

**Comprehensive Plan for the
Water Resources of the Susquehanna River Basin:
2021-2041**

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Susquehanna River Basin Commission





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The Susquehanna River Basin Commission was created as an independent agency by a federal-interstate compact* among the states of Maryland and New York, the Commonwealth of Pennsylvania, and the federal government. In creating the Commission, the Congress and state legislatures formally recognized the water resources of the Susquehanna River Basin as a regional asset vested with local, state, and national interests for which all the parties share responsibility. As the single federal-interstate water resources agency with Basinwide authority, the Commission's goal is to coordinate the planning, conservation, management, utilization, development, and control of Basin water resources among the public and private sectors.

**Statutory Citations: Federal - Pub. L. 91-575, 84 Stat. 1509 (December 1970); Maryland - Natural Resources Sec. 8-301 (Michie 1974); New York - ECL Sec. 21-1301 (McKinney 1973); and Pennsylvania - 32 P.S. 820.1 (Supp. 1976).*

This report is available on our website at <https://www.srbc.net/our-work/planning/comprehensive-plan.html>. The Commission also has a limited supply of hard copies. For a hard copy, contact the Susquehanna River Basin Commission, 4423 N. Front Street, Harrisburg, PA 17110-1788, (717) 238-0423, FAX (717) 238-2436, E-mail srbc@srbc.net. For more information concerning the Commission, visit our web site: www.srbc.net.

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OPENING LETTER

2021 marks the 50th Anniversary of the 100-year Susquehanna River Basin Compact. In recognition of this milestone, I am excited to present this Comprehensive Plan for the Water Resources of the Susquehanna River Basin, which articulates our vision, goals, and objectives for the Basin over the next two decades.

Together with our stakeholders, the Susquehanna River Basin Commission (Commission) has accomplished a great deal in the Compact's first half-century to improve conditions in the river and its watersheds through management of water resources in the Basin. From flood forecasting and early warning systems, abandoned mine drainage cleanup, restoration of native fish populations, development of water storage facilities, water withdrawal and consumptive use regulations, contributions to Chesapeake Bay restoration, and more, much has been achieved in support of public, industry, and ecological needs. Still, there is work to be done in many of these areas, and the future will hold both new challenges and opportunities.

Since its inception, the Commission has had a leading role in managing water quantity and water quality through direct action and by organizing, managing, advising, and monitoring the efforts of federal, state, and local governments and key stakeholders to ensure optimal conditions and promote sustainable development. Although the general themes of water-related threats to public welfare originally conceived 50 years ago remain unchanged, the Commission's focus has shifted to align with contemporary water resource issues particularly within a changing climate and along with variable societal, environmental and economic justice pressures. The 2021 Comprehensive Plan is designed to maintain the momentum of the past, while also taking advantage of the latest scientific and technological advances to continue to promote multi-jurisdictional collaborative management of water resources in the Basin.

Not intended to be static, the plan will be updated again in 2031 in light of accomplishments, new priorities, emerging issues, and new capabilities. But until that time, the Commission's Water Resources Program, the implementation vehicle for the Comprehensive Plan, will be used to guide annual technical programs and initiatives, and to facilitate coordination among our member jurisdictions, to meet the plan's goals and objectives.

Andrew D. Dehoff, P.E.
Executive Director

ACKNOWLEDGEMENTS

The Commission would like to express sincere appreciation to all parties involved in developing the 2021 Comprehensive Plan for the Water Resources of the Susquehanna River Basin. The Comprehensive Plan Committee and several staff members provided expertise and devoted many hours writing, editing, and formatting the Plan. Numerous stakeholders from partner agencies, environmental organizations, and the public and private sector provided helpful review and comments during meetings, webinars, and the public comment period. Members of the Commission's Water Resource Management Advisory Committee contributed valuable feedback and guidance. Snowflake LLC facilitated the Plan process with invaluable direction and insight. And finally, such an endeavor would not have been possible without continuing support and assistance from our commissioners from the New York State Department of Environmental Conservation, the Pennsylvania Department of Environmental Protection, the Maryland Department of the Environment, and the United States Army Corps of Engineers.

EXECUTIVE SUMMARY

The Susquehanna River Basin Compact (Compact) requires the Commission to plan for the immediate and long-range development and use of the water resources of the Basin (see Appendix A). The Comprehensive Plan provides an overarching framework for the Commission to manage the Basin's water resources and serves as a guide for all Commission programs and activities. This updated Comprehensive Plan outlines the vision, needs, and strategy for effectively managing the water resources of the Basin during the period from 2021 to 2041. The complete plan is available on the Commission's website at <https://www.srbc.net/our-work/planning/comprehensive-plan.html>.

Vision

The Commission envisions a clean, sustainable, and adequate water supply in the Susquehanna River Basin that supports a range of human, economic, and ecological needs. Through collaborative partnerships and coordinated action, as well as use of the best science, water resources in the Basin will be managed effectively to meet existing and emerging challenges in the face of changes to the landscape and climate extremes. As a result, Basin communities will be able to reliably depend on their water supply for a range of uses, be better prepared and able to mitigate the impacts from floods and droughts, and benefit from healthy aquatic ecosystems and enhanced recreation.

Fulfilling the vision means addressing diverse, complex water resources needs, now and in the future. These needs are interconnected and continually evolving, requiring integrated and adaptive water resources management approaches to ensure water demands are met while balancing public health and safety, economic development, and ecosystem stewardship. They include, for example:

- ensuring adequate water supply for electric generation, public water supply, manufacturing, mining, natural gas, agriculture, and recreation;
- restoring impaired streams impacted by agriculture, abandoned mine drainage, urban runoff, habitat modification, and atmospheric deposition;

- improving flood and drought warning, planning, and mitigation for vulnerable communities and sectors; and
- reducing stormwater runoff and associated sediment, nutrient, and pollutant loadings from developed lands.

There are four Priority Management Areas (PMAs) identified in the Comprehensive Plan: (1) Water Supply, (2) Water Quality, (3) Flooding and Drought, and (4) Watershed Management. Climate change is a cross-cutting challenge that is addressed in the objectives identified within each priority area. Coordination and outreach to partners and the public plays an important role in all four areas. Likewise, technology and data analytics support and enhance efforts planned throughout. Overall, it is also important to ensure management goals meet the needs of underserved or disadvantaged communities within the context of environmental justice. The PMAs and their associated goals and objectives are shown below in Figure 1.

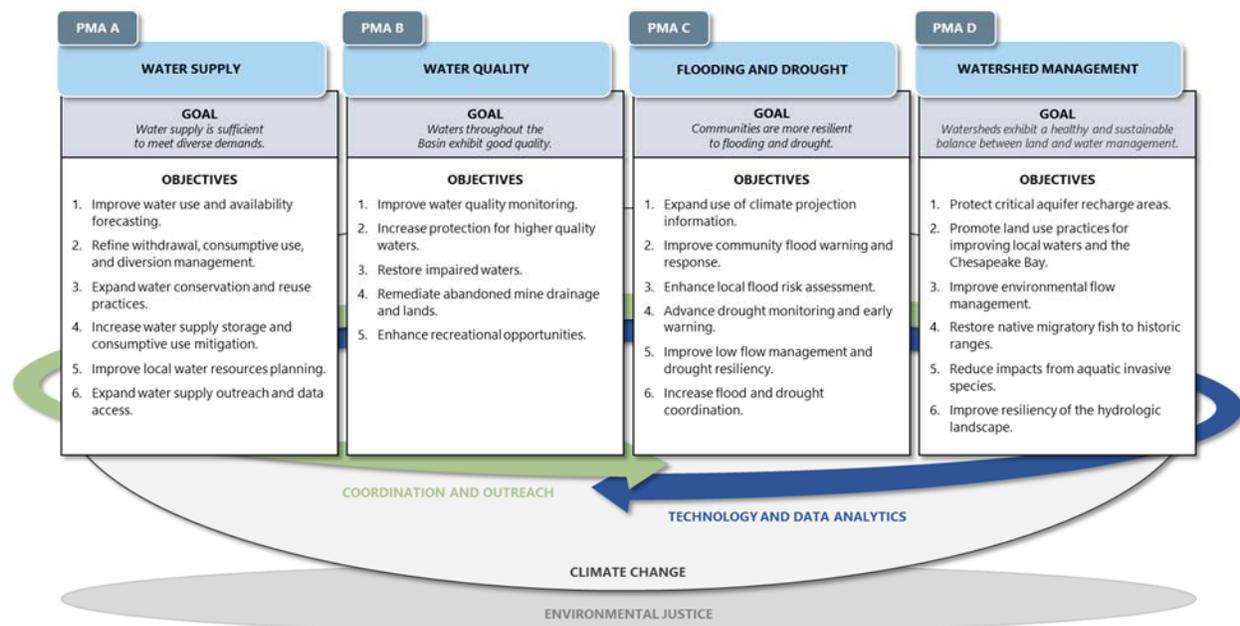


Figure 1. Priority Management Areas, Goals, and Objectives

The Comprehensive Plan includes projects and facilities the Commission has determined to be required for optimum planning, development, conservation, utilization, management, and control of the Basin’s water resources to meet present and future needs. These include Commission-regulated projects as well as other projects and facilities that meet specific criteria outlined in the Comprehensive Plan.

The Comprehensive Plan will be implemented through the Commission’s annual Water Resources Program (WRP) and associated budget (<https://www.srbc.net/our-work/planning/water-resources-program/>). The WRP outlines priority projects and initiatives, key performance measures, and methods for tracking progress (Appendix B). The budget includes projects proposed to be undertaken or continued during the fiscal year, along with the estimated cost and method of financing for each project. The yearly WRP and budget formulation process will ensure priority projects are adequately planned and funded in order to effectively implement the Comprehensive Plan over the next 20 years and achieve its goals and objectives.

1. VISION

The Commission envisions a clean, sustainable, and adequate water supply in the Susquehanna River Basin that supports a range of human, economic, and ecological needs. Through collaborative partnerships and coordinated action, as well as use of the best science, water resources in the Basin will be managed effectively to meet existing and emerging challenges in the face of changes to the landscape and climate extremes. As a result, Basin communities will be able to reliably depend on their water supply for a range of uses, be better prepared and able to mitigate the impacts from floods and droughts, and benefit from healthy aquatic ecosystems and enhanced recreation.

2. INTRODUCTION

This document presents the Comprehensive Plan for managing the water resources of the Susquehanna River Basin from 2021 through 2041. Issued on the 50th anniversary of the Compact, it builds on five decades of achievements in the Basin and lays out a path to further successes supporting public, industry, and ecological needs. The Basin will face many challenges over the next 20 years, but there are also many opportunities for the Commission and its stakeholders to rise to the occasion. Together, the Commission and its partners have evaluated today's conditions and tomorrow's needs, and developed this Plan to assure the Basin's water resources are managed effectively through coordinated, collective action.

The Plan's primary purposes are to provide:

- a framework of goals and objectives that focus and guide coordinated action among the Commission and its partners to effectively manage the water resources of the Basin, and
- a mechanism to ensure critical projects that promote sustainable management and use of the Basin's water resources receive stakeholder support and are adequately funded.

Susquehanna Basin

The Susquehanna River is the largest river lying entirely in the United States that drains to the Atlantic Ocean. The river flows 444 miles from its origin at the outlet of Otsego Lake in Cooperstown, New York, until it empties into the Chesapeake Bay at Havre de Grace, Maryland. The Susquehanna River and its hundreds of tributaries comprise more than 49,000 miles of waterways and drain 27,500 square miles within the states of New York, Pennsylvania, and Maryland (USGS, 2004). This drainage area is known as the Susquehanna River Basin. Figure 2 shows a map of the Basin and its six major subbasins.

The Commission's Susquehanna Atlas contains various maps and data associated with key characteristics of the Basin (<https://www.srbc.net/portals/susquehanna-atlas/data-and-maps/>). These characteristics influence the water resources needs of the Basin and management strategies developed to address them.



Figure 2. Susquehanna River Basin and Subbasins

Commission Authority

The Compact was enacted in December 1970 as Public Law 91-575 and joined the federal government and states of New York, Pennsylvania, and Maryland as equal partners for a period of 100 years to manage the Basin's water resources. The Compact created the Commission as the agency to develop and effectuate plans, policies, and projects relating to water resources of the Basin in a coordinated manner. In January 1971, the Compact took effect and the Commission was officially established.

The Compact requires the Commission to formulate and adopt a Comprehensive Plan for the immediate and long-range development and use of the water resources of the Basin. The Comprehensive Plan is to include public and private projects and facilities required, in the judgment of the Commission, for optimum planning, development, conservation, utilization, management, and control of the water resources of the Basin to meet present and future needs. The Comprehensive Plan is also to take into consideration the effect of the plan upon the receiving waters of the Chesapeake Bay.

Plan Approach

This 2021 Comprehensive Plan incorporates the perspectives of a diverse group of stakeholders who provided input used to help interpret the Compact's broad authorities in the context of contemporary and anticipated future water resources needs. These contributors included:

- commissioners, alternates, and advisors,
- Water Resources Management Advisory Committee,
- Commission management and staff, and
- interested public, private, and nonprofit sector stakeholders.

Based on feedback from these stakeholders, the 2021 Comprehensive Plan focuses on the four PMAs previously mentioned: Water Supply, Water Quality, Flooding and Drought, and Watershed Management. All are examined in part through the lens of ongoing climate change and the Commission's desire to focus more attention on disadvantaged communities within the context of environmental justice.

Climate Change

The Commission regards climate change as an existential threat to the Basin's water resources in terms of more extreme floods and droughts, vulnerability to reliable water supplies, and exacerbation of critical issues already facing the Basin such as water quality impairments, stormwater runoff, and the need to plan for future water demands. The Commission will include climate change implications as a primary consideration in the undertaking of all technical studies and projects, decisions on projects and planning, and before committing Commission resources to the same.

Together, these PMAs and their respective goals and objectives comprise a forward-thinking, collaborative approach to water resources management in the Basin using the latest science, data, and analytical methods. The Commission carefully considered the roles of its partners in the plan, seeking to leverage the Commission’s unique capabilities with those of its partner agencies. Doing so will help support and strengthen member jurisdiction programs to optimally manage the Basin’s water resources and meet a complex web of human, economic, and ecosystem needs, now and into the future. The critical water resource needs of the Basin, and the PMA goals and objectives developed to address them, are described in the following sections.

3. WATER RESOURCES NEEDS

Water resources needs in the Basin are diverse and complex. They are also interconnected and continually evolving, requiring integrated and adaptive water resources management approaches to ensure water demands are met while balancing public health and safety, economic development, and ecosystem stewardship. Primary needs fall into the general categories of water supply, water quality, flooding and drought, and watershed management.

The following sections discuss these water resources needs, both today and as projected over the next 20 years.

Water Supply

- Table 1 outlines 2019 and projected 2040 population and estimated domestic water use in the Basin. The data indicate a 8% increase over the next 20-years. **As population and domestic water demand in the Basin continue to grow, there will be an ongoing need to increase water conservation and ensure public water supplies are sustainable into the future.**

Table 1. 2019 and Projected 2040 Population and Domestic Water Use

Year	Population	Domestic Water Use (mgd)
2019	4,179,503*	418.0
2040	4,495,040	449.5

*2019 population data from American Community Survey, U.S. Census Bureau, 2019

- Figure 3 depicts 2019 and projected 2040 water use by sector, including surface water withdrawals, groundwater withdrawals, and consumptive use (NYSDEC, 2019; NYSDOH, 2019; PADEP, 2019a; MDE, 2019; SRBC, 2019). The data show an overall 12% decrease in surface water withdrawals, 2% increase in groundwater withdrawals, and 0.2% decrease in consumptive use over the 20-year planning horizon. **The water supply needs of these sectors fluctuate over time in response to market conditions, improved technology, etc. This underscores the need to continue tracking and forecasting water use by industry type to inform planning and regulatory decisions.**

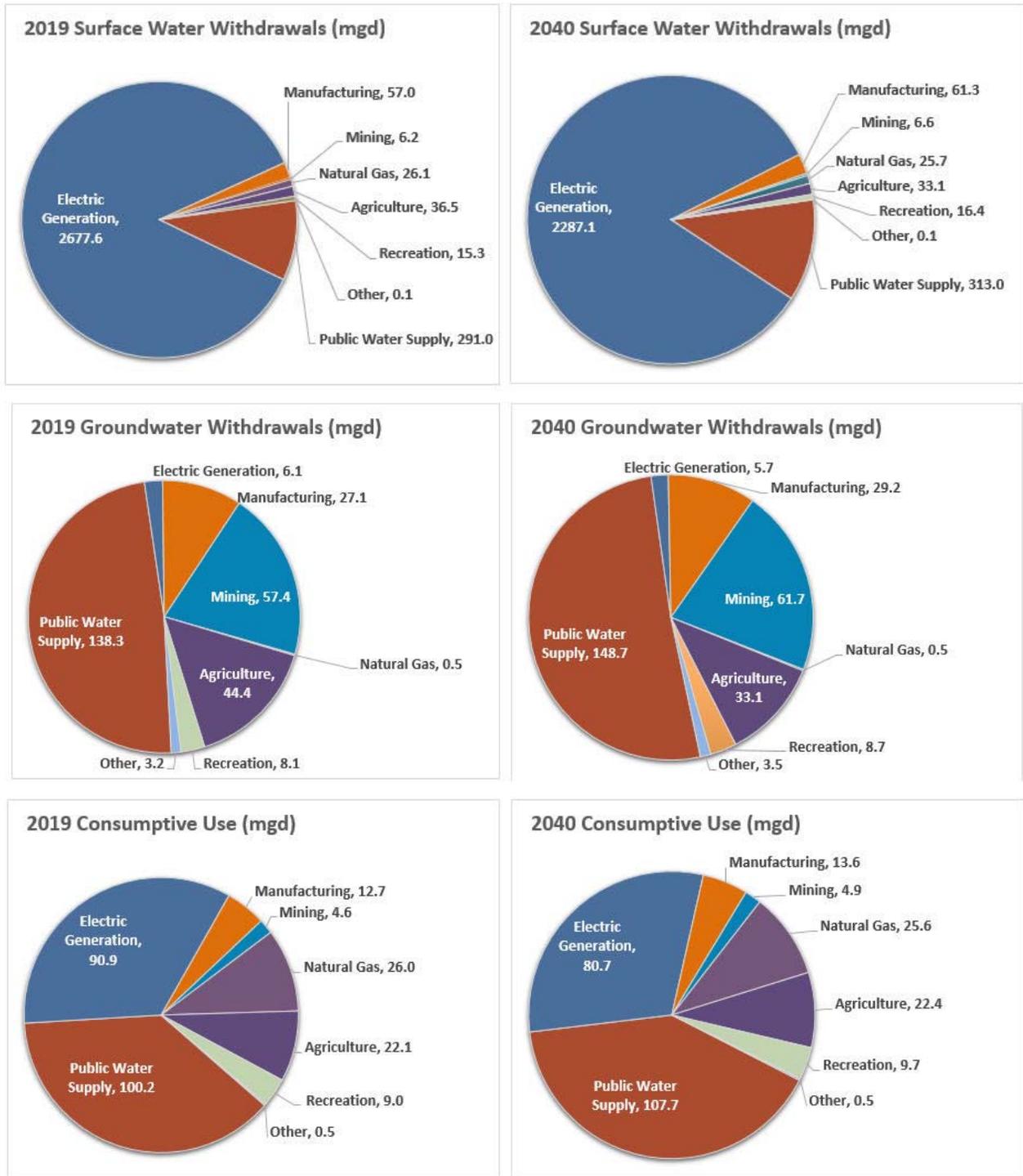
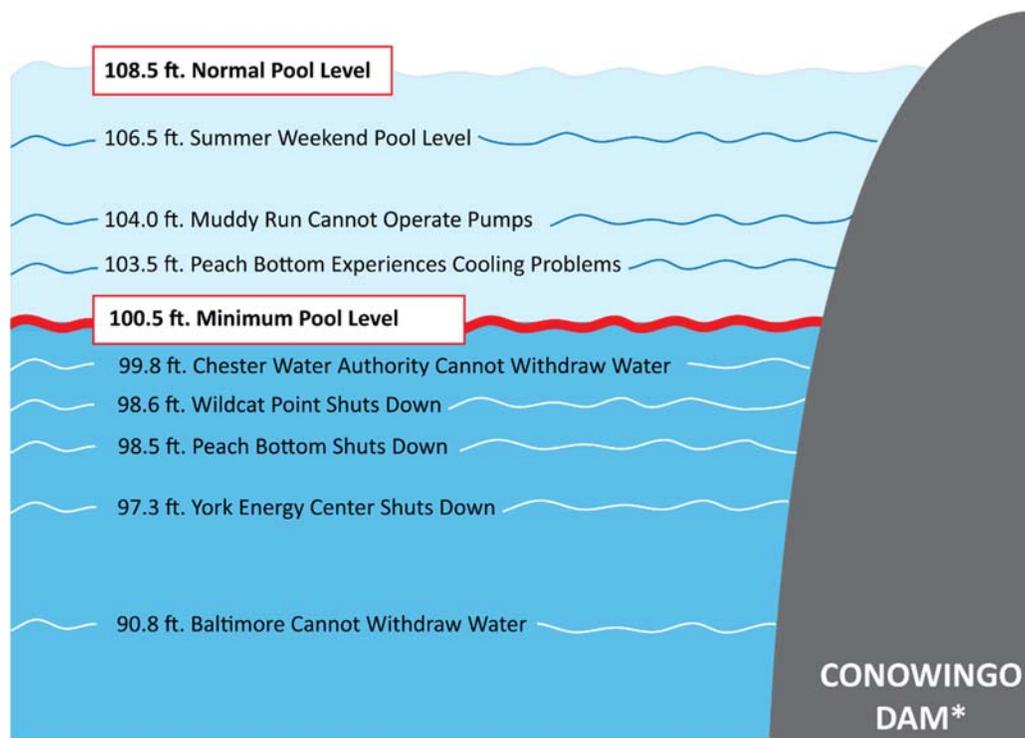


Figure 3. 2019 and Projected 2040 Withdrawals and Consumptive Use by Sector

- Conowingo Reservoir, on the lower Susquehanna River, provides a source of water supply for some of the most significant, competing water users in the Basin. Critical reservoir elevations associated with these facilities are detailed in Figure 4. The Commission’s Conowingo Pond Management Plan recommended an operational alternative that balanced satisfying water demands with meeting minimum flows and reservoir levels to ensure water supply is sustainable during droughts and water use conflicts are avoided (SRBC, 2006). **Conowingo Reservoir will continue to be a priority setting for managing competing water demands and environmental flows moving forward, particularly in a changing climate.**



* Elevations are based on Conowingo datum, which is 0.7 feet below National Geodetic Vertical Datum.

Figure 4. Critical Conowingo Reservoir Elevations

- The Commission’s Groundwater Management Plan identifies several water challenged and potentially stressed areas (SRBC, 2005). The Commission’s Cumulative Water Use and Availability Study (Balay et al., 2016) and web map (<https://www.srbc.net/our-work/programs/planning-operations/cumulative-water-use-availability-map/>) summarizes water use, water capacity, and water availability conditions for watersheds throughout the Basin. Figure 5 highlights watersheds identified as being potentially stressed, water challenged, or having limited water capacity or availability. **These areas have less water available for sustainable water development and warrant more detailed study, enhanced planning, and proactive management to avoid future water use conflicts and impacts.**

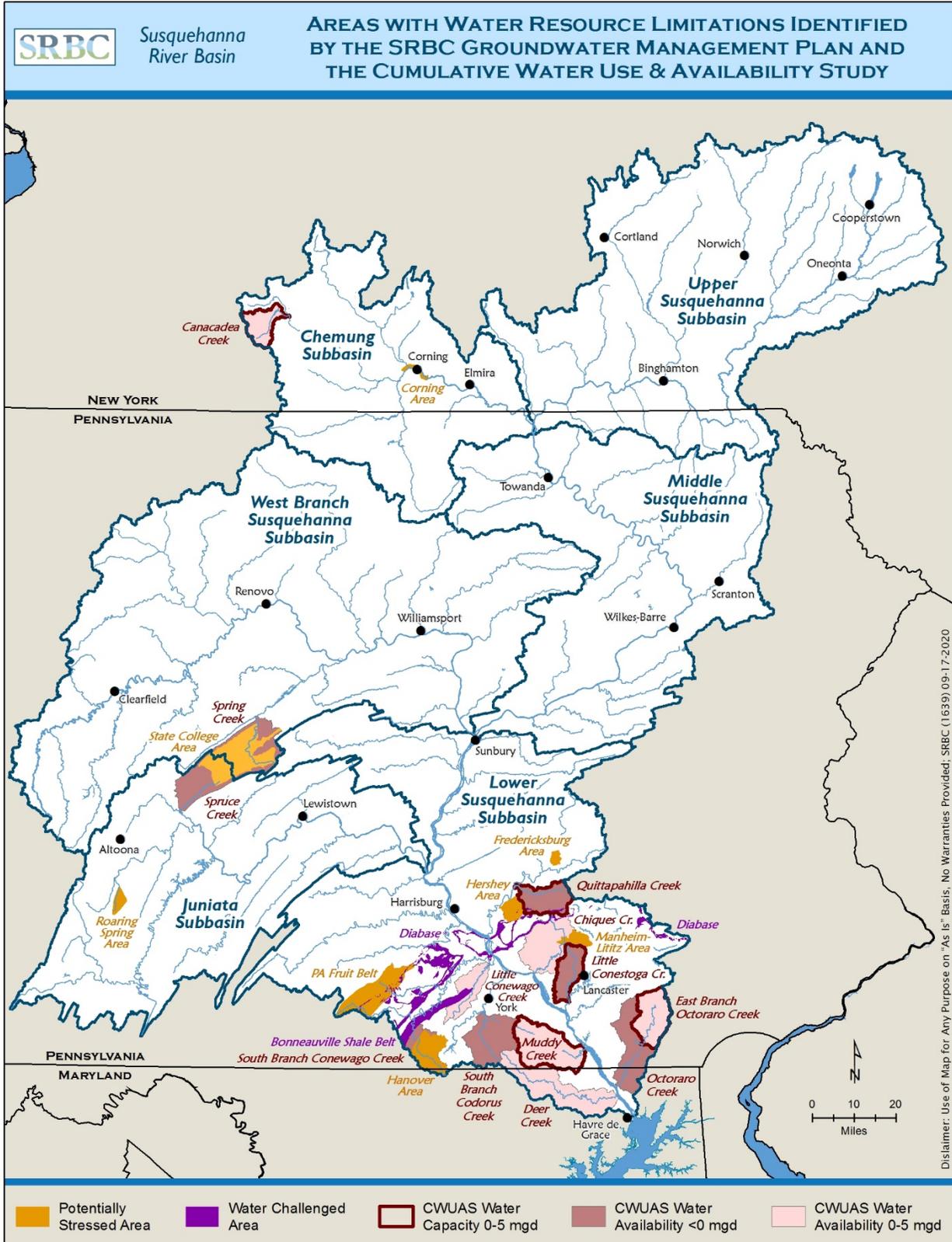


Figure 5. Potentially Stressed, Water Challenged, and Low Water Availability Watersheds

- Based on the Commission’s Cumulative Water Use and Availability Study (Balay et al., 2016) and web map (<https://www.srbc.net/our-work/programs/planning-operations/cumulative-water-use-availability-map/>), Table 2 includes a list of tributary watersheds with the highest 2019 consumptive use. **These watersheds represent priority locations for developing additional mitigation and water conservation measures. Such action will help reduce manmade impacts caused by consumptive use during low flow periods to ensure water is available for downstream uses, including environmental needs.**

Table 2. Watersheds with Highest 2019 Consumptive Use

Watershed Name	Drainage Area (mi²)	2019 Approved CU (mgd)	2019 Reported CU (mgd)
South Branch Codorus Creek	116.8	42.9	17.9
Octoraro Creek	210.3	35.3	18.3
Lower Swatara Creek	571.2	31.8	16.3
Lackawanna River	347.7	26.0	8.0
Tioga River	1,383.1	25.1	5.4
Conestoga River	474.8	20.0	11.9
Bald Eagle Creek	773.2	19.4	7.4
Lower Chenango River	1,611.0	17.7	5.5
Lower Conewago Creek	515.6	16.6	7.5
Lycoming Creek	271.9	15.4	4.7

- Potential climate change impacts on water supply include the following: increased intensity, decreased duration, and altered timing of precipitation and related effects on seasonal water availability; increased evapotranspiration and resultant decreases in surface water storage and streamflow; and, decreased snowpack and associated reductions in groundwater recharge. **These changes warrant an elevated focus on water availability forecasts, sustainable water allocations, water conservation practices, enhanced reservoir operations, and increased groundwater recharge to ensure Basin water supply is sufficient to meet demands under future climate conditions.**

Water Quality

- The Basin is still predominantly forested and, as such, has over 15,300 miles (31%) of streams designated as achieving higher quality water status (USGS, 2016). An additional 27,700 miles (56%) are designated as meeting acceptable water quality standards (PADEP, 2019b; NYSDEC, 2017a; MDE, 2016a). Both are depicted in Figure 6. **These conditions dictate the need to maintain the integrity of these higher quality waters in the face of a changing landscape and climate.**

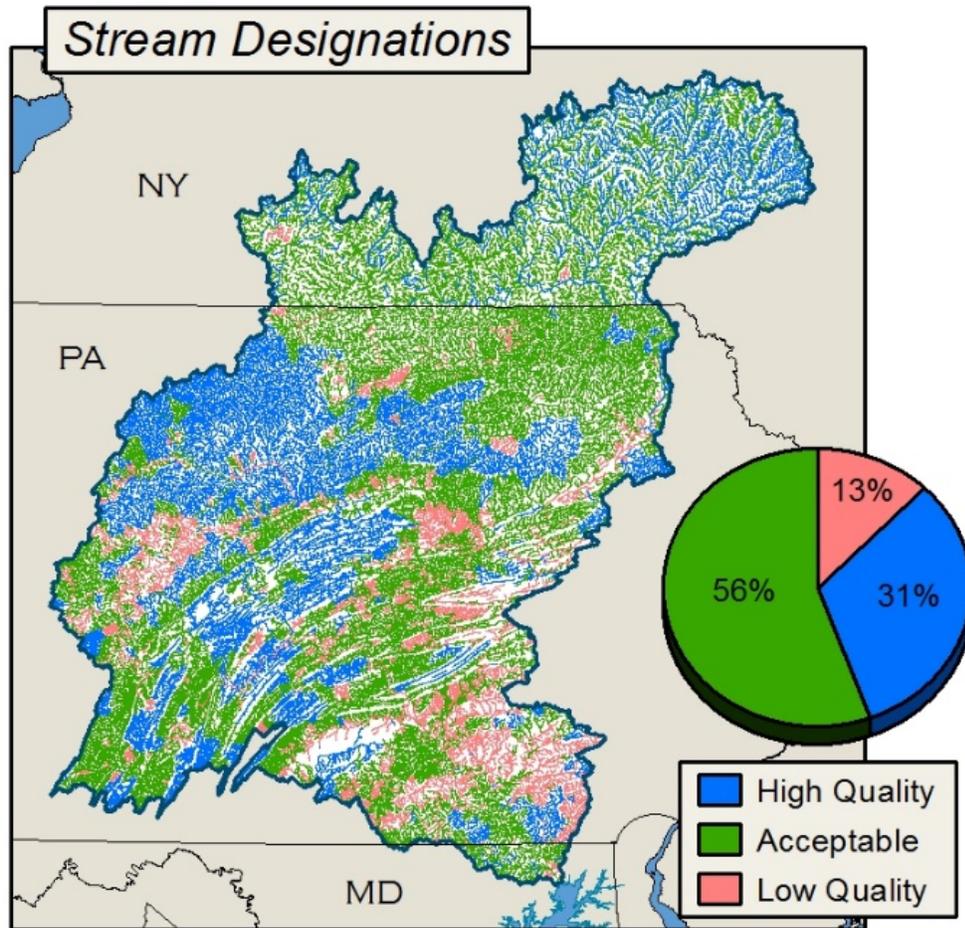


Figure 6. Stream Water Quality Designations

- The Commission’s Water Application and Approval Viewer contains a reference layer identifying impaired stream reaches in the Basin (<https://www.srbc.net/waav/>). There are currently over 7,500 miles (15%) of impaired streams, based on aquatic life assessments, with impairment sources primarily comprised of agriculture, abandoned mine drainage, urban runoff, habitat modification, and atmospheric deposition (Table 3; PADEP, 2020a; NYSDEC, 2017b; MDE, 2016b). **These streams represent priority locations for implementing water quality improvement projects to restore impaired waters and enhance recreational opportunities in the Basin.**

Table 3. Stream Impairment Sources

Impairment Source	Stream Miles (mi)	Stream Miles (%)
Agriculture	3,472	7.0
Acid Mine Drainage	1,904	3.9
Urban Runoff	709	1.4
Habitat Modification	692	1.4
Atmospheric Deposition	468	0.9

- The Commission’s Water Quality Index Map is used to assess and compare water quality conditions throughout the Basin based on water samples collected and analyzed from 2000-2019 at over 1,700 sites (<https://www.srbc.net/portals/water-quality-projects/water-quality-index/>). Scoring is comprised of three category scores and an overall water quality score. The map displays water quality conditions from water samples for tributary watersheds and mainstem river reaches in the Basin. Figure 7 depicts areas identified as having very poor or poor overall water quality index scores. **These watersheds warrant prioritization for developing restoration plans and implementing best management practices and projects required to improve local water quality in the Basin.**
- There are over 6,700 National Pollutant Discharge Elimination System (NPDES) discharges in the Basin (USEPA, 2020). Of these, there are over 30 associated with Combined Sewer Overflows (CSOs) and over 1,300 associated with Concentrated Animal Feeding Operations (CAFOs). The occurrence of emerging contaminants are increasingly associated with such discharges in the form of pharmaceuticals, caffeine, microplastics, and personal care products. **These discharges represent opportunities for achieving additional point source pollution reductions to improve Basin water quality and advancing monitoring science to keep pace with tracking the occurrence and transport of traditional and emerging pollutants.**
- The Commission’s Mine Drainage Portal Map contains reference layers identifying abandoned mine drainage-impaired stream reaches and abandoned mine lands in the Basin (<https://www.srbc.net/minedrainageportal/Map>). There are currently 1,904 miles (4%) of abandoned mine drainage-impaired streams (PADEP, 2020a) and 110 square miles (0.4%) of abandoned mine lands (PADEP, 2020b). **These areas are prime targets for remediating abandoned mine drainage and lands in order to restore impaired waters, improve aquatic ecosystems, and expand recreational opportunities in the Basin.**
- The Commission’s expansive network of continuous instream monitoring stations assists with tracking water quality conditions throughout the Basin (<https://www.srbc.net/continuous-instream-monitoring>). Potential climate change impacts on water quality include increased pollutant loads from runoff events associated with greater frequency of intense storms, as well as destabilization of streambanks and floodplain disconnection from more extreme flood events. Increasing temperatures across the Basin will also add stress to coldwater aquatic ecosystems. **These changes will dictate a need to focus more on stormwater impacts and management, as well as the restoration and protection of floodplains and riparian buffers needed to stabilize stream corridors and mitigate rising temperatures.**

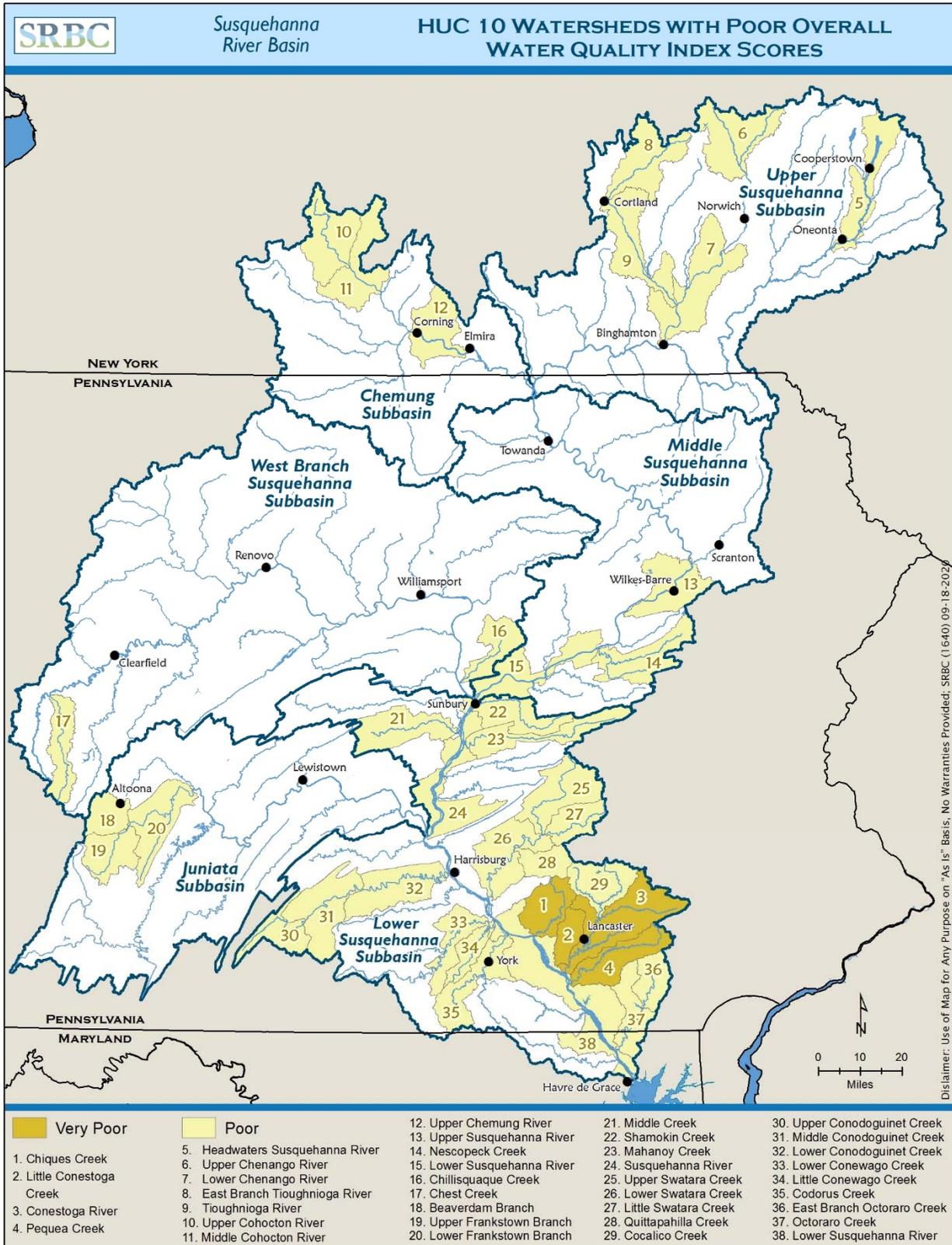


Figure 7. Watersheds With Poor Water Quality Index Scores

Flooding and Drought

- Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) data provide insight on flood-risk for Basin communities (FEMA, 2020a). Since 1978, over 1,050 municipalities (74%) throughout the Basin have received NFIP assistance. Figure 8 depicts cumulative payments by municipality, which include a total of 36,107 claims and \$832,419,567 in total payments across the Basin. **These areas warrant prioritization for improving flood warning and response, enhancing flood risk assessment, and implementing flood mitigation strategies to increase community flood resilience in the Basin.**

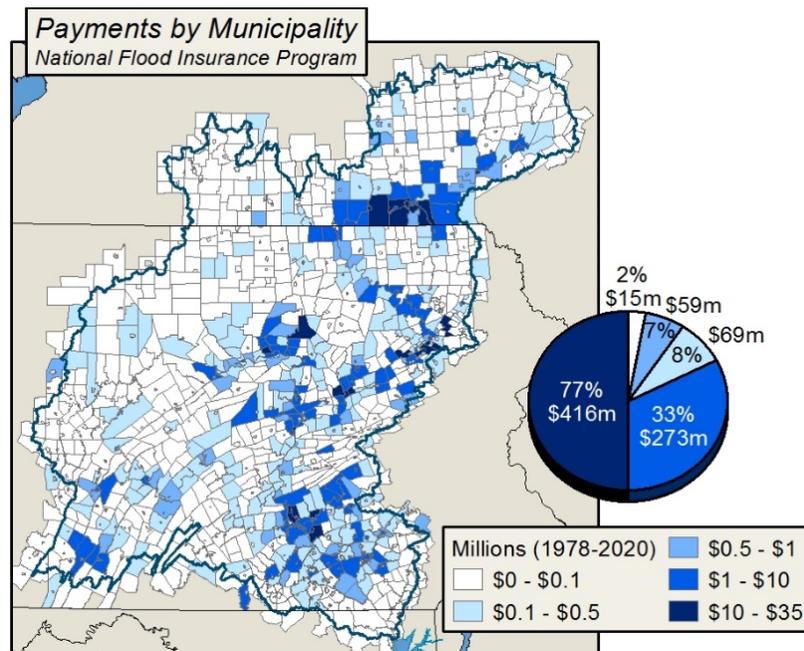


Figure 8. National Flood Insurance Program Payments by Municipality

- The Federal Emergency Management Agency (FEMA) National Flood Hazard Layer (NFHL) (FEMA, 2020b) and United States Army Corps of Engineers (USACE) National Levee Database (NLD) (USACE, 2020) indicate there are over 330 flood damage reduction projects that protect over 120 communities in the Basin. **These projects, and their associated infrastructure, require ongoing maintenance to ensure they continue to meet their intended purposes. The challenges associated with aging infrastructure, coupled with landscape modifications and a changing climate, make operation and maintenance of these structural flood risk management projects a critical need now and into the future.**
- There are over 1,100 community public water supply systems in the Basin that serve a population of over 3 million (PADEP, 2018; NYSDOH, 2018; MDE, 2018). This does not include public water supply systems with out-of-basin diversions, which

serve over another 2 million people outside the Basin. **These systems are vulnerable to drought impacts of varying degrees. As such, they represent opportunities for ongoing improvements related to water loss reduction and conservation, drought contingency planning, and developing backup sources to increase community drought resilience in the Basin.**

- Under Water Supply needs above, several watersheds are identified as being potentially stressed, water challenged, or having limited water capacity or availability (Balay et al., 2016; SRBC, 2005). These settings are more prone to water supply challenges and water use conflicts during droughts. **Accordingly, they serve as priority areas for implementing mitigation measures including water supply alternatives, operational changes, demand modifications, and environmental and water quality enhancements to improve low flow management and drought resiliency.**
- The Commission's Drought Coordination Plan describes the Commission's drought management authority, drought watch, warning, and emergency stages, monitoring data and criteria for determining drought stage, and drought response actions by the Commission and partner agencies (Runkle, 2000). **Since adoption of the plan in 2000, monitoring networks have changed, data portals have improved, new drought indicators have emerged, and climate science research has provided new insights. Accordingly, there is a need to update the Commission's drought monitoring, early warning, and management procedures and tools to increase drought preparedness in the Basin.**
- Potential climate change impacts on flooding and drought include the following: increased precipitation via more intense storms and resultant increases in extreme flood events and flash floods; increased temperatures contributing to decreased snowpack and associated reductions in groundwater recharge and baseflow; increased summer and fall temperatures, coupled with little change in precipitation; and, related increases in frequency of short-term droughts. **These changes warrant an elevated focus on community flood warning and response, stormwater management, drought early warning and contingency plans, improved reservoir operations, and increased groundwater recharge. This will help ensure Basin communities are more resilient to flooding and drought under future climate conditions.**

Watershed Management

- The Commission's Groundwater Management Plan (SRBC, 2005) and Northern Lancaster Groundwater Study (Edwards and Pody, 2005) emphasize the importance of identifying and protecting critical aquifer recharge areas (CARAs) in the Basin. These areas provide a large fraction of the groundwater recharge to aquifers used for water supply. **As such, there is an essential need to delineate and properly manage CARAs in the Basin to help ensure water supply sources are sustainable, and to preserve local baseflow in streams, now and into the future.**

- The Commission’s Sediment and Nutrient Assessment Program and related work supporting partner agency efforts to meet Chesapeake Bay pollutant reduction goals has helped identify priority watersheds for achieving sediment and nutrient load reductions (<https://www.srbc.net/portals/water-quality-projects/sediment-nutrient-assessment/>). **The watersheds identified in Figure 9 represent key areas for implementing best management practices and projects aimed at achieving nitrogen, phosphorus, and sediment pollution reduction goals to improve local water quality and restore the Chesapeake Bay.**

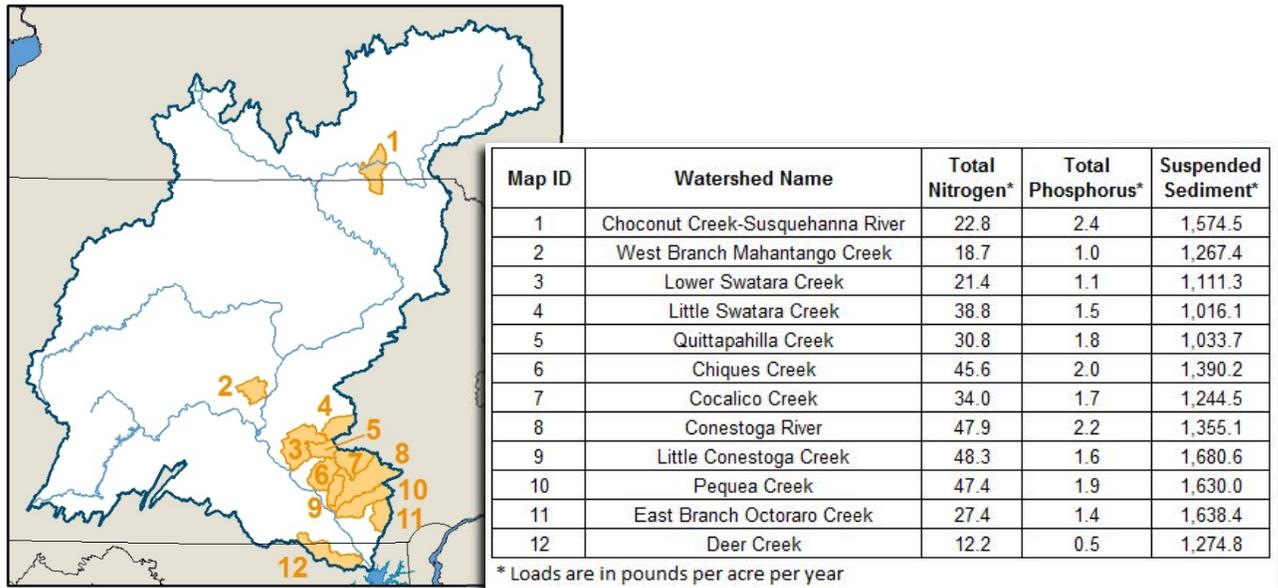


Figure 9. Priority Watersheds for Sediment and Nutrient Load Reductions

- The Nature Conservancy completed the Ecosystem Flow Recommendations for the Susquehanna River Basin study and report in 2010 (DePhilip and Moberg, 2010), which resulted in the ecosystem flow recommendations summarized in Table 4. The set of recommended flows are tailored to protect the species, natural communities, and key ecological processes within the various stream types in the Basin. **These ecosystem flow recommendations warrant incorporation into water use permits, reservoir release operations, and mitigation projects to improve environmental flow management in the Basin.**

Table 4. The Nature Conservancy Ecosystem Flow Recommendations

Season	Flow Component	Flow Statistic	Flow Recommendations		
			Headwater streams < 50 sq mi	Streams and small rivers (50 – 200 sq mi)	Major tributaries and mainstream (>200 sq mi)
Annual and Interannual Events	High Flows	Large flood	Maintain magnitude and frequency of annual Q0.05 (20-yr flood)	Same for all streams	Same for all streams
		Small flood	Maintain magnitude and frequency of annual Q0.2 (5-yr flood)	Same for all streams	Same for all streams
		Bankfull	Maintain magnitude and frequency of annual Q0.5 (Approx. 1 to 2-yr flood)	Same for all streams	Same for all streams
All Months	High flows	Monthly Q10	<10% change to magnitude of monthly Q10	Same for all streams	Same for all streams
	Seasonal flows	Monthly Median	Between 45 th and 55 th percentiles	Same for all streams	Same for all streams
		Monthly Range	≤ 20% change to area under curve between Q10 and Q75	Same for all streams	Same for all streams
	Low flows	Monthly Low Flow Range	No change to area under curve between Q75 and Q99	≤ 10% change to area under curve between Q75 and Q99	≤ 10% change to area under curve between Q75 and Q99
		Monthly Q75 Monthly Q95	No change	No change	No change
Fall	High flows	Frequency of events > Monthly Q10	NA	NA	1-5 events
Summer		Frequency of events > Monthly Q10	2-8 events	2-8 events	2-8 events

- The Commission is an active member of the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) formed to restore self-sustaining anadromous fishery resources and their habitats in the Basin. Figure 10 shows dams with and without fish passage facilities and the current status of fish passage in the Susquehanna River and its major tributaries. **There is an ongoing need to monitor passage effectiveness, employ adaptive management at passage facilities, remove existing blockages, implement stocking programs, and make other necessary adjustments to restore native migratory fish to historic ranges in the Basin.**

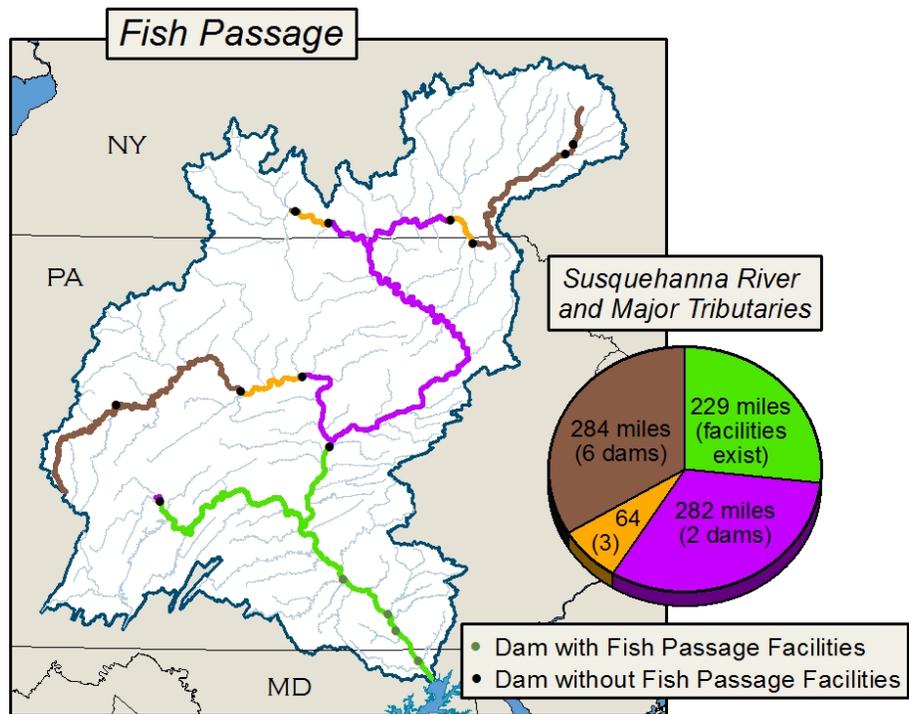


Figure 10. Fish Passage in Susquehanna River and Tributaries

- The Susquehanna Basin’s aquatic ecosystem is under constant threat from a range of invasive species that affect both stream habitat and disruption of the natural food chain. The more common threats in the Basin include zebra/quagga mussels, didymo algae, and the more recent introduction of the Northern snakehead fish (<https://www.paimapinvasives.org/>). **The Commission and its partners need to continue to advance capabilities for monitoring these threats in order to best develop strategies for control and eradication.**
- A changing landscape and climate requires increased focus on capturing and treating runoff using best management practices that can handle greater storm intensity and hydrologic variability as well as restoring and protecting floodplains, wetlands and riparian buffers. This will address multiple objectives such as flood risk management to increase public safety and reduce property damages, water pollution reduction to protect drinking water and aquatic health, increased infiltration and groundwater recharge to enhance water supply sustainability, and support healthy watersheds and recreational resources. **Collaboration is needed among the Commission and its local and regional partners to implement practices on the landscape to best promote hydrologic resiliency in the face of a changing landscape and climate.**

4. WATER RESOURCES MANAGEMENT PLAN

Based on an assessment of existing conditions and future needs, and feedback from a diverse set of stakeholders on challenges and opportunities, the 2021 Comprehensive Plan focuses on the four PMAs previously mentioned: Water Supply, Water Quality, Flooding and Drought, and Watershed Management. This section details what the Commission and its partners will strive to achieve over the next 20 years within the context of the PMAs (Figure 11).

Two cross-cutting streams enable and support achievement of PMA goals: coordination and outreach to partners and the public, which plays an important role through all four PMAs, and technology and data analytics, which will expand water resources management capabilities in all areas. The Commission is also cognizant of the overarching influence of climate change and the importance of environmental justice, and will look to address these challenges to improve management as conditions change and support more equitable treatment of Basin communities.

For each of the PMAs, there is a:

- Summary goal statement for management actions in the Basin,
- Description of the vision for the Basin over the next two decades,
- Outline of the Commission’s role with regard to water resource management partners,
- Presentation of key objectives that need to be accomplished through 2041, and
- Set of potential measures that may be used to evaluate progress and results.

The Comprehensive Plan does not include specific actions to be taken under each objective and identifies those in the Commission’s annual WRP (see Section 7).

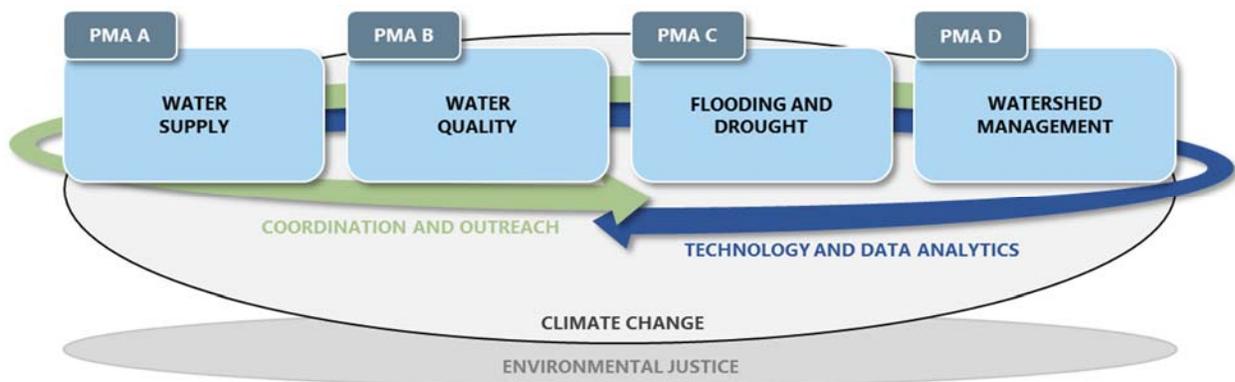


Figure 11. Priority Management Area Framework

Priority Management Area A – Water Supply

Goal: Water supply is sufficient to meet diverse demands.

Vision

All users of the Basin’s water resources have reliable, conflict-free, and sustainable water supply for current and future generations, even as demographic, economic, and climate conditions evolve.

Current State

Water supply throughout the Basin is generally adequate to satisfy existing demands. There are specific areas identified as having competing water uses and/or limited water availability, particularly during droughts. There are also individual water supply systems and sources with known challenges. Certain regions of the Basin are experiencing increased water demand and development. Water use information continues to improve. The electric generation and public water supply sectors represent the largest demands on water supply. Water use limits and mitigation measures help avoid conflicts and impacts to both human and ecosystem needs. Water conservation and reuse practices have not been implemented as extensively as in other parts of the country. Aging water infrastructure continues to pose challenges.

Role

Through its planning and regulatory functions, the Commission will continually assess water use and availability conditions throughout the Basin and review and approve water withdrawal, consumptive use, and diversion projects in a sustainable, equitable, and efficient manner. The Commission will routinely undertake the planning, development, and implementation of projects to offset water use impacts and address shortages in water availability. Additionally, the Commission will coordinate with other regulatory agencies and organizations during both its planning and regulatory functions to avoid duplication of efforts and work in an efficient and complimentary manner. Lastly, the Commission will enhance outreach efforts to ensure disadvantaged and underserved communities have the opportunity and ability to provide feedback for management decisions regarding the activities listed above.

Objectives

A-1	Improve water use and availability forecasting. Increasing use of technology and data analytics will improve the tracking and forecasting of water supply versus demand conditions to inform planning and regulatory decisions. This will also aid in identifying areas of significant water use and limited water availability to guide water development, conservation, and mitigation activities.
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<p>A-2</p>	<p>Refine withdrawal, consumptive use, and diversion management.</p> <p>Increasing efficiency of water withdrawal, consumptive use, and diversion approval processes, from project sponsor preparation through regulatory review and compliance, will help responsibly manage the Basin’s water supply. Incorporating risk-based management and refining evaluation of water availability and use, in order to avoid undesirable impacts on other users and ecosystems, will aid in balancing the conservation and utilization of water resources.</p>
<p>A-3</p>	<p>Expand water conservation and reuse practices.</p> <p>Enhancing water conservation efforts through increased public and industry education and implementation of best practices and technology will reduce stress on existing water supplies. Supporting increased water reuse and recycling practices and replacement of aging infrastructure will also increase water supply resiliency and reliability.</p>
<p>A-4</p>	<p>Increase water supply storage and consumptive use mitigation.</p> <p>Implementing traditional water storage and flow augmentation projects, as well as alternative mitigation methods including water conservation, groundwater recharge, and water quality improvements, will help offset impacts from reduced water availability during critical low flow periods.</p>
<p>A-5</p>	<p>Improve local water resources planning.</p> <p>Providing technical support and resources to local planning agencies regarding water use and availability conditions will help facilitate the inclusion of water supply considerations in growth planning activities, as well as improve understanding and responsibility relative to the link between land use decisions and local water resources.</p>
<p>A-6</p>	<p>Expand water supply outreach and data access.</p> <p>Informing the public and industry of the state of the Basin’s water supply and their role in improving management of water use and conservation can be enhanced through targeted education and outreach as well as improved access and awareness of data and relevant guidance information.</p>

Success Indicators

Indicators that demonstrate success in achieving Water Supply objectives include, but are not limited to, avoidance of water availability deficits, increased water conservation and reuse savings, and additional water supply storage and consumptive use mitigation.

Priority Management Area B – Water Quality

Goal: Waters throughout the Basin exhibit good quality.

Vision

The waters of the Basin meet or exceed water quality standards and are able to support desired water supply, aquatic life, and recreational uses.

Current State

Overall water quality has improved through time and most of the Basin’s waterways fully support water supply, fish consumption, aquatic life, and recreation. Over 15 percent of the Basin’s waterways are still degraded by agricultural runoff, legacy coal mining impacts, urban and suburban stormwater runoff, and discharges from combined sewer overflows (CSOs) (PADEP, 2020a). Additionally, scientific advancements mean that substances as well as effects, unnoticed in the past, are now seen and their possible risks must be considered. Such recent threats to water quality include emerging contaminants associated with the use of pharmaceuticals, personal care and cleaning products, pesticides, and plastics. Increased chloride levels in streams is another water quality issue of concern only beginning to be fully understood. Climate change also poses an increasing threat to water quality and aquatic habitat.

Role

While the Commission does not regulate water quality, it serves an important role by assisting member agencies, filling gaps, and pursuing long-term monitoring of waters throughout the Basin. The Commission continuously expands its monitoring activities, both in context of geography and the range of water quality issues monitored, but also with the innovative use of technology and new data analysis techniques. With over five decades of data collection, the Commission’s monitoring database is an indispensable resource for improving stewardship of water resources throughout the Basin. Within the context of this role, the Commission will also increase efforts to assist disadvantaged and underserved communities understand local water quality conditions and any steps needed to maintain or restore healthy conditions.

Objectives

B-1	Improve water quality monitoring. Improving use of technology, adequate geographic coverage, innovative data analytics, and coordination with key stakeholders will help improve monitoring techniques, enhance future projections, and better leverage limited resources. Developing an increased understanding of the changing climate and its influence on the fate and transport of pollutants will better inform restoration and protection strategies.
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<p>B-2</p>	<p>Increase protection for higher quality waters.</p> <p>Increasing monitoring, assessment, and coordination with state and local agency partners concerning waters classified as having excellent water quality or use designations requiring special protections will improve water resource conservation by maintaining focus on preserving high quality stream conditions as surrounding land uses and climate conditions change over time.</p>
<p>B-3</p>	<p>Restore impaired waters.</p> <p>Implementing restoration projects in collaboration with partners will help increase the scale and effectiveness of the efforts needed to restore the Basin’s impaired waterways through leveraging complementary resources. More effective and expansive implementation will also better support drinking water and other uses, and contribute to a healthier and productive Chesapeake Bay.</p>
<p>B-4</p>	<p>Remediate abandoned mine drainage and lands.</p> <p>Increasing implementation of land and water treatment strategies to address legacy coal mining impacts in collaboration with external partners will help restore impaired waterways.</p>
<p>B-5</p>	<p>Enhance recreational opportunities.</p> <p>Improving water quality promotes recreational use through support of healthy and sustainable waterways that attract fishing and wildlife viewing, swimming and boating activities, and adds aesthetic value to river communities and the region overall. Increased access and participation associated with water-based recreation increases stakeholder support for best management of Basin water resources.</p>

Success Indicators

Indicators for demonstrating success in achieving water quality objectives include, but are not limited to, improving water quality trends and indicators, fewer contact recreation closures, reduction of stream impairment listings, and increases in waterways under an elevated protected status.

Priority Management Area C – Flooding and Drought

Goal: Communities are more resilient to flooding and drought.

Vision

Basin communities will be prepared for and equipped to mitigate the effects of flooding and drought in a changing climate, minimizing loss of life and property, economic disruption, and adverse environmental impacts.

Current State

The Basin’s topography, climate, and settlement patterns make it prone to recurring riverine flooding and associated impacts. Recent increases in the frequency of high intensity precipitation events have also elevated flash flooding concerns (Shortle et al., 2020). Existing flood control reservoirs, levees, and other structural measures provide flood damage reduction benefits to local communities. Flood forecast and warning tools continue to improve, particularly for gaged locations throughout the Basin. Providing comparable products for many ungaged settings and rural communities remains a challenge, and changing climate patterns and extreme events constantly pose challenges in new areas. Basin hydrologic conditions continue to reflect a wetter trend since the record droughts of the 1960s (Zhang et al., 2010). Still, drought conditions in the early 2000s were significant enough to impact numerous water supply operations (Royslance, 2002). There continue to be advancements in drought monitoring and forecasting tools, but drought planning and operations in the Basin still primarily rely on traditional indicators and historic thresholds for initiating drought response actions.

Role

The Commission, in coordination with federal, state, and local partners, will continue to focus on non-structural flood and drought risk management measures, such as flood inundation mapping and drought management planning, to assist municipalities and industries in leveraging resources and implementing projects for mitigating the effects of flood and drought events and facilitating climate change adaptation. The Commission will also increase efforts to ensure equitable attention to underserved and disadvantaged communities when assessing and working with vulnerable communities.

Objectives

C-1	Expand use of climate projection information. Assessing regional climate projections and their implications to future hydrologic extremes will improve flood and drought planning and climate resilience in the Basin.
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C-2	<p>Improve community flood warning and response.</p> <p>Working in partnership with communities repeatedly impacted by significant flood events by utilizing a combination of monitoring data, forecast information, and decision support tools will expand local flood warning and response capabilities.</p>
C-3	<p>Enhance local flood risk assessment.</p> <p>Collaborating with partner agencies and stakeholders to conduct flood studies and develop flood inundation mapping for vulnerable communities will improve assessment of local flood risks and facilitate cost-effective mitigation decisions.</p>
C-4	<p>Advance drought monitoring and early warning.</p> <p>Increasing use of technology and data analytics will advance drought monitoring and early warning capabilities, which will facilitate increased drought preparedness and inform drought operations and mitigation strategies.</p>
C-5	<p>Improve low flow management and drought resiliency.</p> <p>Implementing a combination of water supply alternatives, operational changes, demand modifications, and environmental and water quality enhancements will improve low flow management and drought resiliency in the Basin.</p>
C-6	<p>Increase flood and drought coordination.</p> <p>Increasing agency coordination and outreach to industry and communities regarding flood and drought conditions will improve understanding of risks associated with flooding and drought, as well as preparedness and mitigation strategies.</p>

Success Indicators

Indicators that demonstrate success in achieving Flooding and Drought objectives include, but are not limited to, improved flood and drought early warning products that incorporate climate adaptation, more widespread forecast and mitigation coverage, increased water supply storage and backup sources, better community engagement with institutional resources and partnership opportunities, and reduced flood and drought damages.

Priority Management Area D – Watershed Management

Goal: Watersheds exhibit a healthy and sustainable balance between land and water management.

Vision

Integrated land use and water management practices allow watersheds to function in a natural and sustainable manner to protect and improve the quantity and quality of water resources in the Basin.

Current State

Activities on the surrounding landscape dominantly influence the Basin’s water resources. These influences include both legacy land use issues such as resource extraction and forest clearing for a variety of purposes, but also present day commercial and agricultural uses, and urban and suburban growth. The more forested portions of the Basin typically exhibit higher water quality, while the more developed portions of the Basin impact water quality and aquatic ecosystems, especially where inadequate management has led to the introduction of pollutants, invasive species, and excessive stormwater runoff. Additionally, increases to impervious areas from land development reduces infiltration and groundwater recharge, and generally disrupts the natural hydrologic cycle, which exacerbates conditions during both floods and droughts.

Role

As an interstate coordinating agency, the Commission will continue to work diligently with our federal, state, and local partners to leverage resources available at all levels to best inform and promote solutions at the land and water management interface for protection, conservation, restoration, and enhancement of water resources according to science-backed understanding of processes and development practices that affect water availability, water quality, and aquatic ecosystems across the Susquehanna River Basin in a seamless and equitable manner.

Objectives

D-1	Protect critical aquifer recharge areas. Identifying and promoting protection of open space and other land uses that provide for increased groundwater recharge will enhance the resiliency of water supply, stream baseflow, and water temperatures. Educating local stakeholders on the value of reducing impervious surfaces and promoting green infrastructure in their communities improves shared responsibility for management of the resource as well.
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<p>D-2</p>	<p>Promote land use practices for improving local waters and the Chesapeake Bay.</p> <p>Assisting with state and local implementation of projects and other best management practices will reduce runoff from land uses contributing to nutrient and sediment pollution, as well as protect forested areas and establish riparian buffers to offset climate change impacts to cold water habitats. Assessing and tracking anticipated pollutant loading reductions will also help inform needed adjustments to management strategies required to meet reduction goals.</p>
<p>D-3</p>	<p>Improve environmental flow management.</p> <p>Collaborating with partner agencies and the regulated community to conduct studies and model opportunities for improving environmental flows and balancing instream uses by making project improvements and/or modifying operations will help avoid water use conflicts, support healthy ecosystems, and increase recreational functions.</p>
<p>D-4</p>	<p>Restore native migratory fish to historic ranges.</p> <p>Promoting, coordinating, and/or implementing measures to provide for passage of migratory fish and eel at Basin hydroelectric dams, improving habitat connectivity for trout, supporting aquatic mussel reintroduction, and other native species measures, will help to restore Basin aquatic ecosystem conditions overall. Tracking progress regarding occurrence and extent of restored populations will also assist with adapting best management measures.</p>
<p>D-5</p>	<p>Reduce impacts from aquatic invasive species.</p> <p>Promoting, coordinating, and/or implementing measures for the early detection and reduction of aquatic invasive species within Basin waterways, and working to eradicate established populations will relieve pressure on native species and enhance aquatic ecosystem health. Tracking progress regarding occurrence and extent of populations will also assist with adapting best management practices.</p>
<p>D-6</p>	<p>Improve resiliency of the hydrologic landscape.</p> <p>Promoting and implementing practices that restore landscape function and limit hydrologic alteration by reducing or mitigating impacts associated with land development, especially with respect to improving stormwater management practices will enhance preservation/restoration of critical hydrologic features such as wetlands, floodplains, and forest cover/buffers, to best preserve and sustain groundwater and surface water resources.</p>

Success Indicators

Indicators for demonstrating success in mitigating land use and human activity impacts may include, but not be limited to, more unaltered flow regimes, reduced stormwater generated pollutant loads, reduced occurrence/extent of invasive species, reestablishment of native species to historic ranges, and increased reforestation along streams.

5. PROJECTS AND FACILITIES

The Compact calls for the Comprehensive Plan to include projects and facilities which are required, in the judgment of the Commission, for optimum planning, development, conservation, utilization, management, and control of the Basin's water resources to meet present and future needs. These include projects subject to review and approval in accordance with the Commission's regulations (<https://www.srbc.net/regulatory/regulations/>) and other water resources projects and facilities that meet the following criteria:

- The project or facility is aligned with the powers and duties of the Commission outlined in the Compact.
- The project or facility is required to meet present and future water resources needs of the Basin.
- The project or facility may have a significant effect on Basin water resources, interstate waters, or receiving waters of the Chesapeake Bay.
- The project or facility is compatible with the visions, goals, and objectives contained in the Comprehensive Plan.
- The project or facility is developed in support of the Water Resources Program (WRP) and sponsored by the Commission or a partner agency.

Projects requiring Commission review and approval will be included in the Comprehensive Plan after formal action is taken at Commission business meetings. Approved projects will be incorporated into the Comprehensive Plan and accessible via the Commission's Water Application and Approval Viewer (WAAV). This will enable the list of Commission-approved projects included in the Comprehensive Plan to be continually updated and current.

Non-Commission regulated projects and facilities, sponsored by the Commission and partner agencies, that meet the criteria outlined above will be incorporated in the Comprehensive Plan after public hearing and formal action. This includes priority projects identified in the WRP after they have been successfully completed. These non-regulated projects are included in Table 5 and will be added to the Comprehensive Plan website that will be maintained and refreshed on a regular basis.

The Commission relies on a variety of other projects and facilities to carry out its water resources management mission. These include rain and stream gages, water quality monitoring stations, river forecast points, fish passage facilities, etc. While not necessarily regulated or sponsored by the Commission, these amenities are essential to achieving many of the goals and objectives contained in the Comprehensive Plan. An inventory of these projects and facilities, including website links to their attributes and data, is also included in Table 5.

Table 5. Inventory of Projects and Facilities

Project/Facility	Agency	Data Source/Website
Commission Approved Projects	SRBC	https://www.srbc.net/waav
Consumptive Use Mitigation Projects	SRBC	https://www.srbc.net/hydrologic-conditions-monitor
Continuous Instream Monitoring Stations	SRBC	https://mdw.srbc.net/continuous-instream-monitoring
Abandoned Mine Drainage Treatment Projects	SRBC, PADEP	https://www.srbc.net/minedrainageportal/
Flood Warning Systems	SRBC, Other	1. https://www.srbc.net/our-work/programs/planning-operations/stagecam.html 2. https://www.srbc.net/portals/susquehanna-atlas/projects-map/
Public Water Supply Systems	PADEP, NYSDOH, MDE	NA (sensitive data)
Public Water Supply Reservoirs	USACE, Dam Safety	https://nid.sec.usace.army.mil/ords/f?p=105:1
Power Generation Facilities	US Energy Information Administration	https://www.eia.gov/state/maps.php
Water Quality Monitoring Stations	USGS	https://waterwatch.usgs.gov/wqwatch/
Wastewater Treatment Facilities	EPA NPDES	https://www.epa.gov/frs
River Forecast Points	USGS, NWS	https://www.weather.gov/marfc/
Flood Control Reservoirs	USACE, State Dam Safety	1. https://www.nab-wc.usace.army.mil/nab/ 2. https://nid.sec.usace.army.mil/ords/f?p=105:1
Levees & Floodwalls	USACE, FEMA	https://www.nab.usace.army.mil/Home/Levee-Safety-Program/Levee-Inspection-Status/
Rain Gages	NWS, USGS, Other	1. https://waterdata.usgs.gov/pa/nwis/current?type=precip&group_key=NONE 2. http://www.climate.psu.edu/data/ 3. https://water.weather.gov/precip/download.php
Stream Gages	USGS	https://waterwatch.usgs.gov/index.php?r=02&id=real
Groundwater Monitoring Wells	USGS	https://cida.usgs.gov/ngwmn/index.jsp
Fish Passage Facilities	Private	https://www.srbc.net/portals/susquehanna-atlas/projects-map/#

6. IMPLEMENTATION

The Comprehensive Plan will be implemented through the Commission’s annual WRP and the associated budget. Figure 12 shows the relationship between these key planning components.

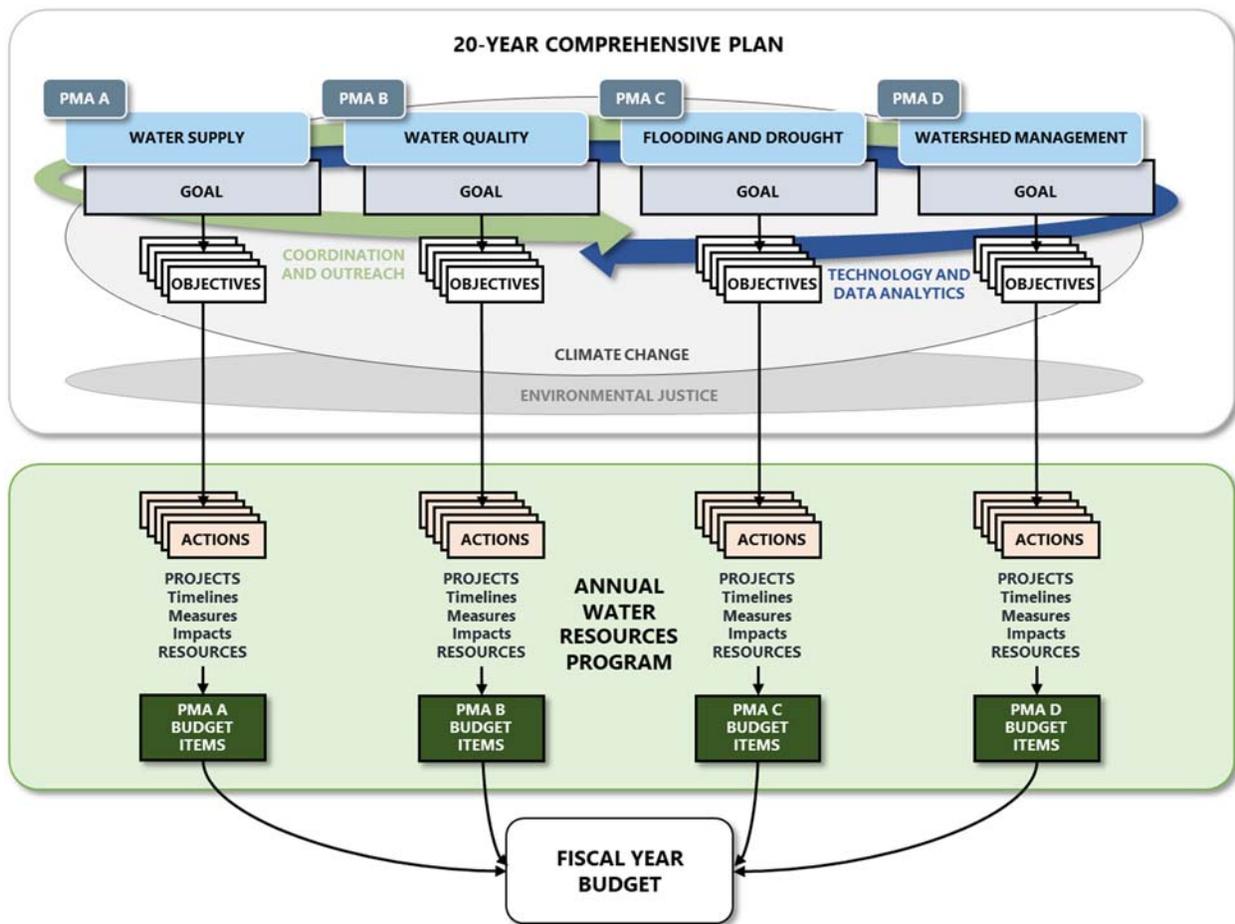


Figure 12. Comprehensive Plan, Water Resources Program, and Budget

The Compact requires the Commission to adopt a WRP every year to ensure water resources needs in the Basin are satisfied. Guided by the Comprehensive Plan, the WRP outlines priority projects and initiatives, key performance measures, and methods for progress tracking and responses (e.g., reallocating resources). The Compact also mandates that the Commission approve an annual capital and current expense budget consistent with the WRP and ongoing and future projects. The budget includes all projects proposed to be undertaken or continued during the fiscal year, along with the estimated cost and method of financing for each project. The yearly WRP and budget formulation process will ensure priority projects are adequately planned and funded in order to effectively implement the Comprehensive Plan over the next 20 years and achieve its goals and objectives.

The Compact allows the Commission to periodically review and revise the Comprehensive Plan to assure its content is current, and effectively guides the immediate and long-range development and use of the water resources of the Basin. Prior to adopting revisions to the existing or a new Comprehensive Plan, the Commission must consult with water users, interested public entities, and signatory agencies, as well as conduct public hearings. This 2021-2041 Comprehensive Plan will be implemented over the next 20 years, with a formal review of the plan’s relevance scheduled for 2031. If adjustments are needed at that time to address emergent PMAs, goals, or objectives, the Comprehensive Plan will be revised in accordance with requirements outlined above.

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Appendix A

Susquehanna River Basin Compact

<https://www.srbc.net/about/about-us/docs/srbc-compact.pdf>

Appendix B

Water Resources Program

<https://www.srbc.net/our-work/planning/water-resources-program/>