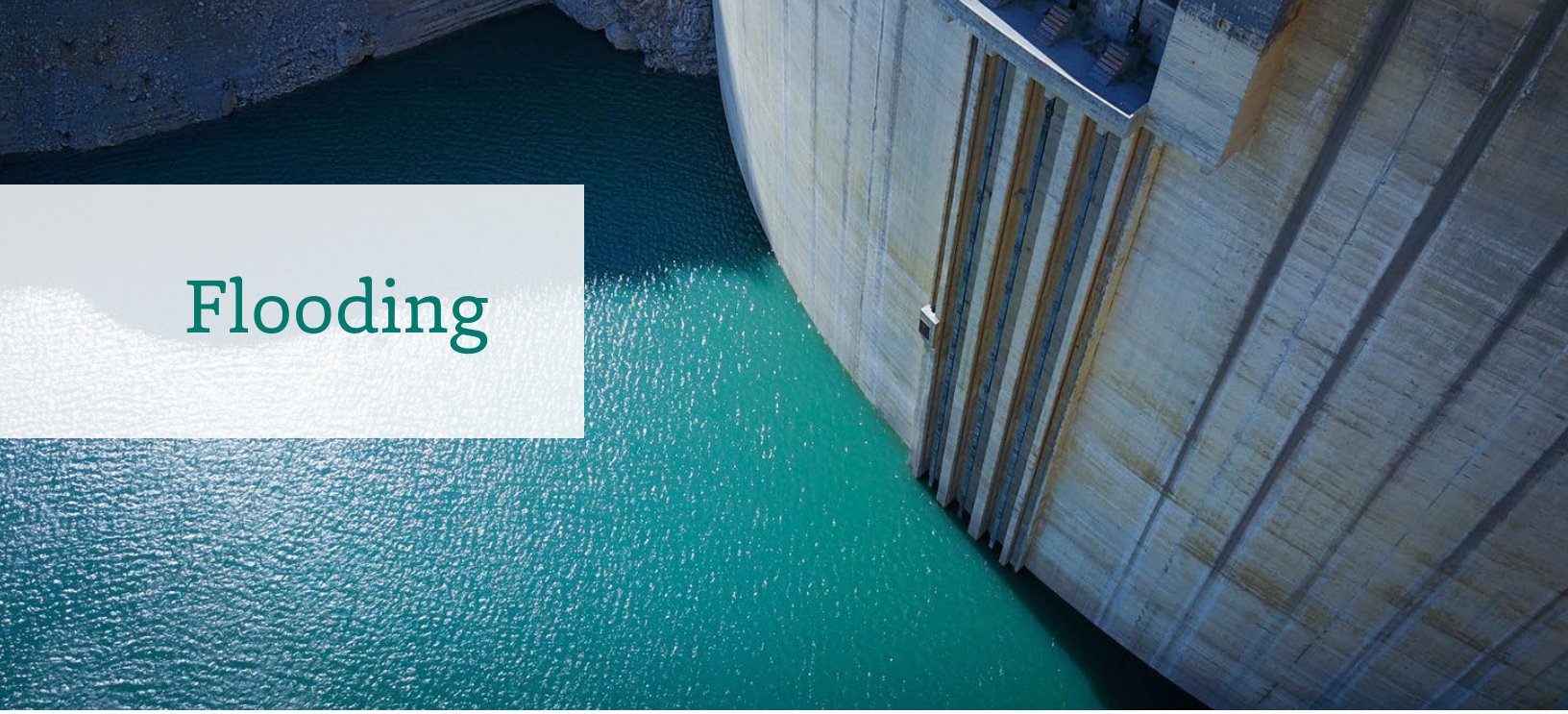

# Flooding

## Actions

**N5** Design and implement an educational campaign that leads to reduced impacts of stormwater and basement sewage backups, promotes use of green infrastructure, and accurately conveys risks to and responsibilities of property owners.

**N6** Review city regulations, technical documents, departmental processes and plans, property owner programs, enforcement mechanisms, and monitoring efforts to ensure that current practices reduce localized flooding and basement/sewage backups.

**N7** Develop an emergency plan that can be implemented during a flood to ensure adequate transportation and logistics for critical resources.

**N8** Identify and assess risk associated with older flood control and stormwater infrastructure, and use data gathered to reduce risk by developing property owner education, informing the city's capital projects, and establishing property owner requirements.

**A6** Advocate for state and federal government to implement policies that reduce erosion and runoff and promote infiltration.

# Background

Increased precipitation, one of two broad climate changes identified in the Great Lakes Integrated Sciences and Assessment (GLISA) ***Climate Change in Columbus, Ohio*** report, will create a greater flood risk for Columbus.[1] This increased flood risk creates major vulnerabilities to energy and water infrastructure, health, and transportation. The National Centers for Environmental Information climate change ***summary for Ohio*** highlights changes that have already taken place since the mid-twentieth century, including an increase in average annual precipitation and extreme events (greater than two inches per day).[2] Future projections include increases in precipitation during autumn, winter, and spring that may affect timing and locations of flooding.

Flooding and basement backups are not only dependent on precipitation but also decisions made by the City, developers, and residents. While most consider it ill-advised to construct buildings and critical infrastructure in floodplains, flooding occurs outside of these areas as well. GLISA notes that throughout the Midwest, minor infrastructure and property inundation often occurs at 1.25" of daily rainfall. For Columbus, there were 2.8 more days per year in 2012 where precipitation exceeded 1.25" compared to 1951, meaning the potential for basement backups and standing water on streets has increased.[1]

The August 2017 Houston floods, resulting from Hurricane Harvey, serve as a recent, cautionary case study. Development patterns resulted in a significant increase in impervious surfaces and location of structures within reservoirs.[3] The sustained rainfall during Harvey inundated the region and caused significant damage to both public and private infrastructure. The region saw smaller flooding events during the springs of 2015 and 2016 and summer of 2018, indicating that the flooding during Harvey was not an isolated event. Furthermore, an investigation over an eight-county region around Houston in 2015, using a random sampling of permits issued by the Army Corps of Engineers to developers, discovered an oversight failure in enforcing wetlands mitigation. The failure resulted in only 236 acres being installed when 1,306 acres should have been installed.[4] In this case, the lack of ground-truthing that mitigation wetlands were installed was the issue, not permitting. In a city without sufficient regulation and oversight, proper installation of risk-reducing measures may not be taken voluntarily, and the failure of individual property owners to comply can result in damage to properties other than their own.

Current floodplain maps underestimate flood risk, and engineering technical bulletins designed to inform infrastructure projects understate the frequency and intensity of extreme rainfall events. These maps and technical bulletins, which until recently have used historical data to anticipate future events, need to rely more heavily on computer modeling of complex Earth-system processes to inform planning for a future that is different than the past. Employing such computer modeling, while having a cost, ensures that infrastructure is designed to handle the conditions it will likely be subjected to over its lifetime.

Understanding the different causes of localized flooding and basement backups, as well as the City's current and future infrastructure plans, is key to adapting to the risk of increasing precipitation in Columbus. In order to address these vulnerabilities, we propose four necessary (N) actions and one aspirational (A) action to adapt to the increased flood risks.

**N5** **Design and implement an educational campaign that leads to reduced impacts of stormwater and basement sewage backups, promotes use of green infrastructure, and accurately conveys risks to and responsibilities of property owners.**

To maintain proper drainage and mitigate property damage during flooding events, the City has installed a network of infrastructure along major drainages. Following the massive floods of 1913 and 1959, measures were taken to mitigate damage from future events. However, these were still not sufficient, and a 7-mile long Franklinton Floodwall was built between 1993 and 2004. Maintenance schedules and flood control plans guide the upkeep and use of the physical infrastructure. However, stormwater systems in many areas have not been upgraded to include floodgates or backflow preventers; where they have been implemented, unintended or additional property development may lead to increased susceptibility of basement backups. Private flood control infrastructure was also installed during this time, but not all of it was documented and maintenance is not consistent.

Water flows through storm sewers under the force of gravity to lower elevations including the city's major rivers. During elevated river levels, flow in storm sewers may reverse direction and flow from the river into protected areas. Floodgates and backflow preventers are designed to restrict water flow from inundating these protected areas. Stormwater infrastructure, without floodgates or backflow preventers, may therefore exacerbate localized flooding.

Basement flooding occurs primarily through a failure in the sanitary sewage/combined stormwater collection system (most of the city has separate systems) or other stormwater drainage issues, and the two are rarely related. The property owner is responsible for the portion of the sewage collection system extending from the building to the point of connection to the city sewer, while the City is responsible for the rest. A failure in the sewer collection system caused by blockage (e.g., roots, debris, grease, pipe failure) can lead to basement flooding. The system-designed carrying capacity can also be overwhelmed by excessive infiltration and inflow during a rain event (e.g., residential downspouts directing stormwater to the sewer system), causing water to back up into the property owner's basement. Poor stormwater drainage (e.g., poor grading around the building, altered stormwater drainage paths on/over/across the property) can also cause basement flooding, as water enters through basement windows or defects in the floors and/or walls.

In the case of backflow preventers, their cost is negligible if installed during construction or retrofitted when pipes are exposed, but their impact can be tremendous if they prevent even one basement backup. Likewise, solutions to direct water at least eight feet from a building's foundation and services to routinely clear roots and debris from sanitary sewer lines are low-cost options available to all homeowners. Consideration should be given to redundancy in systems. For instance, sump pumps are commonly used in new construction, but without a battery backup, they will not function during an intense rainfall event with a power outage. Both backflow preventers and sump pumps require periodic inspection, proper maintenance, and an understanding of their limits.

Increasing precipitation is a threat multiplier to the capacity for the city's sewer and stormwater infrastructure. Therefore, the City of Columbus has been a leader in green infrastructure (GI) deployment—encouraging the use of GI in private development and constructing GI as part of its own operations. GI, as guided by ***Blueprint Columbus***, reduces impacts of stormwater runoff by temporarily storing water, promoting

infiltration and uptake of water by vegetation, and capturing sediment and pollutants contained within runoff.[5] GI also has the potential to provide co-benefits, including ecosystem restoration, mitigation of the urban heat island, the addition of local jobs, and aesthetic beauty. The City currently provides funding to the Franklin Soil and Water Conservation District (FSWCD) for the ***Community Backyards program*** to do on-property consultations with homeowners wishing to install GI on their private property.[6]

The City should work to identify knowledge gaps in the shared responsibility of reducing flooding and basement backups (e.g., grading, backflow preventers and their maintenance, cleaning out of sanitary sewer lines, relining, downspout disconnects, and clearing drainage swales) and installing GI. This includes encouraging landlords to communicate the needs to tenants as well as notifying property owners who are known to be at risk but may not be aware. Since new risks might be uncovered as technical documents are updated, model runs more accurately capture performance of the system, and policies are reviewed, the Department of Public Utilities (DPU) should swiftly communicate information to property owners through website material, bill inserts, and yearly hot cards mailed to property owners. In essence, the city needs to clearly communicate its best understanding of the system in a timely fashion so that property owners and tenants have opportunities to reduce their risk.

**N6** **Review city regulations, technical documents, departmental processes and plans, property owner programs, enforcement mechanisms, and monitoring efforts to ensure that current practices reduce localized flooding and basement/sewage backups.**

**Regulations and Technical Documents**

The City of Columbus has two existing documents that will continue to address localized flooding and basement/sewage backups in the city. These include the ***Columbus City Code Chapter 1150 (Floodplain Management)*** and the ***Stormwater Drainage Manual (SWDM)***.[7, 8] Updates to these documents should include enhanced specifications for wetlands, catchments, and stormwater pipes to take into account greater loads due to more intense rainfall events. New construction and retrofits should be required to include infrastructure that has the ability to store stormwater or promote its infiltration into the subsurface.

Chapter 1150 should continue to be used to protect the city's inhabitants from flooding, stream bank erosion, and the hazards associated with developing in the floodway. This Columbus City Code gives the City the authority to regulate development in the floodplain. If development is proposed in the 100-year floodplain, it must be properly elevated, and any flood volume lost due to filling the floodplain fringe must be offset so that the flood carrying capacity of the watercourse is maintained. Only very limited development is allowed in the floodway, such as reforestation, wetland reforestation, and construction of recreation trails. These regulations help to protect the population from flooding that could otherwise occur as a result of new development and redevelopment; these regulations should continue to be enforced.

The City should continue its protection of existing water resources via enforcement of the SWDM. The SWDM requires the permanent protection of the Stream Corridor Protection Zone (SCPZ) —the stream and riparian area along the stream—for streams in Columbus and prohibits development in this zone without being granted an exception from current city zoning requirements. The SWDM sets forth the City's wetland policy,

requiring preservation of existing wetlands in the SCPZ and encouraging mitigation of wetland impacts outside the SCPZ, within the limits of the development site. The SWDM also requires the installation of stormwater controls during and post development to reduce soil erosion and protect water quality. The SWDM is currently reviewed and updated periodically to capture recent trends in extreme rainfall, but the document does not take into account projections for the frequency, intensity, and duration of rainfall events expected by the middle to end of this century. It is imperative that each iteration of the SWDM consider the current and projected precipitation changes, as many subsequent decisions made in Columbus are guided by this document.

The SWDM informs Blueprint Columbus and provides design criteria for the use of GI such as green roofs, permeable pavement, rainwater harvesting, and bioretention facilities. The City offers up to a ***100 percent reduction in stormwater fees*** to property owners who install GI to manage stormwater runoff from their properties.[9] This policy is designed to encourage installation of GI as a means of stormwater quantity and quality control. The City should continue to incentivize the installation of GI via the GI credit, should continue to use GI in its own construction programs, and may wish to consider adopting additional policies or practices that require or incentivize the installation of GI on private property as a means of reducing the impacts of stormwater runoff from public and private property.

**Departmental Processes and Plans**

The City should analyze whether current storm sewer sizing requirements will be sufficient to convey the stormwater loads from more intense and higher frequency rainfall events as projected. The DPU already has a review plan in place to identify projects where there may be sanitary sewer capacity issues that require modeling of these scenarios. If capacity issues are found, DPU requires the developer to reduce density, requires upsizing the stormwater infrastructure, or disapproves the development. Through Blueprint Columbus, DPU will disconnect improper perimeter drains from basement floor drains for over 18,000 acres of property located in the city. Studying the impact of improvements installed through Blueprint Columbus will inform the next generation of infrastructure and provide guidance in future code updates.[5] Although systematically identifying unlawful connections outside of Blueprint Columbus areas will be challenging, the City should consider legislation requiring an inspection of basement perimeter drains and remediation of improperly connected drains on all properties at the sale of the property.

**Property Owner Programs**

The City should consider policies or best practices that require or incentivize any new or redevelopment projects to use GI to reduce runoff. For homeowners, the Community Backyards program offers rebates for the purchase of native plants. This program is an example of how an agency can deploy a number of innovative strategies to reduce runoff using incentives.[10] Market mechanisms, including assessing a cost per volume of anticipated or actual runoff, should also be considered. Regardless, the costs associated with runoff, which have often been an externality, need to be explicitly accounted for in both development and redevelopment.

In some cases, technology, such as backflow preventers on sewage and stormwater systems, can be installed to reduce damage to property during localized flooding. ***Project Dry Basement*** is a program currently run by the DPU and is

designed to prevent sanitary sewer backups in single- and two-family homes.[11] If a home is eligible, the City will provide installation of an approved backflow prevention device on the home sewer line using the City's certified plumbing contractor. This program should continue.

**Enforcement Mechanisms and Monitoring Efforts**

Sufficient enforcement is required to ensure that property owners and developers abide by approved plans in compliance with regulations. The City, as a regulated municipal separate storm/sewer system, is required pursuant to its ***National Pollutant Discharge Elimination System*** permit to maintain the legal authority necessary to inspect, monitor, and enforce construction and post-construction stormwater controls.[12] Additionally, the City's code, erosion and sediment pollution regulations, and its SWDM (which has been promulgated as a Director's rule) give the City enforcement authority to require properties to return to compliance and pay a penalty if they violate requirements of the City code, regulation, or rule.[13, 14]

Over 500 construction sites are inspected annually to ensure erosion and sediment control practices are properly implemented. City inspectors also perform frequent inspections of stormwater quality controls on public and private property to make sure controls are maintained and operable. And under the ***Pretreatment Program***, over 275 industries are inspected annually to confirm that Ohio Environmental Protection Agency (OEPA) permit requirements for such users are met.[15] The City annually inspects residential septic treatment systems for compliance with public health requirements. The City annually inspects home-septic treatment systems for compliance with public health requirements. Underpinning all of these efforts is the City's commitment to monitor its stormwater outfalls during dry weather to detect illicit discharges that might be introduced into the storm sewer system. When the City finds violations of stormwater code, regulations, or rules, it takes action to return a property to compliance first through administrative enforcement and later through judicial enforcement if a property fails to return to compliance. This combination of monitoring and enforcement is essential to ensure that the quantity controls in the SWDM, which are designed to prevent flooding from occurring, are properly constructed and maintained. As precipitation increases, this will become increasingly critical to ensure that the Columbus population is properly protected.

To inform policies and modeling over the long-term, a monitoring program should be created that collects data (e.g., water storage and flow, sediment movement, and nutrient loads) annually from a certain portion of completed projects. Such a program would gauge the efficacy of various installed solutions and ensure that they result in the desired storage or infiltration goals. This program would create a continual feedback loop to guide future decisions. The City, in consultation with experts, should determine the data to be collected, the number of sites to be examined annually, and current policies that may connect to this program.

**N7** **Develop an emergency plan that can be implemented during a flood to ensure adequate transportation and logistics for critical resources.**

Extreme precipitation can inundate low-lying roadways, fill reservoirs beyond capacity, render bridges unusable, and necessitate closing of floodgates. For this reason, Columbus should have an emergency transportation plan in place

to use when necessary. During floods, it can become increasingly difficult to move people out of harm's way in a timely fashion or to transport assets to neighborhoods in need. As was witnessed in South Carolina in 2015, California in 2016 and 2017, and Houston in summer 2017, a geographically widespread and temporally sustained event can prevent resources from getting to those individuals who need them.[16, 17, 18] While the Great Flood of 1913 was the last time that Ohio experienced such widespread conditions, increased precipitation make such events more likely.

Franklin County Emergency Management and Homeland Security (FCEM & HS) has developed the Emergency Support Function 1 (ESF1): Transportation that may be implemented during floods.[19] ESF1 is responsible for management of transportation systems and management of transportation infrastructure during threats or in response to actual incidents. Activities under this ESF1 are directed by Franklin County Engineer's Office (FCEO) and Central Ohio Transit Authority (COTA) with support from many other transportation industry entities. Transportation encompasses all transit surface modes, including ground transportation, air travel, and rail routes; transportation infrastructures (roads, routes, and bridges); and assets that move people and supplies in and out of Franklin County. During disaster events, it may become necessary to relocate citizens to protected areas. Conducting these types of movement is the primary responsibility of COTA supported by agencies charged through ESF1. This emergency support function also includes the ***City of Columbus Downtown Evacuation Plan*** and the Mid-Ohio Regional Planning Commission (MORPC) ***Evacuation Framework***.[20, 21] The City needs to determine whether ESF1 is sufficient for emergency transportation in Columbus during floods or if a supplement is needed for the city. All planning documents should be periodically updated as our scientific understanding of flood threats improves and lessons are learned from floods affecting other communities.

As is noted in the Emergency Preparedness chapter of this plan, Columbus should develop geographic information system (GIS) resources that tag critical assets and transportation infrastructure that may be affected by a flood. By sharing this information with various stakeholders, new transportation routes could be developed based on a variety of circumstances. Particularly vulnerable populations, such as those in close proximity to a floodplain or unable to relocate due to inaccessibility of transportation, should also be identified on the GIS resource. The ***Ohio Department of Transportation (ODOT)*** recently identified transportation links that are most at risk due to climate change; these include one that is susceptible to flooding in Central Ohio and should be included in all planning documents.[22] GIS staff members knowledgeable in the data will be necessary throughout the entirety of an emergency to provide information to decision makers and emergency services and to create updated maps that may be shared with the public. Such a staff position exists within FCEM & HS.

In addition to transporting people away from affected areas, plans need to be developed to provide transportation and logistics for critical resources, such as medical supplies and bottled water. GIS resources should be used to identify both critical assets (e.g., hospitals, fire stations, shelters, and distribution centers) and transportation routes between them (e.g., primary and secondary routes). These GIS tools should include identification of neighborhoods and routes that are likely to be inundated under various scenarios. In the case of l regional events, plans should specify procurement of supplies from outside the region via reliable transportation routes.

Following a series of recent floodwall exercises, DPU began exploring the creation of a live map to display safe-travel options in the event floodgates are closed. If this tool was pushed into development, it would involve collaboration between DPU, the Department of Public Safety, Columbus Police, and Columbus Fire on the creation of roadway routing for emergency and residential vehicles. While this tool would only be used during major river flooding, it would be a first step to identifying and communicating transportation routes.

**N8** **Identify and assess risk associated with older flood control and stormwater infrastructure, and use data gathered to reduce risk by developing property owner education, informing the city's capital projects, and establishing property owner requirements.**

The City of Columbus reviews and implements stormwater infrastructure improvements based on needs informed by engineering modeling as well as flooding and water-in-basement complaints raised by its residents. Engineering modeling can be enhanced by updating the SWDM, which informs modeling based on anticipated frequency, intensity, and duration of rainfall events. Updating the SWDM is discussed above. Likewise, the City can continue to utilize reported flooding and water-in-basement complaints contained within its management database (WAM), including use of GIS cluster/heat mapping, to inform capital projects.

DPU has established an Internal Floodwall Committee within the Division of Sewerage and Drainage (DOSD) tasked with gathering all physical information related to the floodwall, including deficiencies and guidance for developers who intend to build in close proximity to the floodwall. This ensures that developers understand the regulatory requirements of the Army Corp of Engineers. The City is also taking inventory of, evaluating, and improving floodwall protections to flood-prone properties. The Internal Floodwall Committee should include flood-control infrastructure on private property and sewage/stormwater infrastructure that passes through floodwalls.

Based on needs, the City should install floodgates and backflow preventers, construct new storm sewers with greater flow capacity, install GI, work to educate property owners, or develop multicomponent solutions to address localized flooding. The City should continue to prioritize improvement projects that address localized flooding based on information that is learned through updated modeling, analyses of flooding and reported water-in-basement events, and efforts of the Internal Floodwall Committee. Through examination of overall impact and risk to impacted property owners, DOSD will determine where to add these components.

The City should provide property owners and tenants the necessary information on elevated flood risks in a timely fashion and in understandable formats. Without this information, individuals are unable to properly prepare and take actions to reduce their liability. The work of the Infrastructure Committee within DOSD should continue and may result in recommended requirements for property owners with privately-held flood control measures.

**A6** **Advocate for state and federal government to implement policies that reduce erosion and runoff and promote infiltration.**

As the well-known educational refrain states, "we all live downstream." This is true of Columbus, which largely receives its drinking water from surface and groundwaters that originate north of the city. These lands are largely used for

agriculture, with the rest primarily being residential property. During storm events, runoff can deliver pollutants and sediment to the waterways that travel downstream to Columbus. These pollutants include fertilizer, herbicides, and pesticides from non-point sources, while the sediment is largely composed of topsoil from non-vegetated surfaces. These materials can damage aquatic ecosystems and make water treatment more difficult and therefore costly. As we have seen with inland lakes, such as Buckeye Lake and Grand Lake St. Marys, there are both economic and quality-of-life consequences that result from impaired waterways.

Water concerns in the Midwest have historically been of lower consequence than those in more water-stressed regions of the country because water supplies here are plentiful relative to population size. However, water quality issues have become more frequent and severe in Ohio, as has been the case with the increasing occurrence of harmful algal blooms (HABs) throughout the state. While local municipalities and water districts are responsible for providing drinking water, with the ***OEPA playing a role in certifying drinking water quality***, the state and federal governments are responsible for the regulation of practices within watersheds.[23] This creates tension as local municipalities have no direct control of what arrives in their waterways—even drinking water supplies—from landowners upstream. Despite this, it is the downstream residents that assume the cost of treating the water. In Columbus, this was manifested in a contingency contract for $1 million for reagents and $3 million for upgrades to a water treatment facility to address poor drinking water taste associated with algal blooms.[24] Downstream locations also lose out on recreation opportunities and the aesthetic enjoyment of nature as water quality deteriorates.

As with all code and zoning requirements, state law limits actions that can be taken by the City. The City should work collaboratively with state and federal agencies and elected officials to improve the management of our aquatic ecosystems and water resources on a larger scale. ***Sustaining Scioto***, an effort to ensure sufficient drinking water for Columbus in light of our anticipated population growth, provides a blueprint through mid-century.[25] State actions, such as an addition to the state budget bill in 2017 that weakens protections to lands surrounding reservoirs, impair the ability of Columbus to provide safe water for its citizens.[26, 27] When necessary, the City should reiterate to state agencies and elected officials concerns about limits on its ability to deliver safe and affordable service. Ongoing conversations on the protection of our waters need to be informed by published research, best practices, and respect for the rights of all individuals within a watershed. Creative solutions, such as payment to landowners for ecosystem services, could emerge from such conversations.

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