Climate Vulnerability Assessment Report

City of Rochester, New York

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Table of Contents

1

Introduction

To continue its climate action efforts and become more resilient, the City of Rochester ("the City" or "Rochester") has conducted a Climate Vulnerability Assessment (CVA). This effort expanded on the adaptation and resiliency components outlined in the community-wide Climate Action Plan, released in 2017. The CVA provides insight into Rochester's strengths, challenges, and opportunities as it prepares for changing climate conditions. By understanding which resources and assets within the city will be most affected, how daily operations and community quality of life may be impacted, and who is most vulnerable to these impacts, the City will be able to prioritize strategies that address its greatest vulnerabilities as it moves into the next phase of developing an adaptation plan.

1.1 About the City of Rochester

Located in Monroe County, the City of Rochester is the third largest city in the state of New York and home to approximately 210,249 residents.[1] In addition, the City hosts more than 8,000 businesses—many of which are major employers in the region.[2] The City's economy, fueled by its technology sector, benefits from an educated workforce and cutting-edge research at several higher education institutions in the area, including the University of Rochester, Rochester Institute of Technology, and Monroe Community College. Furthermore, Rochester accommodates more than two million visitors annually, who enjoy the rich history as well as the natural resources and amenities offered by the region.[3]

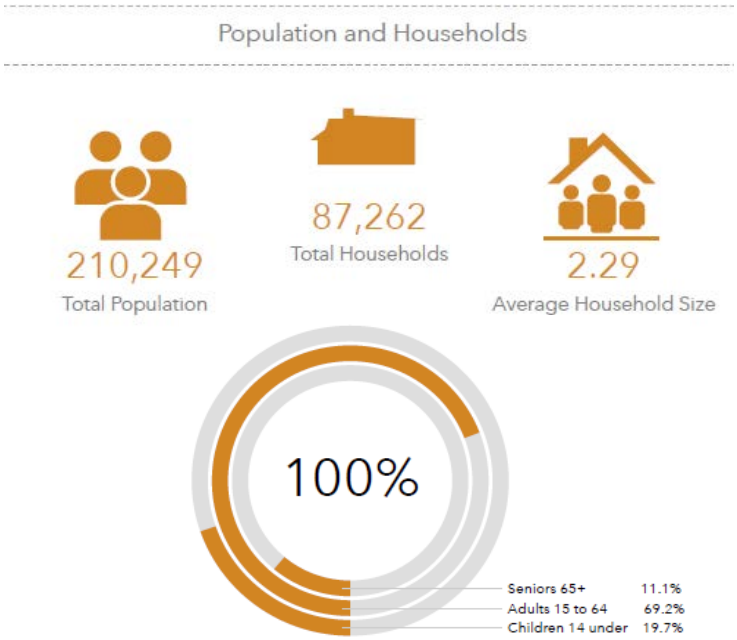
1 United States Census Bureau, 2011-2015 and 2017 American Community Surveys.

2 United States Census Bureau, 2011-2015 and 2017 American Community Surveys.

3 Visit Rochester, http://www.visitrochester.com/about-roc/.

Figures 1 and **2** present a snapshot of Rochester's demographic and economic trends, all of which provide important context for the City as it considers its long-term development and prosperity. While the City has experienced a resurgence of revitalization and reinvestment opportunities across its neighborhoods, poverty and social disparity remain major issues to overcome. Understanding Rochester's potential climate impacts is critical to the City's continued economic prosperity, as well as to ensuring that Rochester remains a safe, livable, and vibrant place to live and visit.

Figure 1. Rochester By the Numbers: Populations and Households



Source: American Community Survey (ACS), Esri and Infogroup; 2011-2015, and 2017 data.

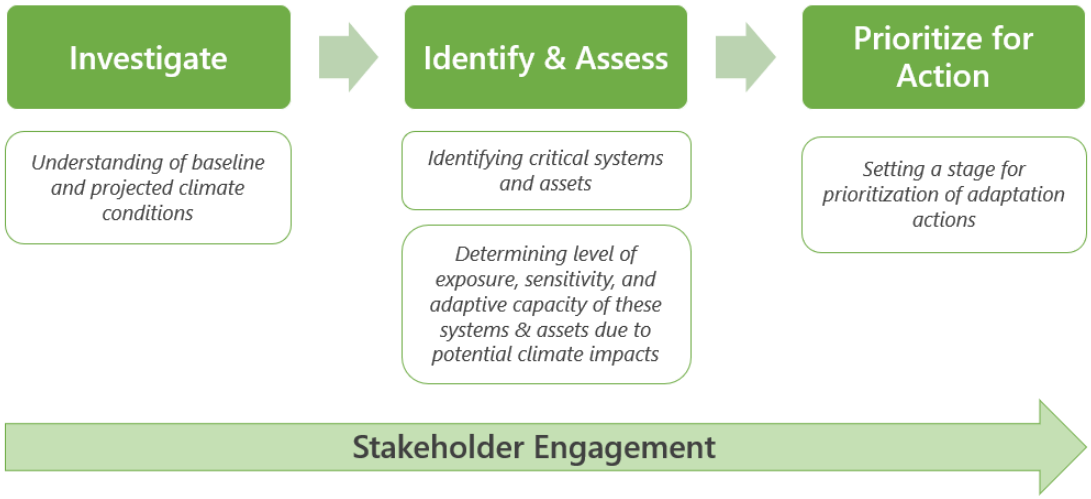
Figure 2. Rochester By the Numbers: Businesses and Employment

Source: American Community Survey (ACS), Esri and Infogroup; 2011-2015, and 2017 data.

1.2 About the Climate Vulnerability Assessment

The goal of this climate vulnerability assessment (CVA) is to identify physical infrastructure and assets within the city that are most susceptible to the projected climate impacts, as well as vulnerable populations that are already underserved or disproportionately affected and therefore likely to bear the greatest burden of climate impacts. **Figure 3** illustrates the process utilized to complete this CVA.

Figure 3. Climate Vulnerability Assessment Approach



1.2.1 Investigate

The first step of the CVA process was to conduct a baseline assessment of historical climate trends in the City of Rochester and the region, as well as the projected climate conditions and potential climate impacts that the City should anticipate in the near-term, mid-century, and end of century. For this preliminary data review, recent climate impact assessments (completed at the national, state, and regional level) were referenced to identify the climate stressors that could disrupt and threaten the City's critical assets and operational components. Climate impacts considered for the assessment include, but are not limited to, increased heat, extreme storm events, and changes in precipitation patterns, such as rain, snow, and ice, as well as drought conditions. The preliminary impact analysis used information from various sources, including:

- Third National Climate Assessment (NCA)'s 2014 "Climate Change Impacts in the United States, Chapter 16: Northeast" (Horton et. al., 2014);
- Fourth National Climate Assessment, Volume I: Climate Science Special Report (CSSR) (Wuebbles et. al., 2017);
- National Oceanic and Atmospheric Administration (NOAA)'s 2013 "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment," Part 1, Climate of the Northeast. U.S. Technical Report (Kunkel et. al., 2013);
- NOAA National Centers for Environmental Information (NOAA NCEI)'s State Summaries;
- New York State Energy Research and Development Authority (NYSERDA)'s "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information" (Horton et. al., 2014); and
- U.S. Geological Survey National Climate Change Viewer (Alder and Hosteler, 2016).

Refer to **Appendix B** for detailed climate projection information.

1.2.2 Identify & Assess

As part of the CVA, the City reviewed existing plans and reports to identify all key assets, resources, and services to evaluate. Next, the City analyzed the sensitivity and adaptive capacity of each of the identified assets and operational components, based on its understanding of direct and indirect climate impacts, as well as levels of exposure of these assets/components to various impacts. This exercise provides insight into how climate affects the City's critical assets and operations and, more importantly, how it can adapt to the changing climate.

Sensitivity Assessment

Sensitivity level indicates the degree to which a system or sub-system might be affected by the climate impacts to which it is exposed. For example, a potential impact to transportation infrastructure from increased heavy rain events is flooding of roadways or road washout. A sensitivity assessment for the City of Rochester's transportation infrastructure determines the anticipated level of severity of this type of impact. For the purpose of ranking the types and

severity of damage that might occur as a result of each climate impact, sensitivity levels were categorized as follows:

- **S0**: System will not be affected by the impact
- **S1**: System will be minimally affected by the impact
- **S2**: System will be moderately affected by the impact
- **S3**: System will be largely affected by the impact
- **S4**: System will be entirely affected by the impact

Adaptive Capacity Evaluation

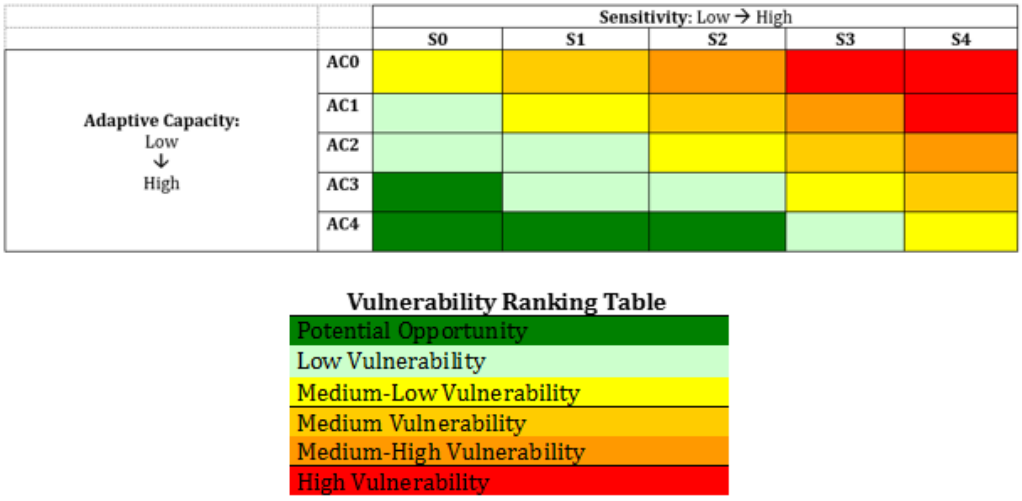
Adaptive capacity reflects a system's ability to respond successfully to climate variability or extreme events. It speaks to the ability to adjust to changes, manage damages, take advantage of opportunities, or cope with consequences.

For the purpose of ranking the existing practices or available resources to manage and/or respond to various climate impacts, adaptive capacity levels were categorized as follows:

- **AC0**: System is not able to accommodate or adjust to impact
- **AC1**: System is minimally able to accommodate or adjust to impact
- **AC2**: System is somewhat able to accommodate or adjust to impact
- **AC3**: System is mostly able to accommodate or adjust to impact
- **AC4**: System is able to accommodate or adjust to impact in a beneficial way

Once the sensitivity and adaptive capacity were determined, a vulnerability ranking was calculated to reflect how susceptible the systems/sub-systems in each planning area are to the effects of climate change. For instance, if a system's sensitivity is low (S0) and adaptive capacity is high (AC4), vulnerability is likely to be low. **Figure 4** demonstrates how the vulnerability ranking levels were formulated.

Figure 4. Vulnerability Ranking Categories Based on Sensitivity and Adaptive Capacity Evaluations



Throughout this process, the City also examined its assets and resources through the lenses of *equity*, *accessibility*, and *public health* for a comprehensive, cross-cutting consideration of the City's overall sensitivity, adaptive capacity, and vulnerability.

1.2.3 Prioritize for Action

Upon gaining a better understanding of its strengths and vulnerabilities, the City can focus its resources on identifying, assessing, and prioritizing potential short- and long-term strategies and actions for implementation. This CVA sets the stage for the next phase of adaptation and resiliency planning, which begins with soliciting ideas from community stakeholders regarding adaptive strategies and actions that they would like to see included in the assessment and prioritization process.

1.2.4 Stakeholder Engagement

The City of Rochester recognizes that a thorough assessment of climate vulnerability requires input from an array of stakeholders. To that end, the City prepared a Public Involvement Plan (PIP) and conducted public outreach throughout the course of the project. The PIP defined the overall objectives of engagement, identified key stakeholders and tools, and outlined techniques to engage a variety of stakeholders throughout the study process. The PIP formalized the commitment of the City to solicit meaningful input and engage the public throughout the process. A copy of the PIP can be found in **Appendix D**.

The engagement process included the following major components: (1) pre-engagement interviews with key stakeholders, (2) two workshops with a Technical Advisory Committee, (3) interviews and focus groups with stakeholders, and (4) an input session for stakeholders and interested members of the public. In addition, the City collaborated with students at the University of Rochester on a project that examined health equity issues facing Rochester in conjunction with climate change.

Pre-Engagement Interviews

In order to gain agency and stakeholder perspectives early in the process, the City conducted six, 30-minute interviews with key community stakeholders. The purpose of pre-engagement interviews was to inform ongoing engagement activities, as well as to anticipate stakeholder perceptions of the project and potential issues. Pre-engagement interviews were an opportunity to develop constructive stakeholder relationships; better understand impacts, concerns, and opportunities; and better mitigate risks to the project. The pre-engagement interviews supplemented and strengthened engagement techniques identified in the PIP. Pre-engagement interview questions included the following:

- In what ways do you think Rochester is most vulnerable to the effects of climate change?
- Which populations do you think are most vulnerable? How should we include vulnerable community members/populations in the Vulnerability Assessment project?
- What do you think are the biggest opportunities/best outcomes of this project?

- Are there any hot button issues we should be aware of before we start engaging the community?
- Who else should we talk to?

Stakeholders noted during the interviews that Rochester is most vulnerable to flooding, increased temperatures, disruptions to the energy grid and agriculture, and increased demand on social services. Stakeholders noted that certain populations in Rochester are especially vulnerable to the impacts of climate change and that their circumstances and needs should be addressed in the assessment. In many cases, these vulnerable populations are already underserved or face disproportionate, systematic burdens. Climate impacts therefore disproportionately affect these populations, which often have the fewest resources to bounce back from climate-related events.

The vulnerable populations identified by stakeholders include:

- Seniors/elderly
- Children
- Low-income residents
- People without access to vehicles
- Disabled
- Individuals without the ability to access resources in a crisis (e.g., family, friends, financial resources)
- Individuals dealing with substance abuse
- Non-native English speakers
- Undocumented immigrants
- Refugees
- Visually/hearing impaired
- Individuals with mental illness

Stakeholders also noted numerous opportunities for the project, including broadening the discussion of vulnerability to a larger audience, shaping future funding priorities for infrastructure, strengthening emergency preparedness and response, enhancing/protecting natural resources, building partnerships, and planning for how best to allocate existing resources to support vulnerable populations.

Technical Advisory Committee

The City convened a Technical Advisory Committee (TAC) comprised of technical experts, policy leaders, educational institutions, business groups, City staff, regional agency representatives, and other individuals notably involved in (or familiar with) planning for and responding to emergency events and natural disasters. The purpose of the TAC was to provide first-hand, on-the-ground knowledge of climate implications to operations and activities throughout the city and to assist in tailoring project findings to Rochester's unique strengths and challenges.

TAC members and representatives of the City and consulting team discuss the Climate Vulnerability Assessment.

TAC members included representatives of the City of Rochester, local utilities, local universities, transportation and transit agencies, public health entities, housing organizations, and advocacy groups. A list of TAC members can be found in **Appendix D**.

The role of the TAC included:

- Providing guidance, technical expertise, and feedback on the CVA;
- Connecting the City and Project Team with key stakeholder groups;
- Participating in two workshops; and
- Participating in ongoing project outreach (help promote the project and seek feedback).

The City hosted two workshops with the TAC throughout the project:

Workshop #1: March 14, 2018 from 9:00-12:00 at the City Water Bureau Training Room

The purpose of the first workshop was to share information about the project and provide a summary of local and regional climate change projections and impacts. The City gathered

feedback from TAC members about their experience and knowledge of extreme weather events that are likely to become the norm in future years, as well as information regarding the anticipated implications of various climate impact scenarios. TAC members were also asked to provide feedback about critical systems and assets in Rochester and the degree to which those assets and systems are likely to be exposed to future climate impacts. TAC members also identified the most vulnerable populations throughout the community.

Workshop #2: June 6, 2018 from 9:00 – 12:00 at the City Water Bureau Training Room

The purpose of the second workshop was to present the vulnerability assessment framework and ask TAC members to evaluate sensitivity, adaptive capacity, and overall vulnerability for the identified systems and critical assets in Rochester. TAC members were split into smaller groups to discuss the framework and rankings in detail. Summaries of TAC meetings can be found in **Appendix D**.

Targeted Stakeholder Interviews/Focus Group

In order to engage stakeholders not represented on the TAC, the City conducted interviews and a focus group with additional stakeholders. These engagement efforts included representatives from the City of Rochester and Monroe County, health advocates, members of the disability community, organizations that provide services to refugees, organizations involved in food systems, and local universities. The key themes that emerged in discussions about vulnerable populations and potential impacts of climate change included the following potential vulnerabilities related to housing and transportation:

- Aging housing stock (older roofs, windows, insulation, mechanical systems)
  - Lack of cooling/heating systems
  - Increased risk of mold/illness
  - Acute damage from extreme weather
- Transportation (potential disruptions)
  - Access to employment
  - Access to medical facilities
  - Access to locations with internet/libraries
- Less engagement with local government/fear of seeking help

A full summary of the stakeholder interviews and a list of participants can be found in **Appendix D**.

Public Input Session

The City hosted a public input session on August 29, 2018 at the Rochester City Hall Council Chambers. The purpose of the input session was to share information about the project and seek feedback on the draft Vulnerability Assessment report. A presentation was given at the beginning of the input session to introduce the project. Participants were then invited to review project information presented on poster displays throughout the room, ask team

members questions, and provide feedback on comment cards and sticky notes. A summary of feedback received at the input session can be found in **Appendix D**.

1.3 Overarching Themes of Equity, Accessibility, and Public Health

Analysis of the potential climate implications on the identified systems and subsystems above was performed through the lenses of equity, accessibility, and public health for a comprehensive understanding of the City of Rochester's sensitivity, adaptive capacity, and overall vulnerability. These cross-cutting considerations influence the ability of these systems to recover, accommodate, or adapt effectively.

Equity

In general, low-income populations and communities of color are more vulnerable and do not have the means to prepare for or adapt to climate change, as they are already burdened by limited financial resources and less likely have the means to voice their needs. This is a particular concern for the City of Rochester, which has a higher rate of unemployment (compared to Monroe County overall). Furthermore, approximately 30 percent of households in the City live below the poverty level.[4]

Accessibility

Similarly, populations most vulnerable to climate change are those often face greater difficulty accessing services. Disruptions to basic services (such as public transportation) and access to community-service facilities are most likely to disproportionately impact low-income populations and communities of color that depend on these resources more than other populations. Additionally, like many urban areas, amenities such as green space, transit-oriented housing, or safe biking and walking paths, are unevenly distributed in Rochester. As a result, health and safety issues, such as heat exposure or respiratory-related illness (due to mold issues, poor air quality, etc.), intensify for these vulnerable populations.

Public health

Climate change will have a variety of public health consequences, including, but not limited to, heat-related illnesses, allergies, asthma, water and food borne illnesses, and cardiovascular disease. Warmer weather could also lead to longer breeding seasons and expand ranges for pests such as ticks and mosquitoes that carry harmful vector-borne diseases to human health. Similar to other cross-cutting issues, public health issues will more severely impact low-income populations and communities of colors that lack resources to respond or adapt to these changing conditions.

4 United States Census Bureau, 2011-2015 and 2017 American Community Surveys.

2

Climate Profile

Rochester is already experiencing changing climate conditions at a regional and local level, specifically relating to temperature and precipitation. For instance:

- The Northeast region's average annual temperature has increased approximately 2°F over the last two decades.[5] New York's statewide average annual temperature, in particular, has increased approximately 2.4°F since 1970, with winter warming exceeding 4.4°F; in many areas across the state, spring has begun earlier and winter snow cover has decreased compared prior decades.[6]
- The Northeast is one of the regions that has also seen more extreme precipitation and more frequent flooding (including from rivers). In fact, between 1958 and 2010, the Northeast saw more than a 70% increase in the amount of precipitation falling in very heavy events (defined as the heaviest 1% of all daily events).[7] When Hurricane

5 NOAA National Centers for Environmental Information (NOAA NCEI)'s New York State Summary.

6 New York State Energy Research and Development Authority (NYSERDA)'s "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information" (Horton et. al., 2014).

7 Third National Climate Assessment (NCA)'s 2014 "Climate Change Impacts in the United States, Chapter 16: Northeast" (Horton et. al., 2014).

Irene hit in August 2011, inland areas including upstate New York were severely impacted by extreme flooding. Roads and bridges were either washed out or blocked by downed trees and power lines; many homes and businesses were flooded, forcing owners and renters to evacuate; and floodplain forests were damaged by flash floods. This catastrophic event took 41 lives and cost an estimated $16 billion. Although Rochester was not in the direct path of this storm, the City experienced flooding from remnants of this and other tropical systems.

› Since 1998, the maximum ice cover extents on Lakes Erie and Ontario have been below the long-term average. In fact, since 2006, Lake Ontario has remained below 30% ice cover (with the exception of ice cover during the 2013–2014 winter).[8]

2.1 Summary of Regional and Local Climate Projections

A variety of studies and publications on climate trends and projections was reviewed for this assessment. As shown in **Table 1** below, each data source employs a slightly different reference timeframe for baseline and projections. For simplicity, this report refers to the general timeframes as "baseline"; "mid-century"; and "end of century."

Table 1. Climate Projection Timeframes

Source	Timeframes		
	Baseline	Mid-Century	End of Century
NCA 3	1971-2000	2041-2070	2071-2099
NCA 4	1901-1960	2036-2065	2071-2100
NOAA	1971-1999; 1971-2000; or 1980-2000	2041-2070	2070-2099
NYSERDA ClimAID	1971-2000	2050-2079	2080-2100
USGS	1981-2010	2050-2074	2075-2099

Table 2 provides a summary of climate change projections for the City of Rochester and surrounding areas. The majority of the information listed in this table references data from the NYSERDA ClimAID 2014 report, given their specificity to regional and local levels. For climate conditions noted with an asterisk (*), referenced baseline and projections data are based on the other data sources listed in Table 1.

Table 2. Summary of Climate Change Projections for the City of Rochester and Surrounding Areas

Climate Conditions	Timeframes		
	Baseline	Mid-Century	End of Century
Average Annual Temperature	47.7°F	52°F to 54°F	54°F to 59.4°F
Number of Days ≥ 90°F	8 days	22 to 34 days	27 to 57 days

8 NOAA NCEI and NOAA Great Lakes Environmental Research Laboratory.

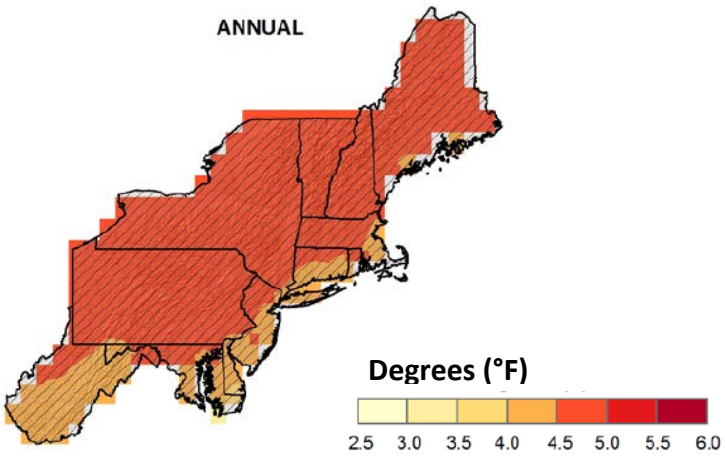
Number of Days Per Year Below 32°F	133 days	86 to 96 days	68 to 88 days
*Consecutive Days with Temperature > 95°F	1 to 2 days	2 to 4 days	N/A
Number of Heatwaves	≤ 1 event	3 to 4 events	3 to 8 events
Duration of Heatwaves	4 days	4 to 5 days	4 to 6 days
Average Annual Precipitation	34 inches	4% to 10% increase	4% to 19% increase
Days Per Year with Over 1" Rainfall	5 days	5 days	5 to 6 days
*Extreme Events	2-3 times more frequent by end of the century		
Annual Snowfall	Less frequent snowfall, shorter snow season		
Drought	Increase in short-duration drought during summer season by end of the century		

Increases in Temperatures

In general, the City of Rochester and surrounding areas are projected to experience a continued increase in temperatures, potentially as much as 7°F by mid-century and over 10°F by end of the century. Like the rest of the Northeast region, more days with a maximum temperature at or above 90°F and fewer days with a minimum temperature below 32°F are also expected. Heatwaves[9] are projected to occur more—potentially four times more frequently by mid-century and up to eight times more frequently by the end of the century. The duration of those heatwaves is also projected to increase slightly. Furthermore, by the end of the century, it is more likely that late-summer short-duration droughts will increase. **Figures 5** and **6** illustrate the projected increase in annual temperatures and seasonal temperatures throughout the Northeast, respectively, using the NARCCAP regional climate simulations for the high (A2) emissions scenario.

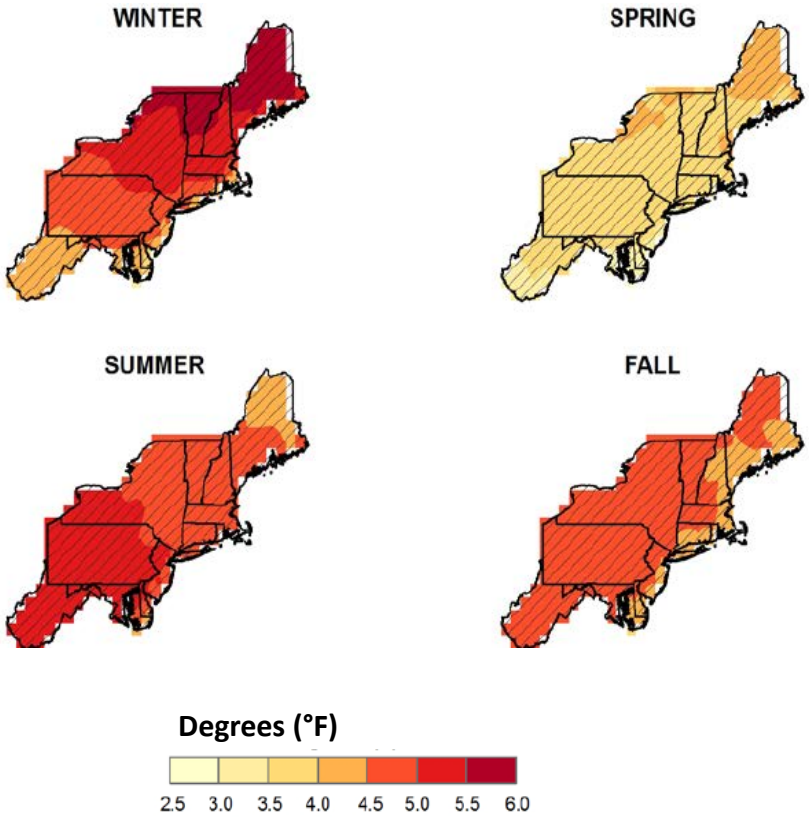
9 Defined by NOAA as two or more consecutive days of uncomfortably hot and unusually humid weather.

Figure 5. Increase in Annual Temperature by Mid-Century



Source: NOAA Technical Report NESDIS 142-1, "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment. Part 1, Climate of the Northeast U.S."

Figure 6. Increase in Seasonal Temperatures by Mid-Century



Source: NOAA Technical Report NESDIS 142-1, "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment. Part 1, Climate of the Northeast U.S."

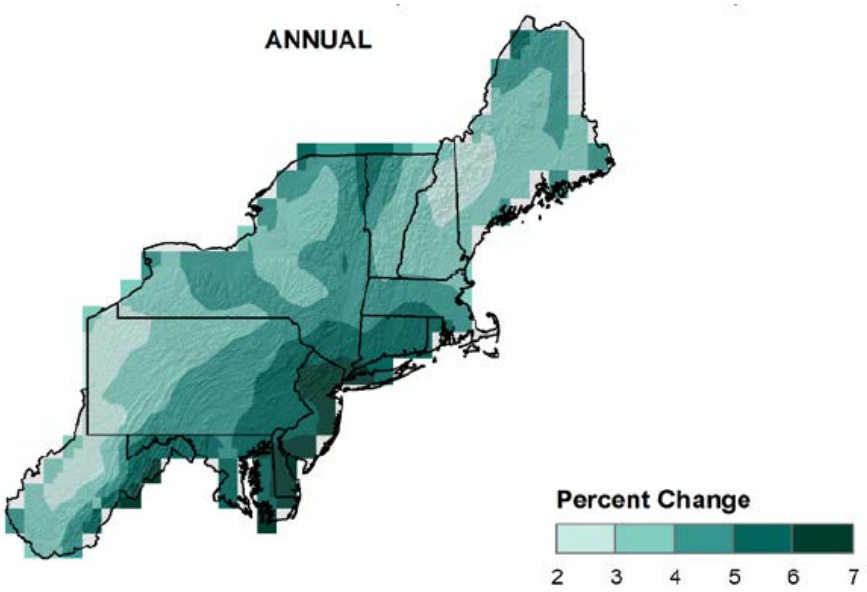
Highlights of potential direct and indirect implications that the City of Rochester may experience as a result of increased annual average temperature and more frequent and prolonged extreme temperature events include:

- Urban heat island effects;
- Changes or loss of ecosystems and biodiversity due to climate shift, as well as increased risk of invasive species and pests;
- Increased stress on energy systems due to increased demand for cooling—on the other hand, warmer winters could also result in reduced energy consumption for heating;
- Increased demand for water for irrigation;
- Reduced integrity of pavement, utility infrastructure, as well as outdoor building equipment as a result of prolonged extreme heat;
- Increased risk of freeze-thaw conditions, which can cause more frost heaves and potholes on roadway and bridge surfaces;
- Increased public health risks and safety issues, such as heat exposure and heat-related illness, especially for vulnerable populations (including children, the elderly, pregnant women, etc.); and exacerbated health conditions (i.e., asthma, allergies, and other respiratory conditions) due to increased pollen production and poor air quality;
- Reduced quality of soil and crop yields; and
- Potential shift in crop and livestock production due to climate shift.

Changes in Precipitation Patterns

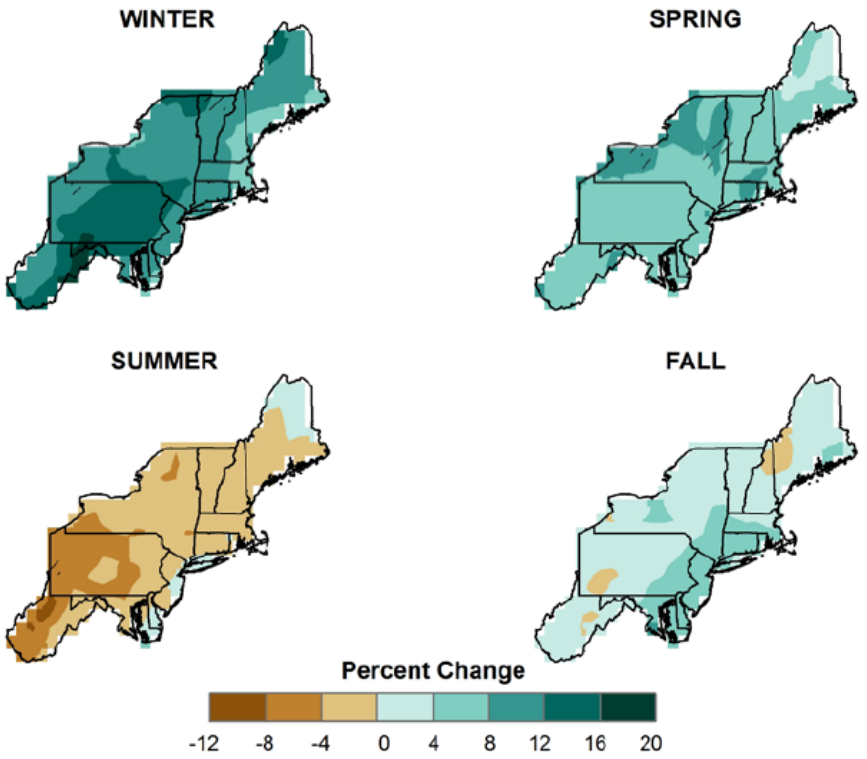
Despite the challenge of accurately projecting the volume and timing of precipitation patterns, climate scientists are certain that more frequent and more intense precipitation events will to occur throughout the century. For upstate New York, the average annual precipitation is projected to increase up to 10% by mid-century, and nearly 20% by end of century. Precipitation volume may vary by seasons, however, with warmer winters to be expected; winter precipitation will most likely occur as either rain or ice instead of snowfall. **Figures 7** and **8** illustrate the projected annual precipitation volume and seasonal patterns, respectively, throughout the Northeast by mid-century, using the NARCCAP regional climate simulations for the high (A2) emissions scenario.

Figure 7. Annual Increase in Precipitation by Mid-Century



Source: NOAA Technical Report NESDIS 142-1, "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment. Part 1, Climate of the Northeast U.S."

Figure 8. Annual Increase in Seasonal Precipitation by Mid-Century



Source: NOAA Technical Report NESDIS 142-1, "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment. Part 1, Climate of the Northeast U.S."

Highlights of the potential direct and indirect implications that the City of Rochester may experience as a result of changing frequency and intensity of precipitation include:

- Increased risk of sediment and contaminants in nearby water bodies and waterways due to runoff from to overflow stormwater systems, subsequently putting water quality and recreational activities also at risk;
- Flooded roadways, railways, runways, etc. due to overwhelmed stormwater/drainage systems, and/or flash flooding from heavy rain;
- Damage to building envelope, including increased risk of mold exposure from driving rain;
- Reduced navigability, putting travelers at risk as well as disrupting/delaying delivery of goods and services; and
- Change to or loss of ecosystems and biodiversity as a result of inundation or washout from heavy rain.

Increase in Extreme Storm Events (Microbursts, Ice Storms, Severe Thunderstorms, etc.)

As the ocean and atmosphere continue to warm, North Atlantic hurricane activities are projected to increase in frequency, intensity and duration. The Northeast in particular is projected to experience the largest increase in the number of extreme events by two to three times the historical average for the region by the end of the century. Although the implications from these storms for upstate New York are uncertain, remnants from these storms have wreaked havoc on the region in the past and are likely to intensify.[10] Highlights of direct and indirect implications that the City of Rochester may experience as a result of increased frequency of extreme storm events include:

- Damage to roadways and bridges due to fallen trees, debris, or flooding, making roadways and bridges impassible/inaccessible and also creating unsafe conditions for traveling;
- Damage to building and outdoor equipment;
- Increased risk of severe injury or death caused by debris, flooding, etc., which also presents safety issues, especially for those engage in outdoor activities;
- Delays or disruptions within transportation network, as well as delivery of goods and services;
- More frequent power outages due to damaged transmission and/or distribution equipment; and
- Damage to telecommunication services and associated network infrastructure (i.e., towers, data centers, stations, transmission lines).

Refer to **Appendix B** for more detailed analysis of climate trends and projections for the City of Rochester and surrounding areas.

10 Fourth National Climate Assessment, Volume I: Climate Science Special Report (CSSR) (Wuebbles et. al., 2017).

3

Planning Subject Areas

The following planning subject areas serve as the overarching framework for the City of Rochester's environmental, social and economic resources:

- Infrastructure
- Natural Resources
- Socioeconomic Resources

Within each of these planning subject areas, various systems have also been outlined, representing the City's built environment, operational components, and services to be evaluated in the vulnerability assessment. **Table 3** presents the systems and subsystems/sectors categorized under each of the planning subject areas.

When possible, key assets and operational components under each of these systems and subsystems have also been identified. For certain systems, however, especially the "Socioeconomic Resources" planning subject area, associated physical assets may not exist, and therefore potential climate change impacts have been evaluated at the level of the system as a whole. It should be noted that this assessment also examines how climate impacts on these systems and subsystems may overlap, as well as how climate change may result in cascading impacts across systems and subsystems. Refer to **Appendix B** for a full list of identified critical assets and operational components in Rochester.

Table 3. Planning Subject Areas, Systems, and Subsystems

Planning Subject Area	System	Subsystem/Sector
Infrastructure		
	Transportation	Highway, local roads, and bridges
		Public transportation
		Bike/pedestrian network
		Port and marina
		Airport
		Railways
	Energy/Utilities	Telecommunication
		Energy generation and distribution
	Water	Water supply
		Wastewater and stormwater management
		Flood-protection infrastructure
	Buildings and Facilities	Commercial and businesses
		Residential
		Industrial
		Municipal, public, and critical facilities
		Others (institutional, places of workshop, data centers, etc.)
Natural Resources		
	Environmental Resources	Water bodies and waterways
		Wetlands
		Urban forests
	Natural Habitat	Sensitive and rare habitats
	Recreational & Open Space	Open space, public parks and facilities
Socioeconomic Resources		
	Public health resources	Health services
		Citizen health/public health (vulnerable populations focus)
		Emergency services
		Air quality
	Economy	Key industries/employers
		Jobs/workforce
	Cultural resources	Historic and cultural resources
	Social/Human Services	Food systems
		Quality of life

3.1 Infrastructure

Infrastructure systems, such as transportation networks, utilities, and critical facilities, are vital resources that keep the City of Rochester running smoothly. Increased temperatures and more intense precipitation patterns pose threats to these systems' functions and to the safety of their users. Furthermore, these systems are intricately connected, such that when one of them is compromised, it can cause a cascading impact that disrupts others as well. Moreover, as infrastructure projects are typically designed and built with the expectation of lasting many decades, understanding the potential climate implications for the near-term, mid-century, and end of century will help inform planning for future projects, including design elements that should be taken into consideration to reduce their vulnerabilities to more frequent and severe climate conditions.

This section describes the current conditions of the City of Rochester's infrastructure systems as well as the potential implications for these systems and subsystems in the face of projected climate impacts. It also describes the key sensitivities of Rochester's infrastructure and explores their capacity to accommodate or adapt to potential climate change impacts.

3.1.1 Transportation

Highways, Local Roads, and Bridges

The City of Rochester is connected to the surrounding areas and the region at large by interstates (I-390, I-490, and I-590) and the New York State Thruway (I-90). Within the City, more than 30 different neighborhoods are linked to each other and to key resources (including critical facilities such as hospitals, fire stations, municipal offices, etc.), by an intricate network of arterials (major through roads) and local streets. The City also maintains more than 30 bridges, comprising the major interstates or through roads, as well as pedestrian bridges that connect the City on both sides of the Genesee River. The TAC noted that most of these bridges are currently in a good state of repair; they are sufficiently high and have redundancies that enhance their structural integrity.

Rising temperatures and more frequent extreme heat events can affect pavement integrity, which would exacerbate the current roadway conditions around Rochester; in fact, based on input from the TAC, stretches of highways and roads around the City contain pot holes. Roadway surfaces and bridge structures could also face increased risk of buckling or cracking, as Rochester is expected to experience more frequent freeze-thaw conditions due to the fluctuation of temperatures around freezing (associated with increased winter temperatures). Bridges may require additional load restrictions to minimize the damage. On the other hand, anticipated warmer winters could also mean reduced salt and chemical use for ice or snow removal, and therefore reduced chemical run-off contamination of nearby water bodies.

More frequent precipitation and extreme storms also present challenges to the City of Rochester's roadway infrastructure. As noted in Monroe County's 2017 Hazard Mitigation Plan Update, flooding and severe storm events (winter storms, ice storms, blizzards) are considered high hazards that have caused extensive damage (safety risk, property

damage/loss, etc.) in Rochester. Similarly, according to the Genesee-Finger Lakes Regional Critical Transportation Infrastructure Vulnerability Assessment, urban flooding and flash floods have regularly occurred during heavy rainstorms, and the City's aging roadways may not have capacity to handle higher volumes of water. Furthermore, compounded by more frequent periods of drought, heavy rains and extreme storms that follow can cause soil and culverts (road and bridge infrastructure support) to weaken or wash out, therefore putting the infrastructure's stability and safety at risk.

Overall, the roadways and bridges in Rochester have moderate sensitivity to impacts associated with increased temperatures but high sensitivity to the potential increase in more frequent extreme precipitation and weather events. Adaptive capacity for this transportation system is also fairly high. According to feedback from the TAC, there are redundancies in place such as plans for detours, to minimize disruption during emergency or evacuation events. Additionally, recognizing the potential climate impacts facing the system, County representatives and City staff on the TAC noted that efforts have been underway to learn and adopt best practices (such as design standards, material use to withstand prolonged high heat, etc.) from other regions with climates similar Rochester's projected future climate. At the same time, the availability of and ability to allocate and/or prioritize financial resources to begin implementing these best practices remain significant challenges.

Bike/Pedestrian Network

Biking is increasingly popular as both a mode of transportation and a recreational activity in Rochester. To date, the City offers nearly 64 miles of on-street bicycle lanes, with approximately 140 more miles planned. The City also launched the Pace Bike Share City Program in July 2017, installing 46 bike stations and making more than 300 bikes accessible throughout the City. An extensive network of off-road multi-use trail systems is also maintained for bikes and pedestrians, including, but not limited to, the Genesee Riverway Trail, the Promenade at Erie Harbor, and the ARTWalk along University Avenue. In addition to the Bicycle Master Plan, the City has also developed strategies and implementation actions in its Community-wide Climate Action Plan to encourage the use of alternative transportation modes. As more community members rely on these trails and paths to get around, this infrastructure system will become an important resource for protecting and enhancing the City's long-term mobility and livability.

Similar to roadways and bridges, the bike and pedestrian network may experience both positive and negative climate change implications. It is moderately sensitive to potential climate impacts, except for more frequent and extreme precipitation/storm events. According to feedback from the TAC, the majority of these trails and paths are newly built and well maintained, and therefore have a relatively high adaptive capacity to withstand potential climate impacts; as such, extreme temperatures and storm events may not necessarily be a significant threat to the physical infrastructure. Warmer temperatures also provide residents and visitors with more time to engage in outdoor activities, further increasing the popularity of the bike and pedestrian network, and thus potentially reducing vehicle miles traveled, improving air quality, and reducing GHG emissions. However, fallen trees and debris caused by extreme rainfall or storm events (e.g., severe thunderstorms,

microbursts, ice storms) can pose a major public health and safety risk for bicyclists and pedestrians using the network.

Public Transportation

The Regional Transit Service (RTS), a regional bus system operated by the Rochester Genesee Regional Transportation Authority, provides public transportation and paratransit services for the City of Rochester and surrounding communities in Monroe County, as well as for communities in neighboring counties in Western New York. RTS operates more than 200 buses and runs 41 fixed public transit routes. Since 2008, RTS has been able to keep its fare at $1 per ride and maintain a high annual ridership of approximately 17 million.[11] These statistics indicate that public transportation is a vital and affordable resource for many to navigate the region.

Increasing temperatures, including more frequent and prolonged extreme heat days, lead to more rapid weathering of fleet and communication systems (tires, mechanical equipment, etc.), overheated electrical equipment, and damage to fleet due to poor roadway pavement conditions. Increasing temperatures may also raise costs for maintenance and for cooling public transportation facilities (including bus stations, bus depots, and maintenance facilities). Extreme heat can also increase the risk of heat exposure and heat-related illness for RTS workers (bus drivers, maintenance workers, etc.) as well as the risk of rider discomfort, particularly if the bus fleet and transit shelters do not have adequate ventilation or cooling systems. Additionally, public transportation operations and quality of service depend greatly on roadway conditions. More frequent heavy rains and extreme storm events may lead to road washout or closure, and therefore result in more disruptions or delays in service.

Overall, the public transportation system has moderate sensitivity and high capacity to adapt to potential climate impacts, despite potential implications to public health and safety risks caused by extreme precipitation and weather events. As noted, the system's operations and services will also rely on the ability of the roadway systems to remain operational.

Port and Marina

The Port of Rochester is located where the Genesee River meets Lake Ontario, approximately nine miles from downtown Rochester. In recent years, the Port was transformed from an underutilized area into a vibrant community gathering space for various recreational activities, including boating and fishing, swimming, hiking, and biking (the Port is connected to the Genesee Riverway Trail), and enjoying restaurants, outdoor festivals, concerts, and movies hosted at the Port of Rochester Marina.

Projected heavy rains could lead to reduced navigability at the port and disrupt port operations. Staff at the Port of Rochester Marina note that high water events are already a frequent occurrence. However, various measures have been considered or incorporated during the planning and construction of the marina three years ago to prevent interruptions due to high water. For instance, a floating dock system prevents major disruption to boats,

11 Regional Transit Service Fast Facts, https://www.myrts.com/.

docks, and electric functionality, and makes the Port of Rochester a desirable place for tenants to locate, relative to other ports without this adaptive feature. The Port of Rochester is also equipped with over two dozen ice eaters, which prevent freezing and related damage by circulating water, although warmer winters have and will continue to reduce the frequency of icing issues.

Despite the significant adaptive capacity built into the Port already, weather events and temperature change may threaten other aspects of the Marina's operations. Foreign object debris from extreme storm events damages port infrastructure and boats, and more extreme hot days may lead to increased costs related to the cooling of port facilities and equipment. Furthermore, extreme temperatures and storm events also increase health and safety risks for port staff (particularly seasonal staff working outside) and marina visitors, as well as prevent or disrupt opportunities for hosting outdoor activities.

Airport

The Greater Rochester International Airport (ROC) plays an important role in connecting the immediate Rochester area to the surrounding region of Western New York, as well as to other destinations across the country and the world, serving about 120 flights daily and approximately 2.4 million passengers annually.[12]

Climate change impacts on ROC present many challenges to the airport's operations and services. More extreme weather events (including ice or snow storms, microbursts, severe thunderstorms, etc.) could result in more frequent flight delays and cancellations, and even the temporary shutdown of the airport. Airport runways may experience climate change implications similar to those for roadways and may therefore need new performance specifications to adapt to extreme and prolonged heat.

Railways

High temperatures cause rail tracks to expand and buckle. More frequent and severe heat waves may require track repairs or speed restrictions to avoid derailments. Heavy precipitation could also lead to delays and disruption, and tropical storms and hurricanes can also flood or leave debris on railways, disrupting rail travel and freight transport. These impacts are particularly concerning for the CSX rail lines and Rochester and Southern Railroad (RSR) branches running through the Rochester area, as well as for the City's two active rail yards, the Brooks Avenue Yard and the Goodman Street Yard.

3.1.2 Utilities & Energy

Telecommunication

Telecommunication systems and data centers are critical components of the City of Rochester's operations, especially during emergencies. The projected increase in temperatures and more frequent heatwaves will likely increase cooling demand and costs

12 Greater Rochester International Airport, https://www2.monroecounty.gov/airport-welcome.php#AirportStatistics.

associated with maintaining communication systems and equipment. These additional maintenance needs particularly implicate facilities that provide critical care and/or essential services for the City. Similarly, more frequent freeze-thaw conditions could increase the risk of damage to equipment due to fluctuating changes in humidity, and the likelihood of icy rather than snowy conditions during winter time could increase demand for de-icing equipment. Electrical voltage spikes during extreme storm events (such as microbursts, severe thunderstorms, etc.), which are also projected to occur more frequently and intensely, represent another major concern related to communication systems. These spikes, along with damage caused by wind, down trees, and foreign object debris, can result in downed communications and increased demand for maintenance and repairs for damaged systems.

Based on feedback from the TAC, the City's telecommunication system has moderate sensitivity to the potential climate impacts. Additionally, given that most operations and activities across the City greatly rely on the system to stay connected and function, the system already has built-in redundancies to reduce risk of down-time, disruption, and/or permanent damage, therefore enhancing its adaptive capacity.

Energy Generation and Distribution Infrastructure

Recognizing that reliable supply and services are critical to the City's operations, Rochester Gas and Electric (RG&E) ensures that energy infrastructure has redundancies and back-up systems in place. However, changing climate conditions may still require increased spending and maintenance to ensure the infrastructure's capacity and reliability. For instance, increased temperatures will likely result in warmer water temperatures, meaning that cooling water for the nuclear power plant may require additional energy. Warmer summers with more periods of drought, combined with potentially earlier snow-melt, may reduce the water level of rivers and streams, which subsequently affects the ability of hydropower plants along the Genesee River to generate power.

On the service side, warmer summers and more extreme hot days will increase cooling demand, putting more stress on the energy grid and potentially increasing the frequency of brownouts and blackouts. Similarly, more severe storms, including more frequent ice storms during winter seasons, could exacerbate the frequency of transmission failure and duration of power outages. Collectively, these potential climate impacts could result in higher costs for energy generation and maintenance of energy infrastructure and, simultaneously, limited capacity and supply due to increased demand.

Overall, the system has moderately high sensitivity to increased temperatures and more frequent extreme storm events, but it also has fairly high adaptive capacity to accommodate and/or respond to potential climate impacts. In fact, Rochester already has a few resilience measures in place to protect its energy system. For instance, much of the natural gas and electric transmission and distribution infrastructure in the City, which is maintained by Rochester Gas and Electric (RG&E), is located below streets. As such, the infrastructure is protected from extreme weather events, which are projected to occur more frequently and intensely by the end of the century. In addition, there are several district energy systems within the City, including the Rochester District Heating Cooperative (RDH), Monroe County's Iola Powerhouse, the University of Rochester's cogeneration facility, and Recycled Energy

Development at Eastman Business Park.[13] Entities connected to these district energy systems will benefit from being independent from the rest of the grid.

3.1.3 Water

Water Supply

The City of Rochester primarily gets its water from Canadice and Hemlock lakes, which is treated at the Hemlock Water Filtration Plant, located approximately 35 miles south of the City of Rochester, before being transmitted to the city using a system of tunnels, conduits, and storage reservoirs, including the Rush, Highland, and Cobbs Hill Reservoirs. The City also purchases water from (and sells water to) the Monroe County Water Authority. Based on the ClimAID report and other New York State projections, it is unlikely that a downward shift in the long-term reservoir supplies will occur.[14] However, factors such as population influx, increased irrigation, and increased use of supplies by water-dependent industries could create a significant increase in demand for water. For instance, RG&E has several hydroelectric plants that are actively generating power, and Eastman Kodak Company operates a wastewater treatment plant that is dependent on the river for power as well as for processing water.[15]

In terms of risk to water quality, the projected increase in temperatures will result in warmer water temperatures, which enable algal blooms to intensify in lakes and reservoirs and threaten the water supply quality. Additionally, more extreme storm events will increase the risk of power outages, potentially interrupting water treatment plant and distribution system operations, and subsequently delaying the distribution of water to the City.

Overall, water supply resources have moderate sensitivity to potential climate impacts from increased temperatures and increased frequency of extreme precipitation and storm events. At the same time, there are adequate response procedures and redundancies to ensure the availability of water supply. Both the County and City have existing water conservation and control measures in place, including volume restrictions for lake water withdrawal. These measures result in a fairly high adaptive capacity for the system.

13 City of Rochester 2015 Energy Plan (part of Five Cities Energy Plans).

14 NYSERDA, 2011.

15 City of Rochester's Office of Planning and Department of Neighborhood and Business Development, Local Waterfront Revitalization Program.

Wastewater and Stormwater Management

The City of Rochester is served by three different sewer networks: a combined sewer system, separate sanitary sewers, and separate storm sewers. The sewer network in the City of Rochester is owned and operated by Monroe County. The separate storm sewers collect stormwater and urban runoff, which is directly discharged into the Genesee River, New York State Barge Canal, or small stream networks. The combined sewer system collects sanitary sewage, industrial wastes, and stormwater runoff in the same network and transports the water to the Van Lare Wastewater Treatment Facility—one of the wastewater treatment plants for Monroe County[16]—for treatment. When the combined sewer infrastructure is overwhelmed by high volume, the excess water flows through relief points along the Genesee River and Irondequoit Bay. Based on TAC feedback, about 70% of Rochester's wastewater system is a combined sewer and stormwater system. Combined sewer overflow is particularly concerning in the context of more frequent intense precipitation events that stress the sewage and stormwater management system and can lead to an increase in the volume of untreated stormwater and wastewater that is discharged directly into the Genesee River or local waterways. In addition, sewage backups occur during severe wet weather events, which can lead to untreated sewage in people's homes.

Overall, the system is moderately sensitive to climate change but also has fairly high adaptive capacity to respond to and/or accommodate the potential impacts. According to feedback from the TAC, the County has been exploring available technology to adjust or modify wastewater treatment process that may be impaired by warmer water (due to warmer temperatures).

Flood-Protection Infrastructure

Dams serve as flood control (such as Mt. Morris Dam), as reservoirs for water supply management, as well as for hydroelectric power generation. This infrastructure is an important capital asset that must be maintained. Dam failure can pose a major risk to public safety. Monroe County has nine dams that have been classified as "high- hazard", including the Highland Park Reservoir Dam, Cobbs Hill Reservoir Dam, and Court Street Dam in Rochester.[17] Recognizing the potential risks associated with dam failure, the City has developed emergency action plans for them.[18]

A major concern with dam infrastructure is the risk of overcapacity due to more frequent and intense precipitation events. Flood risks associated with dams, however, will depend on timing and magnitude of runoff and precipitation volume. Warmer winter temperatures can increase winter rainfall and snowmelt, causing peak flows to occur earlier. At the same time, increase in periods of drought can also impact the health of trees and other large vegetation along the river banks, which may indirectly affect the operations of dams and reservoirs due to treefall and debris blockage. Overall, dam infrastructure in Rochester has moderate sensitivity to increased temperatures and high sensitivity to extreme precipitation and storm

16 Monroe County Department of Environmental Services, "Wastewater: Collection and Treatment by Monroe County-Operated Facilities."

17 Office of the New York State Comptroller, http://wwe1.osc.state.ny.us/localgov/dams/damsbycounty.cfm?county=Monroe#.

18 The City's Department of Environmental Services (DES) developed and submitted these emergency action plans to NYS Department of Environmental Conservation's (NYSDEC) Dam Safety Program.

events. However, the system also has high adaptive capacity in place to accommodate or adapt to these potential impacts. As noted by TAC members, there are good systems in place for existing dams during emergency overflow.

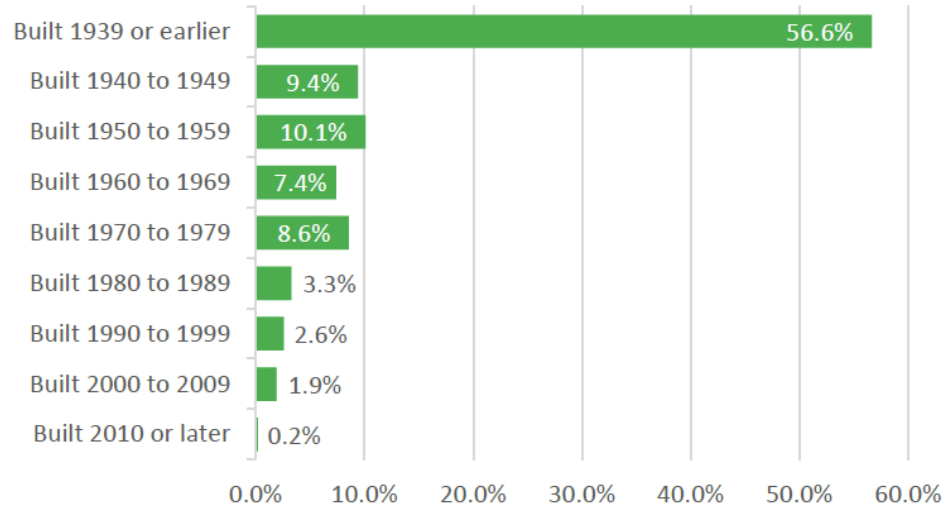
3.1.4 Buildings and Facilities

The City of Rochester is home to more than 8,000 businesses, including several large employers such as Gleason Works, RF Harris Communications, Delphi, and others. The City also hosts the Eastman Business Park, a major industrial office park. Additionally, there are several educational institutions located throughout the City, including the University of Rochester, Rochester Institute of Technology, Monroe Community College, and SUNY Brockport-Downtown Campus.

Community resources and facilities in Rochester include neighborhood community centers, senior centers, homeless shelters, and other care facilities (i.e. battered women shelters, etc.). Other critical facilities include fire and police stations, public libraries, schools, and health service facilities. These facilities provide vital services, especially during natural disaster emergencies.

On the residential side, approximately 63 percent of homes in Rochester are renter-occupied, and 12 percent of homes are vacant.[19] The majority of the housing stock was built more than 40 years ago. **Figure 9** presents a breakdown of the age of the City's current housing stock.

Figure 9. Age of the City's Housing Stock



Source: Rochester Community-wide Climate Action Plan (based on Esri ACS Housing Summary, 2016).

In general, the fluctuation of extreme temperatures and frequency of extreme storms will accelerate the weathering and even deterioration of building exteriors, and in some cases even result in property loss. Additionally, seepage and flooding due to intense rainfall and

19 United States Census Bureau, 2011-2015 American Community Survey 5-year Estimates.

extreme storms can also damage critical systems and equipment if located in basements or lower levels of buildings. This is a major concern especially for critical care facilities, which rely on such equipment to maintain operations. At the same time, one advantage for Rochester is that it is supported by zoning code requirements for on-site infiltration, which can help reduce risks associated with flooding hazards.

For older buildings and facilities that may not have adequate ventilation, increased temperatures could affect the internal building temperatures, which may cause heat stress and other heat-related illness to occupants. In addition, increased risk of mold exposure due to driving rain could present serious health and safety issues. Older buildings are most likely to develop mold growth due to inadequately sealed building envelopes, poor heating ventilation, and air conditioning (HVAC) systems. This deterioration is particularly burdensome for low-income homeowners who may not have the financial resources for remediation. Renters will also be more vulnerable if their rental properties are not properly maintained.

Overall, buildings and facilities in Rochester have relatively moderate-high sensitivity to the projected increase in temperatures, extreme precipitation, and extreme storm events. There is some adaptive capacity to the potential climate impacts, however, such capacity is noticeably lower for residential units given the aging and relatively high percentage of renter-occupied housing stock.

3.1.5 Summary of Findings

Overall, infrastructure systems and subsystems have low to moderate vulnerability to potential impacts from climate change. Evaluation of the Infrastructure systems and subsystems indicates a high sensitivity level to extreme storm events. At the same time, the majority of these systems and subsystems also have high adaptive capacity, as many systems are equipped with redundancy or back-up systems. Additionally, agencies and organizations that manage and operate these infrastructure systems are equipped with available technical expertise to adjust and prepare these vital resources for climate change. **Tables 4** and **5** present key strengths and vulnerabilities, as well as the overall vulnerability ranking for each of the systems and subsystems under Infrastructure.

Table 4. Key Strengths and Challenges Facing Infrastructure Systems and Subsystems

System	Strengths/Potential Opportunities	Vulnerabilities/Challenges
Transportation	› Available technical ability & expertise to harden or strengthen roadway infrastructure. › Majority of bike and pedestrian network is new and in good condition. › State of repair is good for many bridges – high & sufficient redundancies in place. › Decreased use of salt and chemicals on roadways and bridges (e.g., for snow and ice removal, etc.).	› More frequent localized flooding. › Inadequate bus/public transit shelters (or shelters without A/C) to cool passengers while waiting. › Increased risk of heat exposure and heat-related illness for public transportation passengers. › Uncertainty about resources needed for winter storm response (More ice? More snow?).

System	Strengths/Potential Opportunities	Vulnerabilities/Challenges
	› Bike/pedestrian network might be used more; biking season maybe increased/prolonged with less extreme cold days. › Marina has built-in adaptive features, including floating dock system that prevents major damage during high water events.	› Increased risk and damage to highways, roadways, bridges, and bike/pedestrian paths due to more frequent extreme storm events (microburst, extreme t-storms, ice storms, etc.), making certain areas impassible or inaccessible. › More frequent heavy rain and storm events increase foreign object debris in the Port of Rochester, disrupting boat and other port operations.
Utilities & Energy	› Many telecommunication and energy systems have redundancies and built-in back-up power. › Ongoing efforts to increase power transformers' capacity and minimize risks (to the infrastructure) associated to increased temperatures. › Demand-response program is available for larger customers to reduce energy consumption. › RG&E is piloting battery storage. › Residential energy programs (smart thermostats, etc.) available, allowing utility to control and adjust, preventing overload, blackouts, and brownouts. › Reduced demand for heating, less stress on generation capacity with fewer extreme cold days.	› Increased stress on power grid due to higher cooling demand with warmer temperatures and more extreme hot days. › Back-up systems may have limitations if impacts are more extensive (i.e., back-up systems can support for up to 3 days, but it might take more than 3 days to recover the main system). › Higher risks when power transformers are close to capacity, compounded by increased temperatures. › Transmission line instability due to more freeze-thaw conditions (potentially more ice than snow). › Increased risk of power outages, delays, or service disruption with more frequent extreme weather events. › Safety risk for maintenance workers.
Water	› Good systems in place for dams during emergency overflow. › Great redundancy system in place for water supplies. › Available technology in place to modify wastewater treatment process. › Water conservation measures in place—restrictions to permitted extraction volumes in lakes. › Reduced spring runoff volumes due to decreased snow pack & spring melt—reduced water body contamination.	› Five dams in the area classified as "high hazard," including three in Rochester (Cobbs Hill, Highland Park Reservoir Dam, and Court Street Dam). › Flooding already experienced at water treatment plant during heavy rains. › Increased winter rainfall and snowmelt (due to warmer winter temperatures) causing peak flows to occur earlier in the season.
Buildings & Facilities	› Zoning Code—on-site infiltration requirements. › Reduced maintenance needs and cost for snow-related issues.	› Challenge for food production facilities with increased temperature and duration of extreme hot days. › Buildings or homes without adequate ventilation—heat stress and other heat-related illness, especially for vulnerable

System	Strengths/Potential Opportunities	Vulnerabilities/Challenges
		populations (e.g., elderly, young children, pregnant women). › Increased risk of ice damming due to more freeze-thaw cycles. › Increased risk of mold growth with more frequent rain and/or flooding. › Increased safety risks for commuters, service disruption, and product delivery delay due to more frequent extreme weather events.

Table 5. Summary of Vulnerability Ranking of Infrastructure's Systems and Subsystems

System	Subsystem/Sector	Vulnerability Ranking				
		Increase in extreme temp. day & duration	Increase in periods of drought	Decrease in days below 32°F	Increase in days over 1" rainfall	Increase in extreme storm events
Transportation	Roads, highways, and bridges	Potential Opp	Low	Med-High	Med-Low	Med-High
	Bike/pedestrian network	Low	N/A	Low	Med-Low	Med-High
	Public transportation	Med-Low	N/A	Med-High	Med-High	Med-High
	Port and marina	Med-Low	N/A	Low	Low	Med-High
	Airport	Med-Low	N/A	Low	Low	Med-High
	Railways	Med-Low	N/A	Low	Low	Med-High
Utilities & Energy	Telecommunication	Med-Low	N/A	Low	Low	Med-Low
	Transmission and distribution infrastructure	Med-Low	N/A	Low	Low	Med-Low
Water	Water supply	Med-Low	Med-Low	Potential Opp	Med-Low	Med-Low
	Wastewater	Low	N/A	Med-Low	Low	Med-Low
	Stormwater	Med-Low	N/A	Med-Low	Low	Med-Low
	Flood-protection infrastructure	Low	Med-Low	Med-Low	Med-High	Med-High
Buildings & Facilities	Commercial, businesses, industrial, public facilities	Med-Low	Low	Potential Opp	Low	Med-Low
	Residential	Med-High	Low	Low	Med-Low	High
	Critical facilities	Med-Low	Low	Potential Opp	Low	Med-Low

Appendix C provides full details on the evaluation of sensitivity, adaptive capacity, and vulnerability ranking for these systems and subsystems.

3.2 Natural Resources

The City of Rochester is surrounded by unique natural resources and environmental assets and offers extensive access and recreational opportunities. Rochester also takes pride in its open space and urban forest systems, recognizing that these resources provide important economic, environmental, and social benefits for the City and its residents.

This section describes the current conditions of the City of Rochester's natural resources as well as the potential climate change implications for the City of Rochester's natural resources systems and subsystems. It also describes the key sensitivities of these systems and subsystems and explores their adaptive capacity to accommodate or adapt to the potential impacts.

3.2.1 Environmental Resources

Water bodies and waterways

The Genesee River, Irondequoit Bay, Lake Ontario, the Erie Canal, Hemlock and Canadice Lakes are major water bodies and waterways that supply the City of Rochester with fresh water for consumption and recreation. These water bodies and waterways also provide ecological habitat for animal and plant species, as well as recreational and tourism opportunities for visitors and residents of the City.

With a projected increase in air temperatures, water temperatures will also increase over time, not only resulting in negative effects on the water quality (algal blooms), but also increasing stress on native habitats, especially those of cold-water fish species. Increases in heavy rainfall events can also lead to increased turbidity of waterbodies and reservoirs and compromise water quality as overwhelmed stormwater and sewer systems lead to pollutant and chemical run-off in waterbodies. More extreme storm events also pose a threat to the shoreline of water bodies and waterways. In fact, the shoreline of Lake Ontario is already experiencing erosion due to more frequent flash floods during storm events in recent years. As a result, these water resources' sensitivity to climate change impacts are fairly high, especially with the projected increased temperatures and more frequent extreme precipitation and storm events. Their adaptive capacity is moderate and influenced by other factors, such as natural topography of the resources, health of trees (in buffer areas surrounding these water bodies and waterways), and the region's efforts and ability to control and minimize pollutant run-off, to name a few.

Wetlands

There are state-regulated freshwater wetlands located within the City, in Genesee Valley Park, Seneca Park, Durand Eastman Park, and near Emerson Street/Mt. Read Blvd. Increased temperatures and more frequent occurrence of drought may cause seasonal wetlands to dry up more quickly, therefore impacting wetland habitats that are home to many species of salamanders, birds, and invertebrates. Fluctuation in extreme temperatures and more frequent extreme storm events will negatively affect these native wetland habitats and

vegetation. Additionally, warmer seasons could also increase the presence of invasive species that would lead to damage and even loss of wetland biodiversity.

Urban Forests

According to the City's Urban Forest Master Plan, the City maintains more than 67,000 trees along city streets and in parks and cemeteries.[20] New pathogens and invasive species are the primary climate change-related threat to trees in the short term. However, in the long run, the region's changing climate might no longer be suitable for current native species and dominant species (e.g., Maple, Honeylocust, Ash). Furthermore, a combination of more frequent extreme weather events and drought periods will increase the risk of damage and significant loss to the City's tree inventory. Overall, the system is moderately sensitive to climate change, and has some adaptive capacity to accommodate and adapt to the potential climate impacts. Protecting the City's urban forests are critical, because without trees to filter toxic pollutants from the air, to intercept stormwater run-off, or to provide shade and relieve the City from urban heat island effect, climate change implications to the City's infrastructure and well as the residents' quality of life will intensify even more.

3.2.2 Natural Habitat

Sensitive and Rare Habitats

Because invasive species often thrive in a warmer climate, Rochester's wetlands, ponds, rivers, and other environmentally sensitive areas are already experiencing impacts that require actions to protect native species. Furthermore, increase in extreme warm temperatures, flash floods from extreme storm events, and prolonged rainfalls exacerbate the livelihood of sensitive and rare habitats. For example, more frequent severe storm events would increase the risk of damage or destruction to roost trees, which are critical for the five species of bats that the Irondequoit Bay supports to raise their pups during breeding seasons. Overall, the system is highly sensitive to climate change, and has some adaptive capacity to accommodate or adjust to potential climate impacts.

3.2.3 Recreational and Open Space

Open Space, Public Parks and Facilities

Rochester has more than 3,500 acres of nationally recognized parks, offering both active and passive forms of recreation, from organized sports facilities and playgrounds, to scenic overlooks and trails. Park amenities include picnic areas, lodges, playgrounds, ball fields and tennis courts; some also include sandy beaches, ice-skating rinks and pools.[21]

As the City is projected to experience more extreme hot days and heatwaves, increased use of water and electricity will be expected to maintain parks and recreation facilities, as well as to accommodate cooling demand of park and facility users. At the same time, warmer

20 Rochester Urban Forest Master Plan, 2012.

21 City of Rochester Parks, http://www.cityofrochester.gov/parks/.

winters present both positive and negative implications. On the one hand, longer warm seasons will benefit those who enjoy outdoor activities, increasing visitation and use of parks and recreation facilities. However, warmer winters can also negatively impact winter tourism and any snow-dependent activities.

Furthermore, changing climate and more frequent extreme weather events pose a challenge to Rochester's landscape, as well as the attractiveness of parks and open spaces across the City. Known as the Flower City, Rochester also takes pride in its annual Lilac Festival, during which thousands of visitors flock to the City to celebrate and enjoy lilac blooms. Potential impacts to the physical landscape on which this annual event relies would result in cascading effects to the City, both socially and economically.

Overall, Rochester's open space and parks are moderately sensitive to climate change, but the system also has moderately high adaptive capacity to accommodate and adapt to potential climate impacts. Recognizing that the public will rely even more on these resources as warmer temperatures are anticipated, the City is developing and implementing measures to enhance their needs. For instance, the City of Rochester has already partnered with RG&E launch a program called "Cool Sweep," which helps city residents who have limited opportunities to find relief from summer heat through the use of cooling sprays from fire hydrants.

3.2.4 Summary of Findings

Overall, natural resources systems and subsystems present a medium-high vulnerability level. Rochester's natural resources have high sensitivity to extreme temperatures and precipitation as well as extreme storm events. Although there is some adaptive capacity in place, changes for many environmental assets and natural resources due to climate impacts may not be controllable. **Tables 6** and **7** present key strengths and vulnerabilities, as well as the overall vulnerability ranking for each of the systems and subsystems under Natural Resources, respectively.

Table 6. Key Strengths and Challenges Facing Natural Resources' Systems and Subsystems

System	Strengths/Potential Opportunities	Vulnerabilities/Challenges
Environmental Resources	› Completed an Urban Forest Master Plan in 2012.	› Candice and Hemlock Lakes have limits on how much water can be pumped. › Due to topography, Hemlock Lake is more exposed to microbursts; increased risk of shoreline erosion along Lake Ontario and severe flash flooding events. › Potential sediment issues in canal/river with increased heavy rain events (affecting water quality). › Certain tree species (maple, beech, birch) may not be able to survive with increased days of extreme temperatures.

System	Strengths/Potential Opportunities	Vulnerabilities/Challenges
Natural Habitat	› N/A	› Pests and invasive species could expand their range and stress/outcompete native species over time.
Recreational and Open Space	› Majority of parks are well-suited to and have capacity for increased users. › Increased visitation and use of park facilities, especially cooling facilities (i.e. spray parks) on hot days.	› Declined winter recreation/tourism and any snow-dependent activities.

Table 7. Summary of Vulnerability Ranking for Natural Resources' Systems and Subsystems

System	Subsystem/Sector	Vulnerability Ranking				
		Increase in extreme temp. day & duration	Increase in periods of drought	Decrease in days below 32°F	Increase in days over 1" rainfall	Increase in extreme storm events
Environmental Resources	Water bodies & waterways	Med-High	Low	Med-Low	Low	Med-High
	Wetlands	Med-Low	Med-Low	Med-Low	Med-Low	Med-High
	Urban forests	Med-Low	Med-High	Med-Low	Med-Low	Med-High
Natural Habitat	Sensitive and Rare Habitats	Med-High	Med-High	Med-High	Med-High	Med-High
Recreational and Open Space	Open space, public parks and facilities	Med-High	Low	Med-Low	Med-High	Med-High

Appendix C provides full details on the evaluation of sensitivity, adaptive capacity, and vulnerability ranking for these systems and subsystems.

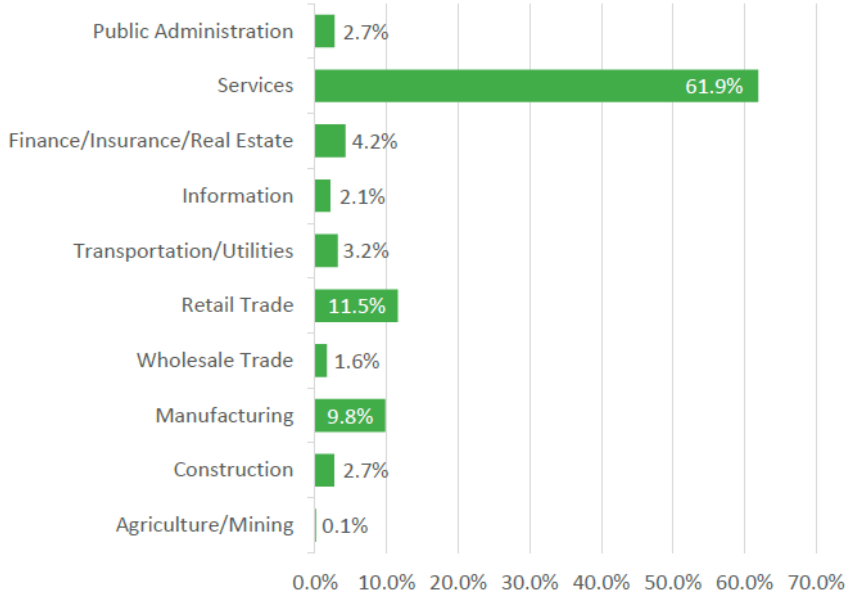
3.3 Socioeconomic Resources

Increased temperatures, changes in precipitation patterns, and more frequent extreme weather events will have impacts on economic, social, and cultural resources within the City of Rochester. Among residents, the degree of these impacts will vary, as some populations are more vulnerable than others. Changing climate impacts will not only present concerns related to public health issues, but also reduce the quality of life for many Rochester residents. Additionally, while Rochester has recently experienced a resurgence of economic reinvestment and revitalization opportunities, the City's growing economy could be compromised if businesses and employees are not protected or unable to adapt to the changing climate.

3.3.1 Economy

Despite the higher unemployment rate (9.3 %, compared to the County's 5.3%)[22], Rochester's economy continues to grow, following state and national trends. Much of Rochester's growth and economic activity is supported by the services industry (61.9%), retail trade (11.5%), and manufacturing (9.8%), as shown in **Figure 10**.[23] The City is also home to some of the largest employers in the region, such as the University of Rochester, Rochester Regional Health, and Harris Corporation, to name a few. Rochester is also home to many local, small businesses, which may experience climate impacts even more severely, as they don't necessarily have the financial resources to prepare for and/or to recover quickly from disaster.

Figure 10. Estimated Employment by Industry in the City of Rochester



Source: Rochester Community-wide Climate Action Plan

Climate change can have both positive and negative impacts to the economy, and even potentially shift Rochester's industries. Agriculture and construction businesses may benefit from having extended warmer days, but snow-dependent industries may suffer from losses. For instance, while more people may enjoy the opportunity for outdoor recreational activities (hiking, boating, etc.) longer, warmer weather will also hurt the traditional winter recreation businesses (skiing, ice fishing, etc.). It should also be noted that while an influx of climate refugees may put more stress on the City's operations and resources, it can perhaps also be a positive opportunity for the city to grow as more workers and businesses

22 United States Census Bureau, 2017 American Community Survey.

23 City of Rochester Community-wide Climate Action Plan.

opportunities from other regions may consider moving into the city given its more temperate climate conditions.

Climate impacts can have cascading impacts for businesses, thus putting the City's economic stability, and even the region's, in jeopardy. Projected increase in extreme precipitation and storm events will increase the risk of physical damage to these business facilities as well as the infrastructure (i.e., roadway closure, power outages, etc.) that supports their operations. For businesses in the service and manufacturing industries, it can cause disruption and/or delay to the delivery of their products and services. For employees, increased temperatures may affect their productivity, especially for outdoor workers (construction workers, landscapers, etc.) and for those working in older facilities without adequate cooling and ventilation. Extreme weather events will also impact the ability of employees getting to and from work. Outdoor workers may also be more vulnerable to the increased presence of new or shifting vector-borne disease as a result of warmer temperatures.

Overall, Rochester's economy is moderately sensitive to climate change impacts. The system also has some adaptive capacity, as many businesses are able to adapt to the changing climate. Plus, having redundancies and back-up systems already built in for most of the City's physical infrastructure systems (transportation network, energy, etc.) provides the stability and capacity for businesses to quickly recover from emergency and disaster events, thus minimizing the disruption and delay to their operations.

3.3.2 Public Health Resources and Services/Quality of Life

Within the context of public health, increased extreme temperature days will affect air quality, increase the risk of heat-related illnesses, and result in longer breeding seasons and ranges for pests (such as ticks and mosquitoes) that carry and can infect the population with harmful diseases (such as West Nile virus and Lyme disease). Increased precipitation can lead to mold exposure in homes and buildings, and increased risk of gastrointestinal (GI) diseases. These are some of the direct and indirect impacts of climate change that can put the health and well-being of many people living in Rochester at risk, especially vulnerable populations such as young children, elderly, or chronically ill. Furthermore, climate change impacts will exacerbate issues around equity and accessibility. Given a high unemployment rate (compared to Monroe County's overall rate) and percentage of households living below the poverty line in the City, community-service resources (e.g., food pantries, soup kitchens, public markets, community gardens, schools, libraries) are important to low-income populations. Disruptions or delays to these services due to climate change effects may further impact the quality of life of these residents. Conditions during heat waves and extreme weather events can pose health and safety issues, compromising the ability of low-income and other vulnerable residents to access these resources.

Climate change impacts will amplify public health issues, and therefore put more stress on the existing healthcare resources and services. Flooding and extreme storms can cause service disruptions, property damage, and other complications that delay emergency service providers or prevent people from getting treatment. A potential rise in hospitalization rates will also put a significant strain on staffing, medical resources, and equipment available for timely treatment. However, based on feedback from the TAC, healthcare service and

emergency service providers currently have the capacity to accommodate higher service demands.

Overall, the City of Rochester recognizes climate change will most severely impact the City's vulnerable populations and different neighborhoods and demographic groups will experience impacts differently and have different resources available to respond and bounce back.

3.3.3 Summary of Findings

Overall, socioeconomic systems and subsystems present a low-medium vulnerability. The City's social system indicates a high level of sensitivity, however, with respect to projected climate impacts for vulnerable populations. On the one hand, healthcare and emergency services indicate high adaptive capacity, as they are able to handle additional demand for care and services, but on the other hand, the overall quality of life in Rochester may be impacted as certain resources and amenities become limited or inaccessible. **Tables 8** and **9** present key strengths and vulnerabilities, as well as the overall vulnerability ranking for each of the systems and subsystems under Socioeconomic Resources.

Table 8. Key Strengths and Challenges Facing Socioeconomic Systems and Subsystems

System	Strengths/Potential Opportunities	Vulnerabilities/Challenges
Healthcare Resources and Services	› Existing healthcare facilities and services have high capacity to address potential increase in service demands. › Emergency plan in place for potential disease outbreaks (County Public Health Department).	› Increased risk of heat exposure and heat-related illness; poor air quality, concern for respiratory-related illness. › More days with heavy rains may lead to CSO-exposure (unsafe for water recreation). › Increased risk of pollutant runoff, risk of pesticides entering the food chain - implications for safety, distribution, and consumption.
Economy	› Longer construction season and/or other outdoor work with warmer temperatures. › More workers from other regions moving to Rochester (and additional business opportunities) due to more temperate weather conditions. › Agricultural benefits with longer growing season—new job opportunities, increased revenue, and new farms.	› More frequent shutdown of businesses due to extreme weather events. › Delay and/or disruption of production or service due to property damage/loss, inaccessible resources, inability of employees to commute to work.
Cultural Resources	N/A	› Health and safety of zoo animals threatened. › Invasive species, termites and mold exposure due to more heavy rains result in quicker deterioration of

System	Strengths/Potential Opportunities	Vulnerabilities/Challenges
		sensitive materials (bricks, artifacts, etc.)
Social/Human Services	› Fewer homeless individuals seek shelter services when temperatures are above freezing.	› Late harvest and reduced yields (due to heavy precipitation), leading to shortage of fruit and vegetable supplies › Individuals with disabilities or language barrier may be disproportionally affected—unable to access evacuation routes and understand or receive warnings of impending danger, limited ability to communicate their needs.

Table 9. Summary of Vulnerability Ranking for Socioeconomic Systems and Subsystems

System	Subsystem/Sector	Vulnerability Ranking				
		Increase in extreme temp. day & duration	**Increase in periods of drought**	**Decrease in days below 32°F**	**Increase in days over 1" rainfall**	**Increase in extreme storm events**
Public Health Resources	Health services	Low	N/A	N/A	N/A	Med-High
	Citizen health/public health resources	Med-High	Med-High	Low	High	High
	Emergency services	Med-High	N/A	N/A	Med-Low	Med-High
	Air quality	Med-High	Med-High	N/A	N/A	Med-Low
Economy	Jobs/workforce	Med-High	Med-Low	Potential Opp	Low	High
	Key industries & employers	Med-Low	Med-Low	Low	Low	High
Cultural Resources	Historic & cultural resources	Med-Low	N/A	N/A	Low	Low
Social/Human Services	Food systems	Low	Med-Low	Potential Opp	Low	Low
	Quality of life	Med-Low	Low	Low	Med-Low	Med-Low

Appendix C provides full details on the evaluation of sensitivity, adaptive capacity, and vulnerability ranking for these systems and subsystems.

4

Recommendations and Next Steps

Based on the assessment on sensitivity and adaptive capacity of the identified systems and subsystems, the following are key vulnerabilities, cross-system strengths and vulnerabilities for the City of Rochester to consider.

4.1 Strengths and Opportunities

High adaptive capacity in place for most systems

Based on the discussions and feedback from the Technical Advisory Committee, major systems servicing the City's physical infrastructure as well as health care services already have redundancies or back-up systems in place that will allow them to quickly respond to and recover from service disruptions and emergency issues.

Available technical knowledge/expertise and best practices

The City recognizes that climate change is inevitable, and therefore, has been actively engaging in various planning efforts over the years to mitigate and minimize climate impacts on its operations and residents as much as possible. While this CVA is the first step of its adaptation and resiliency planning efforts, many regional agencies and city departments have already begun looking ahead, especially considering potential expertise or actions needed to protect the City's physical infrastructure. Additionally, as the City of Rochester will not be alone in facing climate change impacts, it can also look to lessons-learned and best practices in other areas or regions, especially places that may have already experienced the similar climate being projected for Rochester.

New economic opportunities

While it is critical to prepare for the negative consequences of climate change impacts, the City may also experience some positive impacts that lead to new economic opportunities. For instance, warmer winters may allow for a longer construction season, or help boost tourism as timing for outdoor activities will also likely to extend. Shift in climate may also enable introduction of new crops, and even longer growing seasons that open Rochester up for more agricultural opportunities.

4.2 Vulnerabilities or Challenges

Increased stress on existing systems

While the majority of systems in the City have high adaptive capacity to respond to and recover from service disruptions, it should be noted that most systems, especially the physical infrastructure systems, will still experience more stress due to increasing demand and usage. Even if technical capabilities exist for responding to these issues, the fact that such stresses are likely to be more frequent and for longer durations will require planning for design, operations, and maintenance that assume these conditions.

Uncertainty about resources needed for repair and maintenance

This is a particular concern for potential increases in frequency of freeze-thaw conditions, which cause more regular damage to roadways and other infrastructure, and also presents uncertainty around the types of resources (and duration and volume) needed for a range of icy, snowy, and/or wet winter storm response.

Uncertainty about the ability to accommodate increased demands

Climate change impacts are already severely affecting other regions across the U.S., compromising many people's livelihood and well-being. As a result, "climate refugees" are increasingly forced to leave their homes and restart somewhere else, temporarily and even permanently. In fact, the City of Rochester has recently experienced an influx of climate refugees from Puerto Rico as a result of Hurricane Maria in 2017. While the City will experience some negative climate impacts, its overall climate vulnerability is lower than many other parts of the country and may be seen as a safe haven for many seeking new homes. An influx of people into the City will certainly add more stress on the City's operations and services, but it remains difficult to forecast the capacity and resources needed to accommodate the potential population increase or how quickly such an influx may occur.

4.3 Preliminary Recommendations from the TAC

The following preliminary short-term actions and strategies are recommended by the Technical Advisory Committee, as an outcome of the sensitivity and adaptive capacity assessment workshop.

Infrastructure

- Consider additional mechanisms to ensure adequate heating and cooling at bus stops;
- Increase efforts around tree maintenance and debris clean-up to prevent damage to electrical wires and towers;
- Make street design deadlines flexible to accommodate additional maintenance services as needed; and
- Incorporate resiliency measures into early-design stage of infrastructure projects.

Natural Resources

- Modify tree planting guide, and introduce new street trees that are more drought resistant;
- Develop strategies to safely removing dead or dying trees, to prevent waterway blockage, etc.;
- Develop a comprehensive invasive species tracking and removal program; and
- Conduct a mapping exercise to assess distribution of parks and recreational facilities, especially those with cooling mechanisms during extreme hot days/heatwaves, among neighborhoods.

Socioeconomic Resources

- Develop an awareness program to communicate public health issues related to climate change;
- Create mechanisms for renters to communicate or report on issues related to their buildings (mold exposure, lack of ventilation, etc.);
- Create a system/platform for Lyme disease registry; and
- Consider providing preventative care and/or resources to vulnerable populations prior to anticipated extreme temperature days or storm events.

The City also continues gathering feedback and additional ideas from community stakeholders via an online survey. This on-going effort will further inform the assessment and prioritization of strategies and actions in the upcoming adaptation planning phase.

4.4 Development of a Climate Adaptation Plan

Building on this high-level climate vulnerability assessment, the next step for the City of Rochester is to identify, assess, and prioritize specific adaptation strategies or actions. A comprehensive analysis on the applicability and feasibility of identified strategies and actions will also be key to effective implementation and resiliency enhancement. As such, the adaptation plan will hone in on more specific details, including, but not limited to:

- Criticality of assets;
- Timing of the expected climate impact, lifespan of assets, and appropriate timing for investment; and

- Ability to leverage additional resources and/or collaborative partnerships to address common risks for the region at large.

The adaptation planning efforts will also rely on the continuation of stakeholder engagement, and public input and participation.

5

Key Terms and Definitions

Adaptive Capacity – The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Climate – The average weather conditions at a particular place over a long period of time.

Climate Change – A change in global or regional climate patterns that can be identified (i.e. by using statistical tests) and lasts for an extended period, typically decades or longer. According to the Intergovernmental Panel on Climate Change (IPCC), climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes to the composition of the atmosphere or in land use.

Climate Change Condition – Direct climate-related consequences of global climate change, such as changes to the annual average temperature and precipitation, and frequency and intensity of extreme weather events.

Climate Projections – Model-derived estimates of future climate. Likelihood that something will happen several decades to centuries in the future for given developing conditions. Model projections typically include global temperature and precipitation, extreme precipitations and droughts, and snow and ice.

Climate Impact – An effect that results from changing climate conditions. Climate impacts include things such as flooding, drought, heat waves, wildfires, and landslides.

Criticality – The consequences of failure for an individual asset or operation with respect to the continued functioning of the City.

Exposure – A degree of climate stress upon a particular unit analysis; it may be represented as either long-term changes in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events.

Resilience – The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.

Risk – The likelihood of an event happening, and the consequence should that event take place.

Sensitivity – The degree to which a built, natural, or human system will be impacted by changes in climate conditions.

Vulnerability – The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Weather – The daily conditions of the atmosphere in terms of temperature, atmospheric pressure, wind, and moisture.

6

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7

Appendices

A. Resources & References

B. Summary of Climate Trends and Projections Identified Critical Assets, Operational Components, and Infrastructure

C. Impacts Matrix

D. Stakeholder Engagement Notes

APPENDIX A: Resources & References

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APPENDIX B

- Summary of Climate Trends and Projections
- Identified Critical Assets, Operational Components, and Infrastructure in the City of Rochester

Summary of Climate Data Review

Regional and Local Climate Trends

Changing climate conditions related to temperature and precipitation have been observed and experienced throughout the Northeast, including in the state of New York and City of Rochester area, such as:

- The average annual temperature for the Northeast has increased approximately 2°F over the last two decades (NOAA NCEI).
    - In New York, the statewide average annual temperature has increased approximately 2.4°F since 1970, with winter warming exceeding 4.4°F (NYSERDA ClimAID). An increase in average annual temperature was observed in all regions across the state.
    - In many areas of New York, Spring has been starting earlier and winter snow cover is decreasing compared to a few decades ago (NYSERDA ClimAID).
    - Increase in length of freeze-free season over the last 30 years. The freeze-free season is defined as the period of time between the last spring frost (a daily minimum temperature of less than 32°F) and the first fall frost (NOAA NCEI).
    - Despite a trend toward warmer winters, the risk of frost and freeze damage continues, and has paradoxically increased over the past decade (NCA 3).
- New York's statewide average precipitation is a little over 40 inches annually; this varies regionally, with mountainous regions of the state receiving more than 50 inches per year. Statewide annual precipitation has ranged from a low of 31.6 inches in 1964 to a high of 55.7 inches in 2011 (NOAA NCEI).
- The Northeast is one of the regions that has also seen more extreme precipitation and more frequent flooding (including from rivers). In fact, between 1958 and 2010, the Northeast saw more than a 70% increase in the amount of precipitation falling in very heavy events[1] (NCA 3).
    - When Hurricane Irene hit in August 2011, inland areas including upstate New York were severely impacted from extreme flooding. Roads and bridges were either washed out or blocked by downed trees and power lines; many homes and businesses were flooded and had to evacuate; floodplain forests were inevitably damaged by flash floods. This catastrophic event took 41 lives and resulted in an estimated economic cost of $16 billion. While Rochester was not in the direct path of this storm, it has experienced flooding from remnants of this and other tropical systems.
- New York has been experiencing an increase in the average annual precipitation since 1900, with "year-to-year and multiyear variability becoming more pronounced" (NYSERDA ClimAID).
- Since 1998, the maximum ice cover extents on Lakes Erie and Ontario have been below the long-term average. Since 2006, Lake Ontario has remained below 30% ice-cover (except for a higher value during the cold 2013–2014 winter) (NOAA NCEI, NOAA Great Lakes Environmental Research Laboratory).

[1] Defined as the heaviest 1% of all daily events.

- About half of the annual snowfall comes from the "lake effect" process and is very localized. Total season snowfall on average is about 90 inches in Rochester (2013 Finger Lakes Regional Sustainability Report).

Regional and Local Climate Change Projections

To consider potential changes to the climate that have no precedent in historical measurements, scientists and policy makers have developed climate model simulations that project the potential future pathway scenarios of greenhouse gas emissions. The resulting climate scenarios are helpful for planning purposes; however, they should only be viewed as scenarios and not forecasts, as actions taken today and into the future will influence the outcomes.

Emissions Scenarios:

NCA 3

Third National Climate Assessment (NCA)'s 2014 "Climate Change Impacts in the United States, Chapter 16: Northeast" (Horton et. al., 2014). This report presents the observed and projected climate data for the Northeast. Graphics showing projected changes in this report were simulated by the Coupled Model Intercomparison Project Phase 3 (CMIP3) models, using A2 and B1 greenhouse gas emissions scenarios. A2 and B1 are two of the four greenhouse gas (GHG) emissions scenarios published by the Intergovernmental Panel on Climate Change (IPCC) in its 2000 Special Report on Emissions Scenarios (SRES). GHG emissions would continue to increase under the A2 scenario, but would be substantially reduced under the B1 scenario.

NCA 4

Fourth National Climate Assessment, Volume I: Climate Science Special Report (CSSR) (Wuebbles et. al., 2017). While the development of NCA 4 is in progress, a special report on climate data was released in 2017. The CMIP5 models were simulated to show projected changes in this report, using two of the four representative concentration pathways (RCP) scenarios 4.5 and 8.5. The RCP scenarios are numbered according to changes in radiative forcing in 2100 relative to preindustrial conditions. RCP 8.5 implies a future with continued high global carbon emissions growth, whereas RCP 4.5 represents a lower global carbon emissions growth.

NOAA

National Oceanic and Atmospheric Administration (NOAA)'s 2013 "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 1, Climate of the Northeast. U.S" Technical Report (Kunkel et. al., 2013). The projected data presented in this report are based on the A2 and B1 emissions scenarios as the primary basis for climate change projections. For most baseline conditions within this report, NOAA uses 1971-1999, 1971-2000, or 1980-2000 as the model reference periods due to variation in data availability.

NOAA National Centers for Environmental Information (NOAA NCEI)'s State Summaries. NOAA NCEI produces state summaries to provide state-level information based on the Third U.S. National Climate Assessment released in 2014. The summaries cover assessment topics directly related to NOAA's mission, specifically historical climate variations and trends, future climate model projections of climate conditions during the 21st century, and past and future conditions of sea level and coastal flooding. This analysis references the state summary for New York.

NYSERDA ClimAID 2014

New York State Energy Research and Development Authority (NYSERDA)'s "Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information" (Horton et. al., 2014). This report is an update to the original ClimAID assessment report previously published in 2011. In this report, CMIP5 models, developed for the Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment Report (AR5), were used to simulate projections for temperature, precipitation, sea level rise, and extreme events, and driven by the RCP 4.5s and 8.5 scenarios.

USGS

U.S. Geological Survey National Climate Change Viewer (Alder and Hosteler, 2016). These images are created by spatially averaging the NASA NEX-DCP30 data set, and projections are based on the average of 30 CMIP5 models.

Timeframes

These sources use a variety of reference periods for their measurements and timeframes for projections. For simplicity, this report refers to the timeframes as "baseline"; "mid-century"; and "end of century" as indicated in Table 1 below.

Table 1 – Climate Projection Timeframes

Source	Timeframes		
	Baseline	**Mid-Century**	**End of Century**
NCA 3	1971-2000	2041-2070	2071-2099
NCA 4	1901-1960	2036-2065	2071-2100
NOAA	1971-1999; 1971-2000; or 1980-2000	2041-2070	2070-2099
NYSERDA ClimAID	1971-2000	2050-2079	2080-2100
USGS	1981-2010	2050-2074	2075-2099

Summary of Climate Projections

Table 2 provides a summary of climate change projections for the Rochester area. The majority of the information listed in this table utilizes data referenced in the NYSERDA ClimAID 2014 report, given its specificity to the regional and local levels. For climate conditions noted with an asterisk (*), referenced baseline and projections data are based on the other data sources listed above.

Table 2 – Summary of Climate Change Projections

Climate Conditions	Timeframes		
	Baseline	**Mid-Century**	**End of Century**
Average Annual Temperature	47.7°F	52°F to 54°F	54°F to 59.4°F
Number of Days ≥ 90°F	8 days	22 to 34 days	27 to 57 days
Number of Days Per Year Below 32°F	133 days	86 to 96 days	68 to 88 days
*Consecutive Days with Temperature > 95°F	1 to 2 days	2 to 4 days	
Number of Heatwaves	≤ 1 event	3 to 4 events	3 to 8 events
Duration of Heatwaves	4 days	4 to 5 days	4 to 6 days
Average Annual Precipitation	34 inches	4% to 10% increase	4% to 19% increase

Days Per Year with Over 1" Rainfall	5 days	5 days	5 to 6 days
*Extreme Events	2-3 times more frequent by the end of century		
Annual Snowfall	Less frequent snowfall, shorter snow season		
Drought	Increase in short-duration drought during summer season by end of century		

This section summarizes the highlighted climate projections and primary climate impacts described in the referenced data sources. Overall, while there may be variations among the reviewed sources, in terms of projection models and type of emissions scenarios, it should be noted that all sources still demonstrate a close range and consistency in projection results and trends.

TEMPERATURE PROJECTIONS

NCA 3

- The average annual temperature in the Northeast is projected to increase between 3°F to 6°F (under B1 scenario), or between 4.5°F to 10°F (under A2 scenario) by the end of century.
- Upstate New York, and specifically around Rochester area, is projected to experience between 20 to 30 days per year with maximum temperatures at or above 90°F by mid-century.

NCA 4

- Projected changes in annual average temperature for the Northeast will increase between 3.98°F (under RCP4.5 scenario) to 5.09°F (under RCP8.5 scenario) by mid-century, and between 5.27°F (under RCP 4.5 scenario) to 9.11°F (under RCP 8.5 scenario) by end of the century.
- Most regions could experience approximately 20 to 30 more days per year with maximum temperature over 90°F by mid-century. Consistently, it is projected about 20 to 30 fewer days per year with a minimum temperature below freezing in the northern and eastern parts of the nation.

NOAA

- By mid-century, the average annual temperature for the Northeast region is projected to increase between 2.5°F and 4.5°F (B1 scenario) and between 3.5°F and 5.5°F (A2 scenario), from the baseline range of current average annual temperature range between 51°F and 55°F. By the end of the century, the region's average annual temperature is projected to increase between 3.5°F and 5.5°F (B1 scenario), and 6.5°F to 8.5°F (A2 scenario).
    - Upstate New York region seems to fall on the lower end of the ranges under both scenarios for mid-century as well as end of century projections.
- The average seasonal temperatures are also projected to increase, with the slightly smaller increase in the spring. The following projections are for A2 scenarios:
    - Average annual winter temperature is projected to increase between 5.5°F and 5.5°F;
    - Average annual spring temperature is projected to increase between 3°F and 4°F;
    - Average annual summer temperature is projected to increase between 5°F and 5.5°F; and
    - Average annual fall temperature is projected to increase between 4.5°F to 5.5°F.
- By mid-century, the Northeast region is projected to experience an increase of up to 21 days per year with maximum temperature above 95°F.

  - Upstate New York/Rochester area is projected to have an increase of 6 to 9 more days per year with maximum temperature above 95°F.
  - Consecutive days with maximum temperatures exceeding 95°F is also projected to have a small increase between 1 to 2 more days per year for the upstate New York/ Rochester area.
- By mid-century, the Northeast region is projected to experience approximately 26 less days per year with maximum temperature below 32°F.
  - It is projected a decrease between 20 to 22 days less per year with maximum temperature below 32°F for upstate New York/Rochester area.
- By mid-century, the Northeast region is projected to experience up to 24 less days per year with maximum temperature below 10°F.
  - It is projected 12 to 15 less days per year with maximum temperature below 10°F for upstate New York/Rochester area.
- The length of freeze-free season in the Northeast is also projected to increase by 23 to 27 days.

NYSERDA ClimAID Report[2]

- The statewide average annual temperature is projected to increase between 4.1°F to 6.8°F by mid-century, and 5.3°F to 10.1°F by end of the century.
  - In Region 1, where City of Rochester is located, average annual temperature is projected to increase between 4.3°F and 6.3°F by mid-century, and 6.3°F to 11.7°F by end of the century. The Baseline average annual temperature (1971-2000) is 47.7°F.
- The average number of days per year with maximum temperature above 90°F is projected to increase to between 22 and 34 days by mid-century, and between 27 to 57 days by end of century.
- The average number of heat waves each year is projected to be between 3 to 4 events by mid-century, and between 3 to 8 events by end of the century, compared to baseline of no more than one annually. Furthermore, the duration of heat waves is also projected to slightly increase, but no more than 1 additional day by mid-century, and up to 2 additional days by end of century.
- The average number of days with minimum temperature below 32°F will decrease from the baseline average of 133 days to between 84 to 96 days by mid-century, and 68 to 88 days total by end of century.

PRECIPITATION PROJECTIONS

NCA 3

- Winter and spring precipitation is projected to increase in the Northeast region, especially the northern part of the region.
- It is noted that the frequency of heavy downpours is projected to continue to increase as the century progresses.
- By end of the century, the Upstate New York/Rochester area is projected to experience approximately 10% to 20% increase in annual average maximum precipitation volume (RCP 2.6 scenario), and approximately 20% to 30% increase (RCP 8.5 emissions scenario).

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[2] 2014 data updates are presented here; Region 1

- At the same time, update New York/Rochester area is also projected to experience approximately 10% increase in number of consecutive dry days (days receiving less than 0.04 inches or 1 mm of precipitation) by the end of the century.

NCA 4

- Projected changes in precipitation volume and frequency remain similar to the projections presented in NCA 2014 report. However, one major thing to note is that the Northeast is projected to experience the largest increase in number of extreme events by 2 to 3 times the historical average for the region by the end of the century.

NOAA

- Percentage change in average annual precipitation for the Northeast region varies between 0% to 12% for both mid-century and end of century.
    - Upstate New York/Rochester area is projected an increase between 6%to 9% (under both A2 and B1 scenarios) by mid-century, and an increase between 9% to 12% (A2 scenario) or 6 to 9% increase (B1 scenario) by end of the century.
    - Percentage change for average seasonal precipitation is also projected to increase between 16% to 20% during the winter season, 12% to 16% during the spring season, 4% to 8% during the fall season, and a decrease of up to 4% for the summer season.
- By mid-century, the Northeast region is projected to experience an increase between 4 to 12 days per year of precipitation of greater than 1 inch.
    - It would be closer to a projected increase of 6 to 8 days for the upstate New York/Rochester area.
    - Maximum consecutive number of days with precipitation of less than 0.1 inches will increase only slightly increase by no more than 1 day annually by mid-century for upstate New York/Rochester area.

NYSERDA ClimAID Report

- Statewide average precipitation volume is projected to increase between 3% to 12% by mid-century, and between 4% to 15% percent by end of century. It is noted that seasonal projections are less certain than annual results; however, much of this additional precipitation is projected to likely occur during the winter months. Precipitation projections for late summer and early fall show a slight reduction in many climate models.
    - In region 1, where Rochester is located, the average annual precipitation is projected to increase 4% to 10% by mid-century, and between 4% to 19% increase by end of century, from the baseline annual average (1971-2000) of 34 inches.
    - The average number of days per year with 1-inch rainfall is not projected to change for mid-century, but will slightly increase from the baseline of 5 days to between 5 and 6 days by end of century for Region 1.
- By the end of the century, it is more likely than not that late-summer short-duration droughts will increase.
- As the century progresses, it is projected that snowfall is likely to become less frequent, with the snow season also decreasing in length.

USGS

- Decrease of approximately less than 1 inch in change in annual average snowfall in Rochester area by midcentury and end of century

Climate Change Impacts

There are a number of climate impacts likely to continue to be experienced or that will emerge given the projected future climate conditions. In addition to the data sources referenced above, the *2013 Finger Lakes Regional Sustainability Plan* and the *2017 City of Rochester Climate Action Plan* were also referenced for a high-level overview of potential climate change impacts at regional and local levels. A high-level snapshot of potential impacts (as well as some opportunities) based on the described climate projections above, include:

Increase in temperature days and duration:

- Increase in pollen production which may exacerbate asthma, allergies, and other respiratory conditions.
- Changes or loss of ecosystems and biodiversity (especially in nearby Lake Ontario)
- Increase in airborne particulate matter and reduced air quality
- Quality of soil and crop yields reduced
- Increased demand for water for irrigation
- Depletion of water supply
- Increase in public health and safety risks, particularly for the elderly, children, and pregnant women populations
- Urban heat island effects
- Increase in growing season, but potential shift in crop production and livestock areas due to climate shift
- Reduced demand for heating (reduced energy consumption), but at the same time, energy demand for cooling may increase

Changing in frequency and intensity of precipitation:

- Increase in sediment and contaminants in water bodies
- Increase in soil erosion and runoff due to greater flood or flash flood risk
- Potential sanitary sewers and stormwater management systems overflow, pollutant run-offs, and therefore putting water quality and recreational activities at risk
- More frost heaves and potholes on road and bridge surfaces due to more freeze-thaw conditions
- Increase in mold problems in homes and businesses
- Increase in travel delays
- Potential damage to power plants, rail lines, trees, during extreme weather events.

Identified Critical Assets, Operational Components & Infrastructure in Rochester

As part of the City's climate vulnerability assessment, the following three planning subject areas as the overarching framework for the City's environmental, social, and economic resources:

- Infrastructure
- Natural Resources
- Socioeconomic

Within each of these planning subject areas, various systems (and subsystems) have also been outlined, representing the City's built environment, operational components, and services to be evaluated in the vulnerability assessment. When possible, preliminary research of key assets under each of these systems and subsystems has also been conducted. However, it should be noted that for certain systems, especially under the "Socioeconomic" planning subject area, there may not be associated physical assets, and therefore potential climate change impacts will be evaluated at the system level as a whole.

The following list of identified planning subject areas, systems and subsystems, and key assets is compiled based on the Project Team's review of existing planning reports and documents, including:

- City of Rochester's 2012 Municipal Operations Climate Action Plan and 2017 Community-wide Climate Action Plan
- 2015 City of Rochester Energy Master Plan
- Center City Master Plan
- Renaissance 2010 Plan (Rochester's current comprehensive plan, but update is in progress)
- The Long-Range Transportation Plan for the Genesee-Finger Lakes Region 2040 (LRTP 2040)
- 2013 Special Report: Poverty and the Concentration of Poverty in the Nine-County Greater Rochester Area
- 2011 Finger Lakes Regional EDC Strategic Plan
- 2013 Finger Lakes Regional Sustainability Report
- 2016 Genesee-Finger Lakes Regional Critical Transportation Infrastructure Vulnerability Assessment
- New York Climate Change Science Clearinghouse

Planning Subject Area	System	Sub-system/Sector	Key Assets
Infrastructure	**Transportation**	Roads and bridges	• Major roadways: ○ NY State Routes 15, 31, 33A, 96, 104, 204, 363 • Major arterials in the City: ○ Monroe Avenue ○ University Avenue ○ State Street ○ Mt. Read Blvd

Planning Subject Area	System	Sub-system/Sector	Key Assets
			○ Lyell Avenue ○ East Avenue ○ Lake Avenue ○ Main Street ○ Dewey Avenue ○ Atlantic Avenue ○ Clinton Avenue ○ Culver Road ○ Goodman Avenue ○ St. Paul Avenue ○ Mt. Hope Avenue ○ Winton Road ○ Elmwood Avenue ○ Exchange Blvd • Bridges: ○ I-390 over Genesee River ○ Broad Street Bridge ○ Elmwood Avenue Bridge ○ Veterans Memorial Bridge (NY Route 104) ○ Frederick Douglas-Susan B Anthony Bridge (I-490) ○ Colonel Patrick O'Rorke Memorial Bridge ○ Ford Street Bridge ○ Andrew Street Bridge ○ Main Street Bridge ○ Driving Park Bridge ○ Smith Street Bridge
		Public Transportation	• Regional Transit Service (RTS) – Monroe routes • RTS Transit Center • RTS operations centers • Bus shelters
		Highway	• I-390, I-490, I-590 • New York State Thruway
		Bike/pedestrian network	• Genesee Riverway Trail (and Eastman & Genesee Riverway Trails) • El Camino Trail • Erie Lackawanna Rails-to-Trails Pedestrian Bridge • Lake Avenue to Lighthouse Trail and Overlook • Susan B. Anthony Trail • Turning Point Trail

Planning Subject Area	System	Sub-system/Sector	Key Assets
			• On-street bike routes (from Rochester Bike Master Plan) • ARTWalk (along University Avenue) • The Promenade at Erie Harbor • Pedestrian bridges (Pont de Rennes, U of R, etc.)
		Airport & port	• Greater Rochester International Airport (ROC) • Port of Rochester • Amtrak Rochester Station • Greyhound/Trailways Bus Station
		Railways	• CSX railroad
		Others	• Snow plow network and prioritized routes
	Utilities	Energy	• RG&E Transmission and Distribution Infrastructure • RG&E hydropower plants • Eastman Business Park energy generation systems • Rochester District Heating Cooperative (RDH) infrastructure • University of Rochester cogeneration facility • City and County solar PV arrays
		Telecommunication	• Emergency response /communication systems • Data centers
		Others	• Power transformers • Fuel farms
	Water	Water supply	• Cobbs Hill, Highland Park, and Rush Reservoirs (and Hemlock and Canadice Lakes) • Hemlock water Filtration Plant • Pump stations • Monroe County Water Authority
		Wastewater	• Northwest Quadrant and VanLare WWTF

Planning Subject Area	System	Sub-system/Sector	Key Assets
			• Sanitary sewer system[3]
		Stormwater	• Storm drains • Storm sewer system • Outfalls
		Flood-protection infrastructure	• Mount Morris Dam • Court Street Dam • Various smaller dams in the area • Flood wall • Station 5 (below waterfall?)
	Buildings and Facilities	Commercial/Businesses	• Eastman Business Park • Wegmans • Xerox • Blue Cross Arena • Philips Associates – management company for nursing homes • Small businesses • Food processing and other distribution centers in the region
		Residential	• Senior centers • Homeless shelters • Other shelters (i.e. battered women, etc.)
		Industrial	• Eastman Business Park • Gleason Works • RF Harris Communications • Delphi
		Institutional	• University of Rochester • Rochester Institute of Technology • Monroe Community College • SUNY Brockport downtown campus • K-12 schools
		Municipal/Public facilities	• Neighborhood community centers • Central Library • Branch libraries (serve as neighborhood "cooling centers") • Facilities Maintenance Center

[3] Note: About 70% of Rochester's wastewater system is combined sewer and stormwater system.

Planning Subject Area	System	Sub-system/Sector	Key Assets
			• Environmental Services Operations Center • Homeless services
		Critical facilities	• UR-Strong Memorial Hospital • Rochester General Hospital • Highland Hospital • St. Mary's Hospital (serve majority of vulnerable populations) • Unity Hospital (services much of the west side of the City, even though it is outside of City limits) • Emergency Response Facilities (Fire stations, police stations, City Rec Center, designated community centers, cooling and warming centers)
		Others	• Place of worship (churches, temples, etc.) • Data centers • Materials management and recycling centers • Facilities and contaminated sites that rely on power for operations and maintenance services (i.e. ventilation, etc.)
Natural Resources	**Environmental resources**	Water bodies & Waterways	• Genesee River / Genesee River Watershed • Irondequoit Bay • Lake Ontario • Erie Canal • Hemlock Lake • Canadice Lake • Red Creek (particular flooding concern for University of Rochester)
		Wetlands	• State regulated freshwater wetlands[4] ○ In Genesee Valley Park: RH-2, RH-3, RH-4 ○ In vicinity of Emerson St/Mt Read Blvd: RH-18

[4] Environmental Resource Mapper http://www.dec.ny.gov/gis/erm/

Planning Subject Area	System	Sub-system/Sector	Key Assets
			○ In Seneca Park: RH-6, RH-8, RH-9, RH-20, RH-21) ○ In Duran Eastman Park (RH-12, RH-13, RH-14, RH-15, RH-16,
		Urban forest[5]	• Dominant street tree species: Norway Maples; Honeylocust, Linden, Ash, Oak, Sycamores and London planetrees, Japanese Tree Lilac • Hemlock trees (not so much in the city, but on the banks of Hemlock and Canadice Lakes - vis a vis wooly adelgid disease) • Dominant park tree species: Maple, Oak, Pine, Spruce, Linden, Crabapple, Honeylocust, Arborvitae, Ash • Lilac bushes
	Natural habitat	Sensitive and rare habitats	• Muskrats • Bats
	Recreational and open space	Open space, public parks & facilities	• Durand Eastman Park • Genesee Valley Park • Ontario Beach Park • Seneca Park/Seneca Park Zoo • Turning Point Park • Highland Park • Cobb's Hill Park • Public recreational facilities, cooling facilities & playgrounds • Marinas • Gorge & waterfalls • Conkey Corner Park • El Camino
Socioeconomic	**Public health**	Health services	• Health care providers (i.e., Trillium Health, Lifespan, etc.) • Health clinics • Pharmacies • Monroe County Department of Public Health

[5] Based on the 2012 Urban Forest Master Plan

Planning Subject Area	System	Sub-system/Sector	Key Assets
		Emergency services	• Public safety, fire and police officers/volunteers • Community Emergency Response Team (CERT) • Emergency Communications Center (911 facility) • Monroe County Emergency Operations Center • Public Safety Building
		Air Quality	• N/A
	Economy	Access to services; Jobs/Workforce Key industries/ employers	• University of Rochester • Insurance companies • Wegmans? • Rochester Regional Health • Paychex • Xerox • RIT • Lifetime Health
	Cultural Resources		• Eastman House • The Strong Museum • Rochester Museum and Science Center • Memorial Art Gallery • Mt. Hope Cemetery • Preservation Districts ○ Designated Buildings of Historic Value (DBHV) • Heritage Trail • Kodak Theater (Eastman) • The Little Theater • Radio stations: WXXI,
	Social system /Human services	Food systems	• FoodLink (regional food bank) • Community gardens • Food pantries / emergency food pantries, soup kitchens • Urban agriculture sites • Grocery stores, neighborhood convenience stores • School cafeterias (feed children year-round) • Rochester Public Market • YMCA (also a major employer)
		Others	• Center for Disability Rights

APPENDIX C: IMPACTS MATRIX

	Transportation					
	Roads, highways, and bridges	**Public Transportation**	**Bike/pedestrian network**	**Port & Marina**	**Airport**	**Railways**
Increase in extreme temperature days (over 90°F) and duration (heatwaves)	Loss of pavement integrity and/or decreased utility of pavement due to prolonged heat exposure. Thermal expansion of metal structures (e.g., bridge expansion joints). Maintenance implications for vehicles, including damage from potholes, etc. Broken down vehicles due to overheat, resulting in clogged roadways, etc. Greater electrification of transportation means greater stress on electric grid. Autonomous vehicles more sensitive to paint striping, pavement unevenness, etc.	Weathering and/or damage to fleet (tires, mechanical equipment, etc.). Fluctuations in voltage may result in the damaging of equipment and interruption of service. Inadequate bus/public transit shelters (or shelters without A/C) to help cool people down while waiting for public transportation--increasing risk of heat exposure and heat-related illness for public transportation passengers. Increasing costs for cooling for public transportation facilities (stations, bus depots, maintenance facilities, etc.) Overheated electrical equipment and communications systems. If people used more digital/real time information - less sensitivity to heat (this is really about the user though)	Increasing risk of heat exposure and/or heat-related illness for pedestrians and bicyclists. Loss of pavement integrity and/or decrease utility of pavement due to prolonged heat exposure. Likely increase in bike/ped because more warm months. Although network might not be used as much without trees and shades for cooling.	Increasing risk of heat exposure and/or heat-related illness for port workers and marina visitors. Increasing cost for cooling port facilities.	Loss of runway pavement integrity and/or decrease utility of pavement due to prolonged heat exposure. Overheated electrical equipment and communications systems (disrupted airfield operations). Length of runways becomes inadequate due to decreasing air density (reduced aircraft performance). Stress on energy system due to increase in cooling demand for airport facilities. Increasing cost due to increasing demand for cooling facilities.	Expansion and buckling of railway tracks and joints. Overheated trains, electrical systems and communications equipment. Regional brownouts, interruption or delay to services. Increasing cost for cooling rail terminals/facilities.
Sensitivity	*S0*	*S2*	*S1*	*S2*	*S2*	*S2*
Adaptive Capacity	*AC3*	*AC3*	*AC3*	*AC3*	*AC3*	*AC3*
Vulnerability Ranking						
Increase in periods of drought	Damage to or loss of street trees due to water shortages.	N/A	N/A	N/A	N/A	N/A
Sensitivity	*S1*					
Adaptive Capacity	*AC3*					
Vulnerability Ranking						
Decrease in days below 32°F	More frequent freeze-thaw conditions, creating frost heaves and potholes on road and bridge surfaces, which could result in load restrictions to minimize the damage. Uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing. Adverse environmental impacts reduced through decreased use of salt and chemicals on roads (from snow and ice removal, etc.)	Reduced damage on fleet due to decreased use of salt and chemicals on roads (i.e., snow and ice removal,etc.). Reduced maintenance needs and cost for snow-related issues. More frequent freeze-thaw conditions, creating frost heaves and potholes on road and bridge surfaces, which could result in load restrictions to minimize the damage. Uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing.	Increased stress on sidewalks and bike/paths due to more freeze-thaw cycles. Reduced maintenance needs and cost for snow-related issues. Adverse environmental impacts reduced through decreased use of salt and chemicals on sidewalk and bike/ped paths (i.e., snow and ice removal, etc.). Uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing. Warmer weather allows for more use of the bike/ped network.	Reduced maintenance needs and cost for snow-related issues. Adverse environmental impacts reduced through decreased use of salt and de-icing chemical on nearby trails and commercial areas in the marina. More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing.	Reduced maintenance needs and cost for snow-related issues. Damages to taxiways, runways, roadways, etc. due to more freeze-thaw conditions. Adverse environmental impacts reduced through decreased use of salt and deicing chemicals on taxiways, runways, roadways etc. More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing.	More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing. Reduced maintenance needs and cost for snow-related issues.
Sensitivity	*S3*	*S3*	*S1*	*S1*	*S1*	*S1*
Adaptive Capacity	*AC2*	*AC2*	*AC3*	*AC3*	*AC3*	*AC3*
Vulnerability Ranking						

	Transportation					
	Roads, highways, and bridges	**Public Transportation**	**Bike/pedestrian network**	**Port & Marina**	**Airport**	**Railways**
Increase in days per year with over 1" rainfall	Reduced roadway visibility. More frequent or severe flooding of roads and the potential for road washout. Weaken soil and culverts (that support roads, tunnels, bridges) during flash floods. Roadway closure due to heavy rain. Localized flooding, increased repair and maintenance efforts to keeping drains and culverts clear.	Reduced roadway visibility. More frequent or severe flooding of roads and the potential for road washout. Service disruptions or roadway closure due to heavy rain.	More frequent or severe flooding of roads and the potential for road washout. Erosion, scouring and undermining of pavement on sidewalks and bike paths.	Reduced navigability at ports.	Reduced runway visibility. Travel disruptions due to heavy rain, or runway closure due to flooding. Damage to airport runways and disrupted airfield operations due to flooding. Erosion, scouring and undermining of runway pavement. Weaken soil and culverts (that support runways, roadway to terminals, etc.) during flash flood.	Reduced visibility (risk for track signaling, switching, etc.). Erosion, scouring and undermining of railroad infrastructure (e.g., rail-bed supports, rail lines, etc.). Travel disruptions due to heavy rain and/or track closure due to flooding.
Sensitivity	*S2*	*S3*	*S2*	*S1*	*S1*	*S1*
Adaptive Capacity	*AC3*	*AC2*	*AC3*	*AC3*	*AC3*	*AC3*
Vulnerability Ranking						
Increase in extreme storm events (microbursts, severe t-storm, ice storms, wind storms, tornadoes, etc.)	Damages to roadways and bridges due to fallen trees, debris, making roads and bridges impassible or inaccessible. Safety risk to drivers. More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing.	Damages to public transportation fleet, facilities, and bus stations/shelters. Disruptions or delays in services. Safety risk to drivers and passengers (while waiting for service). More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing.	Damages to bike/ped paths due to fallen trees and debris, making bike/pedestrian path impassible or inaccessible. Disrupted snow plow network and inability/capacity to clean sidewalks after storm events. More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing. Safety risk to bicyclists and pedestrians.	Disruption to port operations and navigation aids. Debris and foreign object damages to port facilities, marina, boats, etc. More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing. Delay in services due to power outages. Safety risk to port workers and marina visitors. Reduced ability to store boats at ports.	Debris and foreign object damages to aircraft, airfield, and ramps/gates, and also interference with aircraft landings and takeoffs. Disruption to airport operations and navigation aids. Delay of cargo shipment. Delay in services due to power outages. More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing. Safety risk to airfield workers.	Damage to train and electrical equipment due to electrical voltage spikes. Power outages, resulting in disruption to electrification of third rail. Delays in services due to power outages. Flooding of underground pathways and/or tunnels used by trains. Debris and foreign object damages to rail tracks, rail signals, communication equipment, etc. More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow); potentially increasing demand for de-icing.
Sensitivity	*S4*	*S4*	*S4*	*S4*	*S4*	*S4*
Adaptive Capacity	*AC2*	*AC2*	*AC3*	*AC3*	*AC3*	*AC2*
Vulnerability Ranking						

	Energy			
	Telecommunication	**Power Plants**	**Transmission and Distribution (T&D) Infrastructure**	**Others (power transformers, fuel farms, etc.)**
Increase in extreme temperature days (over 90°F) and duration (heatwaves)	Overheating of data centers, exchanges, base stations, etc. Decreased range of wireless signal transmission. Increasing air-conditioning requirements and cost to maintain communications systems and equipment; potentially higher cooling demands but the capacity should be there; cost and maintenance implications. If servers go down, this will significantly impact a lot of departments; edundant systems are in place up to certain time limits. Potential impacts to wireless technology, phone and internet systems, having an impact on quality of life.	Increasing stress on power grid due to higher cooling demand. Increasing risk for more brownouts and blackouts due to increasing electric demand. Reduced generation efficiency due to increased temperature of cooling water. Increased heat exposure, heat-related illness, and safety risks for maintenance workers.	Increasing stress on power grid due to higher cooling demand. Increasing risk for more brownouts and blackouts due to increasing electric demand. Increasing cost for building new transmission and distribution infrastructure to support greater demand. Sagging transmission lines as a result of increased load due to higher temperatures. Increasing thermal expansion of power lines, reducing the amount of power that can be securely transported. Increased heat exposure, heat-related illness, and safety risks for maintenance workers.	Transformer failure during prolonged heatwaves. Weathering and/or damage to equipment and structures. Increased heat exposure, heat-related illness, and safety risks for maintenance workers.
Sensitivity	*S2*	*S3*	*S3*	*S3*
Adaptive Capacity	*AC2*	*AC2*	*AC3*	*AC2*
Vulnerability Ranking				
Increase in periods of drought	N/A	Shortage of water supply for cooling water, impacts to energy production.	N/A	N/A
Sensitivity		*S3*		
Adaptive Capacity		*AC3*		
Vulnerability Ranking				
Decrease in days below 32°F	Reduced maintenance needs and cost for snow-related issues. More frequent freeze-thaw conditions, uncertainty about resources need for storm response (potentially more ice than snow); potentially increasing demand for de-icing of equipment.	Reduced demand for heating, less stress on generation capacity. Reduced maintenance needs and cost for snow-related issues.	Transmission line instability due to more frequent freeze-thaw conditions; potential damage to transmission lines (potentially more ice than snow). Reduced maintenance needs and cost for snow-related issues.	Structure and pipeline instability due to more freeze-thaw conditions. Reduced maintenance needs and cost for snow-related issues.
Sensitivity	*S1*	*S1*	*S1*	*S1*
Adaptive Capacity	*AC3*	*AC3*	*AC3*	*AC3*
Vulnerability Ranking				
Increase in days per year with over 1" rainfall	Reduced quality and strength of wireless service due to increased rainfall. Changes in requirements to maintain internal environments of system devices due to changes in humidity.	Increase in hydropower generation potential. Flood damage to low-lying/underground infrastructure and access points.	Flood damage to low-lying/underground transmission line and equipment.	Disruption of fuel transportation due to damaged infrastructure (flooding, pipeline damage, etc.).
Sensitivity	*S1*	*S1*	*S1*	*S1*
Adaptive Capacity	*AC3*	*AC3*	*AC3*	*AC3*
Vulnerability Ranking				
Increase in extreme storm events (microbursts, severe t-storm, ice storms, wind storms, tornadoes, etc.)	Damage to communication system due to electrical voltage spikes. Damage to telecommunications towers, data centers, stations, etc. from high wind or fallen trees. Power outages, delay or disruption of services.	Disruption of operations (temporary shutdown of power plants, facilities, etc.). Debris and foreign object damages to power plant infrastructure and facilities. Safety risk to power plant workers.	Debris and foreign object damages to power lines. Safety risk to maintenance workers.	Disruption to fuel transportation (pipes, road, or rail). Debris and foreign object damages to fuel farm facilities. Risk of fuel farm explosion. Safety risk for outdoor maintenance workers.
Sensitivity	*S3*	*S3*	*S3*	*S3*
Adaptive Capacity	*AC3*	*AC3*	*AC3*	*AC3*
Vulnerability Ranking				

	Water				Buildings and Facilities		
	Water Supply	**Wastewater**	**Stormwater**	**Flood-protection infrastructure**	**Commercial/Businesses/Industrial/ Public facilities**	**Residential**	**Critical Facilities (hospitals, emergency response facilities, etc.)**
Increase in extreme temperature days (over 90°F) and duration (heatwaves)	Lower water availability due to increased evaporative losses from Hemlock and Canadice Lakes and Lake Ontario; more concentrated pollutant loads (less water, same amount of pollutant). Increase in cyanobacteria blooms (algal blooms) that could threaten water supply quality. Increase water demand for irrigation, cooling, and other consumptive uses.	Higher temperature of treated wastewater causing thermal impacts on receiving water. Higher water temperature may affect biological wastewater treatment processes. Increased heat exposure, heat-related illness, and safety risks for maintenance workers at the wastewater plant. Overheated equipment, disruption to operations of wastewater plant.	Higher temperature of stormwater runoff causing thermal impacts on receiving waters. High temperature water comes into system, but high adaptive capacity for dealing with it.	3 dams classified as "high hazard" in Rochester (Court Street, Cobb Hill, and Highland).	Thermal expansion of metal structures of commercial buildings or industrial buildings. Increase in cooling demand on commercial and industrial buildings causing stress on the energy system and potential power outages. Increase in internal temperatures in buildings without adequate ventilation, causing heat stress, health problems, and reduced productivity. Cornhill Landing brings in water for cooling - potential issue with higher water temperature. Food production facilities may be more sensitive (currently some refrigeration is barely passing compliance).	Potential power outages due to increase in cooling demand. Increase in internal temperatures in buildings or home without adequate ventilation, causing heat stress and other heat-related illness, especially for vulnerable popultations (elderly, young children, pregnant women, etc.) Increased risk of mold exposure and related illness, and acute damage from extreme weather.	Potential power outages due to increase in cooling demand. Increase in internal temperatures in buildings or facilities without adequate ventilation, causing heat stress, health problems, and reduced productivity. Damage to temperature-sensitive infrastructure (electrical systems), specifically for critical facilities potential severe or fatal implications caused by a loss of power. Increased demand (equipment, supplies) to respond to heat-related illness treatments Increasing cooling demands may be an issue during extended periods of extreme heat/heatwave.
Sensitivity	*S2*	*S1*	*S2*	*S1*	*S2*	*S3*	*S3*
Adaptive Capacity	*AC3*	*AC3*	*AC3*	*AC3*	*AC2*	*AC1*	*AC3*
Vulnerability Ranking							
Increase in periods of drought	Lower water availability. Increase in water demand for irrigation. Can only take so much water out of Candice and Hemlock Lakes without exceeding permit; water conservation measures already in place.	N/A	N/A	Risks of treefall and debris (unhealthy trees and other large vegetation damaged by drought/disease prior to large storm events) resulting in blockage of spillways, etc.	Reduced water availability; impacts to businesses reliant on significant water use.	Impacts to gardens, lawns, and tree canopy.	
Sensitivity	*S2*			*S2*	*S1*	*S1*	*S1*
Adaptive Capacity	*AC3*			*AC3*	*AC3*	*AC3*	*AC3*
Vulnerability Ranking							
Decrease in days below 32°F	Lower water availability caused by decrease in spring snowmelt volume and increase in evaporation due to reduced ice cover. Extended cold would be more concerning, so less cold day may actually be positive.	Increase occurrence of snow melt during winter decreases wastewater temperature and impairs biological wastewater treatment processes.	Decrease snow pack and spring melt could reduce spring runoff volumes; reduced contamination of water bodies.	Warmer winter temperatures may increase winter rainfall and snowmelt, causing peak flows to occur earlier in the season. Spring runoff is projected to decline. Flood risks will depend on timing and magnitude of runoff and precipitation.	More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow). Reduced maintenance needs and cost for snow-related issues.	More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow). Reduced maintenance needs and cost for snow-related issues. Ice damming at houses - once had gutter replacement costing approx. $800,000 citywide	More frequent freeze-thaw conditions, uncertainty about resources needed for storm response (potentially more ice than snow). Reduced maintenance needs and cost for snow-related issues.
Sensitivity	*S0*	*S2*	*S2*	*S3*	*S0*	*S1*	*S0*
Adaptive Capacity	*AC4*	*AC3*	*AC3*	*AC3*	*AC3*	*AC2*	*AC3*
Vulnerability Ranking							

	Water				Buildings and Facilities		
	Water Supply	**Wastewater**	**Stormwater**	**Flood-protection infrastructure**	**Commercial/Businesses/Industrial/ Public facilities**	**Residential**	**Critical Facilities (hospitals, emergency response facilities, etc.)**
Increase in days per year with over 1" rainfall	Stress onwater treatment plants during high turbidity events. Flooding of plants, impacts to infrastrucure and erosion.	Decreased efficiency of wastewater treatment plant due to higher volume of stormwater entering combined sewer system. Risk of combined sewer overflow and contamination of water bodies.	Increased risk of exceeding the capacity of drainage infrastructure, causing localized flooding. Risk of combined sewer overflow and contamination of water bodies.	Increased risk of overcapacity due to potential increase in flood flow. Increased water levels and unpredictable spillways could lead to uncontrolled releases of water. Rainfall or runoff-related erosion risk, can also act as the starting point for internal embankment failures (piping, slumping etc). Dams have to be checked on: Cobbs Hill, Highland Park Reservoir Dam, and Court Street Dam.	Seepage and flooding of interior, and physical damages to building materials. Seepage and flooding of interior, and physical damages to building materials and equipment, especially if critical systems and equipment are located in the lower levels or basements of buildings (i.e., electrical, industrial waste, security systems controls, back-up generators, potable water, etc.). Increase risk of mold growth due to more frequent rain and/or after flooding events. Impacts on historical buildings	Seepage and flooding of building interior and basements. Water damages to homes (building envelope, foundation, etc.) Washout or flooding impacts on housing. Debris (e.g., leaves during fall) can clog drainage and cause back up or flooding. Increase risk of mold growth due to more frequent rain and/or after flooding events. Ongoing stress/damage to older building envelopes/materials.	Disruptions in maintenance, repair, and/or delivery of necessary medical supplies, aid (food or water), and utility supplies. Potential impacts to electrical systems from increased rainfall events, increasing the chance of power outages. Seepage and flooding of interior, and water damages to building materials and medical equipment within the facility, especially if critical systems and equipment are located in the lower levels or basements of buildings (i.e., electrical, medical waste, security systems controls, back-up generators, potable water, etc.).
Sensitivity	*S2*	*S1*	*S1*	*S4*	*S1*	*S2*	*S1*
Adaptive Capacity	*AC3*	*AC3*	*AC3*	*AC3*	*AC3*	*AC2*	*AC3*
Vulnerability Ranking							
Increase in extreme storm events (microbursts, severe t-storm, ice storms, wind storms, tornadoes, etc.)	Risk of power outages interrupting treatment plant and distribution system operations.	Increased risk of combined sewer overflows due to stormwater exceeding conveyance and treatment capacity. Risk of power outages interrupting treatment plant and remote lift/pump station operations.	Increased risk of exceeding the capacity of drainage infrastructure, causing localized flooding. Increased risk of erosion and sedimentation.	Increased risk of overcapacity due to more frequent occurrence and severity of flood events. Rainfall or runoff-related erosion risk and debris blockage can also act as the starting point for internal embankment failures (piping, slumping etc).	Damage to building structure/envelope (especially of older buildings and facilities). Accelerated deterioration of building exteriors due to weathering, erosion, and inundation. Closure and/or restricted access to low-lying buildings due to flooding. Potential economic impacts due to the loss of business, inability for employees to come to work and disruption in the importing and exporting of goods. High sensitivity economically for downtime.	Damage to building structure, especially of older homes. Accelerated deterioration of building exteriors due to weathering, erosion, and/or inundation. Fallen trees and debris from severe storms causing power outages. Closure and/or restricted access to homes due to flooding. Impacts to the aging housing stock (older roofs, windows, insulaion and mechanical systems). Lack of heating or cooling sructures, increased mold/illness, and acute damage from extreme weather.	Damage to building structure/building envelope of older buildings and facilities (e.g., clinics, hospitals, nursing homes). Accelerated deterioration of building exteriors due to weathering, erosion, and/or inundation. Disruptions in employee commutes, in the context of critical care facilities, this is a major impact. Disruptions in the access to critical or medical care facilties for potential emergency situations resulting from severe weather and extreme cooling and heating.
Sensitivity	*S2*	*S2*	*S2*	*S4*	*S2*	*S4*	*S2*
Adaptive Capacity	*AC3*	*AC3*	*AC3*	*AC2*	*AC3*	*AC1*	*AC3*
Vulnerability Ranking							

	Environmental Resources						Natural Habitat	Recreational and Open Space
	Waterbodies & Waterways				Wetlands	Urban forest	Sensitive and rare habitats	Open space, public parks & facilities
Increase in extreme temperature days (over 90°F) and duration	**Hemlock + Canadice Lakes** Canadice and Hemlock lakes have limits on how much water can be pumped.	**Lake Ontario**	**Canal /River**	**General impacts** Increase in Algal Blooms due to warmer temperatures, which may lead to water quality issues and fishkills. More concentrated pollutant loads due to evaporative losses (less water, same amount of pollutant).	Seasonal wetlands may dry up faster impacting dependent species (salamanders, birds, invertebrates).	If combined with periods of drought, increased risk of wildfire. Change in tree species cover, certain species may not be able to survive at increased days in extreme temperatures. For example, maple, beech, birch may no be able to survive.	Muskrat (species of concern) is critical for nesting habitat creation for endangered black tern. A significant reduction of muskrat population from increased predator populations moving northward could negatively impact tern populations (from NYS DEC). Depending on level of intensity/duraction, can negatively impact other species (migration, breeding, habitat, shifts in predator/prey cycles, etc.).	Increased use of water and utility sources at publicly owned and operated parks and recreation facilities due to high temperatures. Increasing cost for cooling facilities. Increase demand/use, potential issues related to crowding, safety, and parking. Increase risk of drowning (Ontario Beach).
Sensitivity	*S4*	*S4*	*S4*	*S4*	*S2*	*S2*	*S4*	*S3*
Adaptive Capacity	*AC2*	*AC3*	*AC3*	*AC2*	*AC2*	*AC2*	*AC2*	*AC2*
Vulnerability Ranking								
Increase in periods of drought	**Hemlock + Canadice Lakes**	**Lake Ontario**	**Canal /River**	**General Impacts** Drought can lead to increase algal blooms. More concentrated pollutant loads due to evaporative losses (less water, same amount of pollutant) - potentially a water supply issue. Loss of habitats.	Loss or damage of wetland resources due to extended and/or more frequent droughts. Species that depend on precipitation fo reproduction may be impacted (e.g., birds, amphibians, etc.)	Trees susceptible to damage from drought could experience die-off. Increased risk of wildfire. Increased risk of falling trees and impacts to people and infrastructure.	Vernal pools can evaporate more quickly due to drought conditions, and negatively impact species that inhabit them.	Limited irrigation of landscaping.
Sensitivity	*S1*	*S1*	*S1*	*S1*	*S2*	*S4*	*S4*	*S1*
Adaptive Capacity	*AC3*	*AC3*	*AC3*	*AC3*	*AC2*	*AC2*	*AC2*	*AC3*
Vulnerability Ranking								
Decrease in days below 32°F	**Hemlock + Canadice Lakes**	**Lake Ontario**	**Canal/River** Risk of ice jam	**General Impacts** Complete ice cover reduces lake effect snowfall. Reduction of ice cover could lead to stronger and increased storms. Erosion (can be natural occurrence) - a concern with multiple years of less or no snow/ice cover.	Fewer freezes to kill off pest species could lead to damage and loss of wetland vegetation.	Early blooming of tree species, followed by population damage by killing frosts. Some trees require the freeze-thaw cycles to grow. If migration patterns don't adjust accordingly, pollination could be impacted.	Less snow cover could lead to less snowmelt available to fill vernal pools making them reliant on more spring rain. If prolonged, possible that pests, invasive and/or pathogens species could expand their range and stress/outcompete native species over time. Negative impact on species that depend on snowcover. If prolonged, shifts in migration/ranges of some species may have cascading impacts on other species.	Increased visitation and use of park facilities. Potential decrease in winter months for winter recreation/tourism, and any snow-dependent activities.
Sensitivity	*S2*	*S3*	*S2*	*S2*	*S2*	*S2*	*S4*	*S3*
Adaptive Capacity	*AC2*	*AC2*	*AC3*	*AC2*	*AC2*	*AC2*	*AC2*	*AC3*
Vulnerability Ranking								
Increase in days per year with over 1" rainfall	**Hemlock + Canadice Lakes**	**Lake Ontario**	**Canal/River** Potential sediment issues, which may reduce water quality.	**General Impacts** Increased turbidity to waterbodies and reservoirs due to increased runoff. Decreased water quality due to combined sewer overflow (caused by increased rainfall).	Increased runoff leads to increased nutrient loading to wetlands and potential decrease in groundwater recharge. Pariculate pollutants could also have increased mobility and negatively impact habitats (e.g., plastic bags, litter, etc.).	Moisture stress for certain species can lead to increased mortality.	Washout of habitats during flash floods, prolonged rainfall events.	Risks of flooding and water damage at park facilities. Safety risk.
Sensitivity	*S1*	*S1*	*S2*	*S1*	*S2*	*S2*	*S4*	*S3*
Adaptive Capacity	*AC3*	*AC3*	*AC2*	*AC3*	*AC2*	*AC2*	*AC2*	*AC2*
Vulnerability Ranking								
Increase in extreme storm events (microbursts, severe t-storm/ice storms, tornadoes, etc.)	**Hemlock + Canadice Lakes** Topography dependent --> likelihood of microbursts (Hemlock more exposed)	**Lake Ontario** Shoreline erosion already experienced along Lake Ontario. More frequent severe flash flooding events.	**Canal/River**	**General Impacts** Increased pollutants in waterways during flash floods.	Erosion to wetland areas along Lake Ontario and Irondequoit Bay.	Increased tree damage from storm events, damage to older forests, but also potential opportunity to create clearings and open habitats.	Areas near Irondequoit Bay support 5 species of bats. Damage/destruction of roost trees (due to storm events) which are critical for bats to raise their pups during breeding seasons. Stress/damage to many species, especially during breeding seasons.	Potential for damage to park facilities and equipment due to severe storm events. Damage to trees, fallen trees/debris. A lot of parks are waterfront and/or have big trees, which may result in erosion of parklands.
Sensitivity	*S3*	*S3*	*S3*	*S3*	*S3*	*S3*	*S4*	*S3*
Adaptive Capacity	*AC2*	*AC2*	*AC2*	*AC2*	*AC2*	*AC2*	*AC2*	*AC2*
Vulnerability Ranking								

	Public Health				Economy		Cultural Resources	Social System/Human Services	
	Health services	**Citizen Health/Public Health (*vulnerable population focus)**	**Emergency services**	**Air Quality (*vulnerable pouplation focus)**	**Jobs/workforce**	**Key industries/employers**	**Historic and cultural resources**	**Food systems**	**Quality of Life**
Increase in extreme temperature days (over 90°F) and duration	Potential increase in hospitalization rates; health care providers' infrastructure and capacity to provide services (efficiently) due to increasing demand for treatment. This includes increased cases of asthma and heat stress. Increase in demand for home healthcare services.	Difficulty accessing these facilities, transpotation and loss of power to systems. Risk of heat exposure and heat-related illness. Health and safety concerns for vulnerable populations (children, elderly, low-income, individuals with pre-existing illness).	Potential increase in hospitalization rates. Increased stress on emergency service providers' infrastructure and capacity to provide services (efficiently) due to increasing demand for treatment.	Elevated levels of ground-level ozone; health concern for those with asthma and other chronic respiratory-related illness. Higher pollen counts due to higher temperatures and CO2 levels; health concern for individuals with allergies, asthma, and other respiratory-related illness. *vulnerbale population focus	Limitation to outdoor operations and maintenance services. Health and safety concerns (heat exposure, heat-related illness) for outdoor workers. Positive impact: More people (workers and business opportunities) from other region moving to Rochester due to more temperate weather conditions. Outdoor workers are more vulnerable to vector-borne diseases.	Decrease in productivity if employees cannot get to work and/or if facilities need be shut down (blackouts). Decrease in productivity if facilities cannot adequately keep up with cooling demand. Increased costs due to more cooling demand of facilities (i.e., buildings, warehouses, offices, etc.).	Damage or deterioration of resources (historic buildings). Overheating of sensitive materials. Health and safety of zoo animals.	Increased heat stress on crops and farm animals (especially for dairy production), therefore reducing yields. Changing in climate may become unsuitable for New England/New York native crops. Crop damage due to invasive species. Shorter shelf life for food, likelihood to spoil in high temperatures.	Health/safety of students in schools if buildings are inadequately air conditioned. Limited outdoor activities (hiking, outdoor events, etc.), especially those with respiratory-related conditions. Impact to tourism and popular annual events in Rochester, specifically related to nature-based attractions, such as the Lilac Festival. Low-income or renters are more likely exposed to poor air quality and lack of ventilation in older buildings, due to lack of financial resources for remediation.
Sensitivity	*S1*	*S3*	*S3*	*S3*	*S3*	*S2*	*S2*	*S1*	*S2*
Adaptive Capacity	*AC3*	*AC1*	*AC1*	*AC1*	*AC2*	*AC3*	*AC3*	*AC3*	*AC3*
Vulnerability Ranking									
Increase in periods of drought	N/A	Potential respiratory issues with increased airborn particles (i.e., dirt and dust).	N/A	Poor air quality caused by build up of stagnant air, increased dust level, increased high-particle days, etc.).	Impact to work availablity for farm workers, landscaping businesses.	Key industries that depend on annual rainfall include, agriculture, food processing, power plants (for cooling), and recreational facilities and marinas.	N/A	Increased risk of crop damage. Impact to local food supply, including community gardens, CSA programs, and local farms that supply the public market. The public market serves a high proportion of low income residents.	Increased drought could impact vegetation, the city's trees, people's lawns, community gardens, etc. May reduce the colors of fall foliage and by extension may reduce tourism to the area.
Sensitivity		*S3*		*S2*	*S2*	*S2*		*S2*	*S1*
Adaptive Capacity		*AC1*		*AC1*	*AC2*	*AC2*		*AC2*	*AC3*
Vulnerability Ranking									
Decrease in days below 32°F	N/A	Warmer winter (or longer warm weather period) leads to longer breeding seasons and expands ranges for pests such as ticks and mosquitoes, increasing risk and exposure to harmful diseases such as Lyme disease and West Nile Virus. Safety risk for outdoor activities (freeze-thaw, wintry mix).	N/A	N/A	Longer construction season and/or other outdoor work. Negative impacts to wokers and jobs in the snow removal industry.	Regional economic impacts due to the loss of business opportunities for outdoor winter recreation (xc skiing, skating, ice fishing).	N/A	Frost damage, reducing yields. Earlier onset of spring and warmer winters could allow some parasites and pathogens to survive more easily, increasing risk to crops and livestock. Longer growing season (shorter winters) may provide agricultural benefits, including new job opportunities, increased revenue, and new farms.	Fewer homeless seeking shelter services when temperatures not below freezing. Decrease in winter activities, impact to winter tourism. Longer season for warm-weather activities/recreation.
Sensitivity		*S1*			*S0*	*S1*		*S1*	*S1*
Adaptive Capacity		*AC3*			*AC3*	*AC3*		*AC4*	*AC3*
Vulnerability Ranking									
Increase in days per year with over 1" rainfall	N/A	Respiratory illness from mold and toxic flood residue in homes. Increase prevalence of mosquitos, which may carry diseases harmful to human health. CSO-exposure when swimming in lake(s).	Intermittant flooding in underpasses could limit emergency service access in certain places throughout the city. Flooding that could interfere with emergency vehicle service accesss.	N/A	Flooding risks to construction projects.	Disrupted transportation and delivery services.	Flood damage or deterioration of resources (historic buildings). Invasive species, termites and mold exposure, resulting in quicker deterioration of sensitive materials (bricks, artifacts, etc.).	Shortage of fruit and vegetable supplies due to late harvest and reduced yields, as result of heavy precipitation. Moisture-reliant pathogens could thrive. Increasing risk of pollutant runoff which could also mean increasing risk of pesticides entering the food chain or evolution of pesticide resistance, with subsequent implications for the safety, distribution, and consumption of livestock and aquaculture products.	Limited outdoor activities. Low-income or renters are more likely exposed to mold issues due to lack of financial resources for remediation. Increasing clean-up and repair costs to damaged properties due to more frequent flooding.
Sensitivity		*S4*	*S3*		*S1*	*S1*	*S1*	*S1*	*S2*
Adaptive Capacity		*AC1*	*AC3*		*AC3*	*AC3*	*AC3*	*AC3*	*AC2*
Vulnerability Ranking									
Increase in extreme storm events (microbursts, severe t-storm/ice storms, tornadoes, etc.)	Power outages, delays and disruptions to health care services. Evacuations may be complicated by the need for concurrent transfer of medical records, medications, and medical equipment. Transportation-related issues: Potential concern for health care staff which preventing them from getting to work and thus impacting the capacity of facilities to provide services; potential concern for people in need of care to access these facilities and services in the time of need.	Transportation-related issues: potential concern for people in need of care to access these facilities and services in the time of need. Power outages caused by severe weather may have serious impacts on elder care facilities (i.e., retirement homes). Impacts to cooling and heating systems and health care equipment.	Power outages, delays and disruptions to critical health care equipment and services. Potential increase in hospitalization rates; Emergency service providers' infrastructure and capacity to provide services (efficiently) due to increasing demand for treatment. Severe weather impacts may cause disruptions for emergency care services, and the ability to reach critical care facilities.	Tree loss (caused by wind storms, microbursts, and other severe storms) may result in public health impacts due to reduced air quality and urban heat island effect.	Safety risk to outdoor workers. Disruption to outdoor operations and/or maintenance services. Increase demand for maintenance/construction workers depending on the magnitude of damgage.	Decrease in productivity if employees cannot get to work and/or if facilities need to be shut down. Disrupted transportation and delivery services. Power outages caused by severe weather may have serious impacts on elder care facilities (i.e., retirement homes). Impacts to cooling and heating systems and health care equipment.	Damage or deterioration of resources (structure damage or collapse).	Ice storm damage to crops. Wind damage to crops. Storm damage prevent distribution/access to food.	Some individuals with disabilities or language barrier may be disproportionally affected if they are unable to access evacuation routes, have difficulty in understanding or receiving warnings of impending danger, or have limited ability to communicate their needs. Limited outdoor activities. Fallen trees and debris damages to properties, increasing home insurance costs for residents. Increasing clean-up and repair costs to damaged properties. Disruption to essential services due to power outages (such as school delays and/or closings).
Sensitivity	*S3*	*S4*	*S3*	*S3*	*S4*	*S4*	*S1*	*S1*	*S2*
Adaptive Capacity	*AC2*	*AC1*	*AC2*	*AC3*	*AC1*	*AC1*	*AC3*	*AC2*	*AC3*
Vulnerability Ranking									

APPENDIX D: STAKEHOLDER ENGAGEMENT NOTES

City of Rochester, NY
Lovely A. Warren, Mayor
Rochester City Council

sustainable rochester

PUBLIC PARTICIPATION PLAN

ROCHESTER CLIMATE VULERABILITY ASESSMENT

1.0 PURPOSE OF THE PLAN

OVERVIEW

For the last several years, the City has worked to reduce greenhouse gas emissions by developing mitigation strategies, which include the development of the Municipal Operations Climate Action Plan, the Energy Master Plan, and the Community-wide Climate Action Plan. As a next step towards becoming more resilient, the City of Rochester, through its Office of Energy and Sustainability, is conducting a Climate Vulnerability Assessment (CVA). The CVA will be a continuation of the City of Rochester's climate efforts to date, supporting the resiliency and adaptation components discussed in the City's recently released community-wide Climate Action Plan. Furthermore, a better understanding of the City's exposure, sensitivity, and adaptive capacity to the potential impacts of climate change will help inform decision-making, planning prioritization, and resource allocation, as it forms the foundation for an upcoming Climate Adaptation Plan.

The City and the Project Team recognize that a thorough assessment of climate vulnerability will require input from a broad array of stakeholders. This Public Participation Plan (PPP) defines key stakeholders and tools, and outlines techniques to engage a variety of stakeholders throughout the study process. The PPP is designed to be a living document with purposeful flexibility. It may evolve over the course of the project as the effectiveness of tools and techniques is evaluated. If necessary, the plan will be modified to better suit the project and broader community.

Finally, this plan formalizes the commitment of the City to solicit meaningful input and engage the public throughout the process.

2.0 COMMITTEES

TECHNICAL ADVISORY COMMITTEE

Overview: The City will convene a Technical Advisory Committee (TAC) made up of technical experts, policy leaders, educational institutions, business groups, and City/regional agency staff or those involved in (or familiar with) planning for and responding to climate change.

vhb

HIGHLAND PLANNING

Purpose: To provide first-hand, on-the-ground understanding of climate implications to operations and activities throughout the city, to assist in tailoring project findings to Rochester's unique strengths and challenges, and to provide expertise.

Members:

Carl Ast, RG&E Asset Management
Mary Austerman, New York Sea Grant, Wayne County Cooperative Extension Office
Patty Bedard, City of Rochester - Water Bureau
Joe Bovenzi, Genesee Transportation Council
Enid Cardinal, Rochester Institute of Technology
Veronica Dasher, RG&E Public Affairs
Sue Hughes-Smith, Rochester People's Climate Coalition
Brian Kehoe, Rochester School District
Dan Kenyon, RTS
Dorraine Kirkmire, City of Rochester – Planning Department
Tim Kohlmeier, Monroe County Emergency Operations Center
Katrina Korfmacher, University of Rochester Environmental Health Sciences
Zina Lagonegro, City of Rochester – Zoning Department
John Lam, Reconnect Rochester
Mary Rose McBride, Lifespan
Erin McCormick, RGRTA
Mike Mendoza, Monroe County Department of Public Health
Laurie Picardo, RG&E Pubic Affairs
Wade Silkworth, Monroe County Department of Public Health
Chris Snyder, City of Rochester – Zoning Department
Jayme Thomann, Genesee Finger Lakes Regional Planning Council
Julie Tolar, RTS
Michelle Virts, Monroe County Pure Waters
Michael Waller, Rochester Regional Health
Harold Zink, Rochester Housing Authority

COMMUNITY STAKEHOLDERS

Overview: Community stakeholders include anyone with a stake or an interest in the project, including residents, business owners, neighborhood organizations, and non-profit entities. The City will engage community stakeholders throughout the project. Given the focus of the project on assessing vulnerabilities, it will be important for the City to identify and engage vulnerable populations and entities who serve/represent them.

Purpose: To represent the concerns and community knowledge of the vulnerable populations identified in Task 3 and assist in identifying climate impacts on those communities.

3.0 ENGAGEMENT ACTIVITIES

PRE-ENGAGEMENT INTERVIEWS

Pre-Engagement Interviews (Task 1): In order to maximize the efficacy of our engagement process, Highland Planning (HP) will conduct three to five interviews with individuals identified by the project team to review and refine this plan. The purpose of pre-engagement interviews is to gain an understanding of how stakeholders are likely to perceive the project and what the likely issues will be. Pre-engagement interviews are an opportunity to begin developing constructive stakeholder relationships, better understand impacts, concerns, opportunities, and better mitigate risks to the project. Pre-engagement interviews will also help the team better understand which stakeholders should be included in focus groups later in the process. Individuals interviewed may include:

- City Operations representative
- Non-Profit representative
- Academic representative
- Neighborhood representative(s)

COMMUNICATIONS

- Social Media Calendar (Task 5): HP will work with the City Communications Bureau to draft a series of social media images advertising the public meeting and showing key findings, to be shared by the City.
- Press Release (Task 5): HP will draft a press release announcing the public meeting and draft report.

FOCUS GROUPS AND DATA GATHERING

- Coordination of data gathering (Task 2): Highland Planning will work with the City to determine which departments can provide data to VHB for analysis.
- Targeted focus group interviews (Task 4): Highland Planning will conduct 3-5 focus group interviews with community advisors to assess the vulnerabilities and adaptive capacity of a select set of neighborhoods to climate impacts for each planning subject area. Highland Planning will work with VHB to develop a list of questions in advance of the focus groups.

TAC WORKSHOPS

- Workshop #1 (Task 3): This workshop will serve to provide a summary of local and regional climate change projections and impacts. The team will gather feedback from the TAC on their experience to date with the extreme weather events that are likely to become the norm in future years as well as what the implications would likely be of various climate impact scenarios. We will also solicit input on which assets and systems are most critical throughout Rochester, and the degree to which stakeholders believe those assets and systems are likely to be exposed to future climate impacts. This workshop will also be used to identify the most vulnerable populations throughout the community who are already underserved or disproportionately burdened and therefore likely to bear the greatest burden of climate impacts or have the fewest resources to bounce back from events (least adaptive capacity).
- Workshop #2 (Task 4): This workshop will be used to present an overview of climate impacts on Rochester's critical systems and assets based on climate research, case studies, local knowledge, and best practices, and to conduct an interactive discussion on the sensitivity and adaptive capacity of those systems.

PUBLIC MEETING:

- Public Meeting (Task 5): Using an open house format with an ordered series of stations walking attendees through the assessment. E.g.
    - Station 1: Overview of anticipated local climate change impacts
    - Station 2: Vulnerability of physical systems
    - Station 3: Vulnerability of social systems
    - Station 4: Survey/feedback station utilizing PollEverywhere and tablets.

4.0 ENGAGEMENT ACTIVITIES BY TASK

TASK 1: ESTABLISHMENT OF STAKEHOLDER COMMITTEE

The goal of Task 1 is to create a stakeholder committee to provide technical expertise and input on the CVA.

TASK 1 ENGAGEMENT ACTIVITIES

The purpose of engagement strategies during Task 1 will be to establish a stakeholder committee and finalize the Public Participation Plan.

Task 1 engagement will include:

- Pre-Engagement Interviews

TASK 2: CLIMATE DATA REVIEW AND IDENTIFICATION OF POTENTIAL CLIMATE IMPACTS

The goal of Task 2 is to review and supplement existing information around regional climate change and anticipated local climate change impacts.

TASK 2 ENGAGEMENT ACTIVITIES

The purpose of engagement strategies during Task 2 will be to gather data for the summary of baseline climate conditions, projection scenarios, and impacts in preparation for the first workshop.

The Task 2 engagement may include:

- Coordination of data gathering

TASK 3: EVALUATION OF PLANNING SUBJECT AREAS

The goal of Task 3 is to determine planning subject areas and their systems (and subsystems/sectors) to be included and evaluated in the vulnerability assessment.

TASK 3 ENGAGEMENT ACTIVITIES

The purpose of engagement strategies during Task 3 will be to "ground-truth" the present and potential implications of climate change impacts as identified in the summary of literature review findings. We will also solicit input on which assets and systems are most critical throughout Rochester, and the degree to which stakeholders believe those assets and systems are likely to be exposed to future climate impacts.

The Task 3 engagement will include:

- Workshop #1

TASK 4: SENSITIVITY AND ADAPTIVE CAPACITY ANALYSIS

The goal of Task 4 is to conduct sensitivity and adaptive capacity analysis for systems and sub-systems/sectors associated with identified planning subject areas.

TASK 4 ENGAGEMENT ACTIVITIES

The purpose of engagement strategies during Task 4 will be to present climate impacts for each planning subject area for near-, mid-, and long-term scenarios, and assess the sensitivity and adaptive capacity of each system and sub-system to the impacts.

The Task 4 engagement will include:

- Workshop #2
- Targeted focus group interviews

TASK 5: VULNERABILITY ASSESSMENT AND PREPARATION OF DRAFT REPORT

The goal of Task 5 is to assess how vulnerable the systems in each planning subject area are to the effects of climate change, prepare draft Climate Vulnerability Assessment, and solicit public comments.

TASK 5 ENGAGEMENT ACTIVITIES

The purpose of engagement strategies during Task 5 will be to share the Draft Vulnerability Assessment and understand whether the project's team's analysis "rings true" with the public.

The Task 5 engagement will include:

- Public Meeting
- Social Media Calendar
- Press Release

5.0 ROLES

Highland Planning: Meeting facilitation, preparation of meeting summaries, conduct focus groups, coordinate meeting logistics, prepare final summary of public input.

VHB: Develop meeting materials and technical presentations, focus group questions, attend and facilitate workshops, prepare draft and final report.

City: Update project webpage, share social media posts, share press releases, communicate with TAC members, attend meetings, select TAC members.

6.0 SCHEDULE

	TASK	SUBTASK	SCHEDULE
1	**Establishment of a Stakeholder Committee**		January
		Kickoff Meeting	3-Jan
		Identify stakeholders and prepare invitations	17-Jan
		Develop stakeholder engagement plan	26-Jan
2	**Climate Data Review and Identification of Potential Climate Impacts**		January/February
		Review existing climate change projections/reports	26-Jan
		Define climate change scenarios and impacts	26-Jan
		Draft Memo summarizing baseline climate conditions, projection scenarios, and impacts	2-Feb
		Revise memo based on City/stakeholder feedback	16-Feb
3	**Evaluation of Planning Subject Areas**		February/March
		Develop preliminary recommendations of planning subject areas/systems to be evaluated and categories of critical assets	23-Feb
		Prepare materials for Workshop 1	2-Mar
		Facilitate Workshop 1	9-Mar
		Conduct targeted focus group interviews	23-Mar
		Summarize findings and finalize vulnerability framework	6-Apr
4	**Sensitivity and Adaptive Capacity Analysis**		April/May
		Assess exposure of assets/systems to climate impacts	27-Apr
		Develop supporting GIS maps	27-Apr
		Develop vulnerability matrix for assessing sensitivity and adaptive capacity	27-Apr
		Prepare materials for Workshop 2	11-May
		Facilitate Workshop 2	18-May
		Summarize Workshop 2 findings into a summary vulnerability matrix	25-May
5	**Vulnerability Assessment and Preparation of Draft Report**		June-August
		Prepare outline of Draft CVA	8-Jun
		Prepare draft CVA content	13-Jul
		Prepare materials for open house/public workshop	10-Aug
		Facilitate open house/public workshop	17-Aug
		Summarize feedback from open house/public workshop	24-Aug
6	**Development of Final CVA**		September
		Revise CVA based on public, stakeholder, and City feedback	7-Sep
		Develop designed summary or highlights report	7-Sep
		Prepare final technical document and designed summary for City review	14-Sep
		Finalize all deliverables and submit to City	28-Sep

City of Rochester, NY
Lovely A. Warren, Mayor
Rochester City Council

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CITY OF ROCHESTER CLIMATE VULNERABILITY ASSESSMENT

FOCUS GROUP AND ONE-ON-ONE INTERVIEW SUMMARY

OVERVIEW

The City of Rochester, through its Office of Energy and Sustainability, is conducting a Climate Vulnerability Assessment (CVA). The CVA will be a continuation of the City of Rochester's climate efforts to date, supporting the resiliency and adaptation components discussed in the City's recently released community-wide Climate Action Plan. A better understanding of the City's exposure, sensitivity, and adaptive capacity to the potential impacts of climate change will help inform decision-making, planning prioritization, and resource allocation, as it forms the foundation for an upcoming Climate Adaptation Plan.

In order to gain agency and stakeholder perspectives, **Highland Planning conducted focus groups and one-on-one interviews with community stakeholders to inform the vulnerability assessment**. A summary of those discussions is below.

SUMMARY

VULNERABILITIES

- Winter starts later and extends later into May
- Increased precipitation means soil becomes wet, and we are more vulnerable to wind storms, which impact trees and cause power outages
- The electric infrastructure
- Flooding in the spring. There is less green space in the City to manage stormwater runoff
- Heat waves in the summer, especially prolonged heat waves
- Aging wastewater infrastructure
- Ice storms/wind storms/loss of power
- Increasing load on the grid with more days over 90 degrees
- Wastewater/sanitary overflow can become a pollution problem
- Localized flooding
- Condition of homes (i.e. mold and other issues that can cause respiratory problems)
- The increase in "gray space" (i.e. paved areas) creates heat island, increased runoff
- Economic disparity in conjunction with poverty
- Drastic temperature changes.
- Rain
- Public transportation system – many people depend on that for daily travel
- Concentration of poverty in the City, the low-income people are most affected. Most likely to suffer from heat, or recover from flooding, suffer from diseases. In terms of people, not assets.

VULNERABLE POPULATIONS

- Disabled – people seek the Center for Disability Rights as a refuge in the heat
- Elderly – senior housing is segregated. Many don't have air conditioning. Seniors may be less likely to seek help during or after an event for fear of being forced out of their home.
- Refugees (There are about 20,000 refugees in the city now. About 75 percent are women aged 30 to 50. Most have been in a refugee camp for years prior to coming here.)
- People with mental health issues
- The deaf community
- Immigrant populations
- Undocumented individuals
- Low income populations (heat, cooling, ability to get to safe places)
- People who don't have access to medical facilities

ASSETS

- People
- Water (need to make sure that wastewater doesn't pollute our water)
- Spray parks
- Public transportation system
- Roadway system
- Tourism
- Events/festivals
- Cultural events
- Large employers
- Universities
- Libraries
- Social service providers

IMPACTS OF CLIMATE CHANGE

- Damage to businesses and loss of jobs
- Effects on agriculture
- Roads can be impacted by flooding, freeze/thaw
- Wastewater infrastructure can be overloaded by runoff, sediment, pollution, which would require more treatment
- Localized flooding impacts people with disabilities who face challenges getting around the city. Navigating during flooding is challenging for people without cars, or people in wheelchairs
- More difficult for people to get to work if transportation infrastructure is damaged
- Will need to have cyber infrastructure in place (and electricity)
- Need internet access for low income population
- Public health- sickness due to mold in homes, especially for lower income residents
- Increased freeze/thaw can impact roads and sidewalks, which impacts people who walk or use wheelchairs in the city
- Transit system is not entirely accessible to the disabled population
- City's housing stock: There could be a dramatic impact on older homes that have not been maintained over the years. Rochester is made up of about 60% rental properties. Aging properties that have not been maintained are much more vulnerable than others. Older roofs, windows, mechanical systems. Homes that have wet foundations, windows that are leaking. Very expensive to repair and upgrade. Most of the housing stock was built between

1890 to 1920. It's expensive to heat homes in our region. These homes weren't well insulated well to begin with. The cost to strip them out and get them insulated is cost-prohibitive. Especially when our housing stock is low value.

- Difference in policy needs for renters vs. low income home owners. There is a sense that because the City collects so much information about rental properties through the inspection program, that as a result there are more resources for rental properties. What about low income owner occupants?
- The multi-properties have boiler systems, which are expensive to maintain or replace. The landlords are not replacing them, but are removing them and installing electric baseboard heat in the units. That is putting the cost onto the tenants. We have a huge population of people on assistance. Moving to electric baseboard is pushing the cost onto the tenants. This also continues to put a huge draw on the electricity grid. This could snowball. It's currently about 25% of the housing stock, but it is increasing. Property managers are starting to do this because they can get out from under having to pay for heat. It's really hard for code enforcement people to stop it because it is legal. NYSERDA had not heard about this phenomenon. People need to understand that it's problematic for the electric grid.

OTHER COMMENTS

- Need to work from existing programs. RPPC is a good example of that. If we create a new group, we are fighting each other for dollars and time resources.
- Can we start looking at code enforcement as a strategy for public health and climate adaptation? UR is doing a study that is correlating violations in homes to health problems. They are using code enforcement data to tie it to health outcomes. They have done some field study. They have tried to link it to the most prominent health concerns for people going to health centers. Trying to direct funding to resolve code issues, with the idea of saving insurance and medical costs.
- Has the city studied the amount of impervious area?
- For the refugee population, there are some unique considerations. Many arrive here after spending years in refugee camps, with varying levels of trauma, education, language skills. Many are fearful to speak up about issues they experience with housing and transportation. The majority are women, many are large families (of 8 to 10).
    - Transportation is key, although there is fear associated with the bus, especially if people have never used public transportation. Like many Rochesterians, many refugees are living in unsafe conditions. For refugees, there is an additional fear of asking for help and a sense they should be grateful. They don't know how to look for new housing. They are afraid to seek help. They also tend to be larger families or 10 or 12. Cold weather is difficult for them, too. This year was difficult, flu season was difficult for people.
    - Refugees with physical disabilities or other illnesses are especially vulnerable. Some illnesses are more prevalent in these populations (diabetes, high blood pressure, mental health, PTSD, depression).

City of Rochester, NY
Lovely A. Warren, Mayor
Rochester City Council

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ROCHESTER CLIMATE VULNERABILITY ASSESSMENT

MEETING SUMMARY
TECHNICAL ADVISORY COMMITTEE (TAC) MEETING #1
MARCH 14, 2018
9:00 – 12:00

INTRODUCTION

The City of Rochester's Office of Energy and Sustainability convened a Technical Advisory Committee (TAC) to provide guidance and feedback for the Climate Vulnerability Assessment (CVA). The CVA is a continuation of the City's climate change and sustainability efforts to date, supporting the resiliency and adaptation components discussed in the City's recently released community-wide Climate Action Plan.

This document includes a summary of the presentation and discussion at the first meeting of the TAC.

MEETING ATTENDEES

Committee Members

Carl Ast, RG&E Asset Management

Mary Austerman, NY Sea Grant, Wayne County Cooperative Extension Office

Patti Bedard, City of Rochester - Water Bureau

Joe Bovenzi, Genesee Transportation Council

Sue Hughes-Smith, Rochester, People's Climate Coalition (RPCC)

Brian Kehoe, Rochester School District

Dan Kenyon, RTS/RGRTA

Dorraine Kirkmire, City of Rochester - Planning

Tim Kohlmeier, Monroe County Emergency Operations Center (OEM)

Katrina Korfmacher, University of Rochester Environmental Health Sciences

John Lam, Reconnect Rochester

Mary Rose McBride, Lifespan

vhb

HIGHLAND PLANNING

Laurie Picardo, RG&E Public Affairs

Wade Silkworth, Monroe County Department of Public Health (MCDPH)

Chris Snyder, City of Rochester - Zoning

Michelle Virts, Monroe County Pure Waters

Michael Waller, Rochester Regional Health

Harold Zink, Rochester Housing Authority

Staff and Consulting Team

Anne Spaulding, City of Rochester Office of Energy and Sustainability

Melissa Chanthalangsy, City of Rochester Office of Energy and Sustainability

Kari Hewitt, VHB

Van Du, VHB

Susan Hopkins, Highland Planning

Andre Primus, Highland Planning

PRESENTATION

Melissa Chanthalangsy (City of Rochester) welcomed the group and thanked everyone for participating in the Climate Vulnerability Assessment project. Kari Hewitt (VHB) provided an overview of the meeting agenda.

Meeting Agenda:

- ✓ Welcome & Introductions
- ✓ Overview of the Rochester Climate Vulnerability Assessment Project
- ✓ Presentation of climate change data & open discussion on potential climate impacts
- ✓ Presentation & open discussion on the recommendations of planning focus areas, systems, and critical assets/resources
- ✓ Wrap up & next steps

Kari noted that the project team is made up of the City of Rochester's Office of Energy and Sustainability, which is supported by VHB, and Highland Planning. She described the role of the TAC, which is summarized below.

Role of the TAC:

- ✓ Provide guidance, technical expertise, and feedback on the CVA
- ✓ Connect the Project Team with key stakeholder groups
- ✓ Participate in two workshops
- ✓ Participate in project outreach

Purpose and Scope

Kari reviewed the purpose of the project and the team's overall approach to the analysis. The purpose of the project is to better understand the City's vulnerabilities and adaptive capacity, help guide to the City's capital project planning, and make sure Rochester is a resilient city. The approach includes three main components: (1) Understanding of baseline and projected climate conditions; (2) Identifying critical systems and assets/ determining level of exposure, sensitivity, and adaptive capacity of these systems & assets due to potential climate impacts; and (3) setting the stage to prioritize actions for adaptation.

Climate Projections and Trends

Van Du (VHB) presented information about climate trends and projections. A copy of preliminary findings from that analysis is attached as Appendix A.

Stakeholder Engagement

Susan Hopkins (Highland Planning) provided an overview of the public engagement plan for the project, which includes the following components.

- ✓ Pre-Engagement Interviews – February (completed)
- ✓ Technical Advisory Committee Workshop #1 – March (this meeting)
- ✓ Targeted Focus Groups (3-5) – March/April
- ✓ Technical Advisory Committee Workshop #2 – May
- ✓ Public Meeting – August/September
- ✓ Final CVA Report – September

Susan noted that the team had conducted a series of pre-engagement interviews to better understand some of the key concerns and perceptions within the community about climate change vulnerabilities and presented an overview of their findings. A summary of findings can be found in TAC Workshop #1 Presentation.

DISCUSSION

The team led the group through a discussion, organized around the following questions;

What do you find most memorable/surprising from this climate data overview?

- ✓ Days over 90 degrees. That is not comfortable
- ✓ Duration of heatwaves
- ✓ Less snowfall will hurt winter businesses and winter recreation
- ✓ Uncertainty around how the Great Lakes will be affected by climate change
- ✓ Impact on agricultural practices
- ✓ Invasive species, changing disease vectors
- ✓ Funding implications for strained resources from dealing with other impacted areas around the state and Northeast
- ✓ End-user preparation, extra costs/education to manage impacts
- ✓ Influx of people/refugees could be an opportunity, but also has risks

Other implications

- ✓ The intersection of multiple vulnerabilities
- ✓ May have to address shifting funding focus to deal with strained resources to maintain infrastructure systems
- ✓ Increasing costs of energy, water quality control, utilities, etc
- ✓ Need projections on climate refugees, impacts to Rochester—are there risks associated with relocate populations?

Other vulnerable populations not already addressed?

- ✓ People living near water bodies
- ✓ People not on city water
- ✓ Low-income, senior, homeowners –i.e. people who have a combination of risk factors
- ✓ People dependent on medical services
- ✓ Small businesses

DISCUSSION OF PLANNING TOPICS/SUBAREAS

Kari and Van Du lead the group through a discussion of planning subareas, as illustrated below. The purpose of the discussion was to identify critical systems and assets that should be included in the analysis.

	PLANNING SUBJECT AREAS		
	INFRASTRUCTURE	NATURAL RESOURCES	SOCIOECONOMIC
SYSTEMS	Transportation	Environmental Resources	Public Health
	Utilities	Natural Habitat	Economy
	Water	Recreational & Open Spaces	Cultural Resources
	Building & Facilities		Social System/Human Services

A summary of the discussion is below. **Note: critical assets discussed below do not represent an exhaustive list. Committee members were asked to discuss additional assets and resources not already listed on the slides.**

TRANSPORTATION

- ✓ GTC has prepared a vulnerability assessment with GIS data. The system has a lot of redundancy
- ✓ Transit routes can be included in the analysis of transportation/road vulnerabilities because the buses use the road system
- ✓ Analysis of side streets. Most people don't live on major arterials
- ✓ Sidewalk conditions
- ✓ Street trees are critical – if they are becoming vulnerable to disease.
- ✓ There is a database of trees in the city
- ✓ Snow plow network
- ✓ Universities have their own bus systems
- ✓ Bus shelters
- ✓ Waterways – they are recreational now, but would be become transportation corridors in future scenarios?
- ✓ Freight movement – crude oil is being transported through the city.
- ✓ Increasing proportion of electric vehicles means more of the system is powered by electricity. What is the vulnerability of that system?
- ✓ Flooding is not a huge impact in the city, except for areas along the Lake. Neighboring communities are facing many impacts from erosion
- ✓ Commuters – large proportion come from outside the city limits. Want to make sure those people are still able to work
- ✓ Health care in Rochester is very centralized. There is an increasing reliance on facilities in Rochester from all over the region. That has implications for transportation systems.

UTILITIES

- ✓ Telecommunications – what happens to data centers? Data centers contain critical information, such as financial and medical records.
- ✓ OEM maintains a list of 400 + critical infrastructure facilities. Fuel farms in the region are fed by pipelines that do not all have power back-up
- ✓ Internet is key. Need wi-fi in place to allow telecommuting
- ✓ Materials management-waste management and recycling are critical and can be vulnerable to power loss
- ✓ Contaminated buildings that require ventilation and electricity are vulnerable
- ✓ Urban agriculture – needs water
- ✓ There could be a lot of stress put on the electrical grid in general. How does RG&E view adapting to more stress on the system? [Note: in the short-term RG&E does not foresee an issue with demand. Capacity exists currently. They are doing ongoing modeling for future demand]

WATER SUPPLY

- ✓ Flood protection structures along the river (beyond Mt. Morris – do they have the capacity to handle future events?)
- ✓ Monroe County Water Authority is fed by Lake Ontario and Hemlock Lake
- ✓ The water system is vulnerable to anything that comes into the water, as it needs to be treated. The Hemlock Woody Adelgid could kill many Hemlock trees and add to erosion, thus causing more turbidity in the water system than needs to be treated.
- ✓ Even though Rochester has CSO, the system has the capacity to handle events without increased overflows
- ✓ Increased salt on the roads will increase salinity in the water
- ✓ More icing events will cause more freeze/thaw and damage to the roads

BUILDINGS AND CRITICAL FACILITIES

- ✓ FoodLink
- ✓ Grocery stores – especially Wegmans
- ✓ Pharmacies
- ✓ Libraries
- ✓ Data centers (medical records, insurance, payroll processors, etc)
- ✓ Marinas
- ✓ Environmental Services Operations center
- ✓ Unity Hospital services much of the west side of the city, though it is outside the city limits
- ✓ Homeless services and soup kitchens

- ✓ Nursing homes
- ✓ Small businesses – Rochester has a higher proportion of small employers than other upstate cities. Small busiensses tend to be less able to recover after events and are less likely to have an emergency plan)

ENVIRONMENTAL RESOURCES

- ✓ Eastman Business Park has a water draw from Lake Ontario – temperature increases could impact that facility
- ✓ Research completed for Great Lakes?
- ✓ Hemlock and Canadice lakes
- ✓ The watershed itself and the many creeks and tributaries
- ✓ Highland Park and lilacs have environmental, cultural and economic significance
- ✓ Every park in the city is a key asset, providing shade in hot weather
- ✓ Mt. Hope Cemetery (and other cemeteries) contain many species of significant trees
- ✓ Level of Lake Ontario
- ✓ Cooling facilities within parks (i.e. spray parks) are very popular on hot days
- ✓ Health department – i.e. Lyme, West Nile, other diseases

SOCIAL/ECONOMIC/CULTURALFACILITIES

- ✓ Many buildings have air quality control systems that require electricity
- ✓ Wegmans
- ✓ School cafeterias and community centers feed children year round
- ✓ Many people rely on small convenience stores for groceries
- ✓ Food distribution centers/food processing in the region
- ✓ Place of worship
- ✓ Need culturally sensitive resources to prepare for potential impacts of climate change refugees

OTHER QUESTIONS/COMMENTS AND RESOURCES:

- ✓ Look at the Comprehensive Emergency Planning Assessment (Monroe County)
- ✓ Cornell research on Great Lakes
- ✓ What is the messaging on this topic? How do we get beyond the “choir” and what other communities have been successful in doing that?
- ✓ City’s Building and Zoning department offers a database of public data called “Building Blocks”

ROCHESTER CLIMATE VULNERABILITY ASSESSMENT

STAKEHOLDER ENGAGEMENT WORKSHOP

March 14, 2018

City of Rochester, NY
Lovely A. Warren, Mayor
Rochester City Council

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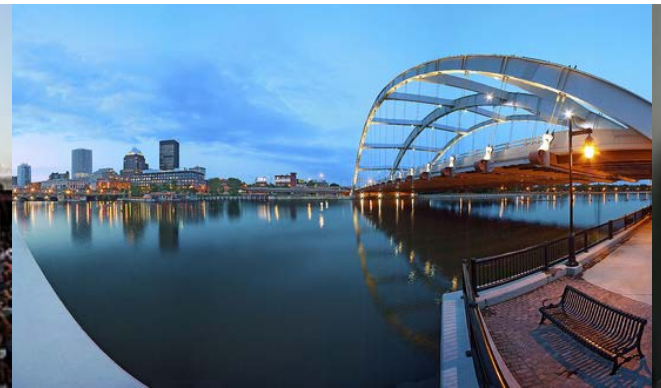


Workshop Agenda

I. Welcome
II. Introductions
III. Overview of the Rochester Climate Vulnerability Assessment Project
IV. Presentation of climate change data & open discussion on potential climate impacts
V. Presentation & open discussion on the recommendations of planning focus areas, systems, and critical assets/resources
VI. Wrap up & next steps

Introductions

Project Team

City of Rochester, NY
Lovely A. Warren, Mayor
Rochester City Council

Anne E. Spaulding, Manager of Environmental Quality, Division of Environmental Quality

Melissa Chanthalangsy, Energy and Sustainability Analysis, Division of Environmental Quality

HIGHLAND PLANNING

Susan R. Hopkins, Project Manager

M. André Primus, Planner

vhb

Kari Hewitt, Director of Sustainability

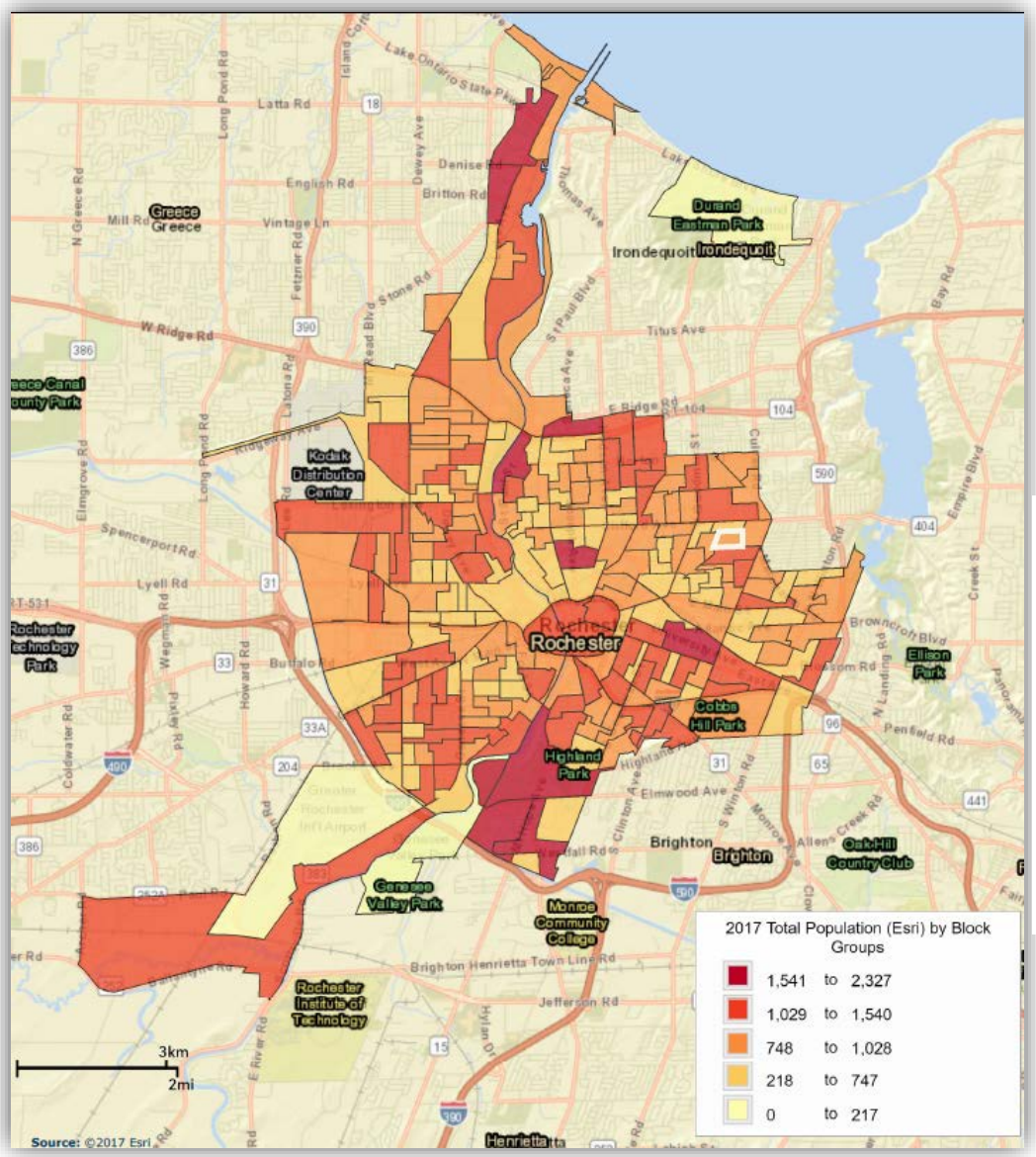
Van H. Du, Sustainability Planner

Role of the Stakeholder Committee

I. Provide guidance, technical expertise, and feedback on the CVA
II. Connect the Project Team with key stakeholder groups
III. Participate in two workshops
IV. Participate in Project outreach

Overview

Rochester by the Numbers

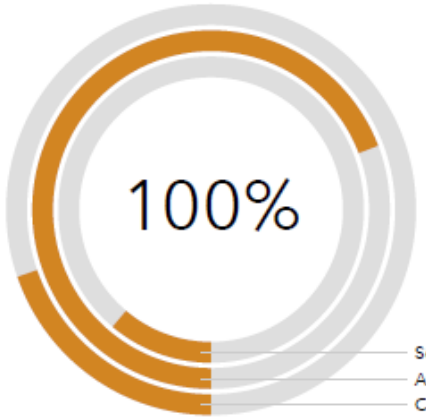


Population and Households

210,249
Total Population

87,262
Total Households

2.29
Average Household Size



26,494
Households With Disability

1,855
Households Without Vehicle

25,478
Households Below the Poverty Level

Source: 2011-2015 and 2017 data; provided by American Community Survey (ACS), Esri, Esri and Infogroup.

Rochester by the Numbers

BUSINESS

8,554
Total Businesses

168,068
Total Employees

31,005
Median Household Income

9.3%
Unemployment Rate

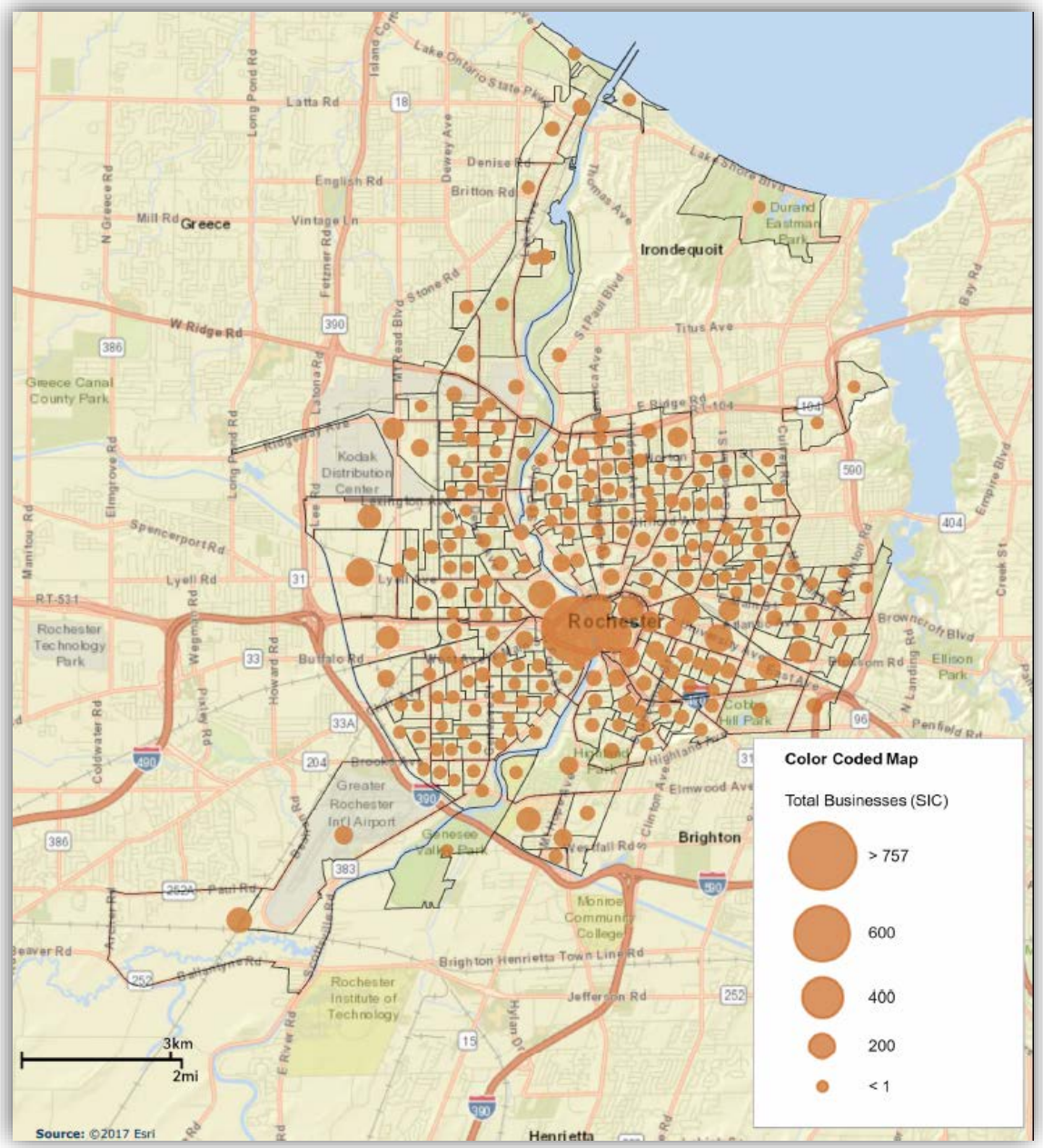
TRANSPORTATION TO WORK

8.8%
Took Public Transportation

10.9%
Carpooled

6.6%
Walked to Work

1.2%
Bike to Work



Source: 2011-2015 and 2017 data; provided by American Community Survey (ACS), Esri, Esri and Infogroup.

Rochester by the Numbers

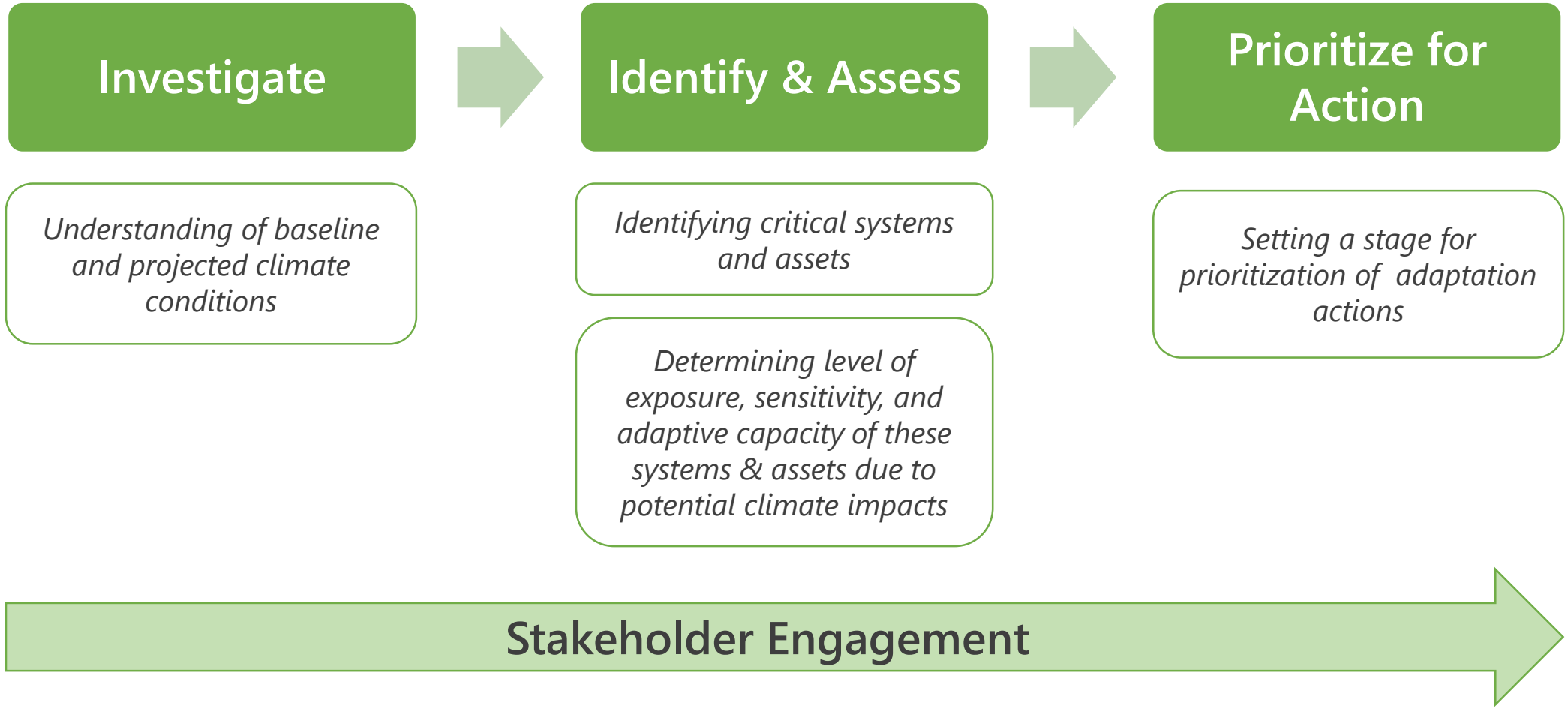
	Rochester City, NY	Monroe County, NY	Syracuse City, NY	Buffalo City, NY
Total Population	210,249	755,765	146,839	260,428
Households with Population Age 65+	6,746	40,160	4,903	10,610
Households with Disability	26,494	71,963	16,369	33,891
Households Below the Poverty Level	25,478	42,178	16,463	31,881
Total Businesses	8,554	27,188	6,022	8,041
Total Employees	168,068	472,159	126,743	181,739
2017 Median Household Income	$31,005	$54,939	$30,979	$31,674
2017 Unemployment Rate	9.3%	5.3%	7.7%	8.8%
Households with No Vehicles	1,855	5,601	1,511	5,175
% of Workers Took Public Transportation	8.8%	2.9%	9.4%	11.7%
% of Workers Carpooled	10.9%	7.7%	9.4%	11.0%
% of Workers Biked	1.2%	0.5%	1.1%	1.1%
% of Workers Walked	6.6%	3.2%	11.1%	6.1%

Source: 2011-2015 and 2017 data; provided by American Community Survey (ACS), Esri, Esri and Infogroup.

Rochester Climate Vulnerability Assessment (CVA)

- Continuation of the City of Rochester's climate planning efforts
  - *Supporting the adaptation and resiliency component of the Community-wide Climate Action Plan*
- Better understanding of the City's vulnerabilities and adaptive capacity
- Serving as guide to the City's capital project planning
- Making sure Rochester is a resilient city

Rochester CVA Approach



Stakeholder Engagement & Schedule

- ✓ Pre-Engagement Interviews – February
- Technical Advisory Committee Workshop #1 – March
- Targeted Focus Groups (3-5) – March/April
- Technical Advisory Committee Workshop #2 – May
- Public Meeting – August/September
- Final CVA Report – September

Climate Trends & Projections

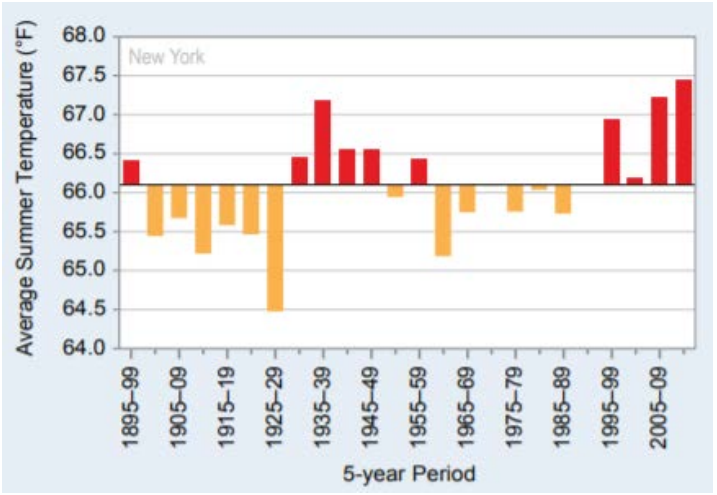
Regional and Local Climate Trends

- Increase in average annual temperature observed in all regions across the state of New York.
  - *Statewide average annual temperature has increased approximately 2.4°F since 1970, with winter warming exceeding 4.4°F.*

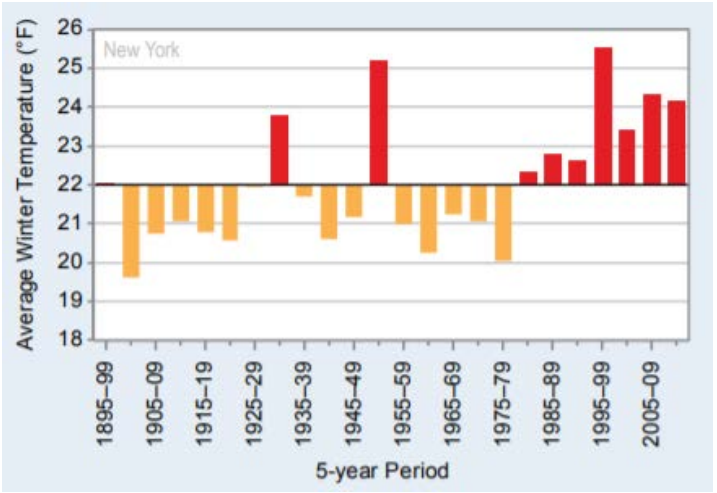
- Spring has been starting earlier and winter snow cover is decreasing compared to a few decades ago.
  - *The average freeze-free season length during 1991-2010 was approximately 10 days longer than during 1961-1990.*

- Since 2006, Lake Ontario has remained below 30% ice-cover (except during the cold 2013–2014 winter).

Observed Summer Temperature



Observed Winter Temperature



Source: CICS-NC and NOAA NCEI

Regional and Local Climate Projections

- *Increase in temperatures*

	Baseline (1971 – 2000)	Mid-Century (2050 – 2079)	End of Century (2080 – 2100)
Average Annual Temperature	47.7°F	52°F to 54°F	54°F to 59.4°F
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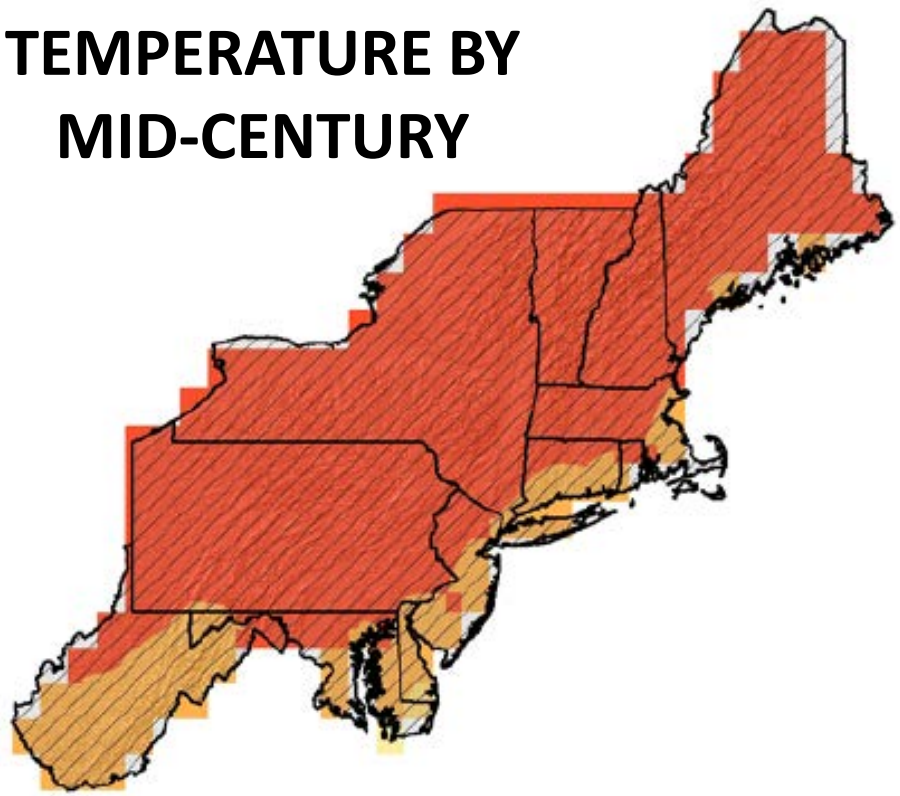
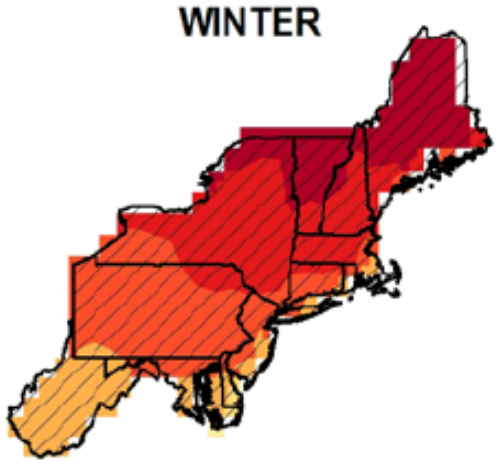
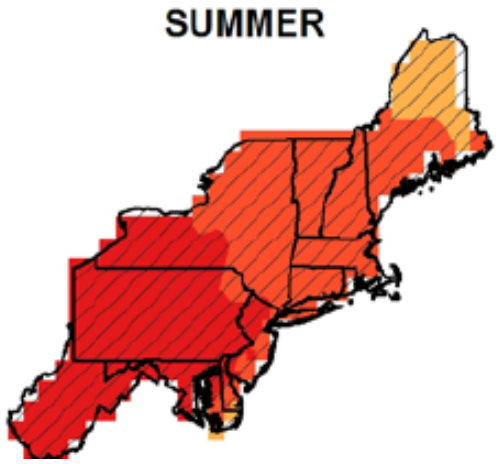
Source: NYSERDA ClimAID 2014 Report
NOAA
NCA 3

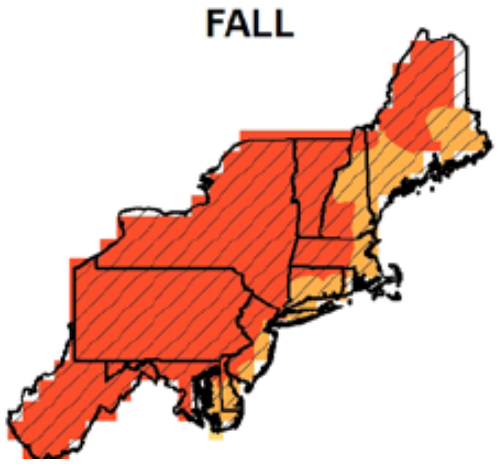
Regional and Local Climate Projections

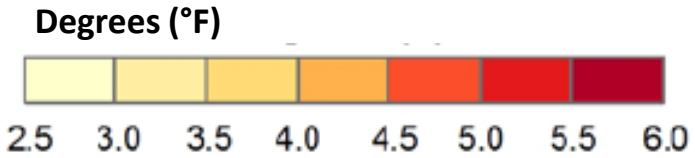
INCREASE IN ANNUAL TEMPERATURE BY MID-CENTURY











Climate projections for annual and season annual temperature using the A2 (high) emissions scenarios. Sources: NOAA

Potential Climate Impacts from Increased Temperature Days & Duration

- Increase in pollen production which may exacerbate asthma, allergies, and other respiratory conditions
- Changes or loss of ecosystems and biodiversity (especially in nearby Lake Ontario)
- Quality of soil and crop yields reduced
- Increased demand for water for irrigation
- Depletion of water supply
- Increase in public health and safety risks, particularly for the elderly, children, and pregnant women populations
- Urban heat island effects
- Increase in growing season, but potential shift in crop production and livestock areas due to climate shift
- Reduced demand for heating (reduced energy consumption), but at the same time, energy demand for cooling may increase
- More frost heaves and potholes on road and bridge surfaces due to more freeze-thaw conditions

Regional and Local Climate Trends

- Statewide annual precipitation has ranged from a low 31.6 inches in 1964 to a high of 55.7 inches in 2011.

- Increase in average annual precipitation since 1900, at a rate of 0.4 inches per decade during 1895-2011.
  - *The wettest multi-year period was 2007-2011 with an average of 46.04 inches, compared to the statewide annual average of 40 inches.*

- More extreme precipitation and more frequent flooding (including from rivers) being experienced.
  - *While Rochester was not in the direct path of Hurricane Irene in August 2011, the City experienced flooding from remnants of the storm (and other tropical systems).*

Observed Annual Precipitation

Observed Number of Extreme Precipitation Events

Source: CICS-NC and NOAA NCEI

Regional and Local Climate Projections

- *Changes in precipitation*

	Baseline (1971 – 2000)	Mid-Century (2050 – 2079)	End of Century (2080 – 2100)
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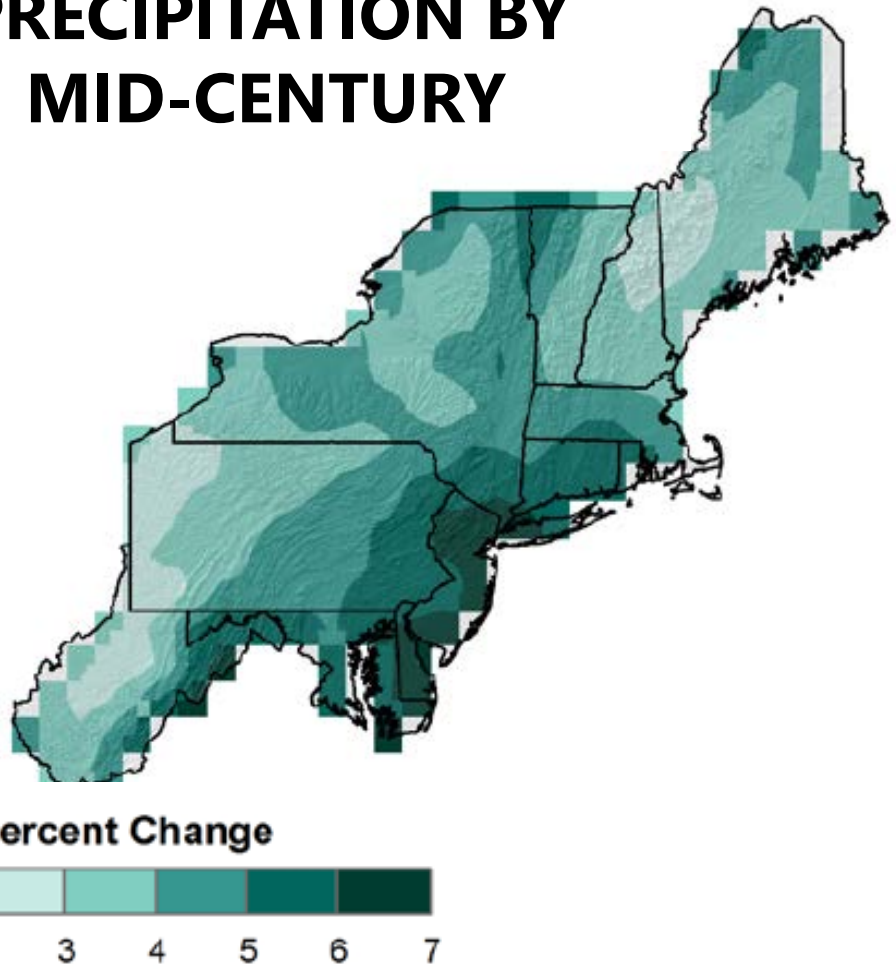
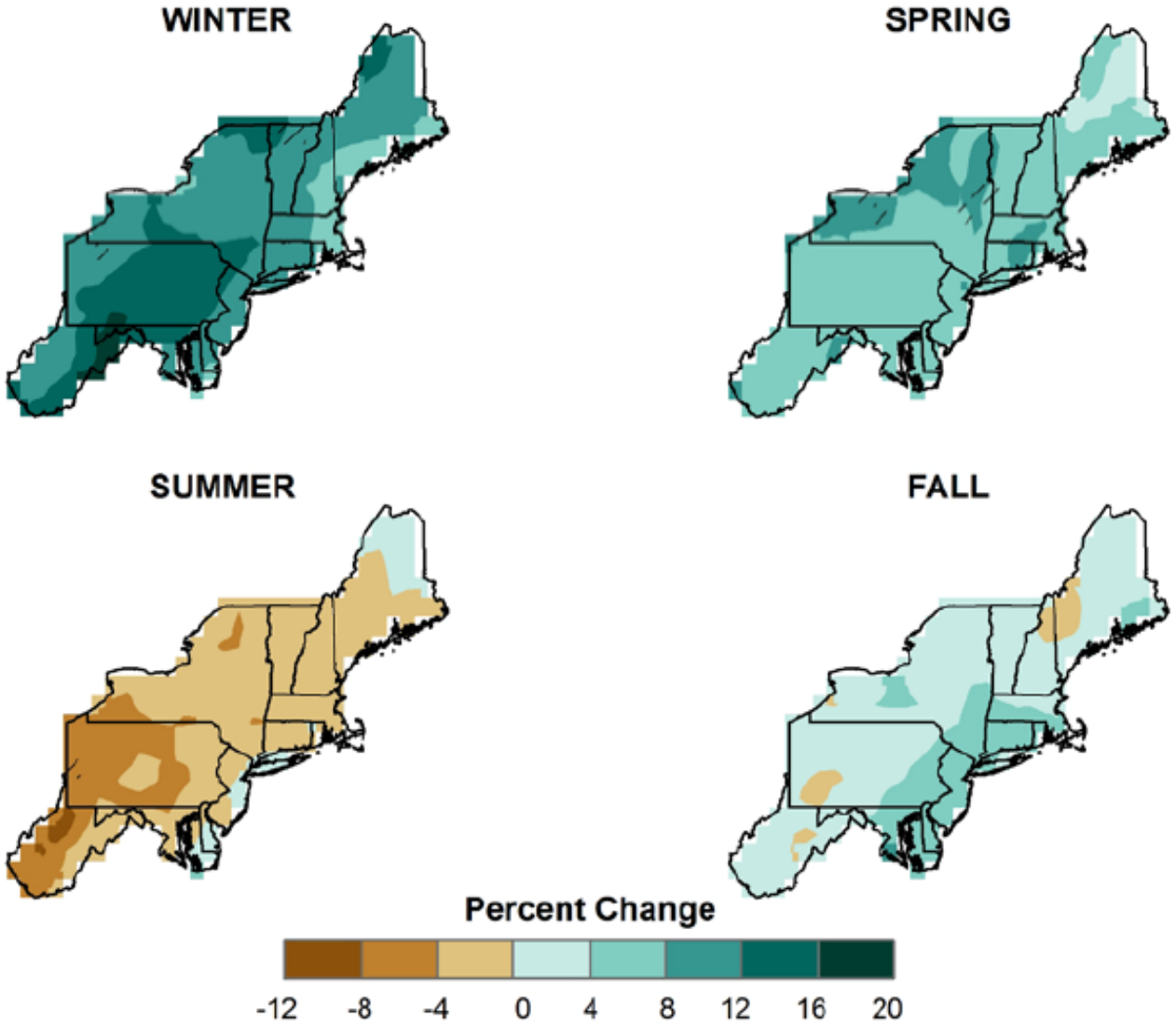
Source: NYSERDA ClimAID 2014 Report
NOAA
NCA 3

Regional and Local Climate Projections

CHANGES IN ANNUAL PRECIPITATION BY MID-CENTURY





Climate projections for annual and season annual temperature using the A2 (high) emissions scenarios. Sources: NOAA

Potential Climate Impacts from Changing Frequency and Intensity of Precipitation

- Increase in sediment and contaminants in water bodies
- Increase in soil erosion and runoff due to greater flood or flash flood risk
- Potential sanitary sewers and stormwater management systems overflow, pollutant run-offs, and therefore putting water quality and recreational activities at risk
- Increase in mold problems in homes and businesses
- Increase in travel delays
- Potential damage to power plants, rail lines, trees, during extreme weather events

Pre-Engagement Interviews: What we heard

How is Rochester most vulnerable?

- ✓ Flooding
- ✓Increased temperatures
- ✓Energy grid
- ✓Disruptions to agriculture
- ✓Influx of people who have been impacted due to impacts of climate change in other locations (i.e. Puerto Rico)
- ✓Already strained services become even more strained during a crisis

Most vulnerable populations?

- ✓ Seniors
- ✓Children
- ✓Low-income
- ✓Disabled
- ✓Non-native English speakers
- ✓Undocumented
- ✓Refugees (climate and/or political)
- ✓Those without the ability to access resources in a crisis (i.e. family, friends, financial resources)

Biggest opportunities for this study?

- ✓Moving the conversation beyond the “choir”
- ✓Shape future funding priorities for infrastructure, emergency preparedness and response
- ✓Opportunity to improve/update environmental infrastructure
- ✓Plan for ways to use/reallocate existing resources to help the most vulnerable
- ✓Build on emergency preparedness planning and strengthening partnerships with Monroe County and State agencies

Open Discussion

- *Which other present and potential implications of climate change impacts do we need to consider for Rochester?*
- *Who are the most vulnerable populations?*
- *What do you find most surprising from this climate data overview?*

Recommendations of Planning Subject Areas, Systems and Sub-systems

Rochester CVA - Planning Subject Areas

	PLANNING SUBJECT AREAS		
	INFRASTRUCTURE	**NATURAL RESOURCES**	**SOCIOECONOMIC**
SYSTEMS	Transportation	Environmental Resources	Public Health
	Utilities	Natural Habitat	Economy
	Water	Recreational & Open Spaces	Cultural Resources
	Building & Facilities		Social System/Human Services




System	Sub-System / Sector	Key Assets

TRANSPORTATION	Road and bridges	• Major roadways:
		  • NY State Routes
		  • Major arterials in the City
		• Bridges

	Public transportation	• Regional Transit Service (RTS) – Monroe routes • RTS Transit Center
	Highway	• I-390, I-490, I-590 • New York State Thruway
	Bike/pedestrian network	• Genesee Riverway Trail
	Airport & port	• Greater Rochester International Airport (ROC) • Port of Rochester • Amtrak Rochester Station • Greyhound/Trailways Bus Station
	Railways	• CSX railroad

System	Sub-System / Sector	Key Assets
UTILITIES	Energy	• RG&E Transmission and Distribution Infrastructure • RG&E hydropower plants • Eastman Business Park energy generation systems • Rochester District Heating Cooperative (RDH) infrastructure • University of Rochester cogeneration facility
	Telecommunications	• Emergency Response & Communication Systems

System	Sub-System / Sector	Key Assets
WATER	Water Supply	• Cobbs Hill, Highland Park, and Rush Reservoirs (and Hemlock and Canadice Lakes) • Hemlock Water Filtration Plant • Pump stations
	Wastewater	• Northwest Quadrant and VanLare WWTF • Sanitary sewer system*
	Stormwater	• Storm drains • Storm sewer system* • Outfalls
	Dam	• Mount Morris Dam

System	Sub-System / Sector	Key Assets
BUILDING & CRITICAL FACILITIES	Commercial	• Eastman Business Park • Major businesses • Commercial corridors and districts
	Residential	• Senior centers • Homeless shelters
	Industrial	• Eastman Business Park • Gleason Works • RF Harris Communications • Delphi
	Institutional	• University of Rochester • Rochester Institute of Technology • Monroe Community College • K-12 Schools
	Critical Facilities	• UR-Strong Memorial Hospital • Rochester General Hospital • Highland Hospital • Emergency Response Facilities (Fire stations, police stations, designated community centers, cooling centers)
	Municipal / Public Facilities	• Neighborhoods • Community centers

System	Sub-System / Sector	Key Assets
ENVIRONMENTAL RESOURCES	Waterway	• Genesee River • Irondequoit Bay • Lake Ontario • Erie Canal
	Wetlands	• State regulated freshwater wetlands
	Urban forest	• Street trees • Park trees
	Conservation land	• Conkey Corner Park • El Camino • Local Waterfront Revitalization Program (LWRP) designated areas

System	Sub-System / Sector	Key Assets
NATURAL HABITAT	Sensitive and Rare Habitats	

System	Sub-System / Sector	Key Assets
RECREATIONAL & OPEN SPACE	Public Park & Facilities	• Genesee Valley Park • Highland Park (also reservoir) • Cobb's Hill Park (also reservoir for City's drinking water) • Seneca Park/Seneca Park Zoo • Turning Point Park • Durand Eastman Park • Public recreational facilities & playgrounds

System	Sub-System / Sector	Key Assets
PUBLIC HEALTH	Health services	• Health care providers • Health clinics • Monroe County Department of Public Health
	Emergency services	• Public safety, fire and police officers/volunteers • Community Emergency Response Team (CERT) • Emergency Communications Center (911 facility)
	Air quality	• N/A

System	Sub-System / Sector	Key Assets
SOCIAL SYSTEM/HUMAN SERVICES	Food systems	• Community gardens • Food pantries / Emergency food pantries, soup kitchens • Rochester Public Market • Local farmer's markets

System	Sub-System / Sector	Key Assets
CULTURAL RESOURCES		• The Strong Museum • Rochester Museum and Science Center • Memorial Art Gallery • Preservation Districts: Designated buildings of historic values (DBHV) • Heritage Trail

System	Sub-System / Sector	Key Assets
ECONOMY	Access to services	• Community gardens • Food pantries / Emergency food pantries, soup kitchens
	Jobs/Workforce	
	Key industries / employers	

Next Steps

I. Conducting focus group discussions
II. Conducting sensitivity and adaptive capacity analysis (Stakeholder Engagement Workshop #2)
III. Preparing a Draft Final Report
IV. Hosting an public open house/workshop to solicit community feedback
V. Developing Final CVA Report

ROCHESTER CLIMATE VULNERABILITY ASSESSMENT

MEETING SUMMARY
TECHNICAL ADVISORY COMMITTEE (TAC) MEETING #2
JUNE 6, 2018
9:00 AM – 12:00 PM

INTRODUCTION

The City of Rochester's Office of Energy and Sustainability convened a Technical Advisory Committee (TAC) to provide guidance and feedback for the Climate Vulnerability Assessment (CVA). The CVA is a continuation of the City's climate change and sustainability efforts to date, supporting the resiliency and adaptation components discussed in the City's recently released community-wide Climate Action Plan.

This document includes a summary of the presentation and discussion at the second meeting of the TAC.

MEETING ATTENDEES

Committee Members

Mary Austerman, NY Sea Grant, Wayne County Cooperative Extension Office

Patti Bedard, City of Rochester - Water Bureau

Joe Bovenzi, Genesee Transportation Council

Jayme Breshard-Thomann, GFLRPC

Sue Hughes-Smith, Rochester, People's Climate Coalition (RPCC)

Enid Cardinal, RIT Sustainability

Veronica Dasher, RG&E Public Affairs

Katrina Korfmacher, University of Rochester Environmental Health Sciences

John Lam, Reconnect Rochester

Erin McCormick, RGRTA

Laurie Picardo, RG&E Public Affairs

Wade Silkworth, Monroe County Department of Public Health (MCDPH)

Chris Snyder, City of Rochester - Zoning

Michelle Virts, Monroe County Pure Waters

Michael Waller, Rochester Regional Health

Harold Zink, Rochester Housing Authority

Staff and Consulting Team

Anne Spaulding, City of Rochester Office of Energy and Sustainability

Melissa Chanthalangsy, City of Rochester Office of Energy and Sustainability

Kari Hewitt, VHB

Van Du, VHB

Susan Hopkins, Highland Planning

PRESENTATION

Melissa Chanthalangsy (City of Rochester) welcomed the group and thanked everyone for participating in the Climate Vulnerability Assessment project. Kari Hewitt (VHB) provided an overview of the meeting agenda.

Meeting Agenda:

- Welcome
- Introductions
- Updates on the Rochester Climate Vulnerability Assessment Process
- Updates on the focus group interviews with community stakeholders
- Sensitivity and adaptive capacity analysis of systems and assets
- Wrap up & next steps

Kari noted that the project team is made up of the City of Rochester's Office of Energy and Sustainability, which is supported by VHB, and Highland Planning. She reviewed the role of the TAC, which is summarized below.

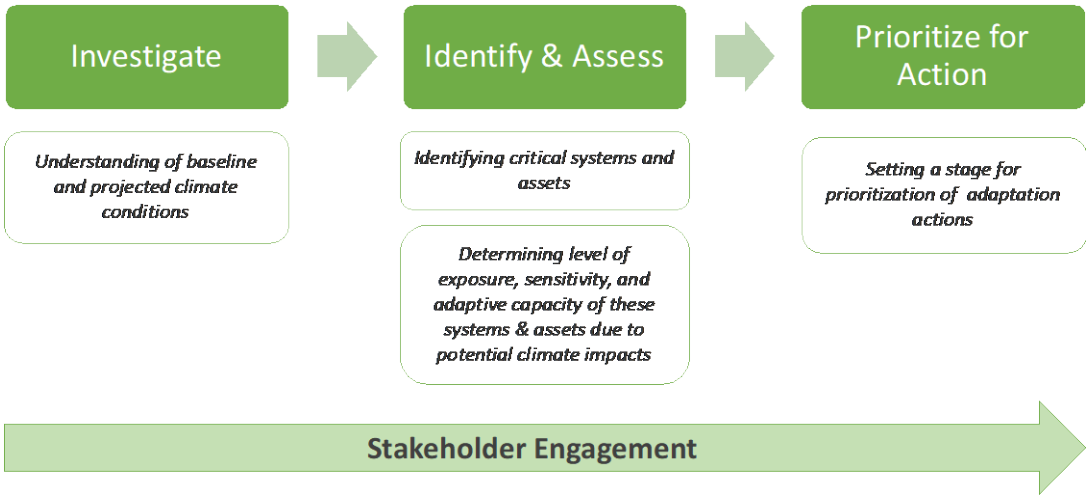
Role of the TAC:

- ✓ Provide guidance, technical expertise, and feedback on the CVA
- ✓ Connect the Project Team with key stakeholder groups

- ✓ Participate in two workshops
- ✓ Participate in project outreach

Purpose and Scope

Kari reviewed the purpose of the project and the team's overall approach to the analysis. The purpose of the project is to better understand the City's vulnerabilities and adaptive capacity, help guide to the City's capital project planning, and make sure Rochester is a resilient city. The approach includes three main components: (1) Understanding of baseline and projected climate conditions; (2) Identifying critical systems and assets/ determining level of exposure, sensitivity, and adaptive capacity of these systems & assets due to potential climate impacts; and (3) setting the stage to prioritize actions for adaptation.



Climate Vulnerability Assessment – Progress to Date

Kari described the tasks completed and progress to date for the vulnerability assessment. She summarized the key take-aways from regional and local climate projects, which include the following:

	Baseline (1971 – 2000)	Mid-Century (2050 – 2079)	End of Century (2080 – 2100)
Average Annual Temperature	47.7°F	52°F to 54°F	54°F to 59.4°F
Number of Days ≥ 90°F	8 days	22 to 34 days	27 to 57 days
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Source: NYSERDA ClimAID 2014 Report, NOAA, NCA 3

Kari also described the vulnerability assessment framework, which categorizes vulnerabilities according to the following subject areas:

	PLANNING SUBJECT AREAS		
	INFRASTRUCTURE	NATURAL RESOURCES	SOCIOECONOMIC
SYSTEMS	Transportation	Environmental Resources	Public Health
	Utilities	Natural Habitat	Economy
	Water	Recreational & Open Spaces	Cultural Resources
	Building & Facilities		Social System/Human Services

Stakeholder Engagement and Schedule

Kari provided an overview of the public engagement plan for the project, which includes the following components.

- ✓ Pre-Engagement Interviews – February
- ✓ Technical Advisory Committee Workshop #1 – March
- ✓ Stakeholder interviews – March/April
- ✓ Technical Advisory Committee Workshop #2 – June
- ✓ Public Meeting – August/September
- ✓ Final CVA Report – September
- ✓ Public Meeting – August/September
- ✓ Final CVA Report – September

Sue Hopkins, Highland Planning, summarized the key themes identified during stakeholder interviews. noted that the team had conducted a series of pre-engagement interviews to better understand some of the key concerns and perceptions within the community about climate change vulnerabilities and presented an overview of their findings. The team spoke

with representatives from the City of Rochester, Monroe County, health advocates, members of the disability community, organizations that provide services to refugees, organizations involved in food systems, and local universities. The most vulnerable populations were identified as the following:

- Seniors/elderly
- Children
- Low-income
- People without access to vehicles
- Disabled
- Visually/hearing impaired
- Mental health
- Non-native English speakers
- Undocumented
- Refugees
- Those without the ability to access resources in a crisis (i.e. family, friends, financial resources)

The key themes that emerged in discussions about vulnerable populations and potential impacts of climate change included potential vulnerabilities related to housing and transportation.

- Aging housing stock (older roofs, windows, insulation, mechanical systems)
    - Lack of cooling/heating systems
    - Increased risk of mold/illness
    - Acute damage from extreme weather
- Transportation (potential disruptions)
    - Access to employment
    - Access to medical facilities
    - Access to locations with internet/libraries
- Less engagement with local government/fear of seeking help

DISCUSSION

Committee members were asked to review each of the subject areas relative to the various climate impacts and generate a vulnerability ranking. The ranking is a combination of two primary factors:

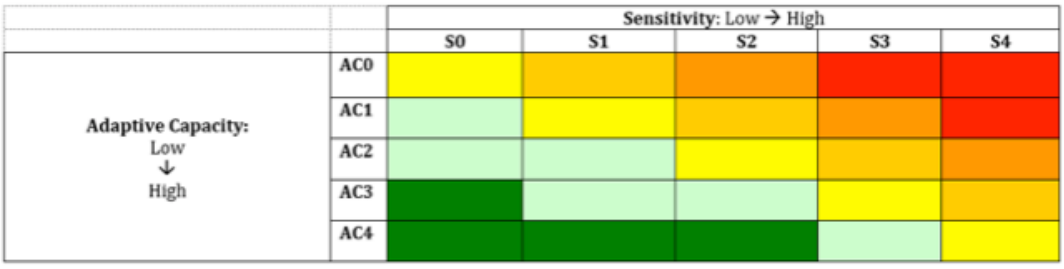
(1) Sensitivity assessment: How a system or sub-system might be affected by the climate impacts to which it is exposed.

Sensitivity Levels	
S0	System will not be affected by the impact
S1	System will be minimally affected by the impact
S2	System will be moderately affected by the impact
S3	System will be largely affected by the impact
S4	System will be entirely affected by the impact

(2) Adaptive capacity evaluation: A system's ability to accommodate changes, manage damages, take advantage of opportunities, or cope with various climate impacts

Adaptive Capacity Levels	
AC0	System is not able to accommodate or adjust to impact
AC1	System is minimally able to accommodate or adjust to impact
AC2	System is somewhat able to accommodate or adjust to impact
AC3	System is mostly able to accommodate or adjust to impact
AC4	System is able to accommodate or adjust to impact in a beneficial way

The end result was a vulnerability ranking for each subject area and asset and identified how vulnerable a system or sub-system is to the effects of climate change based on rankings of sensitivity and adaptive capacity.



Potential Opportunity
Low Vulnerability
Medium-Low Vulnerability
Medium Vulnerability
Medium-High Vulnerability
High Vulnerability

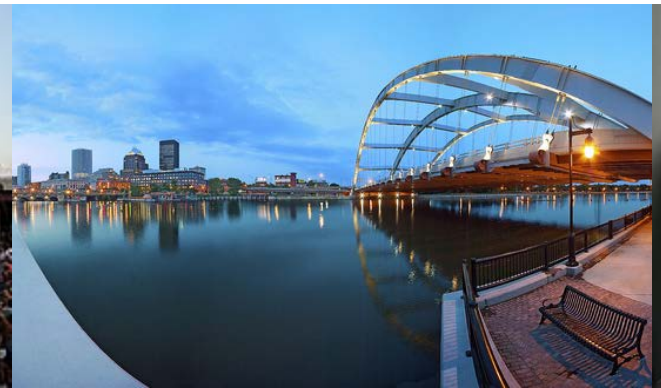
ROCHESTER CLIMATE VULNERABILITY ASSESSMENT

STAKEHOLDER ENGAGEMENT WORKSHOP

June 6, 2018

City of Rochester, NY
Lovely A. Warren, Mayor
Rochester City Council

sustainable rochester

Workshop Agenda

I. Welcome
II. Introductions
III. Updates on the Rochester Climate Vulnerability Assessment Process
IV. Updates on the focus group interviews with community stakeholders
V. Sensitivity and adaptive capacity analysis of systems and assets
VI. Wrap up & next steps

Introductions

Project Team

City of Rochester, NY
Lovely A. Warren, Mayor
Rochester City Council

Anne E. Spaulding, Manager of Environmental Quality, Division of Environmental Quality

Melissa Chanthalangsy, Energy and Sustainability Analyst, Division of Environmental Quality

HIGHLAND PLANNING

Susan R. Hopkins, Project Manager

M. André Primus, Planner

vhb

Kari Hewitt, Director of Sustainability

Van H. Du, Sustainability Planner

Role of the Stakeholder Committee

I. Provide guidance, technical expertise, and feedback on the CVA
II. Connect the Project Team with key stakeholder groups
III. Participate in two workshops
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Overview

Rochester Climate Vulnerability Assessment (CVA)

- Continuation of the City of Rochester's climate planning efforts
  - *Supporting the adaptation and resiliency component of the Community-wide Climate Action Plan*
- Better understanding of the City's vulnerabilities and adaptive capacity
- Serving as guide to the City's capital project planning
- Making sure Rochester is a resilient city

Rochester CVA Approach

Investigate

Understanding of baseline and projected climate conditions

Identify & Assess

Identifying critical systems and assets

Determining level of exposure, sensitivity, and adaptive capacity of these systems & assets due to potential climate impacts

Prioritize for Action

Setting a stage for prioritization of adaptation actions

Stakeholder Engagement

Stakeholder Engagement & Schedule

- ✓ Pre-Engagement Interviews – February
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Climate Vulnerability Assessment: Progress to Date

Regional and Local Climate Projections

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NCA 3

Regional and Local Climate Projections

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NCA 3

Rochester CVA - Planning Subject Areas

	PLANNING SUBJECT AREAS		
	INFRASTRUCTURE	**NATURAL RESOURCES**	**SOCIOECONOMIC**
SYSTEMS	Transportation	Environmental Resources	Public Health
	Utilities	Natural Habitat	Economy
	Water	Recreational & Open Spaces	Cultural Resources
	Building & Facilities		Social System/Human Services




Focus Group & Interviews: What we heard

Interviews/focus groups

- City code enforcement
- Fire department/emergency management
- Operations
- Arborist
- Disability community
- Chamber of commerce
- Common Ground Health
- Refugee community
- Foodlink
- RIT/UR
- RMAPI
- Monroe County Planning Department

Vulnerable Populations

- ✓ Seniors/elderly
- ✓ Children
- ✓ Low-income
- ✓ People without access to vehicles
- ✓ Disabled
- ✓ Visually/hearing impaired
- ✓ Mental health
- ✓ Non-native English speakers
- ✓ Undocumented
- ✓ Refugees
- ✓ Those without the ability to access resources in a crisis (i.e. family, friends, financial resources)

Key vulnerabilities

Related to…

- Aging housing stock (older roofs, windows, insulation, mechanical systems)
  - Lack of cooling/heating systems
  - Increased risk of mold/illness
  - Acute damage from extreme weather
- Transportation (potential disruptions)
  - Access to employment
  - Access to medical facilities
  - Access to locations with internet/libraries
- Less engagement with local government/fear of seeking help

Sensitivity and Adaptive Capacity Analysis

Exposure Assessment

- Determine direct and indirect climate implications on the identified systems and sub-systems.

- Impacts Matrix

	Infrastructure				Natural Resources			Socioeconomic		
	Transportation	Utilities	Water	Building & Facilities	Environmental Resources	Natural Habitat	Recreational & Open Space	Public Health	Economy	Cultural Resources
Increase in extreme temperature days (over 90°F) and duration										
Sensitivity Level										
Adaptive Capacity										
Vulnerability Ranking										
Decrease in days below 32°F										
Sensitivity Level										
Adaptive Capacity										
Vulnerability Ranking										
Increase in days per year with over 1" rainfall										
Sensitivity Level										
Adaptive Capacity										
Vulnerability Ranking										
Increase in extreme storm evens (microbursts, severe t-storm/ice storms, etc.)										
Sensitivity Level										
Adaptive Capacity										
Vulnerability Ranking										

Sensitivity Assessment

How a system or sub-system might be affected by the climate impacts to which it is exposed:

Sensitivity Levels	
S0	System will not be affected by the impact
S1	System will be minimally affected by the impact
S2	System will be moderately affected by the impact
S3	System will be largely affected by the impact
S4	System will be entirely affected by the impact

Adaptive Capacity Evaluation

A system's ability to accommodate changes, manage damages, take advantage of opportunities, or cope with various climate impacts:

Adaptive Capacity Levels	
AC0	System is not able to accommodate or adjust to impact
AC1	System is minimally able to accommodate or adjust to impact
AC2	System is somewhat able to accommodate or adjust to impact
AC3	System is mostly able to accommodate or adjust to impact
AC4	System is able to accommodate or adjust to impact in a beneficial way

Vulnerability Ranking

How vulnerable a system or sub-system is to the effects of climate change based on rankings of sensitivity and adaptive capacity.

		Sensitivity (Low to High) →				
Adaptive Capacity (High to Low) ↓		S0	S1	S2	S3	S4
	AC4					
	AC3					
	AC2					
	AC1					
	AC0					

Vulnerability Ranking Table
Potential Opportunity
Low Vulnerability
Medium-Low Vulnerability
Medium-High Vulnerability
High Vulnerability

Next Steps

I. Preparing a Draft Final Report
II. Hosting an public open house/workshop to solicit community feedback
III. Developing Final CVA Report

ROCHESTER CLIMATE VULNERABILITY ASSESSMENT

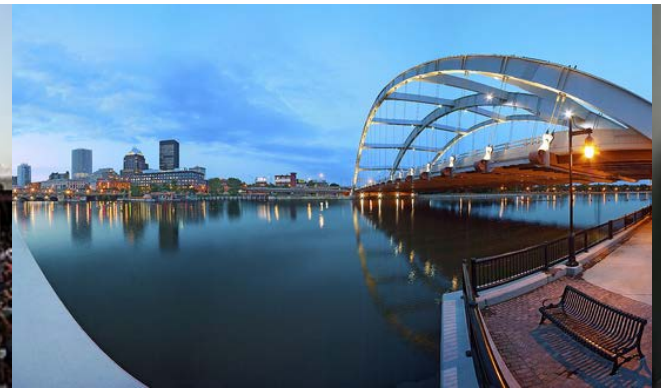
PUBLIC INPUT SESSION

August 29, 2018 | 6-8 PM

200 Years of Douglass 1818 2018

City of Rochester, NY
Lovely A. Warren, Mayor
Rochester City Council

sustainable rochester

Agenda

I. Welcome & Introductions
II. Overview of the Rochester Climate Vulnerability Assessment Project
III. Presentation of climate change data & potential implications
IV. Stakeholder engagement
V. Summary findings of Rochester's strengths and vulnerabilities
VI. Next steps

Welcome & Introductions

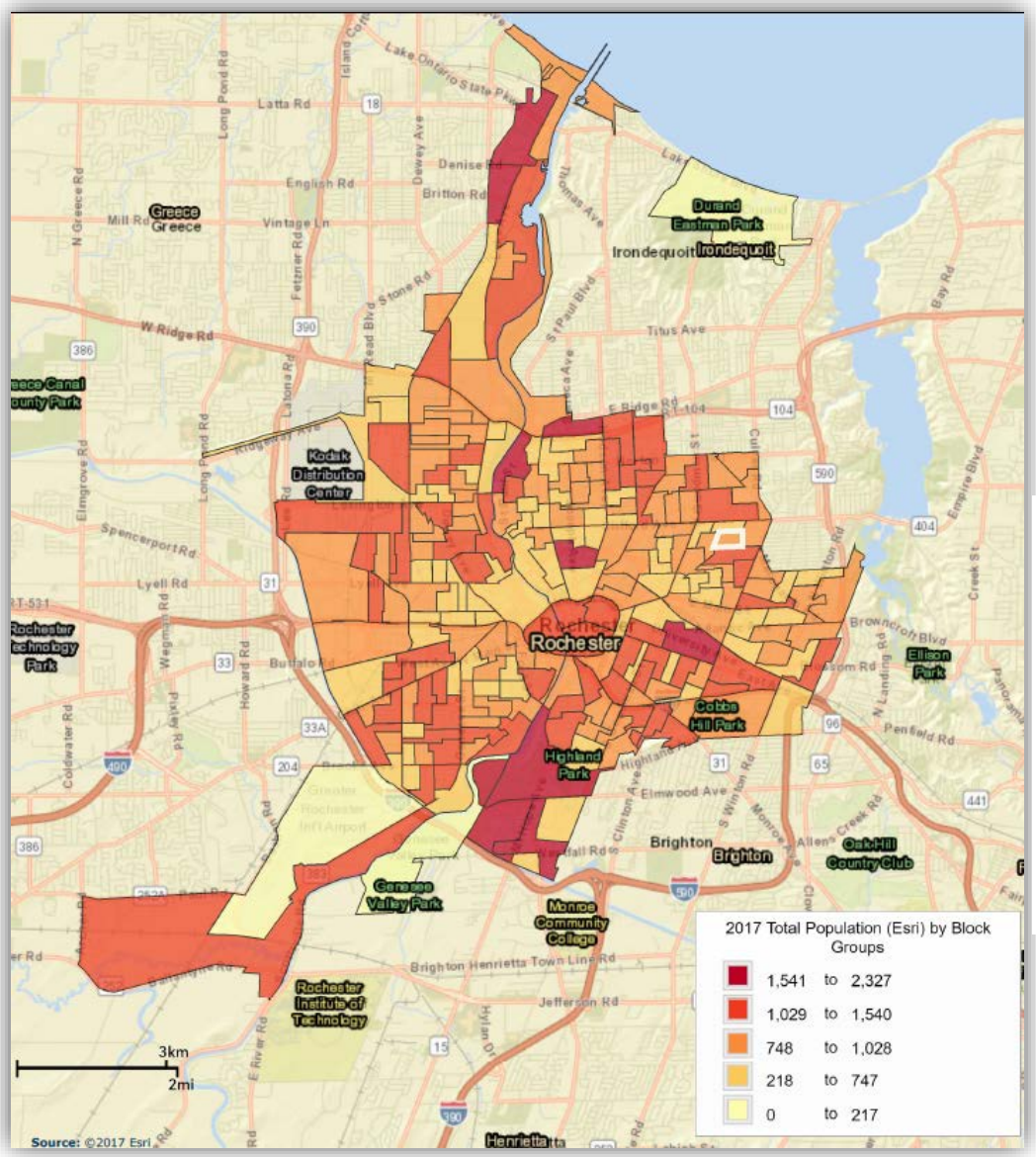
Project Team

Technical Advisory Committee

A fantastic group of technical experts and community stakeholders from various county and city agencies, businesses, educational institutions to provide feedback along the CVA process.

Context

Rochester by the Numbers

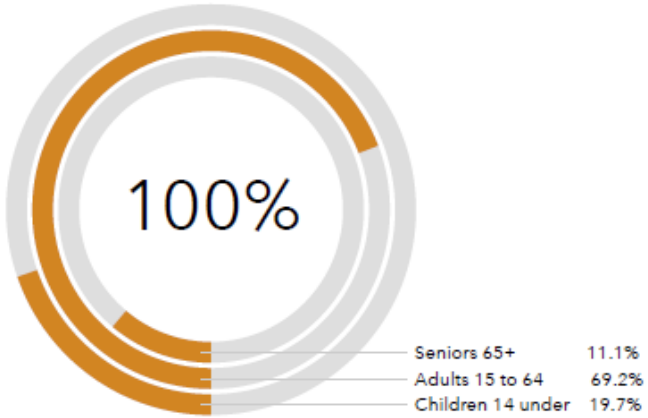


Population and Households

210,249
Total Population

87,262
Total Households

2.29
Average Household Size



26,494
Households With Disability

1,855
Households Without Vehicle

25,478
Households Below the Poverty Level

Source: 2011-2015 and 2017 data; provided by American Community Survey (ACS), Esri, Esri and Infogroup.

Rochester by the Numbers

BUSINESS

8,554
Total Businesses

168,068
Total Employees

31,005
Median Household Income

9.3%
Unemployment Rate

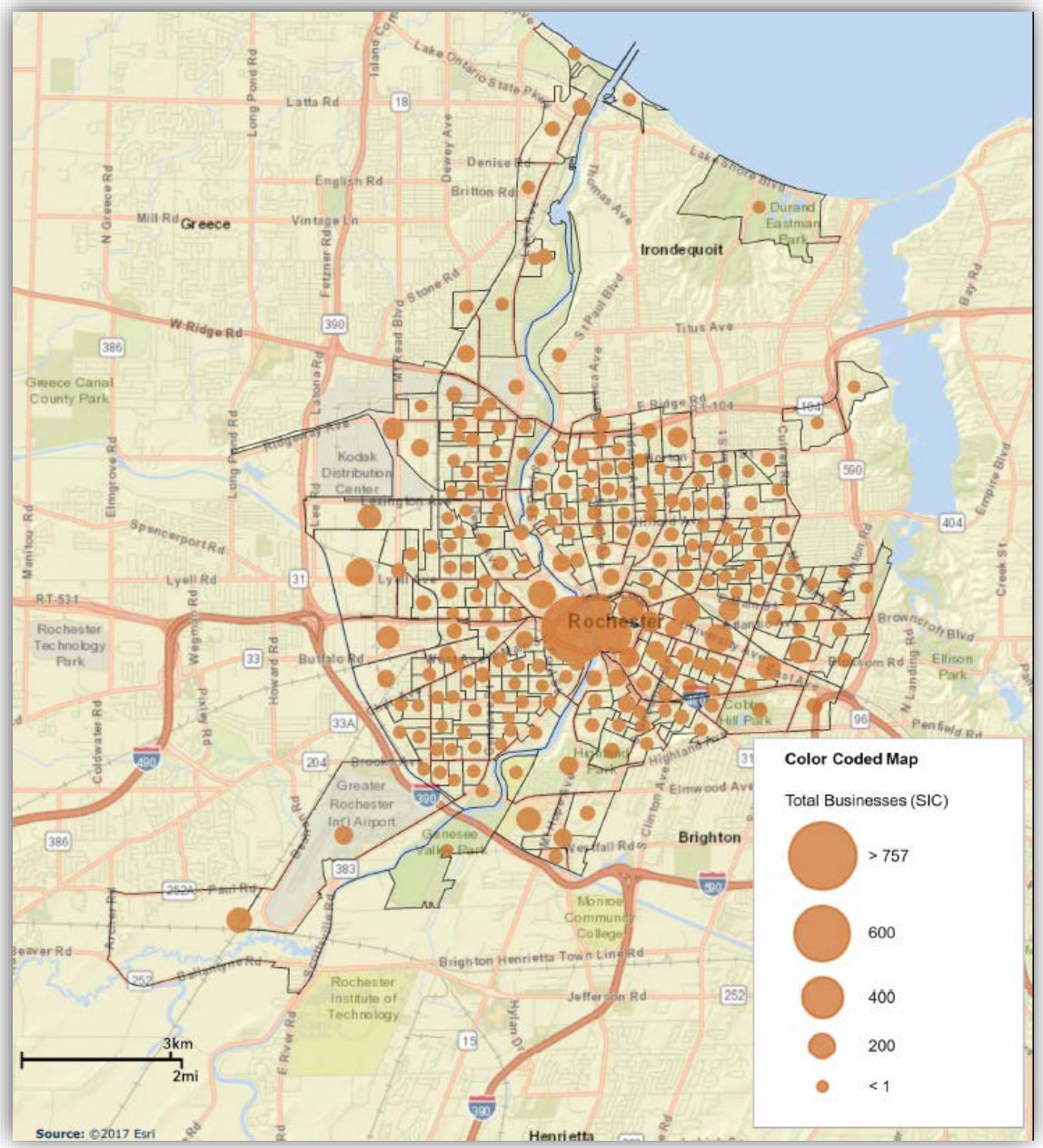
TRANSPORTATION TO WORK

8.8%
Took Public Transportation

10.9%
Carpooled

6.6%
Walked to Work

1.2%
Bike to Work



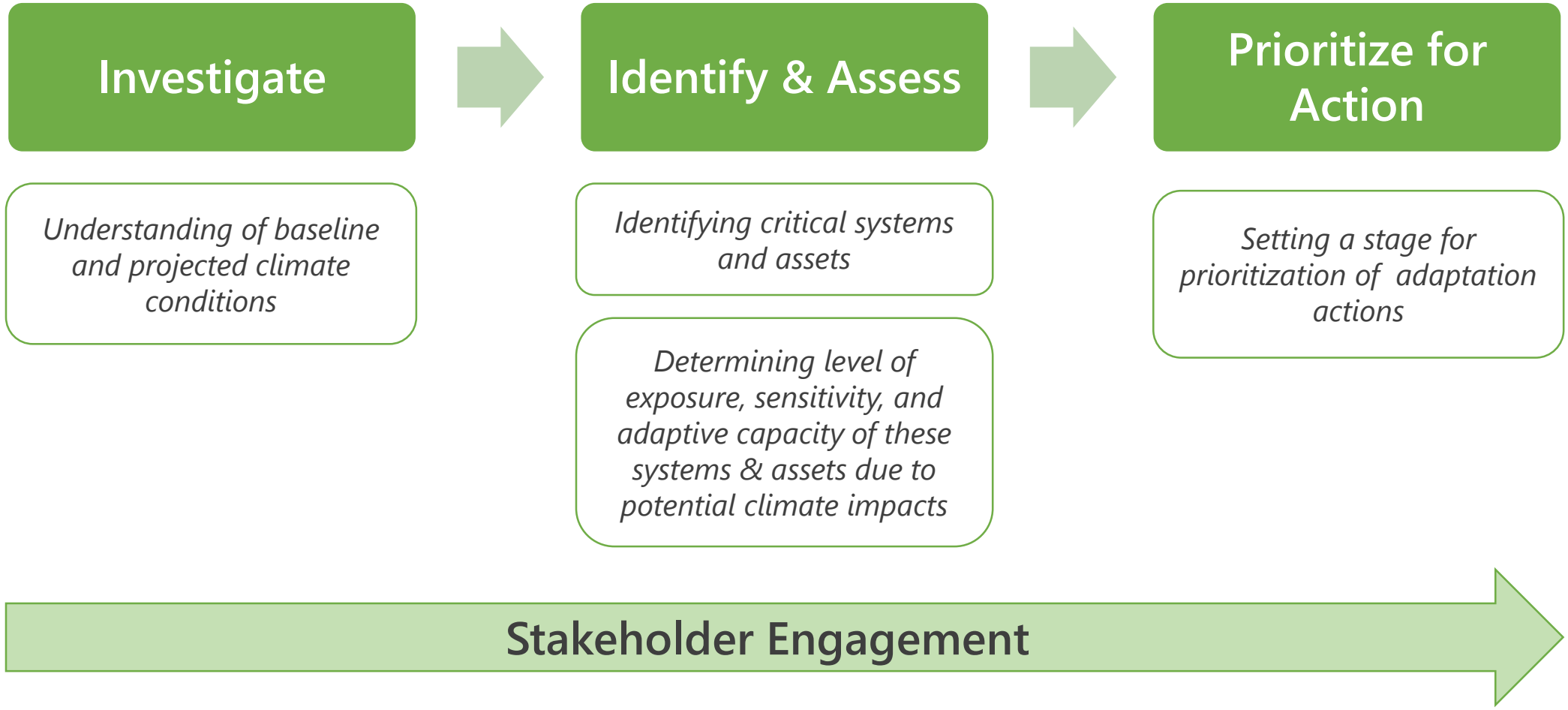
Source: 2011-2015 and 2017 data; provided by American Community Survey (ACS), Esri, Esri and Infogroup.

Overview of the Rochester Climate Vulnerability Assessment Project

Rochester Climate Vulnerability Assessment (CVA)

- Continuation of the City of Rochester's climate planning efforts
  - *Supporting the adaptation and resiliency component of the Community-wide Climate Action Plan*
- Better understanding of the City's vulnerabilities and adaptive capacity
- Serving as guide to the City's capital project planning
- Making sure Rochester is a resilient city

Rochester CVA Approach



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	AC2					
	AC1					
	AC0					

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Climate Trends & Projections

Regional and Local Climate Projections

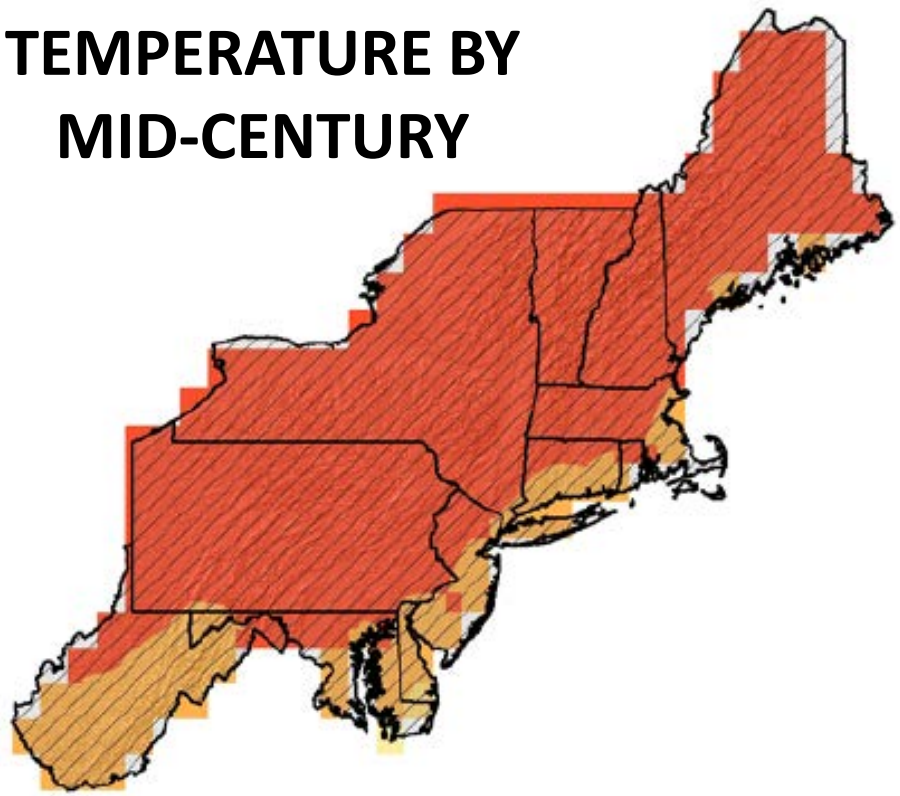
Increase in temperatures

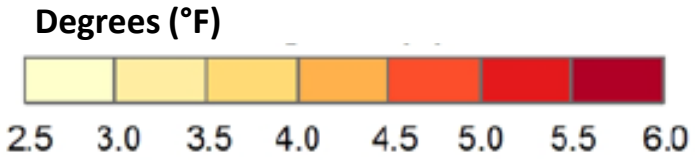
	Baseline (1971 – 2000)	Mid-Century (2050 – 2079)	End of Century (2080 – 2100)
Average Annual Temperature	47.7°F	52°F to 54°F	54°F to 59.4°F
Number of Days ≥ 90°F	8 days	22 to 34 days	27 to 57 days
Number of Days ≤ 32°F	133 days	86 to 96 days	68 to 88 days
Number of Heatwaves	≤ 1 event	3 to 4 events	3 to 8 events
Duration of Heatwaves	4 days	4 to 5 days	4 to 6 days

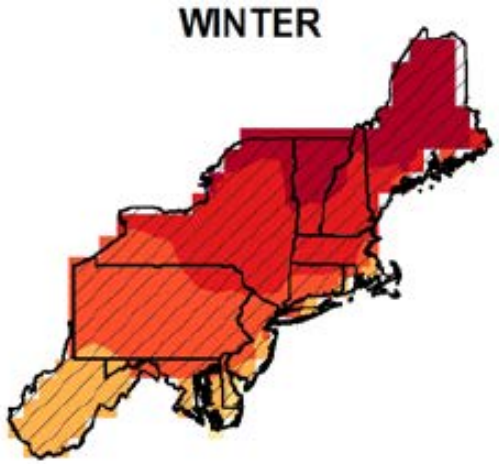
Source: NYSERDA ClimAID 2014 Report
NOAA
NCA 3

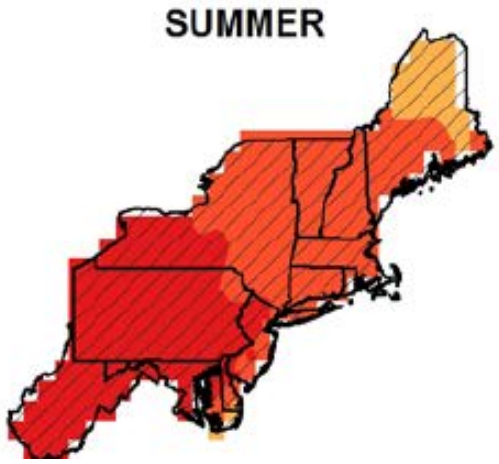
Regional and Local Climate Projections

INCREASE IN ANNUAL TEMPERATURE BY MID-CENTURY









Climate projections for annual and season annual temperature using the A2 (high) emissions scenarios. Sources: NOAA

Regional and Local Climate Projections

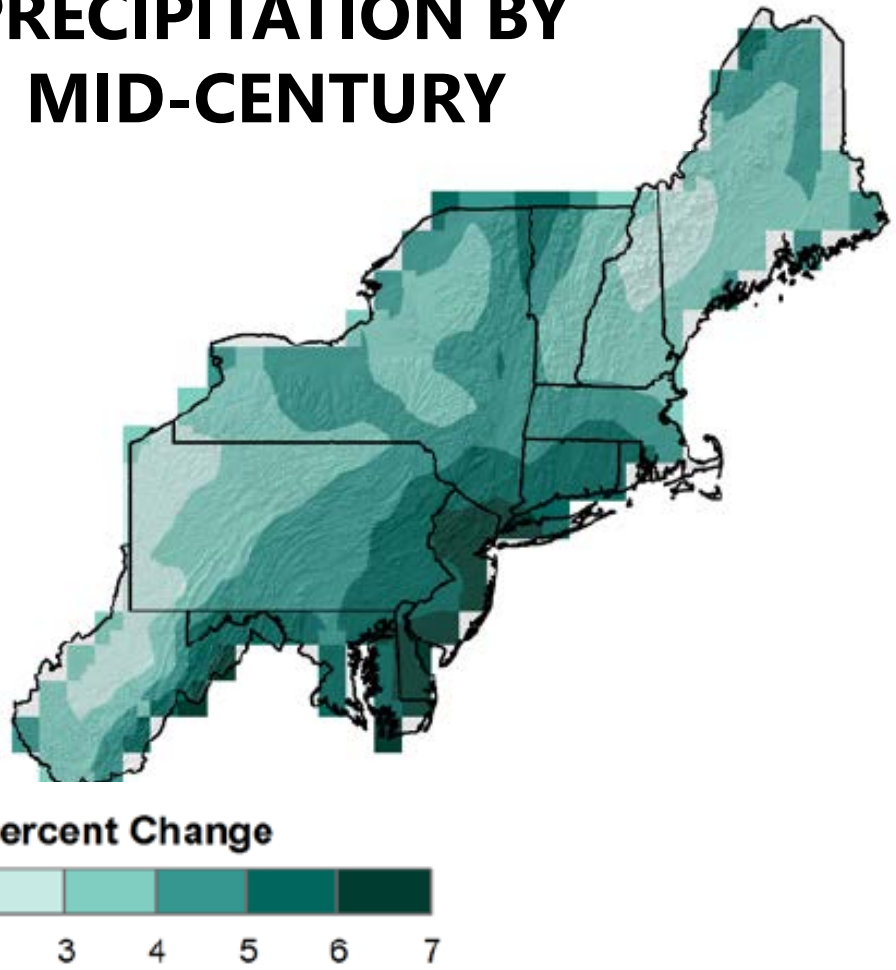
Changes in precipitation

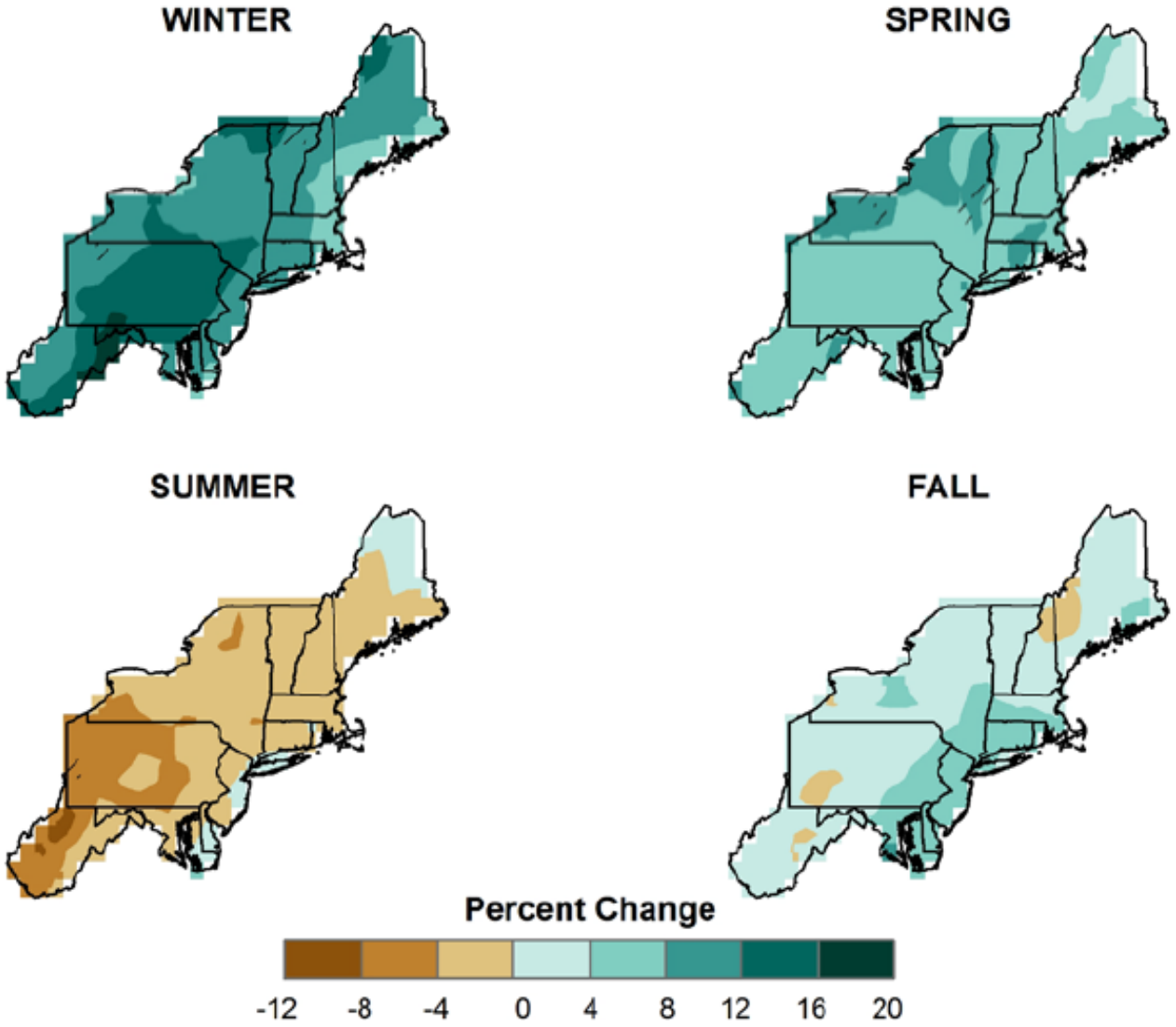
	Baseline (1971 – 2000)	Mid-Century (2050 – 2079)	End of Century (2080 – 2100)
Average Annual Precipitation	34 inches	4% to 10% increase	4% to 19% increase
Days per Year with Over 1" Rainfall	5 days	5 days	5 to 6 days
Extreme weather events	2-3 times more frequent by end of century		
Annual snowfall	Less frequent snowfall, shorter snow season		
Drought	Increase in short-duration drought during summer season by end of century		

Source: NYSERDA ClimAID 2014 Report
NOAA
NCA 3

Regional and Local Climate Projections

CHANGES IN ANNUAL PRECIPITATION BY MID-CENTURY





Climate projections for annual and season annual temperature using the A2 (high) emissions scenarios. Sources: NOAA

Planning Subject Areas, Systems and Sub-systems

Planning Subject Areas

	PLANNING SUBJECT AREAS		
	INFRASTRUCTURE	**NATURAL RESOURCES**	**SOCIOECONOMIC**
SYSTEMS	Transportation	Environmental Resources	Public Health
	Utilities/Energy	Natural Habitat	Economy
	Water	Recreational & Open Spaces	Cultural Resources
	Building & Facilities		Social System/Human Services

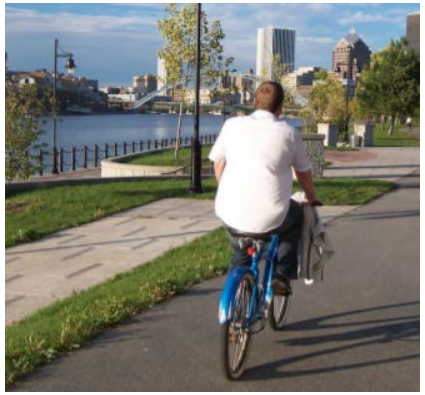



Cross-cutting Considerations

EQUITY

ACCESSIBILITY

PUBLIC HEALTH



Summary of Findings

Vulnerabilities

- Increased stress on existing systems
- Uncertainty about resources needed for repair and maintenance
- Uncertainty about the ability to accommodate increased demands
- Public health and safety risks – especially for vulnerable populations

Strengths & Potential Opportunities

- High adaptive capacity for most systems – redundancies are in place in the event of emergency
- Available technical ability & know-how expertise
- Best practices available in other regions/areas with similar climate (as projected for Rochester)
- New economic opportunities

Stakeholder Engagement: What we heard so far

Benefits of Stakeholder Engagement

- ✓Moving the conversation beyond the “choir”
- ✓Shape future funding priorities for infrastructure, emergency preparedness and response
- ✓Opportunity to improve/update environmental infrastructure
- ✓Plan for ways to use/reallocate existing resources to help the most vulnerable
- ✓Build on emergency preparedness planning and strengthening partnerships with Monroe County and State agencies

Technical Advisory Committee

I. Provide guidance, technical expertise, and feedback on the Climate Vulnerability Assessment process
II. Connect the Project Team with key stakeholder groups
III. Participate in two workshops
IV. Participate in Project outreach

Interviews/focus groups

- ✓ City code enforcement
- ✓ Fire department/emergency management
- ✓ Operations
- ✓ Arborist
- ✓ Disability community
- ✓ Chamber of commerce
- ✓ Common Ground Health
- ✓ Refugee community
- ✓ Foodlink
- ✓ RIT/UR
- ✓ RMAPI
- ✓ Monroe County Planning Department

How is Rochester most vulnerable?

- ✓ Flooding
- ✓ Increased temperatures
- ✓ Energy grid
- ✓ Disruptions to agriculture
- ✓ Influx of people who have been impacted due to impacts of climate change in other locations (i.e. Puerto Rico)
- ✓ Already strained services become even more strained during a crisis

Vulnerable Populations

- ✓ Seniors/elderly
- ✓ Children
- ✓ Low-income residents
- ✓ People without access to vehicles
- ✓ Disabled
- ✓ Visually/hearing impaired
- ✓ Those with mental illness
- ✓ Those dealing with substance abuse
- ✓ Non-native English speakers
- ✓ Undocumented immigrants
- ✓ Refugees
- ✓ Those without the ability to access resources in a crisis (i.e. family, friends, financial resources)

Key vulnerabilities

Related to…

- Aging housing stock (older roofs, windows, insulation, mechanical systems)
  - Lack of cooling/heating systems
  - Increased risk of mold/illness
  - Acute damage from extreme weather
- Transportation (potential disruptions)
  - Access to employment
  - Access to medical facilities
  - Access to locations with internet/libraries
- Less engagement with local government/fear of seeking help

We want to hear from you!

I. How do you think you might personally be affected?

II. How will your business/workplace be affected?

III. Do you have concerns, ideas or strategies for the City to consider?

Next steps

CVA Engagement & Schedule

- ✓ Pre-Engagement Interviews – February
- ✓ Technical Advisory Committee Workshop #1 – March 14, 2018
- ✓ Stakeholder interviews – March/April
- ✓ Technical Advisory Committee Workshop #2 – June 6, 2018
- → Public Open House – August 29th, 2018
- Final CVA Report – September
- Adaptation Planning – Fall 2018

Stay engaged!

Send us your comments and ideas:

https://www.surveymonkey.com/r/RochesterCVA

Make sure your family, friends, and fellow Rochester residents share their suggestions as well!