STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

FACING OUR FUTURE:
Water Resources, Quality and Quantity
Adapting to Connecticut's Changing Climate

"Without set asides for the environment, streams, rivers, lakes, and other water bodies may suffer impairment and degradation during sustained periods of low flow. There may not be enough water to support fisheries and the aquatic life on which they depend, wildlife, and all of the other aspects of the natural environment which are water-dependent, as well as the recreational resources and natural beauty that make Connecticut so attractive to its residents and visitors. With careful planning, however, Connecticut can meet the needs of its citizens without sacrificing the quality of its natural environment." *Report to the General Assembly on State Water Allocation Policies Pursuant to Public Act 98-224,* January 2000.

Implications For Water Quality and Quantity

Connecticut is rich in natural water resources and fortunate to be located in a region of North America with a temperate climate. "The state has approximately 5,800 miles of rivers and streams, virtually all of which eventually flow to Long Island Sound. There are more than 2,300 lakes, ponds and reservoirs, and roughly 15% of Connecticut's land surface is composed of inland and tidal wetlands."[1] Unfortunately the existence of a connection between people and this varied land is not as obvious in today's Connecticut as it once was. Still, over 3.4 million residents depend on Connecticut's land and water resources for water supply, sewage disposal, living and work space, flood safety, farm products, and other socio-economic benefits. All of these uses and needs, without proper management, can impair water quality and availability in Connecticut.

While the state has made great strides in improving the quality of surface water and ground water in the past three decades, continued vigilance and innovation is needed to ensure protection of these irreplaceable resources. The impact of global warming and regional climate change can further tax Connecticut's freshwater resources and its watersheds, by both periodic flooding and drought, along with warming temperatures.

Water availability for ground and surface water systems is a complex function of numerous factors including: precipitation, temperature, evaporation from land and the surface of water bodies, transpiration by plants, runoff across the land surface, water withdrawals for human use, and human uses of the land including infrastructure (see the Infrastructure fact sheet). All of these factors are likely to be influenced by a changing climate. Today, Connecticut's average annual precipitation is approximately 47 inches, and is fairly evenly distributed throughout the year. Some of the annual precipitation is returned to the atmosphere through evaporation and transpiration, while the rest either runs off into streams and lakes or enters the groundwater system. How we use the land and water can greatly alter the water budget, and climate change projections for the future indicate precipitation will be more varied and extreme.

[1] *Report to the General Assembly on State Water Allocation Policies Pursuant to Public Act 98-224*, January 2000.

Increase in Frequency - The frequency of winter precipitation is projected to increase by 20 to 30 percent with more falling as rain than snow. The frequency of heavy damaging rainfall is expected to increase. By late century with warmer temperatures and lower precipitation in summer, drought, which already does occur in Connecticut, is projected to increase in frequency.[2] Connecticut is considered a relatively water-rich state. However, there are already existing conditions and stressors on water resources such as storm water, urban and suburban development, flooding, consumptive uses of water, and even drought. These interrelated variables need to be considered as Connecticut adapts to a changing climate by implementing low impact development, correcting existing poor land-use decision-making, and improving stewardship of water resources.

Stormwater - Stormwater-related events such as flooding can expand floodplains, increase variability of stream flows, increase water velocity and increase erosion. More frequent stormwater-related events are projected with a changing climate and in urban areas with combined sewers this is expected to increase the frequency of sewage overflows. These impacts can adversely affect water quality and aquatic ecosystem health. Erosion and sedimentation can cause significant impacts on coastal areas, wetlands, ponds, lakes, and streams. Nutrient loaded sediments containing phosphorous and nitrogen may settle in impoundments and be resuspended into the water column by storms leading to algal blooms. More frequent and intense storms can cause more frequent "turn over" in lakes and ponds making the normal spring/fall turn over less predictable. Similarly, warming temperatures may strengthen and extend periods of stratification in lakes, ponds and Long Island Sound, exacerbating low oxygen conditions and disrupting natural production cycles.

[2] Connecticut Summary from the Union of Concerned Scientists based on *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions*, a report of the Northeast Climate Impacts Assessment (NECIA, 2007).

Urban and Suburban Development – On undisturbed landscapes much of the precipitation naturally infiltrates into the soil. Natural flood attenuation is being lost in our urban and suburban landscapes where there is a growing amount of impervious surface such as concrete and asphalt. This can contribute to eutrophication and related low oxygen content of waters as loads of nutrients and biodegradable organic materials are increased. Eutrophic waters are inhospitable to many valued forms of aquatic life and as water quality degrades from over production.

Increased precipitation means higher levels of runoff contributing to floods and pollutant delivery from impervious surfaces. Warmer temperatures for longer periods can heat impervious surfaces and the stormwater that flows across them, delivering that heat to the streams and estuaries where it is discharged.

If developed areas are at greater risk from flooding from projected climate conditions, real property losses may increase. New low impact development (LID) practices that address both water quality and quantity concerns under current conditions as well as under a changed climate regime can partially offset impervious cover. Continued protection of floodplains and stream buffers is an important feature of a comprehensive LID strategy to protect the environment and property today and under future conditions. For example, keeping flood plains undeveloped but available to farming provides for an economic benefit while precluding a risk to development that may exacerbate flooding. This allows fields to be rejuvenated with nutrients naturally when flooded while providing a buffer from the negative effects of seasonal floodwaters on constructed property. Likewise, inland wetlands can provide a passive location for floodwaters. Past inland wetland losses have destroyed important habitats as well as the water quality benefits they provide. Protection and restoration of inland wetlands will help revive these lost functions as well as being an important adaptation strategy in Connecticut's changing climate.

Flooding - Flooding is Connecticut's most frequent and closely watched natural hazard. Changes in climate may increase that frequency.

Recently, the Five Mile River area of Darien, New Canaan, and Norwalk experienced three flood events that were at or above the 25-year flood event. In addition to property damage, more frequent flood events can alter the shape of watercourse channels, redefining channel dimensions that destroy habitat as well as flood mitigation capacity.

Flooding in water courses in low-lying coastal areas is further influenced by the effects of marine tides and storm surges. Potential for increased frequency of flooding in these historically heavily developed areas adds an additional challenge to the revitalization of brownfield sites. Flooding must be factored into both considerations of remediation and ultimate end use. (See the Infrastructure fact sheet for other effects of flooding in Connecticut).

Rising sea levels can cause saltwater intrusion of coastal aquifers. The 1938 Hurricane surge, for example, introduced salt water into the Groton reservoir. Sea level rise combined with the projected stronger storms, like the '38 hurricane, may further threaten these and other water supplies in the future. (Additional coastal implications are identified in the Infrastructure and Natural Coastal fact sheets).

With the possibility of more frequent flooding, maintenance of buffer zones will become more significant to both flood mitigation, as well as to preserving water quality and quantity. That protection may come in varied and non-traditional forms that may require relocation, reallocation and creativity as part of Connecticut's adaptive strategy.

Drought – In addition to more intense storms and related flooding, more frequent or longer dry spells are also projected in many climate change scenarios. Changes in depth and duration of snow pack, and reductions in infiltration capacity may ultimately alter recharge of groundwater, which affects water supplies. Poor land use decisions, including increases in impervious cover and higher peak runoff contributing to groundwater not being recharged, could have long term water resource ramifications.

Connecticut River Valley

Agricultural crops, will be impacted by Connecticut's changing climate, and in turn will impact stream flow. New crop varieties may be required to maintain productivity and meet future demands. These crops may have different water needs and timing that could stress aquatic life and water quality as it impacts stream flow.

Connecticut is beginning to see more frequent drought impacts, as shallower wells along some lakes dried up in the summer of 2007 and river flows sometimes fall below levels that protect habitat and the resource. Climate change is projected to increase periodic droughts. New England is overdue for a severe and prolonged drought. Conservation measures and reuse of wastewater effluent for cooling, irrigation and industrial purposes, are an essential part of Connecticut's adaptation strategy. Existing drought management measures will be continually re-evaluated to assure applicability to variability of extreme dryness.

Water Supply - Consumptive uses of water involve the withdrawal or diversion of water from a groundwater or surface water source for drinking, cooking, sanitation, irrigation for agriculture, lawns and golf courses, evaporative cooling, and industrial processes. "There are 151 public water supply reservoirs and roughly 6,600 public water supply wells in Connecticut. Reservoirs provide the majority of public water, serving an estimated 70% of the population. Public water supply wells serve an estimated 14% of the people. The remaining 16% of Connecticut residents use an estimated 250,000 privately owned wells for their water supply."[3]

[3] *Report to the General Assembly on State Water Allocation Policies Pursuant to Public Act 98-224*, January 2000, page 9.

Water supply is a multi-agency concern. For its part, the Connecticut Department of Environmental Protection (CTDEP) needs to enhance oversight of its water resource regulatory programs such as water diversion permitting and streamflow regulation, to verify that current hydrological stressors, projected climate change and the impact on the natural environment and infrastructure are all being taken into account. Other agencies will need to act accordingly.

Action is Needed Now

The key to protecting Connecticut's aquatic ecosystems and habitats is ensuring adequate water quantities, which directly relates to the quality of water resources. Climate change presents additional challenges as Connecticut's existing laws and policies concerning water allocation and water quality management must be harmonized to effectively plan for future needs while balancing ecological sustainability.

Water allocation is a key component of an adaptive management strategy to ensure a sustainable water supply in a changing environment. Protection of stream habitat and streamflows must consider not only the minimum flows that protect aquatic life, but also the range of flows along the hydrograph that are needed to support spawning, migration and other ecosystem life cycle considerations (See the Biodiversity fact sheet for more information). Continued and additional monitoring and management of water withdrawals and diversions are essential to effective management of streamflow conditions today and in a changing climate.

As Connecticut develops its adaptation strategies for watersheds it is essential to preserve areas now that are not impacted by anthropogenic (human) sources. Reference conditions will also allow comparisons between natural systems' responses to change with those impacted by human activity. Large forested watersheds, for example, provide a unique portfolio, and warrant protection. Among these are the Eight Mile and Salmon Rivers, and portions of the Housatonic River. (See the Forestry and Fisheries fact sheets for additional implications).

Efforts to promote responsible growth and best management practices such as LID help attenuate water quality and quantity impacts. LID measures are a critical tool now more instrumental in Connecticut's ability to adapt to a changing climate.

What Connecticut is Doing

The CTDEP supports a watershed by watershed approach for in-stream flow assessment specific to Connecticut basins. These assessments will be maintained within a watershed atlas to assist diversion applicants and resource managers with in-stream flow target-setting and regulation.

The CTDEP is promoting water supply sharing, flood skimming and reservoir expansion to more comprehensively address periods of drought and control downstream overflows. In addition, the CTDEP recommends development of Class B water resources and treated wastewater reuse for non-potable purposes such as industrial supply, cooling water, process water, irrigation, etc.
The CTDEP supports a cooperative program with the United States Geological Survey for monitoring of stream flow and water quality. These actions are critical to support Connecticut's efforts to anticipate and address future impacts adaptively. Other, future considerations include evaluation of modifications to the water diversion program, including implementation of core water conservation measures prior to approving an additional allocation of water through a diversion permit application.

Collaboration in New Development - The Jordan Cove Project highlights many design and construction choices made to reduce stormwater runoff from impervious surfaces and increase onsite groundwater infiltration. With funding from the federal Clean Water Act Section 319 Nonpoint Source Grant Program, this project drew together several partners, including the land owner/developer, local public works and public safety departments, CTDEP, the federal EPA, private environmental consultants and contractors. The project demonstrated the effectiveness of several collaborative LID management practices in maintaining pre-development runoff levels, which will provide a useful adaptive technique for changing climate conditions.

Reduction in Impervious Cover in Preexisting Developed Area - As discussed above, the relationship between impervious cover and water quantity and quality issues is providing an analytical framework to define solutions to today's problems as well as to adaptively prepare for conditions projected in a changing climate. (see CTDEP web site at www.ct.gov/dep/lib/dep/water/tmdl/tmdl_final/eaglevillefinal.pdf) To put this tool to use, the CTDEP has developed a management support document for Total Maximum Daily Load (TMDL) analyses that identifies the relationship of impervious cover and macroinvertebrates in Connecticut streams. There is a strong correlation between pollutant loads, stormwater flows, and runoff from impervious land cover within a watershed. Using this understanding, the Eagleville Brook in Mansfield, Connecticut TMDL set a percent reduction in effective impervious cover compared to current conditions.

The implementation of best management practices (BMPs) are expected to reduce the effect of impervious cover to a level that protects the aquatic biota living in the stream. The CTDEP will continue to work with watershed partners, including the Town of Mansfield, University of Connecticut, and conservation organizations to implement better stormwater management in the Eagleville Brook watershed. This will also provide adaptive benefits for future conditions of flood, drought and heat that may come with a changing climate.

This is one of eight documents in the series *Facing Our Future* concerning Connecticut's changing climate, www.ct.gov/dep/climatechange

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