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A Framework for the Delaware River Basin Commission's Water Resources Resilience Plan

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[1] In accordance with the Resolution for the Minutes adopted on June 11, 2025, no federal funds awarded thereafter to the Commission through the United States Army Corps of Engineers were used in preparation of this report.

DRBC's Water Resources Resilience Plan (WRRP)

PHASE 1 EXECUTIVE SUMMARY

The WRRP will be completed in three phases and will recommend actions that DRBC can take to **manage the Basin's shared water resources** through the known and potential impacts of **climate change and other challenges**.

Phase 1 Framework

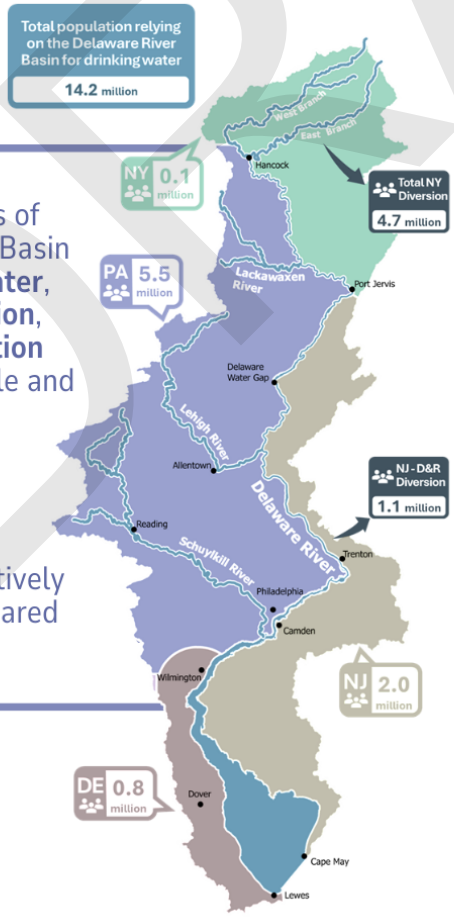
Phase 2 Climate Change

Phase 3 Additional Challenges

- **2010s** — DRBC begins to explicitly address climate change.
- **Dec 2019** — Advisory Committee on Climate Change (ACCC) established.
- **June 2024** — Resolution directs DRBC staff to develop a climate resilience plan.
- **Aug 2024** — Convene an interdisciplinary DRBC team.
- **Dec 2024** — Open online comment card and launch microsite.
- **Feb-Oct 2025** — Host 13 listening sessions with 122 participants.
- **Nov 2025** — Close online comment card with 47 responses.
- **Jan 2026** — Draft Phase 1 report shared for external review.
- **Mar 2026** — Phase 1 report is published, and Phase 2 begins!

The water resources of the Delaware River Basin provide **drinking water**, **navigation**, **recreation**, and **energy generation** for millions of people and support a **diverse aquatic ecosystem**.

DRBC is the regulatory agency charged with collectively overseeing these shared water resources.



The WRRP will identify actions to protect the water resource assets that stakeholders value:

WATER AVAILABILITY	High-quality water supply (streamflow, reservoirs, and groundwater)
AQUATIC LIFE	All species that live in and/or rely on water bodies in the Basin and their habitat
LANDSCAPE	Water-adjacent infrastructure that supports quality of life and recreation

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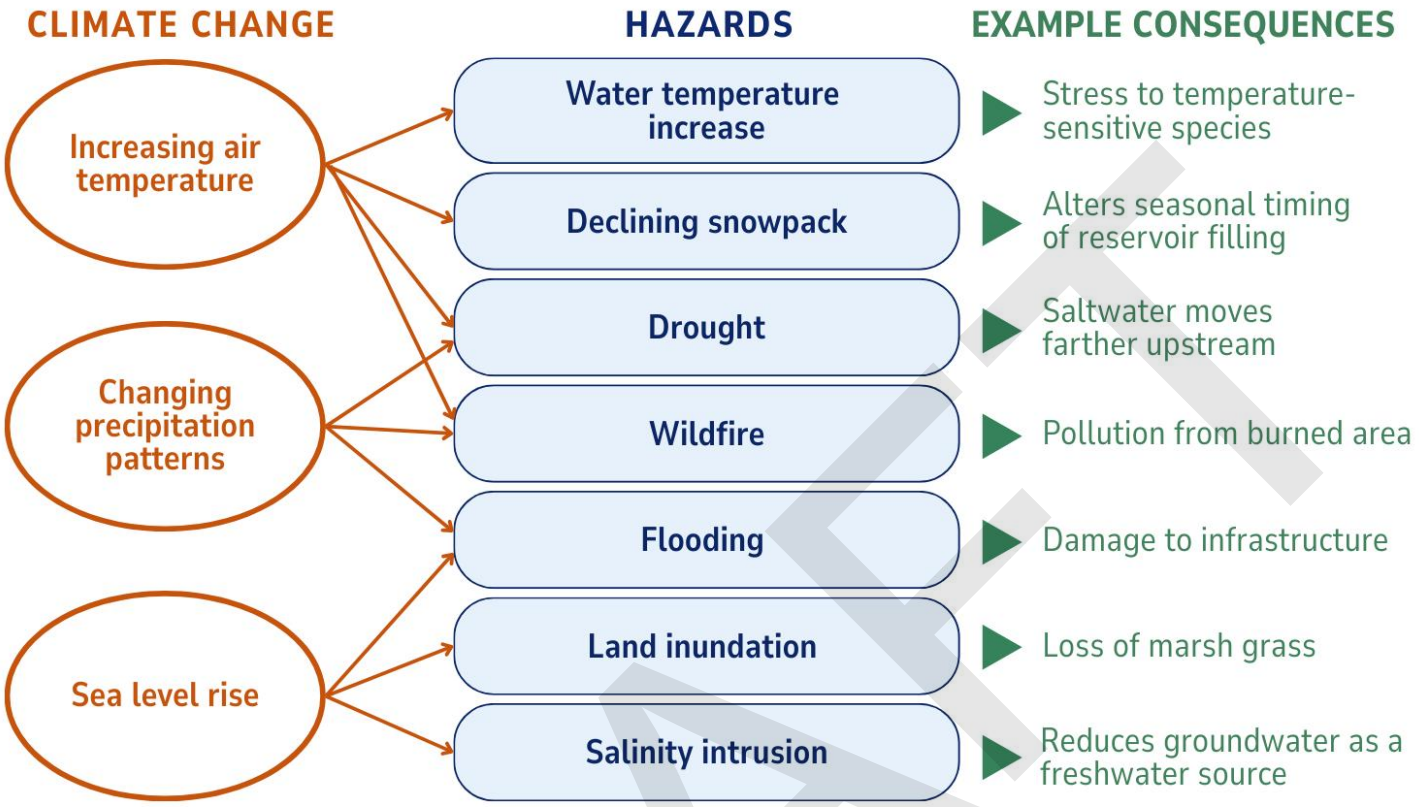
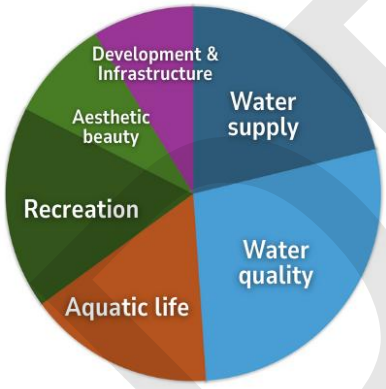
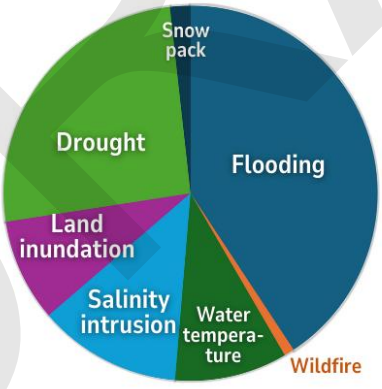
Phase 2 will focus on stakeholders' concerns about **climate change**.



Stakeholders identified common values and concerns.



What do you **value** about the Basin's water resources?



What are your **concerns** about climate change in the Basin?

Phase 3 will focus on additional concerns, such as **freshwater salinization**, **contaminants of emerging concern**, and **changing patterns of water demand**.

GET THE LATEST PLAN UPDATES

https://tinyurl.com/DRBC-WRRP

Workplan for the Water Resources Resilience Plan

PHASE 1

Scenario Planning

The WRRP will consider:

- Mid-century (2060) and end-century (2100) planning horizons.
- A low-emissions scenario and a high-emissions scenario.

PHASE 2

Vulnerability Assessment

How and where are the Basin's water resources most at risk?

- Quantify the changes that are expected to occur at each planning horizon, in each scenario.
- Characterize the impacts of those expected changes on the Basin's water resources.

Gap Analysis

What gaps exist in addressing those identified risks?

- Choose a goal outcome and define a pathway to advance toward that goal.
- Identify "gaps": Pieces of the pathway that are not being addressed by DRBC or other entities.

Recommended Actions and Activities

How can DRBC contribute to closing those gaps?

- Identify potential actions: The gaps DRBC is best suited to address.
- Prioritize these actions according to their impact, urgency, reach, relevance, feasibility, and synergy.

PHASE 3

Expand to Additional Challenges

Develop a vulnerability assessment, gap analysis, and list of recommended actions for additional challenges, which may include:

- PFAS, microplastics, and other sources of pollution;
- Freshwater salinization; and
- Changing patterns of water demand.

Conduct stakeholder input and consult with the ACCC throughout

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List of Acronyms and Abbreviations

ACCC	Advisory Committee on Climate Change
AR5	IPCC's Fifth Assessment Report
AR6	IPCC's Sixth Assessment Report
DE	Delaware
DO	Dissolved Oxygen
DRB	Delaware River Basin
DRBC	Delaware River Basin Commission
GW	Groundwater
IDF	Intensity-Duration-Frequency
IPCC	Intergovernmental Panel on Climate Change
LOCA	Locally Constructed Analogs
NJ	New Jersey
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NY	New York
PA	Pennsylvania
PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances
RCP	Representative Concentration Pathway
SSP	Shared Socio-economic Pathway
SPW	Special Protection Waters
WRRP	Water Resources Resilience Plan

1. DRBC's Water Resources Resilience Plan: An Overview

1.1 Water Resources of the Delaware River Basin

The water resources of the Delaware River Basin (DRB or "Basin") support millions of people and a richly diverse aquatic ecosystem. The 13,500-mi^2 Basin provides drinking water for 14.2 million people in New York (NY), New Jersey (NJ), Pennsylvania (PA), and Delaware (DE) (**Figure 1-1**). The Lower Delaware River Basin is the second-highest electric-producing region in the United States, with multiple thermoelectric and nuclear power generation plants that rely on water from the Delaware River and its tributaries for cooling. The waters of the Basin serve as habitat for endangered species, such as Atlantic Sturgeon and Dwarf Wedgemussel, while providing bountiful recreational opportunities including boating, fishing, swimming, and hiking. The Delaware Estuary also provides valuable waterways for commercial navigation and is home to one of the world's largest freshwater port complexes.

The Delaware River Basin Commission (DRBC or "Commission") was created in 1961 to manage these shared resources without regard to political boundaries. As described in Article 1.3.e of the Delaware River Basin Compact, the statute that created the Commission, DRBC's purposes include: "to promote interstate comity", "to encourage and provide for the planning, conservation, utilization, development, management and control of the water resources of the basin," and "to apply the principle of equal and uniform treatment of all water users."

As the regulatory agency charged with collectively overseeing shared water resources in the Basin, the DRBC is a vehicle for the member states and the United States, together with local partners, to advance the resilience of these critical resources in the face of new challenges, including climate change. DRBC's 64-year track record has demonstrated the power of cooperative resource management to improve and protect the Basin's water resources. When the DRBC was created in 1961, for up to six months each year the urban portions of the Delaware River Estuary had little to no dissolved oxygen (DO), conditions under which most aquatic life cannot survive. In response, DRBC established water quality requirements to protect resident and migratory fish in 1967. DO concentrations now regularly surpass those established criteria, which has allowed fish populations to return to the Estuary. In 1992, DRBC adopted the Special Protection Waters (SPW) regulatory program to protect the exceptional water quality in the non-tidal Delaware River. The SPW program includes regular monitoring in collaboration with the National Park Service (NPS), stricter regulations for wastewater discharges in this portion of the watershed, and regulation of other sources of pollution. These efforts have succeeded in keeping the exceptionally high quality of the Basin's non-tidal interstate waters clean. Through the *Our Shared Waters* network, DRBC works with over 100 partner organizations representing utilities, non-profits, government, community groups, and businesses to raise awareness and connect people to the Delaware River Basin's water resources.

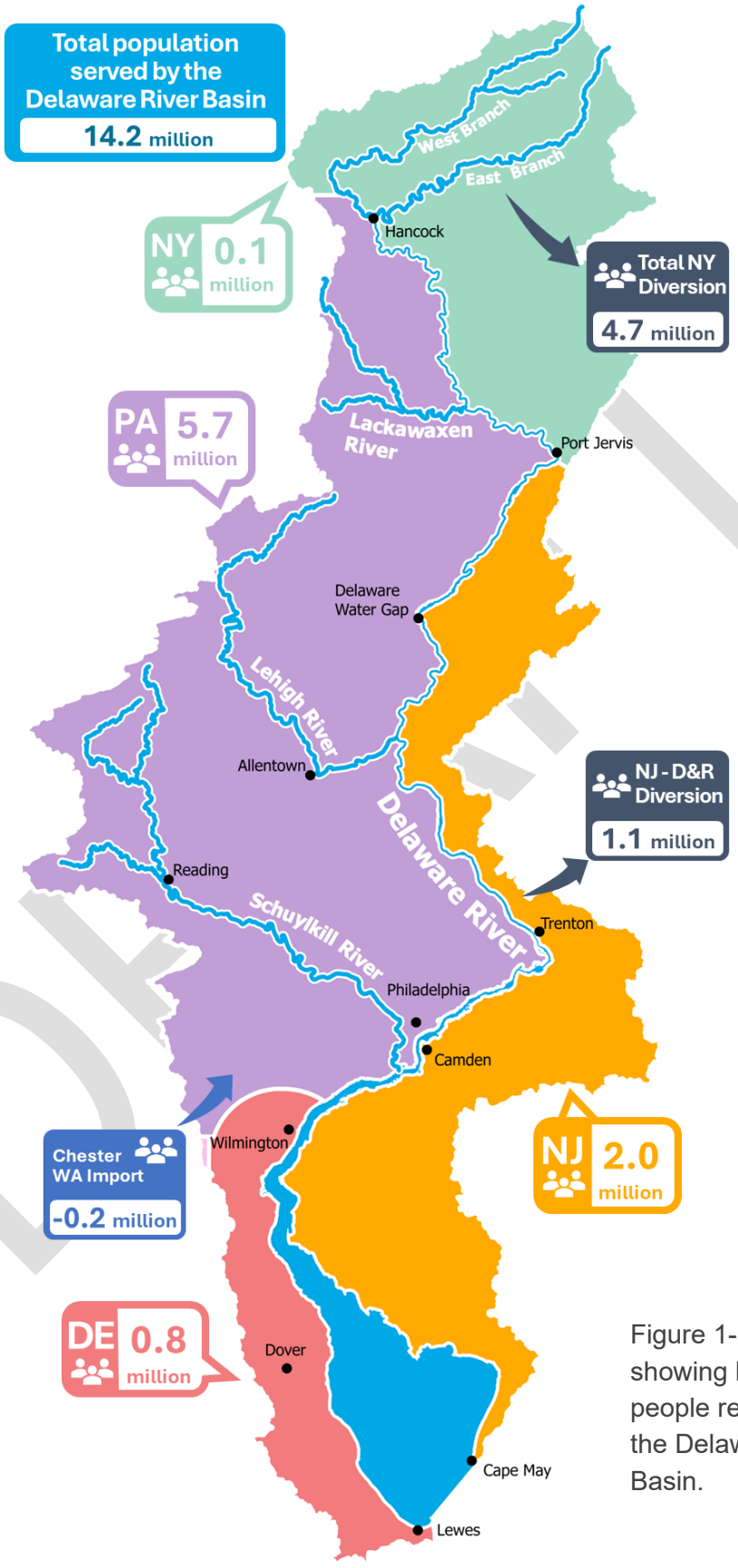


Figure 1-1. A map showing how many people rely on water from the Delaware River Basin.

1.2 Purpose and Vision for the DRBC's Water Resources Resilience Plan

Climate change, as used throughout this document, describes observed global changes to average temperatures, rainfall patterns, and other conditions that have occurred over the past century and are expected to continue (NASA, 2025). On June 5, 2024, via the formal process used for undertaking major DRBC initiatives, the Commissioners unanimously adopted Resolution 2024-04, which sets forth the finding that:

> Climate change has caused and will continue to produce impacts on the water cycle, including on water availability; water quality; the management and uses of Basin water for economic, recreational, ecosystem sustainability, and other purposes; and the functionality and resilience of water infrastructure and other vital projects and activities within the Delaware River Basin.

Based on this finding, the resolution directs the Commission staff to develop a climate resilience plan that will guide the Commission's efforts to develop management approaches, including recommended policies and rules, for improving resilience and adaptation to a changing climate. In light of initial feedback from partners and stakeholders, who raised a wide range of concerns about the Basin's water resources that are outside the scope of the resolution, and recognizing that the authority, jurisdiction, and expertise of the Commission is focused on water resource management, the climate resilience plan will be formally known as the Water Resources Resilience Plan (WRRP). The WRRP will focus on the many challenges that the Basin's water resources face due to climate change and other causes.

The vision statement for DRBC's WRRP is as follows:

> **The Water Resources Resilience Plan will recommend actions that the DRBC can take to manage the Basin's shared water resources through the known and potential impacts of climate change and other challenges.**

This vision aligns with the Commission's broad efforts to ensure an adequate and equitable supply of suitable quality water for Delaware River Basin water users and the environment. The DRBC will use the WRRP to guide, coordinate, and expand ongoing and future work related to assessing and mitigating the impacts of climate change and other challenges to the Basin's water resources. The remainder of this document details, at a high level, the Commission's expected process for developing the WRRP.

1.3 What Do We Value about the Basin's Shared Water Resources?

Inspired by input detailing what stakeholders value about the Basin's water resources, **Table 1-1** defines three shared basin-wide **water resource assets** that collectively provide wide-ranging benefit to Basin water users. These water resource assets will form the basis of the WRRP and comprise broad concepts with many inter-related component parts that each have different characteristics. Importantly, the pathway to protect and advance the resilience of each water resource asset will include actions that address individual components. For example, even though migratory fish and benthic macroinvertebrates are grouped together with other elements of "Aquatic Life," distinct protective actions for each may be considered as part of the WRRP.

Effective management of these water resource assets is necessary to support those who rely on the Basin's water resources for drinking water, habitat, recreation, energy, navigation, irrigation, industry, and assimilative capacity. The WRRP reflects this need, with a focus on protecting and managing these water resource assets through emerging challenges in the future, including those caused by climate change. Specific objectives for each water resource asset will be defined in Phase 2 but may include maintaining or enhancing existing water quality and habitat, preserving water availability, and minimizing flood losses.

Table 1-1. Shared water resource assets.

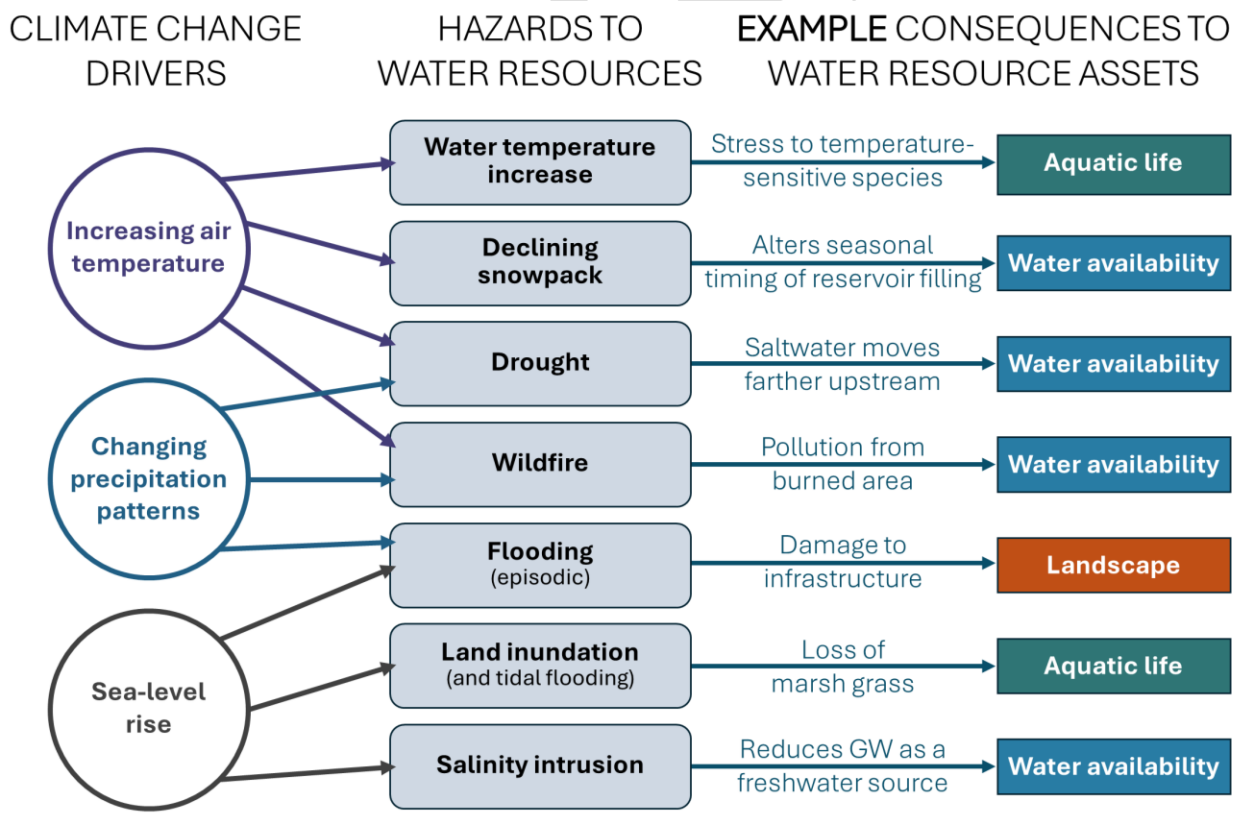
Water Resource Asset	Includes…
Water Availability	Water supplies, such as streamflow along the main stem Delaware River, major and minor tributaries, and headwater streams; confined and unconfined groundwater aquifers; and reservoir storage. Water quality parameters such as salinity, temperature, dissolved oxygen, and nutrients.
Aquatic Life	All species that live in and/or rely on water bodies in the Basin, such as fish, shellfish, benthic macroinvertebrates, aquatic vegetation, and algae. Wildlife habitat such as marshlands and riparian vegetation.
Landscape	Water-adjacent infrastructure that supports quality of life and recreation, such as parks, bridges and roads, dams, buildings and homes, and boat launches.

1.4 What Concerns Do We Have about Water Resources in the Future?

Hazards are specific processes or events that present challenges to managing one or more of the Basin's water resource assets. Hazards may be discrete events that occur with some frequency, such as droughts or floods, or gradual, continuous processes, such as increasing water temperature or land inundation due to sea level rise. Figure 1-2 illustrates how increasing air temperature, changing precipitation patterns, and sea level rise due to climate change are driving seven specific hazards that affect the Basin's water resources and that align with stakeholder input. These hazards are drought, flooding, salinity intrusion, increasing water temperature, land inundation, wildfire, and declining snowpack. An example consequence of each hazard on a water resource asset is shown on Figure 1-2.

The Basin's water resources face many additional hazards that are not driven by climate change, including contaminants of emerging concern, freshwater salinization, and changing patterns of water demand. These hazards will be considered in Phase 3 as part of a broader assessment of potential threats to future water resources.

Figure 1-2. Illustration of the relationships between climate change drivers, hazards, and consequences to water resource assets.



Many partners working in the Basin have completed, or are working on, climate resilience planning efforts. Each of the four Basin states has produced a thorough climate action plan that addresses many concerns relating to water resource management. Many cities that rely on the DRB's water resources (including New York City, NY; Philadelphia, PA; Wilmington, DE; Trenton, NJ; and Bethlehem, PA) and partner organizations working in the Basin (including the Partnership for the Delaware Estuary and the Delaware Valley Regional Planning Commission) have ongoing climate resilience planning processes. In recognition of these efforts, DRBC strives for the WRRP to build on and complement our partners' work. The WRRP will adapt the traditional climate resilience plan framework to apply to water resources throughout the Basin, emphasizing DRBC's role in convening multiple partners and providing coordinated water resources management and regulation at a basin-wide scale.

1.5 Water Resources Resilience Planning Process

Like many climate planning efforts, DRBC's WRRP will be completed in several phases, each building on those that precede it. A brief description of each phase is included below.

1.5.1 Phase 1: A Framework for DRBC's Water Resources Resilience Plan

Phase 1 outlines a workplan for the WRRP and sets the stage for specific work to be completed in Phases 2 and 3. Notably, this Phase 1 report defines the water resource assets, climate change hazards, planning horizons, and future scenarios that will form the foundation of Phase 2, as well as the metrics that will be used to prioritize recommended actions and activities. These decisions reflect collective input gathered from many partners and stakeholders during Phase 1. In the process of carrying out Phases 2 and 3, it is possible that new information will arise, or new limits will be discovered, that will require adjusting the definitions and priorities laid out in this document.

1.5.2 Phase 2: Advancing Resilience of the Delaware River Basin's Water Resources to Climate Change

The objective of Phase 2 is to develop a list of recommended actions and activities that DRBC could undertake to advance resilience of the Basin's water resources to climate change. These recommendations will complement and build on DRBC's and partners' past and ongoing work. Developing this list will proceed in three steps, detailed below in Section 4:

(1) A vulnerability assessment will characterize the impacts that each water resource asset is expected to experience due to a specific climate change hazard identified above.

(2) A gap analysis will identify potential actions and activities, considering the work that DRBC and others are undertaking to address the impacts identified in the vulnerability assessment.

(3) The identified actions and activities will be prioritized according to a set of metrics.

1.5.3 Phase 3: Advancing Resilience of the Delaware River Basin's Water Resources to Additional Challenges

During Phase 3, the three-step process applied in Phase 2 to evaluate and plan for climate change hazards will be applied to additional challenges that are not driven by climate change. The objective for Phase 3 is to provide recommended actions and activities that DRBC could take to advance the resilience of the Basin's water resources in light of these additional challenges.

1.5.4 Implementation

The Commission has been studying, considering, and preparing for the impacts of climate change in the Basin for decades before Resolution 2024-04 was passed. Recent initiatives by the Commission include partnering with the Pennsylvania Emergency Management Agency on flood mitigation workshops for local municipalities; modeling to evaluate the impact of changing precipitation patterns, rising air temperatures, and sea level rise on the Basin's water resources; and supporting the development of an interactive web-based tool to project extreme precipitation in the Basin. Throughout the Water Resources Resilience Planning process, DRBC staff will continue such work, which may include:

- Continuing ongoing technical projects relating to climate change and additional challenges,
- Pursuing funding for new technical studies,
- Adapting monitoring programs to collect new information, and
- Developing new tools and resources to visualize data.

Upon completion of Phase 2, the Commission will consider implementation of the most highly recommended actions and activities. Implementation is a separate endeavor from the planning process that will, when feasible, be pursued concurrently. In collaboration with relevant advisory committee(s) and/or work group(s), Commission staff may build on the recommendations from the WRRP to develop specific proposed actions requiring Commission consideration. These actions may include revising existing policies and regulations or adopting new policies and regulations. Any new or revised policies or regulations will include a public hearing and public comment period. As required by Resolution 2024-04, the Commission's annual Water Resources Program will include a section on climate resilience. In addition to the informal external input solicited throughout all three Phases of the WRRP, the public hearing and written comment period the Commission provides on each draft Water Resources Program will afford members of the public an opportunity to comment each year on DRBC's WRRP progress.

2. External Input

2.1 Advisory Committee on Climate Change

In December 2019, by Resolution 2019-8, DRBC established the Advisory Committee on Climate Change (ACCC). This committee includes nine "reserved" members, representing the four Basin states (NY, NJ, PA, DE), the federal government (two members), New York City, Philadelphia, and the Partnership for the Delaware Estuary. Additional "non-reserved" members include representatives from academic or research institutions, environmental or watershed organizations, business or industries, and water or wastewater utilities. A current list of ACCC members can be found on the DRBC website.[2] The fundamental role of DRBC's advisory committees is to provide scientifically-based information and recommendations for Commissioners to consider.

As required by Resolution 2024-04, DRBC staff will continue to regularly update ACCC on the status of the Water Resources Resilience Plan, and ACCC members will continue to use their expertise to advise and consult as the plan is developed and implemented. ACCC meetings are open to the public and also serve as a forum for public engagement, including with non-member stakeholders.

Since Resolution 2024-04 was passed in June 2024, ACCC has met six times. At each meeting, DRBC staff updated the committee on the WRRP's status and received feedback from the committee that guided next steps in developing this Phase 1 report. All presentations to the ACCC, as well as meeting summaries that include the committee's and the public's comments, are available on the ACCC page of DRBC's website.[3] Many of the resulting discussions and resources informed this Phase 1 report, including:

- The suggestion to conduct focused, informal stakeholder engagement during each phase of the planning process,
- Resources and guidance related to the definition of scenario planning boundaries and selection of future climate scenarios, and
- Input to help clarify the water resource assets and climate change hazards definitions.

ACCC hosted guest presentations from the four Basin States, New York City Department of Environmental Protection, Philadelphia Office of Sustainability, and Rutgers University's Climate Change Resource Center about their climate resilience work. These presentations provided helpful context and inspiration for the WRRP and are readily available on the DRBC's website.[3]

[2] https://www.nj.gov/drbc/about/advisory/ACCC_committee.html

[3] https://www.nj.gov/drbc/about/advisory/ACCC_index.html#2

2.2 PUBLIC AND PARTNERS

DRBC conducted public engagement efforts during Phase 1 to ensure the WRRP's scope considers the breadth of public and partner concerns about the effects of climate change on water resources. There were four primary questions posed to the public and partners during Phase 1:

1. How do you interact with water resources in the Delaware River Basin?
2. What are your concerns about water resources in the future, for example, due to climate change?
3. How would you like to see the Commission protect water resources?
4. How would you want to stay informed and engaged about DRBC's Water Resources Resilience Plan?

In an effort to be more accessible to the public served by DRBC and the many partners that collaborate with the Commission, DRBC provided multiple ways to engage:

- An online comment card through which anyone could share their thoughts from December 2024 through November 2025,
- 13 virtual and in-person listening sessions (**Figure 2-1**),
- Informal "office hours" during partner outreach events in all four Basin states,
- Presentations at partner organizations' meetings,
- A public comment period for the annual Water Resources Program in 2025, and
- Open public remarks during ACCC meetings as noted above.

This public input effort has been distinct from the formal notice and comment procedure used for Commission actions. The format was selected based on the Commissioners' and ACCC members' experiences with public outreach for their own planning efforts, including those addressing climate resilience. The process also afforded an opportunity for DRBC to test new approaches to engage with the Basin community and observe which were most effective, informing future engagement efforts in Phases 2 and 3.

2.2.1 Summary of Stakeholder Input Received during Phase 1

Stakeholder input gathered during Phase 1 influenced many decisions and definitions reflected in this report. Over 150 people engaged during Phase 1, including 121 people who attended a listening session and 47 people who responded to the online comment card (some people did both). These stakeholders represented all four Basin states and had a wide range of affiliations, including state and federal government, non-profits, public and private utilities, academia, faith-based groups, youth, community groups, and Basin residents. Of those who identified what state they are from, 40% live in the Basin's most populous state, Pennsylvania (**Figure 2-2A**).

Figure 2-1. DRBC staff hosting an in-person listening session.

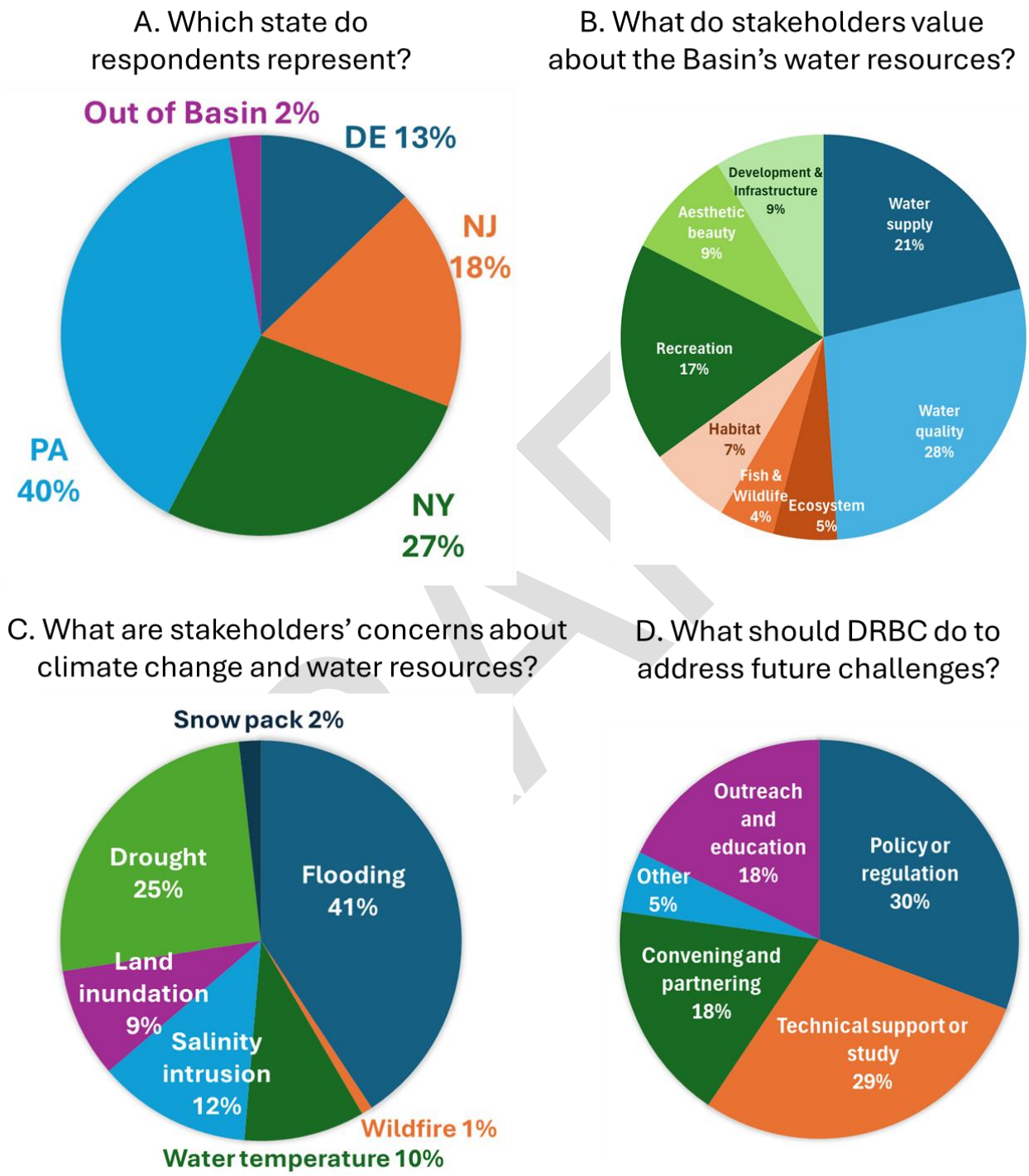
DRBC Director of External Affairs and Communication, Elizabeth Koniers Brown, leads a listening session at the Route 9 Library and Innovation Center in New Castle, DE.

Many stakeholders shared how much they appreciate and interact with the Basin's water resources, remarking on the Basin's aesthetic beauty, the range of recreational activities they partake in, and the importance of the Delaware River as a water source. (**Figure 2-2B**). This input helped DRBC staff identify what the Basin community values most and informed the list of water resource assets that will serve as the foundation of the WRRP.

Stakeholders also shared many specific concerns about the future of water resources in light of climate change. More than half of respondents (53%) mentioned flooding as a concern, and one-third (33%) mentioned drought (**Figure 2-2C**). In total, stakeholders identified seven distinct climate change hazards that will be addressed in Phase 2. Stakeholders brought up many additional challenges that are not driven by climate change, listed below in Section 5, that will be considered for inclusion in Phase 3.

When asked how DRBC should respond to these challenges, stakeholders shared a variety of ideas that largely fell within the DRBC's existing roles: policy or regulation, technical support or studies, convening and partnering, and outreach and education (**Figure 2-2D**). Specific ideas, which may extend beyond these categories, will be considered during the gap analysis in Phase 2, at which stage potential actions will be identified (Section 4.2 below).

Figure 2-2. A summary of stakeholder input received during Phase 1.



Originally, DRBC named this plan its "Climate Resilience Plan." At early public input sessions, participants expressed confusion about the scope of the plan, assuming that, like most "Climate Action Plans," emissions and energy would be a major focus area, though these topics are outside of DRBC's authority as set forth in the DRBC Compact (Section 4.3.1 below) and are outside the scope of Resolution 2024-04. In addition, as noted above, many stakeholders consistently expressed concern about challenges facing the Basin's water resources that are not caused by climate change. In response to this feedback, the climate resilience plan was renamed the "Water Resources Resilience Plan." This name better communicates the Commission's focus on water resources and broadens the scope of the plan to include a wider range of challenges.

2.3 External Input during Phases 2 and 3

Throughout Phases 2 and 3, DRBC staff will continue to consult regularly with ACCC members during committee meetings, to be held approximately three times per year, and to reach out to members between meetings as necessary. Guest presentations at ACCC meetings will continue to provide additional context, inspiration, and examples to guide work during Phases 2 and 3.

The Commission will continue to solicit input from the public and DRBC's partners during Phases 2 and 3, and this stakeholder engagement will likely include approaches similar to those used in Phase 1, including an online comment card, listening sessions, partner outreach events, and more. Participants will have the opportunity to provide written and/or verbal feedback and to respond to and prioritize hazards, vulnerabilities, and/or gaps to be addressed. DRBC also may develop posters and infographics to communicate the topics under consideration, offer incentives for participation, and experiment with other ways of increasing the project's visibility and facilitating public engagement.

3. Scenario Planning for the Water Resources Resilience Plan

Scenario planning involves defining one or more future scenarios to consider in the planning process and is a foundational step in climate resilience planning and management. The WRRP will rely on work by the Intergovernmental Panel on Climate Change (IPCC) that lays out potential future scenarios based on current understanding of the physical processes driving climate change (**Figure 3-1**). The IPCC scenarios are the foundation of the majority of climate planning work around the globe and can be used to understand the range of possible future conditions (Jay et al., 2018). While it is impossible to precisely predict the specific impacts climate change will have at a given location and time, exploring and selecting multiple possible future scenarios helps resource managers identify important indicators to monitor and prepare to respond to challenges that are likely to arise (NPS, 2020).

3.1 Historical Baseline and Planning Horizons

The scenario planning process requires defining the geographic extent that will be considered. The DRBC's spatial domain is defined by the Basin boundaries, and the WRRP will generally also focus on this specific region. In the context of different analyses conducted as part of the WRRP, however, the relevant spatial domain may vary. For example, assessing and planning for the impacts of sea level rise might focus on the tidal portion of the main stem Delaware River and its tributaries. The spatial extent relevant to specific water resource assets and climate change hazards will be defined on a case-by-case basis during Phase 2, as it will not be feasible to include every water body in the Basin in the spatial domain for every analysis.

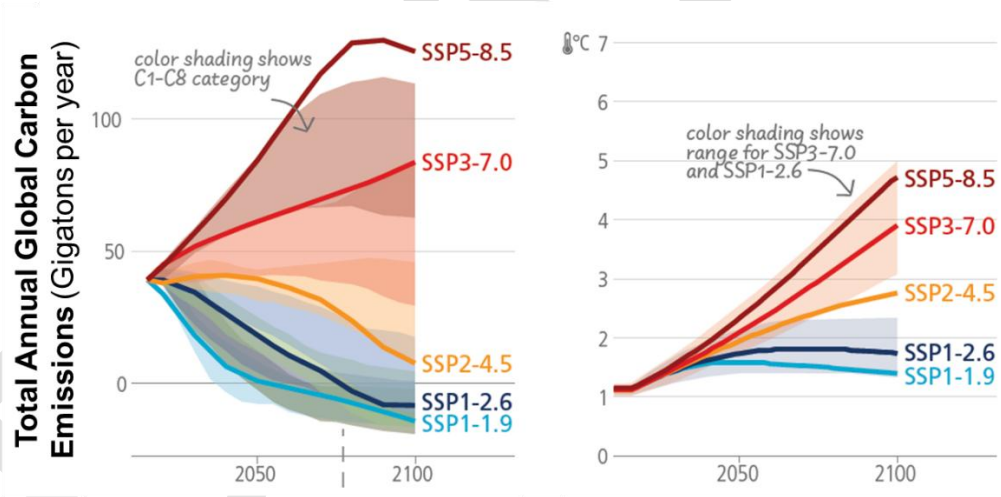
Defining a **historical baseline** to be used as a starting or reference point against which to evaluate projected future changes is also important (IPCC, 2023). Our current design standards, policies, programs, and plans are in general designed for climate patterns that are consistent with the historical baseline. Many factors may influence the selection of a historical baseline time frame. It is desirable for this time frame to be long enough to include a representative range of conditions, but short enough to represent a stationary period (i.e., not include long-term trends). Including important extreme events, such as the drought of record (1961–1967 in the Delaware River Basin) and large main stem floods (1955, 1996, 2004, 2005, and 2006), can be important for understanding how the frequency and magnitude of these impactful events may change in the future. The IPCC global circulation models, which are the foundation of most climate change projections, uses a historical baseline of 1950–2005 (IPCC, 2014), while the United States National Oceanic and Atmospheric Administration (NOAA) defines climate "normals" for the United States using a 30-year period, e.g., 1981–2010 (Arguez et al., 2012). With these considerations in mind, the baseline for the WRRP will represent climate in the Delaware River Basin over the period 1950–2005, in line with the historical IPCC scenarios and including the drought of record and several large flood events.

Finally, **future planning horizons** specify the future time frames to be considered. The WRRP will consider a near-term horizon of 2060 (covering the period 2030–2060), aligning with existing DRBC water resource planning work that uses a planning horizon of 2060 (DRBC, 2025), as well as an end-century horizon of 2100 (covering the period 2070–2100), aligning with the IPCC scenarios' end date (IPCC, 2023).

3.2 Scenario Selection

IPCC future climate change scenarios contain global information about a wide range of variables, including projected temperature, precipitation, and sea level rise. The most recent set of global model results that make projections about possible future conditions were released in 2023 as part of the Sixth Assessment Report (AR6). Before that, global model results from the Fifth Assessment Report (AR5) were released in 2014. The WRRP will consider two commonly-applied future climate scenarios from the AR6 report: a moderate emissions scenario (SSP2-4.5[4]) and a high emissions scenario (SSP3-7.0[4]) (Figure 3-1). For each scenario, a range of predictions from 32 climate models is available. Collectively, projections from the 32 SSP2-4.5 models and 32 SSP3-7.0 models represent a wide range of possible future conditions in the DRB.

Figure 3-1. Schematic of different emissions scenarios from the IPCC AR6.



Left: Total annual global carbon emissions for the very low (SSP1-1.9), low (SSP1-2.6), moderate (SSP2-4.5), high (SSP3-7.0), and very high (SSP5-8.5) emissions scenarios. *Right*: Global temperature increase for the same five scenarios. Figure adapted from (IPCC, 2023).

[4] Shared Socioeconomic Pathways (SSPs) are scenarios that represent global trends in future greenhouse gas emissions as well as changes to related factors, including population growth, urbanization, and economic growth. The number at the end of the scenario name indicates the projected change in radiative forcing by 2100 relative to preindustrial conditions, with a higher number associated with higher emissions. For example, SSP2-4.5 represents a scenario where radiative forcing will have increased by 4.5 W/m^2 as of 2100 due to modest reductions in global greenhouse gas emissions. The SSP3-7.0 scenario represents increasing emissions through 2100.

4. Phase 2 Workplan

The goal of Phase 2 is to provide recommended actions and activities that DRBC can take to address the impacts that specific climate change hazards will have on the shared water resources of the Basin. Developing these recommendations will require completing three steps, each outlined in a section below.

4.1 Vulnerability Assessment

Vulnerability is "the propensity or predisposition to be adversely affected" (IPCC, 2023). A common framework for evaluating vulnerability in the context of climate change includes three elements (Hyman et al., 2025):

- **Exposure**: expected changes to the nature, magnitude, and variability of hazards that a system is exposed to,
- **Sensitivity**: the system's responsiveness to these changes, and
- **Adaptive capacity**: the system's capability to adapt to these changes.

In a typical climate plan, the goal of a vulnerability assessment is to guide prioritization and protection of the most vulnerable assets. Often, thousands of unique assets are considered, and this long list is reduced to focus on those that are most at risk from a specific hazard or set of hazards. In the context of a basin-wide resilience plan for water resources, the process needs to look different. We already know that each of the identified water resource assets are vulnerable to multiple hazards from climate change. The goal of the WRRP's vulnerability assessment, then, will be to characterize **where and how each water resource asset is most vulnerable to climate change hazards**, within the scenario planning boundaries outlined above.

The WRRP's vulnerability assessment will be conducted in three steps:

1. **Identify which of the seven defined climate change hazards are expected to affect each water resource asset.** This includes identifying any instances where the impacts of multiple hazards on a water resource asset may compound.

2. **Quantify the changes (exposure) each water resource asset may experience.** To the best of available data, exposure will be quantified for each selected scenario and planning horizon. Table 4-1 lists the data sources that will be used to evaluate the impacts of each hazard in the DRB. In addition, scientific literature and relevant reports will be consulted to put the results in a wider geographic context and guide the assessment of compound impacts from multiple hazards.

To reflect the uncertainty inherent in future projections, the expected changes will be expressed as a range, for example: "In 2050, under scenario A, we expect between X and Y inches of sea level rise." Some hazards, such as flooding, may be represented by multiple quantified changes, for example, changes in the intensity of 1-in-5-year storms as well as 1-in-50-year storms.

3. **Characterize the impacts to each water resource asset from the expected changes identified.** This characterization will include quantitative (where possible) or qualitative assessments of the water resource asset's sensitivity and adaptive capacity, as well as potential consequences to end users. Where possible, maps will be used to visualize the varying impacts throughout the Basin, highlighting which places may be at higher risk than others from specific hazards.

In Phase 2, the vulnerability assessment will rely on existing data and tools, though in the process we may identify additional technical information that would allow for a more complete assessment. In that case, DRBC staff may recommend pursuing technical studies to support a more complete assessment in future updates to the WRRP.

Table 4-1. Data sources to evaluate the impact of each climate change hazard in the DRB.

Climate change hazard	Data source(s)
Increasing water temperature	These three hazards can be evaluated with seasonal information about future air temperature and precipitation patterns, which are available as Localized Constructed Analogs (LOCA) statistically downscaled climate projections: https://loca.ucsd.edu/
Declining snowpack	
Drought	
Salinity intrusion	These two hazards can be evaluated using sea level rise projections from NOAA (Sweet et al., 2022).
Land inundation	
Flooding	Combined with the sea level rise projections cited above, the expected future intensity, duration, and frequency (IDF) of extreme precipitation can inform compound flooding risk. DRBC's online IDF tool (https://drbc-idf.rcc-acis.org/) currently uses data from AR5. It is expected that it will be updated with AR6 data in time to be used for Phase 2 work.
Wildfire	The National Park Service's online Future Climate Scenarios tool (https://climatetoolbox.org/tool/Future-Climate-Scenarios) can evaluate future conditions relating to multiple wildfire-related variables. It currently is available with AR5 data and the timeline for updating it to include AR6 data is uncertain. Thus, we will use analogous AR5 scenarios to evaluate future wildfire conditions.

4.2 Gap Analysis

A gap analysis helps pinpoint areas where current and expected preparedness, adaptive capacity, infrastructure, policies or strategies are insufficient to address specific challenges and expected impacts as identified in a vulnerability assessment. In the context of the WRRP, the gap analysis aims to **generate a list of potential actions and activities that would help protect specific water resource assets from climate change hazards**.

The WRRP's gap analysis will be conducted in three steps. An abbreviated example follows for the first two steps.

1. **Define a goal outcome of resilience for each water resource asset**, considering the expected impacts to each asset identified in the vulnerability assessment. The goal outcome may include impacts we want to avoid, such as drinking water becoming too salty or a certain amount of flooding damage, or a level of resilience that we aspire to. A goal outcome may include both qualitative and quantitative parts, as appropriate.

For example, a goal outcome could be: *Water availability in the Basin will be maintained through a future drought of magnitude X,* with X having been defined in the vulnerability assessment. This goal outcome could include having enough water supply to meet users' needs, protecting critical drinking water intakes from saltwater intrusion, not fully depleting reservoir storage, and maintaining flow objectives.

2. **Define a pathway to advance toward the goal outcome.** The pathway will consist of many possible steps that fall into three categories, addressing the following questions:

Knowledge: What information would help to guide planning and management decisions to move toward the goal outcome?

Action: What can we do to advance toward the goal outcome?

Equity considerations: How can we ensure that all Basin water users are protected as we move toward the goal outcome?

Identified steps may include which partner(s) could be involved and a recommended time frame, if appropriate. As an example, three possible steps on the pathway for the example goal outcome above could be:

Knowledge: Technical study to answer the question, *Do we need additional freshwater storage?*

Action: Pursue additional storage options (in collaboration with the U.S. Army Corps of Engineers, quarries, and others).

Equity consideration: If acquiring additional storage, how would the costs be distributed?

3. **Identify any gaps that exist in the pathway.** A gap is a need for information or action that has not yet been addressed, and for which no plan has yet been developed. Identifying gaps will

require a review of current and planned work by DRBC and its many partners supporting the Basin's water resources, including the Basin states, federal agencies, utilities, and community and stakeholder groups. In the context of ongoing and planned work in the Basin, we will identify a subset of possible recommended actions that will then need to be prioritized.

4.3 Prioritizing Recommended Actions and Activities

All actions and activities identified in the gap analysis will be evaluated using a set of metrics to help determine which actions and activities are most urgent, meaningful, and feasible. The following metrics will guide prioritization:

- **Impact**: What impact will this action or activity have in terms of preparing and adapting the Basin's water resources to climate change?
- **Urgency**: How urgently is this action or activity needed to address current or imminent climate change impacts?
- **Reach**: What is the geographic and demographic extent of the benefit of undertaking this action or activity?
- **Stakeholder Relevance**: How well does this action or activity address issues that partners and stakeholders think should be prioritized?
- **Feasibility**: What resources (including funding, staff time, and expertise) will be required to complete this action or activity?
- **Synergy**: How does this action or activity fit into the overall landscape of work being done to address climate change in the DRB? How well does it complement and build on DRBC's and others' work?

Each action or activity will be assigned a score that reflects its relative benefit according to the metrics above, and thus the strength of DRBC staff's recommendation that the Commission undertake it. The precise details of the scoring methodology will be developed as part of Phase 2, and the scoring may reflect consultation with and input from ACCC, the public, and other partners and stakeholders. Based on its score across all six metrics, each item will be sorted into one of the following five categories: extremely important, very important, moderately important, slightly important, and not at all important.

The list of extremely and very important actions is intended to be broad in scope and reflect a wide range of possibilities for consideration, but an item's inclusion on the list does not imply a commitment on behalf of DRBC to undertake that action or activity. In some cases, a partner may be better poised to take on or lead a particular action, DRBC may not have adequate resources to do so, or other priorities may take precedence.

4.3.1 DRBC Authority

Resolution 2024-04 expressly directs the Commission staff "to identify and recommend activities and actions *within the authority, jurisdiction, and expertise of the Commission*…" (emphasis added) and makes clear that the Commission's authority does "not include setting or implementing broad [greenhouse gas] reduction goals… ."

DRBC's authority is defined by the agency's organic statute, the Delaware River Basin Compact, which includes within the jurisdiction of the Commission the following subject matters: water supply, pollution control, flood protection, watershed management, recreation, hydroelectric power, and water withdrawals and diversions. In defining the Commission's powers and duties, the Compact makes no mention of air emissions. The U.S. Environmental Protection Agency and the Commission's member states regulate air emissions and air quality under the federal Clean Air Act and state laws and implementing regulations. The Commission is not, through its Water Resources Resilience Plan, proposing to replicate or expand upon those programs. For critical actions that fall outside DRBC's regulatory authority, partners may be identified that may more appropriately serve in that role.

5. Phase 3 Workplan

When Phases 1 and 2 of the WRRP are complete, DRBC will have developed and applied a framework to plan for climate change hazards that are relevant to water resources in the DRB, but the Basin's water resources face additional challenges that are not driven by climate change. The following, non-exhaustive list includes some specific hazards that may be considered in Phase 3, reflecting many concerns raised by stakeholders during Phase 1 and others identified by DRBC staff:

- Contaminants of emerging concern, PFAS (perfluoroalkyl and polyfluoroalkyl substances), and microplastics
- Changes in water demands and locations of withdrawals
- Freshwater salinization
- Chemical spills
- Non-point source pollution
- Expansion of power generation
- Deteriorating and aging water and wastewater infrastructure
- Increasing development and impervious surfaces
- Land use changes, such as loss of forest, wetlands, or riparian buffers
- Channel deepening and dredging
- Water affordability and public perception
- Increasing tanker sizes and traffic

It is likely that the scenario planning boundaries defined for Phase 2 will also be applied in Phase 3, as many of these additional challenges interact with and compound the climate change hazards evaluated in Phase 2. (For example, additional impervious surfaces can increase flooding risk by reducing the ability of the land surface to absorb rainwater.) DRBC staff will conduct vulnerability assessments, gap analyses, and stakeholder engagement in Phase 3 in a manner similar to what is planned for Phase 2. Finally, additional recommended actions and activities to address these additional challenges will be developed and prioritized using the same metrics and approach used in Phase 2.

6. Revising the Water Resources Resilience Plan

The DRBC is committed to a dynamic process in which resilience planning, and the resulting recommendations, evolve in response to new information and ideas. The WRRP will provide key information in a timely manner to enable the Commissioners to make sound decisions that maintain or improve the resilience of the Basin's water resources. To ensure that any future recommended actions and activities have meaningful impact, the WRRP will be regularly revised, updated, and/or expanded to include new information, science, and revised analyses. This section outlines several factors which may prompt the revision of some or all of the WRRP and its recommendations.

6.1.1 Filling Information Gaps

To complete Phases 2 and 3 in a timely manner, the vulnerability assessments will rely on datasets and resources that are currently readily available for the DRB. However, additional information may be required for a more complete assessment of specific asset–hazard combinations. In this case, the specific needs will be identified, and additional technical studies and/or partnerships may be recommended and pursued. If new technical information becomes available, it would be worthwhile to revisit the vulnerability assessment (as well as the parts of the gap analysis and recommended actions that depend on the vulnerability assessment) and update these analyses with more complete information.

6.1.2 Scientific Advances

The latest scientific findings regarding climate change and other challenges are continually updated, so resilience plans often include ongoing updates to reflect changing conditions and new information (NPS, 2013). Forthcoming advances in scientific research may improve our understanding of climate change, contaminants of emerging concern, land use change, and other challenges that impact the water resources of the Delaware River Basin.

As noted in Section 3.2, Phase 2 will rely on global model results and climate scenarios from the IPCC's Sixth Assessment Report, released in 2023. It is expected that WRRP revisions will include an update to evaluate new future scenarios from updated model results, starting with the Seventh Assessment Report (expected in the late 2020s). Researchers and practitioners are continually interpreting these global model results with respect to more regional and local concerns, and these findings may provide additional opportunities to update the scientific findings underpinning Phase 2.

6.1.3 Responding to Regional Events

Climate change and other challenges already affect the Basin's water resources. Data and community observations gathered from real-life extreme events, including floods, droughts, and spills, can be invaluable for understanding the underlying processes involved and appropriate

management strategies. When a severe event occurs in the Basin that can provide useful data to inform management actions and activities that advance resilience, DRBC staff may choose to incorporate data from this event into an update or addendum to the WRRP. For example, DRBC staff may conduct a case study of the event, including discussions of its possible causes, its impacts, and what management actions were or could have been taken to mitigate those impacts. When completed, this case study might be used to inform a revision of any recommended actions and activities related to that hazard and/or to revise the relative prioritization of all recommended actions and activities. Conducting such a case study would also provide an opportunity for outreach to gather partner responses and public perspective about the event.

6.1.4 Wider Context

Developing recommended actions and activities for DRBC to consider requires understanding the measures federal, state, local, and other partners are already undertaking or planning to improve the resilience of the Basin's water resources. For example, to ensure efficiency and prevent duplication, DRBC staff may recommend not taking a critical action if others have already committed to that action. However, if partners' plans or priorities change, or if partners launch a new initiative, DRBC may respond by updating the gap analysis and recommended actions to ensure that DRBC is supporting and complementing partners' work. A significant policy change at the federal and/or state level could also affect the context in which DRBC is performing this work and necessitate revisions to parts of the WRRP.

7. REFERENCES

Arguez, A., Durre, I., Applequist, S., Vose, R. S., Squires, M. F., Yin, X., Heim, R. R., & Owen, T. W. (2012). NOAA's 1981–2010 U.S. Climate Normals: An Overview. *Bulletin of the American Meteorological Society*, *93*(11), 1687–1697. https://doi.org/10.1175/BAMS-D-11-00197.1

DRBC. (2025). *Water Resources Program FY2026-2028* (2025–3). Delaware River Basin Commission. https://www.nj.gov/drbc/library/documents/WRPFY26-28.pdf

Hyman, A. A., Crone, E. R., Benson, A., Dunham, J., Lynch, A. J., Thompson, L., & Mims, M. C. (2025). Exposure, sensitivity, or adaptive capacity? Reviewing assessments that use only two of three elements of climate change vulnerability. *Conservation Science and Practice*, *7*(1), e13293. https://doi.org/10.1111/csp2.13293

IPCC. (2014). *Climate Change 2014: Synthesis Report.* [Fifth Assessment Report of the Intergovernmental Panel on Climate Change]. Intergovernmental Panel on Climate Change. https://archive.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_All_Topics.pdf

IPCC. (2023). *Climate Change 2023: Synthesis Report.* [Sixth Assessment Report of the Intergovernmental Panel on Climate Change]. Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar6/syr/

Jay, A., Reidmiller, D. R., Avery, C. W., Barrie, D., DeAngelo, B. J., Dave, A., Dzaugis, M., Kolian, M., Lewis, K. L. M., Reeves, K., & Winner, D. A. (2018). *Chapter 1: Overview. Impacts, Risks, and Adaptation in the United States: The Fourth National Climate Assessment, Volume II*. U.S. Global Change Research Program. https://doi.org/10.7930/NCA4.2018.CH1

NASA. (2025, September 15). *What Is Climate Change?* https://science.nasa.gov/kids/earth/what-is-climate-change/

NPS. (2013). *Using Scenarios to Explore Climate Change: A Handbook for Practitioners*. National Park Service Climate Change Response Program. https://irma.nps.gov/DataStore/Reference/Profile/2205127

NPS. (2020). *Integration of Climate Change Scenario Planning into the Resource Stewardship Strategy Process*. National Park Service Climate Change Response Program. https://irma.nps.gov/DataStore/Reference/Profile/2267238

Sweet, W. V., Hamlington, B. D., Kopp, R. E., Weaver, C. P., Barnard, P. L., Dekaert, D., Brooks, W., Craghan, M., Dusek, G., Frederikse, T., Garner, G., Genz, A. S., Krasting, J. P., Larour, E., Marcy, D., Marra, J. J., Obeysekera, J., Osler, M., Pendleton, M., … Zuzak, C. (2022). *Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines* (NOAA Technical Report NOS 01). National Oceanic and Atmospheric Administration, National Ocean Service. https://oceanservice.noaa.gov/hazards/sealevelrise/noaa-nos- techrpt01-global-regional-SLR-scenarios-US.pdf