**United States Environmental Protection Agency**

**Environmental Financial Advisory Board**



# Funding for Pre-Disaster Resiliency

*April 2019*

# Table of Contents

## EPA's Charge

In January 2018, EFAB received the following charge from EPA's Office of Water:

"Infrastructure design that mitigates risks associated with extreme events is critical to achieving resilience capacity. Such designs are critical to mitigating post-event costs and service interruptions to water, wastewater and stormwater treatment works. It is also critical to develop a good understanding of what is an optimal resilience investment for a community given risks and future expectations for high impact events and their frequency. In addition, natural infrastructure, coastal ecosystems preservation and restoration can be a critical component to mitigation and water quality impairment that can bend the resilience investment cost curve for communities with high flood risk. For example, stormwater drainage can be designed to adapt to risks associated with changing sea levels. It is now increasingly possible to measure the risks and compare the costs and benefits of natural/green infrastructure solutions with that of conventional gray infrastructure/defenses.[1] Cost/benefit measurement can be applied equally to flood and drought resilience investment.

There are many federal programs that invest in risk mitigation, including natural infrastructure, but they are often a by-product of other intended goals borne by other federal agencies such as Federal Emergency Management Agency (FEMA), Army Corps of Engineers (ACE) and US Department of Agriculture (USDA). In addressing the following questions, we ask EFAB to consider how EPA funding programs mesh with the programs of the other federal agencies (or not) and identify opportunities for improvement. Given that EPA oversees the Clean Water and Drinking Water SRF Funds, 319 grant programs for states and federal territories and WIFIA, and that program administrators (either EPA or the states) establish project funding priorities/criteria we request EFAB to respond to the following:

- To provide a fresh assessment of how these programs serve as incentives/barriers to resilient investment, including natural and green infrastructure, designed to mitigate risk and reduce the costs of extreme events?
- Are there specific changes that could be made to the list of qualified projects that could enhance the opportunity to fund pre-disaster risk/cost mitigation projects? Could we add a classification of project qualifications as outcome-based? For example, should program criteria prioritize infrastructure intended to reduce FEMA payout for flooding or to reduce expected mortality rates should the incidence for high impact events rise? Should program criteria address the potential value of risk and probability?
- When it comes to post event response, what have federal and state partners done to assure a robust and cost-effective response that can further mitigate event impacts on communities? What incentives are given to rebuild to a greater degree of resilience than before? Given recent events, what are the best management practices that have been developed that can be documented?

[1] "Financing Natural Infrastructure for Coastal Flood Damage Reduction", Lloyd's Tercentenary Research Foundation, London, June 2017 http://conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/FinancingNaturalInfrastructureReport.pdf

- What can be done to encourage efforts to address resilience as viewed from a regional and/or a watershed perspective? For example, can states/SRFs do more to facilitate regional and/or watershed-based cooperation?
- What changes, if any, are needed to EPA programs to assure that natural and green infrastructure solutions are given proper weight in criteria setting given cost/benefit impacts on resilience investment? Are there opportunities for connectivity across EPA offices/federal agencies regarding the promotion of natural infrastructure acquisition, green infrastructure (GI) and related Best Management Practices?
- What metrics are there to measure/quantify Return on Investment (ROI) made to protect critical infrastructure that mitigate extreme event risk or impacts?
- Are there any good, quantified examples of proactive resilience investment expenditures that resulted in net savings as analyzed after a relevant disaster event?
- How do we encourage communities to make investment in pre-mitigation infrastructure a priority in their capital improvement plans/budgeting process? How is rating agency criteria affecting resilience investment?"

## Introduction, Background, and Need for the Charge

**"Disasters, both natural and man-made, will always pose a threat, and every community in America will face a disaster at some point. A sobering fact is that the costs of disaster, measured in lives lost and property destroyed, have been steadily increasing in the United States over the past 50 years…**

**Not only does mitigation save lives, it is a more cost-effective, wiser use of taxpayer dollars. Studies demonstrate that for every $1 spent on mitigation, between $4 and $8 is saved in avoided disaster-recovery costs.**

**It costs less to prevent and minimize damage and to strengthen our communities than it does to simply spend resources on recovery afterward: a common-sense approach but not one that our federal programs currently emphasize. Facilitating and incentivizing mitigation is the most effective means of bending the cost curve for disasters."**

> *Representative Bill Shuster (R-PA), Transportation and Committee Chair for the 115th Congress, in an op-ed for Investor's Business Daily, speaking to the damage from Hurricane Florence and in support of resilience measures (September 25, 2018).*

**"It's frustrating to us because we repeat this same cycle over and over again. If you want to live in these areas, you've got to do it in a more resilient fashion."**

> *Federal Emergency Management Agency Administrator Brock Long, in a press briefing discussing Hurricane Michael, on citizens ignoring evacuation warnings and the need for more consistent infrastructure and building codes to harden communities against flooding (October 12, 2018).*



According to the National Oceanic and Atmospheric Administration (NOAA), in 2017 alone there were 16 natural disasters that each caused at least $1 billion in losses and damage. Altogether, the combined losses from all weather and climate disaster events, regardless of severity, killed 362 people and totaled $306.2 billion in losses and damage[2]. In addition to the sheer magnitude of the initial damage, the prolonged nature of rebuilding and economic recovery – from the household level to the community – can be significant.

For example, approximately 3% of northern California's estimated 1,200 wineries were destroyed by the 2017 wildfires. Regional chambers of commerce estimate that Napa Valley employs over 30,000 in tourism-related jobs that generate more than $3.8 billion in economic activity to the region, all of which is estimated to take at least some measurable hit in the near term. As this report is being finalized, California is assessing the loss of life, property and economic activity as a result of the 2018 wildfires. Apart from the direct impacts to the economy and the eventual increased risk of landslides, wildfires can impact the quality of the water supply[3]. Lingering effects of natural disasters can be seen in New Orleans, Louisiana where the estimated 2017 population of about 400,000 is still only about 85% of its 2000 census figure, more than a decade after Hurricanes

[2]National Oceanic and Atmospheric Administration https://www.noaa.gov/news/2017-was-3rd-warmest-year-on-record-for-us

[3] Science Daily (https://www.sciencedaily.com/releases/2018/03/180320084403.htm)

Katrina and Rita and even as the city struggled again with two extreme rainfall events in July and August 2017.

Resiliency has developed into a key theme for local and regional governments in the U.S. which is due in part to the rising acceptance that climate change-related risks represent exposures for public entities and their infrastructure (highlighted during the 2017 hurricanes in North America). Additionally, the interlinked trends of growing and urbanizing populations, which bring concentrations of social and economic assets in areas already susceptible to extreme weather-related events (such as hurricanes and flooding). Furthermore, nearly 40% of the population in the U.S. lives in urban, coastal areas that could be threatened by not only storms but also sea level rise.[4]

Drinking water, sanitary sewer and stormwater infrastructure are crucial for public health and safety in both urbanized and rural America. Improved resilience against the two most common perils – floods and droughts – could help communities not only reduce the damage and loss suffered during these perils but also speed up the return to normalcy.

## Defining Resilience and Framing the Report

The workgroup started with a definition of *Resilience* that included key concepts from an existing Memorandum of Agreement between FEMA and EPA that states "Smart growth approaches and mitigation measures applied to pre-and post-disaster development and redevelopment are a major part of ensuring that investments and future growth improve environmental, economic, and public health outcomes. Smart growth will also help communities become more resilient to future hazards that may occur, including becoming more resilient to the impacts from climate change."[5] For utilities in specific, it means "the ability of water infrastructure systems to withstand and recover from natural and man-made disturbances to their functioning."[6] One EFAB member defined it more succinctly during internal workgroup deliberations: "resilience is an insurance policy. It is an investment in the future to help the community bounce back more quickly when – not if – some kind of peril occurs."

This report will focus mainly, but not exclusively, on investments in flood control and stormwater infrastructure - which are generally the function of the local or regional unit of government – and analyze how such investments can help with infrastructure resiliency. Equally if not more important is investing in natural solutions such as wetlands restoration and preservation. Aside from the pure economic argument as a potential lower cost alternative to utilizing nature rather than investing in new grey infrastructure, wetlands offer measurable benefits not only to the immediate riparian zone but also to population centers downstream and even upstream.

We view as out of scope any electric utility infrastructure assets, as most of the U.S. population is served by investor-owned, rate-regulated utilities, typically subject to prudent investment guidelines by state regulatory authorities, and each having local and regional discretion to put into

[4] "Ocean Facts," National Oceanic and Atmospheric Administration's National Ocean Service website, https://oceanservice.noaa.gov/facts/population.html.
[5] Memorandum of Agreement between Department of Homeland Security/Federal Emergency Management Agency (DHS/FEMA) and the U.S. Environmental Protection Agency (EPA); Section III, para. 1. (August 2016).
[6] Drinking Water State Revolving Fund Eligibility Handbook. EPA publication 816-B-17-001, Section 4.1, p. 19.

the rate base investments such as undergrounding of distribution lines to protect against ice and trees, poles made from concrete or composite instead of wood as part of added system reinforcement against high wind, and vegetation management practices as part of the operating budget.

The working group acknowledges that flooding and drought are not the only natural disasters. Still, much of the loss of life and property as well as most of the related resilience efforts focus on flood and drought risks over investing in resilience against wildfires (currently mainly a function of the Department of Interior) and tornados and earthquakes. Local building codes have the potential to promote resiliency in the case of tornados and earthquakes but those events are generally so catastrophic that the focus is most often on post-event responses. We also do not view cybersecurity, terrorism or other malfeasance or deliberate acts to be in scope for this report but agree that risk management at all levels needs to be comprehensive and acknowledge that natural events are not the only causes of loss of life and property.

It is the Board's opinion that what should be included in the discussion are the "pain points" that create headwinds towards long-term operational and financial planning. Without effective long-term plans, both the services that communities provide on a daily basis as well as the contingency and disaster planning that all local and regional governments should be doing could suffer. This includes:

- Messaging by elected and administrative officials, both on recommendations on what to do as well as what *not* to do;
- Asset management;
- Public sector accounting and financial reporting; and,
- Better collaboration between and within the Federal government

Lastly, it is the view of the Board that there is both a *Funding* and a *Financing* problem in the United States. Nearly every professional organization and academic institution has identified an infrastructure funding gap – the traditional sources of money that have historically been responsible for most of the infrastructure spending in the U.S. are the various levels of government; mainly the Federal, states and local/regional units of government. The real level of spending by all units of government on infrastructure has by all measures decreased for many decades and has become more visible as assets age further and non-discretionary spending for health care and public pensions makes each budget full of tougher and tougher decisions. So, infrastructure *funding* – the ongoing dedication of financial and other resources – becomes more difficult.

The *financing* problem is different. Traditional options for raising capital like the capital markets work well. They are transparent, liquid and generally accessible and high functioning. Because the money comes from investors who are willing to put their capital at risk, a rate of return is expected. Financing strategies also exist outside of traditional sources that could provide the capital towards investments in resilience. As the units of government become more financially constrained, so does their respective abilities to finance infrastructure projects. Thus, it also becomes an affordability problem.[7]

[7] Bipartisan Policy Center https://bipartisanpolicy.org/blog/infrastructure-finance-faqs/

## Discussion and Analysis

We believe that the primary barriers to communities addressing key infrastructure pre-disaster resilience is characterized by one or more of the following principles:

1. **Understanding the problem and potential solution.** Not every local, regional or state views stormwater and flood control as something that should be funded, managed and operated by a dedicated non-tax revenue stream. This problem is the one of education and we believe this is the easiest to solve, assuming that flooding – whether from extreme weather events or sea level rise – is the most common peril.

   Stormwater infrastructure is one aspect of flood control. However, not all flood control projects are eligible for state revolving fund borrowing, which typically is among the lowest cost of funds for water-related projects. For example, climate resilience for centralized wastewater treatment is already an eligible project category for clean water state revolving fund participation. But flood control projects can generally only qualify for SRF borrowing if they can demonstrate a water quality benefit. Furthermore, state revolving fund programs for both drinking and clean water have been proven and well-managed for decades.

   *EFAB supports the consideration of expanding the SRF program, either by definition tweaks of what constitutes an eligible project, or by the creation of a new or expanded Federal program, as further discussed below.*

2. **Mindset and focus on long-term planning.** Even for those communities that may have relatively greater financial resources and more discretion in how to strategically deploy those resources, there is not always consensus regarding how to prioritize projects. Often, leadership devotes attention and resources to the provision of drinking water and sanitary sewer because they are essential services that must be provided around-the clock in the name of public health. Because 'water is life' and demand is constant, conveying the message for contingency planning and risk management as what is essentially a prudent insurance policy that can help limit the loss of life and property – and perhaps population and economic opportunity – can be difficult. Creating awareness for the need to engage in long-term planning and robust risk management against perils that do not occur often is not necessarily difficult. Creating political support to commit what is most likely substantial financial resources to hedge against those perils can be very difficult because of the innate subjectivity.

   *EFAB supports the use of objective tools to determine a measurable return on investment (ROI) to help communities and – if applicable – rate regulators – make more informed decisions*.

3. **Asset management approach to track and monitor operational performance.** Rather than assuming a particular asset will "run to fail" and then be replaced, asset management allows utilities to track and monitor operational performance with a litany of data. By itself, this is not meaningful to resilience and mitigation. But data gleaned from asset management systems can assist in aligning the entire organization and the messaging of addressing a utility's weaknesses by, for example:

- providing the finance and back-office team life-cycle cost, inventory and procurement-related information;
- providing compliance reporting to satisfy environmental regulators;
- providing decision-makers greater certainty that the appropriate levels of financial resources will exist when the asset needs to be renewed or replaced; and,
- providing financial regulators enough information to support any rate case.

Asset management data could also help establish the justification for longer-lived assets carrying a financing and depreciation treatment more in line with the asset's useful life. In recent years, EPA has incorporated programmatic elements and policies within the SRF programs that can promote resiliency investments.[8] Incorporating/developing a robust program, system wide and regardless of whether it is water, wastewater or stormwater, can pave the way for effective system governance.

*EFAB supports better and more consistent use of asset management programs which can help provide utility governing bodies more and better information. It is a tool that utilities use to improve reliability.*

4. **Money is currently limited.** LRGs – the entities that historically have provided most of the waterworks, sanitary sewer and stormwater infrastructure – have competing priorities but do not generally have financial and other resources to address them all within any given fiscal year. Generally, utilities derive virtually all of their operating revenues from rates and charges. For municipally-owned utilities, this insulates the utility against flat property tax revenues or economically-volatile local option sales taxes, as well as any cuts in state shared revenues. For investor-owned utilities, the singularity of operating revenues makes rate regulation more straightforward. But regardless of ownership and governance, the reliance on rates and charges to grow operating revenues means affordability is a "third rail issue" in an increasing number of communities. EFAB and others that follow drinking and clean water service provision have observed that in addition to sensitivity towards rate increases, more utilities are making considerations towards their rate structure. Specifically, as per capita per day consumption is flat or declining, some utility managers such as DC Water have made revisions such as increasing the minimum charge in the base rate and softening the impact from the volumetric rates. But even these moves are intended to be largely revenue neutral. Operating expenses, including fixed costs such as bond debt payments or pension payments, have tended to increase in a sector that is generally very highly leveraged. The result for some utilities is a choice between pressure on the bottom line and available cash reserves or raising rates.

   Still, we believe there are a variety of financing strategies and ongoing funding options that could be explored further, but financial capacity among local and regional governments is inconsistent and willingness to borrow to invest in infrastructure varies wildly from community to community. The private sector, including some very large investment banks

[8] Environmental Protection Agency, State Revolving Funds: Financing Drought Resilient Water Infrastructure Projects, available at https://www.epa.gov/sites/production/files/2018-01/documents/srf_drought_paper_-_final_2_8-31-17.pdf

and hedge funds, have announced new commitments to infrastructure[9]. The U.S. has considered, but not yet created, a national infrastructure bank.

*EFAB endorses the concept of aligning private sector interest with public sector necessity, potentially complementing not only the state revolving funds and WIFIA but also efforts by the Army Corps of Engineers, Federal Emergency Management Agency, and USDA Natural Resources Conservation Service (NRCS) all of which have similar and often overlapping infrastructure goals.*

5. **Collaboration among Federal agencies.** While it is uncertain if Congress and the President will agree upon and pass an infrastructure bill, there does seem to be broad consensus for the need for more leadership on messaging the problem between and among the Federal agencies, especially in an environment of financial resource scarcity. Historically, state and local governments have built the majority (by dollar amount) of the infrastructure in the United States. This workgroup does not expect that to change, thus making the messaging even more important. There is no single solution. You get what you pay for, and if not attended to with ongoing upkeep, infrastructure failures could increase. De-prioritizing risk management, including resilience planning and preparedness, exposes the community to the potential increase in day-to-day risks, let alone tail risk from extreme events.

   Several federal agencies – chief among them the Federal Emergency Management Agency and U.S. Army Corps of Engineers – have active roles in cost sharing and financial incentives but also in establishing best practices and guidelines. It is EFAB's view that the EPA is an equally important partner in pre-disaster resilience and mitigation. Given its successful financing programs, EPA can also be a champion for pre-disaster resiliency in a way that is still respectful of federal budget constraints

   *EFAB encourages the ongoing collaboration among all Federal agencies – FEMA, USDA, US ACE, EPA, and others - with funding and financing programs that assist with developing green infrastructure or other innovative solutions that readily promote resilient communities.*



[9] "KKR Closes $7.4 Billion Global Infrastructure Fund" (September 6, 2018); https://media.kkr.com/news-releases/news-release-details/kkr-closes-74-billion-global-infrastructure-fund
"Blackstone Nears First Close of $5 Billion for Infrastructure Fund" (June 25, 2018); https://www.bloomberg.com/news/articles/2018-06-25/blackstone-is-said-to-raise-5-billion-for-infrastructure-fund

## Recommendations

The below recommendations from EFAB are rank-ordered in terms of most-preferred and most likely to be actionable items for consideration by EPA to those that are more general observations of areas of opportunity. The recommendations may not include new technology, processes or protocols; however, they are what we believe will create headwinds for more efficient pre-disaster resilience and mitigation planning and execution. (See the Appendix for case studies documenting pre-disaster resiliency implementation success.)

1. *Encourage Long-Term Planning and Use of Asset Management Planning Tools for both Municipal and Investor-Owned Utilities.*

   We believe that the use of long-term planning and/or asset management planning could help align utility leadership by ensuring the requisite financial resources are in place before the replacement or renewal needs to be scheduled or hopefully before the next storm or drought, but also creates more objective data to provide to the decision-makers who must engage and ultimately garner support from the community. The Board also believes that this information should be presented to funding program managers as they consider the repayment terms. If, in the view of managers, the applicant can demonstrate that the resilience-related asset is long-lived and has an expected useful life beyond the maximum amount of years over which the final loan payment can currently extend, that the managers can choose to consider that in the repayment schedule. This approach can be applied with both public (SRF, USDA, FEMA) and private sources of infrastructure funding. Additionally, we believe that SRF and WIFIA applicants should demonstrate that the utility has in place or plans for a robust asset management system and that EPA should encourage that these projects receive higher funding priority.

2. *Develop a Coordination Team to Foster Communication among Federal Agencies including EPA, ACE, USDA's NRCS and FEMA. The team should set priorities and reduce gaps in funding pre-disaster resiliency for public infrastructure.*

   EFAB endorses section 4101 of Senate Bill 3021, America's Water Infrastructure Act of 2018. The intended purpose of the Bill is to provide funding for ports, inland waterways, upgrade dams and irrigation systems and increase water projects. Section 4101, stormwater infrastructure funding taskforce, specifically directs the EPA administration to develop the taskforce and submit a report. We believe that this report should specifically outline the connections, redundancy and gaps between and within federal agencies. For example, relief funds from FEMA are critical in aiding the recovery of affected communities. However, by offering grant funds only for rebuilding *after* a declared disaster, an argument can be made that the investment disincentives communities from pro-actively preparing for disasters and investing in resilience measures. The report should develop an overarching strategy with direction on programmatic changes to fund and encourage pre-disaster resiliency for public infrastructure.

3. *Consider the Creation and Authorization of a New Stormwater State Revolving Fund (SWSRF) and/or Expansion of SRF or WIFIA to Include Additional Stormwater/Flood Control Eligibilities.*

Funding programs including the SRF have been well managed by the States to ensure public health and the environment. The ability to fund stormwater/flooding pre-disaster or mitigation projects, however, may be limited relative to the nation's clean water and drinking water needs. The new SWSRF program or expanded SRF/WIFIA should include, stormwater-eligible projects, without qualification, as well as flood control as qualified projects also have a clear benefit to public health and safety as well as to the environment.

Should a new program be created, funding for this SWSRF would need to be obtained. One possibility would be to coordinate with FEMA and use some amount of the appropriation for FEMA's Pre-Disaster Mitigation Program, authorized under Section 203 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. It is EFAB's opinion that more projects could be funded by leveraging a loan program using existing SRF structures and management teams rather than a federal grant with state and/or local matching. In fiscal 2018, FEMA's total budget for grants was about $2 billion, roughly the same as the combined funding for the Drinking and Clean Water Revolving Fund appropriations. EFAB identified a number of success stories from the use of stormwater infrastructure helping to improve flood control by the use of gray and green retention, detention and barriers. These anecdotes tended to be irrespective of whether the LRG creates funding through general taxes or stormwater revenue fees and charges, although the latter most likely creates an ongoing and more certain revenue stream and one that could potentially be matched to federal and state participation.

Depending upon the total funding needs, another possibility would be to reconsider the creation of a national infrastructure bank. Consideration would have to acknowledge that the investor community's interest in infrastructure investments both domestically and abroad is very high. We do not feel that a federal infrastructure bank would compete with existing loan programs offered by the EPA or USDA, since the latter is most often utilized by the medium, small and very small community water systems. The largest utilities generally utilize the tax-exempt capital markets and now, perhaps, WIFIA. The U.S. population is increasingly coastal and urban, with most of the largest cities along the Atlantic or Pacific Oceans or Gulf of Mexico needing to invest in resilience and mitigation infrastructure. In cases where urban planning has already at least identified and even designed projects, the construction phase is very costly and might have a decades-long timeline with multiple phases. This means they may simply be too large for existing options, or even alternative solutions like catastrophe or social impact bonds or that funding in phases may greatly delay readiness. However, a proposed national infrastructure bank is structured and ultimately capitalized would be at the discretion of the federally-elected officials, but EFAB believes that the time is right to reconsider the idea.

4. *Recommend Water Infrastructure and Resiliency Finance Center (WIRFC) Develop a Compendium of Information to Measure Resiliency Costs, Benefits and Best Practices.*

   There are a number of global tools, benchmarks and studies (proprietary and academic) that attempt to measure resilience at the sub-sovereign (typically city) level. It is EFAB's observation that all are valuable and useful in slightly different ways: some are focused on social infrastructure, others on utilities and the environment, and those that look to mitigate

risks from manmade causes such as cyber or physical terror attacks. Even EPA has an existing "Route to Resilience" compendium of best practices specific to water infrastructure[10]. Just as there is no consensus on definitions, assumptions and methodology, there is no universally accepted holistic tool. It is EFAB's view that without a uniform way to measure the costs and benefits as well as best practices for resilience that community leaders could face an information overload. Each study would seem to provide sound recommendations, leading to analysis paralysis with no clear path to apolitically prioritize mitigation investments. We also urge EPA, FEMA, the Army Corps of Engineers and other federal agencies tasked with the provision of infrastructure to look to the private sector for measurements of resiliency costs and benefits. The homeowner insurance industry for example, while generally regulated in each state, has valuable models in place to assess risks by location. There are also private vendors that follow "tail risk" events and use the data to build sophisticated models that predict destruction and likely population shifts from storms and sea level rise. By achieving more robust and transparent disclosure about communities as a whole all the way down to an individual parcel as to the exposure of any particular risk and any mitigation measures already in place – disclosure to potential bond investors, to rate regulators trying to discern what might meet the threshold of "prudence," or even to prospective homebuyers – market forces alone may help to achieve prioritization and potential ROI based simply on collective wisdom.

Once the compendium of information is completed, we recommend that this information is easily accessible on EPA's website. Given the importance of pre-disaster resiliency as discussed throughout this report, EPA should consider having a "Pre-Disaster Resiliency and Funding" link on its homepage under "Key Topics" section and reference to not only the compendium information and related matters but also to its Federal Funding for Water and Wastewater Utilities in National Disasters (Fed FUNDs) page.

## Summary/Conclusion

In response to the EPA Office of Water's charge, EFAB organized a workgroup and analyzed the matter. In our analysis, we summarized the key barriers for communities in addressing key infrastructure pre-disaster resilience to the following principles: (i) understanding the problem and potential solution, (ii) mindset and focus on long-term planning, (iii) asset management approach to track and monitor operational performance, (v) money is currently limited, and (vi) collaboration among Federal agencies.

From these principles, we established the following recommendations:

1. Encourage Long-Term Planning and the Use of an Asset Management Planning Tools for both Municipal and Investor-Owned Utilities;
2. Develop a Coordination Team to Foster Communication among Federal Agencies including EPA, ACE, USDA's NRCS and FEMA. (The team should set priorities and reduce gaps in funding pre-disaster resiliency for public infrastructure);

[10] EPA https://www.epa.gov/waterresilience/route-resilience-2018-drinking-water-and-wastewater-utilities

3. Consider the Creation and Authorization of a New Stormwater State Revolving Fund and/or Expansion of SRF or WIFIA to Include Additional Stormwater/Flood Control Eligibilities;
4. and
5. Recommend WIRFC Develop a Compendium of Information to Measure Resiliency Costs, Benefits and Best Practices.

Given the long-standing, expensive and growing challenge to funding pre-disaster resiliency, there is no easy solution. However, EFAB believes that our recommendations above are an important first step to understanding and addressing this nationwide challenge for EPA and our nation.

## Appendix: Case Studies in Resilience

# NEW YORK

### Super-Storm Sandy – New York City Department of Environmental Protection Wastewater Resilience Plan

In response to Superstorm Sandy, the New York City Department of Environmental Protection (DEP) sought to identify its operational risks and vulnerabilities to flooding events due to extreme weather and future sea level rise for the 14 wastewater treatment plants and 96 pump stations it operates, and quantify the capital investments that, if implemented, would help protect these facilities against future damage. The October 2013 NYC Wastewater Resilience Plan[11] (the Plan) determined that all of DEP's treatment plants and 58 of its pumping stations were at risk to flood damage. A key finding of the Plan was that with the implementation of approximately $315 million of protective measures, the City would be able to avoid $2.46 billion worth of potential repair and replacement costs over a 50-year period (costs in 2013 dollars).

Superstorm Sandy made landfall in New York City on October 29, 2012. Damage, estimated at $95 million, occurred throughout DEP's system, most often due to the failure of electrical power and equipment that drive treatment processes. While emergency generators allowed varying levels of treatment to continue, DEP's Rockaway plant was so overwhelmed by flooding that it did not operate for three days, only able to perform basic disinfection activities; additionally, two other plants were not able to operate for a period of several hours. Approximately 562 million gallons of untreated sewage was released into local waterways. While the damage was extensive, implementation of its Storm Preparedness Plan prior to Sandy's landfall enabled DEP to recover and be able to treat 99% of the City's wastewater within four days after the storm and then resume secondary treatment citywide by November 11.

DEP's Wastewater Resilience Plan provides a climate risk and adaptation analysis specific to each of DEP's treatment plants and 58 at-risk pump stations. Many DEP facilities are located in low-lying areas and are close to bodies of water—a design feature that is common to the wastewater industry as these locations facilitate transmitting and discharging effluent at lower costs than higher elevations. These circumstances can make flooding an inherent risk of the wastewater industry. DEP's climate analysis addressed this risk by mapping the location of current and projected 100-year flood elevations at each of its facilities using recently updated FEMA maps. A margin of 30 inches was added to the 100-year elevations to account for storm surge associated with projected sea level rise by 2050.

The risk analysis identified specific items of infrastructure that would be affected in flood events. Flood pathways were found and mapped at each treatment plant based on the flood elevations of the climate analysis. Equipment was deemed at risk if it was within the flood pathway and was critical to allowing the plant to continue to provide primary treatment. At Rockaway, the DEP facility hardest hit by Hurricane Sandy, 689 pieces of equipment, more than one-third of all of the

[11] New York City Wastewater Resiliency Plan
http://www.nyc.gov/html/dep/html/about_dep/wastewater_resiliency_plan.shtml

equipment in the plant, were found to be mission critical. The risk analysis also showed that 58 of the system's 96 pump stations were vulnerable to the storm surge elevations indicated in the climate analysis.

The risk analysis also identified the facilities where future improvements should be prioritized. The selection criteria for pump stations was based on the area population and critical facilities (hospitals, schools, public safety) that would be impacted by the pump station's failure. The six treatment plants where failure could impact bathing beaches have the highest priority for the implementation of protective measures.

The adaption analysis addressed the potential strategies that would best protect the system's infrastructure. The strategies were evaluated based on their feasibility, cost and level of resilience that they would provide at the facilities identified in the risk analysis. The strategies include:

- elevating equipment above the critical flood elevation;
- flood-proofing equipment by using submersible pumps and installing watertight boxes around electrical equipment;
- installing flood barriers around flood pathways and critical areas;
- sealing structures with watertight doors and windows;
- temporarily deploying sandbags around doorways, vents and windows before a surge event; and
- providing backup power generation at pump stations. (Treatment plants already have such equipment.)

The adaption analysis provided each treatment plant and the 58 pump stations with specific recommendations on the protective measures and their costs at each critical location. (See accompanying pdf.) Costs for these measures (in 2013 dollars) were estimated at $187 million at the treatment plants and $128 million at the pump stations.

Benefits were also quantified and indicate that the returns to DEP for investing in disaster resilience would be significant. The benefits to DEP are the costs that it would not have to incur repairing and replace damaged facilities, given the probabilities of recurring storm surge over a 50-year period. These avoided costs were estimated at $1.76 billion (2013 dollars) at its treatment plants, almost ten times the $187 million cost of recommended measures. The avoided costs for investment in pump station resilience are $709 million (2013 dollars), almost four times the $128 million cost of the recommended measures.

Initiatives to implement report recommendations began the following year. DEP's first action was to incorporate the new flood elevation levels and six adaptive measures into the repairs of existing equipment and in the design and construction of new facilities. Another important step was to provide operators at each plant with placards that allow them to quickly see where protective measures should be undertaken when storm surge advisories are announced.

Implementation of specific protective measures is being coordinated with other improvements at DEP facilities. When feasible, protective measures are being scheduled toward the end of an asset's useful life or in conjunction with other upgrades, significantly lowering the overall cost of the improvements. Several adaptive measures are pending at the Rockaway treatment plant, as DEP

evaluates whether to convert the plant into a pumping station, given the significant cost of other capital improvements that are needed at the facility. Four design contracts are addressing resilience upgrades across the system and construction contracts are scheduled for bidding this year.[12]

The federal government and New York State have been important financial partners in DEP's Resilience Plan. In the aftermath of Sandy, Congress appropriated $600 million in 2014 to the state revolving funds of New York and New Jersey to reduce vulnerability to future natural disasters. New York State used these and its own funds to create a $339.7 million Storm Mitigation Loan Program (SMLP). Through 2022, DEP has budgeted $206.4 million for resilience projects, with $161 million being provided through SLMP loans and the balance through FEMA.[13]

## NEW JERSEY

### POST-SUPERSTORM SANDY DAMAGE ASSESSMENT OF SOUTH MONMOUTH REGIONAL SEWERAGE AUTHORITY PUMP STATIONS

Recognizing a unique opportunity to compare pre- and post-resilience costs of a singular incident on similar, but independent, water/sewer components this analysis compares the impact from Superstorm Sandy (2012) on four (4) pump stations of the South Monmouth Regional Sewerage Authority (SMRSA) in four (4) adjacent towns. The intent of this analysis is to educate readers and stakeholders, particularly managers of Federal Disaster Relief grant programs and end-user water/sewer systems, to the cost - AND value - of investing in resilience measures for water/sewer systems prior to a severe event. The limited scope of this analysis is not meant to provide answers for all inquiries, rather it demonstrates a cost/benefit analysis which furthers additional considerations, questions and discussion. For example, what other post-resilience savings exist (e.g. lower insurance premiums) that further justify pre-event resilience investments?

SMRSA manages a treatment plant and a conveyance system consisting of eleven (11) pump stations and one metering chamber for eight coastal communities in New Jersey. Prior to Hurricane Irene ten of the eleven pump stations were traditional brick and mortar stations located at low elevation points in communities within blocks of the Atlantic Ocean. As sea level rise has exacerbated the impact of severe storm conditions in recent years, these pump stations have come under increasing risk of being damaged by high winds, excessive precipitation and tidal surge. In October 2012, when Superstorm Sandy landed along the central coast of New Jersey, these ten pump stations were flooded and sustained major damage. However, the one mobile unit pump station in Sea Girt, located just one block from the Atlantic Ocean and which had replaced a traditional brick and mortar station in 2011, weathered the storm with minimal damage. The unit mimics a single unit mobile home trailer on wheels with all electronic and computer equipment contained in the trailer and the pumps and piping submerged underground. For the two occasions when weather and tidal surge put the pump station at risk (i.e. Hurricane Irene and Superstorm Sandy), upon notification of a mandatory evacuation, the electronic components were disconnected from the pumps and the trailer was towed to higher ground until weather conditions improved allowing for the return of the unit. The brilliance of this strategic approach is manifested

[12] Fiscal 2018 Consulting Engineer's Report, page 18 of the New York City Water Finance Authority
[13] One NYC Progress Report 2018, page 84

in the net cost of the damage to the Sea Girt pump station during Superstorm Sandy as compared to the other similarly located brick and motor pump stations. The total loss to the Sea Girt station was less than $19,000 versus the damage and resilience costs of the other three pump stations, excluding life-cycle replacement costs, of between $0.683 and $2.464 million. Note that this analysis covers the three pump stations for which SMRSA financed the rebuild and resilience costs through the NJ Water Bank, New Jersey's SRF financing program and for which the NJ Water Bank had cost figures. The Pitney Avenue and Lake Como projects received 90% reimbursement of eligible costs from FEMA* while the Belmar project received a 19% principal forgiveness loan (a grant-like award) from the NJ Water Bank through additional federal EPA SRF funds granted to New Jersey specifically for Superstorm Sandy flood and resilience work.

| **Pump Station** | **(Est.) Storm Costs** *(Repair + Downtime)* **(A)** | **(Est.) Life Cycle Replace Costs (B)** | **(Est.) Resilience Investment (C)** | **Actual Dollars Spent** *(Repair + Resilience + Life Cycle)* **(D) = A+B+C** | **Break-even Storm Events** *(Resilience Costs / Storm Costs)* **(C /A)** | **FEMA or Sandy SRF Disaster Aid Funds Provided *** **(E)** | **Net Costs to cover Storm + Increased Resilience Costs ** (D-B) – (E)** |
|---|---|---|---|---|---|---|---|
| Pitney Avenue | $902,714 | $0 | $368,656 | $1,271,370 | 0.41 | ($1,126,998) | $144,372 |
| Belmar[1] | $298,173 | $2,100,000 | $385,428 | $2,783,601 | 1.29 | ($528,884) | $154,717 |
| Lake Como[2] | $1,853,349 | $0 | $610,711 | $2,464,060 | 0.33 | ($2,217,654) | $246,406 |
| Sea Girt[3] *(Mitigation already in place)* | $18,556 | N/A | $0 | $18,556 | N/A | $0 | $18,556 |

* **FEMA Local Share Requirement**: Due to the magnitude of the destruction caused by Sandy throughout the State, FEMA's local match requirement was reduced from the standard 25% to just 10% of eligible costs. More typically, local municipalities and Utilities are required to pay 25% of the total eligible costs as well as cover all non-FEMA eligible rebuild costs.

** **Net Cost to SMRSA:** Excludes Life-Cycle replacement cost for the Belmar Pump Station of $2.1 million.

[1] **Belmar, NJ:** Pump Station was at the end of its useful life and already in need of replacement.

[2] **Lake Como, NJ:** Pump Station was relocated outside the floodplain rather than replaced with a Mobile Station.

[3] **Sea Girt, NJ:** Mobile Resilient Pump Station (**MRPS**) sustained $18,556 in damage during Superstorm Sandy (a SCADA antenna mast was bent by high winds and a backup control panel was damaged by wind-blown rain).

**Notes:**

SMRSA's design of the Sea Girt Mobile Station and ability to transport the station's electrical components out of harm's way during a storm minimized damage to the pump station, reduced pump station down time and related costs, and lessened the potential of sewer overflows. Superstorm Sandy cost SMRSA approximately $10 million in total damage, submerging and knocking out 10 of their 11 pump stations. Yet, the Sea Girt MRPS, which had been driven to higher ground and then returned within 24 hours, was the only pump station that endured minimal damage. **SMRSA Management estimates that the Sea Girt mobile station saved a combined $1.5 million dollars during Hurricane Irene and Superstorm Sandy** as the pump station, having been moved during both storms, sustained no substantial damage during either storm.
***This MRPS design was deemed a Best Management Practice (BMP) by FEMA and was the recipient of the 2014 NJ Governors' Environmental Excellence Award for Innovative Technology***

**Conclusions:**

- By investing and upgrading the Sea Girt pump station to a mobile design unit capable of being removed prior to a severe weather event, SMRSA minimized the risk of substantial damage and major expense, including down time of service for both major weather events after installation. In the very short run (within 3 years), SMRSA's initial investment of **$1,639,901** to build and install the Sea Girt mobile station had a straight investment return of more than 91.4% when compared to the estimated $1.5 million in damage repairs it saved SMRSA during Hurricane Irene and Superstorm Sandy. Any future storms will likely further these return savings.
- Because the Belmar and Pitney Avenue Pump Stations were rebuilt using the same MRPS enclosure design concept, it is assumed these stations will realize similar savings by avoiding comparable damage as the Sea Girt pump station during future storm events.
- The Lake Como pump station located at the opposite end of the lake from Pitney Avenue was made inoperable and relocated. SMRSA minimized the cost of the Pitney Avenue and Lake Como pump station projects by maximizing the availability of State and federal financing options. SMRSA applied for and received approximately $1.127 million and $2.217 million for the rebuild of these two pump stations respectively through **FEMA's Section 406 Public Assistance** (PA) Program, meant to assist impacted communities with the cost of rebuilding damaged facilities. The result was a net storm cost to SMRSA of just **$0.144 million** for the Pitney Avenue pump station and **$0.246 million** for the Lake Como pump station, making FEMA a crucial partner in the rebuild of both pump stations.

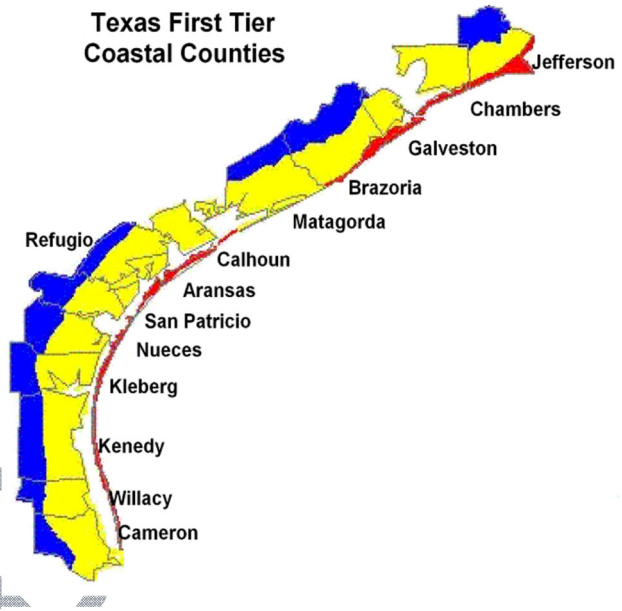
TEXAS

## Texas Windstorm Insurance Association

In 1971, in order to combat the insurance market's unwillingness to write policies in the wake of Hurricane Celia, the Texas Legislature established the Texas Windstorm Insurance Association ("TWIA" or "the Association"). The TWIA functions like an insurance company in terms of its operations and revenue structure but differs in two distinct ways. All net insurance premiums and other revenues made by the Association go directly into the Catastrophe Reserve Trust Fund

("CRTF") every year. Second, because it is a residual insurer of last resort, it is not a direct competitor in the private market and therefore more closely resembles a quasi-government entity than it does a private insurance company. TWIA's primary funding channels consist of insurance premiums, the CRTF, bond issuances, and reinsurance. The Association's debt obligations do not currently carry ratings. The State of Texas has no obligations with respect to TWIA's bond issuances.

The primary mission of the Association is to provide windstorm and hail insurance to residential and commercial properties in the "designated catastrophe area" where access to necessary coverage is not readily available. Policy applicants must have been denied coverage by at least one insurer in the private market. The coverage area consists of 14 coastal counties and parts of Harris County as shown in the map to the right. The shading indicates the three building code standards in this region – Seaward (red), Inland I (yellow), and Inland II (blue).



Source: TWIA Media Briefing Book

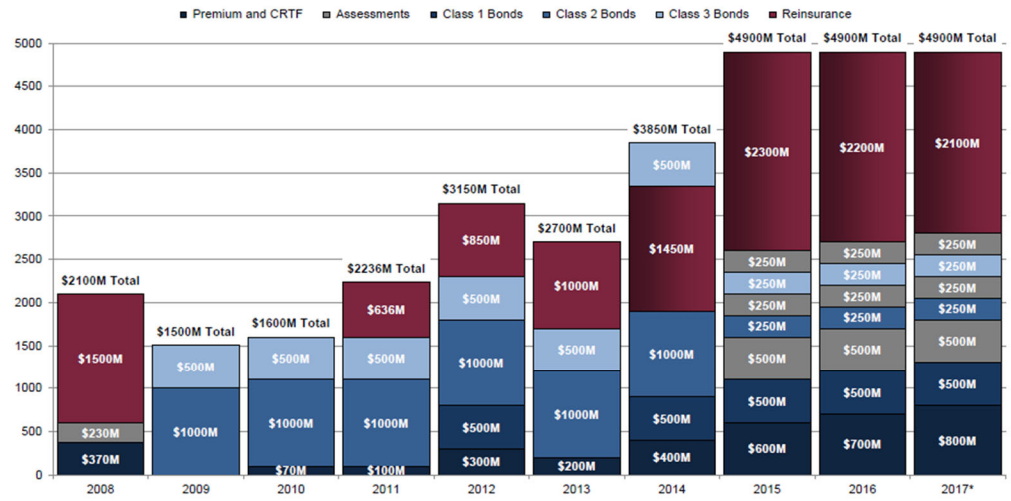
In order to most effectively handle unfortunate events that could result in high volumes of claims being filed in a short period of time, TWIA has developed the Catastrophe ("CAT") Incident Response Plan. The plan explicitly identifies the roles and responsibilities of all internal departments, the size and scalability of the event, gives instructions for filing claims, updates on TWIA's response to stakeholders and most importantly, outlines the steps necessary to secure funding to pay all covered claims. The CAT plan makes use of a resource scalability model designed to assess the magnitude of the impending storm before it makes landfall and thereby the inflow of claims that can be expected to follow. From there, TWIA can ensure that it is properly staffed in all of the departments involved in receiving, processing and closing claims.

TWIA has worked hard to improve the CAT plan over the years. Its effectiveness was evidenced last year in the Association's response to Hurricane Harvey. When Harvey struck the Texas coast in August 2017, TWIA issued their first claim payments within 72 hours and processed and closed approximately 90% of all claims made within the first 75 days. In total, TWIA had issued more than $1.08 billion in claim payments by April 30, 2018 in response to nearly 76,000 claims.

TWIA's ability to make that many claim payments in such a short amount of time would not have been possible without the policy changes that allowed TWIA to issue public securities. In 2005, Hurricanes Rita and Katrina made landfall and initiated a sharp increase in demand for coverage provided by TWIA, resulting in losses of nearly $3 billion for the Association in 2008 when many policy-holders filed claims after Hurricanes Ike and Dolly. In response to increasing liabilities, legislation was passed in 2009 and 2011 that allowed TWIA to issue Class 1, 2 and 3 bonds in

order to help restore reserves and finance the writing of future policies. All classes of bonds are backed by a net revenue pledge of the Association, which includes net premiums collected and other revenues. Class 2 and 3 bonds, after a finding of by the Commissioner of Insurance, may also be repaid by surcharges on coastal property policies and Class 3 bonds may be payable from member assessments.

## Historical Funding Comparison




Funding for 2008 shown as it existed for Hurricane Ike, post-Hurricane Dolly; unlimited additional funding available via reimbursable assessments
Funding for 2009-2011, 2013 assumes $0 Class 1 Public Securities issuable; 2012, 2014-2015 include $500 Million pre-event Class 1 Public Securities
Funding for 2015 shown as of September 1, 2015, incorporating SB 900
Funding for 2015-2016 incorporate bond repayments that differ from prior years
Funding for 2017 based on terms authorized by TWIA Board of Directors.

Source: TWIA Media Briefing Book

TWIA has experienced a strong recovery after a severely depleted reserve fund in 2008. As shown above, TWIA has successfully increased its funding level each year from 2009 to 2017. As a result of its 2016 operations, the balance of the CRTF available for the 2017 hurricane season was $737 million, its highest balance to date. Also, out of a total of 36 residual market plans nationwide, TWIA is the second largest and has the second lowest operating expense, as a percentage of premium, at 5.3%. The average expense for all other plans is approximately 30% of premium. TWIA's expenses have been under-budget for the past six years – a testament to the ability and experience of TWIA's management team, which has over 150 years of combined insurance industry expertise.

Lastly, TWIA remains focused on constantly improving their policyholder service. It receives complaints on only 0.2% of claims and continues to receive positive customer survey results after processing and closing claims, averaging 4.37/5 in 2017.

# IOWA

## *Dubuque Bee Branch*

The City of Dubuque has experienced six Presidential Disasters between 1999 and 2011 due to flash flooding with damages totaling nearly $70 million.

In 1998, the City commissioned an engineering study to look into the nature of the flooding and identify solutions to mitigate or eliminate the flash flooding experienced in the Bee Branch Watershed. The end result was the Drainage Basin Master Plan completed and adopted in 2001. It revealed that there were more than 1,100 properties at risk of flood damage as a result of the flash flooding. A subsequent study in 2009 by the Federal Emergency Management Agency (FEMA) identified a flood-prone area with 1,373 properties. In addition to homes, there are over 70 businesses in the at-risk area that combined employ over 1,400 people with over $500 million in annual sales. Eighty-five percent (85%) of the impacted properties have buildings that are potentially eligible for listing on the National Register of Historic Places. In fact, fifty-seven percent (57%) of the 1,373 buildings are more than 100 years old.

The Drainage Basin Master Plan outlined several improvements throughout the watershed to mitigate future flooding and disasters. Having identified the flooding issue as a top priority, the Dubuque City Council adopted the Drainage Basin Master Plan and established funding, including a stormwater management utility, to construct the first phases of the Bee Branch Watershed Flood Mitigation Project in 2003. The Bee Branch Creek project is one element of the multi-phase Bee Branch Watershed Flood Mitigation Project. The combined phases of the project will reduce the volume of floodwaters, slow the rate the floodwaters flow through the upper watershed, increase the safe conveyance of floodwaters through the flood-prone area, and provide physical barriers to prevent floodwaters from inundating the City's only potable water source.

The Bee Branch Watershed consists of 6.5 square miles of land located in the northeast part of the city. It is characterized by steep slopes and bluffs that shed water quickly from the west to the east. It drains to the Bee Branch Creek and ultimately to the Mississippi River. While it only constitutes less than 25% of the City's area, over 50% of the 58,400 Dubuque residents either live or work in the Bee Branch Watershed.

The Bee Branch Creek project involves replacing almost one-mile of storm sewer with a creek and floodplain that resembles the one that traversed the area approximately 100 years ago. This "day-lighting" of the buried Bee Branch Creek will allow storm water from flash floods to safely move through the area without flooding adjacent properties. During heavy rains, storm water will rise out of the creek and fill the green space instead of flooding streets and homes.

Prior to the project, the creek was dead and buried in an underground storm sewer. As is the case with many rural creeks, the Bee Branch Creek does not dry up in the days following a rainstorm. It is constantly fed with groundwater. In the case of the Bee Branch, much of the groundwater is

carried to the creek through the storm sewer system. This groundwater discharge serves to keep a steady flow of cool, clean water into the creek.

Large diameter storm sewers discharging into the creek were equipped with Nutrient Separating Baffle Boxes (NSBBs) to help prevent garbage and pollutants from entering the Bee Branch Creek. The NSBBs triple compartment scour-free design and screening system captures sediment and suspends trash and debris in a dry state. Dry state storage greatly minimizes nutrient leaching, bacteria growth, and odors leading to improved water quality for the surrounding water bodies. The City has strategically placed the Baffle Boxes so that they are also easily accessible for cleaning from the surface using a vacuum truck.

To further promote the infiltration and filtering of runoff prior to it reaching the creek, permeable pavement was added in several streets, a parking lot and two alleys. The City plans to convert 240 alleys within the watershed into "green," permeable alleys. So far, 80 have been converted to date. Seventy-four (74) of those alleys were converted to permeable paving using the first Iowa Clean Water SRF Water Resource Restoration Sponsored Project.

Native plants that once dominated the Iowa landscape were strategically used along the Bee Branch to manage rainfall and diversify the landscape. Species include black-eyed susans, purple coneflowers, brown fox sedge, prairie blazing star, cardinal flowers, and many others. With extensive root systems, tallgrass prairie vegetation helps to form deep, rich soils with high organic matter content and ample pore space between soil particles. These soil characteristics absorb and infiltrate most rainfall, while shedding little runoff. The native landscaping along the creek also attracts songbirds, dragonflies, hummingbirds, butterflies, and other desirable species. It is more resistant to pests and disease. While aesthetically pleasing, it requires little maintenance because they are adapted to Iowa temperatures and rainfall patterns. This can lead to significant cost savings when compared to labor intensive turf grass. Prairie grass was also planted in multiple biofields strategically located along the creek to intercept and promote the infiltration of storm water runoff from small storm sewer systems along the creek.

In the summer of 2017, 4.9" of rain fell in less than 24 hours in Dubuque. With the completed Bee Branch Creek Project, property damage was largely avoided. In 2002, a similar rainstorm that dropped 4.9" of rain in a 24-hour period resulted in enough property damage to warrant a Presidential Disaster Declaration. Based on the damage caused by the 2002 storm, it can be estimated that the 2017 storm would have caused $11.6 million in property damage without the completed Bee Branch Creek Project.

The project was funded by weaving a variety of local, state, and federal funding sources, all with different rules and regulations on how they can be spent. Funding was received from Iowa's Clean Water State Revolving Loan Fund, US Department of Transportation (US DOT), Iowa Department of Transportation (IDOT), Iowa Department of Natural Resources (IDNR), US Department of Commerce Economic Development Administration (US EDA), the Iowa Economic Development

Agency (IEDA), and the Iowa Department of Homeland Security and Emergency Management and Flood Mitigation Board (SFMB).

While the main purpose of the project was to mitigate flooding, the project has also improved water quality, provided aquatic habitat and created greenspace in an area where low-to-moderate income and minority populations call home. The City maximized the benefits of the project by incorporating additional amenities for the community.

The Bee Branch Creek Project is:

- A storm water management and disaster prevention project:
  - Over 1,300 homes and businesses were at risk of flood damage during heavy rains.
  - A Presidential Disaster has been declared six times in the past fifteen years as a result of the public and private property damage following heavy rains.
  - Daylighting the creek will allow storm water from flash floods to safely move through the area without flooding adjacent properties.
- An environmental improvement project:
  - The restoration of 2,000 feet of a once buried creek and its associated floodplain.
  - Daylighting the creek and exposing it to sunlight and creating natural creek bank areas allows for aquatic and riparian vegetation that can improve water quality by taking up organic and inorganic pollutants resulting in increased dissolved oxygen, reduced suspended sediment, reduced phosphorus and nitrogen, and reduced bacteria.
  - Installation of infiltration practices such as bio-swales and permeable pavement.
  - Cascading water features have been constructed at multiple locations along the creek. In addition to providing pleasing scenery and sounds, these mini-waterfalls serve as aeration systems, introducing fresh oxygen into the ecosystem that fish and plants need to thrive.
- A neighborhood park serving low-income and minority populations with:
  - A community orchard
  - Embankment slides
  - Scenic Overlooks
  - Hike/Bike Trails (Maintenance Access)
  - Green Amphitheater.
- A regional tourist attraction:
  - A 2,000-foot hike/bike trail connecting to the 26-mile Heritage Trail hike/bike trail between Dubuque and Dyersville (IA) to the Mississippi River and Mines of Spain trail systems.
  - Overlooks that provide scenic views of the natural beauty associated with the creek.
  - A creek and linear park that connects to multiple City parks.
- An outdoor classroom:
  - An outdoor amphitheater next to the restored creek, adjacent to an elementary school and along the national Mississippi River Trail through Dubuque.

- Interpretive signs with information on the history of creek, benefits of prairies, the orchard, the fish habitat, and resurrected creek.

### *Middle Cedar Partnership Project*

In June 2008, the City of Cedar Rapids, Iowa was engulfed by flood waters from the Cedar River. The river crested at over 31 feet, 19 feet above flood level. The flood surpassed the previous record, set nearly 80 years earlier, by 11 feet. Floodwaters spread across more than 10 square miles of the city. Over 1,000 blocks in the heart of the community were flooded. More than 300 public buildings and 900 businesses were damaged, 5,400 homes housing more than 18,000 citizens were affected, and 10,000 residents were displaced by the disaster. The flood caused over $5.4 billion in damages to the community.

Since that time, Cedar Rapids has implemented a flood control plan that includes many traditional flood mitigation practices: floodwalls, levees, real estate acquisition, stormwater management projects, 200 acres of new greenway and 8 acres of wetlands.

However, the city wanted to do more than just build more barriers. They wanted to see if they could work with landowners upstream to capture the rain where it fell and reduce the quantity of water flowing downstream. Cedar Rapids partnered with a variety of agricultural groups, commodity associations and conservation districts to create the Middle Cedar Partnership Project (MCPP).

The MCPP was awarded a USDA Regional Conservation Partnership Program (RCPP) grant of $2 million. These funds will be matched with an addition $2.3 million in primarily technical, and some financial assistance from the 16 MCPP partners. The partners include:

- Farmers / Producers
- USDA Natural Resources Conservation Service
- Benton / Tama Counties and Miller Creek Water Quality Initiative projects
- Benton Soil and Water Conservation District
- Tama Soil and Water Conservation District
- Black Hawk Soil and Water Conservation District
- Dupont Pioneer
- Sand County Foundation
- The Nature Conservancy
- Iowa Farm Bureau
- Iowa Soybean Association
- Iowa Pork Producers Association
- Iowa Corn Growers Association
- Iowa Department of Agriculture and Land Stewardship
- Iowa Department of Natural Resources
- Iowa State University Extension Service

- City of Cedar Rapids

The Middle Cedar watershed encompasses 2,417 square miles. The Cedar River is part of this watershed. Not only does Cedar Rapids draw its drinking water from shallow alluvial wells along the Cedar River but the river runs right through the middle of the City. The goal of the MCPP is to encourage upstream conservation entities and local farmers and landowners to install conservation practices to improve water quality and soil health and thereby slowing runoff to help with flood mitigation.

The project will first develop watershed plans in five targeted sub-watersheds in order to effectively target best management practices (BMP) to high priority locations in the watershed. The plans will incorporate conservation practice placement maps which will take into account landscape characteristics such as land use, soil type, topography, and other information to identify best placement of conservation practices to achieve maximum benefit in reaching specific goals. These maps, and other information, will be used to prioritize placement of BMPs.

Conservation practices currently identified include nutrient management, cover crops, bioreactors, saturated buffers, wetland creation, and wetland easements. These conservation practices help keep runoff from cropland to a minimum. To enhance adoption rates of conservation practices, outreach will be provided to local farmers to share the benefits of conservation practices that hold significant promise for nutrient reduction.

## OKLAHOMA

### City of Tulsa: Resilience after the Storm

The City of Tulsa is in northeastern Oklahoma, along the banks of the Arkansas River with multiple large tributaries running through the community. Tulsa was first established in the 1820s and began a period of growth in the early 1900s with the discovery of oil[14]. The city's population grew rapidly with primary areas of development along the River.

Even in Tulsa's early days, the community experienced devastating flooding. The flood of 1908 caused more than $6.22 million (in 2017 dollars) in damages and, as the population of the community increased, so did the damages. The 1923 floods left thousands homeless and caused $7.3 million (in 2017 dollars) in damages[15]. Flooding continued in subsequent years, racking up millions and millions of dollars property damage and lives lost.

The City of Tulsa chose early on to take a pro-active approach to address flooding. Community leaders and affected residents demanded it. After the 1923 floods, City leaders developed the first land-use plan, which set forth the foundation for development of the City. This development featured methodically designed housing areas at higher elevations and designated the lower

[14] Oklahoma Historical Society, Tulsa, Available at http://www.okhistory.org/publications/enc/entry.php?entry=TU003

[15] City of Tulsa, Flooding History, https://www.cityoftulsa.org/government/departments/engineering-services/flood-control/flooding-history/

elevations for parks and trails. Further, these Tulsa visionaries set aside more than 2,800 acres for a park in the floodplain of one of the largest tributaries.

As flooding continued into the mid-1950s, the federal government also began implementing structural controls designed to prevent flooding. The US Army Corp of Engineers completed Keystone dam upstream of the City in 1964, and many residents believed that the flooding of Tulsa was coming to an end. Flooding, however, continued and increased with the urbanization of the City. With each flood, leaders took more steps towards resilience.

In 1970, the City joined the National Flood Insurance Program and eventually enacted a moratorium on building in the floodplain. Later, the City developed comprehensive floodplain management policies, began drainage master planning and developed stormwater regulations for new development. The City of Tulsa collaborated with neighboring communities and state and federal partners. They accessed federal funding as appropriate to acquire property located in the floodplains.

The City of Tulsa solidified their commitment to resilience in 1986 by establishing a dedicated stormwater utility fee to provide "stable funds for maintenance and management… {with} the entire fee exclusively for floodplain and stormwater management activities." The City believed that they could be open to continued growth, but that growth could not and would not result in new or enhanced flooding.[16] This approach continues to shape Tulsa's vision of land and infrastructure development.[17]

The City of Tulsa has identified flood prone areas and turned them into parks and open spaces, which provide benefits beyond reduced flooding. Furthermore, Tulsa has developed multi-use detention basins across the city. The basins function as soccer fields, parks, open spaces and walking trails when dry and hold flood water during storm events.

One of the premier examples of Tulsa's vision for progressive stormwater management was realized in the Mingo Creek Watershed. The City of Tulsa and the US Army Corp of Engineers collaborated on a bold effort to address the ongoing flooding by creating increased amounts of greenspace. As area residents were initially skeptical of the plan, showcasing collaboration at all levels of government was essential in developing trust within the community. An intensive public outreach campaign on the importance of stormwater management was critical to the effort.

Funding for the Mingo Creek Watershed project came from a variety of sources including sales tax, bond issue funds, stormwater utility fees, as well as federal funds. In total, more than $437 million dollars went into the project. Since the implementation, there have not been any major property losses due to flooding. Ancillary benefits seen as part of the increased green space in the Mingo Creek watershed include water quality improvements, reconstructed wetlands, and community wellness.



[16] Naturally Resilient Communities, Mingo Creek, Tulsa, Oklahoma, http://nrcsolutions.org/tulsa-oklahoma/
[17] Learning from Disaster: Tulsa's Resilient Floodplain Design – 100 Resilient Cities.

Stormwater management continues to play an important part in the City of Tulsa. In 2018 the City unveiled its *Resilient Tulsa Strategy*[18]. The strategy goes well beyond flood resilience and echoes the benefits and importance of green space for stormwater management.



[18] City of Tulsa, Resilient Tulsa, available at https://www.cityoftulsa.org/media/7673/reslient-tulsa-digital-web.pdf