Resiliency Plan for Governments in the Little Traverse Bay Watershed:

LOCAL CLIMATE SOLUTIONS

TIP OF THE MITT Watershed Council

Petoskey-Harbor Springs Area
community foundation

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Chapter 1

What are we used to?

Our Four Seasons

The Little Traverse Bay Watershed is a wonderful place to live or visit if you like the four seasons. Winter provides opportunities for skiing, snowmobiling, hunting, and fishing that carryover into spring, along with morel mushroom hunting and the blooms of trillium. Summer provides a pleasant way to escape the heat by coming Up North to enjoy sparkling water resources, mild daytime temperatures, and pleasant summer nights. Fall provides a spectacular display of color and more opportunities for hiking, birding, sightseeing, and hunting. These seasonal changes all provide recreational, ecological, and economic benefits throughout Northwest Lower Michigan and the Little Traverse Bay Watershed.

What kind of climate are we used to that provides us with these benefits?

Winter weather is something residents of the Little Traverse Bay Watershed are accustomed to, with an average annual snowfall of 103.23 inches. We have trails for snowshoeing and cross-country skiing, in addition to scenic, frozen inland lakes dotted with ice fishermen. Blizzards are rare but can be fierce, and we expect rough winter weather in this part of the world with an average annual extreme snowfall of 36.75 inches. On average, we have 71 days with a maximum temperature below 32° F.[1]

Spring runoff can be epic in the Watershed if winter has been snowy. Cold Blue-Ribbon Trout Streams beckon across the landscape, providing habitat that fosters some of the best fishing in the world. Average annual rainfall is 30.21 inches, with late spring recharge feeding summer stream flows from groundwater.[2] The tornado index for the region is 20.38. A higher tornado index value means a higher chance of tornado events. For reference, the average tornado index for Michigan is 140.33 and the average tornado index of the United States is 136.45. This demonstrates that the Little Traverse Bay region has a very low chance of tornadoes.[3]

Annually, air temperatures in the region average 43° F.[4] However, we have warm summers filled with long days of sunlight near the 45th parallel north. Although summer can be hot, we normally average only 5 days exceeding 90° F annually. Importantly, summer nights cool down to pleasant ranges, with average July temperatures ranging from 75°-55° F in the hours of 8 pm to 4 am.[5] The growing season is about 160 days, favoring various fruits and vegetables, including grapes for regional wineries.[6]

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[1] Michigan Office of the State Climatologist, "Petoskey (6507)" Climate Statistics: Normals & Statistics, https://climate.geo.msu.edu/climate_mi/stations/6507/, accessed August 7, 2018.

[2] Ibid.

[3] USA.com "Emmet County Natural Disasters and Weather Extremes" http://www.usa.com/emmet-county-mi-natural-disasters-extremes.htm accessed August 7, 2018.

[4] Michigan State Climatologist's Office.

[5] Weather Spark, "Average Weather in Petoskey Michigan, United States" https://weatherspark.com/y/16134/Average-Weather-in-Petoskey-Michigan-United-States-Year-Round, accessed August 7, 2018

[6] Michigan State Climatologist's Office.

Finally, Great Lakes water temperatures have traditionally been moderate. For example, Lake Michigan averages 67° F in the summer and 37° F in the winter.[7] We expect Little Traverse Bay to freeze over in the winter, favoring local activities that depend upon a frozen Bay. This includes ice fishing, in addition to viewing a large, sunken crucifix at the bottom of the Bay that can be seen by walking across the ice.

All of the above is what we are used to in the Watershed, but things are changing.

Looking Forward

We are entering a new era and our local climate story is changing. Regional communities have already experienced unusual and intensifying weather patterns. Our coastal communities recently had strong storms resulting in wind and water damage, and predictions for the area indicate these storms and changing weather patterns will continue into the future. Local governments must prepare for expected impacts in order to protect citizens, property, natural resources, and the local economy.

On May 11, 2018, Tip of the Mitt Watershed Council hosted a Climate Change Summit for local governments, funded by the Petoskey–Harbor Springs Area Community Foundation. The purpose of the Climate Change Summit was to inform natural resource managers and local officials about expected impacts from our changing climate and help local governments make our coastal cities resilient to these changes. "Coastal resilience means building the ability of a community to 'bounce back' after hazardous events such as hurricanes, coastal storms, and flooding – rather than simply reacting to impacts" National Oceanic and Atmospheric Administration (NOAA).[8]

The agenda for the Summit can be seen in Appendix B. Videos of each presentation from the Summit are available on our website: www.watershedcouncil.org/climate-change-summit.

Also in May 2018, the International Joint Commission noted the following regarding climate change in the Great Lakes region: "…more emphasis must be placed on moving from science to action. Studies have identified climate change impacts in the basin, but more work is needed to adapt to the stresses this puts on people and infrastructure in the basin. Governments need to be better prepared."[9]

This Resiliency Plan for Local Governments in the Little Traverse Bay Watershed comes from what we learned at the Climate Change Summit, and from additional research and data collection. We did this work so that area governments can learn about climate change impacts and take important steps to become better prepared. In addition to presentations from the Summit, we have compiled information from other efforts to engage stakeholders on this topic to create a broad plan that can guide local governments in the Little Traverse Bay Watershed. We hope it provides helpful suggestions to make communities more resilient to these important changes to our local

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[7] Great Lakes Environmental Research Laboratory, "Great Lakes Statistics," National Oceanic and Atmospheric Administration (NOAA) CoastWatch Great Lakes, https://coastwatch.glerl.noaa.gov/statistic/statistic.html accessed August 6, 2018.

[8] NOAA, "What is resilience?" https://oceanservice.noaa.gov/facts/resilience.html accessed August 6, 2018.

[9] International Joint Commission, "More Work is Needed to Adapt to Impacts from Climate Change on the Great Lakes," Great Lakes Connection, May 4, 2018, http://ijc.org/greatlakesconnection/en/ accessed May 31, 2018.

climate story. You can implement specific action steps included in this Plan or use it to guide additional local planning efforts.

In the following pages, you will find information and resources that support the overarching goals of the Little Traverse Bay Watershed Protection Plan. In fact, the Climate Change Summit and this document help implement the following step from the Watershed Plan:

> EI: Emerging Issues and Threats, step EI.2 – *"Mitigate Climate Change impacts, including more severe coastal storms in our area, by protecting and restoring vulnerable areas and implementing best management practices throughout the Watershed. Note: Convene working groups to identify and prioritize vulnerable areas; develop strategies given climate predictions; disseminate strategies via Climate Change campaign."*

Five Steps to Resiliency

NOAA recommends **Five Steps to Resiliency:**[10]
Here is how this Plan helps accomplish each step:

1. Explore Hazards

A community cannot be resilient without recognizing potential hazards. The first two chapters of this Plan provide basic information regarding past and future climate trends that are specific to our region. The four seasons we experience inherently possess many economic and ecological things we value. You can use this information to consider what hazards are most relevant to your community, then define or refine any goals and objectives you want to specify to guide your actions.

2. Assess Vulnerability & Risk

Additionally, Chapters 3-7 of this Plan outline some of the changes expected regionally, and note our valuable assets that these changes will affect. Some of the vulnerabilities in our area are highlighted and this document can be used to evaluate site-specific community assets that need protection.

3. Investigate Options

The Climate Change Summit was the main source of our information regarding options and feasible actions, but we also researched additional sources and provided them for your reference. This Plan creates a foundation for discussion and consideration of options for your community. From a regional perspective, we considered solutions for the most pressing and potentially common risks in Chapters 3-7. We examined case studies to see how other communities have taken action. You will find informative case studies included in resources listed in the references section.

[10] NOAA, "Steps to Resilience," https://toolkit.climate.gov/#steps accessed August 7, 2018.

4. Prioritize & Plan

Challenges and opportunities exist for every local community. Costs, benefits, resources, and values vary across the area, so local communities are the best ones to prioritize and settle on what specific local efforts they will use from this Plan. This can include creating a section devoted to resiliency in a local master plan, doing a stand-alone effort, or simply working from this Plan by taking action steps listed for various categories. The steps included in this document are generally compatible with other areas of community concern.

5. Take Action

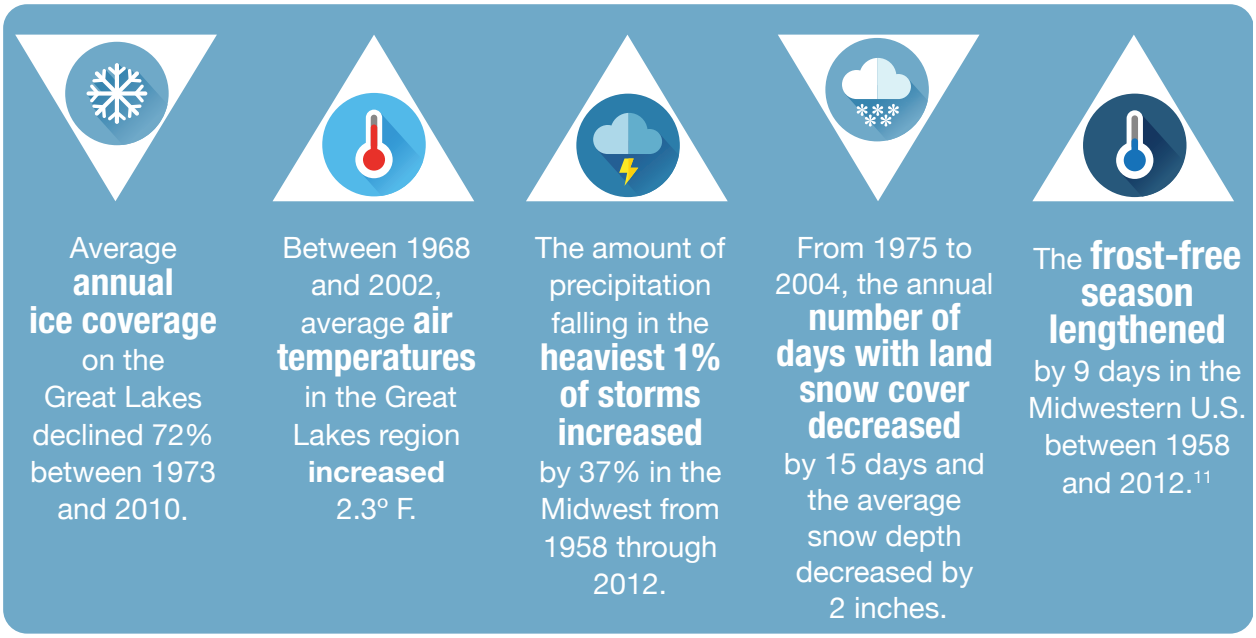
We sincerely hope that this document is helpful and provides guidance that leads to effective action, making your community more resilient to the expected changes. We listed numerous actions for your consideration, and if you wish to dig deeper we have provided references for additional recommendations. If you have questions about this Plan, please contact Tip of the Mitt Watershed Council at (231) 347-1181. We are happy to assist you with implementation steps.

Chapter 2

What should we expect in the future?

The Great Lakes Region

The effects of climate change are already apparent in the Great Lakes region. Over the last 60 years, the Great Lakes basin has seen measurable changes in temperature, precipitation, and extreme weather events.



Northwest Lower Michigan

In the Northwest region of the Lower Peninsula similar trends are evident. We have also seen air temperatures increase as the region gets warmer, with higher elevations seeing the biggest increases. (Some areas near Lake Michigan have seen slight cooling or no increase in air temperatures.) Precipitation has also increased across most of the region, with Traverse City and Petoskey seeing more than an extra inch of rain per year, on average, in the past 10 years.[12]

As the climate changes, our normal four seasons will also change, and this will affect our way of life. Many things we value will be vulnerable. For example, tourism generates millions of dollars in revenue from visitor spending year-round, not just during summertime. Fall and winter provide extremely popular tourist opportunities that result in economic benefits for Emmet County, which makes up a full 20% of total revenue from visitor spending in Northwest Michigan. More importantly, tourism leads to 4,867 jobs in Emmet County, resulting in $172 million in labor income.[13]

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[11] Tip of the Mitt Watershed Council, *Climate Change Adaptation for Coastal Wetlands*, October 2016, page 4.

[12] Hyndman, David, et al., "Evaluating the Impacts of Projected Climate Changes on the Grand Traverse Bay Region," Michigan State University Integrated Assessment, 2014-15, pages 12-13.

[13] Pure Michigan, "The Economic Impact of Travel in Michigan: Tourism Satellite Account Calendar Year 2016", 2016 The Economic Impact of Travel in Michigan - County Level, https://medc.app.box.com/s/yso7vz641n3xcmldw99hrx2319u0h0xs accessed August 9, 2018.

Because the Little Traverse Bay region is a year-round tourist destination, many local businesses thrive in Emmet County. What is at stake, economically? Below is a table of revenue from visitor spending for local business sectors that benefit from our current climate and four seasons:

Visitor Spending by Local Business Sector	
Lodging	$101 million
Food and Beverages	$71 million
Retail	$44 million
Recreation	$98 million
Transportation	$49 million
TOTAL	**$363 million**[14]

What do we have in store for us in Northwest Lower Michigan? What should we expect as our local climate story unfolds? As we learned at the Climate Change Summit and through our additional research, many issues will arise for us in the Little Traverse Bay Watershed. This document will focus on these four categories of interest to the local governments in the region:

- *Variable Temperature Patterns and Extreme Heat*
- *Severe Storm and Flooding Events*
- *Coastal Dynamics*
- *Infrastructure Impacts*

We emphasized this list for the reasons cited below.

Variable Temperature Patterns and Extreme Heat

Northwest Lower Michigan is a world-class tourist destination. As noted earlier, one thing that shapes our culture and way of life is winter weather. Another is the fact that our pleasant summers provide an escape from hotter areas down state and in other areas of the nation and the world. Unfortunately, one element of global climate change is rising temperatures. For us, this will mean:

- *Increased frequency and length of severe heat events*
- *Extended growing season (earlier spring/later fall)*
- *Increased risk of drought and wildfire, particularly in summer*
- *Reduced ice cover on the Great Lakes*[15]

Chapter 3 will explore this category of Variable Temperature Patterns and Extreme Heat.

Severe Storms and Flooding Events

Severe storms and flooding events will be a challenge for thousands of shoreline property owners on both the Great Lakes and on inland lakes and streams. Storms with straight-line winds recently hit the region.[16] The Great Lakes are currently at high levels, swinging in just a few years from very low levels. Future swings are expected. Several inland lakes and streams are at high water

[14] Ibid.

[15] Land Information Access Association (LIAA) and Beckett & Raeder, Inc., P*lanning for Community Resilience in Michigan: A Comprehensive Handbook*, April 2017, page 21.

[16] "Straight-line winds are damaging winds (typically 60 mph or greater) that travel in a uniform direction as they propagate across an area." Defined at Weatherology, "What are straight-line winds?" https://weatherology.com/articles/160/What+are+Straight-Line+Winds%3F.html accessed August 3, 2018.

levels. Floodplains are changing in relation to boundaries and frequency of floods. As a result, we are likely to experience:

- *More frequent and severe storms*
- *Increased winter and spring precipitation*
- *Less precipitation as snow and more as rain*
- *More flooding events with risks of erosion*[17]

Chapter 4 will highlight Severe Storms and Flooding Events.

Coastal Dynamics

As described in a recent 2017 publication by Land Information Access Assocation (LIAA), since records began, Lake Michigan's water level has fallen by as much as four feet in as little as two years. In the future, climate change may cause even greater extremes for water levels in the Great Lakes.[18] For example, record lows were recorded in 2013 but we have been near record high water levels since that time. We think Coastal Dynamics is an accurate title and description for a chapter about what our regional coastal communities are facing – dynamic water level conditions that have always included natural fluctuations and will likely be exacerbated by our changing climate. Chapter 5 will highlight Coastal Dynamics and discuss:

- *Warmer water temperatures*
- *Greater extremes in Great Lakes water levels that may impact recreation and shipping lanes*
- *Reduced ice cover on the Great Lakes*

Infrastructure Impacts

All of the categories noted above require local governments to understand their built environment in order to assess resiliency to changing weather patterns. Extreme heat, severe storms, and increased flooding are going to impact basic infrastructure like roads and buildings. Infrastructure will be vulnerable unless local governments confront these problems and work to become resilient. Chapter 6 will focus on infrastructure, including:

- Stormwater and sewer systems
- Septic systems
- Transportation infrastructure
- Harbor infrastructure

Emissions

Among the United States, Michigan is ranked high as an emitter of greenhouse gases. However, there are mitigating factors including the fact that half of the State contains forested land cover. Forests reduce the State's net emissions.[19] Therefore, Michigan would be ranked higher without our forest land cover. Additionally, some local governments are in a great position to offer residents access to renewable energy choices, and if you are among those, we urge you to do so.

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[17] LIAA, page 21.

[18] Ibid, page 31.

[19] Union of Concerned Scientists, "Confronting Climate Change in the US Midwest," July 2009, https://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/climate-change-michigan.pdf accessed August 3, 2018, page 9.

Chapter 3

Variable Temperature Patterns and Extreme Heat

Climate Stressors

The United States Environmental Protection Agency (EPA) has noted why specific climate-related stressors are important to consider when planning for resiliency. A few of these stressors are helpful to understand variable temperature patterns and extreme heat, covered in this chapter. Each of the four stressors listed below are likely to affect the Little Traverse Bay Watershed.

Warmer summers
"This stressor is generally about the warm season being even warmer. This stressor (like warmer winters, below) is about the general climate. Air, surface, soil, and groundwater temperatures will be warmer. The general climate effects of having warmer oceans or lakes are included here."

Warmer winters
"This stressor is about a cold season not being as cold as it formerly was."

Warmer water
"This stressor (regardless of season) comes from a higher temperature of water bodies (including the ocean) and affects the chemical, physical, or biological characteristics of the water body itself."

Increasing drought
"Drought is a deficiency in precipitation over an extended period. The magnitude of the deficiency, the duration, or the number of droughts could be greater."[20]

Stressors in the Watershed

In the Little Traverse Bay Watershed, variable temperature patterns and extreme heat from climate change will likely result in:

- *Increased frequency and length of severe heat events*
- *Extended growing season (earlier spring/later fall)*
- *Increased risk of drought and wildfire, particularly in summer*
- *Reduced ice cover on the Great Lakes*[21]

An increase in severe heat events and associated drought is expected.[22] Extreme heat will have human impacts in addition to infrastructure impacts. Importantly, this also means impacts to farm animals and pets, not to mention wildlife habitat.

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[20] US EPA Office of Water, *Being Prepared for Climate Change: A workbook for developing risk-based adaptation plans* (EPA 842-K-14-002), August 2014 https://www.epa.gov/sites/production/files/2014-09/documents/being_prepared_workbook_508.pdf, accessed July 10, 2018, page 24.

[21] LIAA, page 21.

[22] Ibid.

Because of expected temperature increases, Northern Michigan summers and winters will be much warmer than what we are used to. Temperatures that are more variable will lead to more freeze-thaw cycles, which will affect habitats and infrastructure in very visible ways. This will affect everything from insects to bird populations. For example, fisheries could change dramatically with warmer air and water temperatures. Roads, sidewalks, driveways, and buildings will show wear and tear more quickly, making repairs necessary more often and raising maintenance costs for both public and private entities.

There could be increased use of air conditioning, putting strains upon the energy grid. If strains upon the grid are too great, brownouts or blackouts could cut off air conditioning. However, many homes in the region do not have air conditioning because of our normally mild climate. Vulnerable populations are likely to require increased medical attention and citizens will seek relief.

This is also where nighttime temperatures become important. Climate change is diminishing our ability to cool down in the evening. Warmer evenings give people and wildlife less time to recuperate from peak heat. This means stress will become evident in nature, including impacts to our abundant forests. It also means using air conditioning for more hours per summer season, or more electricity to run fans. People without access to parks and green spaces, air conditioning, or a vehicle to escape to cooler places will see greater impacts if they are unable to find relief from the heat.[23]

We should prepare for more frequent, intense short-term droughts. As temperatures rise, more water evaporates from soil and plants, meaning it requires more rainfall just to maintain soil moisture. Because the Midwest is projected to receive less rain in the summer (when temperatures are hottest), the likelihood of drought will increase. Unfortunately, at the same time, water levels in rivers, streams, and wetlands will decline during summers. In Michigan, long-duration droughts (lasting more than two years) are likely to decline.[24] However, short-term droughts with very high temperatures will be unpleasant and dangerous.

The Little Traverse Bay Watershed is dependent upon groundwater for much of its drinking water supply, and that could be a problem in the future. While cities do use surface water, some sections of cities may rely on groundwater supplies and most townships and villages rely on individual wells for drinking. The Watershed Council encourages capturing stormwater runoff to improve water quality, and to allow for groundwater recharge. Groundwater recharge is important for drinking water supplies and crucial for irrigation of farm fields. The growing season is expected to be longer, placing more demand on groundwater resources to keep crops watered in much warmer weather. This increased demand across all sectors could trigger shortages.

[23] Ibid, page 23

[24] Union of Concerned Scientists, page 6.

SOLUTIONS:
Variable Temperature Patterns and Extreme Heat

What can be done to make your community more resilient to variable temperature patterns and extreme heat? Some actions that control stormwater runoff to protect water quality, such as the use of green infrastructure, are things that can help mitigate the impacts of water temperature related climate change and make your community resilient. As you know, stormwater is rain and snowmelt that does not infiltrate into the ground. Instead, it runs off driveways, roads, parking lots, and other compact or hard surfaces. The larger the storm event, the more stormwater, and the larger the potential for warmer water to affect water quality and the community.[25] Minimizing pavement and other impermeable surfaces within your community will help mitigate future changes in temperature and help protect surface waters.

Plant trees. Why is this simple step included here? Because you can plant trees to create shade and keep the ground cooler. Trees and vegetation also intercept the sun's rays and use the energy for evapotranspiration. When the sun's rays hit the tree, water is released and evaporated from the tree's leaves into the air, similar to how sweating cools down a human's skin. Tree roots also help control stormwater runoff and promote infiltration of water.[26] The annual mean air temperature of a large city can be roughly 2-5° F warmer than its outlying areas. In the evening, the difference can be as high as 22° F.[27] "Shading reduces surface temperatures below the tree canopy. These cooler surfaces, in turn, reduce the heat transmitted into buildings and the atmosphere."[28]

- When selecting long-lived plantings such as trees, choose indigenous varieties or their cultivars that can tolerate increased heat stress and reduced moisture.[29]
- Strategically plant trees on public property to shield public buildings from excessive heat. For example, a shade tree blocking western-facing windows can protect against excessive heat as the sun sets. Local landscapers can help with this, or call Tip of the Mitt Watershed Council and we can advise you on strategic planting choices.
- Shade from trees help keep city streets cool, guarding against the creation of urban heat islands. "Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality."[30] Guard against creating heat islands in your urban areas. Plant trees!

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[25] Michigan Sea Grant, "Tools to Increase Awareness of Stormwater during Extreme Storms," Dr. Heather Triezenberg, Program Leader, http://www.miseagrant.umich.edu/wp-content/blogs.dir/1/files/2017/06/17-707-Awareness-of-Stormwater-During-Extreme-Storms-rev2-1.pdf, page 1.

[26] US EPA Office of Water, page 117.

[27] US EPA, "Heat Island Effect," https://www.epa.gov/heat-islands, accessed July 23, 2018.

[28] US EPA, "Trees and Vegetation." *Reducing Urban Heat Islands: Compendium of Strategies. Draft.* https://www.epa.gov/heat-islands/heat-island-compendium accessed August 7, 2018, page 3.

[29] Murdock, Evan and David Hart, "Climate Adaptation Checklist," University of Wisconsin Sea Grant Institute, March 2013, https://eos.ucs.uri.edu/EOS_Linked_Documents/wiscu/wiscug13002.pdf accessed August 3, 2018.

[30] US EPA, "Heat Island Effect," https://www.epa.gov/heat-islands, accessed July 23, 2018.

Construct narrow streets. Landscape with native vegetation. Work with county road commissions when you need to construct new streets and consider making them as narrow as possible while still meeting minimum width requirements. This can result in having less heat-holding asphalt and concrete, and result in less stormwater runoff. In addition to planting trees, smaller plants such as shrubs, vines, grasses, and ground cover also help cool the urban environment.[31]

- Landscape the streetways with swales and rain gardens using drought-tolerant, indigenous vegetation or their cultivars, which are easy to care for and take advantage of extra space.
- Cooling will vary with the types of plants used in your area. Get recommendations on appropriate plants to provide a cooling effect near your streets and sidewalks. Landscapers and Tip of the Mitt Watershed Council can help with these recommendations.

Install green roofs on public buildings. Green infrastructure techniques for roofing lower temperatures as compared to conventional roofs. Also called living roofs, green roofs are partially or totally covered with vegetation. They reduce building temperatures and energy use, and trap stormwater onsite.[32] This is another way to mitigate impacts from rising temperatures or extreme heat. Using them on public buildings can also provide a demonstration for the public.

Pave with permeable materials. This is another example of green infrastructure. "Cool pavements" include a range of technologies that reduce heat island effects. These are paving materials that reflect solar energy, enable water evaporation, or remain cooler than conventional pavements. Conventional paving materials can reach peak summer temperatures as high as 150^0 F and prevent stormwater to be filtered before entering a nearby waterway. This excess heat is transferred to the air above and warms stormwater as it runs into local waterways.[33] Permeable pavers allow stormwater to soak into the pavement and soil, reducing warm runoff and filtering pollutants.

CAKE
Charlevoix-Antrim-Kalkaska-Emmet
Cooperative Invasive Species Management Area
www.antrimcd.com/cake-cisma

Work with the CAKE CISMA. Even though aquatic invasive species are nothing new to the Great Lakes, a changing climate may provide new opportunities for invasive species to thrive, while native plant and animal communities are subjected to increasing stress. The best response today is vigilance. Develop and implement plans for controlling the introduction and spread of invasive species.[34]

- The Charlevoix, Antrim, Kalkaska, and Emmet (CAKE) Cooperative Invasive Species Management Area (CISMA) is headquartered in the Antrim Conservation District. You can reach them at (231) 533-8363 to get help with invasive species problems.

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[31] US EPA, "Trees and Vegetation", page 1.

[32] US EPA Office of Water, page 117.

[33] US EPA, "Using Cool Pavements to Reduce Heat Islands," https://www.epa.gov/heat-islands/using-cool-pavements-reduce-heat-islands, accessed August 3, 2018.

[34] Murdock and Hart, page 4.

Work in partnerships to manage forest lands. The Little Traverse Bay Watershed is surrounded by abundant woodlands and forests. These lands are in both public and private ownership. Regardless of ownership, forests are vulnerable to climate change and drought. Enhanced droughts increase the risk of forest fires. The summer of 2018 demonstrated this in tragic ways, as forest fires ravaged several states across the United States, exacerbated by climate-driven conditions. Michigan is not immune to this threat. We should expect more short-term droughts, which make our forests vulnerable to both pests and fire.

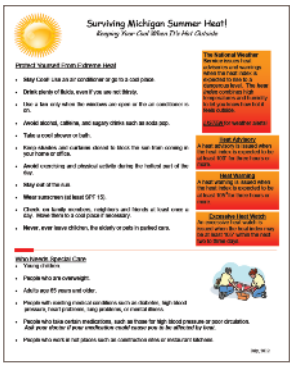
- Forests in the region are owned by federal, state, local, tribal, and private entities. Strengthen partnerships with the local Office of Emergency Management and those who own and manage your forestlands, and engage in conversations about how your local government can help them keep our forests healthy.

- Form coalitions with the local Office of Emergency Management, forest owners, and land conservancies. Practice response scenarios and identify how the coalition can be pro-active. Work together to be prepared for changes that have the potential to influence the entire region.

- Pool resources and do public outreach and education about preventing pest infestations or increasing awareness of fires during drought conditions. Invasive species or fires can also start in homes and spread to forested areas. Everyone must be aware of the dangers and learn about how to prevent disasters.

Provide cooling centers. Cooling centers are places where people can go to escape the heat. These cooling centers are climate-controlled, and are especially important for citizens who do not have air conditioning at work or at home.

Michigan already has a tradition of using libraries and other public institutions as cooling centers. In the future, as this service becomes a much-needed solution, local governments must spread awareness about their locations and make sure it is easy for those in need to reach a cooling center.[35]


Surviving Michigan Summer Heat!

- Be sure to educate your community about the dangers of extreme heat! We included an excellent flyer from the Michigan Department of Community Health in Appendix A. You can find this flyer online at this link: https://www.michigan.gov/documents/mdch/Heat_Flyer_4-2011_351340_7.pdf. Making people aware of the dangers can help decrease impacts on local residents.

[35] LIAA, page 25.


SOUTH
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Chapter 4

Severe Storms and Flooding Events

Stressors in the Watershed

As noted earlier, the EPA has listed various climate-related stressors that are important to consider when planning for resiliency. The stressor listed below is helpful to understand severe storms and flooding events:

Increasing storminess

"This category encompasses all aspects of intensifying precipitation in any form: more seasonal precipitation, more total precipitation during events, higher rates of precipitation during events. Stronger or more frequent instances of extratropical and tropical cyclones, blizzards, or other weather conditions are included here. If they are acting as stressors, then floods, waves, coastal storm surge and wind are part of this storminess category."[36]

Also noted earlier, the Great Lakes are currently at high levels, swinging in just a few years from very low levels, and future swings are expected in both directions. Several inland lakes and streams are at high water levels. Floodplains are changing, in relation to boundaries and frequency of floods. This category will likely bring:

- *More frequent and severe storms*
- *Increased winter and spring precipitation*
- *Less precipitation as snow and more as rain*
- *More flooding events with risks of erosion*[37]

More frequent, severe storms will bring important changes to the Little Traverse Bay Watershed. In addition to strong winds, storms may come with increased intensity of precipitation, but this can actually mean less infiltration of stormwater and more runoff. As the soil is increasingly saturated, water is forced to run over the surface landscape. Because of increased runoff, streams may see greater erosion and scour, leading to higher turbidity and more sedimentation, with consequences for various aquatic species. Along the same lines, less snow and more rain may change the runoff-infiltration balance, meaning that base flow in streams could change, creating a cascade of effects that start with warming waters and include less groundwater recharge.[38]

Flooding

The Union of Concerned Scientists noted that paradoxically, Michigan could face not only the risk of more droughts, noted in the prior chapter, but also the risk of greater flooding.[39] An Integrated Assessment conducted by Michigan State University (MSU) on projected climate changes in Northwest Lower Michigan found that we should expect a shift to more extreme events accompanied by lower snowfall totals. This will increase the likelihood of flooding and affect the seasonal cycle

[36] US EPA Office of Water, page 24.

[37] LIAA, page 21.

[38] US EPA Office of Water, pages 29-32.

[39] Union of Concerned Scientists, page 6.

of groundwater recharge. “The projected increase in variance of precipitation may be the most concerning aspect of projected changes in climate, as more frequent heavy rain events will increase the risk of flooding while more dry and hot periods will likely lead to more extended and severe droughts.”[40]

Urban areas may experience more floods leading to property damage and possible human health impacts. Existing flood control facilities, such as detention basins, may be inadequate. Frequent high rainfall and flooding could make water treatment plants as well as on-site septic systems less effective. Floodwaters could also affect water quality by raising turbidity in streams.[41]

Extreme storms and floods can also have other terrible consequences. Floods can wash high levels of nitrogen, phosphorus, and other nutrients into surface and groundwater resources. This can lead to water quality issues such as harmful algal blooms. Floods can also give invasive species new routes for moving from one waterway to another. The aftermath of flooding can create damp environments that encourage the growth of mold, harmful bacteria, and mosquito infestations. Finally, severe flooding might tempt people to fish, wade, or boat in potentially hazardous waters. Fast-moving and uncertain currents, underwater obstructions, and contaminants could threaten the health and safety of people who venture into floodwaters.[42]

Wetlands

Severe storms and flooding concerns should lead to consideration of using and maintaining wetlands, which are complex ecosystems that provide numerous benefits to local communities. Wetlands act as nature’s sponges, temporarily storing floodwaters and releasing them slowly, thus reducing flood damage. Wetlands also provide protection from storms and ice by absorbing wave energy and buffering shorelines against erosion. Nutrients are also filtered by wetland vegetation before entering nearby waterways.

Interestingly, in September 2018, it was reported that the Insurance Bureau of Canada stated that urgent action is needed to protect wetlands as a way of limiting flood risk. They emphasized that wetlands can be a cost-friendly and effective way to prevent flooding. “In terms of our coastal wetlands, our inland wetlands, our forests, we need to be doing a better job of protecting these in the places where they protect us.”[43] Local governments should understand the types of wetlands they have on public property, and how to use them to make the community resilient to climate change.[44] Factors to consider include:

- Great Lakes coastal wetlands are different from inland wetlands. This is due to the influence of large lake processes, including powerful waves, wind-driven tides known as seiches, and especially the seasonal and long-term fluctuations of Great Lakes water levels.

[40] Hyndman, David, et al., page 2.

[41] US EPA Office of Water, pages 29-32.

[42] Michigan Sea Grant, “Extreme Storms and Flooding,” http://www.miseagrant.umich.edu/explore/climate-weather-and-the-great-lakes/extreme-storms-and-flooding/ accessed August 8, 2018.

[43] Cousins, Ben, CTV News, “'Urgent action needed' to preserve wetlands and mitigate flood risk: report,” https://www.ctvnews.ca/canada/urgent-action-needed-to-preserve-wetlands-and-mitigate-flood-risk-report-1.4099915?utm_content=buffer88430&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer accessed September 26, 2018.

[44] Tip of the Mitt Watershed Council, page 2.

- The dynamic nature of the Great Lakes contributes to the ecological functions of coastal wetlands, which are also vegetated bottomlands. During low water periods, nearshore areas of the Great Lakes that are typically under water are exposed. Vegetation growth naturally increases in exposed wetlands during low water years. This also stabilizes sediment and reduces erosion.

- Coastal wetlands provide a range of important functions. Wetlands provide critical wildlife habitat, prevent shoreline erosion, and protect water quality. They are the most biologically productive ecosystems in the Great Lakes Watershed.[45] Any physical alteration (human-derived or otherwise) alters the ability of a wetland to provide these functions.

SOLUTIONS:
Severe Storms and Flooding Events

Develop a flood response plan. Create a new or revise your existing flood response plan, identifying vulnerable areas consistent with expected climate changes.[46] Include infrastructure concerns as well (see Chapter 6).

Protect against high winds and severe storms. Trees and other large vegetation can serve as windbreaks or shields to reduce wind speed near public buildings. In the wintertime, reducing wind speeds, particularly cold north winds, can provide substantial energy-saving benefits while also protecting habitat and infrastructure.[47]

Use rain barrels, swales, and rain gardens. These tools keep stormwater from running off your property. They allow stormwater to infiltrate rather than run off into waterways, which helps maintain water temperature and replenish aquifers.[48]

Revisit and revise, as appropriate, required waterfront setbacks. In light of coming changes, waterfront setbacks should be re-evaluated to protect structures against water level rises and frequent flooding.[49]

Encourage replacement of hardened shorelines. Wherever possible, replace hardened shorelines with natural shorelines, using bioengineering, green infrastructure, and low impact development best management practices. Require

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[45] Ibid.

[46] Murdock and Hart, page 6.

[47] US EPA, "Trees and Vegetation." *Reducing Urban Heat Islands: Compendium of Strategies. Draft.* https://www.epa.gov/heat-islands/heat-island-compendium accessed August 7, 2018, page 3.

[48] US EPA Office of Water, page 117.

[49] Murdock and Hart, page 6.

any old and/or failing seawalls to be replaced with bioengineering solutions. If replacing an existing seawall is not practical, landowners can still lessen negative impacts by:

- Placing rip-rap in front of a seawall, which helps reduce the wave energy by reducing wave flanking and scouring. Rip-rap can also create a slope that allows animals to access land and provides places for aquatic insects and plants to grow. *Note: placing rip-rap in front of your seawall requires a permit from the Michigan Department of Environmental Quality.*

- Adding deep-rooted native plants into the rip-rap.

- Reducing existing lawn above the seawall and adding native vegetation on the shoreland.[50]

Restore public wetlands and encourage restoration on private lands. For all the reasons noted earlier, our coastal communities will benefit from wetland protection and restoration. If the local government owns coastal wetlands, protect them and restore them wherever possible. If private entities have coastal wetlands that can be either protected or restored, encourage this. For questions about wetland protection or restoration, please contact Tip of the Mitt Watershed Council.

Use your planning process to reduce impervious surfaces in the watershed. Climate change models for this region show that "Reducing imperviousness by 20% in the watershed decreased peak streamflow most throughout the year, with as much as a 4-5% decrease in the fall. All scenarios of retention basin expansion resulted in similar reductions of peak streamflow when compared with moderate reductions in imperviousness."[51] Selective permeable pavement, such as in parking lots, is a solution local communities can consider. Incentives to use best management practices to reduce imperviousness can also be an option. See additional information in Chapter 7.

[50] Michigan Natural Shoreline Partnership, "Understanding Erosion at the Shoreline," http://www.mishorelinepartnership.org/erosion-at-the-shoreline.html accessed September 6, 2018.

[51] Hyndman, David, et al., page 37.

Chapter 5

Coastal Dynamics


Photo: Michigan SeaGrant

Stressors in the Watershed

What do we mean by coastal dynamics? This phrase refers to collective changes created by the complex and dynamic processes affecting coastlines of the Great Lakes. Coastal dynamics are something that citizens and local governments need to consider when thinking of climate change and how the Great Lakes ecosystem is expected to respond. The Great Lakes have seen historic fluctuations that we have learned from, and we must use this knowledge to become resilient against even more extremes. In 2013, we saw record low water levels in Lake Michigan. Since then, we have seen continual levels near record highs. "Climate change may cause even greater extremes in Great Lakes water levels. Inland lakes may also experience lower water levels if drought conditions dry up wetlands and tributaries that contribute to lake water levels."[52]

This category will likely result in:

- *Warmer water temperatures*
- *Greater extremes in Great Lakes water levels that may impact recreation and shipping lanes*
- *Reduced ice cover on the Great Lakes*

Ice Cover

One striking example of a result from climate change already observed is ice cover on the Great Lakes. Decreasing levels of ice cover for both inland lakes and the Great Lakes are very evident to residents of the region when they occur. We will use both Grand Traverse Bay and Little Traverse Bay as examples of Great Lakes ice cover.

The Integrated Assessment conducted by Michigan State University on projected climate changes in Northwest Lower Michigan noted this about Grand Traverse Bay: "There has been a significant shortening of the period of ice cover in the Bay (Figure 1), which can be an indicator

[52] LIAA, page 31.

of less ice cover on the Great Lakes in general. This factor is important as less ice cover tends to cause more snowfall as the open water enhances lake effect snow and also lower lake levels due to loss of water from the Great Lakes by evaporation in open water."[53]

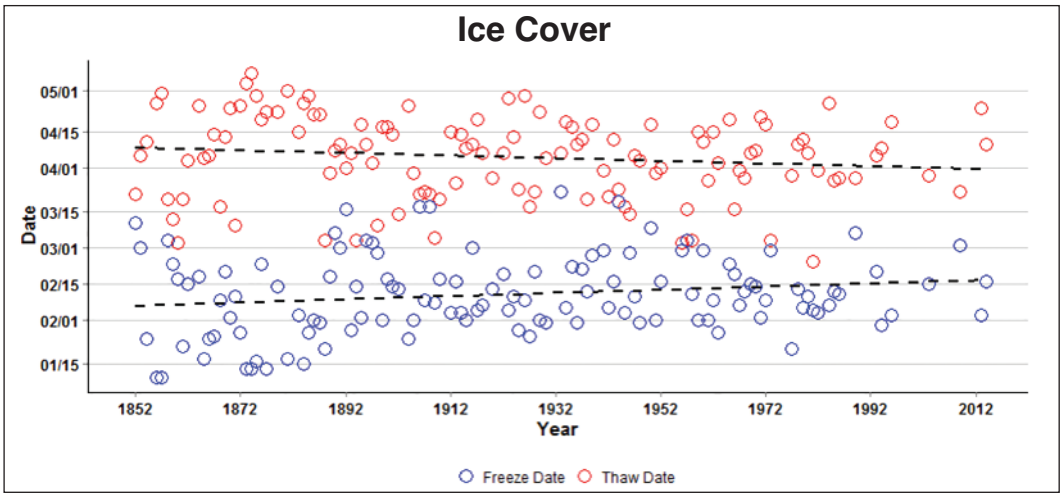

Figure 1. Observed dates of freeze and thaw in the West Arm of the Grand Traverse Bay. The black dashed lines indicate a linear trend in these dates, which shows a decrease in the time that the Bay is frozen (later freeze and earlier thaw). Freeze date is recorded when the waters are frozen out to Power Island for 24 hours. Thaw date is recorded when the ice is no longer frozen out to Power Island for 24 hours. Data source: The Watershed Center Grand Traverse Bay.[54]

According to the Little Traverse Bay Watershed Protection Plan, "Typical 'ice-up' is late January, although it has frozen as early as late December and as late as mid-March. Due to the Lake's dynamic nature, ice formation is highly variable, from smooth, black ice suitable for ice boating; to jagged, jumbled chunks of storm-driven floes frozen together in a six-foot thick mass. Often times, spray from waves breaking on the shore creates interesting ice mountains, caves, and 'volcanoes,' especially on the Bay's northwest end, some up to 25-feet high."[55]

The Petoskey News Review reported that the confines of the Bay, for freezing purposes, include Bay Harbor on the south, to the Forest Beach area in the north. The same article also noted the following:

- March 9, 1953 was the latest in winter that the Bay has frozen;
- December 28, 1976 was the earliest it has frozen;
- The Bay did not freeze in 1998;
- The Bay froze for only three days in 1999;
- Only skim ice was formed in 2000 and 2002.[56]

Water Levels

Frequent extremes in Great Lakes water levels could be serious for both industry and recreation. These extremes will affect shipping lanes, and how much cargo ships can carry. Less ice cover may allow shipping for more months in the winter. However, fluctuating water levels could mean less shipping in years with low water levels. This is just one example of the various challenges extreme changes can bring.

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[53] Ibid.

[54] Hyndman, David, et al., page 16, Figure 7.

[55] Tip of the Mitt Watershed Council, *Little Traverse Bay Watershed Protection Plan*, March 31, 2004, Updated December 31, 2005, EPA/DEQ approved June 26, 20007, Page 15.

[56] Petoskey News Review, "It's Official: Little Traverse Bay frozen," January 16, 2009, http://articles.petoskeynews.com/2009-01-16/freeze_24018138, accessed August 7, 2018.

Sediments in rivers and streams from intense precipitation events will affect harbors, marinas, and private docks. This could lead to additional dredging that will be needed for a variety of reasons, especially in times of low water levels.[57] LIAA noted that inland lakes might also experience lower water levels if drought conditions dry up wetlands and tributaries that contribute to lake water levels. This will affect recreational pursuits.

Whether on the Great Lakes coastline or on inland lakes and streams, shoreline property owners will face unique challenges from being close to large water bodies: water level changes, increased wave action, costal erosion, overtopping of fixed docks, and damage to shore infrastructure.[58]

Consider This Case Study From Southeast Michigan

As noted earlier, we reviewed several case studies when compiling this Plan. This is an excerpt from the LIAA 2017 publication, *Planning for Community Resilience in Michigan: A Comprehensive Handbook* noted in the References Section:

> *"In 2012, the St. Joseph City Commission passed a "no-build" zoning ordinance that is the first of its kind in Michigan. Taking the engineer's advice, the city created an Edgewater Beach Overlay District (EBOD) that prohibits permanent construction within approximately 200 feet of the water's edge. Another recommendation from the engineering firm was that the setback be reviewed at a minimum of every 10 years, or after a 4-foot change in the lake level. The EBOD not only served a technical purpose, but also ensured that the public keeps uninterrupted access to the shoreline, a treasured public asset. Zoning is a powerful tool. In this case, zoning ordinances protected the coastline, property owners, and access to a public resource. This example serves as a reminder that historic development practices aren't always the best guides for an uncertain and changing future. Nevertheless, research, education and community engagement can lead to effective new approaches."*[59]

Creative solutions to tricky problems along our Great Lakes coastlines are possible if stakeholders are included, and lessons learned in other communities are examined for relevance to local circumstances.

Photo: City of St. Joseph

[57] LIAA, page 32.

[58] Murdock and Hart, pages 2, 3.

[59] LIAA, page 33.

SOLUTIONS: Coastal Dynamics

Revisit and revise, as appropriate, required waterfront setbacks. As also noted previously, in light of coming changes, setbacks should be re-evaluated to protect structures against water level rises and more frequent flooding.[60]

Evaluate boat launches. Ensure boat launch ramps are sufficient to provide access across the range of expected water surface elevations, or plan a response to changing water levels from climate changes.[61]

Work with property owners to maintain open space for ecosystem migration with changing water levels. "Many coastal ecosystems are highly sensitive to water levels. If lake levels change significantly, these systems could be drowned or left stranded above the waters that sustain them. Under natural conditions, many plant populations are able to migrate up or down the shore as water levels vary, however in many areas coastal development limits the area available for migration. In the case of coastal wetlands that are protected by a beach or similar formation, water level declines may reduce moisture availability effectively destroying the ecosystem."[62]

CAKE
Charlevoix-Antrim-Kalkaska-Emmet
Cooperative Invasive Species Management Area
www.antrimcd.com/cake-cisma

Work with the CAKE CISMA. As noted earlier, invasive species pose a greater threat because of climate change. Even though aquatic invasive species are nothing new to the Great Lakes, a changing climate may provide new opportunities to invasive species while native plant and animal communities are subjected to increasing stress. The best response today is vigilance. Develop and implement plans for controlling the introduction and spread of invasive species.[63]

- The Charlevoix, Antrim, Kalkaska, and Emmet (CAKE) Cooperative Invasive Species Management Area (CISMA) is headquartered in the Antrim Conservation District. You can reach them at (231) 533-8363 to get help with invasive species problems.

- Vulnerable coastlines are often taken over by invasive species such as *Phragmites*. Work with CAKE CISMA to ensure your dynamic coastlines are not being invaded, and if they are, to find a solution.

[60] Murdock and Hart, page 6.
[61] Murdock and Hart, page 3.
[62] Ibid, page 4.
[63] Ibid.

Chapter 6

Infrastructure Impacts

Stressors in the Watershed

If you read the prior chapters, the impacts and challenges to infrastructure caused by climate change may already be obvious to you. All of the categories previously noted require local governments to understand their built environment in order to assess resiliency to changing weather patterns. Extreme heat, severe storms, and increased flooding are going to impact local infrastructure such as roads and buildings. All of these and other infrastructure will be vulnerable unless local governments confront these problems with a mindset of working to become resilient to change. This category is likely to affect:

- *Stormwater and sewer systems*
- *Septic systems*
- *Transportation infrastructure*
- *Harbor infrastructure*

While water is obviously abundant in the Great Lakes region, conservation practices are important, as water is certainly not limitless. Even though the climate is changing, our area will continue to grow in population – maybe unexpectedly so, if the climate is worse in other regions. Population growth and warming temperatures will increase pressure and demands on water resources. Encouraging water conservation and reducing water use is a low-cost decision that can provide some resiliency against water shortages.[64]

Sanitary Sewers and Septic Systems

Sanitary sewer overflows are discharges of untreated sewage to surface waters. Overflows can be caused by sewer failure or by infiltration/inflow events, where leaks in the sanitary sewer system allow stormwater to enter. These events are generally caused by heavy rains, so it is reasonable to assume that sanitary sewer systems will come under frequent stress in the future. A certain amount of infiltration/inflow is inevitable and usually accounted for in the design of a sewer system. However, it is important to minimize stress on existing systems, so regular maintenance and monitoring of any sanitary sewer system is important.[65]

Michigan currently has very little in the way of septic system oversight. The State and local health departments do supervise the installation of new systems. However, once they are in the ground, there is no legal requirement to ever look at them again, with the exception of a few local ordinances that require inspections at the time a property changes hands. Therefore, it is reasonable to assume that some failing septic systems are in place, and their leaks or other compromises can impact water resources. If severe storms result in more frequent flooding, those faulty septic systems may contribute pollutants to waterways, risking public health. Your community should weigh the advantages of having a local inspection ordinance, even if only when property is transferred.

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[64] Murdock and Hart, page 5.

[65] Ibid.

Transportation and Harbors

Transportation infrastructure is obviously critical to the economic vitality of a community, in addition to providing pathways for emergency management and response. Warming air temperatures will produce an increase in the frequency of transportation maintenance and subsequently higher costs. Rising flood peaks and lake levels could increase flood damages to this infrastructure. Extreme climate events could wash out rural or urban streets, making them inaccessible for emergency response. Delay in getting help not only threatens human life, but could potentially exacerbate other damages to infrastructure.[66]

Ports, harbors, and marinas are also at risk. Water levels in the Great Lakes are likely to fluctuate as they have always done, but possibly at more frequent rates. Currently, there is a great deal of uncertainty about the expected direction and magnitude of Great Lakes water level changes.

Making physical community infrastructure resilient to climate change will not happen overnight. Existing structures, such as bridges or road/stream crossings, will need to be replaced and upgraded. This will have to be evaluated and prioritized on a case-by-case basis, weighing costs to replace against estimated costs of the infrastructure failure. Some of the suggestions below will require lengthy conversations with interested stakeholders. The community should evaluate several points:

- Cost of taking action
- Likely costs of no action
- Potential scale of losses
- Likelihood of unpredictable storms that produce flooding
- Ability to respond in real time[67]

Finally, so as not to create a burden on the community, these needed infrastructure changes should be considered part of ongoing upgrades and maintenance. Now is the time to make the plans and prioritize, so as to be ready as changes unfold.

[66] Ibid, page 6.

[67] Ibid, page 2.

SOLUTIONS:
Infrastructure Impacts

Promote water conservation. Encourage residents and businesses to use high-efficiency appliances and plumbing fixtures. Promote the capture and storage of rainwater.[68]

Minimize leaks. Regularly check the sanitary sewer system for leaks to avoid overflows during heavy rains.[69]

Provide septic system oversight. Consider passing local septic ordinances, such as a Time of Transfer ordinance that requires inspections when property changes hands. Contact Tip of the Mitt Watershed Council for more information, or read our publication The Septic Question Emmet County Report located here: https://www.watershedcouncil.org/uploads/7/2/5/1/7251350/septic_question_report-emmet-finallowres.pdf

Map Vulnerable Locations. This should include both natural resources and the built environment. Mapping could identify vulnerable erosion areas, evolving flood zones, heavy-use water recreation areas, and aging infrastructure that may be impacted by heavy rain and snow events. Make sure your maps indicate details, such as where slopes are too steep to accommodate development, or the extent of floodplains around waterbodies.[70] As you may know, the Federal Emergency Management Agency, FEMA, is revising floodplain information for insurance purposes in response to the more frequent and severe flooding being experienced in Michigan.

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[88] Ibid, page 5.

[69] Ibid.

[70] LIAA, page 110.

Plan for flooding impacts on infrastructure. Develop a flood response plan identifying vulnerable areas. Infrastructure should be reimagined in these areas as a process and system that conveys stormwater to reduce flooding. It should also filter stormwater, to protect our lakes and streams, and capture it for use or to recharge aquifers. This will be especially important as we experience more drought.[71]

- Ensure that alternatives exist for roads at risk from water level rises or flooding. Assess bridges, culverts, and road/stream crossings for potential failure during large storm events. Prioritize and plan replacement and upgrades to critical transportation infrastructure.[72]

Harbor access. If you have a port, harbor, or marinas in your community, flexibility and resiliency should be your goal, especially for long-lived infrastructure. As such, you should assess the practicality and cost of maintaining harbor access under lower water conditions.[73]

Floating docks. Consider replacing fixed docks with floating docks or adaptable dock systems. Choose materials that withstand increased weathering and wave action.[74]

[71] City of Berkeley, *Resilience Strategy: A plan to advance preparedness and equity in Berkeley, a community known for inclusiveness and innovation*, 2014, http://www.ca-ilg.org/sites/main/files/file-attachments/berkeley_resilience_strategy_lowres.pdf accessed September 14, 2018, page 33.

[72] Murdock and Hunt, page 6.

[73] Ibid, pages 3-6.

[74] Ibid, page 3.

Chapter 7

Planning and Zoning Tools

Planning and Zoning

There are already a number of excellent documents devoted solely to planning and zoning efforts related to climate change. Viewing these documents from a mindset of resiliency will help a community cope with changes as they unfold. We encourage you to begin looking at ways you can incorporate climate resilience into plans and policies for your community. Because Michigan is a home rule state[75], local master plans and ordinances play a crucial role in protecting environmental resources, and the same goes for climate change.

Identify and prioritize. After reading this document, we encourage you to use it to identify site-specific risks and vulnerabilities in the community. Identify goals and objectives and organize them into first, second, or third tier priorities. Engage community members in conversations about priorities and eventual decisions regarding climate resiliency.

Master plan. A master plan that is regularly updated provides your community with important tools. These include facts on existing conditions and trends to help understand the impact of current and future decisions. Climate change is a timely topic with localized trends that a community should understand, and creating or updating a master plan could help with this. Master plans also provide a description of where and what type of development is desired. Through a master plan, individuals and businesses can plan for the purchase and use of property consistent with community goals. Incorporating climate change into these plans can help your community become more resilient without compromising economic goals.

Master plans are comprehensive in scope. This feature gives the community an opportunity to review policies and consider new approaches, given what you now know about climate change predictions for this region. As we noted in the infrastructure section of this Plan, convening diverse stakeholders is an opportunity to educate them about what is needed, in hopes of mobilizing support for making the community more resilient.[76] The master planning process is a great way to get stakeholders to participate and provide feedback.

- When you do your next update, include a climate change section in your existing master plan.
- You could also do a separate, stand-alone climate change plan for your community, building upon the points in this document.

Zoning ordinances. A local zoning ordinance can be a very effective tool for protecting water resources against climate change impacts. Zoning tools encourage sustainable development by using approaches that are flexible but protective. Communities should encourage building design standards that emphasize water use efficiency and community resilience during increased climate stress.

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[75] In Michigan, counties, townships, and villages meeting certain statutory requirements may become home-rule units of government. If those statutory requirements are not met, a local unit of government cannot engage in activities unless the state expressly grants authority for it to do so. By law in Michigan, all cities are home rule units.

[76] LIAA, page 109.

Use planning and zoning to reduce impervious surfaces in the watershed. Models for this region show that "Reducing imperviousness by 20% in the watershed decreased peak streamflow most throughout the year, with as much as a 4-5% decrease in the fall. All scenarios of retention basin expansion resulted in similar reductions of peak streamflow when compared with moderate reductions in imperviousness."[77] Use incentives to limit impervious surface coverage in the watershed. For example, in exchange for a larger building footprint require low impact development (LID) techniques onsite to mitigate impervious surface impacts.

Site plan review. The goal of any site plan review process is to ensure that development plans in the community include all the appropriate information and meet all the relevant requirements, including any recent changes made to prepare for climate resiliency. Planning commissioners can use site plan review to evaluate a project to determine consistency with the master plan and zoning code.They should also include any other approvals needed beyond the township or municipal community boundaries, such as relevant county or state standards.[78]

Capital improvement plan. Resiliency efforts can be highlighted if your local unit of government prepares capital improvement plans. These plans provide opportunities to specify a number of the action steps recommended in prior chapters of this Plan.

Septic ordinances. As noted in the Infrastructure chapter, Michigan currently has very little in the way of septic system oversight. The state and local health departments do supervise the installation of new systems. However, once they are in the ground, there is no legal requirement to ever look at them again, with the exception of a few local ordinances that require inspections at the time a property changes hands. Therefore, it is reasonable to assume that some failing septic systems are in place, and their leaks or other compromises can impact water resources. If severe storms result in more frequent flooding, those faulty septic systems may contribute pollutants to waterways, risking public health.

- Your community should weigh the advantages of having a local inspection ordinance, even if only when property is transferred. Tip of the Mitt Watershed Council can help you with this topic, and we have a publication that helps. You can download the Septic Question Emmet County report here: https://www.watershedcouncil.org/uploads/7/2/5/1/7251350/septic_question_report-emmet-finallowres.pdf

Wetland protection and restoration. Any wetlands that the local government owns should be re-evaluated for resiliency. If restoration is needed to ensure those wetlands are functioning to protect the coastline, Tip of the Mitt Watershed Council can help you determine what steps to consider. Also, any other undeveloped wetlands could be protected through zoning.

- Consider adopting a local wetland ordinance that protects smaller, isolated wetlands not regulated by the Michigan Department of Environmental Quality.
- If a wetland protection ordinance is not practical, there are benefits to requiring a building setback from wetland areas of at least 20-30 feet. Consider the advantages of passing a wetland setback, and include natural vegetation buffers adjacent to the wetland.

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[77] Hyndman, David, et al., page 37.

[78] Michigan State University Extension (MSUE), "The Challenging Process of Site Plan Review," http://www.canr.msu.edu/news/the_challenging_process_of_site_plan_review accessed September 22, 2018.

Conclusion

Tip of the Mitt Watershed Council appreciates the time you spent reading this document. Our staff is ready to help you, if you have questions or need assistance with implementing any steps in this Plan. We hope you found it useful and will begin taking action to make your community resilient against coming climate changes.

In early October 2018, the Intergovernmental Panel on Climate Change (IPCC) issued its most recent report, and the findings were grim but not without hope. IPCC is the leading international body of climate change researchers convened by the United Nations. They reported what we already know: the planet has warmed by 1° C and we are seeing consequences right now. Sea levels are rising, glaciers are melting, we're seeing the fastest decline in Arctic sea ice in 1,500 years, and extreme weather events are noticeably more damaging.[79] In 2018 alone, we have seen Hurricane Florence ravage the Carolinas and Hurricane Michael decimate communities in the Florida Panhandle.

The IPCC report urges governments to work to cap global warming at 1.5° C above pre-industrial levels. The Paris Climate Accord has a goal of limiting warming to 2° C by the year 2100. It will be difficult to reach either target. Countries will have to do more than simply give up fossil fuels and stop emitting greenhouse gases – they will also have to use technology that pulls carbon dioxide out of the air. Moreover, land use practices will have to change dramatically. Globally, millions of people will move inland from drowning coastlines.

But the report is hopeful. Even though we don't have much time to act, a pathway to limit warming to 1.5° C is possible. It demands cutting the planet's emissions 45 percent below 2010 levels by 2030. This can be done, but it will take a globally serious effort. Every fraction of a degree of warming matters.[80]

Tip of the Mitt Watershed Council is here to help. If you would like to discuss anything in this report or ask questions, please call (231) 347-1181.

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[79] Irfan, Umair, "A major new climate report slams the door on wishful thinking," https://www.vox.com/2018/10/5/17934174/climate-change-global-warming-un-ipcc-report-1-5-degrees , Vox.com, October 7, 2018 accessed October 8, 2018.

[80] Ibid.

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Appendix A

Surviving Michigan Summer Heat!

Keeping Your Cool When It's Hot Outside

Protect Yourself From Extreme Heat

- **Stay Cool!** Use an air conditioner or go to a cool place.
- **Drink** plenty of fluids, even if you are not thirsty.
- Use a **fan** only when the windows are open or the air conditioner is on.
- **Avoid** alcohol, caffeine, and sugary drinks such as soda pop.
- Take a **cool** shower or bath.
- Keep **shades** and **curtains** closed to block the sun from coming in your home or office.
- **Avoid** exercising and physical activity during the hottest part of the day.
- **Stay out** of the sun.
- **Wear** sunscreen (at least SPF 15).
- **Check on** family members, neighbors and friends at least once a day. Move them to a cool place if necessary.
- **Never**, **ever** leave children, the elderly or pets in parked cars.

The **National Weather Service** issues heat advisories and warnings when the heat index is expected to rise to a dangerous level. The ***heat index*** combines high temperatures and humidity to let you know how hot it feels outside.

LISTEN for weather alerts!

Heat Advisory

A heat advisory is issued when the heat index is expected to be at least 100˚ for three hours or more.

Heat Warning

A heat warning is issued when the heat index is expected to be at least 105˚for three hours or more.

Excessive Heat Watch

An excessive heat watch is issued when the heat index may be at least 105˚ within the next two to three days.

Who Needs Special Care

- Young children.
- People who are overweight.
- Adults age 65 years and older.
- People with existing medical conditions such as diabetes, high blood pressure, heart problems, lung problems, or mental illness.
- People who take certain medications, such as those for high blood pressure or poor circulation. ***Ask your doctor if your medication could cause you to be affected by heat.***
- People who work in hot places such as construction sites or restaurant kitchens.

What is heat illness?

Your body normally cools down by sweating. During extremely hot weather, when sweating isn't enough to cool your body, your body can become overheated to the point that you become ill. Heat illness can cause you to become very sick, and could even cause death.

Check the signs and symptoms of heat illness, If necessary, follow these first aid steps.

HEAT ILLNESS	SYMPTOMS	FIRST AID
HEAT CRAMPS	Heavy sweating, muscle pain	Stop all activity for a few hours. Drink water, clear juice or a sports beverage. Get medical attention if cramps do not go away within 1 hour.
HEAT EXHAUSTION	Heavy sweating, cramps, tiredness, weakness, headache, cool and moist skin, fast and weak pulse, fast breathing, nausea, fainting	Get the person out of the sun, lay them down and loosen their clothing. Apply cool, wet cloths. Give sips of a cool, non-alcoholic drink. Get medical help right away for an infant, the elderly or if the person has an existing medical condition. You should also get medical help right away if the symptoms worsen or last longer than 1 hour. Heat exhaustion can lead to heat stroke.
HEAT STROKE	Skin that feels hot and dry but not sweaty. High body temperature (above 103˚) Rapid, strong pulse. Throbbing headache. Nausea, confusion, dizziness, unconsciousness	Call 911 and get medical help right away! Heat stroke can cause death. Move the person into a shady area and put them in a tub of cool water, shower them with a garden hose, or use any other method to cool them rapidly. Do not give the person alcohol to drink.

Here's Where to Find More Information

- Centers for Disease Control and Prevention, http://www.cdc.gov/Features/ExtremeHeat/
- National Weather Service Heat Page, http://www.weather.gov/om/heat/index.shtml
- Michigan Department of Community Health, http://www.michigan.gov/climateandhealth
- U.S. Environmental Protection Agency, http://www.epa.gov/climatechange/

Michigan Department of Community Health

MDCH

CLIMATE CHANGE SUMMIT

Friday, May 11, 2018
9:00 a.m. - 3:00 p.m.
North Central Michigan College
Howard Street, Petoskey

Funded by the Petoskey-Harbor Springs Area Community Foundation

PURPOSE OF THE SUMMIT

Hold a Summit of practitioners and professionals to specify local impacts and plan for how to help governments make our coastal cities resilient to the changing climate. *"Coastal resilience means building the ability of a community to 'bounce back' after hazardous events such as hurricanes, coastal storms, and flooding – rather than simply reacting to impacts." - NOAA*

ANTICIPATED OUTCOMES

- *Participants have a better understanding of Climate Change risks to the region and local community*
- *Participants identify primary assets that are vulnerable to Climate Change and potential solutions to reduce risk and damage to assets*
- *Participants are optimistic that climate adaptation and mitigation solutions can reduce impacts of Climate Change*

AGENDA

9:00-9:30 *Check-in with coffee*

9:30 Welcome
Gail Gruenwald, Executive Director, Tip of the Mitt Watershed Council

9:35 Summit Introduction and Agenda Review
Emcee Grenetta Thomassey, Tip of the Mitt Watershed Council
Purpose of the Summit; inspired by NOAA 5-steps to Resilience
Today's presentations represent steps 1 and 2: Explore Hazards; Assess Vulnerability and Risk

9:45 PRESENTATION: Impacts of Climate Change on the Great Lakes
Kim Channell, Research Associate for the Great Lakes Integrated Sciences and Assessments (GLISA) at University of Michigan

10:30 PRESENTATION: Integrated Assessment - Climate Change in Northwest Michigan
Antony Kendall, Research Assistant Professor, Department of Earth and Environmental Sciences, Michigan State University

11:15 Make lunch plate

11:30 Lunch PRESENTATION: Exploring Possible Solutions
Harry Burkholder, Executive Director, LIAA

12:15 PRESENTATION: Farming Challenges and Water Impacts
Dave Lusch, Distinguished Senior Research Specialist at Michigan State University
Department of Geography, Environment and Spatial Sciences and the Institute of Water Research

12:45 PRESENTATION: Fish Habitat and Climate Change
Kevin Wehrly, Fisheries Research Biologist, Institute for Fisheries Research,
Michigan Department of Natural Resources and University of Michigan

1:15 PANEL DISCUSSION with the Audience:
Expected Impacts on Coastal Cities - Solutions for Local Governments
Ann Baughman, Freshwater Future, facilitator
Panelists: Kim Channel; Anthony Kendall; Harry Burkholder; Dave Lusch, and Kevin Wehrly
NOAA steps 3 and 4: Investigate Options; Prioritize & Plan

We will use the solutions identified to create the local Adaptation and Resiliency Plan

3:00 Adjourn

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