Climate-Conscious Comprehensive Planning in Delaware:

Developing and Piloting a Planning Process in Milford, Delaware

August 2017

Prepared for
DNREC Division of Energy and Climate

Written by
Philip Barnes, Ph.D., Associate Policy Scientist

Prepared by
Institute for Public Administration
School of Public Policy & Administration
College of Arts & Sciences
University of Delaware

University of Delaware | IPA Institute for Public Administration

Climate-Conscious Comprehensive Planning in Delaware:

Developing and Piloting a Planning Process in Milford, Delaware

August 2017

Prepared for

DNREC Division of Energy and Climate

Written by

Philip Barnes, Ph.D., Associate Policy Scientist

Prepared by

Institute for Public Administration

School of Public Policy & Administration

College of Arts & Sciences

University of Delaware

Preface

It is well known that the state of Delaware and its municipalities are acutely vulnerable to the looming impacts of climate change. While there is no silver bullet or universal approach to address this challenge, the planning profession must play a significant role if our communities are to successfully navigate a climate-changed future. That is why, as the director of the University of Delaware's Institute for Public Administration (IPA), I am pleased to provide this timely report, *Climate-Conscious Comprehensive Planning in Delaware: Developing and Piloting a Planning Process in Milford, Delaware*.

This report is written for planners, local government officials, concerned citizens, and decision-makers who are motivated to move their communities forward in a more sustainable and resilient direction through a truly comprehensive development planning process. The report outlines a systematic method for assessing local climate vulnerability and offers a range of planning and policy recommendations to adapt to climate impacts. It also describes and evaluates the application of the method in Milford; the town's planning commission has readily agreed to pilot the process. What this project and report demonstrate is that the integration of climate change and comprehensive planning is not only possible, but desirable. Communities, such as Milford, that take the lead and address the climate challenge head on will be well positioned to thrive and flourish in the future.

This project and report continues IPA's legacy of extending planning services to Delaware's municipalities. It leverages our expertise in local comprehensive planning and responds to the emerging challenges facing coastal communities. It complements our past research for the state on complete communities, flood-readiness, and low-carbon, sustainable development. Looking forward, this report will likely serve as a guidance and capacity-building document for planning professionals and local decision-makers alike.

As with all major projects such as this one, there is a team of partners and IPA-affiliated staff that brought it to fruition. IPA is grateful for funding from the Delaware

Department of Natural Resources and Environmental Control that supported this project. Recognition is also due to the City of Milford that agreed to participate and advance the frontier of comprehensive planning in Delaware.

I would like to thank IPA's Philip Barnes who researched and developed the climate-conscious planning process and authored this report, and Public Administration Fellows Cristina Stanica and Natalie Criscenzo who conducted background research. Additional thanks go to IPA staff members Lisa Moreland for editing support and Sarah Pragg for designing and formatting the document.

Jerome R. Lewis, Ph.D.

Director, Institute for Public Administration

Contents

Acronyms

ADA – Americans with Disabilities Act

APA – American Planning Association

DGS – Delaware Geological Survey

DEMA – Delaware Emergency Management Agency

DNREC – Department of Natural Resources and Environmental Control

EV – Electric Vehicle

FIRM – Flood Insurance Rate Map

FRAM – Flood Risk Adaptation Map

GIS – Geographic Information Systems

IPA – Institute for Public Administration

MHHW – Mean Higher High Water

SLR – Sea-Level Rise

SEU – Sustainable Energy Utility

TDR – Transfer of Development Rights

Executive Summary

In the summer of 2016, the Institute for Public Administration (IPA) at the University of Delaware began to work with the City of Milford to assist with its comprehensive develop plan update. Shortly after, the Delaware Division of Natural Resources and Environmental Control (DNREC) approached IPA and the city to ask if the two would be partners to develop and pilot a comprehensive planning process that integrates and weaves climate change considerations throughout the plan. An agreement was reached, and the project was launched in the fall of 2016. This was the first effort in Delaware to develop a fully climate-conscious comprehensive plan. In previous comprehensive planning efforts in other municipalities, climate change had only been addressed a handful of times and only very narrowly in the environmental chapter. Given the extent of the state's vulnerability to three climate change impacts—sea-level rise, heavy precipitation, and increased temperatures—climate-conscious planning must become normal practice for Delaware's municipalities. The process begins with an assessment of a community's vulnerability to the three main climate impacts and can be accomplished through a combination of geographic information systems mapping techniques (requiring technical knowledge) and public participation mapping strategies (requiring local knowledge).

The geographic information system technique involves overlaying a community's assets and resources with digitized and publicly available maps of inundation (floodplains and sea-level rise predictions) to identify which assets are at risk of damage. Assets include land, roads, parks, public and municipal service buildings, historic properties, private properties, economic centers, public works infrastructure, and anything else deemed essential to the community. After the vulnerable assets are identified, the results are incorporated into the relevant chapter of the comprehensive plan (e.g., roads for the Transportation chapter, historic properties in the Community Character chapter, etc.). To reduce vulnerability and mitigate risk to climate change, the assets become targets for recommended actions that are also communicated in the relevant comprehensive plan chapter (e.g., work with Delaware Department of Transportation to upgrade and elevate roads, floodproof historic properties, etc.) Key climate adaptation measures, or what might be called "best practices," include elevating new construction above future inundation levels by amending floodplain ordinances, buying out chronically flooded properties and converting the land to open space, enhancing riparian buffer ordinances, supporting green infrastructure and low-impact development practices, restoring and protecting wetlands, and avoiding development in areas vulnerable to future inundation.

The public mapping vulnerability assessment technique is a community engagement process during which community members are invited to share their local knowledge of at-risk assets and populations. A low-tech approach can be employed in a workshop setting in which community members collectively identify, on paper maps, the locations of vulnerable groups. For instance, certain citizens such as the elderly are more vulnerable to increased temperature than others. A workshop can be organized and community members can come together to locate concentrations of elderly residents in the municipality. This can help inform recommendations in the comprehensive plan—the effective and efficient delivery of medical care services in the event of a heat wave, for example.

The climate-conscious planning process was piloted in Milford as the municipality updated its comprehensive development plan. The vulnerability assessment was completed using both the geographic information system and public mapping strategies, and the results were communicated through the language in the comprehensive plan chapters. Unfortunately, throughout the process the climate-related work lagged behind the general task of updating the comprehensive plan, which created a series of challenges for all involved. The Milford Planning Commission members, who were tasked with reviewing draft language and offering feedback, would review a chapter without the climate change content and would then be asked to revisit the same section once the climate assessment and adaptation recommendations were incorporated. This was time consuming for the plan's main authors as well as the Planning Commission members, leaving little time for much else. Despite these challenges, a fully climate-conscious draft of comprehensive plan was completed in the spring of 2017 and presented to the Milford City Council for its review. All parties involved—Milford, IPA, DNREC—agreed that the effort was a success and extremely useful and valuable for the city's continued success.

Certain lessons were learned with this pilot project and four recommendations are suggested for others looking to perform similar work in Delaware. First, there is some confusion, misinformation, and unreasonable expectations around climate change, so the first recommendation is to engage the community (planning commission, residents, businesses, council, and nonprofits, etc.) early in the planning process by offering workshops or information sessions to demystify climate change and its impacts and answer questions. Climate change can also be a threatening topic that has significant implications for long-term community stability, so a second recommendation is to emphasize the positive outcomes that are achieved with climate adaptation efforts and communicate those possibilities by emphasizing the advantages of enhancing community resiliency. The third recommendation is to make heavy use of maps to

communicate local climate vulnerability because they are visually appealing and can offer important context to the magnitude and extent of risk. The final recommendation is to use the latest climate information available for Delaware, including new sea-level rise scenarios and inundation layers for geographic information system modeling.

Local officials, planners, and Delawareans who have questions about the planning activities contained in this report are encouraged to contact Philip Barnes at the Institute for Public Administration, by phone at 302-831-7010 or via email at pbarnes@udel.edu.

Introduction and Project Context

The state of Delaware and its municipalities must anticipate and prepare for the impacts of climate change such as rising seas, more intense precipitation events, and warmer seasonal temperatures (Hayhoe, Stoner, & Gelca, 2013). Delaware's municipalities will experience more frequent flooding, which is already a problem in many communities, as well as additional demands for public health services and infrastructure. Local governments can respond to these challenges by allocating resources and making climate-conscious decisions that will continue to protect their residents' health, safety, and general welfare. Planners can play a leading role in this effort and are uniquely positioned to assess a municipality's climate vulnerabilities, inform local decision-makers, and develop forward-thinking policies that enhance a community's resiliency and sustainability.

Several municipalities in Delaware have conducted climate change vulnerability assessments and developed action plans to address the challenges they face. Lewes, Bower's Beach, Delaware City, Slaughter Beach, and New Castle—all bordering the Delaware Bay—underwent externally funded planning processes to identify local climate threats and recommend appropriate adaptation options. Those processes, particularly in Lewes and Delaware City, produced standalone climate change adaptation plans that prioritized flooding and inundation as the major climate impacts. The Lewes and Delaware City plans were not developed and written through mandate, however, so the municipal governments in these communities are not required to adopt them as official policy and implement them by allocating public resources.

A community comprehensive plan (comp plan), on the other hand, is required in Delaware municipalities, and climate-related recommendations included in the comprehensive development plan become local government policy when the plan is approved by the local council. Delaware municipalities are required by state law to update their comp plans periodically, so all chartered communities undertake a planning effort from time to time. It is therefore intuitive to use the comp plan process to evaluate climate change impacts and address them accordingly, especially because climate change will have consequences for land use, public works, transportation, and other subjects detailed in comp plans. Making comp plans climate-conscious is also considered a best practice according to the American Planning Association (APA), which recommends that comp plans "encourage climate change adaptation" to reduce vulnerability and enhance resiliency (Godschalk & Rouse, 2015).

To date, several Delaware municipalities, notably Frederica and Little Creek, incorporated climate impacts into their comp plans by considered the threat of sea-level rise (SLR). Like Lewes and Delaware City, Frederica and Little Creek assessed climate impacts through the lens of inundation and only within the environmental chapter of their plans. These municipalities followed the new recommendations offered by the Office of State Planning Coordination (OSPC) that a comp plan's environmental protection, open space, and recreation section "should address climate change" (Delaware Office of State Planning Coordination, 2015, p. 7). As noted earlier, however, climate impacts caused by inundation and excessive temperatures are far-ranging and will require attention to land use, transportation, public health, housing, and other relevant subject areas covered in comp plans.

In the summer of 2016, the Division of Energy and Climate within the Delaware Department of Natural Resources and Environmental Control (DNREC) asked IPA staff, who had just begun to consult with the City of Milford to update its comprehensive plan, if they were interested in leveraging their work in Milford to pilot a new approach for climate-conscious comprehensive planning in the state. The proposal was to conduct a climate change vulnerability assessment for the city and integrate the results into each of the comp plan's chapters, including recommendations for how to reduce vulnerability and enhance resiliency. IPA relayed the idea to Milford's staff planner and planning commission, who confirmed that it would be a worthwhile and important exercise for the city (City of Milford, 2016). The agreement reached among DNREC, IPA, and the City of Milford was that the climate change element would not impede or slow down the larger task of updating the comprehensive plan, nor would it cost the city additional human or financial resources. It would, in effect, be a parallel planning effort that would complement the comp plan revision.

DNREC wished to develop and pilot a climate-conscious approach to comp planning in the state and build capacity and knowledge for this type of work going forward. It was agreed that IPA would produce a guidance document at the end of the process to communicate to other planners, decision-makers, and active citizens around Delaware the ways in which this pilot project succeeded, where it fell short, and what important changes can be made to better plan for climate change at the municipal level in the state. This report is written with that intention.

Report Overview and Recommendations Summary

This report begins by outlining the steps that were taken to develop a climate-conscious planning approach for Delaware's municipalities. OSPC's comp plan checklist was used as a foundation for identifying the comp plan subject areas that can incorporate climate considerations. The report then describes a method for conducting a municipal-level climate change vulnerability assessment for the three main climate impacts: SLR, heavy precipitation, and increased temperature. The method involves mapping the geography of local climate impacts (inundation and heat-vulnerable demographics) using a combination of geographic information systems (GIS) software and public participation techniques. Those maps are overlaid with community assets and resources to better inform decision-making and enhance local resiliency. Next, the report highlights the major comp plan subject areas (community character, housing, community and economic development, government services and infrastructure, transportation, land use and annexation, natural resources, and open space and preservation) and, depending on the results of the vulnerability assessment, outlines several climate change adaptation recommendations that can be used to reduce vulnerability for each subject.

The report then switches focus to review the implementation of climate-conscious planning in Milford, Delaware. It describes how the inundation and increased temperature vulnerability assessments were conducted and applied in Milford. The report also goes into detail on the engagement efforts with the Milford Planning Commission and wider community. It discusses the challenges the planning team faced with conducting the climate adaptation work concurrently with the larger comp plan effort and how those challenges were insufficiently managed and created a level of confusion with Milford stakeholders.

The report concludes with reflections on implementing the climate-conscious comprehensive planning process in Milford and outlines four recommendations for others looking to perform similar work in Delaware (see section Lessons Learned and Recommendations.). There is a fair amount of confusion, misinformation, and unreasonable expectations around climate change, so the first recommendation is to engage the community (planning commission, residents, businesses, council, nonprofits, etc.) early in the planning process by offering workshops or information sessions to demystify climate change and its impacts and answer questions. Climate change is also a threatening topic that has significant implications for long-term community stability, so another recommendation is to emphasize the positive outcomes that are achieved with climate adaptation efforts and communicate those

possibilities by emphasizing the advantages of enhancing community resiliency. The third recommendation is to make heavy use of maps to communicate local climate vulnerability (as opposed to the less effective tabular format that is detailed and presented in this report). The final recommendation is to use the latest climate information available for Delaware, which includes new SLR scenarios and inundation layers for GIS modeling.

Researching and Designing a Planning Approach

The idea and logic behind climate-conscious comprehensive planning is straightforward, but how should it be executed in practice? What process should a planner go through to deliver a comp plan that integrates climate change into all relevant subject areas? Importantly, how can that process be tailored to Delaware and designed for the many small municipalities around the state that must engage in comprehensive planning? These were the initial questions the IPA research team sought to answer.

OSPC's comp plan checklist was identified as the starting point for designing a climate comp planning methodology (Delaware Office of State Planning Coordination, 2015). The checklist outlines the subject areas to be covered in a municipal comp plan per Delaware state code. The major subject areas, which effectively serve as chapters in the plans, include demographics and economic conditions, community character, housing, community and economic development, government services and infrastructure, transportation, land use and annexation, natural resources, and open space and recreation. The next step was identifying how those areas are vulnerable to the three major climate change impacts in Delaware, specifically sea-level rise, more intense precipitation events, and increased temperature (Hayhoe et al., 2013). IPA staff conducted research to determine the consequences of these climate impacts on the plan's subject areas and give an indication of the potential municipal vulnerabilities and challenges that require attention throughout the planning process. IPA staff then researched ways in which other municipalities around the state and the country addressed similar issues in their communities. This "best practice" research was useful to help understand the types of recommendations that can be made to mitigate vulnerabilities identified through the SLR, precipitation, and heat vulnerability assessments. The peer municipality plans that were identified as incorporating best practices were Broward County, Florida; Annapolis, Maryland; Rockville, Maryland; Tampa, Florida; Issaquah, Washington; Chester, Pennsylvania; Des Moines, Iowa; Albany, New York; and Keene, New Hampshire. In Delaware, the Frederica, Lewes, and Little Creek plans were also reviewed.

Climate Vulnerability Assessments

Sea-Level Rise

To assess the impact of SLR at the municipal level, the state of Delaware's 2012 SLR vulnerability assessment report was used as a model (Delaware Coastal Programs, 2012). The 2012 report outlines a GIS-based analytic approach in which public and private infrastructure, assets, and resources are overlaid with three SLR scenarios. The three SLR scenarios used in the 2012 assessment, as well as IPA's assessment in Milford, were 0.5 meters, 1.0 meters, and 1.5 meters above average high-water level (known as mean higher high water, or MHHW). These scenarios were developed by the DNREC Sea-Level Rise Technical Workgroup and represent the minimum, intermediate, and maximum expectations, respectively, for SLR by 2100 (DNREC, 2009). DNREC subsequently developed GIS layers for each scenario using a "bathtub model" based on the current MHHW line (DNREC, 2010). The municipal resources that can be downloaded from FirstMap and overlaid with the SLR scenarios include roads, land, historic districts and historic structures, municipal buildings (fire, police, library, etc.), evacuation routes, and downtown development districts (if applicable). A GIS model can then be built with the community resources overlaid with the SLR scenarios, and a vulnerability assessment can be conducted using that model.

Heavy Precipitation

The vulnerability assessment for heavy precipitation follows the SLR version, except instead of the SLR scenarios, GIS layers of the FEMA floodplain—the Flood Insurance Rate Map (FIRM—should be used. In addition to FIRMs, DNREC's Division of Watershed Stewardship produced a single layer called the Flood Risk Adaptation Map (FRAM) that identifies the current 1 percent chance annual storm event after three feet of sea-level rise. While FIRMs are based on historic data and do not anticipate future development or events, the FRAM is effectively forward looking and attempts to identify the future 100-year floodplain that will occur after a moderate amount of sea rise (URS, 2015). The FRAM is the only map for Delaware that combines the two main inundation risks into one useful product.

It is important to note that FIRMs are regulatory, meaning any development within the flood zone must conform to local floodplain ordinances, and mortgaged properties located in floodways are required to purchase flood insurance. However, DNREC's SLR scenarios and the FRAM are not regulatory and are useful only the sense that they provide greater information for

planning and development-related decision-making. Municipalities are not obligated by law to consider or regulate sea-level rise impacts.

Table 1 shows the analytic approach that was described above. The FIRM can be broken down into the 100-year floodplain (AE+A), the 500-year floodplain (AE+A+0.2), or coastal areas subject to wave action (not shown in table). The three SLR scenarios are included, as is the FRAM. To conduct the analysis, a GIS model with the inundation layers are overlaid with layers containing data on community assets and resources (e.g., roads, land, historic properties) and the analytic tools in the GIS software package are used to calculate the magnitudes of vulnerability for each asset. Again, this was the analytic approach employed for the statewide SLR vulnerability assessment (Delaware Coastal Programs, 2012). Maps showing spatial patters of vulnerability can be easily produced with this type of GIS model.

Table 1 – Heavy Precipitation and Sea-Level Rise Vulnerability Assessment Framework

Community Assets/Resources	FIRM		Delaware SLR			FRAM
	AE+A	AE+A+0.2	0.5m	1.0m	1.5m	
Roads (miles)						
Residential Land (% of total)						
Commercial Land (% of total)						
Total Land Area (acres)						
Historic District (% of total)						
Municipal Services (fire, police, school, library, cemeteries, municipal building, etc.)						
Downtown Development District (% of total)						

Increased Temperature

Statewide climate projections predict minor variability for increased temperature across the three counties. The Delaware Climate Projections Portal is a useful resource for gathering annual, site-specific data on a wide range of climate-related indicators such as average temperature, number of cooling degree days (days when air conditioners typically run), and days above 95 degrees (State of Delaware, 2016). Portal users simply select the desired location (among the 14 available weather monitoring stations in Delaware) and the desired indicator and

are presented with graph projections for that indicator at that location until 2100. The projection data can also be downloaded and printed as an image file.

Temperature differences will not vary significantly across a municipality, but certain demographic populations vulnerable to increased temperature can show spatial patterns or clusters. From a public health perspective, it is important to identify and target these populations that are at elevated risk when temperatures rise. Mapping heat-vulnerable populations is possible by building a GIS model with census data indicators that correlate to elevated risk. For example, each of the following demographic populations are all more susceptible to heat: elderly (high rate of heat stroke), low socio-economic status (cannot afford air conditioning, poor housing, etc.), isolated persons and those living alone (lack social support), immigrants and non-native English speakers (difficulty accessing support services) (USGCRP, 2016, Chapter 9). Such census data-based analyses are common for large geographic areas where a high number of census tracts can show spatial patterns and demographic variability.

For small municipalities in Delaware that are covered by a half-dozen census tracts or less, census data-based models are unreliable due to the extremely small sample size. To address this limitation, IPA's research team developed an inexpensive, low-tech, and easily implemented approach to map heat-vulnerable populations in Delaware's smaller towns and cities. The heat-vulnerability mapping process borrows from public participation mapping techniques frequently employed in developing countries (Bernard, Barbosa, & Carvalho, 2011; Hessel et al., 2009). Instead of gathering top-down census data, public participation mapping strategies recruit community members with local knowledge to share their bottom-up information with researchers and planners. The actual public participation mapping technique piloted in Milford is described in detail in a later section, but in short it involves residents using physical maps and their local knowledge to locate clusters of heat-vulnerable demographic groups in their community (low socio-economic status, elderly, non-native English speakers).

Intersection of Climate Impacts and Comp Plan Subject Areas

OSPC's checklist identifies planning subject areas that must be included, per Delaware state code, in any municipality's comp plan (Delaware Office of State Planning Coordination, 2015). As noted earlier, a primary goal of this research and planning effort was to identify the intersection between climate impacts and each of those areas and understand how other communities across the United States incorporated similar challenges into their own comp plans. The required subject areas include demographics and economic conditions, community character, housing, community and economic development, government services and infrastructure, transportation, land use and annexation, natural resources, and open space and recreation.[1] The section on demographic and economic conditions is mostly descriptive rather than anticipatory or future-looking, so climate change will have little or no impact on this section and it was excluded from the analysis. The remaining subject areas were evaluated for their potential vulnerabilities to the three major climate change impacts for Delaware, namely heavy precipitation, sea-level rise, and increased temperatures. The sub-sections below briefly outline the special considerations that should be given to each area when integrating climate change into comp plans, and they offer recommendations and best practices for mitigating vulnerabilities.

It is assumed that the reader is familiar with the content included in these areas, and it will not be reviewed here. For a summary and additional information, please see the Municipal Comprehensive Plan Guide following the checklist (Delaware Office of State Planning Coordination, 2015). Due to time constraints experienced on this research effort, the following sub-sections are not exhaustive of all potential climate impacts in each subject area. Planners, decision-makers, citizens, and other users of this guide should perform additional research as time allows and context requires.

Community Character

A community's historic and cultural resources could be vulnerable to flooding or sea-level rise. FirstMap contains statewide layers of historic districts and historic structures that can be overlaid with the various inundation scenarios to identify vulnerabilities and assets that can be

[1] There are less stringent requirements for communities with populations under 2,000. Because this research effort aims to cover all Delaware municipalities, the most comprehensive list of subject areas was taken into consideration.

targeted for adaptation measures. Community engagement surveys and public participation mapping efforts can also capture data on what the community values as historically and culturally significant, and hence worth protecting. While the geographic locations of important community assets are unlikely to change (due to their historic significance), certain steps can be taken to protect them against damage.

Inundation vulnerabilities could be mitigated by floodproofing historic properties by elevating critical building systems such as HVAC units, water heaters, and other essential services above the predicted water level so they are not damaged in case of inundation. For properties with crawl spaces, flood vents should be installed to prevent foundation damage. In the most extreme cases, where it is technically possible, historic properties can be raised above future high-water levels. Funding for implementing these efforts may be sourced from the Delaware Historic Preservation Tax Credit program as a qualified rehabilitation expenditure. Municipalities with historic properties or historic districts should collaborate closely with local historical societies and historically minded civic groups to develop (or update) a historic preservation plan that considers the impact of flooding and sea-level rise on a community's historic and cultural resources.

Housing

Climate impacts will affect a community's housing situation. Residential property can be subject to inundation from flooding and sea-level rise. This has significant implications for the existing housing stock (which could be damaged) and decision-making on areas suitable for future residential development (which might be in harm's way). Increased temperatures from climate change will expose the consequences of poor housing quality (energy inefficient, drafty, etc.) To address inundation in the housing sector, the state's flooding and SLR scenarios can be overlaid with a community's land use map to locate housing that is vulnerable, as well as undeveloped land located in inundation-vulnerable areas. These areas become good targets for the adaptation options listed below.

Floodproofing efforts, as noted above, will mitigate the risk of water damage. Depending on the design of local wastewater treatment systems, housing backflow preventers may be installed. Chronically flooded properties could be purchased by the municipality using funding from the Delaware Emergency Management Agency's (DEMA) Hazard Mitigation Grant Program. Any property purchased under that program must be converted to low-impact uses such as parks, recreation, or other open space.

For new housing, development in inundation-prone areas could be avoided through zoning restrictions, setbacks, or softer measures such as a transfer of development rights program. If property owners wish to develop their land in areas vulnerable to inundation, a municipality's floodplain ordinance should be robust and define a freeboard requirement so that the lowest habitable floor is a safe distance above the maximum flood elevation. If freeboard requirements are increased, maximum building height restrictions in zoning ordinances may need to be amended to accommodate these raised structures. Further adjustments may be required to building setbacks to meet Americans with Disability Act (ADA) compliance standards.

Increased temperature will impact the housing area, particularly for low-income community members. Those residents may live in drafty or poorly constructed buildings where air condition is less effective, if they can afford the cost of running AC units in the first place. Municipalities should ensure that housing, including affordable housing, is constructed to modern and energy efficient building codes and practices by adopting the 2015 International Building Code standard. Weatherization assistance and housing rehabilitation programs could also be targeted at areas with low-quality housing stock.

Community and Economic Development

As with housing and historic/cultural assets, a community's commercial base is vulnerable to inundation damage arising from flooding and SLR. Economic impacts will be felt as higher temperatures will increase electricity demand for air conditioning, particularly in poorly constructed buildings. Certain economic sectors will be impacted more than others as the environment changes and temperatures rise—agriculture and construction, for example. Vulnerabilities can be assessed by overlaying inundation scenarios with land use maps containing a commercial layer. Local economic inventories can communicate over-reliance on vulnerable industries. To address these concerns, municipalities should consider adopting better land use practices, amending auxiliary services that support local commercial activity, and supporting local economic diversity.

Commercial buildings located in the floodplain or future sea-level rise zones should take precautions to mitigate risk as described above: elevate bottom floors for new construction, install flood vents in crawlspaces, floodproof by raising critical building systems, etc. Municipalities should avoid incentivizing development in locations that are vulnerable to inundation and ensure that commercial structures are constructed (or redeveloped) to higher standards and are not susceptible to water damage. Minimum parking requirements can be

reviewed and revised downward to mitigate stormwater runoff. Low-impact development practices to mitigate stormwater generation—on-site stormwater management, retention and reuse, green infrastructure, green roofs, low impervious surface coverage, etc. —could also be incentivized and supported by planning commission review.[2] Municipalities could also adopt an ordinance that designates the 500-year floodplain as a regulatory zone, effectively creating a more robust defense against damage from future heavy precipitation events and SLR.

Delaware's Sustainable Energy Utility (SEU) offers several energy efficiency incentives that reduce operating costs of buildings that can bring local economic benefits. SEU's Revolving Loan Fund provides low-interest loans to public and private end-users to install renewable energy systems and energy efficiency measures. The Solar Hot Water and Geothermal Grant offers financial assistance to nonresidential users for the purchase and installation of solar hot water heaters. These renewable energy and energy efficiency investments achieve cost savings over the long term, and they also help support local economic activity by employing skilled labor for electrical, heating and plumbing, and other construction-related work. DNREC's Division of Energy and Climate also operates a related funding program called the Energy Efficiency Investment Fund where financing is provided to replace inefficient building services units with newer, more energy efficient versions.

Economic diversity, where multiple industries operate simultaneously in an area, is important to buffer a community against over-dependence on a single employer that could be vulnerable to climate impacts. The construction and skilled-trade sectors are particularly vulnerable to increased temperatures because outdoor working conditions could become unbearable. The agriculture sector is also vulnerable to droughts and irrigation challenges such as salt water intrusion and aquifer depletion.

Government Services and Infrastructure

Municipalities need to ensure that public services, and the critical infrastructures that support them, remain operational and functional with changing climate conditions. Public buildings such as police stations, fire stations, libraries, community centers, and municipal buildings should not be built in areas subject to flooding or SLR. If these types of buildings are currently located in inundation-vulnerable areas, municipalities should look to relocate them to safer ground, especially after they experience damage from a flood event or another natural hazard.

2 See the Delaware Green Infrastructure Primer for more information (de Mooy, 2016).

Public works departments must take climate impacts seriously and adapt accordingly. Municipal infrastructure that could be vulnerable to SLR includes pumping stations, wastewater treatment facilities, stormwater management systems, and public water supply systems. Pumping, wastewater, and stormwater infrastructure could experience reduced operational effectiveness with decreased pressure/head caused by elevated water levels. Drinking water wells could be vulnerable to salinization caused by salt water intrusion into aquifers. These critical components of a municipality's public infrastructure need periodic upgrades and replacements, and public works directors should seek engineering designs that incorporate future high-water levels.

Image 1 – Flooding in Milford after a Nor'easter in November 2009

Photo Credit: DNREC

Excess stormwater runoff is a public works challenge for many Delaware municipalities and will become an even greater challenge with future heavy precipitation events. To mitigate against flooding, municipalities can reduce impervious surface coverage through several best practices. Development that includes best practices such as green infrastructure, low-impact development strategies, and stormwater retention areas are all engineering-based options. A policy-based complement is the creation of a stormwater utility where fees are assessed on properties according to the amount of impervious coverage on the parcel. This incentivizes smaller impervious surface coverage and reduced stormwater generation.

Local health services can help vulnerable residents cope with extended periods of high temperatures. Cooling centers are often set up at public buildings during heat waves and offer air conditioning, water, and on-site medical attention. Municipalities can create cooling centers and publicize them to residents when weather forecasters predict very high temperatures.

Electricity planning is another important subject for municipalities to consider. As temperatures rise in the future, air conditioning use will increase, which will drive demand for electricity. Demand-side management is possible by adopting energy efficient building codes and supporting energy efficient construction and smart metering. Urban greening by planting street trees is an option that naturally cools ambient air temperature (and has the added benefit of mitigating stormwater runoff). Upgrading electrical substations and adding capacity by incentivizing solar photovoltaics can improve grid reliability.

Transportation

Impassible, flooded roadways are already an issue for many municipalities in Delaware and without appropriate measures the situation will worsen in the future. Vulnerable areas can quickly be identified by overlaying the inundation scenario maps with transportation infrastructure GIS layers available on FirstMap. Local governments should work closely with DelDOT to inventory and ameliorate any problem areas. When frequently flooded areas require repaving, regrading, replacement, or the installation of new infrastructure, all effort should be made to raise the roads above future water levels. It is also important to consider potential future inundation of evacuation routes and work closely with the DEMA to ensure the safe movement of people in the event of a hurricane.

Roadway deterioration will become a more severe issue as temperatures rise. With warmer weather, road surfaces (especially asphalt layers) soften and become more vulnerable to damage from vehicle traffic, particularly from heavy vehicles such as buses and tractor trailers. When

roads are constructed or repaved, municipalities could request that DelDOT's engineered asphalt and concrete mixes withstand greater temperatures and wear and tear.

Supporting non-fossil fuel based and public transportation is a recommendation for all municipalities. This involves making a community bike-friendly by installing dedicated bicycle infrastructure such as bike lanes, sharrows, and trails. Pedestrian infrastructure is equally important, including wide and level sidewalks as well as dense and walkable development. Electric vehicles (EVs) are becoming popular but require charging stations located strategically throughout a community to be more effective. Local governments should dedicate some parking as EV-only, especially in commercial cores, and install rapid charging in those parking spots. DNREC's Division of Energy and Climate runs a rebate program for EV charging, which can help to offset costs.

Land Use and Annexation

The cost to provide sprawling municipal services will increase as climate impacts intensify, so local governments should approach annexation opportunities with that consideration in mind. Land that is vulnerable to flooding or SLR should not be annexed and developed without additional standards imposed. Annexation to preserve farmland, open space, and sensitive environmental features can be positive steps as long as there are reasonable controls on development of these areas. It is especially important to preserve existing wetlands because they act as natural sponges to mitigate damage from storm surges and SLR. Setbacks and buffers, conservation easements, and rolling easements are policy options available to local governments that will limit development in high-risk areas. Municipalities might also consider a transfer of development rights (TDR) program to steer development away from areas vulnerable to inundation and toward locations where density is desirable.[3]

Land already located within a municipality can often be used more wisely to limit vulnerability to inundation. It is advisable to avoid development in flood-prone areas and instead direct development toward vacant infill properties to increase density where services already exist, as a TDR program would achieve. An urban growth boundary could also help to prevent sprawl to vulnerable areas. Properties that are frequently flooded can be bought out through DEMA's Hazard Mitigation Grant Program and converted to low-impact usage such as playgrounds or parks. Upzoning to allowing higher density in central commercial districts promotes walkability and easier access to amenities and avoids sprawl to more vulnerable areas.

[3] See (Kristl, 2014) for a more detailed legal assessment of these options.

Conversely, downzoning in inundation-vulnerable areas reduces risk. Promoting community gardens, which have the added benefit of enhancing local food security at a time when traditional agriculture is experiencing the challenges of climate change, could be achieved on vacant and vulnerable property with the creation of a special urban agriculture zone. An urban agricultural zone would provide tax breaks for property owners to allow for small-scale food production on their land. Local governments could also support community gardens by allowing the activity on municipally owned land.

Natural Resources

Municipalities should seek to preserve local natural resources such as wetlands and environmentally sensitive areas because they provide invaluable ecological services such as flood mitigation and storm surge absorption. Strengthening riparian buffer ordinances, perhaps by increasing the width of the buffer, will ensure that these critical edge and transition areas are protected and remain healthy. If there are hardened edges along wetlands, rivers, or streams—with riprap, for example—local governments should consider installing living shorelines that reestablish a more natural and ecologically healthy transition zone between dry land and water.

Sea-level rise can present a challenge to the environment by interacting with sub-surface infrastructure. Legacy pollution trapped in contaminated soil on brownfield and Super Fund sites may leach into the surrounding environment if those sites become inundated. Underground storage tanks, landfills, septic drain fields, and private wells could also experience leaching if water levels rise. Identifying which tanks, wells, and contaminated sites are vulnerable to inundation is more difficult than overlaying GIS data of the underground infrastructure with the SLR scenarios because they map what will happen above ground, not interactions below ground with water tables and infrastructures. Nevertheless, planners should identify these leach-potential sites and infrastructures and work with DNREC and owners to design appropriate strategies to avoid exacerbating pollution levels.

Planting street trees and enhancing the urban tree canopy provide a number of benefits that counteract climate impacts. Street trees help to cool the air and reduce air conditioning demand, which is advantageous during warm periods. They also help to attenuate stormwater runoff by trapping water on leaves, branches, and the trunk. Trees provide habitat for birds and other wildlife, and, if they are fruit or nut bearing, they can enhance local food security. Fig trees, for example, are hardy and particularly well suited to Delaware's climate and are an underutilized species in the First State.

Open Space and Recreation

Many of the planning options discussed in the previous sections relate to open space and recreation, but they will be repeated here. Development should be avoided in undeveloped areas that are vulnerable to flooding and sea-level rise and planning tools such as riparian buffers, agricultural preservation districts, conservation easements, TDR programs, rezoning, and any other open space preservation programs are options to achieve desirable outcomes. In areas that are going to be developed, particularly for large planned unit developments, municipalities can work with developers to institute set asides for open space. Finally, outright purchase of land is an option for local governments to protect ecologically sensitive and inundation-vulnerable areas. Those areas can then be converted into recreational opportunities via a system of trails, paths, and kayak/canoe launches.

Climate-Conscious Comp Planning in Milford, Delaware

The City of Milford approached IPA in early 2016 to invite its staff to advise and consult on the city's ten-year comp plan update. An agreement was reached quickly, and IPA staff began to work with the city in the summer of 2016. As IPA's work with Milford began, DNREC's Division of Energy and Climate invited IPA staff to develop and pilot a climate-conscious comp plan effort in which climate change impacts would be woven into each of the plan's chapters, along with appropriate adaptation and mitigation recommendations. IPA brought the proposal to the Milford planning commission on August 16, 2016 (City of Milford, 2016). To assuage concerns that the additional work would slow down the main task of undertaking the comp plan process, IPA and DNREC made a commitment that additional costs and technical assistance would be supplied by IPA and the State—the city would not be required to provide additional human and financial resources. At the August meeting of the planning commission, IPA noted that if the commission members agreed to take climate impacts into consideration, the city would be in an advanced position when applying for funding to implement the plan's recommendations. The planning commission members agreed that the project should go forward, and they noted their pleasure at being the first municipality in the state to develop an integrated climate-conscious comp plan.

IPA and DNREC formalized their agreement at the end of September 2016, and work on the climate element began October 1, several months after the general consultation with the city began. Because work on the climate element was initiated later, the team faced a constant race to catch up with the main task of writing the comp plan. The timeline for completing the full plan was ambitious. Throughout the project, the plan's chapters—minus the climate work—were written by IPA's project team and Milford's staff planner and submitted to the planning commission for review. This meant the work was reviewed in advance of the climate vulnerability assessments and research. This was not an ideal situation. Chapters would be written absent the climate work and the planning commission would review and comment. Then, when the climate assessment and climate-specific chapter content was completed, the full chapter would be sent back to the planning commission for a second review and comment. In an ideal situation, the planning commission would receive a full chapter draft that included the climate content but, because of the start date and project deadlines, that proved difficult to achieve. So the climate work was continuously chasing the general planning work throughout the entire project.

The sections that follow describe the process of conducting the vulnerability assessments, writing the content for the plan, and interacting with the planning commission. The intent is to provide context for the subsequent "lessons learned" and recommendations to planners who are performing similar climate-related tasks with municipalities in Delaware. This section does not dive deep into the actual content in the plan, since doing so would take too much space here. Most of the recommendations contained in the preceding section were included in the draft of the comp plan, and the reader who wishes to take a deep dive is encouraged to review the actual plan for more detailed information (City of Milford, 2017).

Sea-Level Rise and Heavy Precipitation Vulnerability Assessment

Milford is located on the brackish end of Mispillion River, making the city vulnerable to SLR. A large area surrounding the river and its tributaries also lie in the FEMA-designated floodplain. Milford is therefore vulnerable to inundation, so a GIS analysis was completed using the approach described earlier and summarized in Table 1. The various inundation scenarios (FIRM, SLR, FRAM) were overlaid on Milford community assets to determine the magnitude and the extent of vulnerability for each scenario. Milford's assets that were analyzed include roads, evacuation routes, civic/public buildings, historic district, historic structures, downtown development district, septic systems, underground storage tanks, and land uses. Some of the GIS layers for the assets (roads, evacuation routes, historic district, historic structures, downtown development district) are available for download on FirstMap. The other GIS layers were acquired by requesting them from DNREC staff and the Milford staff planner. The Milford municipal boundary (also available on FirstMap) was used to define the extent of the analysis. The vulnerability assessment results are presented in Table 2.

The Table 2 template, without any of the data filled in, was presented to the planning commission at its November 15, 2016, meeting to demonstrate what the vulnerability assessment would accomplish and what the planning commission could expect to receive in the near future. This was the first major occasion for the planning commission members to "see" the climate element of the comp plan and what it would look like, and it was clear from the very brief discussion that it was too much to absorb in a short time. The planning commission posed excellent questions such as the expected timeframes and probabilities for the SLR scenarios and whether the FRAM was regulatory like the FIRM. Due to time limits and the need to move on to other agenda items, it was not possible to answer all questions at the level of depth required, so IPA committed to hold a separate climate change information session/workshop for the planning commission.

Following the November meeting of the planning commission, the GIS model was generated and the vulnerability assessment completed (see Table 2). The special climate workshop for the planning commission and the wider public was held on January 10, 2017 to communicate the results of the analysis, with about one-third of the planning commission members attending. At the workshop, a printed copy of Table 2 was distributed to each attendee and an online version of the GIS model, using ESRI's ArcGIS Online Service, was projected overhead to provide geographical context to the raw numbers.[4] Representatives from DNREC and IPA were present to discuss the results and answer questions. The overhead maps served as the catalyst for most of the discussion and questions that centered on engineered climate adaptation solutions such as seawalls and other hard structures to keep rising seas at bay. IPA and DNREC noted that such solutions would be extremely expensive and that financial resources to fund large earth-moving efforts were scarce. It was also noted that the city faces current flood risk in the same locations that are vulnerable to future sea-level rise—since much of the FIRM overlaps the three SLR scenarios—so any action taken to address current flood risk will mitigate against future SLR impacts.

In January 2017, the SLR and heavy precipitation vulnerability assessments, along with adaptation recommendations, were fully integrated into the comp plan chapters that had already been written. At the planning commission meeting on January 17, the inundation vulnerability assessment in Table 2was presented to the full commission. The reaction was overall quite positive although some planning commission members voiced specific concerns. The plan contained a statement that climate change is caused by greenhouse gas emissions, and one member questioned whether that claim was supported by climate science. Another member was concerned that the climate change vulnerability assessments would frighten potential residents and businesses because it could be perceived as a high-risk municipality.

[4] This can be viewed at https://arcg.is/18auCD.

Table 2 – Heavy Precipitation and SLR Vulnerability Assessment for Milford

Milford Community Assets/Resources	FIRM		Delaware SLR			
	AE+A	AE+A+0.2	0.5m	1.0m	1.5m	FRAM
Roads (miles)	3.52	5.07	.65	1.37	2.70	6.20
Residential Land (acres)	60.2	70.4	4.9	8.8	17.5	52.1
Commercial Land (acres)	99.7	107.5	13.4	25.7	36.8	73.0
Total Land Area (acres)	422.1	478.3	48.2	102.8	166.5	402.3
Historic District (% of total)	13.7%	20.6%	3.7%	7.8%	10.6%	28.4%
Municipal Services (fire, police, school, library, cemeteries, municipal buildings, etc.)	None	Police Station, Post Office	None	None	None	Police Station, Post Office, Library
Downtown Development District (% of total)	29.1%	35.0%	9.9%	18.2%	24.7%	41.9%
Brownfield/Superfund Sites	None	None	None	None	None	None
Underground Storage Tanks (no.)	18	23	5	11	15	22
Septic Systems (no.)	2	3	1	1	1	1

In response to the feedback, IPA noted that these comments could be addressed by revising the language—that it was a semantic rather than substantive issue. IPA subsequently revised the plan's content that discussed climate change, its impact, and the policy/planning recommendations to adapt—all while preserving the original intent and message. This was accomplished by removing references to anthropogenic climate change, softening the language by turning challenges into opportunities, and emphasizing the forward-thinking nature of Milford's planning and development approach. Overall, the commission was very appreciative of, and pleased with, the climate-related planning effort.

Increased Temperature Vulnerability Assessment

Research shows that the elderly, non-native English speakers, and families of lower economic means are more vulnerable to heat-related health impacts such as heat stroke, exhaustion, asthma, and other temperature-related complications (USGCRP, 2016, Chapter 9).

Each of these demographic groups is represented in Milford (low-income residents, Haitian and Latino residents, elderly residents), so higher temperatures will expose the vulnerability of some Milford residents more than others.[5] To ensure that Milford's most heat-vulnerable residents are provided adequate care and attention during heat waves and extreme temperature events, it is helpful to identify where, geographically, these residents live so health services can be efficiently and more effectively delivered. This geographic information was collected at a public mapping workshop co-hosted by the City of Milford, IPA, and DNREC at the Milford Public Library on December 14, 2016. The workshop was designed to generate local, bottom-up knowledge of the locations of the heat-vulnerable populations in the city.

The city was proactive in recruiting participants to attend the workshop, reaching out directly to civic leaders in the Haitian and Latino communities and asking them to help spread the word. Fliers were posted in City Hall and the event and advertised on the City of Milford's Facebook page (see Image 2). Free pizza was provided to incentivize higher attendance.

[5] Residents living in sub-standard housing and without air conditions are also more vulnerable. However, without performing a house-by-house inventory, it is not possible to accurately identify the geographic distribution of these residents. Nevertheless, it was assumed that residents living in sub-standard housing without air conditioning would also be low-income, so the low-income indicator was used as a proxy.

Image 2 – Flier Announcing the Heat Vulnerability Mapping Workshop

THE CITY of Milford DELAWARE

PLANNING & ZONING DEPARTMENT
P 302.424.3712 F: 302.424.3558

201 SOUTH WALNUT STREET
MILFORD, DE 19963

www.cityofmilford.com

YOU ARE INVITED TO MILFORD'S CLIMATE CHANGE MAPPING WORKSHOP

FREE PIZZA!!

The City is updating its Comprehensive Plan and is taking the opportunity to understand the impact of climate change on residents. But we need your help. We invite you to attend a facilitated public mapping workshop on December 14th, from 5:30 pm to 7:30 pm at the Milford Public Library where you will join other members of the Milford community to locate areas of the city that could be at risk of flooding and higher temperatures. No cartographic skills required! Just bring yourself, your knowledge of Milford, and your appetite. Free pizza will be provided to all participants.

For more information and to RSVP for the event please contact Rob Pierce by phone at 302-424-3712 or via email at rpierce@milford-de.gov.

DATE:	Wednesday, December 14, 2016
TIME:	5:30 PM to 7:30 PM
WHERE:	Milford Public Library, 11 SE Second Street
SUBJECT:	Climate Change Mapping Workshop

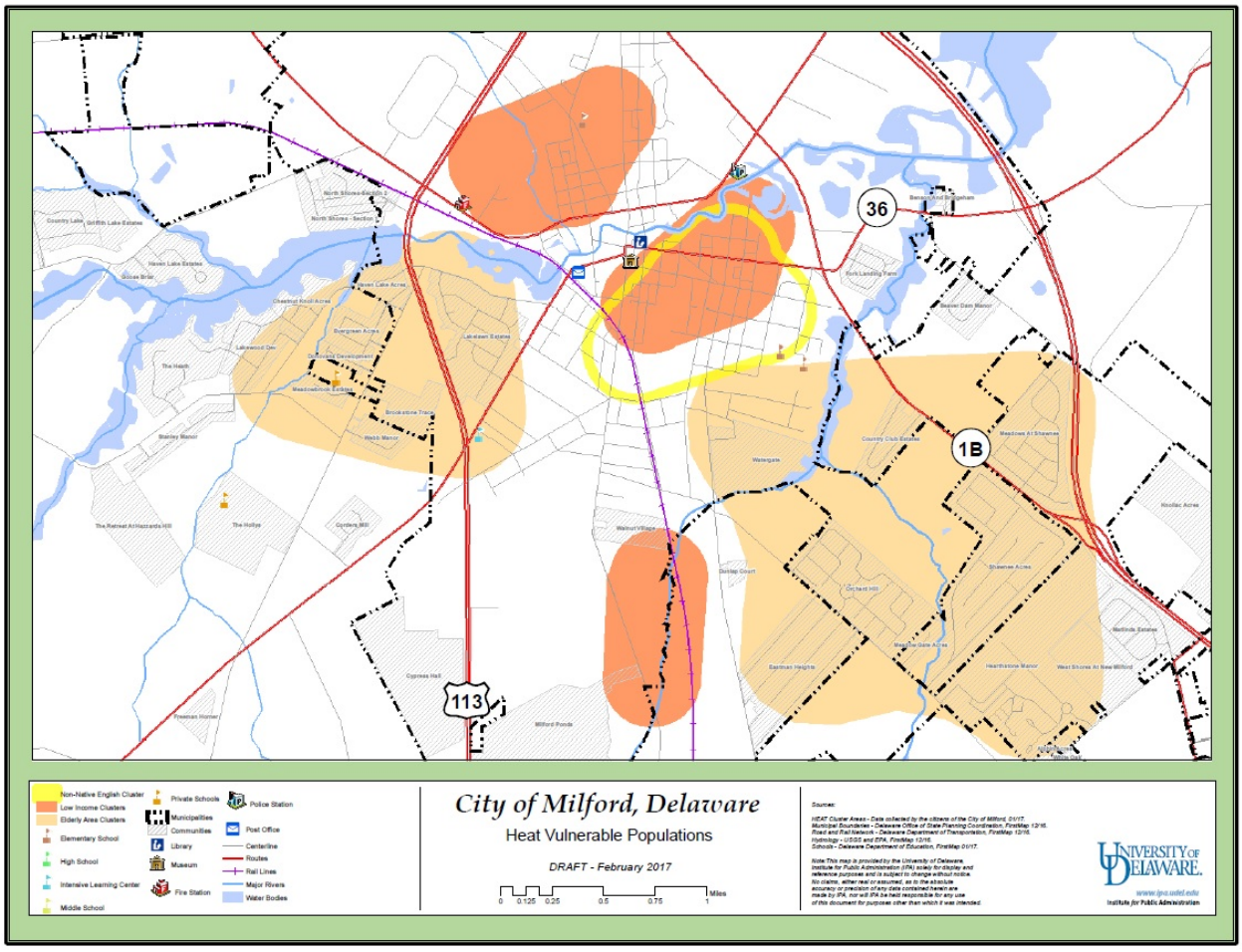
After a presentation by DNREC, which highlighted the impacts of climate change on Milford such as increasing temperatures and more frequent flooding due to heavy precipitation events and sea-level rise, residents attending the workshop were asked to participate in the mapping exercise. Four large paper maps of Milford were placed on tables, and participants were given adhesive dots in multiple colors. Three maps were dedicated to a single heat-vulnerable demographic—elderly, non-native English speakers, and low-income families—and residents were asked to use their local knowledge and place dots on the map where they knew there are concentrations of those populations (Image 3). For the fourth map, residents were asked to identify areas prone to flooding. (This was simply used to verify the FIRM and was not the primary focus of the workshop.) The residents were consistent with their placement of dots for low-income and non-native English speakers, concentrating them together in distinct areas of the city. The dots representing the elderly population were more scattered and distributed, so there was less agreement on the geographic location of this demographic. The final result was a set of paper maps containing adhesive dots that were converted later into digital GIS versions. The conversion process did not re-create the exact location of the individual dots, but rather sought to cluster them into aggregated areas.

Image 3 – Workshop Attendees Mapping Heat-Vulnerable Populations

Photo Credit: Cristina Stanica

The resulting digital map, shown in Image 4, was included in the comp plan. The dark orange areas are low-income clusters, the tan areas are elderly clusters, and the yellow border is the non-native English-speaking cluster. The map also includes icons at locations of public buildings such as the police and fire stations, schools, library, and municipal building.

Image 4 – Map of Heat-Vulnerable Populations in Milford



In terms of this exercise's value to the comprehensive planning process, the plan contains recommendations to use the public library as a cooling center in the event of extremely high temperatures because the library is near many heat-vulnerable residents. The information will also assist emergency medical services to more effectively target key populations for health care service delivery. The heat-vulnerability map was also overlaid with the Milford tree canopy map created by the Delaware Forest Service, which produced similar maps for all 57 municipalities in Delaware and updated these maps as recently as February 2017 (Delaware Forest Service, 2017). The tree canopy in Milford is sparser in the heat-vulnerable neighborhoods, so another

recommendation in the comp plan is to support the planting of street trees in these locations since trees help to cool ambient air temperatures and mitigate the urban heat island effect.

Lessons Learned and Recommendations

The climate-conscious planning process was a learning experience for IPA and Milford since neither group had engaged in similar efforts in the past. Now, with the benefit of having executed the process and being able to reflect on the challenges and opportunities presented, it is worthwhile to take stock of the lessons learned and offer recommendations to other planners, local governments, nonprofit organizations, and citizens who wish to embark on a similar process. This section offers a critical appraisal of the climate planning work in Milford and highlights areas for improvement.

Engage Early and Often

IPA's project team members made the mistake of initially assuming that the Milford planning commission understood climate change as well as they did. While the planning commission members clearly understood the dynamics behind climate change, they were less knowledgeable on the implications for Delaware and, in particular, Milford. IPA's planning team, on the other hand, contained members who have extensive knowledge of, and a background in, climate change research in Delaware. Sea-level rise needed to be demystified, and probabilities needed to be communicated for the extent of SLR by certain timeframes (10 years, mid-century, 2100, etc.).

IPA held the climate information workshop for the planning commission in January, which was several months after the work began. The workshop should have taken place much earlier in the planning process, ideally at the beginning. Informing planning partners about climate change early on helps to put subsequent discussions in proper context and makes dialogue much more productive.

Members of the Milford City Council were not presented with any climate-specific information until they reviewed a draft of the full plan at their regularly scheduled meeting on June 26, 2017. This introduced an element of risk, since council has the right of final review and approval. No council member objected to the climate vulnerability assessment and adaptation recommendations. IPA, the planning commission, and the staff planner could have spent months working on the comp plan and weaving climate change into its chapters only for the council to review the draft and object to the unexpected climate elements and request their removal. That did not happen in Milford, and the city council was very supportive and appreciative of the work. It is, however, ,easy to imagine the opposite reaction of a more critical

council. To mitigate against the potential risk of a late-stage objection from a surprised council, it may be worthwhile to brief council members early in the process, identify what they can expect to receive and review, and answer any questions they may have to preempt and allay their concerns.

The community also needs to be engaged on climate change early in the planning process and, in the case of Milford, they were not. Aside from a few questions about sea-level rise on the community survey that was distributed in late summer 2016, city residents and businesses were not proactively engaged until the mapping workshop that was held in in December. Part of the challenge with this project was that the climate element started well after the general planning process began, so it was difficult to engage the public, council, and planning commission early on. This made the entire process less effective. It is strongly recommended, therefore, to engage community members early and often, listen to their concerns, answer their questions, and build support for the planning process.

Tone It Down, Emphasize Resiliency

Climate change is a threatening topic. Those who understand its implications are right to be legitimately concerned and anxious about the future. But fear and anxiety are not effective motivators for climate action, and a large body of evidence suggests that it catalyzes defensive and skeptical behavior and discussions (Feinberg & Willer, 2011; O'Neill & Nicholson-Cole, 2009). In short, the "doom and gloom" message framing of climate change is at best ineffective and at worst regressive. If apocalyptic messaging is used in planning efforts, it will not win converts or advocates for proactive adaptation measures.

Rather than emphasizing the potentially dramatic consequences of climate change on communities in Delaware, it may be preferable to discuss opportunities to enhance local *resiliency* as a desirable outcome. Enhancing community resiliency to natural hazards such as coastal storms and flooding should be an objective for all of Delaware's municipalities. It is also a non-threatening and positive message that can better motivate stakeholders to act. Importantly, when actions are taken to improve resiliency, it will most likely double as a climate adaptation effort. For instance, adding freeboard helps new development become resilient to current flood vulnerability, but it has the added benefit of being an adaptation measure against future SLR and heavy precipitation events.

This technique was employed extensively in the Milford comp plan. Sea-level rise is explicitly identified as a climate-related issue to be addressed, but references to the causes and

consequences of climate change were kept to a minimum. Instead, nearly all climate change language was contained in "resilient" subsections of the appropriate chapters ("Transportation Resiliency" in the transportation chapter, "Housing Resiliency" in the housing chapter, etc.). The plan's vision statement also states that Milford will be "resilient to environmental change."

With all the references to community resiliency, the planning commission requested clarification and a clear definition of the term. The public engagement and informational efforts described above should be paired with strategies to educate local stakeholders on the theoretical and practical aspects of resiliency, including the long-term benefits resilient development provides to the wider community.

Streamline the Inundation Vulnerability Assessment

The inundation vulnerability assessment described in this document and detailed in Table 1 and is useful and can help inform the planning process, but its value is limited. While the tables themselves provide some understanding of the magnitude of climate vulnerability, they are less helpful for decision-makers because they lack context. Performing the analysis and filling out the table's values proved to be a straightforward GIS exercise, but it took a fair amount of time (due to complications/messiness with some of the raw data layers). The ultimate benefit derived from the tabular analysis was not apparent in the final plan. The information in the table did not impact the decision-making of IPA or the planning commission.

Maps showing the geographic extent of inundation were far more useful from a decision-making perspective and far quicker to produce. Maps provide critical, visual context to the vulnerability assessment, are easy to understand, catalyze discussion, and provide excellent graphics to include in the plan. It is recommended that planners performing similar work in the future should forgo the larger table-based inundation assessment, unless requested by the client, and instead generate maps to communicate local climate vulnerability for each inundation scenario.

Utilize New SLR Layers and Scenarios

New aerial topographic data was acquired in 2014 for Delaware, which the Delaware Geological Survey (DGS) used to update and refine GIS inundation layers for the state (Bates & Callahan, 2016). The new inundation layers, also based on the "bathtub model" are more accurate and refined than the previous layers. Whereas the old set contained three metric-based layers corresponding to the three inundation scenarios (0.5m, 1.0m, and 1.5m), the new GIS

layers are graduated in increments of one foot up to a maximum of seven feet of inundation. These new GIS layers that can be used for inundation vulnerability assessments have two key advantages over the previous set. First, the imperial/British units are more easily understandable for Delawareans since they are our standard unit of measurement. Second, the series of seven increments provide a wider and more precise range of inundation.[6]

In a related project, DGS also refined Delaware's SLR planning scenarios using more up-to-date scientific knowledge (Callahan et al., 2017). The new scenarios (0.52m, 0.99m, 1.53m SLR above MHHW by 2100) are based on a continual increase in greenhouse gas emissions through the 21st century. They are assigned probabilities (5%, 50%, and 95%) so planners, citizens, and decision-makers can select a level of risk and uncertainty with which they are comfortable for any given project.[7] Another advantage of the new scenarios is that the new levels are time-sensitive, meaning that they can better anticipate SLR in the near, intermediate, and long term. One caveat of the new scenarios is that there is considerable uncertainty with the estimates at the end of the century. For long-lasting projects that are sensitive to floods and sea levels (wastewater treatment, for example), planners and decision-makers should be advised to anticipate future inundation above the conservative high (1.53m) scenario. The new inundation layers and SLR planning scenarios should be used in any future climate-conscious planning effort in Delaware.

[6] The new layers can be downloaded here: https://www.arcgis.com/home/item.html?id=063f2b685f00430092f927fc9edb689c
[7] The scenarios are based on SLR model runs. Only 5% of model runs predicted SLR less than 0.52m by 2100. 50% of model runs predict less than 0.99m of SLR by 2100. 95% of model runs were less than 1.53m of SLR by 2100.

Conclusion

Planning for climate change impacts is something that all Delaware municipalities will eventually need to undertake. The sooner communities begin the process, the more prepared and resilient they will be as environmental conditions continue to shift. The comprehensive development planning process is a tremendous opportunity for Delaware's municipalities to investigate their climate vulnerabilities and make appropriate adaptation and mitigation recommendations. Once adopted by council, comp plans become official local government policy, and the municipality can mobilize resources and begin the critical implementation phase.

Milford is the first community in the First State to weave climate consciousness throughout its entire comp plan. The City of Milford is now well positioned to follow through on the plan's recommendations, prioritize and implement adaptation measures, enhance community resiliency, and navigate the uncertain future that climate change portends. But the effort in Milford must be replicated and spread across the entire state. Planners, councils, citizens, nonprofits, and businesses around the state can look to Milford as an example, utilize the planning processes and lessons learned that are outlined in this document, and apply them with care and sensitivity to the local context in their comp plans. The long-term health, safety, and general welfare of Delaware's population will be sustained through such efforts.

References

Bates, N. S., & Callahan, J. A. (2016). *Delaware sea-level rise inundation mapping methodology*. Newark, DE: Delaware Geological Survey. Retrieved from http://www.dgs.udel.edu/sites/default/files/content/files/project/2017-02/SLR_Mapping_Methodology.pdf

Bernard, E., Barbosa, L., & Carvalho, R. (2011). Participatory GIS in a sustainable use reserve in Brazilian Amazonia: Implications for management and conservation. *Applied Geography*, *31*(2), 564–572.

Callahan, J.A., Horton, B.P., Nikitina, D.L., Sommerfield, C.K., McKenna, T.E., & Swallow, D. (2017). *Recommendation of sea-level rise planning scenarios for Delaware: Technical report*. Dover, DE: Department of Natural Resources and Environmental Control, Delaware Coastal Programs.

City of Milford. (2016). *Planning commission: Minutes of meeting August 16, 1016*. Milford, DE. Retrieved from http://www.cityofmilford.com/ArchiveCenter/ViewFile/Item/1997

City of Milford. (2017). *City of Milford comprehensive plan draft*. Milford, DE.

de Mooy, J. (2016). *Green infrastructure primer: A Delaware guide to using natural systems in urban, rural, and coastal settings*. Dover, DE: Department of Natural Resources and Environmental Control. Retrieved from http://www.dnrec.delaware.gov/GI/Documents/Green%20Infrastructure/Green_Infra_Primer2016_FINAL%20web%20version.pdf

Delaware Coastal Programs. (2012). *Preparing for tomorrow's high tide: Sea level rise vulnerability assessment for the state of Delaware*. Dover, DE: Department of Natural Resources and Environmental Control. Retrieved from http://www.dnrec.delaware.gov/coastal/documents/sealevelrise/assesmentforweb.pdf

Delaware Forest Service. (2017). Tree canopy maps. Retrieved July 12, 2017, from http://delawaretrees.com/publications-2/tree-canopy-maps/

Delaware Office of State Planning Coordination. (2015). *State of Delaware comprehensive plan checklist*. Dover, DE: Office of State Planning Coordination. Retrieved from http://stateplanning.delaware.gov/docs/comprehensive-plan-checklist-guide.pdf

DNREC. (2009). *Recommended sea level rise scenarios for Delaware*. Dover, DE: Department of Natural Resources and Environmental Control. Retrieved from http://www.dnrec.delaware.gov/coastal/Documents/SealevelRise/Final%20and%20Signed%20DNREC%20SLR%20scenarios.pdf

DNREC. (2010). *Inundation disclaimer methods*. Department of Natural Resources and Environmental Control. Retrieved from http://www.dnrec.delaware.gov/GEDL/Documents/SeaLevelRiseScenarios/InundationDisclaimer_Methods.pdf

Feinberg, M., & Willer, R. (2011). Apocalypse soon?: Dire messages reduce belief in global warming by contradicting just-world beliefs. *Psychological Science*, *22*(1), 34–38.

Godschalk, D. R., & Rouse, D. C. (2015). *Sustaining places: Best practices for comprehensive plans* (Planning Advisory Service No. 578). Chicago, IL: American Planning Association. Retrieved from http://app.dhpe.org/Resources/files/264/PAS_578.pdf

Hayhoe, C. M., Stoner, A., & Gelca, R. (2013). *Climate change projections and indicators for Delaware*. Lubbock, TX: ATMOS Research and Consulting.

Hessel, R., van den Berg, J., Kaboré, O., van Kekem, A., Verzandvoort, S., Dipama, J.-M., & Diallo, B. (2009). Linking participatory and GIS-based land use planning methods: A case study from Burkina Faso. *Land Use Policy*, *26*(4), 1162–1172.

Kristl, K. (2014). *Assessing the legal toolbox for sea level Rise adaptation in Delaware: Options and challenges for regulators, policymakers, property owners, and the public* (Widener Law School Legal Studies Research Paper No. 14–17). Wilmington, DE: Widener University. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2439805

O'Neill, S., & Nicholson-Cole, S. (2009). "Fear won't do it": Promoting positive engagement with climate change through visual and iconic representations. *Science Communication*, *30*(3), 355–379.

State of Delaware. (2016). Delaware climate projections portal. Retrieved from http://climate.udel.edu/declimateprojections/

URS. (2015). *Delaware flood risk adaptation map: Methods, assumptions and limitations*. Germantown, MD: URS Federal Support Services. Retrieved from http://www.dnrec.delaware.gov/energy/Documents/Flood%20Risk%20Adaptation%20Map_Methods-Assumption-and-Limitations.pdf

USGCRP. (2016). *The impacts of climate change on human health in the United States: A scientific assessment*. (A. Crimmins, J. Balbus, L. Gamble, C. B. Beard, J. E. Bell, D. Dodgen, … L. Ziska, Eds.). Washington, D.C.: U.S. Global Change Research Program. Retrieved from https://health2016.globalchange.gov/downloads

Institute for Public Administration
School of Public Policy & Administration
College of Arts & Sciences
University of Delaware

180 Graham Hall University of Delaware Newark, DE 19716-7380
phone: ***302-831-8971*** *e-mail:* ***ipa@udel.edu*** *fax:* ***302-831-3488***

www.ipa.udel.edu

The University of Delaware's Institute for Public Administration (IPA) addresses the policy, planning, and management needs of its partners through the integration of applied research, professional development, and the education of tomorrow's leaders.