

Resources:

Partnership for the Delaware Estuary

Climate Change and the Delaware Estuary, June 2010 Report: http://www.delawareestuary.org/science_reports_partnership.asp

Living Shorelines: http://www.delawareestuary.org/science_projects_living_shoreline.asp

Green Guide for Property Management: http://www.delawareestuary.org/pdf/pwd_green_guide.pdf

A Homeowner's Guide to Stormwater Management:

<http://www.delawareestuary.org/pdf/HomeownersGuideSWMgmt.pdf>

National Oceanic and Atmospheric Administration

<http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml>

http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8557380

<http://www.csc.noaa.gov/digitalcoast/index.html>

<http://www.csc.noaa.gov/digitalcoast/action/ccap-de-river.html>

Delaware River Basin Commission

State of the Basin Report 2008: <http://www.state.nj.us/drbc/SOTB/index.htm>

Delaware Sea Grant

Smart Growth Strategies and Natural Stormwater Management: <http://www.deseagrant.org/products/protecting-water-quality-smart-growth-strategies-and-natural-stormwater-management-sussex-c>

Delaware Department of Natural Resources and Environmental Control

Interactive Sea Level Rise Map: <http://www.dnrec.delaware.gov/Pages/SLRMaps.aspx>

Office of Coastal Management, New Jersey Dept. of Environmental Protection

Coastal Community Vulnerability & Resilience Assessment: www.nj.gov/dep/cmp

Philadelphia Water Department

http://www.phillywatershed.org/what_we_are_doing/green_infrastructure/projects

References:

- 1 – Kreeger, D., Adkins, J., Cole, P., Najjar, R., D, V., Conolly, P., et al. (2010). *Climate Change and the Delaware Estuary: Three Case Studies in Vulnerability Assessment and Adaptation Planning*. Wilmington: Partnership for the Delaware Estuary.
- 2 – Kauffman, G., Homsey, A., Chatterson, S., McVey, E., & Mack, S. (2011). *Socioeconomic Value of the Delaware Estuary Watershed*. Newark: University of Delaware.
- 3 – Department of Natural Resources and Environmental Control and Partnership for the Delaware Estuary. (2011). *Governor Markell announces investment in Delaware Bay jobs and oyster reefs* [Press release]. Retrieved from http://www.delawareestuary.org/pdf/press_release_030911.pdf.
- 4 – Kreeger, D., Adkins, J., Cole, P., Najjar, R., D, V., Conolly, P., et al. (2010). *Climate Change and the Delaware Estuary: Three Case Studies in Vulnerability Assessment and Adaptation Planning*. Wilmington: Partnership for the Delaware Estuary. And Kreeger, D. presentation 'Results from the Climate Ready Estuaries Pilot'.
- 5 – Delaware River Basin Commission. (2008). *State of the Basin Report*. West Trenton: Delaware River Basin Commission.



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The **Partnership for the Delaware Estuary** leads collaborative and creative efforts to protect and enhance the Delaware Estuary and its tributaries for current and future generations.

Funding for this brochure was provided by Sunoco and the U.S. EPA in support of the National Estuary Program.

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COVER: Photo of clouds (top) courtesy of NOAA / AOML / C. True, Photo of flooded house (right) courtesy of DNREC. BACK COVER: Photo of clouds courtesy of NOAA / AOML / Dr. Edward Hindeman.



WEATHERING CHANGE



**WORKING
WITH NATURE
TO PROTECT
COMMUNITIES AND
CLEAN WATERS**

THE DELAWARE ESTUARY WATERSHED:

6,500 square miles in New Jersey, Pennsylvania, and Delaware



Change is in the air...

...and on the land, and in the water. Science shows that we are experiencing gradual weather and water-related changes. Frequent and severe rain and snow storms with flash floods, hot and dry spells in the summer, and higher tides in coastal areas are on the rise and expected to increase in the near future. Local communities can protect their resources and quality of life by planning for these changes.

Over 6.4 million people...

...live and work along the tidal Delaware River and its streams, and this number will nearly double over the next century. Population changes, along with weather and water-related changes, will pose serious threats to our region's natural resources and challenge our economic and social norms.

Local communities are on the front lines dealing with increased snow removal budgets and repeated repair work on washed out roadways and other damaged infrastructure. Growing stormwater management demands, increased emergency planning needs, rising energy costs, and protecting clean drinking water supplies also pose challenges.

Here in the Delaware Estuary region...

- Average temperatures are expected to increase by **4 to 8 degrees** Fahrenheit over the next century.¹
- Population is predicted to increase **80%** by 2100.¹



Photo courtesy
of DNREC

A flooded house in Kitts Hummock, DE after a May, 2008 storm.



The Chester Creek in Aston, PA after an October, 2010 storm.



Homes at risk on the Delaware Bay in New Jersey.

At Risk...

...are people, property, and clean water. Local community leaders face tough decisions in planning to protect and control the waters that sustain, and yet can threaten, the lives and livelihoods of the people in the region. Increasing precipitation falling on hard, man-made surfaces and buildings runs off and can create an onslaught of destructive stormwater. Uncontrolled stormwater floods developed areas, wipes out natural habitats, erodes streambanks, damages property and community infrastructure, and pollutes streams and other drinking water sources.

Coastal communities face additional flooding challenges as sea level rises and storm surges increase.

Here in the Delaware Estuary region...

- Annual rainfall and snowfall are expected to **increase 7-9%** over the next century.¹
- Tidal waters have **risen a foot** over the past 100 years, and are expected to **rise another 2 to 5 feet** during the next century.¹

Cape May, NJ Desalinization of Wells

Overuse of groundwater in Cape May, NJ caused groundwater levels to fall below sea level and become contaminated by saltwater intrusion. Desalinization, the removal of salt, was determined to be the town's most cost-effective option. Total cost for the desalinization plant completed in 1998 was \$5 million, the largest capital improvement in Cape May's history, adding an extra \$85/year to average household water bills.

Over 15 million people...

...rely on the Delaware River and its tributary streams for clean drinking water. Drinking water intakes on tidal waters are at risk when saltwater is pushed farther up the Delaware River. The salt line, where fresh and saltwater meet, is affected by ocean tides, storm surges, sea level rise, droughts, and the removal of freshwater for industry and people. Freshwater in underground pools (aquifers) that is replenished by a tidal river or stream is also at risk from saltwater intrusion. Change in water salinity impacts family farms, natural habitats and wildlife that depend upon freshwater. Many plants and animals cannot tolerate even small salinity changes in the water they depend on for survival. Desalinization, the removal of salt from drinking water supplies, is very expensive.



Here in the Delaware Estuary region...

- The Delaware Estuary watershed covers just .02% of the continental United States, yet supplies drinking water worth billions of dollars to **2% of the U.S. population**.²
- Farms in our region depend upon clean, freshwater supply and they generate **over \$2.5 billion** in the local economy.²
- Extremely sensitive to changes in water salinity, the oyster industry in the Delaware Bay has an economic impact of **millions of dollars** annually.³



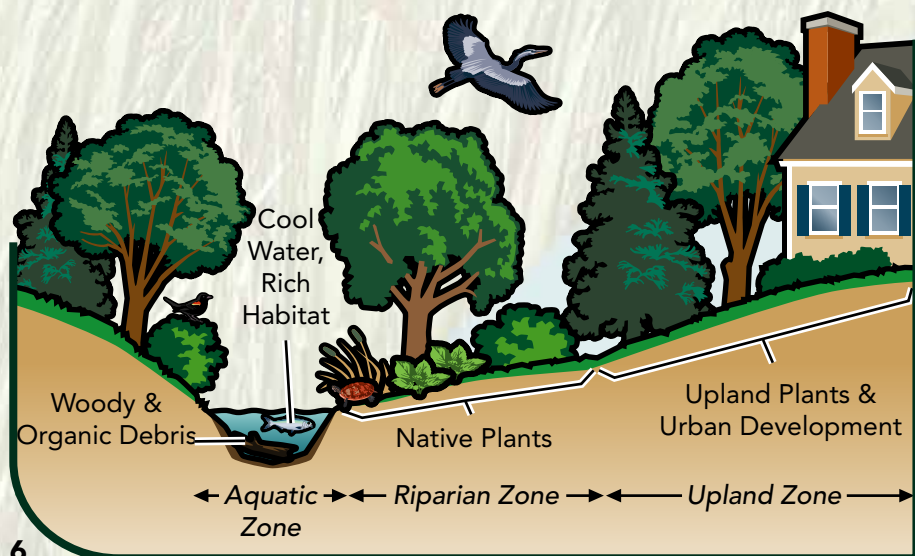


(Above) Marsh erosion in the Maurice River, NJ.

(Below) Healthy, mature riparian buffer in PA.



A Healthy Riparian (Stream) Habitat



Wetlands and Streamside Forests...

...are like giant natural sponges that absorb and filter tremendous amounts of stormwater.

Crucial to water quality and fish and wildlife habitat, tidal wetlands are also a bayside and riverfront community's best defense against flood waters and rising sea levels. They are being lost to erosion and open water at a rapidly accelerated pace. Inland, non-tidal wetland areas absorb stormwater that would otherwise erode and overflow streambanks and end up in streets and basements.

Along local streams, riparian buffers are vegetated areas with trees, shrubs, and long grasses. They slow the flow and filter pollutants from heavy rain and melting snow. The long root systems in mature buffers and forests hold soils firmly in place and absorb tremendous amounts of water. Shade from streamside plants keeps water temperature cooler for healthier fish habitats.

Only a fraction of our historic natural forests, streamside buffers, and wetlands remain today. Those we have left are more critical than ever for community flood protection — and in need of preservation and protection.

Here in the Delaware Estuary region...

- Wetlands and forests provide approximately **\$7 billion in "eco" goods and services**, like water filtration, air purification, flood control, and more.²
- Only about 5% of the Delaware Estuary's tidal wetlands remain today, and **over 25% of them will likely be lost** over the next century.⁴
- Between 1916 and 2002, land in the Delaware River Basin was developed at an average rate of **19 football fields per day**, 70% of which took place on previously forested landscapes.⁵

Philadelphia Planning to Save Money with Green Infrastructure

Philadelphia's sewer pipes carry rainwater as well as sanitary waste to sewage treatment plants. When treatment facilities can't keep up in heavier rain storms, untreated sewage can overflow into the Schuylkill and Delaware Rivers. Other cities in the region with older storm sewer systems face similar challenges.

According to the Philadelphia Water Department, the city could address the problem with traditionally constructed stormwater management techniques. At a cost of \$10 billion (or more), they could build a collector pipe around most of Philadelphia, but the price tag is simply too high. To reduce costs while reducing the city's impact on the Schuylkill and Delaware Rivers, the Philadelphia Water Department is instead planning for water conservation and "green" infrastructure projects. Green infrastructure uses natural and/or manmade systems that imitate nature's water absorption processes. While the city works on making streets and sidewalks more stormwater absorbent, commercial landowners are encouraged to replace traditional pavement with porous alternatives, build rain gardens, and install green roofs and infiltration basins to earn money-saving credits on their stormwater bills. (More details of these "Best Management Practices" are listed in the "Work with Nature" section of this brochure.)

Furthermore, the city plans to convert 500 of its own nonporous, paved-over acres into water-absorbing parkland. A model to other cities and towns, Philadelphia is proving that smart planning for stormwater management, providing incentives for **green infrastructure**, and **working with nature** instead of against it, is **effective** and **budget-friendly**.



Local Leaders Can Make the Difference...

Spending money today to weather future storms may be a tough sell in lean economic times. But considering the costs of losing a neighborhood or the business revenues lost when flood waters shut down Main Street, planning for change today makes good economic sense for the future.

Enforcing ordinances, strengthening building codes, and updating land use plans to protect water resources and infrastructure can greatly improve our region's ability to survive and thrive in the years ahead, while maintaining our quality of life and the water that sustains it.

BEFORE



AFTER

The community of Glenville, DE was destroyed by a flash flood in 2003. State and County governments had to purchase 171 homes (before). The area is now a flood plain that protects neighboring communities (after).

Ready for Change?



Work with Nature... ...To Slow and Filter Water

Green infrastructure takes hints from nature for cost effective stormwater management, allowing water to soak back into the ground to replenish groundwater, restore stream base flows, and reduce flooding.

- Naturalize basins with water-loving native plants, trees, and shrubs.
- Plant trees and shrubs throughout your community, especially along streams (A).
- Consider porous paving alternatives (B).
- Install curb cutouts (C) and bioswales to absorb water from streets and parking lots.



Work with Nature... ...To Protect and Create Wetlands

Protecting existing wetlands in your community is best for both function and cost savings, but restoring or recreating these areas can filter and manage stormwater like a natural wetland.

- Protect wetlands and their buffer areas to allow inland migration or expansion.
- Restore degraded and destroyed wetlands to protect nearby communities from flooding.
- Install rain gardens in low lying areas (D) to mimic wetlands on developed properties.
- Install living shorelines (E) in coastal areas to rebuild protective marshes.





Work with Neighbors

Municipal leaders, residents, and businesses can work together to meet the challenges of changing weather and water conditions.

- Encourage tree planting and the creation or protection of natural areas (F) on developed properties.
- Encourage people in your community to install rain barrels (G), downspout planters, and rain gardens to reduce excessive runoff from their properties.
- Use your community's existing communications (newsletters, bill mailings, websites, and annual reports) to highlight green projects and talk about community water conservation efforts.
- Stretch your dollars by partnering with your local watershed organization on projects and public outreach efforts.
- Work collaboratively with upstream and downstream towns to implement larger and/or multiple projects to significantly improve stormwater control in your watershed. We all live downstream!



Plan for Change

Ben Franklin once said, "An ounce of prevention is worth a pound of cure"—still true today in planning for water quality and community protection in changing times. Planning costs very little, but reactive measures as problems develop can be extremely expensive.

- Look at existing zoning, land use, comprehensive, and hazard/emergency plans and update them to take increasing temperature, precipitation, and sea level conditions into consideration.
- Work together, across zoning, planning, and public works departments to update codes to accommodate and encourage installation of absorbent green stormwater management practices.
- Keep development away from any land that is expected to erode and/or flood to protect public safety, property and other community assets.
- Protect wetlands, streamside forests, and any natural areas existing between them and developed land – they are the best natural defense against flooding in developed areas.
- Require use of green infrastructure for stormwater control in new and expanding land development.

