NEWEA

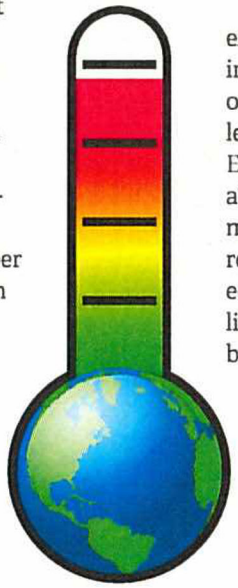
Climate change forces a fundamental change of strategy—defense

by Ray Sirois, H2M Architects + Engineers

In the spring issue of 2009, NEWEA's *Journal* published its first article on climate change adaptation[1]. The article extrapolated the findings of the Northeast Climate Impacts Assessment and projected the results of that work on public works infrastructure in the northeastern United States. Outlined in it was how extreme-weather events had already negatively affected the built environment, and how important adaptation planning is for our local utilities and planning for new infrastructure expected to serve the next generations of New Englanders.

Much has happened since 2009. There has been a significant number of events and developments (planned and unplanned), and new information has come out. This article will cover some of those developments, new information, and climate change events that relate to public works infrastructure over this period. Before covering that recent history, I would like to reflect on the past 50 years.

As a youngster who loved to go sailing out of Salem Harbor (Massachusetts) and Boothbay Harbor (Maine), I thought it strange how marinas and yacht club facilities would simply flush their wastewater directly into the ocean. High tide, low tide, it did not matter. I also remember smelling the Androscoggin River's stench while walking to elementary school in Lewiston, Maine. My dad explained that the Androscoggin River was one of the 10 most polluted rivers in the United States. Later, when visiting Washington, D.C., for the first time during my elementary school years, I also remember being told the same was true with the Potomac River, which meanders around our nation's capital. Of course, the history of these waterways changed after a bi-partisan effort led by Ed Muskie (D-ME). The Clean Water Act became law of the land, and a Republican president, Richard Nixon, established the Environmental Protection Agency (EPA).



The modern environmental movement was born. Today, of course, my son and I fish and canoe the Androscoggin River. On a trip to Washington, D.C. in 2011, I saw a large turtle sunning himself on a log sticking out of the Potomac River. This reptile "living large" on the Potomac is convincing evidence that society has largely succeeded in our huge clean-water initiative, and has done so all within our lifetime, for many of us.

When I traverse the two floors packed with exhibitors at NEWEA's annual conference in Boston, I am moved that all of us in this organization make our living because of that legislation that started in the early 1970s. Environmental legislation has been good for all of our utilities and businesses. NEWEA's membership is a clear example of how environmental legislation is good for the long-term economy, and certainly for our overall quality of life two generations later. I, for one, am proud to be a part of this industry and this success.

In a way, however, our 2009 article signaled that our environmental challenges were about to do a "complete 180." Prior to 2009, environmental initiatives had been designed to protect the *natural* environment by controlling development within the *built* environment, for instance, establishing emissions and discharge limits. Those initiatives all had conservation and protection of the *natural* environment as their primary goals. Today is a totally different game, however. When we look at climate change adaptation strategies, society is being forced to "play defense" with the natural environment.

More than ever, our planning and investments have to protect the *built* environment from an ever-changing and more-hostile *natural* environment! This is a fundamental change in thought and strategy.

Let us look at some of the more recent climate change adaptation-related events and developments since our last article on the subject:

- NEWEA Position Paper: Our organization has adopted this formal position paper on climate change and water resources, and it has been updated twice since it first came out in late 2009. The document makes some important assertions that all members should be aware of as we elect leaders, manage our businesses and utilities, and plan for the future.[2]
- June 2009: Severe precipitation events caused damage to infrastructure across northern New England.
- March 2010: Two severe precipitation events in Connecticut and Rhode Island caused losses, including a flooded wastewater treatment plant (WWTP) in Warwick, R.I.
- The Northeast Regional Climate Center goes live with updated precipitation data for planners and engineers, essentially updating traditional 1960s TP-40 intensity-duration-frequency analyses by incorporating storms for more-recent decades.
- May 2011: Flooding occurs at a water pollution control facility in Montpelier, Vt.
- June 2011: Multiple tornados strike in Massachusetts from Springfield to Sturbridge.
- August 2011: Tropical storm Irene causes $15 billion damage to infrastructure, much of it here in New England and upstate New York.
- November 2011: The New England Water Works Association held an extreme-weather events workshop. There have been several other seminars on climate change adaptation, including Antioch College's Michael Simpson event, the Environmental Protection Agency event in Manchester, N.H., last May, and a Maine Department of Environmental Protection event held this past December.
- Summer 2012: Nuclear power plant in Connecticut has to shut down as seawater in Long Island Sound rises to 75°F—too high to cool the plant.
- June-Aug 2012: Wildfires rage across the United States, mostly in the West, but also in Florida. (When it comes to water resources, New England has challenges that differ from other regions.)
- Oct 2012: Superstorm Sandy causes $65 billion in damage, 233 deaths, a record 13.1-foot storm surge in Long Island Sound as measured in Bridgeport, Conn., and 11 billion gallons of wastewater discharged on the East Coast, mostly from New York and New Jersey.
- May 2013: Damage from extreme precipitation in northern Vermont was pictured in NEWEA's Fall 2013 *Journal*.

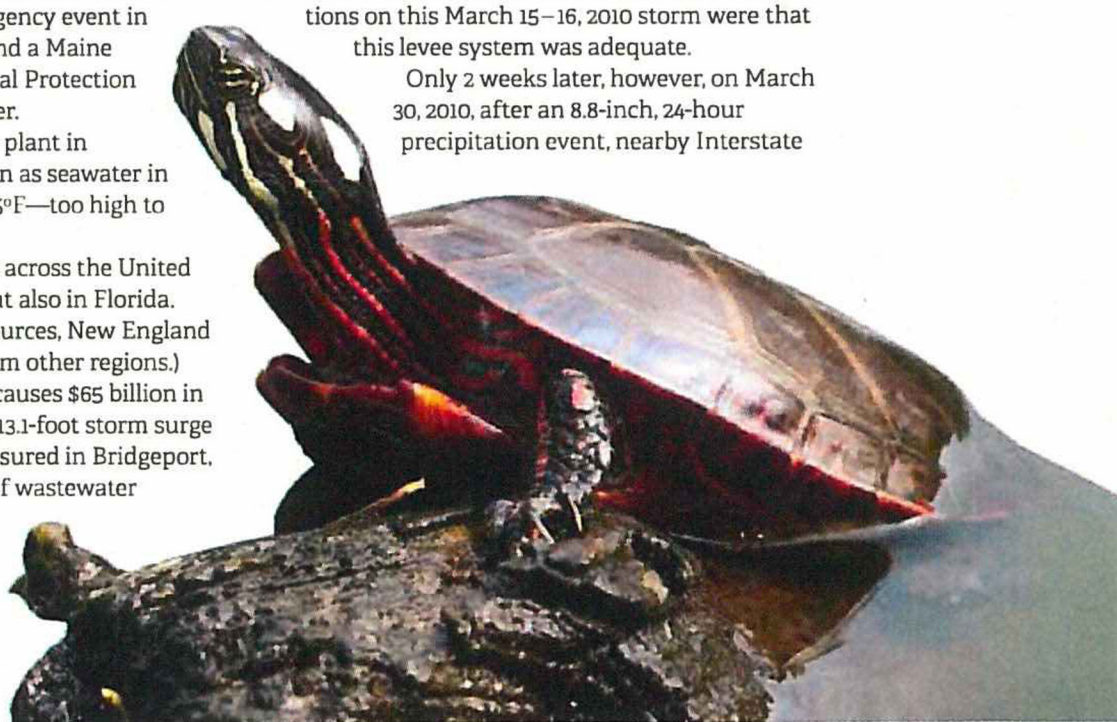
Our planning and investments have to protect the *built* environment from an ever-changing and more-hostile *natural* environment! This is a fundamental change in thought and strategy.

- NEWEA's Fall 2013 *Journal*: Ogunquit, Maine, evaluates climate change adaptation options with sea-level rise (SLR).
- September 2014: EPA releases *Flood Resilience—A Basic Guide for Water and Wastewater Utilities*.[3]
- April 2015: President Obama issues Executive Order 11988 requiring federal agencies to avoid, to the maximum extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of flood plains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Specific guidelines are given.

Warwick Sewer Authority

To highlight one of these events, the Warwick Sewer Authority had significant flooding of its collection system during the week of March 15, 2010. Three pump stations were significantly affected, totaling $50,000 of damage. The Knight Street pump station (see photo on page 44), can operate underwater on generator power and has had to multiple times. Fortunately, the protective levee (also pictured), which protects the Warwick wastewater treatment facility (WWTF), kept the Pawtuxet River out of the treatment plant area. One critically difficult adaptation decision for any utility is where to draw the line with how much protection is needed to protect from SLR or flooding from inland waterways. All indications on this March 15–16, 2010 storm were that this levee system was adequate.

Only 2 weeks later, however, on March 30, 2010, after an 8.8-inch, 24-hour precipitation event, nearby Interstate



Warwick Sewer Authority's Knight Street pump station can operate underwater

This levee, which protects the Warwick WWTF, was breached on March 30, 2010, flooding the treatment plant area

95 flooded and had to close, and that afternoon the same levee protecting the WWTF breached, and the plant flooded. Total damages from this second event were 300 times higher than the first, totaling $15 million. Most of this damage was covered by insurance and Federal Emergency Management Agency (FEMA) funds. The city of Warwick is planning to upgrade the levee system to handle a 500-year flood, essentially raising the line of protection to prevent this event from happening again. This event elevated public awareness of Warwick Sewer Authority's importance, and brought them into the fold with regard to local emergency management.

Ultimately, society needs a new, more-renewable energy mix to minimize carbon emissions, which contribute to climate change. That is the new offense for us and the next generations.

Warwick's advice? "Plan for the worst." It is important to be proactive, engage training, ask for help, network within the city's emergency-action planning as well as with surrounding communities. Warwick is much better prepared today, and has been generous with lessons learned about its story.

Planning for rising water levels

In Maine, the Ogunquit Sewer District continues its adaptation planning to identify planning-level costs associated with relocating the WWTF to a new location off the barrier beach or with regionalizing with its neighbor (the Wells Sanitary District). Ogunquit's recent efforts were presented at NEWEA's 2015 Annual Conference (Session 30).

Ogunquit is not the only utility in New England engaging in risk assessment of SLR and storm surge. To the north, South Portland's WWTP has been analyzing the most recent tide-gauge measurements across Portland Harbor. Tide-gauge data from that location have been available for more than 100 years, but tide data from recent years have already exceeded, at times, the high emissions projected for SLR in Casco Bay. As a result, utility managers envision the need for a dike and berm around the perimeter of the WWTF at an elevation of 17 feet to protect structures built to withstand the 100-year flood elevation of 13 feet.

Other adaptation measures such as a 66-million-gallon-per-day (mgd) effluent pump will also likely be needed. Analysis of the plant hydraulics indicates the existing concrete wall may likely succeed to keep the sea water out for a 100-year storm with 20 more years of SLR. Beyond that, however, if peak flows, high tide, and a storm surge happened at the same time, the plant would be likely to flood *from the inside*. Flooding would come from its own effluent because of the added static head loss of the WWTF outfall pipe due to the higher receiving waters beyond the wall surrounding the plant. While the projected SLR and storm surge might not happen within the next 20 years, the data shows it is possible in the 20- to 30-year planning period. For this reason, both a higher wall and the effluent pump have been included in the WWTF's facility plan upgrade. This case study was also presented at NEWEA's 2015 Annual Conference (Session 20).

South Portland's would not be the first coastal WWTP in New England to find effluent pumping necessary. Old Orchard Beach and Ogunquit, Maine, and Glastonbury, Conn. plants already can do this when necessary during high flows and tides. Construction is underway at the Mattabassett District WWTP in Cromwell, Conn., to add this capability.

Updating precipitation data

Just as good tide-gauge data are important, so too are good precipitation data in performing risk assessments and infrastructure design. No one would use a 55-year-old traffic study to design a new roadway or intersection. Yet with precipitation analysis, some are still doing it with TP-40, the authoritative 1960s-era document that defined precipitation frequency and duration. A 24-hour, 100-year precipitation event, as defined within that document, is happening in many places around New England with much more frequency than the 1 percent chance that such an event is supposed to occur in any given place or year.

Regarding precipitation and storms, stationarity—a mathematical or statistical way to historically assess precipitation and storm impacts—is "dead." We cannot use outdated historical data to predict our future. Knowing that there was no plan to update the 1960s-era TP-40 intensity-duration-frequency analysis, the NRclimate change at Cornell University obtained funding to add more recent decades of rain-gauge data to that traditionally authoritative work. The result is a website at http//precip.net where any location in New York or New England can be specified to get the best available, up-to-date, historical precipitation data. This data can be input into hydrology modeling software such as WinTR-20 or others that take ASCII format as an input.

As reported at this website, "The design of the site and its products have been reviewed by stakeholders with the U.S. Natural Resource Conservation Service (NRCS), various state agencies, and private engineering consulting firms. The site includes estimates of extreme rainfall for various durations (from 5 minutes to 10 days) and recurrence intervals (1 year to 500 years)." This dynamic, ongoing research represents new information and is an important development since our article in 2009. Today, it is a standard resource for projects in the northeastern United States. This online information resource is free and available to all planners and engineers, and its information may be of interest to the public.

Conclusion

Our economy seems to influence a debate for some as to the cause of why we must play defense with our infrastructure planning. Ultimately, the debate does not matter—it is clear. We need to protect both our natural environment *and*, now, our built environment from a changing climate. Ultimately, society needs a new, more-renewable energy mix to minimize carbon emissions, which contribute to climate change. That is the new offense for us and the next generations.

In this article, we have shown how we also need to beef up our defense to protect our public works infrastructure from an ever-changing natural environment.

The flooding of the Warwick WWTF on March 30, 2010, resulted in $15 million in damages

NOTES

1. Reprint of the author's Spring 2009 NEWEA *Journal* article (nrcm.org/documents/NEWEAreprint_climatechange.pdf)
2. NEWEA Position Paper on Climate Change (newea.org/wp-content/uploads/2014/03/CLIMATE-CHANGE.pdf)
3. Flood Resilience—A Basic Guide for Water and Wastewater Utilities (water.epa.gov/infrastructure/watersecurity/emerplan/upload/epa817b14006.pdf)
4. WEF Paper submitted on Warwick WWTF flood event (warwickri.gov/pdfs/wsa/floodmitgation/WEF%20Manuscript%20Warwick%20Flood.pdf)

RESOURCES

- Emergency Response Table Top Exercises (water.epa.gov/infrastructure/watersecurity/climate)
- The Northeast Regional Climate Center—Cornell University (nrcc.cornell.edu)

Ray Sirois is the IT Director for H2M Architects + Engineers.

The author wishes to thank Ed Leonard and David Cockburn (Wright-Pierce) for their help in reviewing this article.