

Planning for Coastal Resilience in Macomb County, Michigan



This report summarizes the results of a year-long public planning process conducted in the coastal communities of Macomb County in 2015. All materials and presentations are available on the project's web page on www.resilientmichigan.org/macombresilience.asp.

RESILIENT | Macomb



January 2016

Acknowledgments

Resilient Macomb is a project of the Traverse City-based Land Information Access Association (LIAA). LIAA has partnered with the Michigan Municipal League, the Michigan Townships Association, the Michigan Association of Planning, and the University of Michigan Taubman College of Architecture and Urban Planning. Resilient Macomb is funded in part by the Michigan Coastal Zone Management Program, Department of Environmental Quality Office of the Great Lakes, and by the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. For more information, please visit the project website at www.resilientmichigan.org/macombresilience.asp

Cover Photos: *Left*, Lake St. Clair near the Selfridge Air National Guard Base (LIAA); *Right*, Oblique imagery in the City of New Baltimore (United States Army Corps of Engineers)



Table of Contents

Part 1.	Introduction	1
Part 2.	Public Process	7
Part 3.	Inventory of Current Projects and Plans	11
Part 4.	Tools and Resources	19
	A. Scenario-based Flood Projections	
	B. Taxable Value Analysis	
	C. Vulnerability Assessment	
Part 5.	Recommendations	33
Appendix A.	Maps	

Map Figure List

1. Climate Future Scenarios
2. Taxable Value by Parcel
3. Taxable Value per Acre by Parcel
4. Percent of Population 65 years and older
5. Percent of Households with People Living Alone
6. Percent of Population that are Non-white
7. Percent of Households Living Below the Poverty Threshold
8. Percent of Population 25 Years and Older with Less than a High School Education
9. Relative Sensitivity of Populations to Extreme Heat Events
10. Impervious Surfaces
11. Percent Impervious Surface
12. Percent Tree Canopy
13. Relative Exposure of Populations to Extreme Heat Events
14. Relative Exposure of Populations to Extreme Heat Events Showing Building Footprints
15. Map 14 with focus on Chesterfield Township and the City of New Baltimore
16. Map 14 with focus on Harrison Township
17. Map 14 with focus on the City of St. Clair Shores
18. Population Vulnerable to Extreme Heat Events
19. Flood Exposure
20. Homes Inside & Outside of Flood Zones
21. Critical Facilities
22. Community Services
23. Food Accessibility

PART 1

Introduction

Many communities across Michigan are wrestling with changing economic, social, and environmental conditions. From rapid shifts in the economy to changes in our natural environment, the need to become resilient is increasingly important. Resiliency plans focus on community systems including utilities, infrastructure, transportation, public health, and emergency response. The Resilient Macomb project gathered diverse stakeholders to identify climate vulnerabilities and recommend actions for managing coastal resources in coastal Macomb County. This report summarizes the results of the Resilient Macomb project, conducted from January through December 2015. In addition to the consultant (LIAA), a number of residents, local officials, community leaders, and government staff from Macomb County and the coastal jurisdictions of St. Clair Shores, Harrison Township, Chesterfield Township, and New Baltimore collaborated to identify climate impacts and plan for a more resilient future in coastal Macomb County.



A fishing boat on Lake St. Clair near the Selfridge Air National Guard Base, 2015.

Why Plan for Coastal Resiliency in Macomb County?

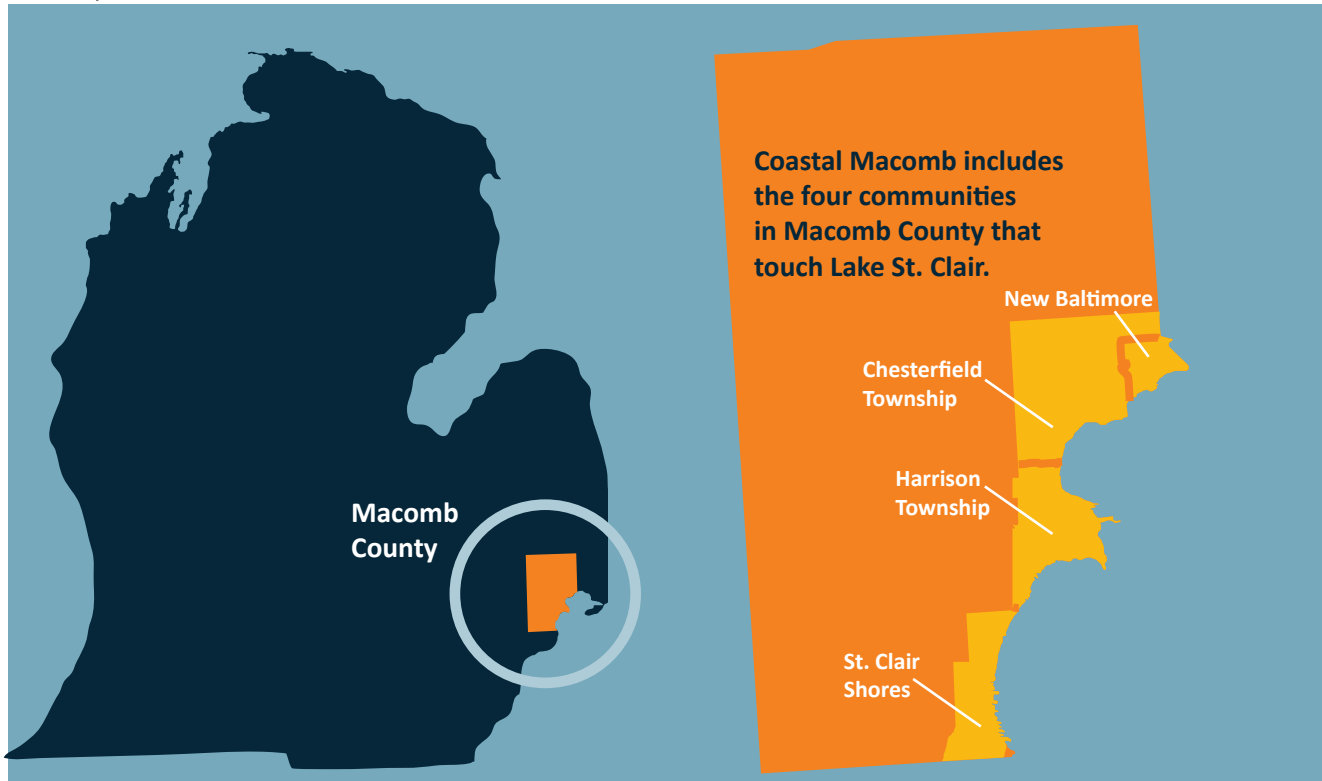
The Resilient Macomb project is a collaborative multi-jurisdictional community planning effort focused on fostering economic and climate resilience in coastal communities located along Lake St. Clair in Macomb County. This project is one of many Michigan communities undergoing a resiliency planning process through LIAA's *Resilient Communities* program.

A number of factors make Macomb County an ideal candidate for this work including:

- Concerted efforts to redevelop large areas of the waterfront
- Coastal issues of flooding and water quality concerns due to changing lake levels and climate change impacts to Lake St. Clair
- The immense benefits the lake provides to residents of Macomb County

Through the Resilient Macomb project, residents and leaders of Macomb County strengthened the

Context Map



community’s ability to manage changes and challenges related to shoreline dynamics and climate variability. The focus of the Resilient Macomb project was to develop a strong and diverse local economy, responsive and interconnected social systems, and carefully managed natural resources in Macomb’s communities along Lake St. Clair. See the context map above for the communities involved in the Resilient Macomb project.

Summary of Climate Trends

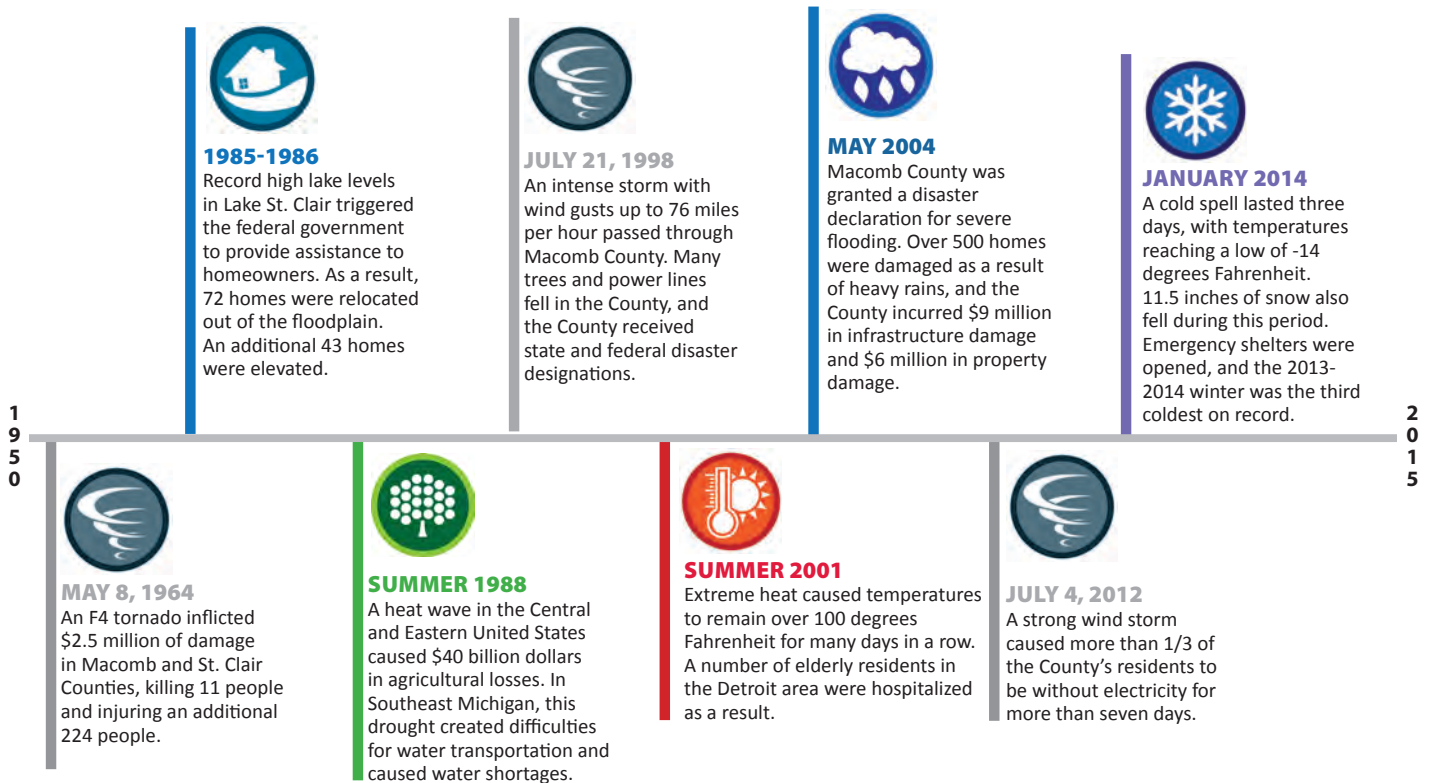
Communities throughout the Great Lakes are working to become more resilient to the impacts of a changing climate. Coastal communities are subject to the natural dynamics of the Great Lakes and have an inherent need to protect private property and steward natural resources. This section summarizes historic severe weather events in the region and summarizes climate change projections for Southeast Michigan, including Macomb County.

Severe Weather in Macomb County

The infographic on the page three summarizes a few of the major weather-related events in the Macomb Community and Southeast Michigan since 1950. Often, severe weather events result in negative impacts to the local economy and vulnerable populations in the community. Climatologists are projecting that extreme weather events will increase in frequency and intensity in Southeast Michigan.

Developed by the Great Lakes Integrated Sciences and Assessments Program (GLISA),

Extreme Weather Events Timeline



these projections are made for the years 2041 through 2070, assuming that greenhouse gas emission rates will continue to rise:

- Temperatures are expected to increase in Macomb County, both in terms of averages and extremes. Southeast Michigan is expected to see a 4.5 to 5.0 degree Fahrenheit (F) increase in average air temperature between 2041 and 2070.
- An additional 30 to 40 days per year are expected to exceed 90 degrees F. Shorter winters may accompany these temperature rises, with about 30 fewer days each year where the temperature falls below 32 degrees Fahrenheit.
- The growing season will likely be extended to include an additional 40 to 50 days each year.
- Precipitation is projected to increase on average but also be concentrated in more intense precipitation events, likely resulting in greater periods of both extreme flooding and extreme drought. An additional 3 to 4 inches of annual precipitation is expected for Southeast Michigan, and the number of days each year experiencing heavy rain falls is expected to increase by at least 1 day per year.
- The likelihood of drought is also projected to increase. Winters are predicted to shorten as air temperatures rise even during the winter season; increases in precipitation, especially during fall and spring, are expected to come in the form of rain.

Lake St. Clair

Lake St. Clair is a shallow body of water, connected to Lake Huron on the north through the St. Clair River and to Lake Erie on the south through the Detroit River. The surface area of Lake St. Clair is 430 square miles, and water throughout the lake averages about 11

feet deep. Two countries (Canada and the United States) and multiple Michigan counties and jurisdictions touch the Lake St. Clair shoreline. Four communities in Macomb County border Lake St. Clair: the City of New Baltimore, Chesterfield Township, Harrison Township, and the City of St. Clair Shores.

Lake St. Clair is connected to both Lake Huron and Lake Erie, making Macomb County part of the Great Lakes system. The lake is a popular destination in the Great Lakes region for recreational boating and fishing, and the counties along the western coast of the lake have supplied marinas and numerous destinations for boaters to lay anchor. Non-motorized boating and kayaking are also popular along Lake St. Clair, and many communities have produced mapped water trails with designated launches for kayaks. Lake St. Clair is also a primary fishing destination in the Great Lakes, due to its nutrient-rich environment that spawns bait fish and, consequently, muskellunge, smallmouth bass, yellow perch, walleye, and others. In fact, tourism generates tremendous economic value to jurisdictions along the coastline, mainly due to fishing and recreational boating activities. Nearly 8 million people live within a one-hour drive of Lake St. Clair, and Macomb County alone boasts 10,000 boat slips and 50 marinas along the Lake St. Clair coastline.

Additionally:

- Lake St. Clair is connected by navigable water to many tourist destinations in the Great Lakes. In addition to marinas, Macomb County's shoreline is home to many restaurants and amenities along the shoreline for boaters. Over one million launches were recorded from public boat ramps in 2013!
- Lake St. Clair enables about 660,000 jobs in manufacturing, farming, mining, and energy production to exist. Tourism is responsible for about 57,000 additional jobs.

Water levels in Lake St. Clair fluctuate along with Great Lakes water levels, changing in decadal and multi-decadal shifts. From 1986 to 2013, water levels in Lake St. Clair were declining from record highs. In 2013, water levels in Lake St. Clair were far below the long-term average. Between 2014 and 2015, levels quickly increased, and in October 2015, Lake St. Clair was about 11 inches above the long-term average. Changing water levels are a natural dynamic of Lake St. Clair, though much of the built environment was not designed to adapt to both high and low water levels. During times of low water levels, dock infrastructure may be inaccessible and vulnerable to damage, boats may experience hazards in shallow water, economic spending from tourism may decline, and costly dredging becomes more necessary to maintain channel access. In times of high water



Lake St. Clair in July 2015.

Table 1.1 Community Overview

	City of New Baltimore	Chesterfield Township	Harrison Township	City of St. Clair Shores
Approximate shoreline length (miles)	3.1	4.7	10.9	6.6
Population (2010)	12,084	43,381	24,587	59,715
Projected population by 2030	13,913	51,417	26,907	60,986
Projected change in population (2010 to 2030)	15.1	18.5	9.4	21.2
% of households with residents 65 years and older (2010)	20.3	18.5	23.2	32.4
% of adults with less than high school education (2006-2010)	7.2	10.6	10.3	9.3
% of residents living alone (2010)	23.2	22.4	33.6	35.1
% of land cover with impervious surfaces	27	20	26	51
% of land cover covered by trees	25.5	23	19	17

Sources: Approximate shoreline was estimated by LIAA. All other data is from SEMCOG’s compiled census data as found on their Community Profile for Macomb County (semcog.org).

levels, structures in coastal areas can be flooded and damaged by rising waters, shorelines can erode causing permanent damage, and stormwater runoff can compromise water quality and impact the ecosystem of the lake.

Lake St. Clair is a shallow lake, averaging a depth of about 11 feet. Because of this, small fluctuations in wind, precipitation, ice coverage and temperature cause dramatic changes to the lake. Compared to the “big lakes,” Lake St. Clair does not produce large waves and generally remains more calm. However, as the climate changes in Southeast Michigan, Lake St. Clair may experience stronger storms, warmer temperatures, decreased ice coverage, and changes in lake dynamics that could threaten the health of the lake and its aquatic life.

Human activities also impact the health of Lake St. Clair. The construction of homes along the shoreline began to accelerate in the 1950s. This, along with the construction of new roads and infrastructure, increased impervious surface coverage (pavement and structures), reduced the number of wetlands and trees, and restricted public access to the coast. During this time, some buildings were built close to the water’s edge, despite rapid changes in the water levels of Lake St. Clair. Existing sewer infrastructure can become overwhelmed during heavy rain events, allowing sewer overflows to discharge into rivers and Lake St. Clair. These discharges increase toxins in the Lake that endanger human and animal health and contribute to long-term water quality deterioration. Climate change holds the potential to impact all of the above issues and present new challenges for communities in coastal areas.

Substantial work has been done to implement best management practices and address key environmental concerns in Macomb County in recent years (as seen in Part 3 of this report). The Resilient Macomb project seeks to address the key issues in coastal Macomb through a new approach using the lens of resiliency. By involving stakeholders from social

services, planning, emergency management, public health, and elected office, the Resilient Macomb project team sought to inform, connect, and customize recommendations for better stewardship of coastal resources throughout Macomb County.

Community Overview

The Resilient Macomb project focused on the four jurisdictions along the shoreline of Lake St. Clair. These communities include the City of New Baltimore, Chesterfield Township, Harrison Township, and the City of St. Clair Shores. Table 1.1 summarizes a number of characteristics of each community. Each community is expected to gain population between now and 2030. Population information including the percentage of households with residents aged 65 and over, the percentage of adults with less than a high school education, and the percentage of residents living alone are included in the table. Each of these characteristics are key factors in determining how well an individual can cope with the negative impacts of extreme weather. Environmental data, including the locations of impervious surfaces like roads, buildings, and sidewalks, as well as the percentage of land currently forested, is important information for assessing a community's ability to mitigate or adapt to extreme heat events. Each of these factors is discussed more closely in the Vulnerability Assessment in Part 4C of this report.

PART 2

Public Process

The planning process for the coastal resilience report involved a number of public meetings, stakeholder interviews, and meetings with local officials. This section summarizes each method used for public outreach and engagement in the Resilient Macomb project.

Project Website

The Resilient Macomb project team created and maintained a page on the ResilientMichigan.org website. The project website was used to communicate with participants, inform residents of upcoming meetings, and provide links to all project materials.

Survey

In order to understand how residents currently interact with Lake St. Clair and where community assets are located, LIAA planners created a survey housed on the Resilient Macomb project page. The survey link was included in press releases for the project Kickoff meeting. The key results from the survey results were:

- Boating, patronizing restaurants, and fishing were the most common uses of Lake St. Clair.
- Respondents would like to use Lake St. Clair more frequently, but limited accessibility to non-boaters, the high cost of lakeshore activities, and the lack of open space prevents them.
- A majority (67%) of respondents felt that Lake St. Clair was clean.
- The area has many key assets including waterfront parks, natural areas, and economic development opportunities.
- Key projects desired by respondents to increase the community's sense of place include, in order of highest to lowest popularity: increase waterfront access for pedestrians; connect bike paths and parks; improve infrastructure for heavy traffic; and involve the community in planning future projects.
- Key projects desired by respondents to improve the lakefront include, in order of highest to lowest popularity: public parks with trails, efficient waste collection at public parks and beaches; road improvements along the M-59 corridor; civic and outdoor activities; and restoration of the Red Run drain and Bear Creek.

Kickoff Meeting

The Kickoff meeting gathered residents and officials from the coastal communities in Macomb County. The main objective of the Kickoff meeting was to share knowledge on coastal resiliency and explore how resiliency may look in Macomb County. The meeting included an overview of some current plans and projects already working to increase resiliency in the County and highlighted practices from other communities that could be

replicated in Macomb County. The meeting included presentations from experts in coastal resource management including:

- Claire Karner, Welcome and Project Overview, LIAA
- Gerard Santoro, Lake St. Clair Access Sites (Historic, Cultural, and Environmental Resources), Macomb County Department of Planning and Economic Development
- Laura Briley, Climate and Weather in the Southeast Michigan Region, University of Michigan Climate Center
- Elizabeth Gibbons, Adapting to Climate Change in the Great Lakes Region, University of Michigan Climate Center, Great Lakes Integrated Sciences and Assessments Center (GLISA)
- Glenn Pape, Strategies for Building Economic Resilience, MSU Extension
- Justin Selden, Adapting to Changing Lake St. Clair Water Levels, Michigan Sea Grant



Above: Photos from the Resilient Macomb Kickoff Meeting, 2015.

Follow-up Coastal Resilience Meeting

While the Kickoff meeting contained general information on climate change and general strategies to increase resiliency, the follow-up coastal resilience meeting gathered residents and officials to view maps and presentations containing a more fine-tuned analysis of Lake St. Clair coastal processes and an assessment of community vulnerabilities. Each of these analyses are summarized in Part 4 of this report. The presentations for the October 13th meeting included:

- Claire Karner, Community Vulnerability Assessment, LIAA
- Dr. Richard Norton, Macomb County Shoreline Analysis, Taubman College of Architecture and Urban Planning at the University of Michigan

The follow-up meeting also included a break-out activity, where participants were asked to identify potential impacts from climate change in coastal areas and prioritize improvement areas. A summary of responses is organized by topic below.

Meeting Notes Summary

Have you noticed changes in weather and climate?

- Extreme cold is a concern, especially to senior populations.
- Potential impacts of climate variability to Macomb include loss of vegetation, difficulties/changes in potable water.

What value does Lake St. Clair provide?

- Lake St. Clair provides tremendous social and economic value because of beaches, parks, restaurants, and boating opportunities.

What are potential vulnerabilities in Macomb County?

- Vulnerable populations in the County include aging populations, low-income populations, and single parent families.
- Infrastructure vulnerabilities include freezing water lines and urban flooding in highly developed areas.
- Climate variability and changing water levels can create economic vulnerabilities in coastal Macomb:
 - Low water levels can lower property values of homes along the canals.
 - Low water levels can have a negative impact on the tourist and boating industries.

Potential Strategies and Projects to Increase Resiliency?

- Plant trees in strategic areas on public and private property.
- Create more public access and viewsheds along the water (as part of a placemaking strategy).
- Invest in non-motorized infrastructure like trails and bike lanes to connect walkable areas.
- Address water quality through storm water management, pervious pavement, and other best management practices.

Stakeholder Interviews

The final step in the public process was to engage and follow-up with local stakeholders in order to refine the recommendations and analyses used in this report. While these

meetings were not advertised to the public, the topics discussed with the stakeholders were based on feedback from the public input. These follow-up stakeholder meetings were conducted in November and December and included local staff from public works, planning, building departments, and parks and recreation from communities in coastal Macomb County. These conversations refined the analysis presented at the Follow-up Coastal Resilience Meeting and identified common goals and recommendations for inclusion in this report.

Conclusion on Public Process

The Resilient Macomb project team held educational public outreach events, met with key stakeholders, and facilitated small-groups through scenario-based climate exercises. This model should be repeated in future planning efforts as it produced thorough, thoughtful community input. However, participation in the Resilient Macomb project was mainly from organizations and staff members already working on resiliency issues. Macomb County has a diverse public that regularly interacts with the shoreline, from private property owners to boaters and residents that use the many local parks. Therefore, a key outcome of this report is a strategy to build a wide base of support for future planning work (part 5 of this report).



Lake St. Clair in July 2015.

PART 3

Inventory of Current Projects and Plans

Various initiatives and plans are in progress along the coastline to address climate change impacts and implement best management practices in coastal Macomb County. Some projects involve a collaboration of a number of communities and organizations while others are specific to an individual community. This inventory was created to catalogue the current projects and plans that address resiliency and coastal concerns in coastal Macomb County. This inventory also serves as an overview of the documents and plans reviewed during the Resilient Macomb planning process. This inventory does not include the large number of paddling trails and recreational projects also underway in the county.

Federal Initiatives

This inventory includes two federal initiatives that offer special support to Lake St. Clair communities.

St. Clair River and Lake St. Clair Comprehensive Management Plan

The United States Army Corp of Engineers (USACE) approved the St. Clair River and Lake St. Clair Comprehensive Management Plan in 2006. The plan was developed with multinational cooperation and input from each level of government in order to elevate and strengthen existing efforts to improve and protect the health of the St. Clair River and Lake St. Clair. The Plan recommends high-priority projects and identifies the organizations that might partner to complete each recommended project.

Great Lakes Restoration Initiative

The Great Lakes Restoration Initiative (GLRI) was created in 2010 through the Environmental Protection Agency with involvement from a number of federal agencies. The initiative works to address Great Lakes Areas of Concern, prevent and manage invasive species, reduce nutrient runoff, and restore habitat to protect native species. A number of projects in the watersheds nearest to Lake St. Clair have received funding through this initiative.

State and Regional Initiatives

Michigan has a strong network of governmental and non-profit organizations working to increase coastal resiliency. Many of these projects and initiatives have special importance for Lake St. Clair communities.

Michigan Clean Marina Program

The Michigan Clean Marina program began in 2005 through a public-private partnership between the Michigan Boating Industries Association, Michigan Sea Grant College Program, Michigan Department of Natural Resources and Environment, and the Michigan Department of Energy, Labor and Economic Growth. Marinas voluntarily pledge to maintain and improve Michigan's waterways by reducing or eliminating releases of harmful substances and phasing out practices that can damage aquatic environments. The key goals of the program include: (1) Reducing insurance and waste disposal costs; (2) Reducing pollution and improving water quality; (3) Protecting fish and wildlife habitat; and (4) Enhancing public image by promoting environmentally sound practices.

Currently, five Marinas in Macomb County are certified through the Michigan Clean Marina Program:

- Miller Marina, City of St. Clair Shores
- River Bend Marina, Harrison Township
- Sundog Marina, Harrison Township
- Belle Maer Harbor, Harrison Township
- MacRay Harbor, Harrison Township

Southeast Michigan Green Infrastructure Vision

The Southeast Michigan Green Infrastructure Vision, adopted by the Southeast Michigan Council of Governments, inventories existing green infrastructure, identifies a future vision for green infrastructure, and provides policy recommendations on how to get there. Regional policies most applicable to coastal resilience include (1) increasing tree canopy and connecting the green infrastructure network in urban areas; (2) constructing green infrastructure on publicly-owned land such as roads and government property, as well as areas with large impervious surfaces, such as private parking lots, to improve the quality of local and regional water resources; and (3) targeting vacant property to increase connectivity, buffer high-quality areas, and improve public access to waterways.

Anchor Bay Watershed Management Plan

The Anchor Bay Watershed Management Plan was completed in 2006 and identifies a number of priorities for the sub watershed. The plan identifies critical erosion and sedimentation areas in coastal Macomb, identifies sources of excess nutrient runoff, and recommends additional strategies to protect the watershed.

Clinton River Watershed Council (CRWC) Water Towns Program

The purpose of the Water Towns program is to connect people to their water environment and improve ecosystem services. CRWC engages the public in visioning and strategic planning for water access points; develops and enhances water-oriented leisure and recreation amenities; and introduces green infrastructure concepts as part of redevelopment opportunities to improve water quality.

Clinton River Spillway Habitat Restoration Project

As of January 2016, this project is an ongoing planning and design study to restore the habitat within the Clinton River Spillway Area of Concern and is funded through the Great Lakes Restoration Initiative (GLRI).

Macomb County Initiatives

Macomb County has developed a number of projects and plans to protect Lake St. Clair.

Lake St. Clair and Clinton River Water Trails

The Macomb County Department of Planning & Economic Development has conducted preliminary planning for redevelopment of the waterfront. This planning effort, funded in part by Michigan's Coastal Zone Management Program, develops a vision for significant coastal destinations that include recreational, historical, or ecological benefit. A number of locations along or near the lakeshore are included in this plan.

Macomb County Blue and Green Infrastructure Vision

The vision aims to establish a sustainable natural environment and thriving economy through the establishment of a series of interconnected linear routes (trails, greenways, waterways, etc.) and hubs (parks, districts, destinations, etc.) throughout the county.

Macomb County Hazard Mitigation Plan

The county's hazard mitigation plan identifies the risk and vulnerability of the community to a number of natural and man-made hazards. Several hazards identified are a result of natural dynamics and climate changes for Lake St. Clair communities including shoreline flooding and erosion, urbanized flooding, drought, and extreme temperatures. The plan details historical occurrences of each hazard and provides information on how likely hazards are to occur in the future. For example, the plan identifies areas most at risk of shoreline flooding and prioritizes the public acquisition of properties subject to repetitive flood damages.

Macomb County Blue Economy Strategic Development Plan

Developed in 2012, the Blue Economy Strategic Development Plan is a comprehensive approach to leveraging the water resources in Macomb County to promote environmental stewardship, economic development, and quality of life. The plan identifies strategies for increasing access for Macomb County residents to Lake St. Clair and other inland water resources in the county. The plan sets forth a Land Acquisition Prioritization Plan to improve water access for the Clinton River and coastal Lake St. Clair. The plan also identifies a series of actions to improve water quality such as implementing an improved drinking water monitoring system, reducing combined sewer overflows, and addressing invasive species through removal and control.

Climate Change and Public Health Learning Collaborative for Urban Health Departments

The Macomb County Health Department received grant funding to address climate

impacts to vulnerable populations in the Macomb community. The nationwide project is called the Climate Change and Public Health Learning Collaborative for Urban Health Departments and is funded by the Kresge Foundation. The purpose of the small grants is to develop models that demonstrate a variety of ways urban local public health departments can develop, integrate, scale up and replicate approaches that simultaneously address climate change, community health and health equity. Macomb County will be focused on addressing flood-prone neighborhoods in the county that were hit particularly hard during the summer of 2014's extreme rain and flooding event in southeast Michigan. Key health issues that resulted from this event included respiratory problems from mold and mildew, mental health issues from economic distress, and issues with getting people to safety who lack mobility (elderly, disabled, living alone, etc.).

Macomb County Blue Ribbon Commission on Lake St. Clair

The Blue Ribbon Commission (BRC) was formed by the Macomb County Board of Commissioners in 1994. In 2008, the BRC released an update to its 1997 report of recommendations to address environmental problems in Lake St. Clair. The 2008 report identified a number of recommended future actions relevant to local land use.

- Prioritize environmentally friendly local land use planning in communities that drain to Lake St. Clair
- Establish ordinances to preserve wetlands
- Support subwatershed planning at the local government level
- Encourage groundwater protection by using health departments to educate citizens and local officials
- Encourage alternatives to conventional septic systems like constructed wetlands and community composting systems
- Map critical slopes and areas of proposed and existing impervious surface
- Modify local codes to preserve and create vegetative buffers along waterways

Local Initiatives

Each community in coastal Macomb County is working to protect and support Lake St. Clair. This short overview is not meant to be a comprehensive list of projects and plans, but does serve to demonstrate the wide range of local work underway in coastal Macomb.

Harrison Township

2010 Harrison Township Master Plan

Harrison Township's Master Plan places special emphasis on the waterfront. The Plan designates the district surrounding Crocker Boulevard and Jefferson Avenue as a "village node," earmarking this neighborhood with renewed interest in redevelopment and the creation of unique community character.

Harrison Township Waterfront Redevelopment Plan

The Harrison Township Waterfront Redevelopment Plan was prepared as a subarea plan to the 2010 Harrison Township Master Plan. The waterfront redevelopment plan determined that a Downtown Development Authority would be a feasible entity to facilitate redevelopment along the shoreline. The Plan also summarizes the community's vision to redevelop the waterfront as a 24-hour destination. Goals of the plan include enhancing public access to Lake St. Clair, connecting its waterfront district to other waterfront destinations such as the Nautical Mile, incorporating Low Impact Development, establishing non-motorized connections to the waterfront, and restoring the Clinton River Spillway. A large part of the waterfront in Harrison Township is now planned as medium-to-high single family residential and multiple family residential. Commercial nodes are planned at Crocker Boulevard/Metropolitan Parkway and along a key section of Jefferson Avenue.

City of St. Clair Shores

Low Impact Development in Kyte Monroe Park

The City of St. Clair Shores received a grant through the Great Lakes Restoration Initiative to install 21,000 square feet of pervious pavement and a 3,000 square foot rain garden in the City's Kyte Monroe Park. This project will divert approximately 95,000 gallons of stormwater that currently drains directly into Lake St. Clair, allowing the water to filter into the groundwater and addressing goals in the Lake St. Clair Management Plan.

2008 City of St. Clair Shores Master Plan

The City of St. Clair Shores Master Plan solidifies the community's vision for the waterfront, including increased public access, additional recreational opportunities, and connected pedestrian pathways along the shoreline.

Nautical Mile Design Charrette

As part of the Resilient Macomb project, LIAA facilitated a public design charrette to summarize the community's vision for a redeveloped Nautical Mile. The vision includes a number of recreational amenities, redeveloped public spaces, and new development opportunities along the waterfront.

City of New Baltimore

The Schmidt Marina Redevelopment

In 2015, the City secured a grant from the Michigan Natural Resources Trust Fund to acquire the Schmidt Marina, allowing the City to provide additional recreational opportunities along the water, connect existing non-motorized pathways in the City, and provide stormwater control benefits through Low Impact Development.

Walter and Mary Burke Park

New Baltimore's downtown waterfront park was redeveloped in 2015 in order to address water quality issues in Anchor Bay. The enhancements to the park were funded by the Great Lakes Restoration Initiative and include pervious pavement, rain gardens, and native plants.

Chesterfield Township

Brandenburg Park Improvements

In response to a failing seawall, Chesterfield Township is pursuing funding to implement a shoreline naturalization project. The project will provide water quality benefits, improve habitat, and control shoreline erosion and flooding.

Invasive Species Removal

The Township is working with SEMCOG on a grant to address the spread of invasive phragmites in the Township. The grant will allow the Township to assess and target the invasive plant, restoring biodiversity and improving water quality.

Salt River Marsh

The Salt River Marsh is within the Township and the Anchor Bay Watershed and is currently being restored to improve aquatic habitat, overall water quality, and overall environmental health. The project will restore natural shoreline in several places along the Salt River, remove invasive species, and dredge several channels that lead to Lake St. Clair.

Selfridge Air National Guard Base

Michigan Army National Guard Resiliency Planning Process

In 2015, LIAA conducted a public planning process to increase resiliency in the greater community around the Selfridge Air National Guard Base. The project involved a public charrette related to coastal resiliency and resulted in a number of recommendations for the base and nearby communities to consider.

PART 4A

Tools and Resources: Scenario-based Flood Projections

As part of the Resilient Macomb planning process, researchers from the University of Michigan's Taubman College of Architecture and Urban Planning analyzed shoreline dynamics of Lake St. Clair in order to help Macomb communities manage their coastal resources. Specifically, the research team identified the extent of flooding under three possible scenarios called "Lucky," "Expected," and "Perfect Storm." This work was presented at the follow-up meeting for the Resilient Macomb project in October 2015.

Scenario Framework

The research team's goal was to use climate projections to identify areas that may experience flooding given changing Lake St. Clair water levels. To do this, the team created three scenarios, each describing a possible future using elevation-based flood modeling. Scenario planning is a useful tool for environmental planning work, as information is presented in a range of possibilities. Each of the Climate Future scenarios are shown on Map 1.

Climate Future Scenarios

"Lucky"

In the Lucky climate future, water levels are relatively low when a storm occurs. Flood damage is minimal and existing seawalls are adequate in protecting land from most flooding.

"Expected"

The Expected Climate Future refers to a time when water levels in Lake St. Clair rise to the long-term average still water elevation of 574 feet and a storm occurs. In this climate future, it is possible a 100-year storm could cause waves of up to 7.3 feet in height, bringing lake levels up to 581.3 feet. Therefore, flooding may spill over Macomb County's seawalls that were constructed to protect land when water levels were 580 feet.

"Perfect Storm"

The Perfect Storm Climate Future refers to a time when water levels in Lake St. Clair rise to the Lake's highest still water elevation of 577 feet and a storm occurs. In this climate future, it is likely that a storm could cause waves of 7.3 feet in height, bringing lake levels up to 584.3 feet. In this case, flooding will overwhelm seawalls and cause widespread

damage.

Data Sources

The researchers used FEMA's Flood Insurance Rate Maps to identify base flood risk for the Lucky Climate Future (A and AE Zones). The information on still water elevation and wave projections was derived from the United States Army Corps of Engineers, and the height of the County's seawalls is from Macomb County and local ordinances.

Findings

Map 1 in Appendix A shows the areas that may flood in the Lucky, Expected, and Perfect Storm climate futures. In general, many areas near the coastline are subject to flooding under each of the three scenarios. Extensive flooding shows near the Selfridge Air National Guard Base, although the many mechanisms in place to reduce flooding impacts (ditches, stormwater pumps, etc.) were not used in the modeling. It would appear that many of the homes near the shoreline are subject to flooding despite the seawall infrastructure currently in place.

This information can be used by local officials, engineers, and public works staff to determine locations to best install higher capacity stormwater infrastructure or best management practices like constructing wetlands, infiltration systems, or retaining areas.

PART 4B

Tools and Resources: Taxable Value Analysis

In order to understand the economic value of land near the coastline, LIAA created a set of maps showing the taxable value of parcels in coastal Macomb County. In general, these maps show that communities in coastal Macomb should encourage strong shoreline management, in part because coastal land has very high economic value. Investing in coastal management will protect the high taxable value of coastal development.

There are two taxable value maps available in Appendix A. Map 2 shows the taxable value of each parcel, while Map 3 shows the taxable value per acre of each parcel in coastal Macomb County.

Taxable Value of Parcels

Map 2 uses tax assessor data to map the taxable value of each parcel as of 2014. Some lots, including public, government, and non-profit uses are not shown with a value, but a majority of parcels in the community are shown with a value ranging from “Lower” (yellow and green) to “Higher” (dark green to blue). Within this general range, over 200 colors represent values along this spectrum, producing a detailed look at taxable value.

Taxable Value Per Acre of Parcels

Map 3 divides the taxable value of each parcel by that parcel’s size, producing a relative comparison of taxable value, regardless of the parcel size. Just as in Map 2, public, government, and non-profit, uses are not shown with a value, but a majority of parcels in the community are shown with a value ranging from “Lower” (yellow and green) to “Higher” (dark green to blue).

Findings

In general, a number of coastal properties have high taxable value regardless of the parcel’s size. These include marinas in St. Clair Shores and New Baltimore, and residential properties along the shoreline in Chesterfield and Harrison Townships. The taxable value of these properties rank as high as many of the large-scale commercial development elsewhere in the community.

Map 2 and Map 3, compared side-by-side, show that many of the large-scale commercial developments (large parcels with high taxable value in Map 2) have lower taxable

values when accounting for the size of the parcels. Parcels along the coastline however, generally increase in relative value between Map 2 and Map 3, due to the higher density of development, especially in residential areas. It seems likely that the presence of Lake St. Clair boosts property values and supports expensive, waterfront homes.

These maps also may show that large-scale, commercial developments, while sustaining high property values, actually generate less taxable value than other, more dense development, when accounting for the size of the parcel.

PART 4C

Tools and Resources: Vulnerability Assessment

The impacts of climate variability on agriculture, infrastructure and human health are being felt almost everywhere across Michigan. With thoughtful planning and preparation, communities can better withstand and recover from severe storms, becoming even better places to live and thrive. Through community-wide planning efforts like this one, resilient municipalities can actively cultivate their abilities to recover from adverse situations and events, strengthen and diversify their local economies and communication networks, increase social capital and civic engagement, enhance ecosystem services, improve human health and social systems, and build local adaptive capacity.

Building Community Resilience with a Vulnerability Assessment

A first step toward increasing resiliency is to identify community vulnerabilities and make action plans to reduce sensitivities and exposures to hazards of all kinds. The following section discusses the results of a community vulnerability assessment for coastal jurisdictions in Macomb County. A vulnerability assessment is a method to identify areas of the community where populations are most likely to experience the negative results of climate impacts. For the purposes of this report extreme heat and heavy flooding are the two climate impacts that were chosen as each of them are expected to occur more often and with greater intensity in Southeast Michigan (see the summary of climate trends in Part 1 of this report). However, many of the considerations and societal impacts identified would be present under other stresses and shocks within the community.

A Vulnerability Assessment is designed to identify and help prioritize adaptation strategies in the community planning process. A model that defines “vulnerability” as “exposure plus sensitivity” is used to complete the Assessment.¹ Exposure refers to hazards in the natural or built environment, while sensitivity refers to the degree to which a community or certain segments of a community could be impacted by an event.

A Vulnerability Assessment provides direction for planning commissioners, municipal staff and public health officials as they work to reduce risks to human health.

¹ Foundations for Community Climate Action: Defining Climate Change Vulnerability in Detroit. University of Michigan. December 2012.

Extreme Heat Vulnerability Assessment

Vulnerability to heat events varies depending on location. In Michigan, there are varying degrees of vulnerability to heat based on a community's proximity to the Great Lakes and geographic latitude. Access to air conditioning, and surrounding environmental factors like tree canopy and impervious surfaces also play a role.

Studies have shown that heat-related mortality generally occurs in areas of the community that are warmer, less stable, and home to more disadvantaged populations.² One study found that neighborhoods with the highest temperatures and the least amount of open space and vegetation were also likely to be the most socioeconomically disadvantaged.³ The same study also found the strongest protective factor for residents was access to air conditioning in the home and in other places, as well as having access to transportation.

A 2012 literature review conducted by researchers at the University of Michigan indicates that infants under five and persons over 65 are highly sensitive to heat events, as are minority and lower-income populations. Living alone, being confined to bed, having a mental illness, not leaving home daily, living on higher floors of multistory buildings, and suffering from substance addiction are additional factors that are associated with increased risk of heat-related mortality.

There have been limited studies conducted on how heat events impact rural and suburban communities, but one study notes that rural populations may exhibit patterns of vulnerability different from those of urban populations.⁴

In order to determine overall vulnerability to extreme heat events, this vulnerability assessment first created separate maps for sensitivity (where sensitive populations live) and exposure (where environmental risk to extreme heat is greatest). To create the sensitivity and exposure maps for this Plan, as well as the resulting vulnerability maps, the project team used a method developed by the University of Michigan's Taubman College of Architecture and Urban Planning.⁵

Step One: Identify Heat Sensitive Populations

Researchers who study heat impacts have determined that the following populations tend to experience the most harm from a heat event:

- People over 65 years of age
- People living alone
- Minority populations
- People living below the poverty line

2 Foundations for Community Climate Action: Defining Climate Change Vulnerability in Detroit. University of Michigan. December 2012.

3 Semenza JC, Rubin CH, Falter KH, et al. Heat-related deaths during the July 1995 heat wave in Chicago. *N Engl J Med* 1996; 335:84–90.

4 Mapping Community Determinants of Heat Vulnerability. *Environ Health Perspectives* 117:1730–1736 (2009). doi:10.1289/ehp.0900683 available via <http://dx.doi.org/> [Online 10 June 2009].

5 Foundation for Community Climate Action: Defining Climate Change Vulnerability in Detroit (December 2012) University of Michigan's Taubman College of Architecture and Urban Planning.

- People over 25 with less than a high school education

In order to identify where these populations live in coastal Macomb County, the project team used geographic information systems (GIS) to create a series of maps, one for each of the five groups listed above. Using U.S. Census data, the project team identified the percentages of people living in each area (by Census Block Group or Block) for each sensitivity factor. After these maps were complete, the project team created a simple index to create a composite sensitivity map as a way to estimate where sensitive populations in any of the five groups may be concentrated. In each of the following maps, Census Blocks with zero population are shown as white on the map, displaying no data.

People Over 65 Years of Age

Studies show that people who are older have greater sensitivity to extreme heat events. Studies also indicate that older age is associated with higher hospital admission rates in heat waves. The Percent of Population 65 and Older (Map 4) depicts the relative concentration of older adults in the community by Census Block. In general, the map shows relatively even distribution of elderly populations within the community.

People Living Alone

Another sensitivity factor is living alone, which serves as a measure of social isolation. Although living alone is not necessarily a risky thing, people who are socially isolated are at greater risk during an extreme heat event. Isolated people may not be able to recognize symptoms of heat-related illness and take proper action. For this factor, the project team used American Community Survey data for Census Block Groups, broken out into individual Census Blocks for geographic representation (Census Blocks with no population were not included). Map 5 depicts the high concentrations of people living alone. In general, the map shows that many Census Blocks in coastal Macomb County have more than 30% of residents living alone. It is important for these residents to be notified in case of emergency and made aware of locations of emergency shelters and other resources during a flooding event or heat wave.

Minority Populations

Studies also suggest that minorities are at greater risk during extreme heat events for various reasons, including less reliable access to health care, transportation and other social supports needed to reduce heat exposures.⁶ In other words, a correlation exists between non-white populations and increased sensitivity to extreme heat. Census Blocks were used to map the relative percentages of non-white populations in the Macomb Community (see Map 6). The map shows a number of Census Blocks with high concentration of minority populations near the coastline and in the rural areas of north Chesterfield Township.

⁶ Waugh and Tierney (eds.) Emergency Management: Principles and Practices for Local Government. Chapter 13: Identifying and addressing social vulnerabilities by Elaine Enarson.

Poverty and Educational Attainment

Two socioeconomic factors associated with increased heat-related morbidity and mortality are the percentage of the people living in poverty and percentage of people without a high school diploma. In general, persons living at or below the poverty line have less access to air conditioning or cooling options for their residences. This could limit a person's access to relief from an extreme heat event. Census Block Groups were used to map the relative percentages of households living below the poverty threshold in the Macomb Community (Map 7). A number of areas of coastal Macomb County have high concentrations of households living below the poverty threshold. Of note is the area just west of Selfridge Air National Guard Base, a mobile home development in Harrison Township.

Similarly, the University of Michigan research team found studies that demonstrate a direct link between low education attainment and poor health.⁷ There is also an established correlation between lower educational attainment and lower income. Based on these findings, Census Block Groups were used to map the relative percent of persons 25 years old and older with less than a high school education in the coastal Macomb Community (see Map 8). The map shows that much of the shoreline population demonstrates high education attainment, but there are neighborhoods where over 20% of residents have less than a high school education further inland.

Overall Heat Sensitivity

To complete the heat sensitivity assessment, the project team worked through several steps. First, in each of the five sensitivity maps, the percentage of sensitive populations were grouped into five categories (ranging from very low to relatively high). The five categories were determined by the GIS software ArcMap using natural breaks in the data, in order to objectively measure areas with high and low concentrations of sensitive populations. Next, a ranking of 1 to 5 was assigned to each of the categories, ranging from 1 for the lowest percentage to 5 for the highest. Following this, the team combined the scores within each Census Block and created an overall sensitivity map. In this map, the most sensitive Census Blocks could reach a maximum score of 25. The sensitivity is color coded for ease of identifying areas with the greatest sensitivity.

The Relative Sensitivity to Excessive Heat Map (Map 9) provides a reasonably detailed map of locations where the highest percentages of at-risk residents live. This does not mean these community residents are in immediate danger. Rather, the map provides planning officials a new way of identifying areas where heat waves could present serious problems for a significant number of citizens. These are populations that could be sensitive to extreme heat events. In general, the map shows that the populations in some areas are relatively more sensitive to extreme heat events than others. Each of the coastal jurisdictions have some neighborhoods with high sensitivity.

The Census data used likely counts some people twice, such as in cases where a person

⁷ Curriero FC, Heiner KS, Samet JM, et al. Temperature and mortality in 11 cities of the eastern United States. *American Journal of Epidemiology*. 30 (2001): 1126-8.

is both a minority and over 65. This may over-estimate the severity of the sensitivities in some locations. Additionally, the sensitivity analysis may underestimate risk because it leaves out several key sensitive populations, such as those with preexisting health concerns (for example, cardiovascular disease or psychiatric disorders). Such data is not often available publicly or on the Census Block level. Emergency managers, hospitals, and community health departments within the region may have additional data available that can be analyzed and considered as the community looks to better understand its overall sensitive populations. To further improve the analysis, additional variables could be collected through local surveys and observation, such as the degree of social connections among individuals within a community, or materials used in housing.⁸

Step Two: Assess Environmental Exposure to Heat Events

When larger communities experience heat waves, air temperatures can vary significantly from place to place during the day and at night. Some of these differences can be attributed to the varying types of land cover found throughout the community. Temperatures can be significantly lower at night in locations with a heavy tree canopy and very little pavement. Conversely, temperatures can be higher in locations with little greenery and lots of pavement.

Impervious surfaces such as paved parking lots, roadways, and buildings absorb large amounts of heat from the air and sunshine. That heat is radiated back into the environment when temperatures begin to fall. At the same time, tree canopy and other vegetation can help cool an area through evaporation and transpiration of water, and by providing shade. In places with a high percentage of impervious surface and little tree canopy, the immediate environment can be much warmer. Urban areas typically have higher heat indexes (combinations of temperature and humidity) than surrounding suburban or rural areas. This condition has been termed the “Urban Heat Island Effect.”⁹

Communities with the Urban Heat Island Effect are at greater risk of health impacts from heat events, as the temperature stays warmer for longer periods of time, even at night. Studies have documented that despite nearby rural areas, communities can experience a 2 to 9 degree Fahrenheit increase due to the Urban Heat Island Effect. Studies have also shown that the environment’s ability to reflect heat is a key to reducing the air temperature. Planting trees, installing green roofs, and planting vegetation in large parking lots help decrease Urban Heat Island Effects, help control stormwater, and promote efficient energy use.

This Vulnerability Assessment used two factors to determine where environmental risk to heat events is greatest:

1. Impervious Surfaces

8 Mapping Community Determinants of Heat Vulnerability. Environ Health Perspectives 117:1730–1736 (2009). doi:10.1289/ehp.0900683 available via <http://dx.doi.org/> [Online 10 June 2009].

9 Basu and Samet. (2002) Relation between Elevated Ambient Temperature and Mortality: A Review of the From the Department of Epidemiology, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD.

2. Lack of Tree Canopy

Following the sensitivity assessment steps described above, the project team analyzed both of these factors at the Census Block Level. Again, these percentages are divided into five categories using the GIS software's natural breaks calculation.

Impervious Surfaces

Impervious surface refers to parking lots, roads, sidewalks, building footprints, and any other area that is paved. Data for impervious surfaces came from SEMCOG, which digitized this information using aerial imagery. Areas with the lowest percentages of impervious surfaces score a 1 in this assessment, while areas with the highest percentages of impervious surfaces score a 5. Map 10 shows the impervious surfaces in the community, used to generate the percentage of impervious surfaces by Census Block in Map 11. Map 10 shows that St. Clair Shores has significant numbers of impervious surfaces that appear to be caused by roads and small homes. Chesterfield Township, on the other hand, has a number of places with very little impervious surface (north of M-29), but many large areas of contiguous impervious surfaces, likely caused by "big box" stores and large parking lots.

In Map 11, all four coastal jurisdictions have high percentages of impervious surfaces within many Census Block Groups. In some cases, impervious surfaces comprise a relatively large percentage of the Census Block due to the presence of large, "big box" stores and parking lots. Residents living nearby these areas may still experience increases in heat due to these impervious surfaces. Therefore, areas with no population were left in the calculations of environmental exposure.

Tree Canopy

Tree canopy data was also obtained from SEMCOG, which digitized where tree canopy is present in the community using aerial imagery. The tree canopy was mapped as a percentage of total land cover within each Census Block (Map 12). In this case, the highest percentage of tree canopy received a 1 and the least vegetative areas received a 5. The map shows that many areas have significant tree coverage. While the type of vegetation is not known, it seems likely that the large Census Blocks near the northern boundary of the study area have more forests and undisturbed tree coverage, while the tree canopy in residential neighborhoods is likely from tree-lined streets and parks.

Composite Heat Exposure

The project team combined the results of the two heat exposure maps to provide a single Community Excessive Heat Exposures Map (Map 13). This map provides a reliable depiction of where the Urban Heat Island Effect would be most and least intense during a heat wave. Communities can use this map to better assess where new vegetation and tree canopy should be prioritized, and where reducing impervious surfaces (e.g., specialized pervious pavement or native landscaping) would be most beneficial.

Map 13 shows that a number of areas have relatively high exposure scores in coastal Macomb County. These areas seem to be clustered in the City of St. Clair Shores and along

M-3 and I-94 in Chesterfield Township.

Environmental exposure can be high in a Census Block even if zero or few residents live in the Block. Although zero or few residents live in these areas, exposure in these areas is still important to consider. Heat impacts may not be defined at the Census Block level, and residents in surrounding Blocks may feel the impacts of high environmental exposure. Additionally, commercial areas and industrial uses with high exposure increase the vulnerability for sensitive populations that may work, shop, or visit these areas.

The project team created Map 14 as a way to help communities understand where population may be concentrated within a Census Block Group. Maps 15, 16, and 17 zoom in on Map 14 in each community to show better detail. These maps show the location of buildings as mapped by SEMCOG in combination with the composite heat exposure map. Because aerial imagery was used to create these building footprints, the use of the property is not certain. The project team assumed that buildings between 700 and 3,000 square feet are most likely to be residential units, although some small retail stores may be included. This information is not designed to provide an exact picture, but should help communities understand where population is concentrated within Block Groups. Because impervious surface is often correlated with development, the exposure scores seem to be higher where residential homes are clustered. However, there are some Census Blocks with high exposure scores but low populations, namely near M-3 in Chesterfield Township. Here, commercial development with large parking lots is responsible for the increase in exposure score. Although few homes are nearby, vulnerable populations can include visitors and employees of these developments.

Step Three: Identify Heat Vulnerability

Steps One and Two describe the process to create a composite heat sensitivity map (where sensitive populations live) and a composite heat exposure map (where environmental risk to extreme heat is greatest). The coastal Macomb Heat Vulnerability Map is a simple additive combination of the overall sensitivity map and the overall exposures map (see Map 18). The resulting vulnerability index depicts where concentrations of exposures and sensitive populations create a higher risk for community residents. In general, those areas with the highest composite scores (orange and red) have residential populations that may be particularly vulnerable to extreme heat events.

Map 18 shows that a number of Census Blocks in coastal Macomb County have high vulnerability to extreme heat events. These areas are clustered in several locations including central Chesterfield Township, west of I-94 in Harrison Township, and in southern Harrison Township and into the City of St. Clair Shores. Special attention should be given to these areas when planning for emergencies, and local communities should reduce heat impacts in these locations by increasing vegetation and reducing impervious surface.

Heavy Flooding Vulnerability Assessment

The following pages summarize a Flooding Vulnerability Assessment conducted for coastal Macomb County.

Climate models suggest that coastal Macomb County is likely to experience heavier and more frequent rain events. Shoreline flooding is also expected to increase, as seawall infrastructure ages and St. Clair's lake level rises in accordance with historic trends. Climate models suggest that precipitation will be more concentrated in winter, spring and fall and that annual precipitation will increase. Potential for substantially larger rain events raises concerns over the potential for harm to human health and damage to buildings and infrastructure.

Buildings, roads, bridges, sewer lines and other infrastructure located in a flood zone are exposed to greater risks. Where flowing floodwaters have the greatest energy, structures may be undercut, collapse or move, and soils will erode. Even areas outside of an identified floodplain are subject to flooding from heavy downpours. Where the soils have low permeability and physical drainage is inadequate, water will accumulate and cause ponding during large storm events. Appropriate planning and land-use regulations can help reduce exposures caused by poor site selection.

Step One: Identify Areas with High Flood Exposure

Flooding can be caused when stormwater or sewer infrastructure is overloaded from heavy rains, or from water level changes in rivers and lakes. In order to identify areas of high risk for flooding, the project team mapped two sources of flooding information to create an overall flood exposure map:

1. Macomb County Hazard Mitigation Plan flood data
2. Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs)

The Macomb County Hazard Mitigation Plan identifies general areas of the county that experience flooding. The majority of the flooding identified in the plan is not caused by Lake St. Clair lake levels, but is likely due to sewer infrastructure, stormwater controls, or topographic conditions such as low elevation.

The Federal Emergency Management Agency (FEMA) develops Flood Insurance Rate Maps (FIRMs) for many counties in the United States. The FIRM shows areas subject to flooding based on historic, hydraulic and meteorological data as well as flood controls. The maps identify a base flood elevation (BFE), sometimes referred to as the 100-year flood zone. These are areas that have a 1% chance of flooding in any given year. The maps also identify the areas with a 0.2% chance of flooding in any given year, also known as the 500-year flood zone. FEMA points out that these percentages are only probabilities, not forecasts. Both the 100- and 500-year flood zones were included in this assessment.

Map 19 shows the Flooding Exposure map for coastal Macomb. This map was created by

combining the two sources of flood data, providing a reasonably certain indication of where flooding risk is greatest in the community. In general, the map shows a number of areas at increased risk for flooding, especially along the shoreline of Lake St. Clair and along the Clinton River.

Step Two: Identify Sensitive Populations

In many communities, flooding impacts are felt most significantly at the household level. A home's flood risk increases when a home is located close to flood hazards and floodplains. However, a household's sensitivity to flooding also depends on how well the home was designed to deal with flooding. As modeled by the University of Michigan, household sensitivity to flooding can be determined by looking at the age of the housing stock and a homeowner's financial ability to maintain and improve the home. In general, homes built before 1940 used a more porous concrete material for basement construction, so water can flow more rapidly through the foundation. Older homes may be more vulnerable if residents have not had the financial resources to make improvements and upgrades.

To conduct a proper sensitivity assessment for flooding in coastal Macomb, the age of the housing stock would be combined with household income data to understand 1.) where there are homes old enough to be more prone to flood damage, and 2.) the likelihood that these older homes had been maintained and upgraded based on the financial ability of the owner. Information on the age of a home is often collected by local assessors or building departments, but this data was not available for the communities in coastal Macomb. Without being able to analyze the age of the housing stock, the project team could not develop a precise assessment of where flood-sensitive populations live in the community.

Step Three: Identify Rain and Flooding Vulnerability

Even though a complete sensitivity analysis was not possible, the project team looked for alternative ways to provide some level of detail on coastal Macomb populations that may be more vulnerable to flood events. Map 20 depicts the location of buildings in relation to flood exposures in the community. This map shows the location of buildings in relation to the flood exposures. The building footprints were mapped by SEMCOG using aerial imagery. Because aerial imagery was used to create these building footprints, the use of the property is not certain, but the project team assumed that buildings between 700 and 3,000 square feet are residential, and that buildings exceeding 3,000 feet are commercial. However, large houses or multi-unit dwellings may be classified as commercial, and some small retail stores may be included in the residential building footprints. This information serves as a starting point for discussion of where the most sensitive populations live in relation to flood hazards. The map shows a number of homes within a flood zone, especially along the shoreline in St. Clair Shores, Harrison Township, and Chesterfield Township.

Municipal infrastructure also plays an important role in protecting homes from flood damage. Communities with an aging storm sewer system or where the storm sewer has

not been fully disconnected from the sanitary sewer are more prone to damage from an overloaded system in a severe rain event.

Other Considerations for Defining Community Vulnerability

During times of extreme weather, disruptions in transportation services, or other community emergencies, it is important that residents, especially those with few resources, are able to access key facilities and services like schools, shelters, and grocery stores. This following section identifies three types of facilities that should be accessible to residents in order to increase resiliency. The locations of these facilities are mapped, but the community should work to assess how accessible these facilities are to residents, especially vulnerable populations.

Critical Facilities

In general usage, the term “critical facilities” is used to describe all man-made structures or other improvements that, because of their function, size, service area, or uniqueness, have the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if they are destroyed, damaged, or if their functionality is impaired.¹⁰

Map 21 shows locations of critical facilities within coastal Macomb. Critical facilities include:

- Fire stations and police stations
- Hospitals, long-term care facilities, and other health care facilities
- Jails and other detention centers
- Schools
- Emergency shelters and emergency operation centers
- Utilities like water and wastewater treatment facilities, and electric substations or generating facilities
- Communications facilities
- Places where 300+ people congregate.

Access and Distribution of Social Services

Service centers and institutions, like homeless shelters and churches, deliver important, day-to-day support to many residents. In the event of an emergency such as an extreme heat event or flash flooding episode, service centers and institutions are especially important as safe places where residents can go if they cannot return home.

¹⁰ Risk Management Series Design Guide for Improving Critical Facility Safety from Flooding and High Winds. FEMA 543 January 2007.

Map 22 identifies locations of community service centers. These locations include:

- Schools
- Places of worship
- Governmental buildings
- Hospitals and clinics
- Libraries
- Other non-profit social service organizations

Communities with high population densities, frequent extreme weather events, or both, are likely to designate locations for services centers during emergencies. In the event of extreme heat waves, designated community cooling centers may provide refuge for sensitive populations and those without access to air conditioning. In general, residents should be able to access to cooling centers within a 15-minute walking distance from their place of residence, as excessive time outside during a heat wave can cause heat stress or other issues. Backup power sources, like generators, should be installed at emergency shelters in the case of power loss during extreme storms or flooding. A Best Management Practice for a resilient community is to designate community service centers that are accessible, evenly distributed across the community, open 24 hours, and well-known to residents.

Food Availability

Climate variability will likely have significant impact on the availability and cost of food. A community can decrease its vulnerability to disruptions in food sources by investing and supporting local agriculture and food processing activities. Support for, and reliance upon, locally produced foods not only alleviates potential future challenges in the global food market, but also helps foster another strong economic sector for the region.

Just as cultivating local entrepreneurship makes a community stronger, the capacity of a community to produce and process its own food greatly increases resilience. Because of its ability to impact health, wealth, and quality of life, there is a national trend in support of the local food movement. Communities can leverage their existing assets, such as the local farmer's market, community gardens, and an established agricultural base, to lay the foundation for additional local food-related jobs. Communities can take more creative approaches as well, such as allowing for agriculture on publicly owned and vacant lands in existing neighborhoods and parklands. To evaluate community vulnerabilities, locations of full-service grocery stores in relation to where people live are shown on Map 23. In the event of loss of power or disruption in potable water supplies, it is important to ensure that residents have access to affordable food and drinking water.

The project team also evaluated access to healthy food to see if there are areas of the community that qualify as a food desert. According to the United States Department of Agriculture (USDA), a food desert is defined as an area void (within one mile) of fresh fruit, vegetables, and other healthful whole foods, while others argue that a one-half mile

radius around food stores should be used to determine food deserts. Food deserts are usually found in impoverished areas. This is largely due to a lack of grocery stores, farmers' markets, and healthy food providers.¹¹ Communities looking to reduce the number of residents living in a food desert can promote or zone for pop-up farm stands in low income areas, enact housing policies supportive of mixed-income development, and establish community gardens in areas identified as food deserts.

Map 23 shows the locations of full service grocery stores and convenience stores in coastal Macomb County. The circles around each full service grocery store represent a ½ mile walking distance, which shows that most areas of the community are not within a ½ mile walking distance of a full service store. The community should work to increase accessibility to these locations, especially for vulnerable populations during times of emergency or disruptions in transportation.

¹¹ <http://americannutritionassociation.org/newsletter/usda-defines-food-deserts>

PART 5

Recommendations

The Resilient Macomb project sought to identify opportunities to increase the resiliency of Macomb County as it manages its immense coastal resources. In order to offer relevant recommendations for the County and local communities to consider, the Resilient Macomb project team reviewed existing documents and plans, engaged the public through events, surveys, and activities, and produced several analysis tools including a vulnerability assessment. The recommendations in this section were developed based on three overarching themes that emerged from the Resilient Macomb process: engage the public, protect and improve water quality in Lake St. Clair, and build community resilience to climate impacts. Each theme is listed, along with goals and possible actions (blue bullet points) the community could take to achieve each goal.

Engage the Public

Macomb County should work to expand the knowledge base of community members interested in climate and coastal issues through an effective awareness campaign. An awareness campaign should:

- Promote regional collaboration by hosting meetings to educate the community on resiliency concerns. Be sure meetings are hosted in community spaces throughout the larger community, intentionally inviting members from each jurisdiction and encouraging County-level staff to attend.
- Use a variety of mediums, from online and social networking sites, to surveys and newsletters to educate the community on emergency preparation, climate variability, and local planning processes.
- Develop strategies to reach populations not traditionally involved in planning processes. For example, develop a strategy to involve youth in the planning process by working with existing youth councils, youth groups, and schools.
- Partner with *Clean Water Action* and use their work on regional perceptions of water quality to design and implement outreach campaigns.
- Provide environmental educational opportunities by partnering with the many like-minded organizations in the area. Projects could include educating shoreline property owners on ways to protect water quality through mailings and events, educating the general public on the value of low impact development through various pilot installations, or providing educational opportunities to local school children. Potential partnerships include Michigan Sea Grant Extension, Nicholson Nature Center, and the Clinton River Watershed Council.

Macomb County should enhance recreational opportunities and public access to the waterfront as a way to increase knowledge of coastal resources.

- Investing in green infrastructure, as identified in the Southeast Michigan Green Infrastructure Vision, will provide recreational opportunities for residents and visitors to appreciate the waterfront through biking and walking trails. Investing in a multi-modal transportation network, with both land- and water-based options, could fill gaps in the existing trail networks and connect more neighborhoods with non-motorized trails.

- Other recreational opportunities could include securing land for a public campground, redeveloping public parks and gathering spaces, and providing signage and pedestrian infrastructure to connect boaters with existing recreational and entertainment opportunities.

Protect Water Quality

Macomb County and local governments should partner to protect regional water quality and the health of Lake St. Clair. Possible actions include:

- Implement woody debris management along the Clinton River
- Explore a Green Streets policy (examples include redirecting runoff to constructed green infrastructure within available road right-of-way spaces and implementing road diets to reduce impervious surfaces)
- Continue to target environmentally significant areas for conservation in parks and recreational lands.
- Link riparian corridors with regional planning efforts.
- Develop a rain garden program to encourage private property owners to implement stormwater control on their properties.
- Partner with public works and engineering staff to pilot projects like bio-swales, rain gardens, and other alternative stormwater control. When in public spaces like parks, use signs to educate community members on the value of these projects.

Build Community Resilience to Climate Impacts

Because climatologists predict that the number of extreme heat days are increasing in Southeast Michigan, local leaders should prepare for and mitigate the impacts of extreme heat. Possible actions include:

- Explore opportunities for locating cooling centers in places that stay open into the late evening (to address reduced evening cooling due to climate change).
- Partner with the Department of Public Health in translating all emergency communication and preparation materials into multiple languages to best reach the County's diverse population.
- Strategically restore and add tree canopy in high exposure areas per the Vulnerability Assessment in Part 4C of this report.

Climatologists also predict that the number of extreme storms and heavy rain events are increasing in Southeast Michigan. Actions to address and reduce the risk of flooding include:

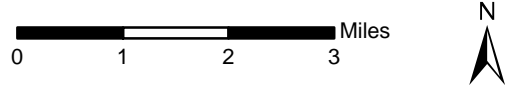
- Increase collaboration between the public health department, emergency operations, and planning during flooding emergencies. Appropriate emergency planning is essential to ensure that resources are targeted toward the most sensitive populations.
- Use climate projections and the climate vulnerability assessment for heavy flooding in order to prepare homes and businesses for future increases in heavy rains.
- Explore opportunities for locating shelters in places with a back-up energy supply (generators).
- Review building standards to ensure that properties in at-risk areas are built to withstand flooding.
- Continue to implement activities at the local level to reduce combined sewer overflow events.

- Seek opportunities to manage stormwater runoff through the use of green infrastructure and wetland restoration.
- Expand the Clinton River Watershed Council (CRWC) WaterTowns program to include green infrastructure and climate adaptation recommendations in each of the Macomb coastal communities.
- Partner with local engineering staff and private property owners to construct bioretention areas, bioswales, and porous pavement in public and private parking lots to reduce stormwater runoff.
- Conduct a community-wide cost-benefit analysis and a cost-effectiveness analysis on infrastructure improvements with both green and gray infrastructure.
- Explore wetland mitigation and/or restoration opportunities to reduce flooding and improve water quality in the County. The County should use data developed by CRWC and 6 Rivers Land Conservancy to prioritize high quality restoration areas. The County should work with local communities in coastal areas to implement local wetland ordinances and protections.

Climate Future Scenarios Map 1

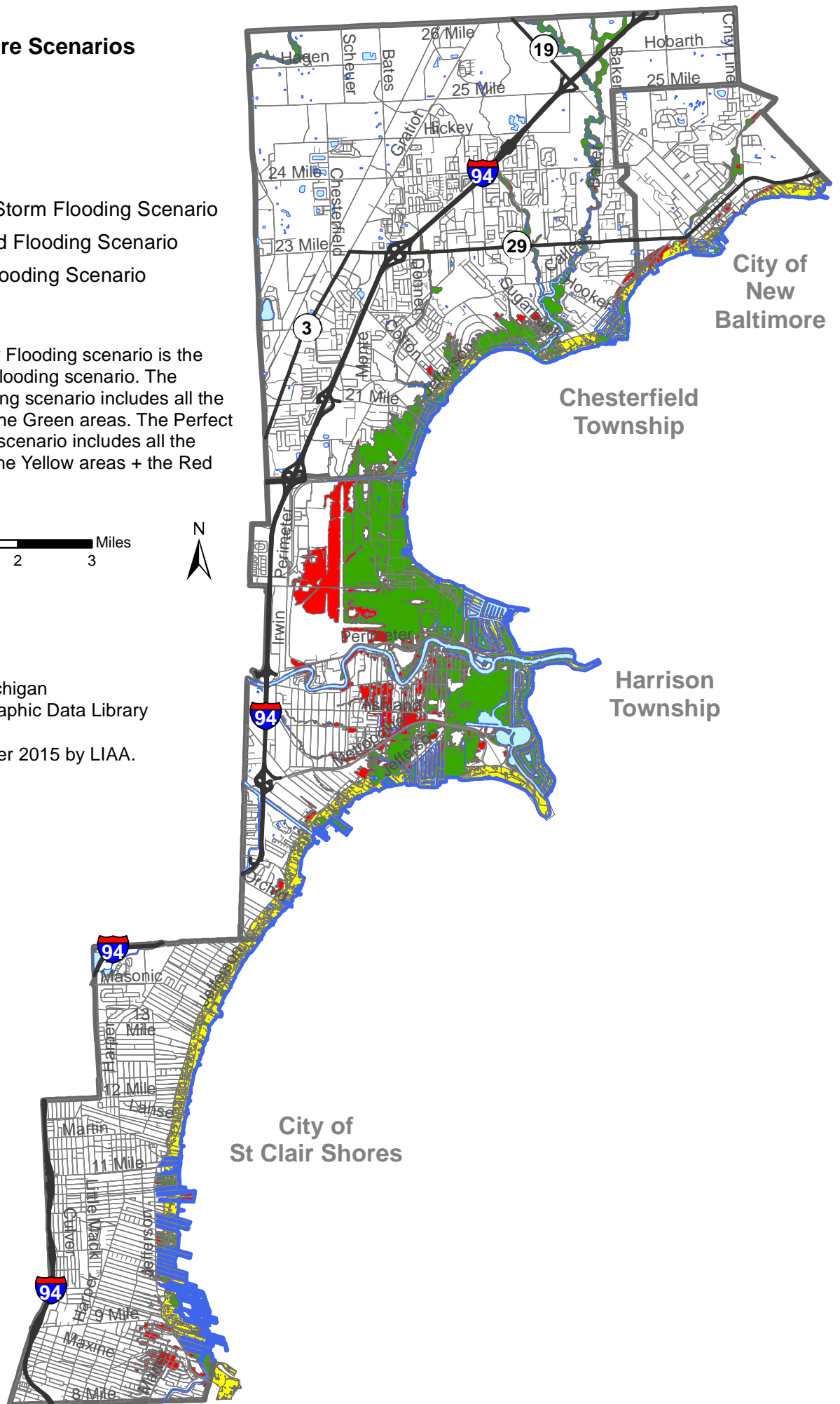
- Perfect Storm Flooding Scenario
- Expected Flooding Scenario
- Lucky Flooding Scenario

Note: The Lucky Flooding scenario is the least extensive flooding scenario. The Expected Flooding scenario includes all the Yellow areas + the Green areas. The Perfect Storm Flooding scenario includes all the Green areas + the Yellow areas + the Red areas.



Data Sources:
University of Michigan
Michigan Geographic Data Library

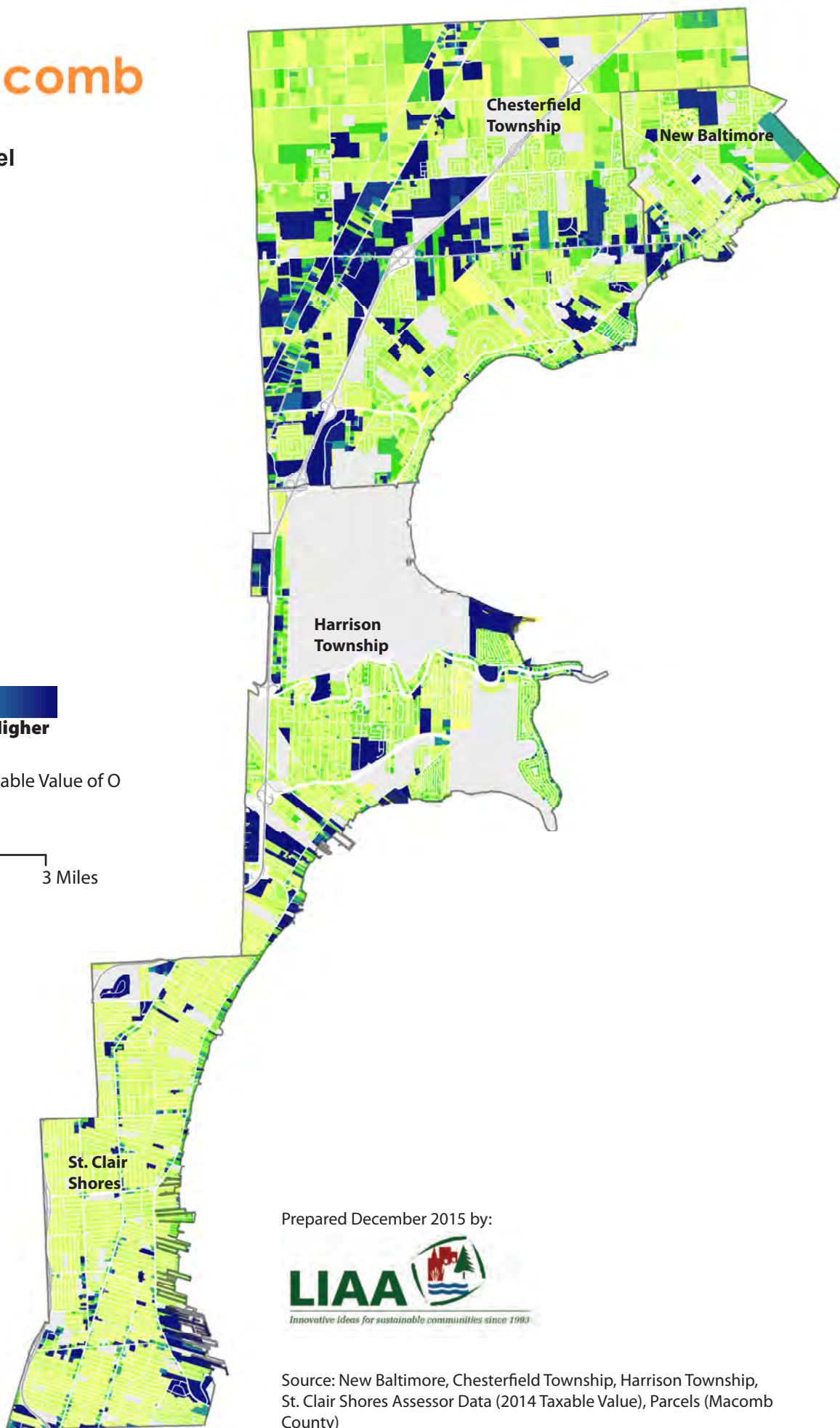
Prepared October 2015 by LIAA.



Taxable Value by Parcel
Map 2



No Data or Taxable Value of 0

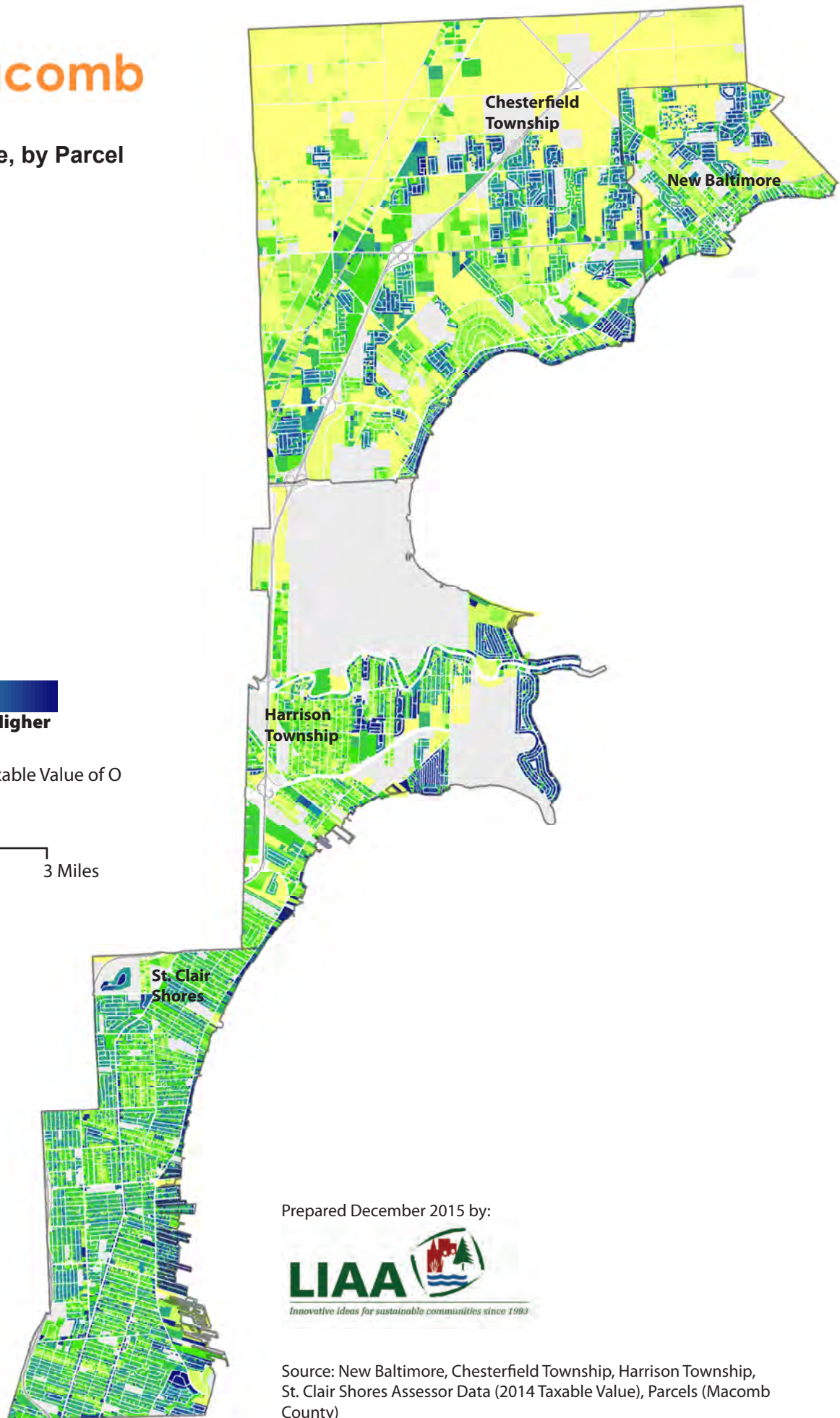
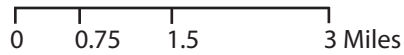
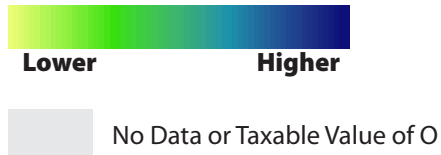


Prepared December 2015 by:



Source: New Baltimore, Chesterfield Township, Harrison Township, St. Clair Shores Assessor Data (2014 Taxable Value), Parcels (Macomb County)

Taxable Value Per Acre, by Parcel
Map 3



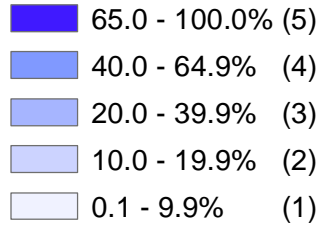
Prepared December 2015 by:



Source: New Baltimore, Chesterfield Township, Harrison Township, St. Clair Shores Assessor Data (2014 Taxable Value), Parcels (Macomb County)

Percent of Population 65 Years and Older

Map 4

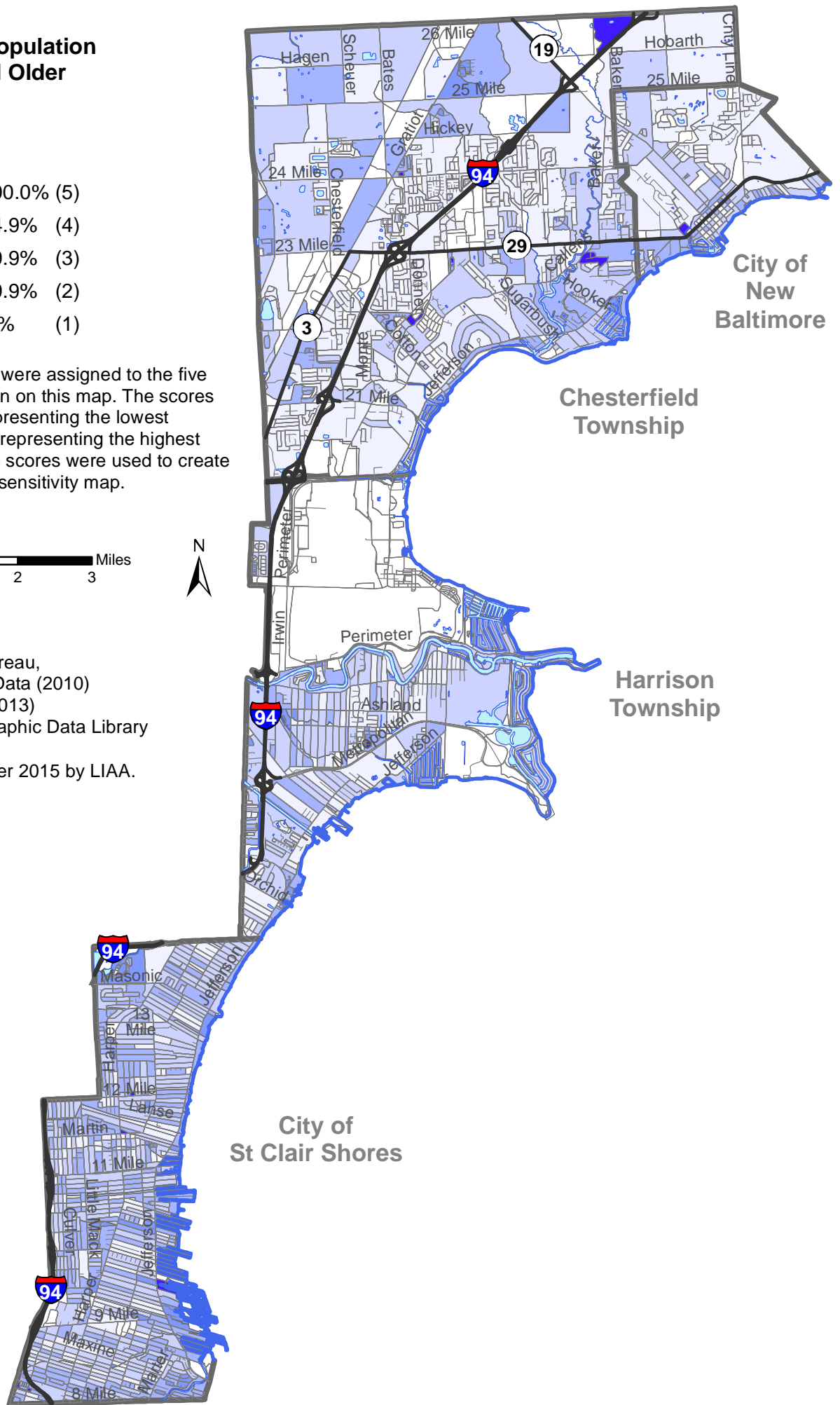


Scores of 1 to 5 were assigned to the five categories shown on this map. The scores range from 1 representing the lowest percentage to 5 representing the highest percentage. The scores were used to create the overall heat sensitivity map.

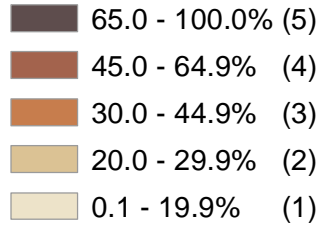


Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 Michigan Geographic Data Library

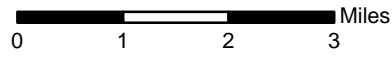
Prepared October 2015 by LIAA.



Percent of Households with People Living Alone Map 5

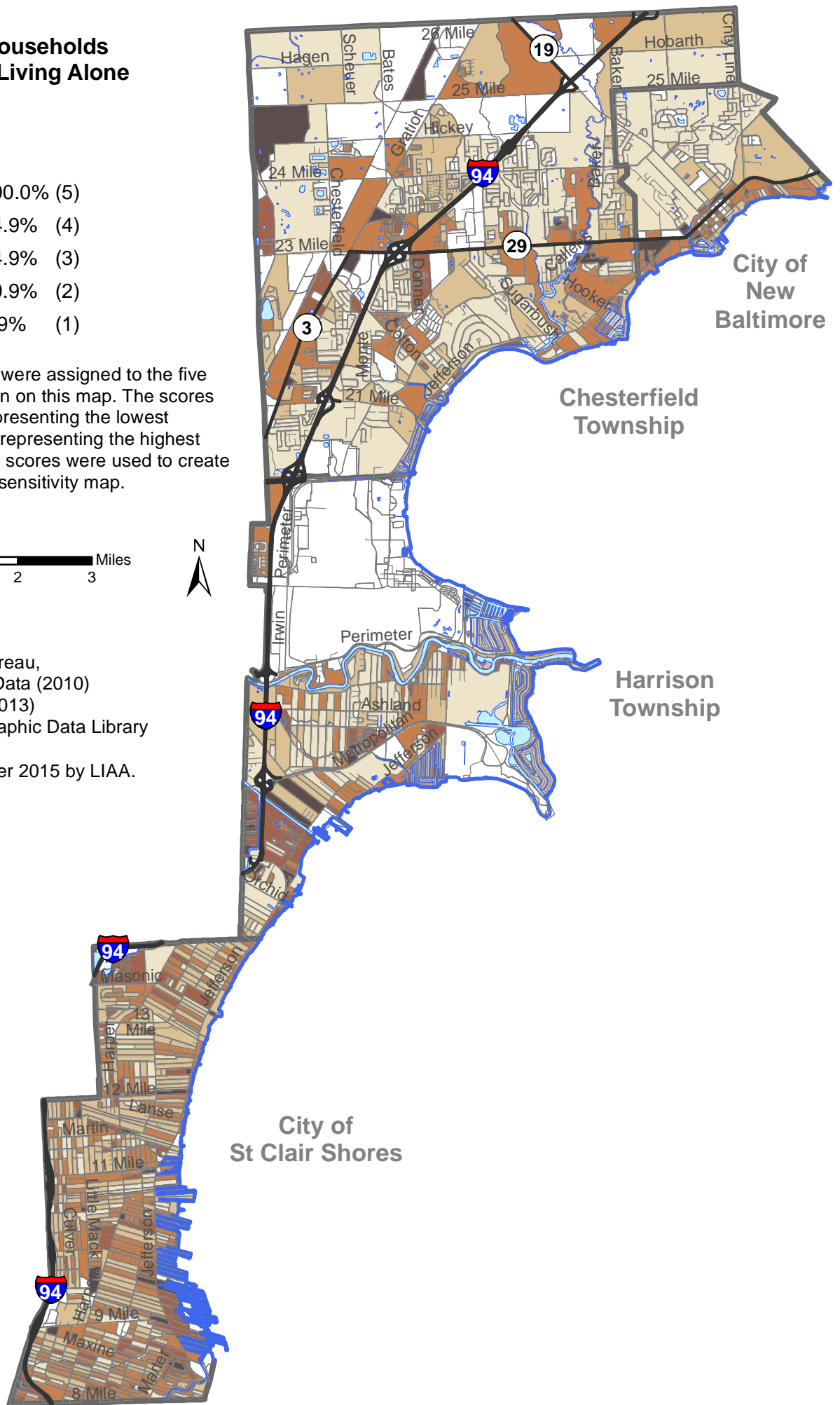


Scores of 1 to 5 were assigned to the five categories shown on this map. The scores range from 1 representing the lowest percentage to 5 representing the highest percentage. The scores were used to create the overall heat sensitivity map.

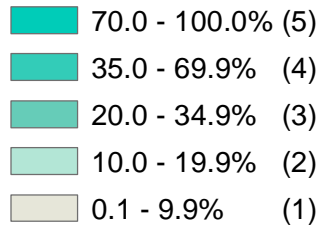


Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 Michigan Geographic Data Library

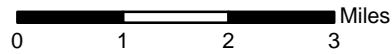
Prepared October 2015 by LIAA.



Percent of Population that are Non-white
Map 6

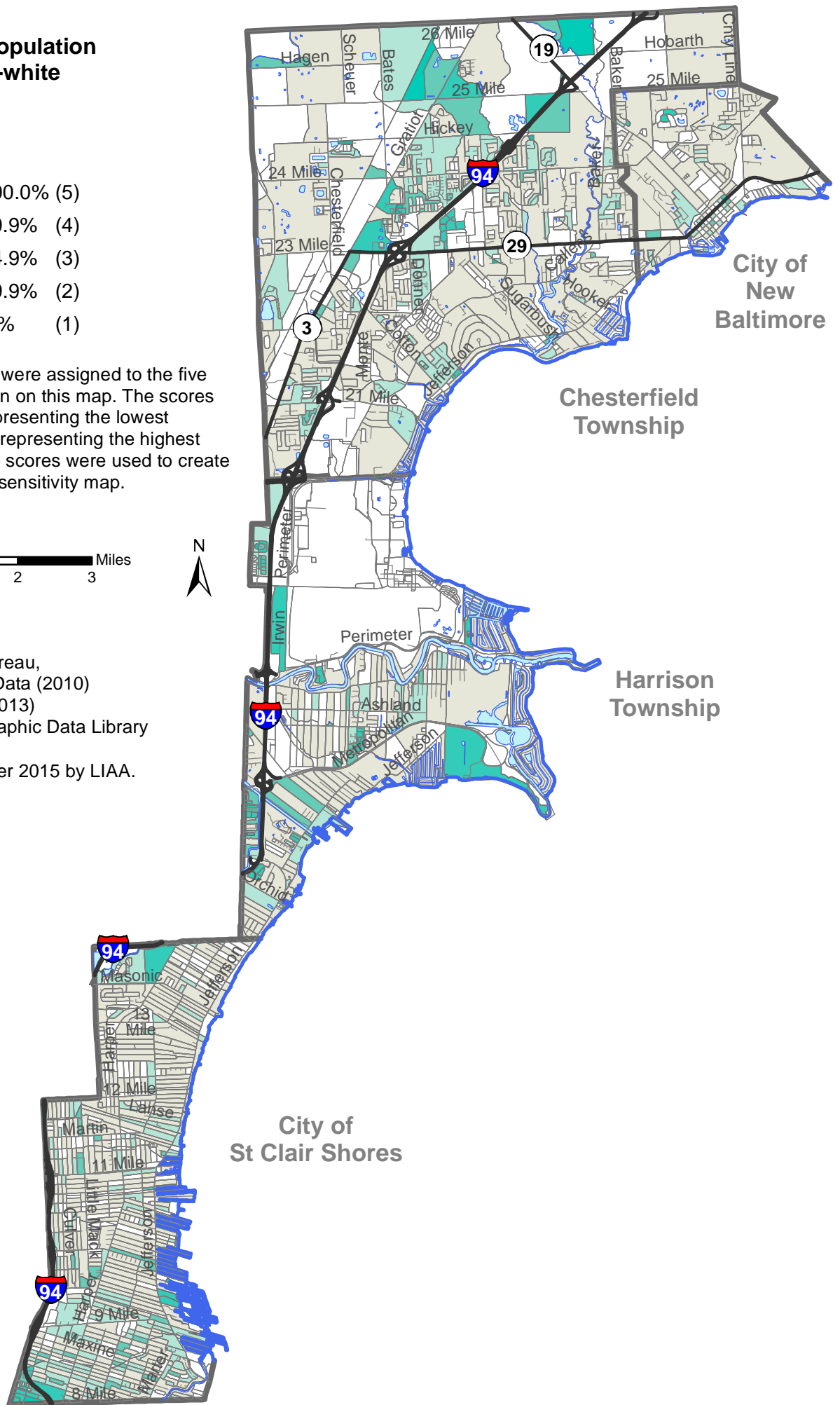


Scores of 1 to 5 were assigned to the five categories shown on this map. The scores range from 1 representing the lowest percentage to 5 representing the highest percentage. The scores were used to create the overall heat sensitivity map.

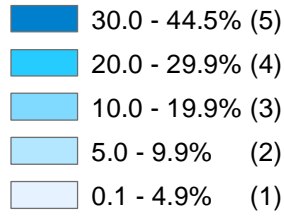


Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 Michigan Geographic Data Library

Prepared October 2015 by LIAA.



Percent of Households Living in Poverty Map 7

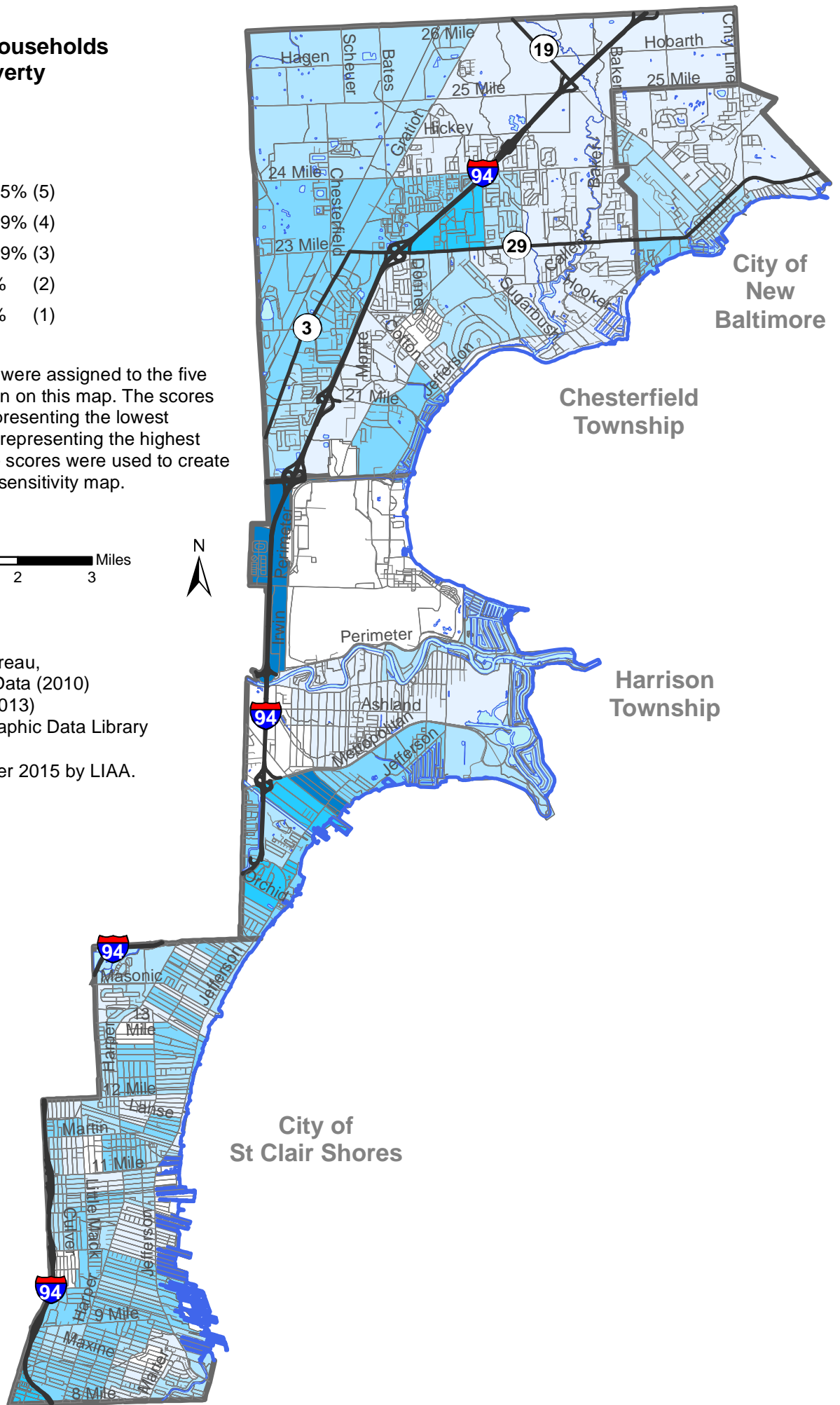


Scores of 1 to 5 were assigned to the five categories shown on this map. The scores range from 1 representing the lowest percentage to 5 representing the highest percentage. The scores were used to create the overall heat sensitivity map.

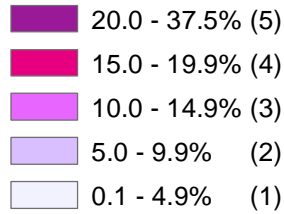


Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 Michigan Geographic Data Library

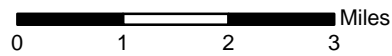
Prepared October 2015 by LIAA.



Percent of Population 25 Years and Older with Less than a High School Education Map 8

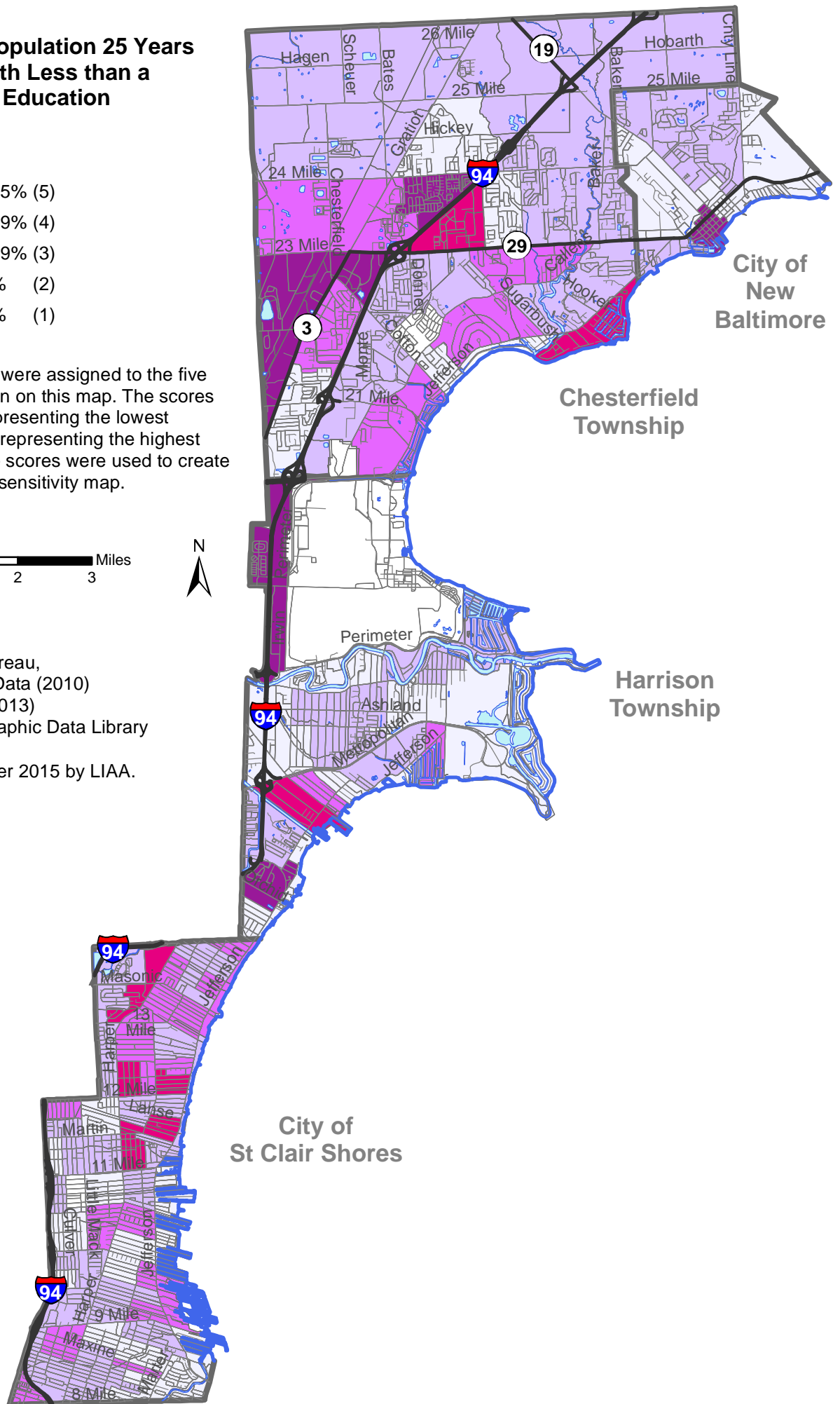


Scores of 1 to 5 were assigned to the five categories shown on this map. The scores range from 1 representing the lowest percentage to 5 representing the highest percentage. The scores were used to create the overall heat sensitivity map.



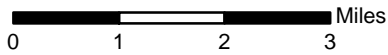
Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 Michigan Geographic Data Library

Prepared October 2015 by LIAA.

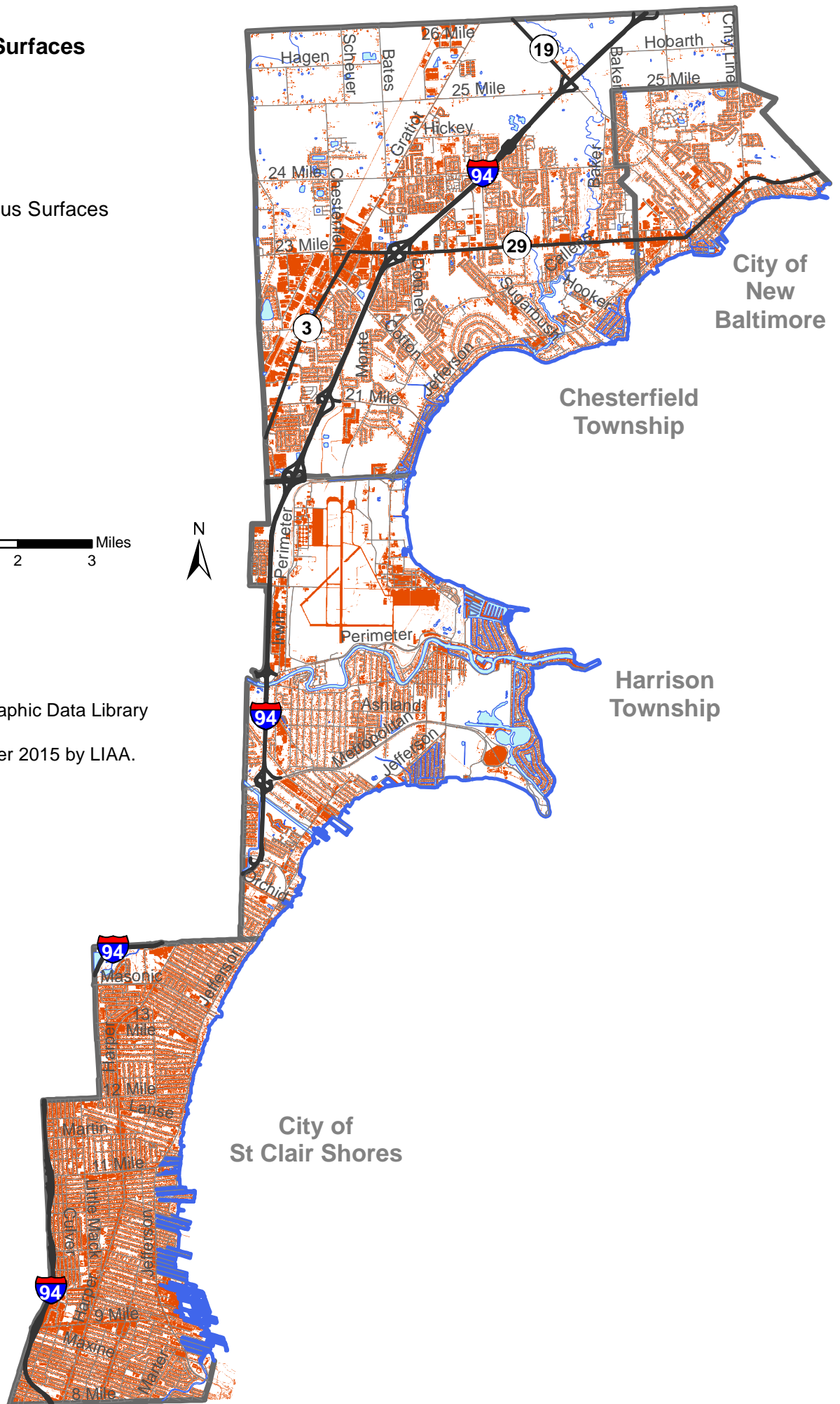


Impervious Surfaces Map 10

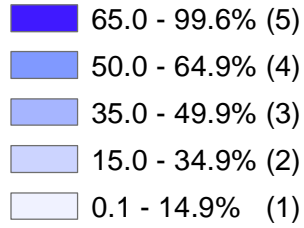
 Impervious Surfaces



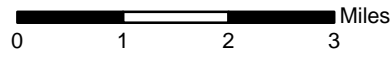
Data Sources:
SEMCOG
Michigan Geographic Data Library
Prepared October 2015 by LIAA.



Percent Impervious Surface by Census Block Map 11

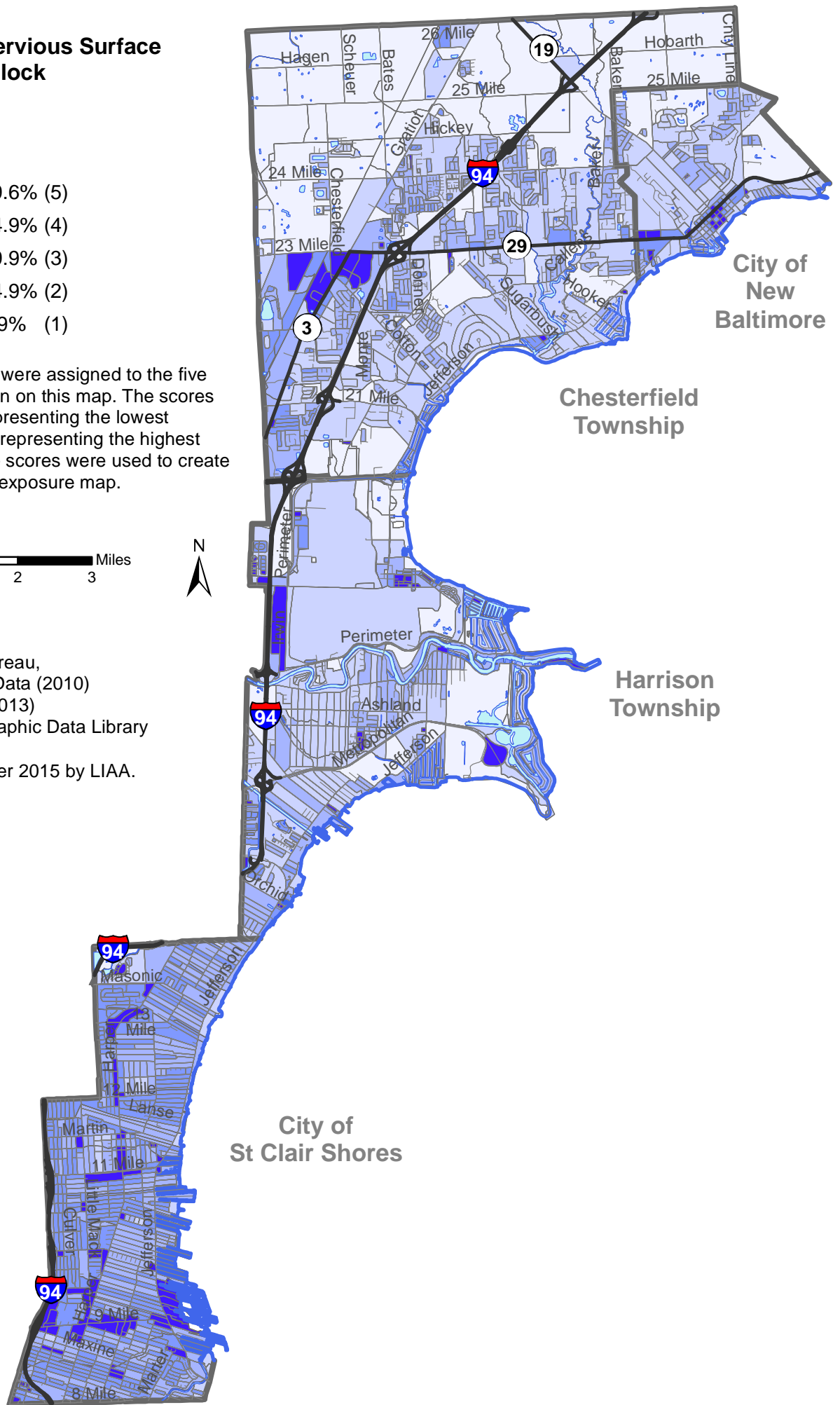


Scores of 1 to 5 were assigned to the five categories shown on this map. The scores range from 1 representing the lowest percentage to 5 representing the highest percentage. The scores were used to create the overall heat exposure map.



Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 Michigan Geographic Data Library

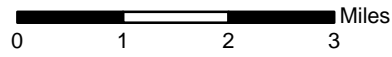
Prepared October 2015 by LIAA.



Percent Tree Canopy Map 12

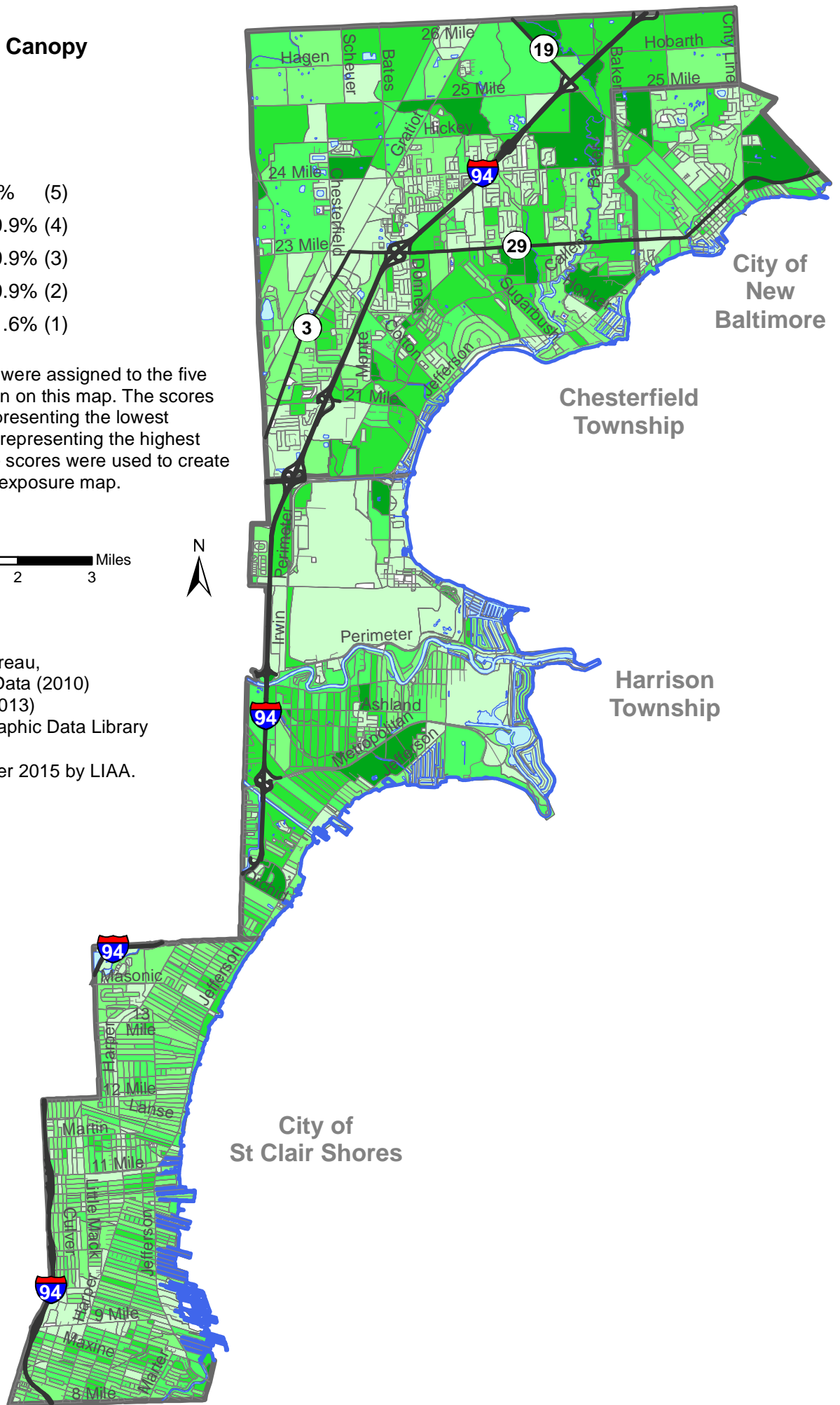
- 0.1 - 9.9% (5)
- 10.0 - 19.9% (4)
- 20.0 - 29.9% (3)
- 30.0 - 49.9% (2)
- 50.0 - 91.6% (1)

Scores of 1 to 5 were assigned to the five categories shown on this map. The scores range from 5 representing the lowest percentage to 1 representing the highest percentage. The scores were used to create the overall heat exposure map.

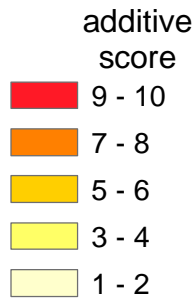


Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 Michigan Geographic Data Library

Prepared October 2015 by LIAA.



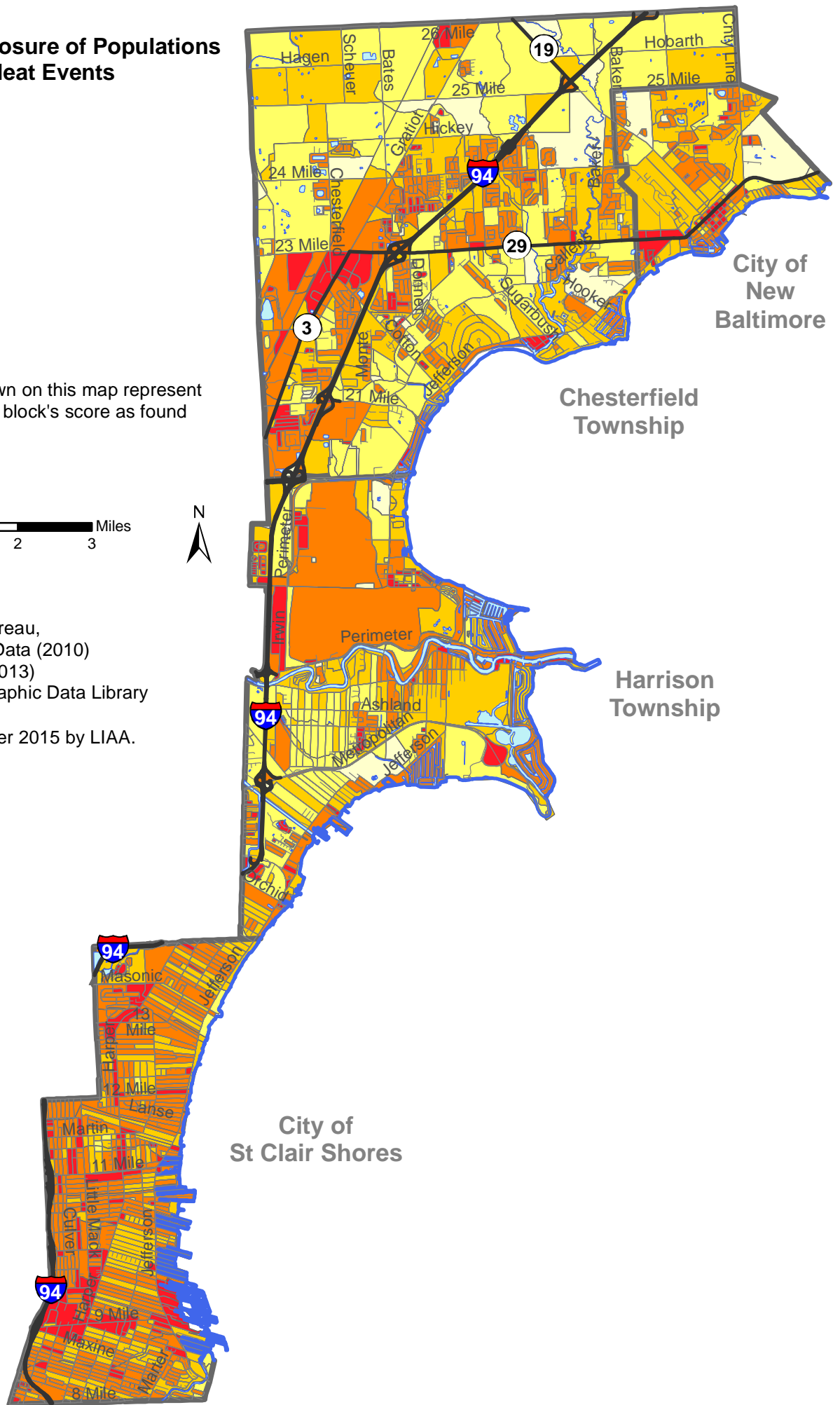
Relative Exposure of Populations to Extreme Heat Events Map 13



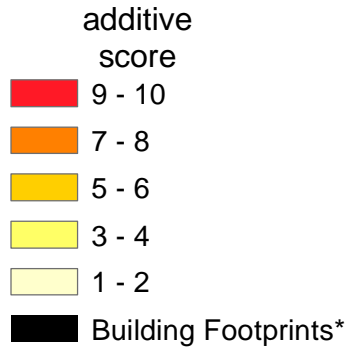
The scores shown on this map represent the sum of each block's score as found on Maps 11-12.



Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 Michigan Geographic Data Library
 Prepared October 2015 by LIAA.

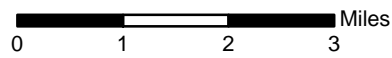


Relative Exposure of Populations to Extreme Heat Events Showing Building Footprints Map 14



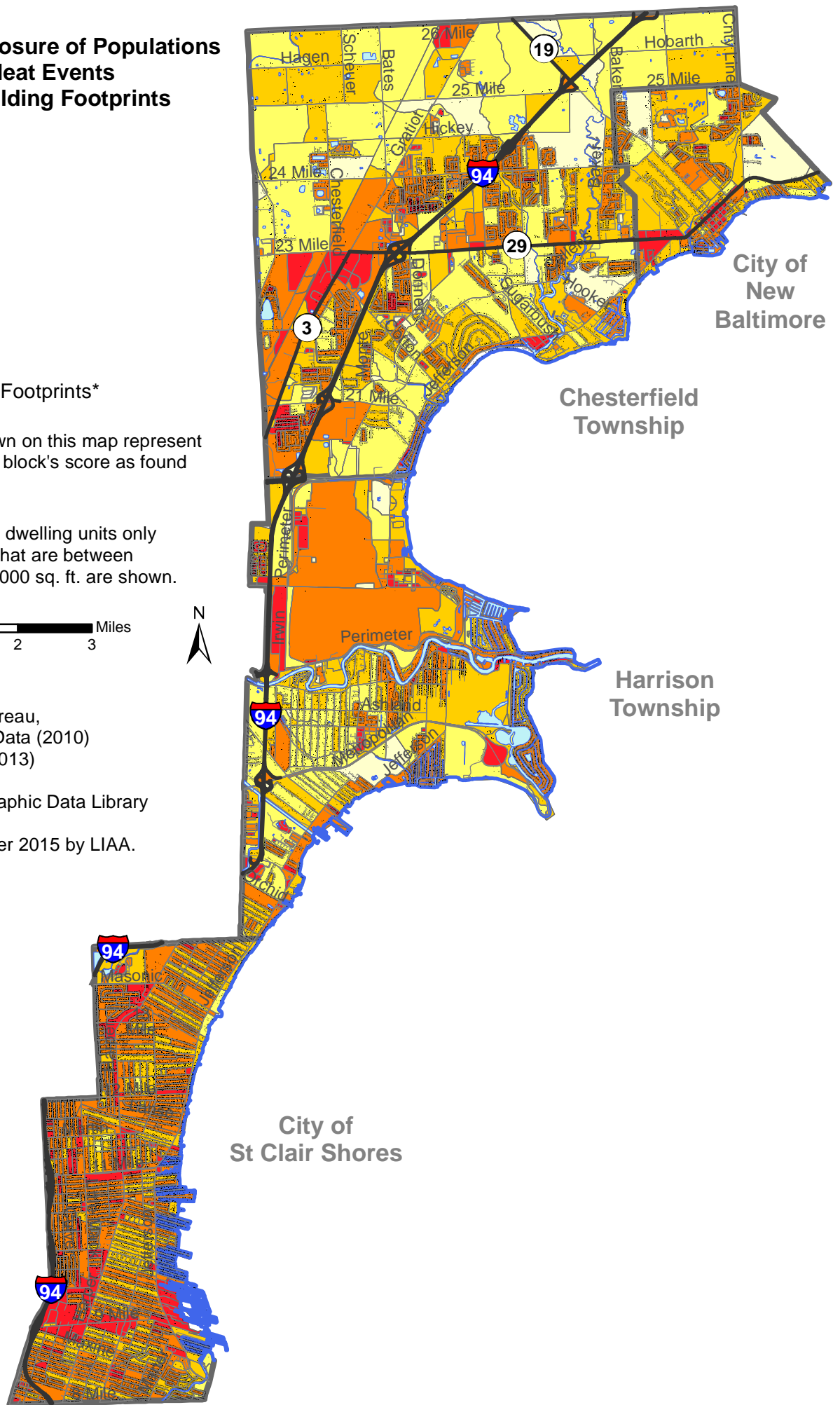
The scores shown on this map represent the sum of each block's score as found on Maps 11-12.

*To approximate dwelling units only those buildings that are between 700 sq. ft and 3,000 sq. ft. are shown.

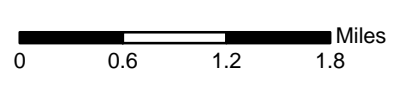
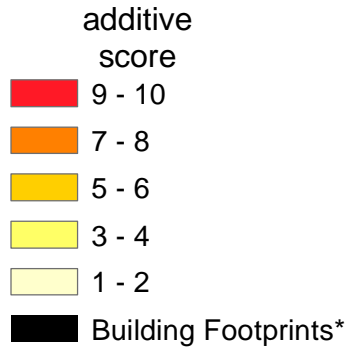


Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 SEMCOG
 Michigan Geographic Data Library

Prepared October 2015 by LIAA.



Relative Exposure of Populations to Extreme Heat Events in Chesterfield Township and the City of New Baltimore Showing Building Footprints Map 15

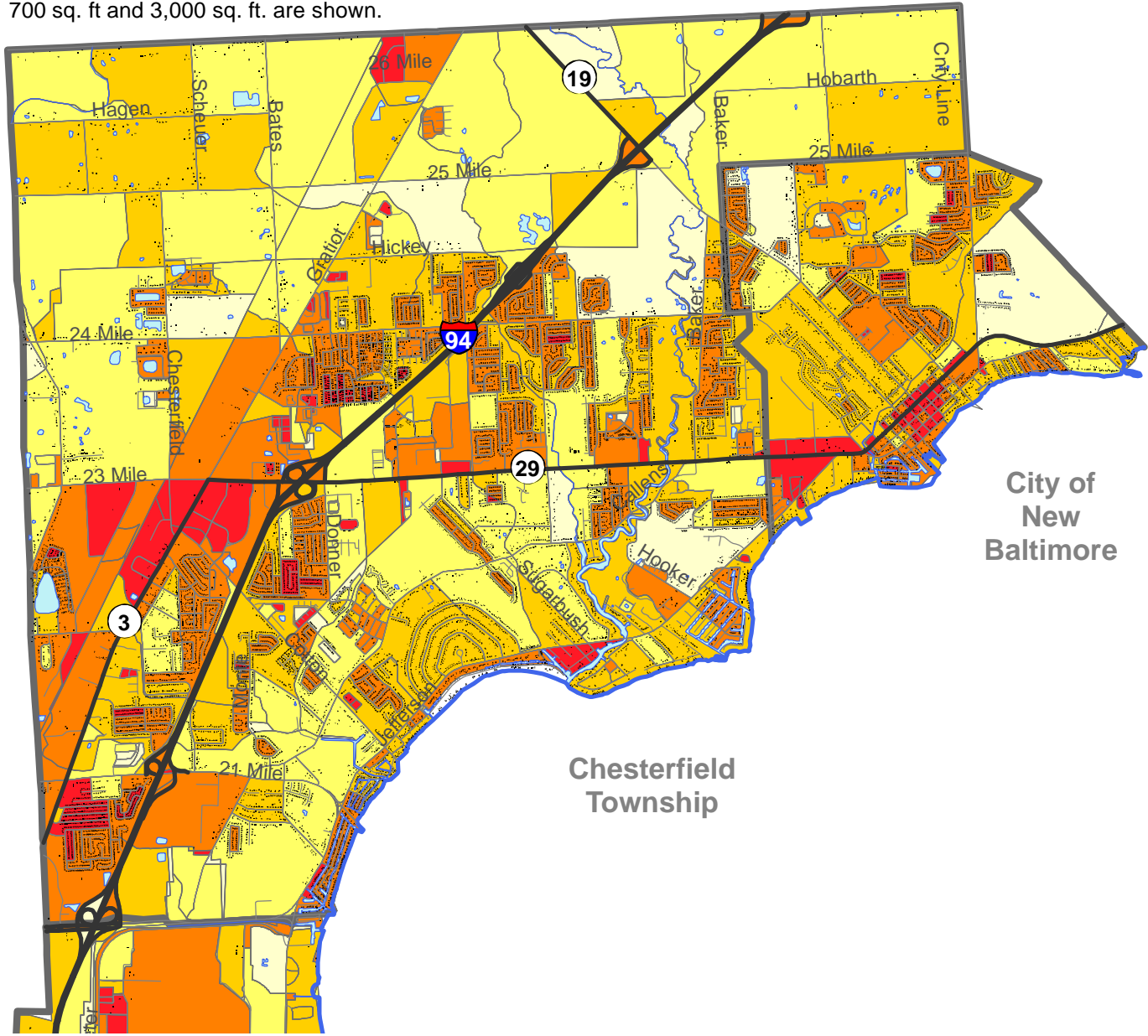


Data Sources:
U.S. Census Bureau,
Block Level Data (2010)
ACS (2009-2013)
SEMCOG
Michigan Geographic Data Library

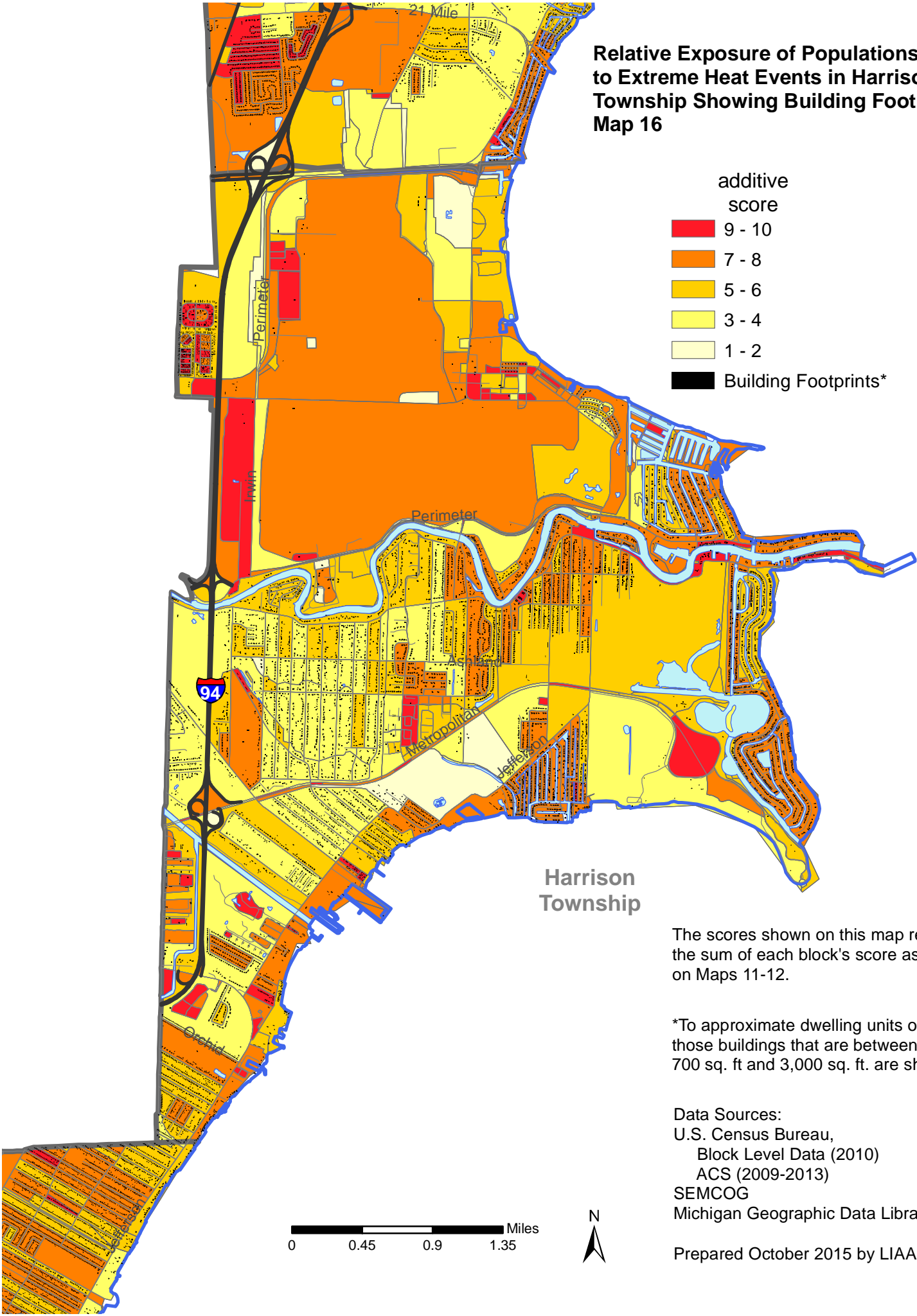
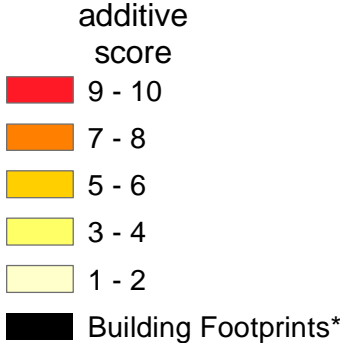
The scores shown on this map represent the sum of each block's score as found on Maps 11-12.

Prepared October 2015 by LIAA.

*To approximate dwelling units only those buildings that are between 700 sq. ft and 3,000 sq. ft. are shown.



Relative Exposure of Populations to Extreme Heat Events in Harrison Township Showing Building Footprints Map 16



Harrison Township

The scores shown on this map represent the sum of each block's score as found on Maps 11-12.

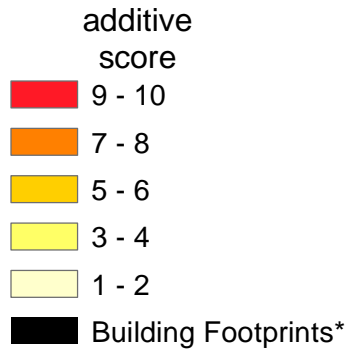
*To approximate dwelling units only those buildings that are between 700 sq. ft and 3,000 sq. ft. are shown.

Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 SEMCOG
 Michigan Geographic Data Library

Prepared October 2015 by LIAA.

Relative Exposure of Populations to Extreme Heat Events in the City of St. Clair Shores Showing Building Footprints

Map 17

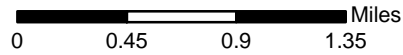


The scores shown on this map represent the sum of each block's score as found on Maps 11-12.

*To approximate dwelling units only those buildings that are between 700 sq. ft and 3,000 sq. ft. are shown.

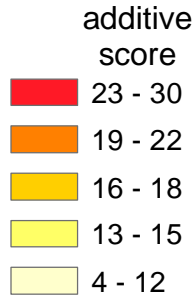
Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 SEMCOG
 Michigan Geographic Data Library

Prepared October 2015 by LIAA.



City of
St Clair Shores

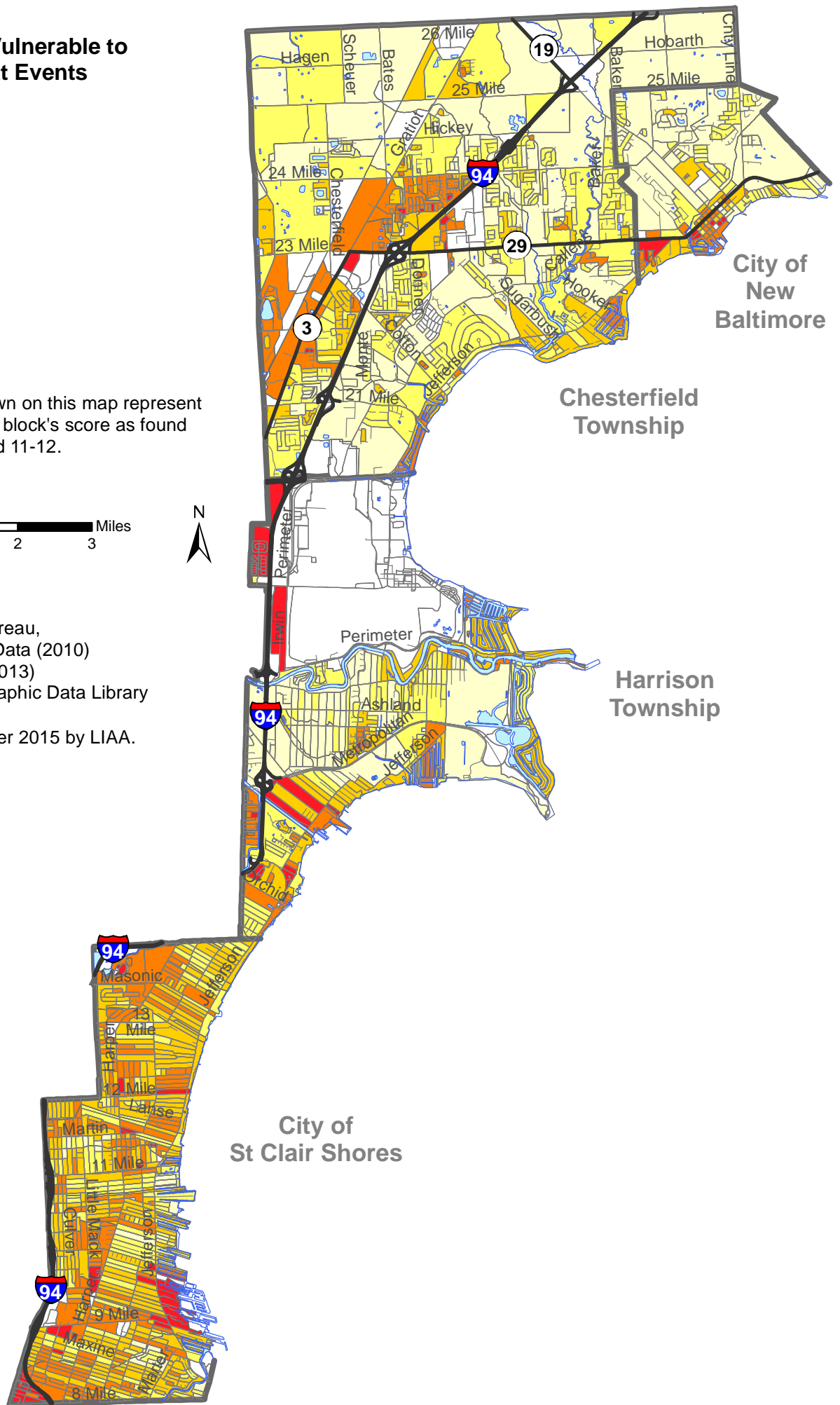
Population Vulnerable to Extreme Heat Events Map 18



The scores shown on this map represent the sum of each block's score as found on Maps 4-8 and 11-12.

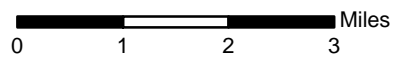


Data Sources:
 U.S. Census Bureau,
 Block Level Data (2010)
 ACS (2009-2013)
 Michigan Geographic Data Library
 Prepared October 2015 by LIAA.



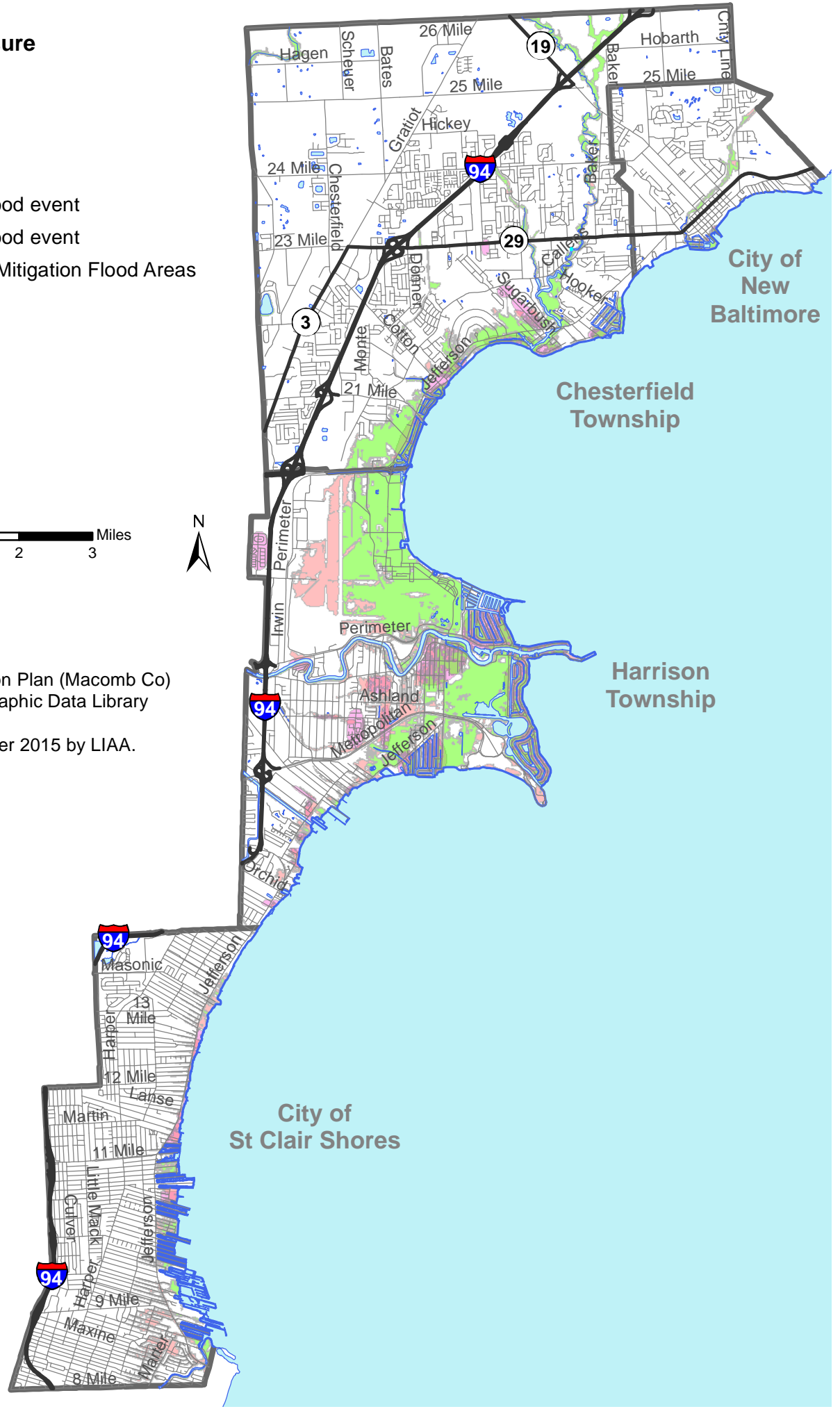
Flood Exposure Map 19

- 100yr flood event
- 500yr flood event
- Hazard Mitigation Flood Areas







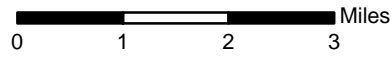
Data Sources:
 FEMA
 Hazard Mitigation Plan (Macomb Co)
 Michigan Geographic Data Library

Prepared October 2015 by LIAA.



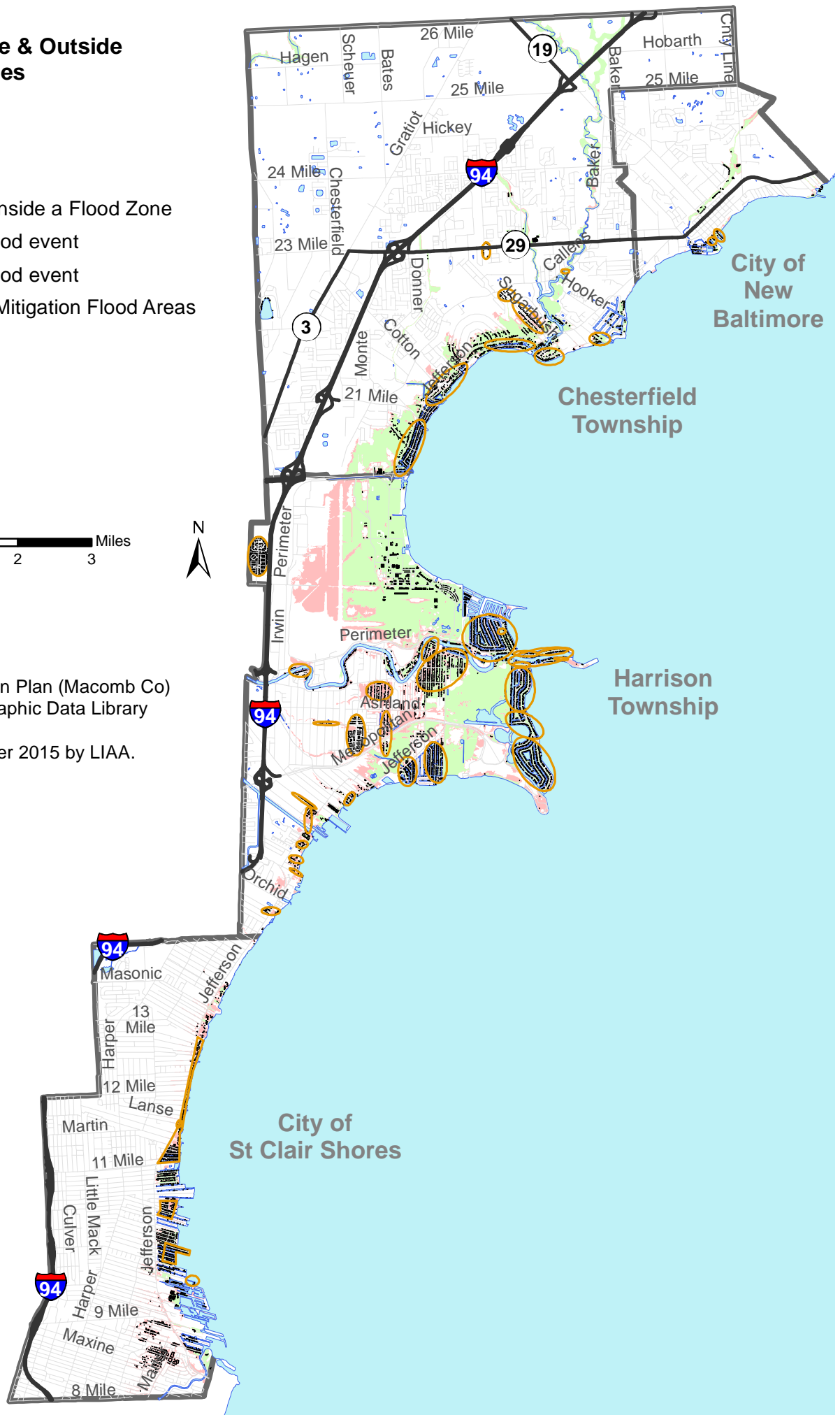
**Homes Inside & Outside
of Flood Zones
Map 20**

-  Homes inside a Flood Zone
-  100yr flood event
-  500yr flood event
-  Hazard Mitigation Flood Areas












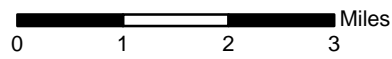
Data Sources:
 FEMA
 Hazard Mitigation Plan (Macomb Co)
 Michigan Geographic Data Library

Prepared October 2015 by LIAA.

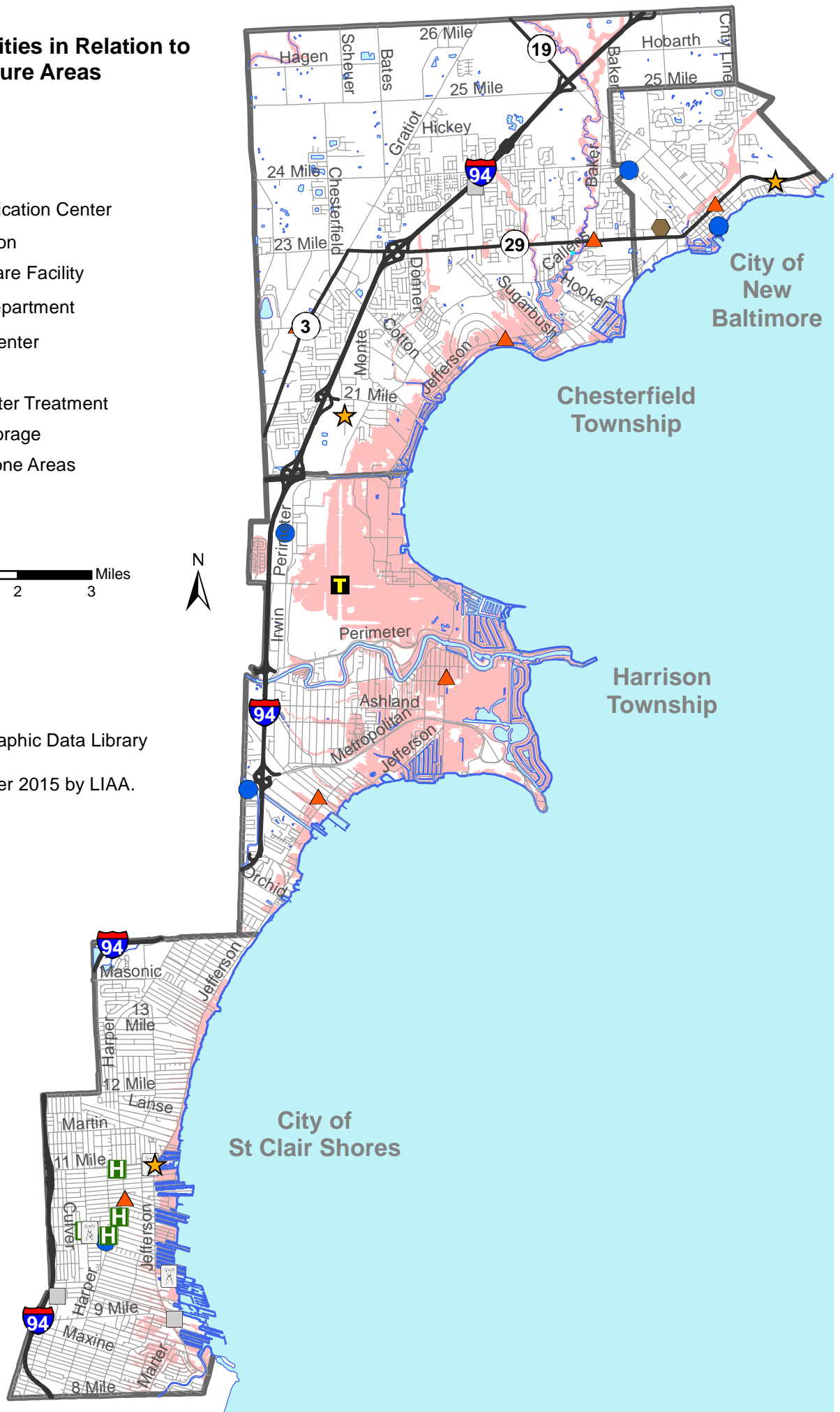


Critical Facilities in Relation to Flood Exposure Areas Map 21

-  Communication Center
-  Fire Station
-  Health Care Facility
-  Police Department
-  Transit Center
-  Utility
-  Wastewater Treatment
-  Water Storage
-  Flood Prone Areas













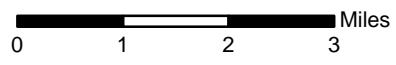
Data Sources:
LIAA
Michigan Geographic Data Library
Prepared October 2015 by LIAA.



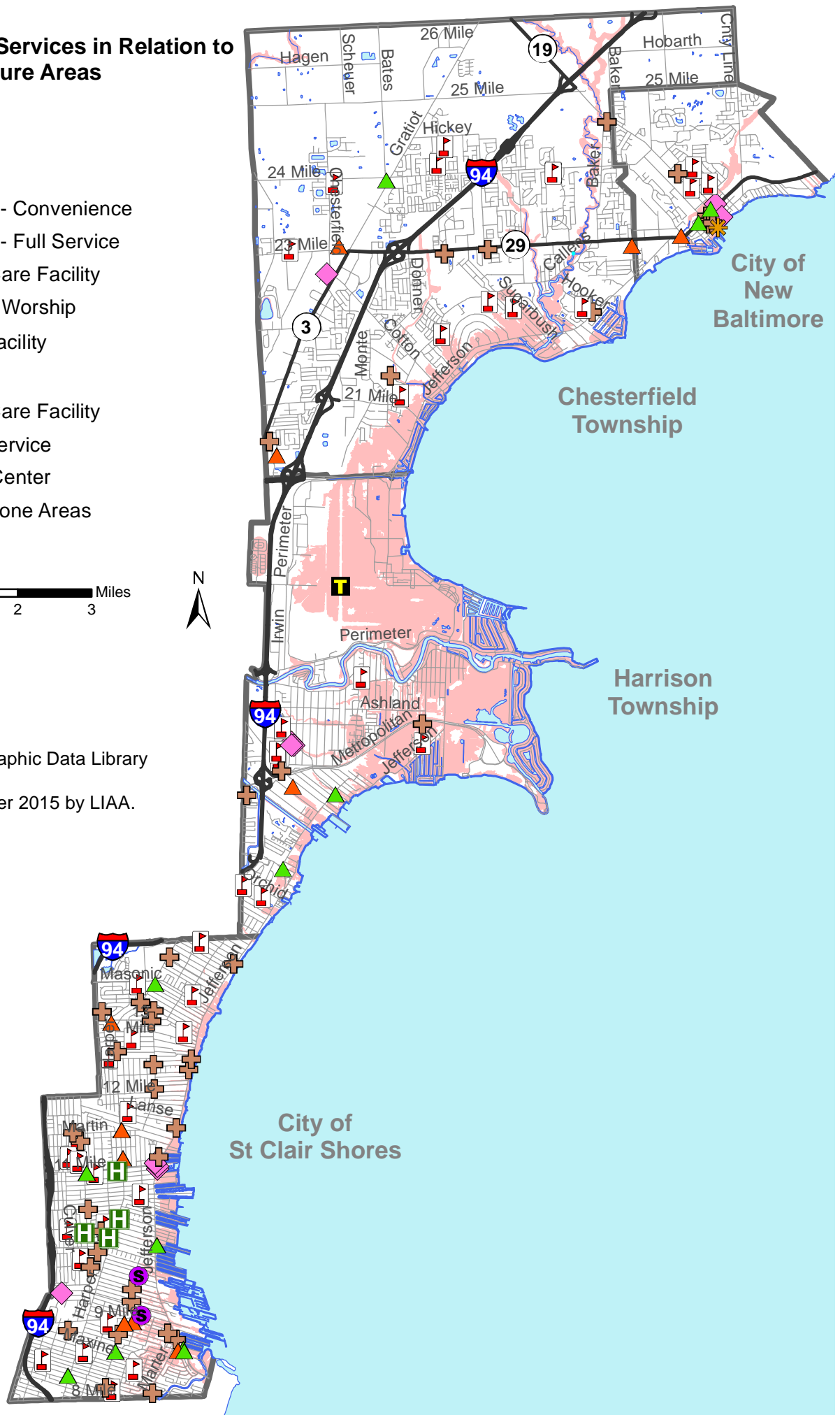
Community Services in Relation to Flood Exposure Areas

Map 22

-  Grocery - Convenience
-  Grocery - Full Service
-  Health Care Facility
-  Place of Worship
-  Public Facility
-  School
-  Senior Care Facility
-  Social Service
-  Transit Center
-  Flood Prone Areas

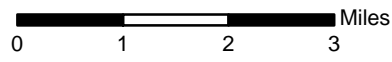


Data Sources:
 LIAA
 Michigan Geographic Data Library
 Prepared October 2015 by LIAA.



Food Accessibility Map 23

- Grocery-Full Service (1/2 mi radius)
- Full Service Grocery Store
- Convenience Store



Data Sources:
 LIAA
 Michigan Geographic Data Library
 Prepared October 2015 by LIAA.

