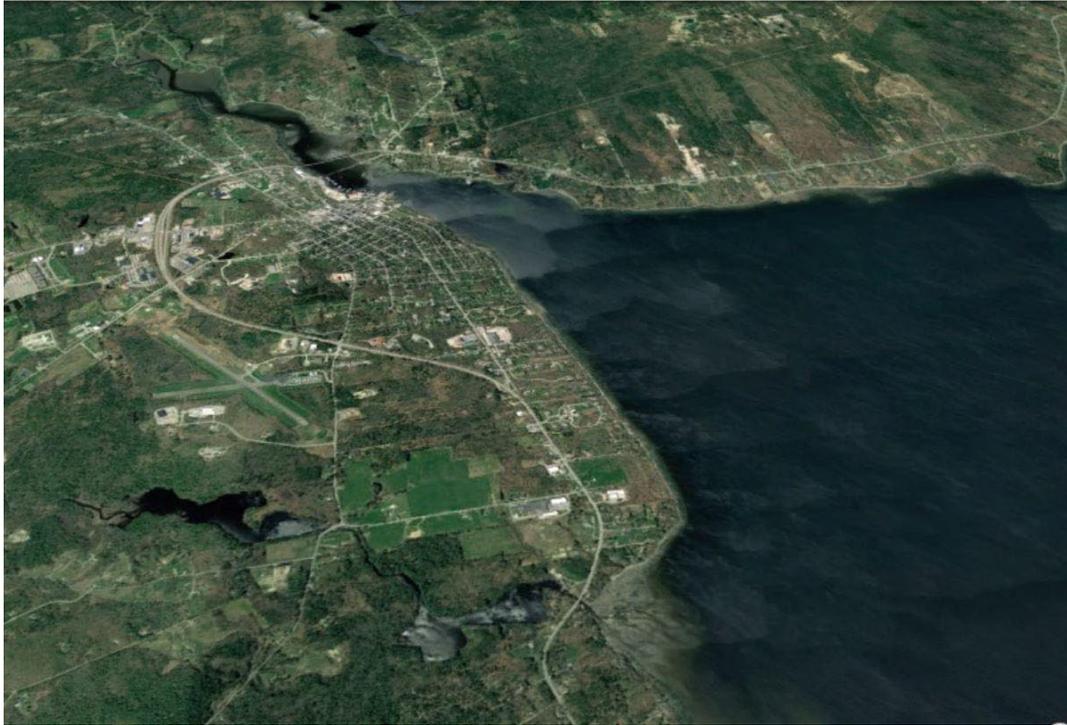


**SEA CHANGE IN THE GULF OF MAINE:
THE OUTLOOK FOR BELFAST**



Part Two: Economic Vulnerabilities and Recommended Next Steps

**A Report to the City Council
by the
Climate Change Committee
Belfast, Maine**

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1. General Introduction

Belfast's midcoast location has been intrinsic to its identity, history, and economy from the time when the Wabenaki people fished here for sturgeon up to the present. That heritage naturally leads to concern for the threat of rising sea levels and other coastal impacts of climate change. The damage caused recently in Belfast Harbor by the wind, waves, and flooding of three severe storms from October 30, 2017 through March 3-4, 2018 highlighted the vulnerability of the City's coast to inevitable changes in what have always been taken for granted – the climate, the weather, and the ocean.

The City Council approved the formation of the Belfast Climate Change Committee (CCC) in March 2018 and directed the CCC to report on the potential impacts to the City of one critical aspect of climate change: sea-level rise. This report, entitled *Sea Change in the Gulf of Maine: The Outlook for Belfast*, comprises three parts with distinct objectives:

Part One. Characterization of the nature and probable consequences of changing sea levels in the specific context of Belfast's harbor and shoreline. (September, 2018)

Part Two. Characterization of damages from erosion and flooding and estimates of economic implications for Belfast of the projected sea-level rise scenarios. (December, 2018)

Part Three. Analysis of the city's options for adaptation in the face of these projections and recommendation of a strategy for increased resilience. (March, 2019)

2. Executive Summary

Part Two: Economic Vulnerabilities and Recommended Next Steps

“Earth’s climate is now changing faster than at any point in the history of modern civilization.” This statement from Chapter 1 of the Fourth National Climate Assessment for the U.S. is startling enough, but if it’s paired with the knowledge that climate in the Northeast U.S. has been changing at three times the global average since the 1980s and four times the global average during the last decade, then it appears as if, for Belfast, the pace is scaling up awfully fast.

The CCC’s first report laid out Belfast’s environmental vulnerabilities; the present report focuses on the connection between environmental vulnerabilities and economic ones. In dealing with economic particulars in Belfast, Part Two doesn’t attempt to be comprehensive, but it does aim to give some examples showing that economic problems for the City are scaling up in sync with the effects of sea change.

Finally, the report recommends some steps that could be taken immediately at low or no cost to enable effective planning. This will lay the groundwork for the CCC’s third report, which will be about setting a steady course toward resilience.

3. Sources

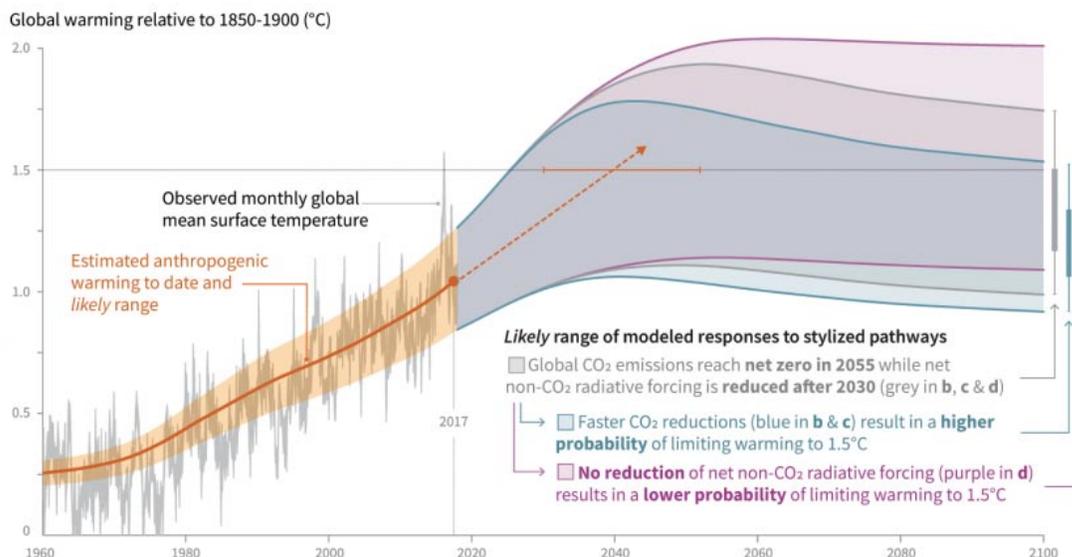
In its current report, Part Two of Sea Change in the Gulf of Maine: The Outlook for Belfast, CCC members continued the same methods of study described in the Sources section of Part One. For Part Two, however, we were able to consult authoritative international, national,

and state reports published much more recently than the ones available to us when we issued Part One, as follows.

On October 1, 2018, the Intergovernmental Panel on Climate Change (IPCC) issued IPCC 2018, a special update alerting the world that carbon emissions are growing faster than predicted per commitments made in 2017 by signatories of the Paris Agreement. This is new news. It means a lower probability of limiting the increase in global warming to 1.5°C (2.7°F) and a higher probability of damaging environmental consequences both short-term and long-term. See graph below) This update was followed on November 27, 2018 by the annual Emissions Gap Report 2018 from the UN Environment Programme that underlined the unprecedented emissions and suggested possible work-arounds if countries do not muster the will to meet their pledges.

Cumulative emissions of CO₂ and future non-CO₂ radiative forcing determine the probability of limiting warming to 1.5°C

a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways



Source: <https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/>

On November 23, 2018, the United States Government issued the Fourth National Climate Assessment (*NCA4*), summarizing and updating the most recent findings and predictions concerning the impacts of climate change on the nation. This timely and comprehensive report provides inter alia a useful overview of a broad range of economic effects and valuable information that may inform our own observations and decisions. The assessment available at the time of Part One was the Third National Assessment (2014).

On November 20, 2018, a report entitled Coastal Maine Climate Futures was issued by the Climate Change Institute of the University of Maine. This report describes five specific Maine climate change scenarios, alone and in combination, with hazards from sea change increasing. The comparable state survey that we consulted for Part One, Maine's Climate Future, was updated only to March, 2015.

The CCC used the international reports for background, including much of the material in this report from *NCA4*, as authoritative context within which to discuss Belfast-specific findings. We will use Coastal Maine Climate Futures for focusing on scenario choice once we are at the point of considering specific strategies for adaptation and mitigation.

It is important to note that the findings of these latest reports are not just routine updates, but contain significantly more serious predictions than previous reports. Both the *NCA4* and IPCC reports have been described with terms such as “sounding alarm bells” and their contents may change the predictions made in Part One of the Belfast CCC's report. Both the most likely scenarios and worst case scenarios for global temperature rise and thus local sea level rise is likely to be higher than the CCC estimated with information previously available, and the time we have to plan and react is likely to be shorter.

As before, the CCC minutes (on the City of Belfast website, <https://www.cityofbelfast.org/>) document the committee's outreach and networking activities, and a CCC digital library that is being compiled provides public access to references and literature consulted.

4. Global, National and Regional Economic Effects of Sea Change

4.1 A Global “Speeding Freight Train” and a National Economic Train Wreck

Global carbon emissions are currently reaching levels we had originally hoped to avoid until much later, according to the latest reports from scientists monitoring climate trends during the past few years. (*Pierre-Louis, “Freight Train”*) Climate change has no boundaries. The urgency of the latest reports only heightens pressures on national, regional, and local economies.

“Without substantial and sustained global mitigation and regional adaptation efforts, climate change is expected to cause growing losses to American infrastructure and property and impede the rate of economic growth over this century.... Annual losses in some economic sectors are projected to reach hundreds of billions of dollars by the end of the century—more than the current GDP of many U.S. states.” (*NCA4, v. II, “Summary Findings” #2*)

4.2 Economic Importance of U.S. Coastal Areas

Coastal areas of the U.S. are disproportionately important to their relative area: though comprising only 18% of total land, they account for 37% of the country’s population, 43% of the US GDP, and 37.5% of total employment, as summarized in the following table.

Region	Employment		GDP		Population		% Land Area
	Millions	% of US	Trillions	% of US	Millions	% of US	
United States	134		\$16.70		316.5		
All Coastal States	109.2	81.50%	\$13.90	83.70%	257.9	81.50%	57.00%
Coastal Zone Counties	56.2	42.00%	\$8.00	48.00%	133.2	42.10%	19.60%
Shore-Adjacent Counties	50.2	37.50%	\$7.20	43.20%	118.4	37.40%	18.10%

(Table 8.1, NCA4, v. II, chap. 8, “State of the Coasts”)

4.3 Regional Risk

Compared with other regions in the U.S., the Northeast is especially at risk for sea change, with resultant ecological and economic vulnerabilities.

4.3.1 Sea Change Ocean and coastal temperatures in the Northeast have warmed at a rate of more than three times the global average since the 1980s, and over the last decade the rate has been more than four times the global average. (NCA4, v. II, chap. 18, “Ocean Warming”) Sea-level rise will be greater than the global average, and the worst-case scenarios for the region in earlier assessments (2014) are now not only shifting upward but looking more likely. The sea-level rise will increase “normal” flooding, precipitation will continue to increase, and “the strongest hurricanes are anticipated to become both more frequent and more intense.” (NCA4, v. II, chap. 18, KM 2)

4.3.2 Ecological Vulnerabilities The health of coastal ecosystems is important several times over in an era of climate change. Atlantic marshes, seagrass beds, scrub trees and

other low-lying vegetation behind beaches protect coastal bluffs from flooding, erosion and the effects of severe storms, and provide habitat for fish, insects, birds and other aquatic and terrestrial species: indeed, for many millions of years coastal wetlands and seagrasses have been among the most productive and biodiverse “nurseries” in the world. Second, coastal ecosystems store carbon, thus mitigating climate change. Yet, because the Atlantic is experiencing sea-level rise higher than all other regions in the U.S. except for the Gulf Coast, these essential functions are quickly being degraded. (*NCA4, v. II, chap. 8, KM2*)

These biological functions are not only important in abstract scientific terms. Natural beauty and rustic, wild landscapes are intrinsic to the identity of Maine. They are a large part of the reason that people want to live in and visit our community, and we cannot afford to lose them.

4.3.3 Economic Vulnerabilities The following are just a few of the most important economic consequences we’ve discovered for continued sea-level rise in the midcoast region of Maine.

Critical infrastructure: Roads, bridges, tunnels, railroads, pipelines, electric substations, power plants, petroleum/chemical storage tanks, airports are necessary to keep every sector of the U.S. economy in business, including the military; in the Northeast such infrastructure is densest along the coast, where it is increasingly threatened by “normal” flooding and storms. Nor can trade be conducted without seaports, which “handle 99% of overseas trade.” (*NCA4, v. II, chap. 12, KM1*) The Northeast’s numerous seaports will grow in number and size and are increasingly in harm’s way.

Fisheries: In the Northeast, fisheries constitute an important sector for both domestic food and export. Climate change has caused widespread relocation of fisheries due to temperature influences and the movement of food sources. In turn, the reproductive cycles of fish have been altered. Ocean acidification is a problem for shellfish worldwide as the ocean absorbs increasing amounts of carbon dioxide. Acidification is worse in the Northeast partly

because precipitation is higher than in many other regions so that greater amounts of freshwater (relatively acid) flow into the sea. In sum, “[A]pproximately 50% of the commercial, forage, and protected fish and invertebrate species on the Northeast Continental Shelf will be highly or very highly vulnerable to climate change through 2050 under the higher [temperature and sea-level rise] scenario.” (*NCA4, v. II, chap. 18, KM2*)

Outdoor recreation, tourist economies, and quality of life: “Outdoor recreation, tourist economies, and quality of life are reliant on benefits provided by our natural environment that will be degraded by the impacts of climate change in many ways....Some fish, birds, and mammals are expected to shift where they live as a result of climate change, with implications for hunting, fishing, bird-watching and other wildlife-related activities. These and other climate-related impacts are expected to result in decreased tourism revenue....” (*NCA4, v. II, Summary Findings #12*)

Private Property: In the U.S., more than a trillion-dollars’ worth of private property lies within one-eighth of a mile from its coasts. “Recent economic analysis finds that under a higher [carbon emissions] scenario... it is likely (a 66% probability)...that between \$66 billion and \$106 billion worth of real estate will be below sea level by 2050; and \$238 billion to \$507 billion, by 2100.” (*NCA4, v. II, chap. 8, KM1*) Because of population density in the Northeast region, even denser on the coast, and because of the region’s particular vulnerability to flooding and storms, a very large amount of property in this region is at risk, certainly under high climate-change scenarios and even under lower ones. At this level of exposure, coastal property owners in the Northeast stand to lose a great deal of wealth, possibly destabilizing traditional norms of financing and taxing property.

5. Local Economic Effects of Sea Change in Belfast



View of Belfast Harbor from the east 1853 (courtesy of Penobscot Marine Museum)

In its earliest days, Belfast was a market town whose geographical location – ice-free harbor and access to outlying farms and woodlands – favored its development as a regional trade center. Later, the importance of shipping ceded to railroads for many years. A working waterfront is once again a major economic driver for Belfast and intrinsic to everyone’s quality of life. The damage inflicted on the harbor by three major storms last year, however (October 30, 2017; January 4, 2018; March 3-4, 2018), was a wake-up call to the city that our coastline is increasingly vulnerable and crucial to Belfast’s economy.

5.1 Coastal Economic Assets

Tourism and boaters contribute substantially to Belfast’s economy. The Harbor Walk and Armistice Bridge are specific draws for visitors. Steamboat Park and the Boathouse are sites for numerous festivals and public performances, as well as daily use by kayakers, strollers, and

citizens of Belfast seeking recreation. The City boat launch ramp is the only year-round ramp on Belfast Bay, and one of the most heavily used launch ramps on the west shore of Penobscot Bay. Hundreds of vessels visit Belfast every year, including cruise ships, charter vessels, and recreational boats of all descriptions. (*Pickering*) Without detailed research into receipts from harbor services, marine fuel sales, moorings, tourist cruises, canoe storage, etc., the CCC cannot quantify the value of the harbor, parks, and other waterside recreational facilities such as the Armistice Bridge, Rail Trail and Harbor Walk, but the qualitative value has obvious attractions for anyone living in or visiting Belfast.

5.2 Ecological and Economic Vulnerabilities

Sea-level rise, along with increased storm surge and severe weather events, as described in Part One of the CCC's report, may severely impact the activities listed above as assets, with substantial economic consequences.



Passagassawakeag River - looking upstream towards Head of the Tide

5.2.1 Ecological Vulnerabilities Along the Belfast shoreline, several low-lying areas are particularly vulnerable to sea-level rise and storms, as the CCC showed in Part One of its report, section 4.2. One of these areas, at the Head of the Tide, is notable because the ecosystem there has not been anthropogenically transformed and remains healthy. In the other areas, erosion and general environmental degradation (loss of sediments and protective vegetation, wildlife habitat, biodiversity) is dramatic, verifying locally the general conclusion that “climate change is altering ecosystem productivity, exacerbating the spread of invasive species, and changing how species interact with each other and with their environment. These changes are reconfiguring ecosystems in unprecedented ways.” (*NCA4, v. II, chap. 7, KM2*)

5.2.2 Economic Vulnerabilities Following relevant categories of economic vulnerabilities listed by NCA4 in its chapter about the Northeast region (*see section 4.3.3 above*), the CCC gives a list for Belfast below. Also, while the CCC lacks the expertise to do a thorough study of the City’s budgets, in each category we try to review contemporary examples of costs from sea-change damages.

Critical Infrastructure: Most of the City’s critical infrastructure, including its commercial downtown, spread out along the side of a steeply-sloped bank, is at a relatively high elevation: indeed, the Post Office at the top of Main Street is over 100 feet above the level of high tide. Most major roads through Belfast, including, notably, the Route 1 bridge across the Passy, are not vulnerable to flooding. A significant exception is the Route 1 bridge passing over the Little River, which is low-lying and could be vulnerable under certain scenarios for sea-level rise. Belfast no longer has a railroad servicing the City along the shore. The airport is on high ground away from the shore. There are no major electric generation/transmission facilities or large petroleum/chemical storage tanks in the City that would pose a risk. In many respects, Belfast is well-protected from sea-level rise and storms compared with cities on the southern coast of Maine, just as Maine’s coast is well-protected compared with the coasts of mid-Atlantic states. However, Belfast is a seaport, and all of the infrastructure related to its harbor, whether for

public or commercial use, is low-lying and vulnerable. Moreover, the City's wastewater treatment plant is down in the harbor area.

The City customarily budgets for maintenance of its critical public infrastructure in the harbor, and also has made capital improvements. The table below in this section gives some figures the CCC has gathered from the operations or capital budgets dealing with maintenance and damage repair for harbor facilities after the 2017-1018 storms, and from repair estimates made by the engineering firm of Gartley & Dorsky. (*G&D*) Some of facilities could be considered critical infrastructure: they are marked with asterisks. Others are related to outdoor recreation or tourism and will be discussed in a later paragraph below. The Harbormaster's office is certainly critical infrastructure: during the January 2018 storm the parking lot on the City pier was flooded and water reportedly threatened to invade that office, but no damage estimate was available. Predictably, substantial City employee time has been expended in making repairs, and that time has not always been called out specifically; other damage, such as displaced seawall stones, was neither budgeted nor repaired.

Perhaps the most significant missing part of this look at representative examples of critical infrastructure has to do with periodic dredging. Since the dredging is done by the Army Corps of Engineers (ACOE), and a large part of the cost is paid with federal funds, the table does not include it, but dredging may have to be done more frequently in the future, as erosion damage from storms increases, and the funding formula may be different. As a baseline, the last dredging done was during 2002-2003, and cost \$1,245,000.

The breakwater is an essential piece of critical infrastructure to protect private and public harbor facilities, but storms have contributed to its deterioration. In a September 30, 2018 submission for repair funding to the Maine Coastal Program, the City detailed the history of the breakwater, built 35 years ago, and noted: "Storm waters routinely wash over the top of the breakwater, especially at higher than normal tides or with surges. Because of the age of the breakwater and predicted elevated sea conditions, serious maintenance or restructuring will

have to be done in the very near future.” (*Pickering*) Annual maintenance from the past is not listed on the table below, as those costs were not part of an evaluation looking toward the future with sea change in mind. “Serious” repairs done in October 1996 and June 2003 are listed, however, because those could be used as a baseline for costs to restructure the breakwater, a decision that definitely will be taken with sea change in mind.

Fisheries: Belfast’s local economy does not have a substantial fisheries sector, but it does have roughly 1-10 established commercial fishing boats running lobster traps or other gear, depending on the season, and it attracts significant numbers of recreational fishermen. According to local lore, the Indian name for the Passagassawakeag River (elsewhere familiarly abbreviated to “Passy”), meant “place to spear sturgeon by torchlight”: clearly, Belfast shared the benefit of prodigious fisheries the Gulf of Maine provided centuries ago. Since then, the direct or indirect economic benefit of fisheries to Belfast has waxed and waned, but over the last two decades the permanent damage to midcoast fisheries from sea change (*see section 4.3.3 above*) has been serious and is highly likely to increase. While the northward migration of certain gamefish species may be a boost for recreational fishing, it probably will not be a major boost to the City’s bottom line. We have no direct and immediate way, however, to quantify the value lost to Belfast’s fisheries sector from sea change.

Outdoor recreation, tourist economies, and quality of life: Outdoor recreation, tourist economies, and quality of life are among the most important contributors to Belfast’s economy, as has been discussed above (*see section 5.1*). Many of the costs associated with these categories cannot be readily determined. For the purposes of this section of the report, budget costs/proposals are tallied for the Boathouse, City Park, and a few other outdoor recreation venues in the City. (*See table below in this section*) So far, the City has authorized the proposed armoring at Armistice Bridge and City Park for \$140,000; additional capital expense budgeted for 2020 is \$12,000; and further armoring at the Boathouse is awaiting decision.

City of Belfast – Harbor Expenses

Item	Maintenance (year)	Repair (year)	Repair estimate (year)
Breakwater*	\$10,000 (2019) \$10,000 (2020)	\$3000 (1996) \$44,000 (2003)	
Boathouse		\$13900 (2018) \$3360 (2018)	
Harbor Walk		\$1619 (2018)	
Various – harbor and floats*	\$2500 (2017-18)	\$730 (2017-18)	
Armistice Bridge	\$1000 (2017-18)		
City Park	\$7500 (2017-18)		
Shoreline armoring /riprap (2018)			\$401,550
Robbins/Kaler Rd.*			\$57,850
Thompson’s Wharf*			\$27,500
City Landing*			\$84,175
Boathouse			\$92,200
Armistice Bridge			\$68,775
City Park			\$71,050

Private Property: Measured in two segments east and west from Searsport to the east, Northport to the west and up the Passy River to the City Point bridge, Belfast’s shoreline is roughly 15 miles long. According to the City Assessor’s map showing the assessed value of all properties, that shoreline contains 232 lots with a total value of \$109,045,500. Excluding the 9 lots that are city-owned, and 3 lots with no or ambiguous data, the estimated tax revenue from the remaining 220 pieces of private property is \$2,388,096. (This straight mill-rate calculation probably is high, since it doesn’t distinguish between property uses, or take into account exemptions or other offsets, but it is a reasonable estimate.) This amount can be compared with the total taxes paid by Belfast property-owners in several different ways, three of which we provide in an Appendix at the end of this report. By any measure, however, the bottom line is pretty much the same: the most valuable properties in the City are the ones most vulnerable to sea-level rise.



Shore armor diversity - west side of Belfast Bay (Photo credit: W. Kochtitzky)

Among the costs of sea change to Belfast's coastline residents will be the loss of value to their properties, as well as the costs of any armoring they may build to protect their properties. (Note that armoring in itself generally makes no difference in the assessed value of a property.) A cruise down the western shore of Belfast Bay reveals many locations where owners have erected bulwarks or seawalls, with varying degrees of success and possibly unintended effects on their neighbors. The sea-level rise, increased storm surge and severe weather events discussed in Part One of this report will undoubtedly result in erosion and storm damage to private property like that experienced at the City-owned sites discussed in portions of section 5 above. Repairs will be expensive; unrepaired damage will decrease the value and salability of the properties. Reduced real estate values will eventually translate into lower real estate taxes payable to the city.

5.3 Economic Losses in Addition to Coastal Damage

As suggested in Section 4 of this report, the best scientific predictions for other economic losses foresee massive costs related to lost workdays from transportation difficulties, bad weather, and

health problems exacerbated directly or indirectly by sea change. Estimating those economic impacts to Belfast is difficult. Suffice to say that among the commercial properties in Belfast most vulnerable to such impacts are Front Street Shipyard, numerous restaurants and stores bordering the Harbor Walk in the area between the shipyard and the bottom of Main St., and the now-vacant private properties between the bottom of Main St. south to the Commons.

5.4 Insurance

Insurance issues clearly need to be mentioned in any consideration of economic vulnerabilities from climate change. Negotiating municipal insurance policies will grow increasingly difficult and expensive. As part of any mortgage agreement, buyers are normally required to secure flood insurance for properties located within certain flood zones specified on maps issued by the Federal Emergency Management Agency (FEMA). Many insurers are pulling out of the market, however, or raising premiums unaffordably high. While the National Flood Insurance Program (NFIP) has become the insurer of last resort, it has experienced huge losses going back over a decade and is virtually bankrupt. Thus, insurance markets are failing for flood-prone areas, making those properties impossible to sell, and, again, undermining the City's tax base. (*NCA4, v. II, chap. 28, KM5; Underwater*)

5.5 Balancing the Costs of Adaptation and Mitigation against Losses

So far, Section 5 of this report has detailed substantial costs recently incurred by the City of Belfast as a result of coastal erosion and storm damage. In light of sea-change predictions discussed in Part One of this report, such costs are likely not only to continue but to increase. Future economic losses are hard to predict with any precision, but it is clear that Belfast, a city wrapped around its bay, has numerous economic vulnerabilities to the effects of sea change.

One reason for estimating future losses is to weigh the comparative advantages of doing nothing with taking steps in advance to adapt and mitigate. The CCC considers this exercise to

be unnecessary: it is already clear that doing nothing will mean Belfast loses decades of advantages gained by careful planning and economic development.

As Belfast considers various strategies for approaching adaptation and mitigation, economic decisions will have to be made on both a macro and an individual basis. The costs of macro solutions (e.g. breakwater modification, changes to the City's Comprehensive Plan, relocation of public walkways, etc.) can be made on a measured basis; we probably have time to observe and monitor actual environmental changes, to notice what scenario for CO2 emissions is playing out, and to determine what level of response is both prudent and feasible. Short-term solutions for individual problems may have to be put in place, however, before an overall approach is developed. Such a solution has been decided for the emergent erosion problems at the Armistice Bridge and City Park, where repairs were authorized this fall to avoid immediate further damage.

6. Recommended Next Steps

Adaptation entails a continuing risk- management process, in which individuals and organizations become aware of and assess risks from climate change, take actions to reduce those risks, and learn over time. The illustration below from the Fourth National Climate Assessment reflects this process:



[NCA4, v. II, chap. 1, “Overview”, Figure 1.20]

Presently, Belfast, along with many other cities and towns of Maine, is increasing its awareness of climate change issues, risks and hazards, and gathering relevant information. This information should include an understanding of the hydrology of Belfast Bay. Some erosion occurs as a result of way infrastructure is designed: when the placement of roads or structures fails to take into account the ways in which wind and water behave, damage is likely. Based on this and other types of information, the City will plan general and specific strategies for adapting to and mitigating the effects of sea change.

The CCC's third report, due March 2019, will be a collaborative effort with the Council to arrive at such strategies. Here in Part Two, however, we recommend certain steps to be taken immediately. These would not only fill gaps in the data necessary for developing strategies at all, but also put tools in place for monitoring and evaluating whichever strategies are finally selected for implementation.

1. The CCC requests authorization from the City Council for the City Manager to assign relevant staff to work with the CCC to complete the Maine Flood Resilience Checklist.

(https://digitalmaine.com/cgi/viewcontent.cgi?article=1520&context=mgs_publications) This detailed 46-page checklist was explained by Jamie Francomano of the Midcoast Regional Planning Commission at an October 29, 2018 meeting attended by members of the CCC, City Planner Sadie Lloyd, Harbormaster Katherine Pickering, and several of the climate change experts mentioned in Recommendation 5 below. As Mr. Francomano explained, there are two immediate benefits to going through this process:

It allows a comprehensive self-assessment by the City of its preparedness or unpreparedness for sea-level rise and other climate change effects; and

It allows for outside actors to take this self-assessment into account when responding to requests from Belfast for grants, assistance and other accommodations. For example, a properly completed checklist may result in lower federal flood insurance premiums for Belfast landowners.

2. The CCC requests authorization to support statewide and other initiatives relevant to climate change, such as a bill to establish a Coastal Risks and Hazards Commission, re-introduced to the Maine Legislature this year by Rep. Lydia Blume. If approved, such a commission would make recommendations and provide support for adaptive or mitigatory

actions that cities and towns might take regarding climate change. As proposed, the commission would operate with negligible cost.

3. The CCC requests authorization to join the Global Covenant of Mayors for Climate and Energy. Joining is free, and, among other benefits, will provide access to templates for climate action plans, descriptions of what other cities have done regarding climate change, and a forum for discussion and exploration of such strategies.

4. The CCC requests authorization to develop weather and water data specific to Belfast Bay. Presently the Harbormaster has no instruments for recording wind speed and direction, tide levels, surge levels, wave heights, water temperature or any other information concerning what is actually happening in our harbor and in Belfast Bay. Instead, she works with data extrapolated from actual measurements made in Bar Harbor and at an offshore buoy distant from here, at the mouth of Penobscot Bay. Without local data, the CCC does not have baseline information concerning the Bay, and cannot accurately measure change over time. Thus, we will be unable to fashion responses either to sea-level rise by itself or to other types of sea change affecting Belfast's coastal ecosystems.

We have not researched exactly what equipment is needed either for water data collection or for the location and number of data-collection sites optimal for the tasks. Acquiring and managing such equipment would entail some cost, possibly in four figures. We anticipate that it may be cost-effective to combine sites for weather and water data collection. Our thought would be to explore, in collaboration with the Harbormaster, the possibility of grants or other funding sources. The City Council and/or City Manager would need to assign responsibility for the purchase, installation, operation and maintenance of the equipment. If so tasked, members of the CCC would be willing to take on such responsibilities.

5. The CCC requests authorization to continue and expand collaborations (so far without cost) with non-governmental organizations and academics studying climate. The following are examples of the CCC's collaborations to date.

- Assisted University of Maine graduate student researcher Will Kochtitzky in making a detailed photographic survey of the entire shoreline of Belfast. *(See example in section 5.22 above)* The initial survey was made in August 2018, and follow-up surveys are anticipated. Each picture is GPS-located so that a precise history of each shoreline location can be developed over time, documenting sea-level rise, erosion and other changes.
- Opened dialogue with state climate experts and University of Maine professors, including Esperanza Stancioff, Extension Professor and Climate Change Educator, University of Maine Cooperative Extension/Maine Sea Grant; Ivan J. Fernandez, Ph.D., School of Forest Resources and Climate Change Institute, University of Maine; Gayle Bowness, Gulf of Maine Research Institute; Peter Slovinsky, Coastal Geologist, Maine Geological Survey; Nathan Robbins, Climate Change/Adaptation Coordinator, Maine Department of Environmental Protection. The purpose of these discussions is to gain knowledge from these climate-change specialists and their colleagues that would assist with our planning for sea change, and possibly also to create permanent relationships with researchers, such as Mr. Kochtitzky, whose ongoing study here would benefit the City.
- Initiated exploration with the Gulf of Maine Research Institute for developing a citizen-scientist platform that will allow Belfast citizens to assist in gathering local data related to the environment.

Some of these collaborations have already borne fruit; others are in the formative stage. One result is that Belfast will host the annual spring meeting of Maine Climate Change Adaptation

Providers (CCAP). In addition, the Maine Chapter of the Sierra Club has chosen Belfast as the site for its May 2019 conference, “Building Thriving Communities”, its focus being on the intersection of environment, economics and health. The City of Belfast is being recognized as a municipality that not only sees the challenges of issues raised by climate change but takes action as well.

To summarize, the CCC has identified several actions related to climate change that can be taken now with minimal short-term investment and tangible immediate benefit to the City. These steps will also develop useful information and relationships on which to base long-term strategies for climate-change adaptation and mitigation.

7. Conclusion

The United Nations’ Emissions Gap 2018 report, issued on November 27, 2018, noted that great effort would be required from the nations of the world to meet their carbon emissions targets in the Paris Agreement, and went on to say:

Knowing that level of action is extremely unlikely, the 2018 Emissions Gap Report points to the growing potential of "non-state actors" to help reach global emissions goals. These include smaller governing bodies such as city, state and regional governments, as well as private entities such as companies, investors and civil organizations. (*Emissions Gap*)

The City of Belfast is a “non-state actor” that nonetheless has already shown itself a leader in taking local steps on energy use and energy efficiency in relation to climate change. Our requests for City Council authorization are meant to continue this track record as Belfast develops strategies for adapting to and mitigating sea change.

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APPENDIX

Three Methods of Putting Belfast Shoreline Property Taxes in Context

The total amount of taxes paid by shoreline properties, per a calculation cited earlier in this report (*see section 5.2.2*) is \$2,388,096. To put this amount in the context of overall property taxes paid to the City, we use the figures in the following table and apply three different calculations.

<u>Budgets</u>	<u>Total Budget/s</u>	<u>Share pd. by City Ppty Taxes</u>	<u>% Ppty Tax Bill</u>
County	\$7,867,975	\$1,541,219	8.91%
School (Regional)	\$27,021,744	\$10,302,066	59.58%
City Operations	\$9,927,589	\$5,110,420	31.50%
City TIF	\$336,888	<u>\$336,888</u>	<u>*(incl. in City Ops)</u>
Total		\$17,290,593	~100%

[2018 budget data was supplied to CCC by Theresa Butler, Assistant City Treasurer, and confirmed to Councilor Hurley in an email by City Manager Joe Slocum, 1-8-'19]

Calculation #1 (Per property taxes paid)

If total property taxes paid on Belfast property are \$17,290,593, then the taxes paid on shoreline properties equals ~14 percent of the total. This calculation is the most straightforward and the one most familiar to City officials.

Calculation #2 (Per cost of City operations)

The current City Operations budget in total is \$9,927,589. The part of the City Operations budget funded by property values—the part on which the mill rate is set—is \$5,110,420. Thus, the amount of taxes paid by shoreline properties **is equivalent to** roughly half the City Operations budget that comes from property values, or a quarter of the City Operations budget overall.

Calculation #3 (Per area)

Privately-owned shoreline properties in Belfast total .58 square miles, which is 1.7 percent of Belfast’s 34 square miles. Put another way, going back to Calculation #1, we can see that 1.7 percent of Belfast’s area is paying 14 percent of its property taxes.

These sample calculations are provided to show different ways of putting coastal property values into perspective, but they all come out to prove points made earlier in this report. Highly vulnerable to sea-level rise, these properties stand to lose considerable value, possibly destabilizing traditional norms of financing and taxing property, and thus spreading private loss community-wide.