with structure

24

Include Sediment Study/Impacts in Site Plans



Concept: Require site plans to include study of sediment flow in site and potential impacts on sediment flow from new structure.

Benefits:
- Adds to understanding of sediment transport in Great Lakes.
- Provides scientific framework to anticipate/prevent beach loss.

Challenges:
- Longer processing times on permits.
- Higher cost from consultant.
- Requires management of information to inform statewide practices.

Purpose	Type	Personal Impact
Develop Understanding, Anticipate Problems	Approval Requirement	Improved Coastal Management/Higher Consultant Costs

26

Include Funds for Monitoring in Permit

Concept: Add fee to permit to create funds for monitoring of new structures for a set period of time.

Benefits:
- Establishes constant review of new projects by impartial authorities.
- Promotes maintained and functional shore protection.

Challenges:
- Setting appropriate monitoring time.
- Higher permitting costs

Purpose	Type	Personal Impact
Support monitoring of shore structures	Fee	Improved function/Higher Costs

27

Incentives for Living Shorelines

Concept: Allow reduction of permit cost if site includes green practices (e.g. vegetation).

Benefits:
- Promotes greener, ecologically healthy coastline.

Challenges:
- Defining appropriate practices, scale of practices.

Purpose	Type	Personal Impact
Promote Practices	Incentive	Lower Permitting Costs/Potentially Higher Project Costs

28

Easing Approval for Offshore Structures

Concept: Approving permits for offshore structures is complicated by impacts to navigation and effectiveness in variable lake levels. Promote new guidelines easing approval by allowing impacts to navigation to be offset by reduction in shoreline erosion and/or implementation of Living Shoreline practices.

Benefits:
- Would make building breakwaters easier.
- Could promote gray-green combination approach.

Challenges:
- Significant change to current legislation.

Purpose	Type	Personal Impact
Promote Practices	New Permitting Rules	Greater Range of Options

29

Coordinated Ordinances between Municipalities

Concept: Municipalities along coastline collaborate to create/maintain consistent ordinances.

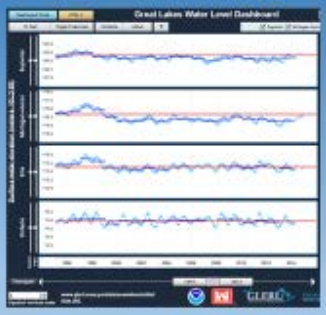
Benefits:
- More consistent rules.
- Increased opportunity to review/revise ordinances.

Challenges:
- Impacts power of individual municipalities.
- Could result in more/less restrictive regulations in your municipality.
- One size fits all approach may ignore local needs/conditions.

Purpose	Implementation Difficulty	Personal Impact
Unify Ordinances Along Coast	Medium	More Consistent Rules/Changes to Regulations

31

Establishing a Policy Review Mechanism



Concept: Establish a condition that results in an immediate review/revision of ordinances and policies (e.g. water level change of 6ft in one year).

Benefits:
- More flexible legislation that allows for rapid response to changing water levels, climate conditions, information, etc.

Challenges:
- Frequent changes to ordinances and policies could lead to confusion.

Purpose	Implementation Difficulty	Personal Impact
Promote Adaptive Management	Low	Faster Response to Change/Less Consistency in Regulations

32

Including Stability/Erosion in Insurance Rates

Concept: Include assessments of Bluff Stability/Erosion Rates in Housing Insurance.

Benefits:
- Insurance coverage in case of Bluff Failure/Rapid Erosion.

Challenges:
- May need federal intervention to ensure that rates are the same across insurance companies (e.g. NFIP).

Purpose	Implementation Difficulty	Personal Impact
Provide Coverage, Promote Practices	High	Potentially Greater Coverage/Potentially Higher Premiums

33

Updated Bluff-Top Construction Ordinances

Concept: Include stability and erosion considerations in construction ordinances.

Example: Setback based on bluff slope, erosion rates, etc.
Example: Guidance on location of septic tanks on bluff-top properties.

Benefits:
- Mitigates human impact on bluff failure, erosion.

Challenges:
- Requires accepted scientific criteria.

Purpose	Implementation Difficulty	Personal Impact
Promote Practices	Medium	More/Less Restrictive Ordinances

34

Educational Resources

Publications, such as a bluff vegetation guide

Video series, such as an explanation of coastal processes through a virtual tour of the coast

Enhanced website to share comprehensive info on coastal processes and engineering

Primary Audience	What is Communicated?	What *isn't* Communicated?	How Could This Help?
Property Owners	Science, Issues, Policies	Specific Recommendations	Promote Awareness and Understanding

Outreach Activities

Educational boat tours

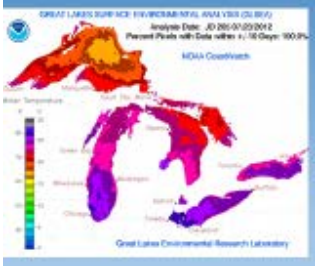
Annual workshop series on coastal erosion

K-12 curriculum activities

Primary Audience	What is Communicated?	What *isn't* Communicated?	How Could This Help?
Property Owners, Public Officials, Students	Science, Issues, Policies, Practices	Specific Recommendations, Alarm	Promote Awareness and Understanding, Build Community

Maps

Informative Maps



- Erosion Rates
- Stability Estimates
- Oblique Aerial Photography

Interactive Maps

- 3D Visualization of Bluff Erosion
- Interactive Slider Bar to Compare Historic and Current Photos
- Map of successful projects on Great Lakes

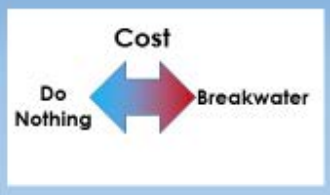
Primary Audience	What is Communicated?	What *isn't* Communicated?	How Could This Help?
General Public	Conditions, Changes, Success Stories	Private Information	Identify & Prioritize Sites, Understand Processes & Changes

38

Decision Support Tools

Example: Bluff Stability Self Assessment

- Answer questions about your property (slope angle, etc.).
- Answers result in scores for particular solutions.
- Helps property owner understand appropriate options before talking to a consultant.



Example: Spectrum of Control Methods

- Ranks various erosion control methods by cost, environmental impact or strength.
- Helps property owners/communities compare different methods across a range of impacts

Primary Audience	What is Communicated?	What *isn't* Communicated?	How Could This Help?
Property Owners, Public Officials	Appropriateness of Specific Methods, Comparisons	Guarantees	Prepare property owners and officials for discussions with Engineers

39

Data and Analysis

Example: Study of projected changes in property values due to erosion and loss of properties-could be presented on a map.

Example: Updated erosion rates and stability analyses of bluffs along coast-could be mapped or inform other tools.

Example: Study of sediment transport in Lake Michigan to identify "Feeder" bluffs that sustain the beaches.

Primary Audience	What is Communicated?	What *isn't* Communicated?	How Could This Help?
Property Owners, Public Officials, General Public	Existing Conditions, Relationships, Projected Changes	Which properties affected, Predictions of bluff Failure	Support Policy Efforts, Property Planning and Prioritization

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