# American Cyanamid Superfund Site Reduces Climate Exposure



The American Cyanamid Superfund site (Bridgewater Township, New Jersey) is located next to the Raritan River above the Brunswick Aquifer - New Jersey's second largest source for drinking water. The area had been used for manufacturing chemicals and as a disposal site of chemical sludge and other wastes. The site's soil, ground water and waste disposal areas are contaminated with volatile organic compounds (VOCs), semi-VOCs, metals and other harmful chemicals. In 2011, Hurricane Irene dumped seven inches of rainfall in 48 hours and the site flooded. Although there was no major release of contaminants from Hurricane Irene, the flooding caused significant damage to the facility. To anticipate and better prepare for future events, the site owner raised critical infrastructure components to several feet above previous flood events and reinforced the berms surrounding two impoundments to increase their strength and prevent flood-related scour. In addition, a remedy selected by EPA in 2012 required that all future engineered caps be designed and constructed to withstand the effects of a 1-in-500 year flood event, at a minimum.

Flooding at the American Cyanamid Superfund Site in 2011.

While the site's operators did not explicitly use climate models to projected vulnerabilities, the actions taken increase resiliency to current flooding threats and adapted the site to better manage risks associated with projected increases in the frequency and intensity of future storms, including flooding. Overall, the site has adapted to climate change by repairing and raising critical areas of the site to handle increased precipitation and flooding threats and reduce threat of contaminant release now and into the future.

## How did they do it?

**Under EPA oversight, the site owner implemented several adaptation measures**

- Raised the critical electrical instrumentation five feet higher than the flood level reached by Hurricane Irene's flood waters.
- Installed submersible pumps in bedrock wells to maintain hydraulic control during future flood events.
- Reinforced the berms of two impoundments to increase their strength and prevent flood-related scour.
- Set a minimum design standard, specifying that all future capping systems be designed to withstand a 1-in-500 year flood event.
- Developed flood plans including river stage monitoring, preparation procedures, evacuation plans, chain of command, etc.

## Applicable EPA Tools

EPA's Climate Change Superfund Site provides resources to help inform remediation efforts.

Climate Change Superfund Site

## Similar Cases and More Information

Waste sites, such as Superfund and RCRA sites, are at potential risk from the impacts of climate change. Brownfield sites may also be at risk from climate change, for an example of brownfield adaptation see Barre City, VT.

- Barre City, Vermont Accounts for Climate Change within a Brownfield Redevelopment Plan

# Anacortes, Washington Rebuilds Water Treatment Plant for Climate Change



The city of Anacortes, WA recognized that its water treatment plant, located along the Skagit River and serving 56,000 people, was vulnerable to current floods and future climate risks. In 2003, the city recognized the need to update the facility from 21.4 million gallons of water per day (mgd) to a stated capacity of 31.5 mgd. Moving the facility out of the floodplain was deemed cost prohibitive in 2008, so officials decided to rebuild on the existing site. Such a strategy can be risky unless climate projections are taken into account and adaptation strategies implemented to reduce future vulnerability.

The New Anacortes Water Treatment Plant.

To determine the plant's vulnerability, Anacortes officials worked with non-profit organizations to determine the 'best available' climate science and the associated impacts to the plant siting. A variety of climate risks were taken into account including:

- more frequent and intense storms
- saltwater intrusion
- increased sedimentation levels

Climate change impacts were projected through the 2080s and downscaled for the Skagit River area. These vulnerabilities included an expanded 100-year floodplain, an estimated 350% increase in peak suspended sediment load in winter, and anticipated upstream migration of the salt water wedge due to the effects of sea level rise.

In design and construction of this plant, officials sought to protect against higher risk of flooding by:

- minimizing penetration below current 100 year flood elevation
- raising critical electrical equipment out of the 100 year flood level
- utilizing water proofing techniques below 40 foot elevation
- designing ring dikes for flood protection

This plant was rebuilt on site at an expected cost of $56 million dollars and improvements to this design better prepare the facility to meet increased service demand as well as projected changes in climate.

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Recognized climate risk and expected vulnerability**<br>• Anacortes recognized the vulnerability of the facility to flooding in 2003 and 2008, however they also identified the cost prohibitive nature of moving the facility.<br>• When upgrading the facility they received input from scientists and used downscaled climate data to inform decision making. | The EPA Coastal Inundation Toolkit can assist utilities in better understanding facility vulnerability by illustrating a range of potential sea level rise and storm surge scenarios.<br>EPA Coastal Inundation Toolkit |
| **Incorporated projections of climate vulnerability within plant design to adapt to future conditions**<br>• Developed a design that acknowledged current vulnerability and sought to reduce future vulnerability under anticipated future conditions.<br>• Elevated critical facility structures and included ring dikes and dewatering pump systems to protect against flooding.<br>• Utilized water tight construction on the facility and used water proof membrane below 40 foot elevation.<br>• Designed to have no/minimal penetrations below 100 year flood elevation and have electrical switch gear located above 100 year flood level.<br>• Raised and strengthened levees near the plant.<br>• Increased sediment removal ability to deal with expected increase from climate change (although plant is still trying to quantify the projected increase of sediment). | EPA's Climate Ready Water Utilities Adaptation Strategies Guide can assist utilities in identifying low cost adaptation strategies to incorporate within plan designs.<br>EPA's Climate Ready Water Utilities Adaptation Strategies Guide |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Identified information gaps for future research**<br>• Preliminary modeling suggests saltwater intrusion is likely to be a future concern; additional analysis is planned.<br>• Further research is needed to better understand the long term challenges associated with sediment loads. | The Climate Resilience Evaluation and Awareness Tool (CREAT) helps utilities conduct traditional risk based or scenario based vulnerability assessments to better understand information gaps and necessary future research.<br>The Climate Resilience Evaluation and Awareness Tool (CREAT) |

## Similar Cases and More Information

To see how a community analyzed the impact of sea level rise on a water utility , view Manchester-by-the-Sea. For a community that recognized the prohibitive cost of protecting a highly vulnerable facility and decided to move to a safer facility , see Iowa City. Protecting the Blue Plains facility is only one of several strategies Washington, D.C. has taken to reduce the threat of flooding on the community. To see how Washington, D.C. is using green infrastructure to reduce stormwater impacts and combined sewer overflows view the DC Consent Decree .

# Barre City, Vermont Accounts for Climate Change within a Brownfield Redevelopment Plan



The Summer Street Housing Limited Partnership, a partnership between the Central Vermont Community Land Trust (CVCLT) and the non-profit Housing Vermont, sought to redevelop a brownfields site in Barre, Vermont. The site was the former location of an automobile servicing station and a paint shop, and previously contained several underground petroleum storage tanks.

To guide the redevelopment efforts, the partnership conducted an Analysis of Brownfields Cleanup Alternatives (ABCA). As part of its analysis – and to build in climate resiliency and adaptation – the partnership used available regional climate projections to anticipate current and future risks; namely flooding and extreme temperatures. The partnership then considered the vulnerability of potential cleanup remedies to the identified climate risks.


Graphic representation of proposed Central Vermont Community Land Trust Remediated brownfields campus.

By including current and future climate threats in its analysis, the partnership was better able to understand potential vulnerabilities associated with its planned brownfields investment. For example, the increasing frequency and intensity of storms projected for the region may lead to flooding that could compromise potential remediation fixes such as engineered caps. By its explicit consideration of projected climate threats, now and in the future, the Partnership's final remedy selection is designed to safeguard public health even as the climate changes.

## How Did They Do It?

### Identified Climate Risks

- Reviewed NOAA Technical Report Regional Climate Trends and Scenarios for the United States National Climate Assessment: Climate of the Northeast United States to identify anticipated regional climate risks.
- After identifying anticipated climate risk, the Partnership used local knowledge of the site to determine primary climate vulnerabilities. Specifically, more frequent and intense storms may lead to flooding which could result in potential contamination releases beyond the site. More extreme temperatures could also exacerbate the risk of soil gas exchange and maintaining healthy indoor air quality.

## Applicable EPA Tools

Review the National Climate Assessment regional projection to better identify projected climate risks.

National Climate Assessment

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Considered climate risk and vulnerability when evaluating cleanup alternatives**<br>• The site's Analysis of Brownfield Cleanup Alternatives stated, "Climate change concerns for site-wide soil gas contamination include: drought conditions could lower the surficial groundwater table, leading to a larger vadose zone for soil gas migration [for more on Vadose Zone Leaching see EPA VLEACH]; and the loss of a winter frost layer could alter soil gas contaminant migration pathways to indoor air in unknown ways."<br>• While several cleanup options were identified, several were rejected because they would not have reduced climate vulnerability. (E.g capping the contaminated soil was not selected because while it may have reduced current exposure, it would have been vulnerable to future flooding events anticipated as a result of projected increased precipitation). | Use the EPA's Analysis of Brownfields Cleanup Alternative checklist to help consider anticipated climate changes in your Corrective Action Plan.<br>EPA's Analysis of Brownfields Cleanup Alternative checklist |
| **Selected a Brownfield Cleanup Alternative that they identified as having Adaptive Benefits**<br>• A cleanup that included a soil management plan (SMP) and targeted excavation was adopted. Excavation was selected due to the level of uncertainty on how climate change could "alter soil gas contaminant migration to indoor air in unknown ways" (as identified in the Analysis of Brownfield Cleanup Alternatives).<br>• For additional safety, a "sub-slab depressurization (SSD) system and vapor barrier to mitigate exposure to indoor air via the vapor intrusion pathway in the future buildings" was included in the Corrective Action Public Notice in order to attain "land use restrictions (LURs) to protect any potential future construction/utility workers or new property owners from exposure to site contaminants. | Use EPA Brownfield Revitalization in Climate-Vulnerable Areas to help inform selection of appropriate adaptation option.<br>EPA Brownfield Revitalization in Climate-Vulnerable Areas |

## Similar Cases and More Information

The Summer Street Housing Limited Partnership anticipated the effects of climate change to their brownfield redevelopment efforts. To see how waste sites (Superfund or RCRA sites) have prepared for climate changes see American Cyanamid Superfund case.

- American Cyanamid Superfund Site Reduces Climate Exposure

# Blue Plains Wastewater Facility in Washington DC Reinforces Facility Against Floods



View of Blue Plains Wastewater Facility along the Potomac River.

The District of Columbia's Blue Plains Wastewater Facility in Washington, DC, serves most of the national capital area, including parts of Maryland and Virginia. This facility is vulnerable to flooding because of its location adjacent to the Potomac River. The facility has historically been protected from flooding by a seawall built to withstand a 1-100 year flood. However, understanding that storms may become more frequent and intense, the DC Water and Sewer Authority decided to implement an adaptation action to prepare for more flooding due to climate change. The Blue Plains facility is undergoing a $13 million dollar construction project, expected completion in 2021, to build a 17.2 ft high sea wall that will surpass the recommended 1-500 year storm level by including 3 feet of freeboard to protect against higher river elevation or wave action. Blue Plains has selected this standard as a proxy to adapt the facility to expected higher river elevation and storm surge inundation. This will help protect the facility against higher river levels and storm surges and reduce threats of Clean Water Act violations. Blue Plains took this action to promote resilience to current conditions and adapt to expected climate changes.

| How Did They Do It? | Applicable EPA Tools |
|---|---|
| **Blue Plains Identified Facility Vulnerability and Appropriate Adaptation Options**<br>• Blue Plains acknowledged the scientific uncertainty of how climate change would impact water levels in the Potomac River. As a major facility with a large investment along the riverfront, building a seawall to protect against flooding was deemed a preferable strategy rather than moving the entire facility to higher ground. | Use the Climate Resilience Evaluation and Awareness Tool to identify facility vulnerability and adaptation strategies that account for climate change. |
| **Blue Plains Chose an Adaptation Action That Exceeded Current Best Practices to Account for Future Changes in Climate**<br>• Blue Plains utilized a proxy measurement to design the seawall to account for uncertainty regarding how climate change would impact Potomac River levels. The seawall (currently under construction) was designed to account for a current expected 1-500 year flood and include 3 feet of freeboard, this design exceeds FEMA's flood risk standards for federally funded projects.<br>  ◦ FEMA's flood risk standards for federally funded projects | The EPA's Adaptation Strategies Guide can help you select adaptation strategies based upon expected facility vulnerabilities. |

## Similar Cases and More Information

Several other communities have adapted to protect their water and wastewater service from flooding and sea level rise. To see how another northeastern community analyzed the impact of sea level rise on a water utility, view Manchester-by-the-Sea. For a community that recognized the prohibitive cost of protecting a highly vulnerable facility and decided to move to a safer facility, see Iowa City. Protecting the Blue Plains facility is only one of several strategies Washington, D.C. has taken to reduce the threat of flooding on the community. To see how Washington, D.C. is using green infrastructure to reduce stormwater impacts and combined sewer overflows view the DC Consent Decree.

# Boston Raises Wastewater Facility to Avoid Inundation



In the late 1980's, Boston's Deer Island Wastewater Treatment Plant needed an upgrade. The Massachusetts Water Resources Authority (MWRA) determined facility vulnerability to sea level rise and decided to raise key portions of the plant by 1.9 feet. The redesign and construction covered a ten year period (1989-1998) and was part of a $3.8 billion upgrade to add secondary treatment and consolidate regional treatment capacity by increasing Deer Island capacity from 250 to 350 million gallons for day. MWRA's decision to raise portions of the plant avoided extensive costs associated with building a seawall and covered the projected vulnerability over the planned life of the facility (through 2050). MWRA considers the vulnerability of its facilities on an on-going basis using current information to assess the effectiveness of its climate adaptation actions. The Deer Island adaptation action has been re-evaluated for effectiveness within the city's Comprehensive Adaptation Plan ("Climate Ready Boston", 2013). This review used a community non-profit's sea level rise study and concluded that MWRA's decision to raise Deer Island is likely to be sufficient to avoid inundation of the facility over the next century.

A view of Boston's Deer Island Wastewater Treatment Plant's redesigned facility

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **MWRA identified facility vulnerability**<br>• MWRA assessed its Deer Island wastewater facility's vulnerability to sea-level rise in accordance with the best available science at the time. | The Climate Resilience Evaluation and Awareness Tool (CREAT) helps understand expected utility facility vulnerabilities from a changing climate. |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **MWRA adapted to future conditions**<br>• When confronted with needing to modernize the Deer Island facility, MWRA took the opportunity to redesign it keeping vulnerability over its projected operating life in mind (i.e., raising key portions by 1.9 feet). | EPA's Climate Ready Water Utilities Adaptation Strategies Guide, assists utilities identify potential facility adaptation strategies based upon expected climate vulnerabilities. |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **As science improves, MWRA re-evaluates risk and vulnerabilities to ensure effective adaptation**<br>• In recent years, MWRA analyzed its entire system's projected vulnerabilities to storm surge (using a proxy measurement equivalent to Superstorm Sandy), the 100 and 500 year storm events and low and high sea level rise scenarios. The analysis identified the facilities most at risk due to anticipated sea level rise. Deer Island, due to the adaptation measures already adopted, was among the least vulnerable facilities.<br>• MWRA also continues to monitor best available science to determine performance, including of the Boston Harbour Association's sea level rise analysis (used within Climate Ready Boston: Municipal Vulnerability Report). This report further supports previous analyses that suggest Deer island is among the least vulnerable facilities.<br>  ◦ Climate Ready Boston: Municipal Vulnerability Report (PDF)(29 pp, 7.17 MB) | The EPA Coastal Inundation Toolkit can assist utilities in better understanding facility vulnerability by illustrating a range of potential sea level rise and storm surge scenarios. |

## Similar Cases and More Information

Sea-level rise is only one impact from climate change. Climate projections are typically best considered as a range of likely impacts based on best available science. To see how a community conducted their own vulnerability analysis to sea-level rise, not relying on external analyses, view Manchester-by-the-Sea. Retrofitting is not the only adaptation strategy for utilities

dealing with projected increased flooding, two other strategies utilities can consider are building a wall to protect facilities from higher water levels (DC Blue Plains) and decommissioning flood-prone facilities (Iowa City, IA) decommissioned a highly flood-prone wastewater facility. For more on how Boston is adapting to climate change, view Climate Ready Boston.

# California Prepares for Increased Wildfire Risk to Air Quality From Climate Change



Wildfires, a longstanding and frequent threat to California, are expected to increase in intensity and frequency due to climate change. While wildfires are obviously a significant threat to property and public safety, they can also significantly affect air quality by increasing the amount of particulates in the air. Because of this, California included wildfire threat within its 2009 Climate Adaptation Strategy and seeks to reduce and adapt to the increasing future threat to air quality from wildfires. Consistent with adaptation planning practices, California conducted a vulnerability assessment to better understand the projected magnitude of impact climate change could have on wildfire activity including concerns such as the effectiveness of California's climate sinks (i.e., carbon stored in vegetation) and how projected climate changes are expected to impact them. While there are many factors that may influence the past trends, climate change is expected to significantly impact California's forests and contribute to an increase of wildfires in the projected future. California's 2010 Rangeland Assessment's chapter on climate change notes that the fire season has been starting sooner and ending later, and the severity of wildfire acreage burned has been increasing in recent years. The Rangeland Assessment also includes reference to literature (i.e., studies) that suggests the increased number of wildfires will lead to a corresponding increase in the number of 'bad' air days from particulate matter. California is anticipating how climate change will affect wildfires and associated public health concerns and adapting by protecting forests, increasing public awareness of proper land management strategies, and promoting efforts to better maintain air quality.

| How Did They Do It? | Applicable EPA Tools |
|---|---|
| **Assessed public health risk from increased wildfires due to changing climate conditions** | Review the 2014 Quadrennial Fire Review (PDF) (96 pp, 4.4 MB) to evaluate the strategic outlook of wildland fire management over the next 10-20 years and use EPA's Wildfire Smoke Guide for Public Health Officials (PDF) (27 pp, 379 K) to identify potential impacts to public health. |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Identified adaptation strategies and created local resources**<br>• Identified resiliency strategies in the California Statewide Adaptation Strategy (PDF) (15 pp, 424 K) including fire suppression efforts, and near and long term adaptation strategies to develop institutional capacity to monitor and mitigate the increased threat and risk of wildfires. These efforts are attempting to reduce wildfires and the associated impacts to air quality and human health.<br>• Developed an Adaptation Planning Guide Exit to help local communities undergo a vulnerability assessment and create adaptation plans.<br>• Promoted public awareness for the need to reduce the frequency and intensity of wildfires and provided grant funds Exit to local organizations to fund projects related to fuel (vegetation) hazard reduction, fire prevention education and training, and fire prevention planning.<br>• Provided guidelines on "Cal-Adapt" Exit on vulnerabilities and how communities can identify adaptation strategies and tools to deal with increased wildfire risk.<br>• Created a public website with an interactive projection of wildfire risk for both regions and individuals to gauge future wildfire risk around the state under two different emissions scenarios. | Use the Forest Service's LANDFIRE (Landscape Fire and Resource Management Planning Tools) to map vegetation, fire, and fuel characteristics at a landscape scale to support resource management initiatives.<br>** (This is a non-EPA resource from the U.S. Forest Service.)* |

## Similar Cases and More Information

Wildfires pose extreme threats to public safety, however this case focuses on EPA's role, in this case, protecting air quality. For more information on wildfires, including the impact to human health and safety, please visit the National Climate Assessment or U.S. Resiliency Toolkit. For another example on how a community is adapting to air quality concerns see the Salt Lake City case.

- National Climate Assessment
- U.S. Resiliency Toolkit
- Salt Lake City

# Camden, New Jersey Uses Green Infrastructure to Manage Stormwater



Camden County Municipal Utilities Authority (CCMUA) provides wastewater services (80 million gallons per day) to approximately 500,000 people in 37 municipalities in Camden County, New Jersey. Historically, CCMUA has experienced combined sewer flooding during intense rain events due to the age of their system and the lack of available funding for infrastructure replacement. Realizing that climate change is expected to increase the frequency and intensity of storms, CCMUA's utility operators decided to better understand the utility's current and future vulnerability.

Working with the EPA, CCMUA used the Climate Ready Evaluation and Awareness Tool (CREAT) to gain greater appreciation of the magnitude of its Combined Sewer Overflow (CSO) and other vulnerabilities and identify potential adaptation strategies. CCMUA's operators formed a partnership.

Camden SMART Initiative, consisting of:

- the local municipality
- state environmental protection agency
- local university
- local non-profits

This partnership enabled the municipality to integrate water conservation and promote a comprehensive network of green infrastructure programs and projects that can help Camden adapt to future conditions. Building off of the success of Camden SMART, EPA partnered with the City of Camden, CCMUA, Cooper's Ferry Partnership and NJ DEP to form the Camden Collaborative Initiative to use the collective impact model to address air quality, solid waste, and neighborhood revitalization concerns, in addition to flooding.

While the site's operators did not explicitly use climate models to projected vulnerabilities, the actions taken increase resiliency to current flooding threats and adapted the site to better manage risks associated with projected increases in the frequency and intensity of future storms, including flooding. Overall, the site has adapted to climate change by repairing and raising critical areas of the site to handle increased precipitation and flooding threats and reduce threat of contaminant release now and into the future.

| How did they do it? | Applicable EPA Tools |
| --- | --- |
| **Assessed climate vulnerability**<br>• Camden used the Climate Ready Evaluation and Awareness Tool to understand the magnitude of climate vulnerability, particularly for CSO vulnerability to projected precipitation changes. | The Climate Resilience Evaluation and Awareness Tool helps utilities determine climate risk and assess vulnerability to projected climate changes.<br>Climate Resilience Evaluation and Awareness Tool |

| | |
|---|---|
| **Developed adaptation response recommendations to improve water quality and reduce CSO's**<br>• Identified adaptation actions including: enacting a water conservation ordinance to reduce water inputs into the sewer system; reducing impervious surface and runoff through promoting rain gardens and parks; "daylighting" streams; converting buildings to parkland; and cleaning inlets and replacing netting systems.<br>• One SMART project disconnected a library's rooftop runoff from the combined sewer system by designing two rain gardens to capture, filter, and infiltrate the first one-inch of rainfall. | The Climate Ready Water Utilities Adaptation Strategies Guide assists utilities identify in identifying potential next steps to adapt to expected climate vulnerabilities.<br>Climate Ready Water Utilities Adaptation Strategies Guide |
| **Formed local partnership to implement adaptation**<br>• Camden formed a partnership group, SMART, to help implement its network of green infrastructure adaptation measures. | Enhancing Sustainable Communities With Green Infrastructure Guide provides a framework to engage the community in implementing green infrastructure projects that improve quality of life and prepare for climate change impacts.<br>Enhancing Sustainable Communities With Green Infrastructure Guide |

## Similar Cases and More Information

To see how another northeastern community analyzed the impact of sea level rise on a water utility, view Manchester-by-the-Sea. For a community that recognized the prohibitive cost of protecting a highly vulnerable facility and decided to move to a safer facility, see Iowa City. To see how Washington, D.C. is using green infrastructure to reduce stormwater impacts and combined sewer overflows view the DC Consent Decree.

# Chicago, IL Adapts to Improve Extreme Heat Preparedness



In 1995, Chicago experienced an extreme heat event that led to the deaths of several hundred people over the course of five days. This event prompted the city to strengthen and update its heat emergency response system. Recognizing that heat waves are expected to increase in Chicago due to climate change,–supported by the Chicago Climate Impacts Report, the city adopted a comprehensive set of actions to reduce deaths from extreme heat events.

Graphic of projected urban heat island exacerbated by climate change.

Chicago's approach focuses on community preparedness with particular attention to vulnerable populations. Since effective public outreach is a time and resource intensive process, Chicago worked with the Field Museum, a world-renowned museum and a leader in science education and engagement, to develop an outreach program that targeted neighborhoods vulnerable to climate change. This partnership engaged the local community to increase awareness of neighborhood vulnerability and identify how residents could reduce the impact of climate exacerbated extreme heat events. This outreach effort has worked to complement traditional disaster response actions that Chicago promoted after the 1995 heat wave.

## How did they do it?

**Identified current disaster response needs for extreme heat resiliency**

- Chicago adopted disaster responses including: expanding *Notify Chicago,* the city's text and email emergency notification system; identified (e.g., public libraries) or established cooling centers; set up a call "311" program to have officials conduct well-being checks for those who may need additional assistance during events such as the elderly or infirm; and conducted disaster preparedness and response trainings.

## Applicable EPA Tools

EPA's Excessive Heat Events Guidebook can help identify current and future disaster response needs for extreme heat adaptation strategies.

Excessive Heat Events Guidebook

**Assessed citywide vulnerability to future climate extreme heat conditions**

- The city assessed future vulnerability using an "analog city analysis".
  - USGCRP's Climate Change, Heat Waves, and Mortality Projections for Chicago
- Chicago identified the most vulnerable residents in their community (e.g., elderly, young) in order to best target heat outreach efforts.

CDC's Assessing Health Vulnerability to Climate Change can help identify the communities most at risk and adopt adaptation strategies that target extreme heat vulnerabilities.

Assessing Health Vulnerability to Climate Change (PDF)(24 pp, 4.3 MB)

** (This is a non-EPA resource from the Centers for Disease Control and Prevention.)*

**Adopted adaptation strategies that targets extreme heat vulnerabilities and support vulnerable populations**

- Partnered with the Chicago Field Museum to conduct tailored outreach to at-risk communities and neighborhoods to increase understanding of current and expected future changes. Relating future climate norms to a previous extreme heat event (in this case, the 1995 heat wave) helped the climate risk resonate with the residents. Chicago identified urban heat island areas that would be worsened by climate change and used this information to target green infrastructure and heat island mitigation efforts.

EPA's Urban Heat Island Strategies identifies strategies for adapting to future extreme heat events by reducing the urban heat island effect.

EPA's Urban Heat Island Strategies

## Similar Cases and More Information

Extreme heat events and other weather extremes can disproportionately impact at-risk or vulnerable communities. To see how Chicago has used green infrastructure to both reduce the impact of future extreme heat events and reduce stormwater runoff during extreme precipitation events, view Chicago Green Infrastructure to Reduce Heat. For another case on how a large municipality has adapted to prepare for extreme heat events, view NYC Heat Preparedness.

- Chicago, IL Uses Green Infrastructure to Reduce Extreme Heat
- NYC Heat Preparedness

# Chicago, IL Uses Green Infrastructure to Reduce Extreme Heat



In 1995, Chicago experienced an extreme heat event that led to the deaths of several hundred people over the course of five days. Recognizing climate change will affect extreme heat events among many other weather events, Chicago decided to conduct a vulnerability assessment to better understand the threat. Chicago conducted a vulnerability assessment that projected future expected temperatures and estimated the magnitude of threat to future heat related mortality. In anticipation of these future threats, Chicago adopted a comprehensive Climate Change Action Plan. The city's first priority under the Chicago Climate Action Plan: Adaptation Strategy Report is to adapt to extreme heat events.

Chicago City Hall's Green Roof.

Chicago's approach assessed vulnerability to extreme heat and promoted resiliency and adaptation actions to reduce climate risk. Specifically, Chicago is promoting resiliency through emergency response procedures, specifically including it as a specific criterion within the county's (Cook County) Hazard Mitigation Plan and identifying that its Extreme Weather Operations Plans have scalability to deal with projected changes.

In order to adapt to future extreme heat events, Chicago is identifying urban heat areas ('heat islands') of concern and then adopting heat island reduction strategies through a variety of municipal programs including: building codes and green infrastructure projects. These green infrastructure strategies provide Chicago with mutual benefits including increasing extreme heat emergency preparedness and improving stormwater management for extreme precipitation events.

## How did they do it?

**Conducted vulnerability assessment of future risk from climate exacerbated extreme heat events**

- Chicago's Climate Action Plan Impacts Report projected the future climate under varying emissions scenarios to identify expected future temperatures, note this analysis projected that by 2050, Chicago could be seeing extreme heat events equivalent to the 1995 heat-wave up to twice per decade.
- Chicago developed an algorithm which analyzed past and future climate changes and residents ability to acclimate to anticipated future changes. This analysis allowed for an estimation of future risk for heat-related mortality.
- Chicago simulated an extreme heat event, using data from the 2003 European heat wave, to better understand the impact on the city.

## Applicable EPA Tools

Use CDC's Assessing Health Vulnerability to Climate Change to identify the communities most at risk and adopt adaptation strategies that target extreme heat vulnerabilities.

Assessing Health Vulnerability to Climate Change (PDF)(24 pp, 4.3 MB)

** (This is a non-EPA resource from the Centers for Disease Control and Prevention.)*

**Chicago Targeted Efforts to Reduce the Urban Heat Island**

- Chicago identified urban heat island “hot spots” to target with heat reduction strategies such as green infrastructure, reflective roofing, and rooftop gardens.
- The city required new flat roofs meet EPA Energy Star Cool Roof Standards, supported commercial green roofs with a Tax Increment Financed Improvement Fund, and promoted reflective roofing.
- The city provided incentives for the adoption of green infrastructure through an expedited ”Green Permit Process” and provided grants for small projects.

EPA’s Urban Heat Island Strategies and EPA Energy Star Cool Roof Standards can be targeted to reduce the urban heat island and adapt to future conditions.

Urban Heat Island Strategies

EPA Energy Star Cool Roof Standards

**Promoted Adaptation Actions that Would Provide Co-Benefits**

- Chicago incorporated heat island reduction strategies - such as green or cool roofs, cool pavements, or increased vegetation and trees - into long-term planning efforts to help lower urban temperatures as well as provide substantive benefits for other programs, including stormwater management.

The Green Infrastructure Wizard Tool can help communities identify and select green infrastructure adaptation strategies that provide co-benefits.

Green Infrastructure Wizard Tool

## Similar Cases and More Information

To see how Chicago has modified their Heat Emergency Response Programs to reduce deaths from extreme heat events, view Chicago Heat Emergency Response. To view another region’s example of extreme heat adaptation planning view Minnesota Heat Health, or the NYC Heat Plan. Chicago implemented green infrastructure projects that would provide both heat reduction and stormwater management benefits, for another example of how adaptation strategies can promote mutual benefits view Salt Lake City Air Quality.

- Chicago, IL Adapts to Improve Extreme Heat Preparedness
- Minnesota Assesses Climate Risk to Public Health
- New York City Adapts To Deal with Projected Increase of Heat Waves
- Salt Lake City, Utah Adapts to Improve Air Quality Through Smart Growth

# DC Utilizes Green Infrastructure to Manage Stormwater

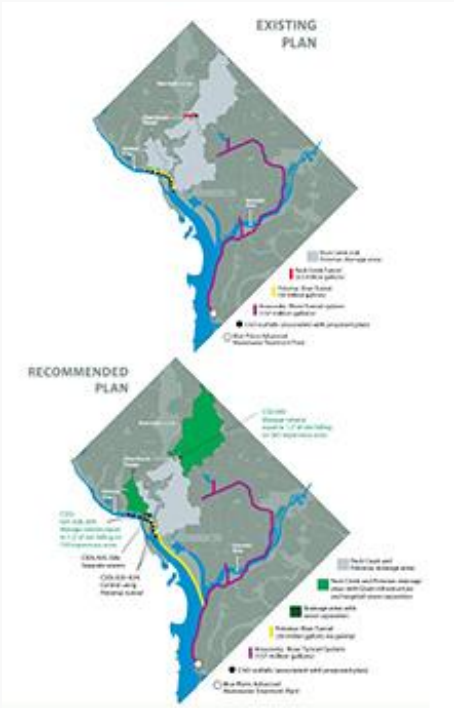
epa.gov/arc-x/dc-utilizes-green-infrastructure-manage-stormwater

Under a consent decree from the EPA to reduce combined sewer overflows (CSOs), the District of Columbia Water and Sewer Authority (DC Water) developed a plan to construct three large holding tunnels to provide extra capacity during high precipitation events. Upon further consideration of the uncertainties regarding future precipitation extremes and the costs associated with developing three large infrastructure projects, DC Water requested to revise the agreement.

The revised plan replaces one tunnel with green infrastructure projects to reduce the amount of stormwater runoff that the system has to handle. A capacity metric (i.e., amount of stormwater runoff managed) associated with the green infrastructure projects was adopted rather than an initial plan requiring a defined financial commitment ($90 million) to better ensure the expected stormwater reduction improvements.

Green infrastructure project: Blue Plains Wastewater Facility in Washington DC Reinforces Facility Against Floods

DC Water reviewed the National Climate Assessment projections for the Northeast to better understand potential future conditions, however no such projections were included in the capacity agreement. While no climate projections were included, the agreement does provides the District of Columbia greater adaptive flexibility to scale and increase green infrastructure to accommodate future precipitation extremes.




Comparison of existing and modified plans.

DC Long-Term Control Plan, May 2015 (PDF) (890 pp, 40 K, )

With the installation of green infrastructure projects in the Rock Creek Park corridor, the revised plan provides substantive environmental, economic, and health benefits as early as 2017 as compared with the original project projection of 2024. The revised plan, upon completion in 2030, is expected to reduce CSO releases by 96% (based upon current precipitation levels).

| How did they do it? | Applicable EPA Tools |
|---|---|
| **Realized current approach was insufficient to meet current and future climate extremes** | The Climate Resilience Evaluation and Awareness Tool (CREAT) can help communities identify expected vulnerabilities from a changing climate.<br><br>Climate Resilience Evaluation and Awareness Tool (CREAT) |

**Selected a unique adaptation option specific to local conditions**

- DC Water developed and proposed a plan utilizing a mix of grey and green infrastructure. The District has identified a variety of green infrastructure and low impact development measures with potential for use, including rain barrels, grassed swales, cisterns infiltration trenches, permeable pavements, increased tree cover, and rooftop greening.

The Green Infrastructure Wizard Tool can help communities identify and select green infrastructure adaptation strategies according to local conditions.

Green Infrastructure Wizard Tool

**Defined performance-based metrics rather than financial**

- DC Water committed to installing Green Infrastructure (PDF) (890 pp, 40 MB) to absorb "…1.2 inches of rain falling on 365 impervious acres of land that currently does not absorb stormwater…" If this commitment proves infeasible, the plan will revert to using underground storage. This plan is projected to reduce CSO's by 96% and is expected to be capable of handling more than 90% of storms (under baseline climate conditions). DC Water has already completed preliminary green infrastructure demonstration projects and is expected to complete an additional 44 acres of by June 2019.

The EPA SWMM and Stormwater Calculator Climate Assessment Tools can help communities simulate and evaluate green infrastructure performance against projected climate impacts:

Storm Water Management Model (SWMM)

Stormwater Calculator

## Similar Cases and More Information

Increased precipitation events may lead to increased sewer overflows as well as threaten the water or wastewater utility facilities themselves. For more information on what a Washington, D.C. wastewater facility is doing to adapt to climate change and the threats from flooding, view Blue Plains Wastewater Facility Case. For information on a city that is moving wastewater services away from an area vulnerable to flooding view the Iowa City Riverfront Master Plan.

- Blue Plains Wastewater Facility in Washington DC Reinforces Facility Against Floods
- Iowa City, Iowa Closes Vulnerable Wastewater Facility

# Fredericktown, Missouri Prepares for Climate Change Drought Risk



Fredericktown, Missouri's drinking water utility services the town of just over 4,000 residents with an average demand of 500,000 gallons per day. Fredericktown had concerns about the resiliency of its water system, specifically regarding the amount of sediment deposition and contaminate influx from heavy rain events that affected source water storage capacity. To complicate its concerns, the region suffered a drought in 2012 which left much of the system's lake-bed exposed, reduced storage capacity, and the utility would have been critically low on available source water if not for a release from an upstream lake.

Recognizing the severity of other droughts at the time in Texas and California, and understanding that drought risk may increase in the future, utility officials realized they needed to prepare for the future. Using the EPA's Climate Ready Evaluation and Assessment Tool (CREAT), the utility was able to project potential climate impacts to their system out to beyond the year 2035. Initial results of this tool showed that the utility not only had to be concerned about future drought, but may also need to prepare for flooding caused by more extreme precipitation events. Using the CREAT participatory process, the utility was able to identify several potential adaptation strategies.

Among those considered were implementation of a water conservation strategy, entering into a water-rights agreement, lake dredging, and development of a water reclamation system. Fredericktown pursued the short-term strategy of developing a contract to use water from a nearby lake during dry periods. The utility operators, recognizing that upstream water releases and short-term contract may not be sufficient under future conditions, also identified a potential long-term adaptation action to dredge the lake. The CREAT Tool enabled the city of Fredericktown to assess climate vulnerability, pursue a short-term resiliency action and identify a long-term climate adaptation strategy.

| How did they do it? | Applicable EPA Tools |
|---|---|
| **Identified climate risk**<br>• Fredericktown, MO recognized their current source water vulnerabilities from levels of erosion, sedimentation and contaminate influx from heavy but sporadic rain events, as well as the increased risk of drought. Together these current threats not only increased the turbidity of the water but reduced the volume of lake storage and could have played a role contributing to greater treatment costs. These current vulnerabilities may be exacerbated by climate change so Fredericktown decided to better understand its climate vulnerability. | EPA's Climate Projections Map can help utilities illustrate projected precipitation and sea level rise scenarios for any climate region.<br>EPA's Climate Projections Map |
| **Assessed its climate vulnerability**<br>• Fredericktown, MO used EPA's Climate Ready Evaluation and Assessment Tool (CREAT) to project potential climate impacts to their system out to 2030 and beyond. They identified vulnerability to increased precipitation events (storms) and changing precipitation patterns including a vulnerability to drought -- and the corresponding vulnerabilities to water quality and sedimentation. | EPA's CREAT Tool can help utilities assess climate vulnerability and identify adaptation options using both traditional risk assessment and scenario-based methods.<br>EPA's CREAT Tool |

**Identified near term resiliency and long term adaptation strategies**

- Adopted short term resiliency by contracting with an upstream organization to release water during shortages.
- Planned for long term adaptation by exploring the idea of increasing water storage capacity by dredging the lake.

The EPA's Adaptation Strategies Guide can help you select adaptation strategies based upon expected facility vulnerabilities.

EPA's Adaptation Strategies Guide

## Similar Cases and More Information

To see how another Midwestern community acted to reduce future vulnerability, see Iowa City. To see how another utility rebuilt in a vulnerable location but took steps to prepare their facility and adapt to concerns over flooding and sedimentation, see Anacortes, WA. For an example on how a wastewater utility identified projected climate impacts and adaptation strategies, and then partnered with relevant entities to adopt these strategies and reduce stormwater impacts and combined sewer overflows, view Camden, NJ.

# Iowa City, Iowa Closes Vulnerable Wastewater Facility



Iowa City, IA was among the hardest hit communities from the 2008 Iowa River floods. Extensive flooding along the riverfront, including inundation of a major wastewater treatment plant located along the river, prompted the community to take action. Rather than restoring the vulnerable North Wastewater Treatment Plant, Iowa City decided to decommission the plant and expand service at a facility located outside the floodplain (average daily treatment of 9.7 million gallons with a design capacity of 24.2 million gallons per day). Although it did not quantify future climate risks explicitly, Iowa City consciously sought means to reduce the vulnerability of its wastewater services to future extreme storm events – which are projected to increase in the Midwest according to the 2014 National Climate Assessment.

Illustration of the riverfront restoration after removal of wastewater facility.

The process to decommission, demolish, and expand wastewater treatment services elsewhere is projected to cost $63 million. By decommissioning the vulnerable wastewater treatment plant and converting the surrounding area into a public greenspace, the city adapts to reduce the threat and impact of future extreme storm events.

## How did they do it?

## Applicable EPA Tools

**Iowa City identified a long-standing vulnerability and adaptation opportunity**

- Iowa City Public Works identified its wastewater treatment facilities as vulnerable to future extreme storm events.
- The city asked for EPA technical assistance to develop an overarching Riverfront Master Plan, including a Treatment Plant Restoration Plan.

Use the EPA Climate Resilience Evaluation and Awareness Tool (CREAT) to identify current and future flooding vulnerability.

EPA's CREAT Tool

**Iowa City reduced current and future vulnerability**

- The city consolidated wastewater treatment service in a low-risk area outside of the floodplain at a cost of $63 million and decommissioned a vulnerable facility thereby reducing future flood risk and the potential for untreated sewage releases.
- By adopting an approach that utilized both gray and green infrastructure, the city yields multiple benefits through a less vulnerable wastewater services, improved stormwater management and creation of a new public space for recreational opportunities.

Use the Adaptations Strategy Guide and the Flooding Resilience Guide to identify adaptation options for flooding concerns.

EPA's Adaptation Strategies Guide
Flooding Resilience Guide

**Iowa City secured outside funding**

- This project was partially federally funded -- $22 million from the Economic Development Administration and $13 million from Community Development Block Grants (CDBG) Supplemental Disaster Funds.

See how EPA is supporting climate-resilient investments in communities across the country by considering future climate changes in funding mechanisms.

Integrating Climate Adaptation into Financial Mechanisms

## Similar Cases and More Information

Iowa City, IA decided to move their facility away from danger. See how Iowa City plans to manage stormwater along the riverfront using green infrastructure and smart growth. To see how a small community utilized EPA tools to determine vulnerability to flooding, view Manchester-by-the-Sea.

- Smart Growth Along the Riverfront Helps Manage Stormwater in Iowa City, Iowa
- Manchester-by-the-Sea, Massachusetts Assesses Climate Vulnerability

# Manchester-by-the-Sea, Massachusetts Assesses Climate Vulnerability



Manchester-by-the-Sea is a small community on Manchester Harbor north of Boston. As the community is only 10 feet above sea-level, the town recognizes its wastewater treatment facility is at risk from sea level rise. To move beyond risk identification the facility's operators needed to determine the magnitude of its vulnerability to the changing climate. A vulnerability assessment can be an in-depth and daunting task for any size community. However, EPA's Climate Resilience Evaluation and Awareness Tool (CREAT) enabled Manchester-by-the-Sea to assess its region's projected climate risks and its facility's vulnerability to inundation from sea level rise. Using CREAT, the facility was able to evaluate potential climate-related impacts such as projected impacts to source water, receiving waters, and other environmental concerns of its stakeholders. CREAT also facilitated the utility's consideration of potential adaptation strategies for reinforcing the facility in anticipation of projected sea level rise. Recognizing sea level rise and increased precipitation threatens more than just the facility itself, the town applied for and was awarded a Coastal Zone Management Grant. This grant, awarded in December 2014, is helping the town assess climate risk and vulnerability to stormwater management in the city. Together, these vulnerability assessments will help the city select and implement adaptation actions to where they are most needed.

- EPA's Climate Resilience Evaluation and Awareness Tool (CREAT)

| How did they do it? | Applicable EPA Tools |
| --- | --- |
| **Manchester-by-the-Sea Identified a Need to Better Understand Climate Vulnerability**<br>• Officials recognized the climate threat to coastal infrastructure and the need to assess vulnerability to sea-level rise, as well as various other climate impacts. | The EPA Coastal Inundation Toolkit can assist utilities in better understanding facility vulnerability by illustrating a range of potential sea level rise and storm surge scenarios.<br>EPA Coastal Inundation Toolkit |
| **Manchester-by-the-Sea Conducted a Vulnerability Assessment to Better Understand Risk from Sea-Level Rise**<br>• Manchester-by-the-Sea worked with the USEPA to conduct a vulnerability assessment by using the Climate Resilience Evaluation & Awareness Tool (see below) to determine sea level rise vulnerability and identify potential adaptation strategies.<br>  ◦ Climate Resilience Evaluation & Awareness Tool<br>• Utility officials selected the headworks building as a priority for identifying vulnerability and potential adaptation options. The headworks building was selected due to the critical nature of the facility and its location within the 100 and 500 year floodplain. | The Climate Resilience Evaluation and Awareness Tool (CREAT) helps utilities conduct a vulnerability assessment to better understand climate risk.<br>Climate Resilience Evaluation and Awareness Tool (CREAT) |

**Identified Further Vulnerability Assessment Needs, Particularly for Stormwater Management**

- NOAA awarded the city a Coastal Zone Management (CZM) Resilience Grant in December 2014 to evaluate stormwater management capacity under future conditions.
- This study will utilize climate projection scenarios to determine whether the town's culvert and bridge crossings within the Sawmill Brook Watershed will be able to accommodate future precipitation and sea level rise conditions.

EPA's Climate Ready Water Utilities Adaptation Strategies Guide can assist utilities identify in identifying potential next steps to adapt to expected climate vulnerabilities.

Climate Ready Water Utilities Adaptation Strategies Guide

## Similar Cases and More Information

Manchester-By-the-Sea is still developing an adaptation plan based on upon their vulnerability assessment. For an example of a Northeastern community that completed a vulnerability assessment and then actively implemented adaptation strategies view the Camden, NJ case. For examples of large scale utility adaptation strategies including facility redesign, retreat, or reinforcement, view the Deer Island, Iowa City, and Blue Plains examples respectively. To see how a larger water utility has adapted, and continues to re-assess vulnerability under the best available science, view the Deer Island case.

# Maryland Analyzes Coastal Wetlands Susceptibility to Climate Change



Maryland, a state many consider synonymous with coastal life and livelihoods, has already experienced the loss of several islands and vast acreage of shoreline due to erosion and sea level rise. Maryland's coastal wetlands are particularly vulnerable to projected climate changes and are already experiencing threats from storms, inundation, and sea level rise –which is occurring at nearly twice the global average-. Accordingly, Maryland's Department of Natural Resources (MDNR), in partnership with the Maryland Department of the Environment (MDE), has sought to implement wetland restoration and conservation programs to protect the state's remaining coastal wetlands from climate change.

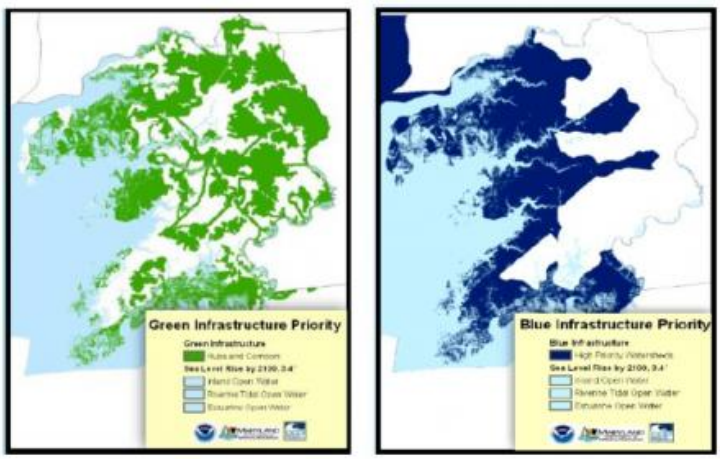



**Figure 1.** These maps are outputs of SLAMM that display high priority nearshore wetlands coincident with the green infrastructure network and high-priority watersheds identified in the blue infrastructure analysis, given sea level rise projected for 2100 in the Chesapeake Bay and a portion of Maryland's Eastern Shore.

High Priority Conservation Areas Identified from the SLAMM Analysis.

Maryland used the Sea Level Affecting Marshes Model (SLAMM) to factor in sea level rise projections and gain a comprehensive look at coastal wetland areas throughout the state. This analysis is allowing the state to better identify the wetland migration areas under future sea level rise conditions and identify high priority wetland areas for protection. Data on wetland characteristics including size, species composition, and ecosystem connectivity has helped inform adaptation options by helping identify and prioritize land necessary for preserving current and future ecosystem diversity and functionality. The analysis enabled MDNR officials to provide information on high priority and vulnerable areas for conservation purposes to land managers, conservation planners, and the public. Consequently, this analysis provides land use planners and conservation organizations valuable information to help preserve areas for wetland migration and adapt to higher sea-levels.

## How Did They Do It?

**Acknowledged the threat and devised a strategy to analyze vulnerability**

- Maryland's Climate Action Plan, the first component of a two phased strategy for adapting to sea level rise and coastal storms, specifies the extreme vulnerability of coastal wetlands and identifies the need to adapt to future conditions and "direct existing land conservation programs… to consider the use of conservation easements and other land conservation initiatives as a means to protect key coastal areas vulnerable to sea-level rise and to provide sufficient lands for wetland migration."
- The 2011 Maryland Commission on Climate Change "Building Societal, Economic and Ecological Resilience" report served as the second phase of this strategy by providing a suite of actions to address climate change. Among the actions recommended were to use downscaled projections of climate conditions as well as potential "at-risk" species and habitats to better inform land management and protection goals for critical areas including "saltwater marshes in danger from erosion", and "tracts of upland habitat where wetlands migration is likely to occur as sea level rises."

## Applicable EPA Tools

The Scenario Based Projected Changes Map can illustrate scenarios of projected changes in annual precipitation, 100-year storm events, and sea-level rise to identify climate threats to the coast.

Scenario Based Projected Changes Map

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Maryland developed an analysis to identify areas for current and future acquisition to spur climate adaptation of coastal wetlands**<br>• Maryland used the Sea Level Affecting Marsh Model (SLAMM) to assess wetland migration and distribution under the projected sea level for the year 2050 and 2100. The analysis used a projection of 1.04 meters of sea level rise by 2100 that was between the range of 2.7 ft and 3.4 ft of sea-level rise that The State's Climate Action Plan projected based on two different emissions scenarios.<br>  ◦ Sea Level Affecting Marsh Model (SLAMM) | Download the Sea Level Affecting Marsh Model (SLAMM Tool) from the U.S. Climate Resiliency Toolkit to help analyze wetland migration under projected sea level rise.<br>U.S. Climate Resiliency Toolkit |
| **Identified "Targeted Ecological Areas" that would provide potential migration zones and integrated adaptation criteria into existing programs**<br>• Maryland published the SLAMM analysis on a public coastal GIS dashboard, The Maryland Coastal Atlas, under the title "The Estuaries Wetland Change Tool" in order to help encourage integration of the analysis into public and private coastal conservation efforts.<br>• Maryland used this analysis to update a GIS Mapping System "GreenPrint" that models state designated "Targeted Ecological Areas," which are lands and watersheds of high ecological value that have been identified as targeted conservation priorities by the Maryland Department of Natural Resources (DNR). | Synthesis of Adaptation Options for Coastal Areas Guidebook helps identify climate risks to coastal ecosystems and review adaptation options available to coastal managers.<br>Synthesis of Adaptation Options for Coastal Areas Guidebook<br>The Rolling Easements Primer can help identify more than a dozen land use and legal tools for ensuring that intertidal habitats can persist even as sea level rises.<br>Rolling Easements Primer |

## Similar Cases and More Information

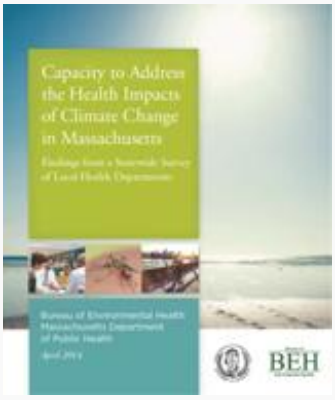
For more information view the EPA's 2015 State Water Agency Practices for Climate Adaptation – Maryland Document or view the U.S. Climate Resiliency Toolkit Case Study. To see another example of how a coastal community assessed their vulnerability view the Southwest Florida Salt Marsh Vulnerability and Adaptation Plan, or the San Juan Estuary Vulnerability Assessment. To learn more about how climate changes can affect natural resources and threaten drinking water availability through saltwater intrusion, see how Tampa Bay Water diversified their source water to promote resiliency to current and future conditions.

- 2015 State Water Agency Practices for Climate Adaptation – Maryland Document
- U.S. Climate Resiliency Toolkit Case Study
- Southwest Florida Salt Marsh Vulnerability and Adaptation Plan
- San Juan Estuary Vulnerability Assessment
- Tampa Bay Diversifies Water Sources to Reduce Climate Risk

# Massachusetts Surveys Climate Readiness of Public Health Departments



Climate change threatens human health through a variety of pathways including more frequent extreme weather events, decreased air quality, and increased spread of vector-borne diseases. Massachusetts, recognizing this risk, surveyed its local boards of public health to gauge the state's level of public health preparedness for climate change. The Massachusetts Department of Health was interested in the local boards' current understanding, level of preparedness, and response capabilities for projected climate change risks. The survey covered surveillance, planning, and intervention activities associated with heat stress, hazardous weather events, indoor air quality, food supply/agricultural issues, vector-borne diseases, and water quality issues. The survey helped identify communities that may be more vulnerable to projected climate change risks. State and local communities can use this knowledge to increase resiliency and adaptive capacity by more effectively guiding and targeting resources and actions to vulnerable health departments.




Massachusetts Public Health Survey Report Cover.

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Assessed the state public health system's current perceived capacity to deal with projected climate risks**<br><br>• The Massachusetts Department of Health worked with the regional coordinators of the five Massachusetts public health regions and the 15 Emergency Preparedness Regional Coalitions to survey the 351 municipalities in the commonwealth.<br>• Less than a quarter (24%) of responding health departments identified climate change preparations as a priority, yet only a fifth (21%) felt they had adequate resources to address climate risks. | CDC's Health Vulnerability: Climate Change Guide For Health Departments helps communities assess capacity and vulnerability to climate risks.<br><br>Health Vulnerability: Climate Change Guide For Health Departments<br><br>** (This is a non-EPA resource from the Centers for Disease Control and Prevention.)* |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| • Only a small minority of respondents identified and systematically tracked many of the threats projected to be exacerbated by climate change such as indoor and outdoor air quality, respiratory conditions, and extreme heat.<br>• Half the respondents identified current efforts to increase resiliency to extreme heat events, such as having developed or in the process of developing plans for siting cooling centers for operation during heat events. | |
| **Identified knowledge gaps on vulnerable populations**<br>• The majority of health departments focused vulnerable population outreach to the elderly, and to a much lesser extent, those with mobility challenges; outside of those two vulnerable populations, outreach was infrequent.<br>• The Department of Health report highlighted a lack of outreach and knowledge gap of vulnerable populations as a key issue to help increase adaptive capacity of local health departments. | EPA's EJ Screen combines environmental and demographic indicators to help highlight places that may be vulnerable to human health impacts on climate change (example demographic indicators include elderly, extremely young, low-income, linguistically isolated communities) and may warrant further review as environmental justice communities.<br>EJ Screen |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Prepared a final report with recommended steps to increase public health system's adaptive capacity**<br><br>• The Department of Public Health "should create region-specific vulnerability maps identifying and quantifying specific environmental and public health threats".<br>• The survey can be used in combination with Massachusetts' Environmental Public Health Data Tracking (EPHT) portal to help communities better prepare for future health impacts.<br>  ◦ Massachusetts' Environmental Public Health Data Tracking (EPHT) portal Exit | EPA's Climate Impacts on Health Page provides information to better increase knowledge of the expected human health risks from climate change.<br><br>Climate Impacts on Health Page |

## Similar Cases and More Information

Massachusetts acknowledged that while the survey has helped identify prospective vulnerabilities, they are unable to tie this data to projected vulnerabilities without further research. To see an example of how a community has identified projected public health vulnerabilities, see the Minnesota Climate Health case study. To see an example of specific steps to reduce vulnerabilities and adapt to changing conditions, view Chicago's Adaptation to Extreme Heat Events, or for how to increase adaptive capacity of vulnerable populations, view Chicago's Heat Emergency Response.

# Metropolitan Washington Council of Governments Identified Smart Growth Strategies for More Resilient Communities




The Metropolitan Washington Council of Governments (MWCOG) worked with EPA through a technical assistance project to help develop climate adaptation policy options for the consideration of its local jurisdictions. The project sought to help local communities prepare for climate change impacts while bringing other environmental, economic, and social benefits. To determine regional vulnerabilities, MWCOG used regional climate change projections from the 2009 National Climate Assessment combined with findings from the Maryland and Virginia state climate commissions, university studies, regional planning group assessments, and input from local government staff. MWCOG relied on its standing committees (made up of representatives from its member jurisdictions) related to buildings, land use, transportation, and water sectors for input on the project and to keep its members engaged throughout the process. This regional effort provided localities with information, such as an analysis of projected climate impacts and how they would affect different sectors, that would have been difficult to develop and duplicative if conducted separately. The effort also raised awareness of climate adaptation in the region and encouraged local governments to explore multi-benefit strategies while anticipating, planning, and preparing for climate change. This effort also resulted in EPA developing the report: "Using Smart Growth Strategies to Create More Resilient Communities in the Washington, D.C., Region (2013)".

| How Did They Do It? | Applicable EPA Tools |
|---|---|
| **MWCOG reviewed climate vulnerabilities and identified potential adaptation strategies**<br>• Analyzed regional climate change projections from the 2009 National Climate Assessment to assess projected climate impacts to the region<br>• Supplemented projected climate risks with findings from the Maryland and Virginia state climate commissions, universities, as well as local staff and regional planning groups<br>• Hosted adaptation trainings and educational events that shared lessons learned from previous hazards to help develop local jurisdiction staff capacity on adaptation | EPA's Local Government Climate Adaptation Training provides a better understanding of how climate change can impact municipal services.<br>Local Government Climate Adaptation Training |
| **Under the technical assistance program, and with input from MWCOG's stakeholders, EPA developed** *Using Smart Growth Strategies to Create More Resilient Communities in the Washington, D.C., Region,* **to give local governments policy options to consider when preparing for future climate risks.** | Using Smart Growth Strategies to Create More Resilient Communities in the Washington, D.C., Region guidebook helps identify policy options for your community to consider when preparing for future climate risks.<br>Using Smart Growth Strategies to Create More Resilient Communities in the Washington, D.C., Region guidebook |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **MWCOG engaged member jurisdictions to spread awareness of potential adaptation strategies**<br>• Engaged representatives from MWCOG member jurisdictions in discussions about their priorities, needs, and concerns related to climate change adaptation<br>• Held a day-long symposium to go into more depth on climate impacts and their implications for the region and local decision-makers | Visit the Climate Resilience Toolkit to find more federal trainings and resources that can help communities spread awareness of potential adaptation strategies.<br>Climate Resilience Toolkit |

## Similar Cases and More Information

To find out more about the region's activities on climate adaptation, visit the MWCOG's Climate Change Impacts and Adaptation web page. Many other communities have collaborated with neighboring municipalities, regional entities or with non-profits to support adaptation planning efforts. To view another case where multiple government jurisdictions collaborated to perform a regional projection for sea level rise and identify adaptation options, view the Southeast Florida regional Climate Compact. Finally, view the Anacortes Water Utility to see how another community used a regional climate assessment, conducted by a neighboring municipality, to rebuild their water treatment plant and account for future climate risk.

## References


- Smart Growth Strategies for More Resilient Communities

# Minnehaha, MN Creek Watershed District Assesses Stormwater Management Climate Vulnerability



The National Climate Assessment shows the Midwestern United States has already experienced large changes in very heavy precipitation and projects such changes to continue and worsen. The Minnehaha Creek Watershed District, responsible for Minneapolis, Minnesota and many of its western suburbs, wanted to better understand the climate threat to its stormwater management capabilities. The District considered climate projections to assess stormwater system vulnerability and adaptation options for two specific locations. The analysis used downscaled global climate model projections to identify the expected mid-century **1-10** year storm. Stormwater system resilience was then considered under these conditions and a number of areas were identified as undersized. For these areas, estimated costs and feasibility comparisons of several stormwater management adaptation strategies were considered against a baseline of expected flooding damages caused by no-action.

The relevance and need to anticipate and plan for future storm events was observed mere months after completion of the study when over 24 inches of rain fell in the Minneapolis area over a period of 3 months. This heavy precipitation led to historic water levels and flooding. Using this study to identify and prioritize undersized portions of the stormwater management system will help the Watershed District's communities adapt to climate change. Recognizing the importance of its effort, the Watershed District developed a guidebook and held multiple outreach events to help other nearby communities replicate its approach and adapt to climate change. (For more information about this case, view the U.S. Climate Resiliency Toolkit's case study on the Minnehaha, MN Creek Watershed).

- Minnehaha, MN Creek Watershed District Assesses Stormwater Management Climate Vulnerability

## How did they do it?

**Assessed current climate vulnerability of stormwater drainage**

- The watershed district used a grant from NOAA's Climate Program Office to develop a vulnerability assessment and analyze adaptation options for two locations in Minnesota.
- The study used EPA's Stormwater Management Model to simulate the stormwater system and rainfall runoff for the projected storm events and regionalized climate models from the CMIP 3 and CMIP 5 Models.
- The analysis focused on mid-century projections for managing the 1-10 year storm - the common design standard for local infrastructure.
- The study estimated cost per volume and feasibility for several adaptation strategies including pipe upsizing, low impact development, dry retention, and underground storage.
- The Weather and Extreme Trends projections estimated that for the two project areas the most effective adaptation measure to manage projected future flooding was largely pipe upsizing. Local officials hope this information can better inform local public work projects. The analysis also noted the need for further research to analyze the potential water quality issues and prospects for downstream flooding from increased flows.

## Applicable EPA Tools

The EPA's SWMM Model Climate Assessment Tool can help assess current climate vulnerability of stormwater drainage systems.

SWMM Model Climate Assessment Tool

**Engaged the community to provide information to adapt to future conditions**

- Held a Climate Adaptation in Minnesota conference in 2013 to support local officials, planners, engineers, and natural resource practitioners to discuss adaptation strategies.
    - Climate Adaptation in Minnesota Exit
- Held four outreach events including three forums that presented and discussed the assessment, findings, and next steps with stakeholders in two focus areas.
- The Community Adaptation Planning for Changing Landscapes and Climate provides a step-by-step process for how the Minnehaha Creek Watershed District conducted their adaptation plan and the relevant process for completing a similar plan in other areas.

The Green Infrastructure Wizard Tool can help you engage the community in developing an educational green infrastructure project that adapts to changing climate conditions.

Green Infrastructure Wizard Tool

## Similar Cases and More Information

To see how Washington, D.C. is using green infrastructure to reduce stormwater impacts and combined sewer overflows view the DC Consent Decree. For more information on what a Washington, D.C. wastewater facility is doing to adapt to climate change and the threats from flooding, view Blue Plains Wastewater Facility Case. For information on a city that is moving wastewater services away from an area vulnerable to flooding view the Iowa City Riverfront Master Plan.

# Minnesota Assesses Climate Risk to Public Health



Minnesota's Strategic Adaptation Plan (2010) identifies public health threats from climate change and states the necessity of improving its public health system's capacity to respond to these threats, particularly for vulnerable populations. Minnesota's health department worked with CDC's Building Resilience Against Climate Effects program to develop a vulnerability assessment (VA) to better understand (e.g., where health conditions might worsen due to climate change) and characterize the state's composite climate hazard risk. The assessment enabled the state to identify the counties facing the most significant climate risks based upon threats from extreme heat, outdoor air quality, vector borne diseases, as well as water quality and quantity concerns.

The assessment also led the state to downscale vulnerability and other climate information to make it more accessible and applicable for regional use. To facilitate local action within vulnerable regions, Minnesota provides tools and resources to local municipalities to better prepare residents and reduce the climate-related public health threat. Minnesota's resiliency tools, some examples of which are the "Extreme Heat Toolkit" and a Climate 101 Training, are available to increase the adaptive capacity within vulnerable counties as they anticipate and prepare for the future. Through such resources and actions noted above, Minnesota is helping its public health system -- public health professionals, healthcare providers, and other health officials -- better anticipate and prepare for future climate risk and reduce projected vulnerabilities.

## How did they do it?

**Developed a public health Strategic Adaptation Plan**

- The Department of Health established a climate change workgroup comprised of senior management and subject matter experts from different health agency programs, among those were officials from divisions specializing in environmental health, emergency preparedness, public health labs, epidemiology and health tracking, family health, infectious disease, pollution control, and vulnerable population health divisions.
- Minnesota developed a public health plan that focused on climate risks from six main pathways:
  - extreme heat events
  - extreme weather events
  - vector-borne diseases
  - air pollution and allergens
  - water quality and quantity
  - waterborne and foodborne diseases
- Several research gaps were identified, among them the need to conduct a vulnerability assessment, the need to better identify and outreach to vulnerable populations, and the need for additional research on the complex relationship between climate change and fine particulate matter (PM) (for more on the national status of this research please visit the EPA's Air Quality and Climate Change Page).
  - EPA's Air Quality and Climate Change Page

## Applicable EPA Tools

Use the National Climate Assessment to better understand the range of projected climate threats to each region and inform adaptation plans.

National Climate Assessment

**Developed a risk map showing both vulnerable populations and county threat prevalence**

- Worked through CDC's Building Resilience Against Climate Effects Program to develop a “Profile Report” that shows the composite climate hazard risk map for the state.
  - Building Resilience Against Climate Effects Program
- The map indicates at the county level, the most significant climate threats from the six main pathways.

CDC's Assessing Health Vulnerability to Climate Change helps identify the most at risk populations, including the elderly, infirm, and communities dealing with public health and environmental justice challenges.

Assessing Health Vulnerability to Climate Change (PDF) (24 pp, 4.3 MB)

* (This is a non-EPA resource from the Centers for Disease Control and Prevention.)

**Provided tools for community use and recognized additional need for community level information**

- Minnesota provides tools and resources such as its Extreme Heat Toolkit and Climate Change 101 Training, to local municipalities and health departments to help them better prepare for public health impacts.
- Minnesota Climate And Health Profile Report 2015 acknowledges that further vulnerability assessments are needed "…at finer geographic levels to help public health departments and others plan for the impacts of climate change."

The US Climate Resilience Toolkit Health Vulnerability: Climate Change Guide For Health Departments can help support local preparedness measures.

Health Vulnerability: Climate Change Guide For Health Departments

## Similar Cases and More Information

Remember, public health concerns can disproportionately affect at-risk or vulnerable communities. To view a case study that identifies and actively engaged vulnerable communities in adaptation planning for heat events, view Chicago Heat Emergency Response. To see how a community has used green infrastructure to both reduce the impact of future extreme heat events -- and reduce stormwater runoff during extreme precipitation events-- view Chicago Green Infrastructure to Reduce Heat. Or for another case on assessing vulnerability to public health and air concerns, view the Massachusetts Indoor Air Survey.

# New York City Adapts To Deal with Projected Increase of Heat Waves



Heat waves are one of the leading weather-related causes of death in the Unites States. According to New York City's vulnerability assessment, this vulnerability is expected to worsen with climate change. New York City has taken substantive actions to reduce its current vulnerability (i.e., increasing its resiliency to current conditions) as well as its future vulnerability (i.e., adapting to the projected future climatic conditions).

In order to promote resiliency, NYC is increasing use of cooling centers and supports outreach through the Be-a-Buddy Program to share life-saving information with particularly vulnerable populations. In order to adapt to future increases in temperature, the city promotes green infrastructure, reforestation and reflective, or "cool" roofs, to moderate the urban heat island effect and reduce the severity and frequency of future projected extreme heat events. New York City is continuing to evaluate their climate vulnerability and the effectiveness of its adaptation actions using the most up-to-date information.

| How Did They Do It? | Applicable EPA Tools |
|---|---|
| **Assess climate vulnerability within Climate Risk Information Report (2013)**<br>• New York City (NYC) derived temperature and precipitation projections using a matrix of 35 Global Climate Model simulations under two Representative Concentration Pathways<br>  ◦ Learn more at USGCRP Models.<br>• NYC analysis identified an average baseline of 2 heat waves per year between 1970-2000. Under the 90th percentile high estimate, the number of heat waves could increase to up to 7 per year by 2050 and the number of days over 90°F could triple from an 18 average baseline to 57 by 2050.<br>• NYC Incorporated this climate risk within local hazard mitigation plans and supported actions to reduce vulnerability and adapt to climate changes. | The National Climate Assessment Future Climate Section can provide a broad projection of temperature change and extreme heat risk for your region based upon emissions scenarios.<br>National Climate Assessment Future Climate Section |
| **Promoted resiliency to current extreme conditions, particularly for vulnerable populations**<br>• NYC promotes resiliency through outreach efforts to particularly vulnerable populations including the elderly, the poor, and those already suffering from chronic illnesses. One example, the "Be-a-Buddy Program" shares life-saving information with vulnerable residents. This and other similar programs constitute resiliency actions as they reduce vulnerability under current conditions, and can be scaled accordingly, but do not reduce the level of increased future climate risk. | CDC's Assessing Health Vulnerability to Climate Change helps identify the communities most at risk, including the elderly, infirm, and communities dealing with environmental justice challenges.<br>Assessing Health Vulnerability to Climate Change (PDF) (24 pp, 4.3 MB, )<br>** (This is a non-EPA resource from the Centers for Disease Control and Prevention.)* |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Implemented adaptation actions that provide co-benefits to air quality, water management and emergency preparedness**<br>• NYC implemented several adaptation actions to address the increasing risk of heat events including promoting 'cool roofs,' urban forestry initiatives, and other strategies to prepare for the projected increase in future heat waves, including reducing urban heat island effect.<br>• NYC Cool Roofs Program trains local individuals to work with a team to coat city rooftops with a white reflective coating. In its recent 2013 Annual Report, the NYC Cool Roofs Program had "cooled and coated" 2,077,537 square feet of rooftop by utilizing over 1,000 local volunteers and funding from corporate and individual donations, sponsorships, and local government.<br>• NYC adopted the Million Trees initiative to plant 1 million trees in the city by 2017. This action anticipates the future climate change risks and provides adaptation benefits for reducing the urban heat island, as well as resulting in greenhouse gas mitigation benefits. | EPA's Excessive Heat Events Guidebook helps identify extreme heat resilience and adaptation strategies. For more on using green infrastructure to provide co-benefits, see the "Reduce the Urban Heat Island Page." |
| **Evaluating performance and risk under the best-available science**<br>• The city partnered with the Princeton Plasma Physics laboratory to help analyze, evaluate and quantify its climate resiliency, adaptation and mitigation actions.<br>• The city updated its vulnerability assessment in 2015 ("Building the Knowledge Base for Climate Resiliency"), including projecting climate risk out to 2100 for the first time. | The Green Infrastructure to Reduce Urban Heat Island Effect webpage provides resources to model and evaluate the performance of green infrastructure strategies that reduce the urban heat island effect.<br>Green Infrastructure to Reduce Urban Heat Island Effect |

## Similar Cases

To see how New York conducted a vulnerability assessment for climate change and extreme heat events, view the NYC Heat Plan case. Remember, extreme heat events and other weather extremes can disproportionately impact at-risk or vulnerable communities, to view a case study that identifies and actively engaged vulnerable communities in adaptation planning for heat events, view Chicago Heat Emergency Response. To see how a community has used green infrastructure to both reduce the impact of future extreme heat events and reduce stormwater runoff during extreme precipitation events, view Chicago Green Infrastructure to Reduce Heat.

- NYC Heat Plan case
- Chicago Heat Emergency Response

## References


- NYC Cool Roofs: 2013 Annual Report (PDF) (13 pp, 12 MB, )
- Heat Related Brief (PDF) (3 pp, 257 K)
- NYC Panel on Climate Change: Climate Risk Information 2013, Observations, Climate Change Projections, and Maps (PDF) (38 pp, 1.2 MB) Exit
- NYC Climate and Health Profile (PDF) (3 pp, 16 K)

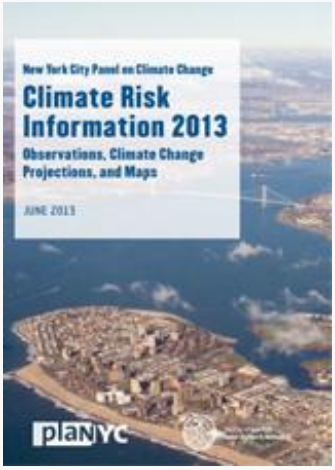
- US Climate Resilience Toolkit: Extreme Heat
- New York City Panel on Climate Change 2015 Report, Chapter 5: Public Health Impacts and Resiliency (PDF) (22 pp, 994 K)

# New York City Assesses Extreme Heat Climate Risk



Heat waves are one of the leading weather-related causes of death in the Unites States. Recognizing the current and future extreme heat risk to its population, NYC decided to assess climate risk and vulnerability. To assess the risk of future extreme heat events, the New York City Panel on Climate Change (NPCC) used the most up-to-date global climate models at the time. The NPCC's Climate Risk Information Report identified a baseline (covering the period 1970-2000) of two heat waves per year on average. NYC projected the number of heat waves could increase (using the 90th percentile as the high estimate) to seven per year by 2050. Additionally, the NPCC's 2013 report states the average annual number of days over 90°F could more than triple (under the high estimate) from 18 to 57 by 2050.

NYC updated its emergency response and hazard mitigation plans as a result of its Climate Risk Information Report. New York City is continuing to refine their climate projections to better assess climate vulnerability under the best-available science. The most recent update was in the 2015 "NPCC: Building the Knowledge Base for Climate Resiliency Report," which for the first time included projections to the year 2100.




New York City's Climate Risk Information Vulnerability Assessment (PDF) (38 pp, 1.2 MB, )

| How Did They Do It? | Applicable EPA Tools |
|---|---|
| **Assessed climate risk**<br>• New York City derived temperature and precipitation projections by using a matrix of 35 Global Climate Model simulations under two Representative Concentration Pathways. | Learn more about the type of models available to assess climate risk at the US Global Change Research Programs website.<br>US Global Change Research Programs website |
| **Incorporated climate risk within adaptation and response plans**<br>• Established a city panel (New York City Panel on Climate Change) to inform its climate activities.<br>• Developed a Climate Adaptation Plan and updated it in 2015.<br>• Incorporated climate risk and vulnerability to heat events within the Hazard Mitigation Plan. (Note: New York State (NYS) Requirement §F6 requires plans developed with State Office of Emergency Management (OEM) administered funds to include climate change hazard information and strategies to address them). | EPA's Excessive Heat Events Guidebook helps communities identify current and future disaster response needs for adapting and proving resilient to extreme heat climate risk.<br>Excessive Heat Events Guidebook |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Educate residents on the threats from extreme heat and provides preparedness resources**<br>• New York created multiple resources including handouts, guides, and even an emergency preparedness mobile app to help residents prepare for extreme heat events | The Green Infrastructure Wizard Tool can help communities implement an appropriate demonstration project that increases education and awareness about the climate risk from extreme heat.<br>Green Infrastructure Wizard Tool |
| **Re-assessing vulnerability under the best available science**<br>• The city recently updated the vulnerability assessment, which for the first time projects climate risk out to 2100, in the 2015 report "Building the Knowledge Base for Climate Resiliency." | CDC's Assessing Health Vulnerability to Climate Change helps communities identify populations most at risk from extreme heat events and other climate threats.<br>Assessing Health Vulnerability to Climate Change (PDF) (24 pp, 4.3 MB)<br>* (This is a non-EPA resource from the Centers for Disease Control and Prevention.) |

## Similar Cases and More Information

Extreme heat events and other weather extremes can disproportionately impact at-risk or vulnerable communities. To view a case study that identified and then actively engaged with vulnerable communities in adaptation planning for heat events, view the Chicago Heat Emergency Response. To see how a community has used green infrastructure to both reduce the impact of future extreme heat events and reduce stormwater runoff during extreme precipitation events, view Chicago Green Infrastructure to Reduce Heat.

- Chicago Heat Emergency Response
- Chicago Green Infrastructure to Reduce Heat

# Pennsylvania Protects Coldwater Fisheries and Water Quality from Climate Change



In 2009, pursuant to the Pennsylvania Climate Change Act, the Pennsylvania Department of Environmental Protection developed a “Pennsylvania Climate Impact Assessment.” This report identified the climate risks to maintaining the health of freshwater ecosystems among several other climate vulnerabilities.

Allegheny National Forest

The report identified warmer air temperatures, and the associated increase of stream waters, may reduce the ability for certain aquatic species to survive. This is supported by the EPA National Water Program's Climate and Water Strategy which identifies cold water fisheries as particularly susceptible to climate change and associated changes in water temperature.

The Climate Impact Assessment specifically suggested that: “Pennsylvania may see a decline in some of our most valued coldwater communities… Of special concern is the impact of higher temperatures and altered flow regimes on Eastern Brook Trout, not only because of its status as a recreationally and culturally important species, but because it is an indicator of high water quality and may be an early victim of deleterious impacts of climate change.”

Pennsylvania, in recognition of the cultural, environmental, and economic importance of cold-water fisheries to the state, and the vulnerability of possible transformation of cold water fisheries to warm water fisheries, identified the need to cover freshwater stream health within their Climate Change Adaptation Report. Pennsylvania, in recognition of the need to adapt to the changing climate and protect cold-water fisheries and freshwater ecosystems, outlined specific adaptation strategies for state agencies within their Climate Adaptation Planning Report.

These strategies, if implemented, can help Pennsylvania adapt to future climate changes for freshwater ecosystems, and will provide benefits to coldwater fisheries and stream health regardless of whether future climate impacts meet or exceed current projections.

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Pennsylvania conducted a Vulnerability Assessment for their natural lands**<br>• Pennsylvania conducted a risk analysis and vulnerability assessment of their natural lands using global climate models from the IPCC AR4 and utilizing two different emissions scenarios and averaging the results over three separate 20 year periods. The Pennsylvania Climate Impact Assessment states that the “average of the projections from a suite of GCMs is most often used because model-average backcasts [running the model for previous decades using known data to determine accuracy] are found to more closely replicate the historical climate record in Pennsylvania in the 20th Century than the backcasts for any individual model, thus indicating greater reliability for the model average than for individual models or subsets.” | Hydrologic and Water Quality System models seven categories of pollutants to estimate future impacts of climate change on water quality and inform vulnerability assessments.<br>Hydrologic and Water Quality System |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Developed a Climate Adaptation Report**<br>• Developed an adaptation report that identified the key issues affecting freshwater streams and the potential consequences of climate change, including impacts to water quality and extent of native fish species. This report identified adverse impacts to specific fish species as well as recommendations for adaptation actions and corresponding research needs to determine effective adaptation strategies. | Adaptation to Attain Clean Water Goals can inform an adaptation report by discussing how climate change may affect the ability to meet future goals of the Clean Water Act.<br>Adaptation to Attain Clean Water Goals |
| **Identified specific recommendations**<br>• Identified how different environmental conditions would lead to differing resilience levels with implications for the targeting of adaptation efforts. For example, the Pennsylvania Climate Adaptation Planning Report specifically highlighted variable levels of resiliency against climate risk as “Limestone spring streams with abundant, deep cold springs will be more resilient in the face of hot weather extremes than freestone streams that rely on surface and shallow groundwater sources. Trout conservation efforts are likely to be more successful in the limestone streams compared to other coldwater streams.”<br>• Recommended adaptation actions including, identifying and protecting critical habitat and, where applicable, removing small dams to conserve habitat and mitigate temperature increases. | Synthesis of Adaptation Strategies Guidebook and the Wildlife Adaptation Strategy (PDF)(26 pp, 934 K, About PDF) details available adaptation options for coastal and inland areas.<br>Synthesis of Adaptation Strategies Guidebook<br>Wildlife Adaptation Strategy (PDF)(26 pp, 934 K, ) |

## Similar Cases and More Information

To view another case(s) that works to protect water quality and fish habitat, view the Piscataqua National Estuary Program or Minnehana River case. For more information on communities that have adapted to maintain healthy streams for aquatic organisms under changing climate conditions view Vermont Culvert Rebuild Policy, or the Maine Culvert Analysis Case.

- Minnehaha, MN Creek Watershed District Assesses Stormwater Management Climate Vulnerability

# Quinault Indian Nation Plans for Relocation



The Quinault Indian Nation village of Taholah is located within Washington State at the confluence of the Quinault River and the Pacific Ocean. Taholah is particularly vulnerable to sea level rise, storm surge, and river flooding – all of which are expected to worsen with climate change. The village is also concerned with the potential threat of tsunamis (which has not been scientifically connected to climate change). The village's vulnerability was highlighted in early 2014 and again in 2015 when storm surge and intense rains caused flooding, landslides, and culvert failures in the lower-laying areas of the village.

To better understand its risk into the future, the Nation conducted a vulnerability assessment with the assistance of an Social and Economic Development Strategies grant from the Administration for Native Americans. The resulting plan – which is incorporating numerous community discussions and forums - centers on relocating 650 residents and vulnerable community facilities a half-mile away from the existing village. The new village will be in a location well above the tsunami and flood zones.

The relocation plan, if implemented, prepares the village to be resilient to anticipated climate change impacts such as storm surge and sea level rise as well as protecting the village from tsunamis; the expected inundation area from a 40-foot wave matches or exceeds the anticipated threat from storm surge and sea level rise resulting from climate change.

Two additional points are worth noting. First, the Nation considered climate (sea level rise, storm surge, and river flooding) and non-climate (tsunami) risks together in determining its vulnerability and adaptation options. Second, the Nation used a tsunami threat standard and FEMA's 1-in-100 year flood zone as the basis for selecting its tsunami risk and climate vulnerability adaptation strategy (rather than conducting a separate climate adaptation analysis).

| How Did They Do It? | Applicable EPA Tools |
|---|---|
| **Identified threats**<br>• Identified key climate, weather, and community vulnerabilities. These threats included anticipated climate threats from sea level rise, storm surge, and river flooding. | National Climate Assessment & EPA Regional Climate Website can help you identify projected climate risks in your region.<br>National Climate Assessment<br>EPA Regional Climate Website |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Determined vulnerabilities (including the most vulnerable population) and adaptation options**<br>• Identified most vulnerable community areas; which threatened more than 600 tribal and non-tribal residents, many of whom are elderly or very young.<br>• Determined the need to relocate population. | EPA's Coastal Storm Surge Mapper can help you determine whether your community may be vulnerable.<br>EPA's Coastal Storm Surge Mapper |
| **Selected relocation as its adaptation action**<br>• The community identified 200 acres near the upper village as a potential relocation option due to its high elevation (120 feet above sea level) and location outside the tsunami hazard zone and FEMA 1-100 year flood zone.<br>• Relocating also enables the Nation to incorporate smart growth techniques including low-impact development and green infrastructure to better prepare the community for the future climate. | EPA's Tribal General Assistance Program Grants may be used to help tribal communities conduct an adaptation plan and inform actions.<br>EPA's Tribal General Assistance Program Grants |
| **Engaged residents in the selected adaptation**<br>• The Nation actively engaged its members in the development of the Village Relocation Master Plan. Multiple stakeholder and community meetings have been held and specific outreach efforts addressed the most vulnerable population by targeting schools and tribal elders. These efforts included community surveys and design charrettes to better identify the desired community layout. The preliminary plan includes a multi-use center for seniors, day care and early school head start programs.<br>• The final relocation master plan (expected to be completed in 2016) will detail the overall strategy and allow for a cost and time estimate. | EPA's Climate Ready Water Utilities program can help communities host an extreme events workshop to identify community risk, engage residents and inform responses.<br>EPA's Climate Ready Water Utilities |

## Similar Cases and More Information

Determining climate risk and vulnerability and developing an adaptation plan are just two components of climate adaptation. For an example of a community in the Northwest that used existing projections to promote climate adaptation planning, view the Anacortes Sea Level Rise Example.

- Anacortes, Washington Rebuilds Water Treatment Plant for Climate Change

# Salt Lake City, Utah Adapts to Improve Air Quality Through Smart Growth



In 2014, Salt Lake City was designated a Climate Action Champion Community for their leadership in reducing emissions and increasing climate resilience and adaptation to air quality concerns from climate change. The Sustainable Salt Lake Plan 2015 articulates the city's broad and ambitious agenda to protect its resources, enhance its assets, and establish a path towards greater community resiliency. The plan set goals to improve air quality, protect community health, and reduce particulate matter (PM) and ozone pollution (which are both projected to be exacerbated by climate change). The city adopted specific transportation measures to decrease miles traveled, reduce vehicle idling, and promote alternatives. These clean air strategies reduce current air pollution (mitigation) that is expected to be exacerbated by climate change (adaptation).

While continuing to address air quality issues, Salt Lake City is now formulating a vulnerability assessment and adaptation plan. The Salt Lake City Climate Response Plan is expected to include: a climate vulnerability assessment, a greenhouse gas mitigation plan, and an adaptation plan. This comprehensive approach to climate adaptation builds off of previous adaptation efforts to better help the city anticipate, plan and prepare to take action to protect residents from future public health and air quality concerns.

- Climate Action Champion Community
- Sustainable Salt Lake Plan 2015 (PDF) (30 pp, 23 MB, )


Salt Lake City's GREENbike bike share program.

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Salt Lake City identified air quality as a critical vulnerability**<br>• Salt Lake City identified air quality as an immediate problem, and one that is likely to be exacerbated by climate change.<br>• Salt Lake increased city department's adaptive capacity through training staff in a Climate Leaders program to better understand how climate change will affect their department's mission.<br>• Salt Lake City created a Climate Dashboard to track progress and provide up-to-date information on accomplishments to the public.<br>• Salt Lake City is currently completing their vulnerability assessment of climate impacts to every city department.<br>• To develop its pending Climate Response Plan, Salt Lake City convened an internal (city government) steering committee to assess risks and vulnerabilities and received input from all city departments. | EPA's Community-Based Climate Adaptation Handout helps communities identify how local government services may be vulnerable to changing climate conditions.<br>Community-Based Climate Adaptation Handout |
| **Salt Lake City prioritized adaptation actions that provide co-benefits**<br>• Salt Lake City knew even before completing an adaptation plan that reducing vehicle emissions, upgrading municipal fleets, and encouraging comprehensive regional transportation programs would both reduce the greenhouse gases that contribute to climate change and benefit public health by reducing air pollution that will be exacerbated due to a changing climate.<br>• Salt Lake City has also participated in mitigation measures through an EPA funded program called Climate Showcase Communities. | EPA's smart growth program provides resources on how communities can implement smart growth strategies that provide co-benefits to air, water and public health.<br>EPA's Smart Growth Program |

## Similar Cases and More Information

To read more about Salt Lake City's efforts to reduce transportation related air emissions, see the EPA's Sustainable Transportation for a Sustainable Future Page. Salt Lake City implemented air quality actions which also provided mutual benefits as climate mitigation activities. For an example of other strategy that can provide co-benefits, see how Chicago used Green Infrastructure to Reduce Extreme Heat. If you would like to know more information about how climate change will affect Air Quality and Human Health view the ARC Homepage.

- EPA's Sustainable Transportation for a Sustainable Future Page
- See how Chicago used Green Infrastructure to Reduce Extreme Heat

## References


- Air & Climate
- Climate Adaptation
- Sustainable Salt Lake Plan 2015 (PDF) (30 pp, 23 MB)
- Climate Action Champions

# San Juan Bay Estuary Program Assesses Vulnerability and Targets Adaptation Measures



The Puerto Rico Climate Change Council brought together numerous experts in 2010 to assess potential climate impacts and vulnerability in Puerto Rico's State of the Climate Report. Among numerous climate risks, the report details several climate threats to the San Juan Bay Estuary Program, one of 28 National Estuary Programs (NEPs) from around the country. Active members of the Puerto Rico Climate Changes Council, the San Juan Bay Estuary Program (SJBEP) decided to follow-up the report with a risk determination and vulnerability assessment for the San Juan Bay estuary. SJBEP worked with the EPA's Climate Ready Estuary Program to undertake a comprehensive vulnerability assessment and identify adaptation strategies. SJBEP used the EPA's Being Prepared for Climate Change Workbook process to catalog climate related vulnerabilities through community workshops, stakeholder meetings, and exercises.

In order to better understand climate concerns and experiences, SJBEP engaged the environmental justice communities that live and work around the bay through workshops and on-site discussions. The completed vulnerability assessment better prepares the San Juan Bay Estuary Program to undertake action to adapt to a changing climate. The report represents a first step for the SJBEP. The vulnerability assessment will help inform the development of a future adaptation plan that identifies appropriate adaptation strategies. Meanwhile, the vulnerability assessment has encouraged the estuary program to pursue measures to improve the resiliency of coastal wetlands and coral reefs.

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Conducted vulnerability assessment with extensive stakeholder engagement process**<br>• Developed a Climate Projection Scenario using the Climate Ready Estuaries Workbook.<br>• Identified and engage vulnerable communities through community workshops and in-person discussions.<br>• Analyzed the likelihood and magnitude of climate threats including extreme weather, sea level rise, erosion, and loss of coastal barriers such as mangroves and coral reefs. | Being Prepared For Climate Change Workbook helps develop a vulnerability assessment and risk-based climate change adaptation plan to reduce the most pressing risks.<br>Being Prepared For Climate Change Workbook |
| **Identified highest likelihood and highest consequence risks for non-point and point source pollution**<br>• Documented top climate risks of concern and identified the timeframe for impact.<br>• Some climate risks were identified as already occurring, examples of this were point source sewage overflows, and non-point source issues such as increased runoff, septic system failures, and greater erosion and sedimentation from sea level rise.<br>• Recognized that other climate affects posed longer-term risk including an increase in harmful algal bloom outbreaks and greater infiltration into sewers due to a higher water table. | EPA Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) can help users create climate scenarios and assess the coupled effects of climate and land-use change on water quality.<br>Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Used this information to inform management plans and implement resiliency measures**<br>• San Juan Bay Estuary program incorporated climate risks within the recent 2013 draft update to the Comprehensive Conservation and Management Plan. (Spanish only).<br>• The program is continuing to promote actions such as using artificial reefs and mangrove plantings to help restore the estuary and increase resilience to future conditions. | Synthesis of Adaptation Options for Coastal Areas Guidebook can assist in identifying adaptation options to protect coastal areas from storm surge and inundation concerns.<br>Synthesis of Adaptation Options for Coastal Areas Guidebook |

## Similar Cases and More Information

San Juan utilized climate projections to determine the threat likelihood and vulnerability of climate risks. To see another example of how a coastal community assessed downscaled vulnerability to potential climate threats view the Southwest Florida Salt Marsh Vulnerability and Adaptation Plan. Many coastal communities in the pacific islands and elsewhere may also have to deal with other challenges including saltwater intrusion and sea level rise; for another coastal sea level rise case, view MD SLAMM Model. To learn more about how another coastal community water utility adapted to saltwater intrusion and potential water quantity considerations, see how Tampa Bay Water diversified their source water to promote resiliency to current and future conditions.

- Southwest Florida Salt Marsh Vulnerability and Adaptation Plan
- MD SLAMM Model
- Tampa Bay Water

# Smart Growth Along the Riverfront Helps Manage Stormwater in Iowa City, Iowa



Iowa City, Iowa was among the hardest hit communities from the 2008 Iowa River floods with extensive flooding along the riverfront. In 2009, EPA and FEMA worked with the state organization, Rebuild Iowa, to identify policy options to accommodate growth in the Riverfront Crossings District and add green infrastructure and open space to reduce flooding. Subsequent EPA assistance on brownfields redevelopment and green infrastructure helped the city develop a master plan to rebuild the riverfront while protecting the environment, promoting equitable development, and helping address the challenges of climate change. The Riverfront Crossings Master Plan aims to create a resilient riverfront community park through using flood mitigation measures and stormwater best management practices to protect against future flooding.

Illustration of the riverfront restoration.

The plan would relocate vulnerable properties and infrastructure away from the floodplain and guide future development away from the most vulnerable areas. The Riverfront Crossings Master Plan promotes green infrastructure, vegetated buffer zones and public spaces along rivers and streams to reduce flooding, runoff, and erosion. While this plan did not explicitly incorporate climate projections, it can help Iowa City better manage projected increases in extreme rainfall, stormwater runoff and flooding along the riverfront. The Riverfront Crossings Master Plan will help Iowa City transition a high risk flood prone area with critical community infrastructure into a public riverfront park that provides recreational amenities, and helps the community adapt to current and future high river flows.

## How Did They Do It?

**Promoted Smart Growth Rebuilding Efforts**

- The city and state agency Rebuild Iowa, with EPA support, developed comprehensive smart growth and green infrastructure development plans that reduce the risk to current and future flooding and avoided placing development within a high risk area.
- Since 2009, EPA has been involved through several technical assistance programs including technical assistance from the EPA's Smart Growth Program, Green Infrastructure Technical Assistance Program, and the inter-agency Partnership for Sustainable Communities.

## Applicable EPA Tools

Iowa City, IA Riverfront Master Plan Report provides more information and to help identify similar strategies to help your community adapt.

Iowa City, IA Riverfront Master Plan Report

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Restored Floodplain and Developed Green Infrastructure to Reduce Flooding Impact**<br>• Designed floodplain restoration consistent with 2009 USEPA Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects.<br>• Used green infrastructure and stormwater best management practices to reduce impact of future flooding by creating a riverfront public park.<br>• Adapted to higher river elevations through moving critical infrastructure out of the floodplain and redesigning the riverfront to provide stormwater management and a recreational amenity for the community. | EPA's Enhancing Sustainable Communities With Green Infrastructure Report helps local governments integrate green infrastructure strategies into community plans.<br>EPA's Enhancing Sustainable Communities With Green Infrastructure Report |

## Similar Cases and More Information

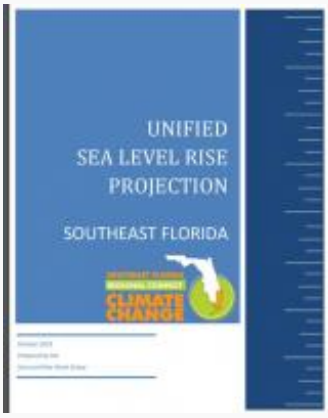
To see how another community has adapted to manage stormwater with a mix of grey and green infrastructure, view the DC Consent Decree example. Remember, critical infrastructure such as drinking water and wastewater utilities may be threatened from extreme precipitation events and flooding, to see how Iowa City, IA adapted to ensure their wastewater service was prepared for future flood risk, view Iowa City, IA North Treatment Plant.

- DC Consent Decree
- Iowa City, IA North Treatment Plant

# Southeast Florida Compact Analyzes Sea Level Rise Risk



Southeast Florida, with a large population located at low elevation, is among the most vulnerable regions of the country to climate change. The region is comprised of four counties (Monroe, Miami-Dade, Broward, and Palm Beach) that share similar geographic traits and coastal vulnerabilities to sea level rise. Rather than separately attempting to identify climate projections and vulnerabilities, leaders of these counties recognized an opportunity to collaborate and identify climate impacts and vulnerabilities across the region.




Unified Sea Level Rise Projection (37 pp, 538 K, )

A first step was to standardize projections and map sea level inundation. This single region-wide effort brought core stakeholders from counties, regional water management organizations, local universities and federal agencies together to create a regional vulnerability assessment of inundation and flooding. The resulting regional map identified vulnerable infrastructure, including drinking water and wastewater utilities from across the region, and was instrumental in informing development of the South Florida Regional Climate Action Plan. The Regional Action Plan "A Region Responds to a Changing Climate" provides a comprehensive set of recommendations for local governments, focusing on sectors such as transportation, natural resource management, emergency management, and the water sector among others. The Regional Action Plan recommendations on water supply, management and infrastructure protection efforts has since been supplemented by the implementation guidance on "Integrating Climate Change & Water Supply Planning In Southeast Florida". The Compact counties, municipalities, and other organization continue to collaborate on updates to climate projections, including a recent 2015 Sea Level Rise Update, and other common adaptation resources.

## How Did They Do It?

**Collaborated with neighboring jurisdictions to develop a vulnerability assessment**

- Four neighboring counties collaborated to identify the best available geographic data and climate change information to assess vulnerability, rather than working independently.
- Analyzed and published the anticipated regional impact of sea level rise on water and wastewater utilities. Note: Prior to publishing the data publicly, some information on specific facilities were excluded due to security concerns.

## Applicable EPA Tools

Being Prepared For Climate Change Workbook outlines how communities of any size can take appropriate steps to develop a vulnerability assessment and risk-based climate change adaptation plan. For more on illustrating vulnerability to a range of potential sea level rise and storm surge scenarios sea level rise, view the EPA Coastal Inundation Coastal Storm Surge Scenario illustrates hurricane strike frequency and worst-case coastal storm surge or inundation scenarios.

- Being Prepared for Climate Change Workbook
- EPA Coastal Inundation Coastal Storm Surge Scenario

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Encouraged and informed regional action**<br>• Developed regional recommendations (South Florida Regional Climate Action Plan) and implementation guidance on how to integrate climate change impacts (e.g., sea-level rise inundation, flooding or saltwater intrusion) within utility water supply planning.<br>  ◦ South Florida Regional Climate Action Plan (PDF) (84 pp, 4 MB)<br>• Provided implementation guidance on such topics as infrastructure siting and design, quantifying reduction in drainage capacity and natural resource degradation in order to help reduce climate vulnerabilities to the water supply, water management services and drinking water, wastewater and stormwater management.<br>• Municipal and local jurisdictions utilized this data to inform and support their adaptation actions, one such example is Miami Beach's adaptation plans to protect utility infrastructure from flooding. | Adaptation Strategies Guide helps communities identify potential adaptation strategies and inform actions for infrastructure located in coastal areas.<br>Adaptation Strategies Guide |

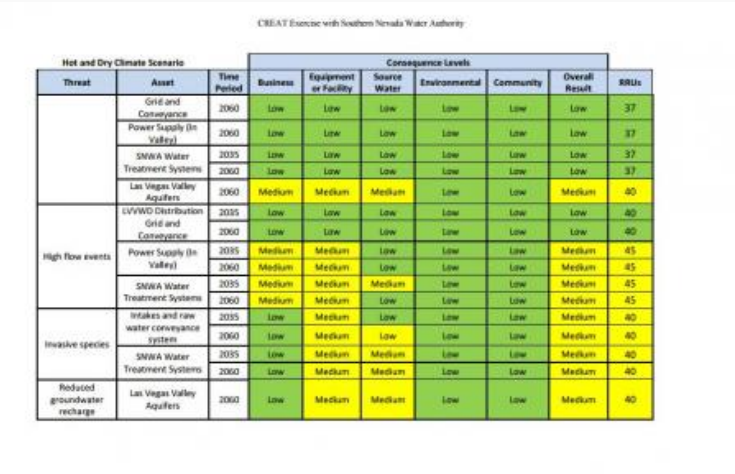
## Similar Cases and More Information

A community doesn’t always have to develop new information, for an example of a community that used existing sources of information to guide decision making, see Anacortes. Many communities in the southeast may have to deal with challenges to their source water – whether it is saltwater intrusion, sea level rise, or threats to the facility infrastructure – to learn how a utility is adapting to ensure source water availability, view Tampa Bay Water. To learn more about the South Florida Compact, view the Climate Resiliency Toolkit’s Collaboration Among Counties Improves Vulnerability Assessments case study.

# Southern Nevada Water Authority Assesses Vulnerability To Climate Change



Southern Nevada Water Authority (SNWA) -- a cooperative of seven water and wastewater agencies -- serves more than two million residents in Nevada, including the city of Las Vegas. SNWA worked with the U.S. EPA's Climate Ready Water Utilities program to conduct a vulnerability assessment of the Las Vegas service area that considered climate impacts and vulnerabilities in two future scenarios (in 2035 and in 2060). Projected climate impacts included hotter and drier summers, drought conditions, and increased algal blooms.



CREAT Exercise with Southern Nevada Water Authority

| Hot and Dry Climate Scenario | | | Consequence Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Threat | Asset | Time Period | Business | Equipment or Facility | Source Water | Environmental | Community | Overall Result | RRUs |
| | Grid and Conveyance | 2060 | Low | Low | Low | Low | Low | Low | 37 |
| | Power Supply (In Valley) | 2060 | Low | Low | Low | Low | Low | Low | 37 |
| | SNWA Water Treatment Systems | 2035 | Low | Low | Low | Low | Low | Low | 37 |
| | | 2060 | Low | Low | Low | Low | Low | Low | 37 |
| | Las Vegas Valley Aquifers | 2060 | Medium | Medium | Medium | Low | Low | Medium | 40 |
| High flow events | LVVWD Distribution Grid and Conveyance | 2035 | Low | Low | Low | Low | Low | Low | 40 |
| | | 2060 | Low | Low | Low | Low | Low | Low | 40 |
| | Power Supply (In Valley) | 2035 | Medium | Medium | Low | Low | Low | Medium | 45 |
| | | 2060 | Medium | Medium | Low | Low | Low | Medium | 45 |
| | SNWA Water Treatment Systems | 2035 | Medium | Medium | Medium | Low | Low | Medium | 45 |
| | | 2060 | Medium | Medium | Low | Low | Low | Medium | 45 |
| Invasive species | Intakes and raw water conveyance system | 2035 | Low | Medium | Low | Low | Low | Medium | 40 |
| | | 2060 | Low | Medium | Low | Low | Low | Medium | 40 |
| | SNWA Water Treatment Systems | 2035 | Low | Medium | Medium | Low | Low | Medium | 40 |
| | | 2060 | Low | Medium | Medium | Low | Low | Medium | 40 |
| Reduced groundwater recharge | Las Vegas Valley Aquifers | 2060 | Low | Medium | Medium | Low | Low | Medium | 40 |

Preliminary Table of Assessed Threats and Likelihood For Each Scenario and Time Period Climate Resilience Evaluation and Awareness Tool Exercise with Southern Nevada Water Authority.

This vulnerability assessment also helped identify more than 60 potential current and future actions to take in response to and prepare for climate change. SNWA followed up this initial analysis with a more in-depth assessments of water source availability under future climate change, population, and water demand projections. These assessments provide SNWA with a better understanding of its climate risks and potential vulnerabilities. The information also informs the water authority's ultimate consideration, selection, and implementation of appropriate adaptation strategies. SNWA continues to anticipate, prepare, and plan for the future as a member of the Water Utility Climate Alliance; a consortium of 10 of the largest water utilities around the country actively engaged on climate change.

| How Did They Do It? | Applicable EPA Tools |
|---|---|
| **Identified projected climate risks and assessed utility vulnerability**<br>• Using EPA's CREAT Tool, SNWA analyzed a range of climate projections for the Las Vegas area (through 2035 and through 2060). | EPA's Climate Resilience Evaluation and Awareness Tool (CREAT) can help assess water utility vulnerability. |
| **Utilized asset/threat pairings to identify and select "adaptation packages" of applicable strategies**<br>• CREAT projections helped identify the most vulnerable assets and assess the facility assets against their respective climate threat. These asset/threat pairings were used to help identify potential cost-effective adaptation strategies.<br>• The analysis identified both resiliency and adaptation actions, and developed "adaptation packages" of strategies that were scaled to the magnitude of scenario risk. For example, resiliency strategies for the short and long-term threat from harmful algal blooms included increasing water quality and temperature modeling, while adaptation options included altering water treatment process or extending source water intake levels deeper. | The Adaptation Strategies Guide can help formulate packages of appropriate adaptation strategies. To better understand how occurrences of harmful algal blooms can be affected by climate change, view the Harmful Algal Blooms & Climate Change Factsheet.<br>Adaptation Strategies Guide<br>Harmful Algal Blooms & Climate Change Factsheet |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Identified initial assessment limitations and the need to conduct further analysis before implementing adaptation strategies**<br>• SNWA understood the limitations of the first study and undertook a follow up analysis that used refined scenarios, included more locations, and encompassed greater focus on water availability and quality concerns (e.g., dissolved oxygen, turbidity, and mixing). | Hydrologic and Water Quality System can provide a more in-depth modeling platform to estimate future climate impacts on water quality and pollutants. |

## Similar Cases and More Information

For more case studies from Water Utility Climate Alliance Members, see the Tampa Bay Water case studies. For more information about ensuring available water supply in the future with climate change view the Anacortes, WA case study. For other cases working to ensure water quality under projected climate impacts view the Pennsylvania Natural Resources Adaptation Plan.

# Southwest Florida Assesses Salt Marsh Vulnerability to Sea Level Rise



Salt marshes are vitally important to Southwest Florida. They serve as storm surge buffers, shoreline stabilizers and breeding grounds for wildlife. The 2014 National Climate Assessment projects that salt marshes are at risk both in Florida and around the country from anticipated climate impacts including relative sea level rise, coastal erosion, and more intense storms. The Charlotte Harbor National Estuary Program and Southwest Florida Regional Planning Commission, supported by an EPA assistance grant, collaborated to assess the historic and current range of salt marshes in this region, and identify their vulnerability to changing climate conditions.

The Climate Change Vulnerability Assessment and Adaptation Opportunities for Salt Marsh Types in Southwest Florida study determined that the current pace of sea level rise appears to allow some locations for marsh migration on mainland shores, however “in other locations salt marshes are drowning where there is no location to move to.” The study further mapped these areas to better determine the barriers to movement and understand where salt marshes are able to, and in the future expected to, move as they adapt to higher sea levels. By providing information on expected migration and isolation areas, the report helps local governments identify priority conservation areas to preserve salt marshes and their associated benefits under current and future conditions. The study included recommendations that governments, stakeholder groups or the public could take as part of their adaptation strategies (e.g., protecting or armoring of shorelines).

- Salt marshes
- 2014 National Climate Assessment

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Identified climate vulnerability to salt marsh wetlands**<br>• Identified key climate risks to marshes including sea level rise, more intense hurricane and storm surges, saltwater intrusion, and greater levels of sedimentation or erosion.<br>• Identified the most at-risk marsh land using a sea level response map scenario that considered the likelihood of land use protections (e.g. conservation designation) and residential adaptation responses (e.g., protecting or armoring shorelines). | Being Prepared For Climate Change Workbook helps develop a risk-based climate change adaptation plan consisting of a vulnerability assessment and an action plan to reduce the most pressing coastal risks.<br>Being Prepared For Climate Change Workbook |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Developed actionable adaptation recommendations**<br>• Specific recommended actions for municipalities were to:<br>  ◦ Identify existing marsh migration corridors for maintenance and conduct further research to identify the highest priority corridors to protect from future development.<br>  ◦ Support restoration of existing salt marshes by removal of exotic vegetation, removal of barriers to tidal connection, and degradation of exotic dominated adjacent uplands.<br>  ◦ Discourage or stop shoreline hardening including seawalls, bulkheads, rip-rap, and "living shorelines" backed by rip-rap.<br>  ◦ Restore impaired water flows to enhance sediment supply for marsh deposition.<br>  ◦ Back-fill mosquito control ditches, borrow pits, and agricultural pits to reduce depth and sediment loss and facilitate salt marsh establishment and migration. | Synthesis of Adaptation Options for Coastal Areas Guidebook helps identify climate risks to coastal ecosystems and review adaptation options available to coastal managers.<br><br>The Rolling Easements Primer provides a more in-depth review of a adaptation option applicable to protecting coastal marshes. |

## Similar Cases and More Information

To see another example of how a coastal community assessed their vulnerability view the San Juan Estuary Programs Vulnerability Assessment Case or the Southeast Florida Climate Compact. Many coastal communities in the southeast may have to account for other climate vulnerabilities, such as threats to drinking and wastewater services. Saltwater intrusion, sea level rise and more intense hurricanes can threaten coastal infrastructure. To learn more about how another southeastern community adapted to saltwater intrusion and potential water quantity considerations see how Tampa Bay Water diversified their source water to promote resiliency to current and future conditions.

## References


- Climate Change Vulnerability Assessment and Adaptation Opportunities for Salt Marsh Types in Southwest Florida

# Tampa Bay Diversifies Water Sources to Reduce Climate Risk



Tampa Bay Water provides drinking water for nearly two and a half million residents on the gulf coast of Florida. Historically, the utility relied largely on groundwater to satisfy the nearly 250 million gallons of water required per day (mgd). The utility's operators recognized the increasing vulnerability of its groundwater source to saltwater intrusion and completed construction of a desalination plant in 2008. The utility now delivers 'blended' water using groundwater, surface water, and desalinated water. However, Tampa Bay Water faces numerous risks from climate change including more frequent and intense storms as well as flooding and the aforementioned threat of saltwater intrusion. Therefore, the utility operators decided to more systematically estimate its source water vulnerability to projected changes in precipitation levels and saltwater intrusion and assess its ability to meet an anticipated increase in demand of water to 275 mgd by 2035.

The analysis confirmed Tampa Bay Water's previous good judgment of diversifying its water sources and indicated that its upgraded system likely enables the utility to meet its anticipated future needs even in a changing climate. Tampa Bay Water continues to anticipate, plan and prepare for the challenges of a changing climate through working with the Water Utility Climate Alliance, a collaboration among ten of the country's water utilities that provide leadership on climate issues, and the Florida Water Climate Alliance, a collaboration among state universities, water utilities and water management agencies focusing on climate change.

| How Did They Do It? | Applicable EPA Tools |
|---|---|
| **Tampa Bay Water diversified water sources to protect its groundwater resource**<br>• Tampa Bay Water invested in a 25 mgd saltwater desalination plant ($158 million) in anticipation and preparation of salt water intrusion. | Adaptation Strategies Guide identifies strategies for how utilities can protect source water from climate change, including from saltwater intrusion.<br>Adaptation Strategies Guide |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Tampa Bay Water found partners, secured funding, and conducted a vulnerability assessment**<br>• Tampa Bay Water used a NOAA two-year grant to fund a collaborative effort with the University of Florida and the Florida Water Climate Alliance to analyze climate impacts downscaling techniques.<br>• In order to better understand future climate projections and their impact to Tampa Bay water supply, this research partnership calculated a way to correct bias in statistically and dynamically downsized General Circulation Model (GCM) and is currently attempting to identify bias correction for the Coupled Model Intercomparison Project-Phase 5.<br>  ◦ Learn more at USGCRP Models<br>• Initial results from this analysis show that there is still high variability in the projected precipitation with climate change, which supports previous efforts to diversify and expand access to water supply sources.<br>• The next phase of this project will explore future population changes and anthropogenic vs. climatic factors affecting water availability in the region in order to evaluate the water management strategies that can reduce risk and increase resilience of the water supply for the Tampa Bay region. | Climate Resilience Evaluation and Awareness Tool (CREAT) helps utilities identify current and future climate impacts and assess vulnerability of water utility facilities.<br>Climate Resilience Evaluation and Awareness Tool (CREAT) |

## Similar Cases and More Information

Many communities in the southeast may have to deal with challenges to their source water, whether it is saltwater intrusion, sea level rise or threats to the facilities infrastructure. To learn more about Tampa Bay's decision to diversify its source water resiliency to current and future conditions view Tampa Bay Water's case study on the Climate Resilience Toolkit. For another water utility that adapted against concerns for saltwater intrusion, view the Anacortes Sea Level Rise Study.

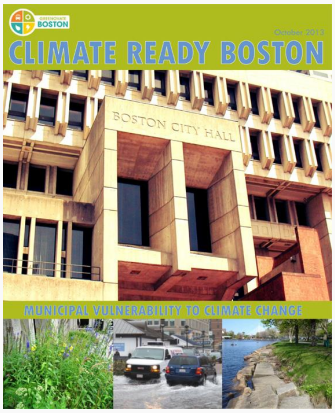
- Tampa Bay Water's case study
- Anacortes Sea Level Rise Study

# The City of Boston Plans for Adaptation

epa.gov/arc-x/city-boston-plans-adaptation

In 2007, Boston's Mayor directed each city department to assess their risks and vulnerabilities from a changing climate. In the subsequent years Boston developed a report "Climate Ready Boston - Municipal Vulnerability to Climate Change," that anticipates climate impacts to, and vulnerabilities for, the city of Boston. The Climate Ready Boston Adaptation Plan projects how climate change is expected to lead to impacts ranging from sea level rise to extreme weather events. The report utilized existing research and analysis to identify potential municipal infrastructure and other city services that could be impacted by climate change. Boston used the knowledge gained from Climate Ready Boston to integrate the climate risks and vulnerabilities within their Natural Hazard Mitigation Plan.

- Climate Ready Boston Adaptation Plan (PDF) (29 pp, 7.17 MB, )




Climate Ready Boston (PDF) (29 pp, 7.17 MB, )

| How Did They Do It? | Applicable EPA Tools |
|---|---|
| **Mayor issued an Executive Order to identify and plan to reduce climate risks**<br>• The Executive Order directed each city department to "prepare an integrated plan that outlines actions to reduce the risks from the likely effects of climate change, and coordinate those actions with the City's plans for emergency response, homeland security, natural hazard mitigation, neighborhood planning, and economic development." | The EPA Regional Climate Website and Local Government Climate Adaptation Training can help you identify regional climate risks and how they may impact local community services.<br>EPA Regional Climate Website<br>Local Government Climate Adaptation Training |
| **City departments conducted vulnerability assessments**<br>• A Climate Preparedness Task Force, consisting of department heads from across city government analyzed vulnerabilities to city services using existing climate studies, including the National Climate Assessment (see below), to inform their vulnerability assessment. | The Climate Change Adaptation Workbook can help community organizations that manage environmental resources prepare a broad, risk-based adaptation plan.<br>Climate Change Adaptation Workbook |

| How Did They Do It? | Applicable EPA Tools |
| --- | --- |
| **Boston used the vulnerability assessments to inform community plans**<br>• The Office of Emergency Management utilized the vulnerability assessments and Vulnerability-Consequence Adaptation Planning Scenarios (VCAPS) to integrate climate change vulnerabilities within their Natural Hazard Mitigation Plan.<br>  ◦ Vulnerability-Consequence Adaptation Planning Scenarios (VCAPS) | View the U.S. Climate Resilience Toolkit to learn more about VCAPS and other tools to help communities integrate vulnerabilities into community plans.<br>U.S. Climate Resilience Toolkit |

## Similar Cases and More Information

Determining climate risk and vulnerability is just the first step to adapting to climate change. Communities also need to identify and employ adaptation strategies as well. To see how Boston adapted its wastewater treatment facility to sea level rise, view the Deer Island example.

- Boston Raises Wastewater Facility to Avoid Inundation