

Catawba-Wateree Water Management Group

INTEGRATED WATER RESOURCES PLAN

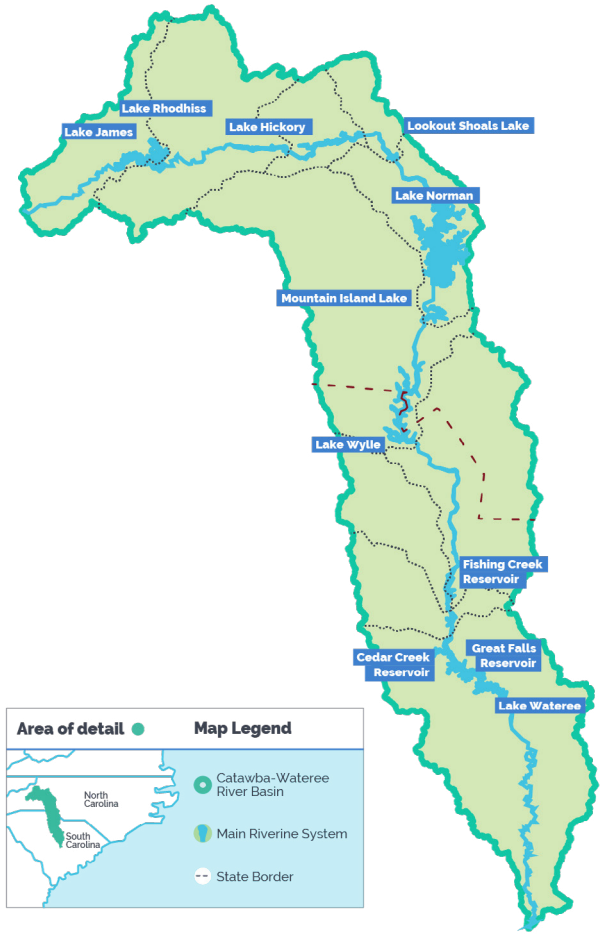
Executive Summary

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Why This Plan Matters

The Catawba-Wateree River Basin (Basin) functions as one connected water system. Changes in one place - new development, drought or high-flow events, or operational adjustments - can affect public health and affordability, economic resilience, energy reliability, aquatic habitat, and recreation elsewhere in the Basin. A shared roadmap is essential, so the region moves in the same direction.

The Integrated Water Resources Plan (IWRP) is that roadmap. It provides direction to keep water reliable and clean through at least 2075 by bringing water quantity, water quality, and source-water protection into a single plan. Because rivers and reservoirs are physically linked and jointly operated, coordinated planning enables consistent decisions and aligned investments across jurisdictions.



The Plan responds to converging pressures: more frequent climate extremes, continued growth and redevelopment, evolving energy operations, and water-quality impairments in key tributaries. During plan development, real-world disruptions, including Hurricane Helene, drought, and increased attention to interbasin transfers (IBTs), heightened understanding of system vulnerabilities. The IWRP pairs watershed science with operations planning, so recommended actions are both technically sound and implementable.

In short, the IWRP helps the Basin meet rising demand without sacrificing water quality, translating five years of technical work into practical steps that communities, industries, and resource managers can take together. Together, these pressures make coordinated, basin-wide planning essential to maintaining both reliable water supply and water quality over time.

This IWRP was developed by the Catawba-Wateree Water Management Group, representing 21 member organizations, using the best available data and projections. It reflects historical and current conditions along with reasonable forecasts to support informed planning. The IWRP is neutral and analytical, presenting facts and scenarios without advocating for any particular outcome.

The IWRP includes recommended actions to enhance water supply resiliency during drought and protect water quality within the Basin. Supporting the IWRP does not limit any rights or options organizations may have in future regulatory proceedings.

How the Plan Evolved

The IWRP builds on more than two decades of coordinated Basin planning and stakeholder collaboration. As part of Duke Energy's hydro project relicensing, the Comprehensive Relicensing Agreement (CRA, 2006) established shared operating rules and called for formation of a water-management group. The Catawba-Wateree Water Management Group (CWWMG) formed in 2007 to identify, fund, and implement strategic initiatives across the Basin. An interstate settlement agreement (2010) reinforced the need to maintain a long-range, Basin-wide plan with periodic updates.

A 2006 Water Supply Study concluded that, without change, water demands could exceed supply by mid-century. The 2014 Water Supply Master Plan (with 2015 Addendum) responded with strategies to stretch capacity of the 11 mainstem reservoirs and formalized use of the CHEOPS operations model (under CRA rules) to analyze drought and seasonal reliability. In 2021, the plan broadened from a water quantity-only focus to an IWRP through a stakeholder-driven process that shaped the plan's expanded priorities. The update added water quality and source-water protection, incorporated future land use scenarios and bounding climate futures, extended the geographic scope downstream to the Congaree River, and updated modeling and data using state-recognized methods. The result is a single playbook that connects watershed science with day-to-day operations.

Water Quantity: Ensuring Reliable Supply Through 2075

WHAT THE IWRP EXAMINES	≈ How much water is being used now, and how that demand is projected to grow through 2075. ≈ Net withdrawals for public water supply, industry, thermoelectric cooling, and agriculture. ≈ The role of Duke Energy's hydro operations in daily and seasonal water access. ≈ Climate impacts like storms, floods, and extreme heat.
WHY IT MATTERS	≈ The region's population and economy are growing, adding water supply demands. ≈ Climate variability and energy demands add pressure on shared resources. ≈ Coordinated planning helps avoid shortages during drought or high-demand periods. ≈ Additional actions will be needed for reliable, fair access to water across the Basin.

Water Quality: Protecting Sources for Clean, Affordable Water

WHAT THE IWRP EXAMINES	≈ Future land use scenarios and the role of riparian buffers, forests, and farms in protecting water sources. ≈ How development patterns affect pollution, runoff, and long-term treatment. ≈ The risks from increased nutrients, sediments, and other emerging contaminants.
WHY IT MATTERS	≈ Land development without protection can degrade water quality. ≈ Water is more affordable and easier to treat when it's clean at the source. ≈ Clean water supports boating, fishing, swimming, and other recreation as well as healthy aquatic ecosystems that make the Basin a hub for quality of life and local economies. ≈ More frequent storms and weather extremes threaten both infrastructure and natural systems.

How We Analyze the Basin

IWRP evaluation followed a three-step process:



The IWRP couples a catchment-scale watershed model with a basin-operations model so managers can see both the drivers and the system response.

- **The watershed model (WaterFALL®)** simulates daily hydrology - runoff and baseflow - as well as nutrient and sediment loads (total nitrogen, total phosphorus, and total suspended solids) for each stream catchment, routing flows and loads downstream with calibrated parameters tied to local gauges and monitoring sites. It identifies where land cover and land-use changes most affect inflows and pollutant delivery and provides hot-spot mapping to prioritize mitigation actions.
- **The operations model (CHEOPS)** represents CRA operating rules across the eleven interconnected reservoirs, including minimum flows, target elevations, intake access, recreational releases, and drought protocols (Low Inflow Protocol). Recent updates incorporated revised storage-elevation curves, spillway and unit configurations, target adjustments, and logic refinements. The modeling framework aligns with North Carolina Session Law 2010-143 requirements and has been used in Basin planning since the 2006 Water Supply Study and 2014 Water Supply Master Plan.

Together, these models allow the Basin to test realistic future conditions by combining projected development patterns and climate scenarios. These results are translated into actionable operating guidance. The integration translates watershed science into decisions about access to stored water, drought staging, peak-flow management, and source-water priorities across jurisdictions.

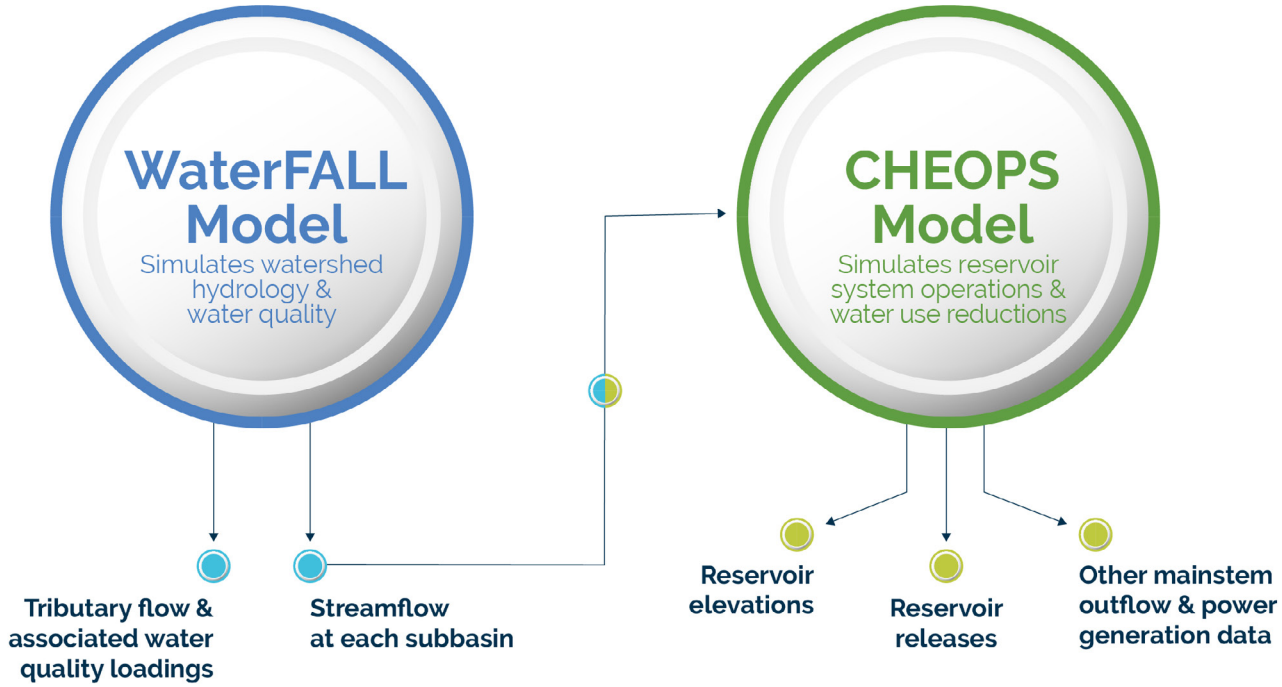


Figure E-2 Overview of WaterFALL and CHEOPS Modeling Framework

Looking Ahead: What We Analyzed and Learned

The IWRP evaluates how the Basin may evolve over the coming decades as population growth, land use change, climate variability, and water use patterns interact across an interconnected system. Rather than focusing on a single forecast, the analyses examine a range of plausible futures to understand where pressures are most likely to emerge, how risks differ across the Basin, and which factors most influence long-term system performance.

Taken together, the analyses provide a Basin-wide perspective on future conditions and highlight consistent signals related to watershed change, water supply reliability, hydrologic response, and water quality. These signals are intended to inform planning by identifying sensitivities and areas requiring closer attention over time, rather than predicting specific outcomes.

Future Land Use and Watershed Change

Projected land use change is a foundational driver of future water resource conditions in the Basin. The IWRP evaluates future land use scenarios extending to approximately 2070 to understand how continued development may alter watershed function and influence both water quantity and water quality over the long term. Figure E-3 presents future (2070) land use.

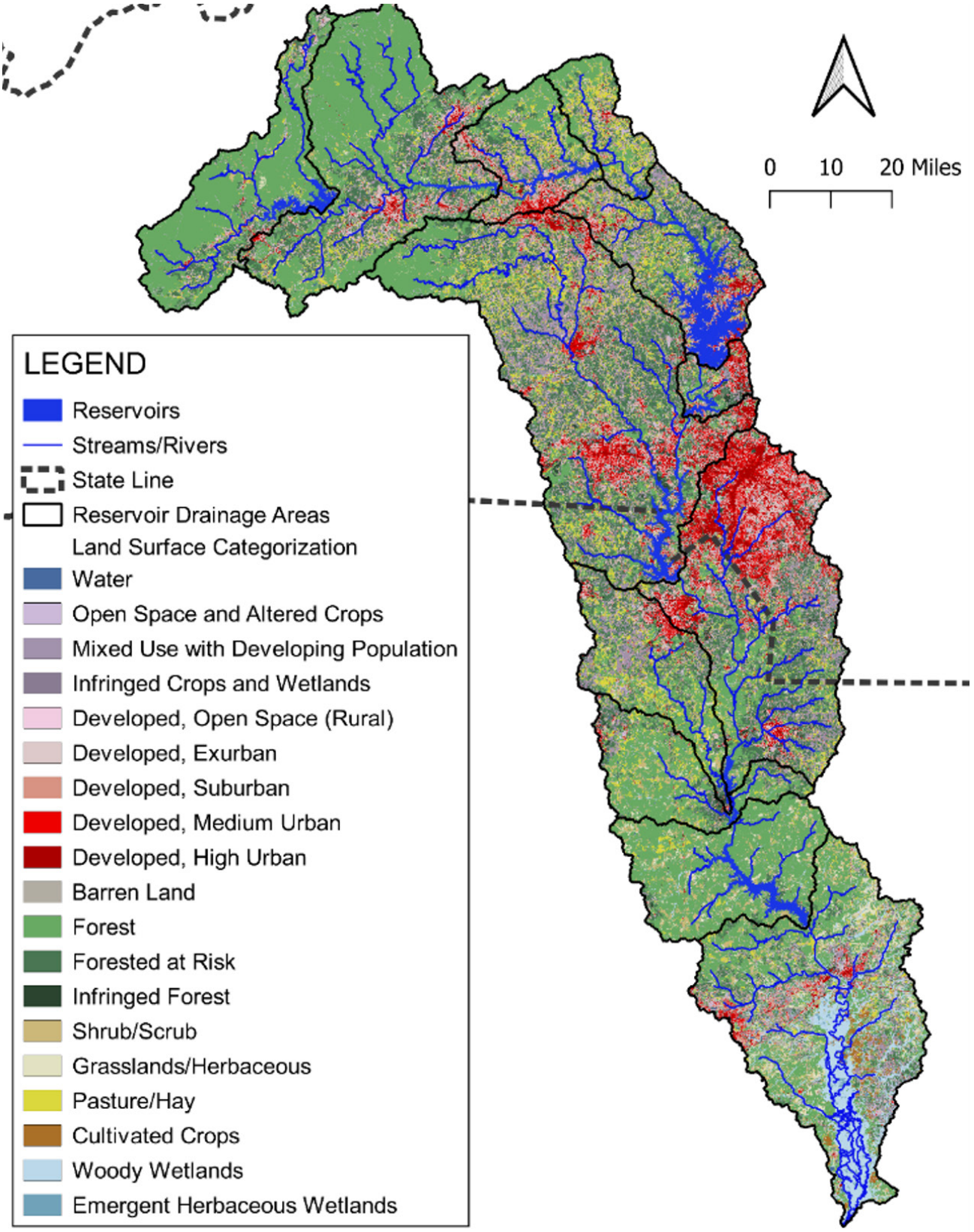


Figure E-3. Future (2070) Land Use Map

By 2070, modeled land use change results in marked increases in impervious cover in several fast-growing subbasins, altering runoff generation, infiltration, and pollutant transport. A key finding is that a relatively small number of subbasins experience disproportionately large hydrologic change, creating localized pressures that propagate downstream through the interconnected reservoir system. As a result, development in one jurisdiction can materially affect water quantity and quality conditions elsewhere in the Basin. Watershed modeling indicates that these land use changes:

- Increase storm runoff volumes and peak flows, amplifying erosion and downstream sediment delivery during intense rainfall events;
- Reduce infiltration and groundwater recharge, diminishing baseflow contribution to streams during dry periods; and
- Shift hydrologic response toward greater variability, with sharper transitions between wet-weather peaks and prolonged low-flow conditions.

Unlike climate-driven hydrologic variability, which fluctuates from year to year, land use change establishes long-term baseline watershed conditions that persist for decades and do not reverse once development occurs. For this reason, land use change is treated throughout the IWRP as a persistent driver that interacts with climate variability, water demand growth, and reservoir operations rather than as a transient influence.

Under the median future land use scenario, developed land area increases substantially across the Basin, with growth concentrated in the central and western portions of the watershed, particularly upstream of Lake Norman, Mountain Island Lake, and Lake Wylie. These areas experience the largest conversions from forest and agriculture to residential, commercial, and mixed-use development, while more upstream headwater catchments remain largely undeveloped. This uneven spatial distribution of growth is a defining feature of future Basin conditions and a primary driver of localized planning challenges identified in the IWRP.

Further discussion of future land use conditions is provided in Section 3 of the full report, with implications for hydrology and water quality examined in Sections 4, 5, and 7.

Key findings related to land use and watersheds include:

- Growth and land conversion are spatially concentrated, creating localized pressures with Basin-wide implications.
- Changes in watershed condition influence both high-flow (flooding and erosion) and low-flow (baseflow support and drought resilience) behavior.
- Land use impacts accumulate over time and across jurisdictions, reinforcing the importance of Basin-wide planning.

Water Quantity and Surface Water System Performance

Water supply reliability in the IWRP is evaluated by examining how projected water demand, surface water availability, reservoir storage, and operational constraints interact across the eleven interconnected reservoirs of the Catawba–Wateree system.

WATER QUANTITY DEMANDS

Under the most likely planning forecast, Basin-wide net surface water withdrawals increase by approximately 160 million gallons per day (MGD) by 2075, rising from about 194 MGD in the base year to roughly 354 MGD. This represents an increase of more than 80 percent in net withdrawals over the planning horizon. Alternative growth futures evaluated in the IWRP span a wider range, with projected Basin-wide net withdrawals by 2075 ranging from approximately 287 MGD under lower-growth conditions to about 432 MGD under higher-growth conditions.

Demand growth is not evenly distributed across the Basin. The largest increases occur in the central portion of the river basin, particularly Lake Norman, Mountain Island Lake, and Lake Wylie, which together account for more than 110 MGD of additional net withdrawals by 2075 under the median forecast. These reservoirs serve rapidly urbanizing service areas and play a critical operational role in balancing upstream inflows, downstream demands, hydropower operations, and minimum flow requirements.

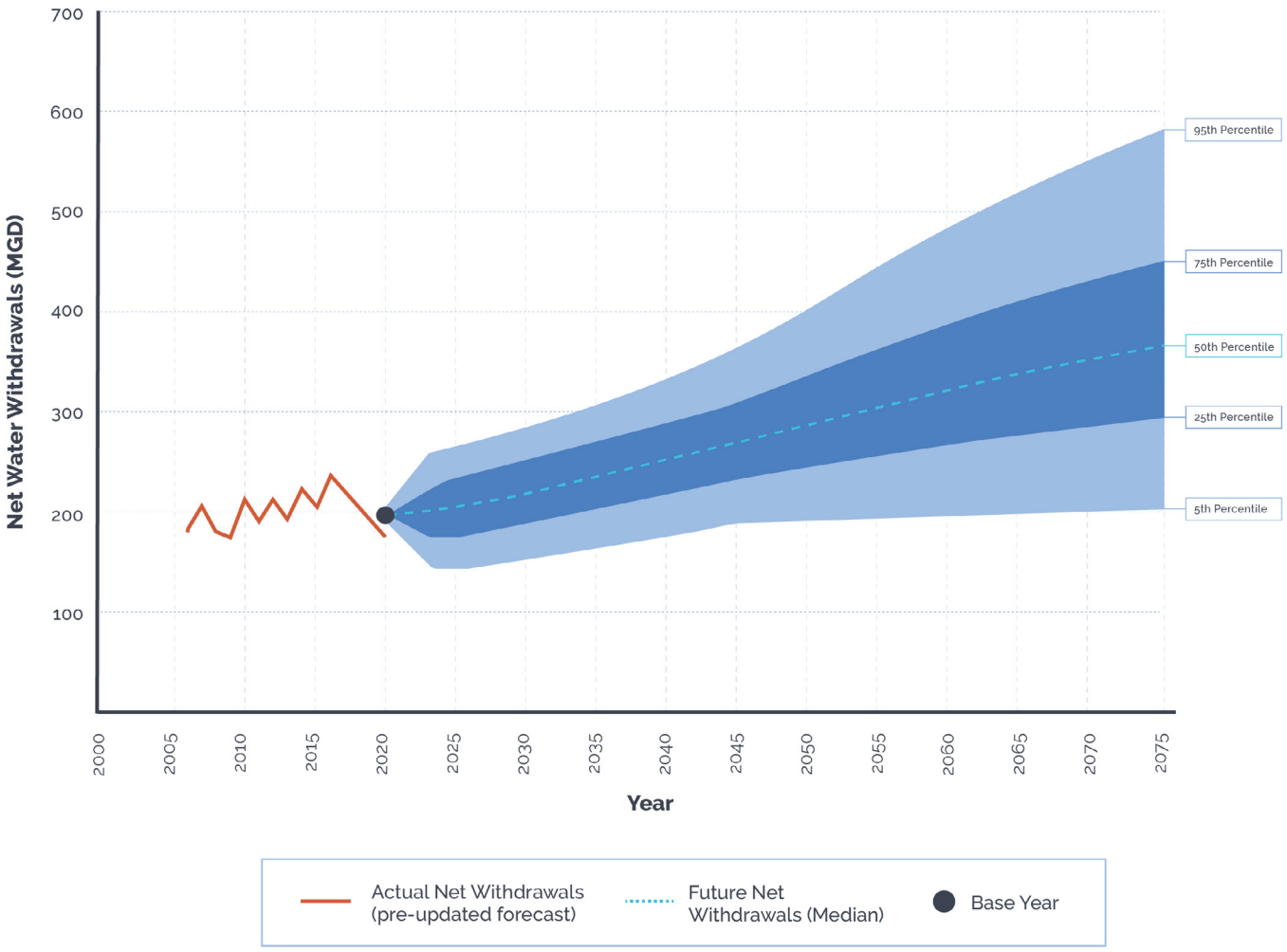


Figure E-4. Water Demand Projections through 2075

WATER SYSTEM PERFORMANCE

Modeling results indicate that the Basin's surface water system remains generally resilient across a wide range of future conditions, but system performance varies substantially by reservoir and location. Differences in storage volume, intake elevations, upstream watershed response, return flows, IBTs, and operational constraints contribute to uneven sensitivity to demand growth and hydrologic stress.

When tested against a recurrence of the historical Drought-of-Record, coordinated reservoir operations under existing CRA rules and drought protocols significantly extend system reliability. In many locations, coordinated operations delay the onset of access limitations by multiple decades compared to uncoordinated conditions. However, vulnerabilities emerge earlier in a small number of reservoirs where demand growth, storage characteristics, and hydrologic variability intersect.

To support long-range planning, the IWRP identifies planning thresholds, or Decision Point Years, which represent the approximate timeframe when additional evaluation of management or operational strategies may be warranted if drought conditions similar to the historical Drought-of-Record reoccur. These thresholds are not forecasts of system failure; rather, they are indicators of relative system sensitivity. Under the most likely demand forecast:

- Lake Wylie reaches a planning sensitivity window as early as the 2025–2035 timeframe, reflecting high demand growth and limited storage flexibility.
- Mountain Island Lake exhibits planning sensitivity later, in the 2075–2085 timeframe, under baseline conditions.
- Most upstream and downstream reservoirs maintain accessible supply well beyond 2075, even under Drought-of-Record conditions.

RESERVOIR	Decision Point Year Range by Water Demand Scenario
	2025 · 2035 · 2045 · 2055 · 2065 · 2075 · 2085 · 2095 · 2105 · 2115 · 2125
Lake James	Baseline
Lake Rhodhiss	Baseline
Lake Hickory	Baseline
Lookout Shoals Lake	Baseline
Lake Norman	High Demand ← Baseline
Mtn. Island Lake	High Demand ← Baseline → Low Demand
Lake Wylie	High Demand · Baseline → Low Demand
Fishing Creek Reservoir	Baseline
Great Falls Reservoir	Baseline
Cedar Creek Reservoir	Baseline
Lake Wateree	Baseline

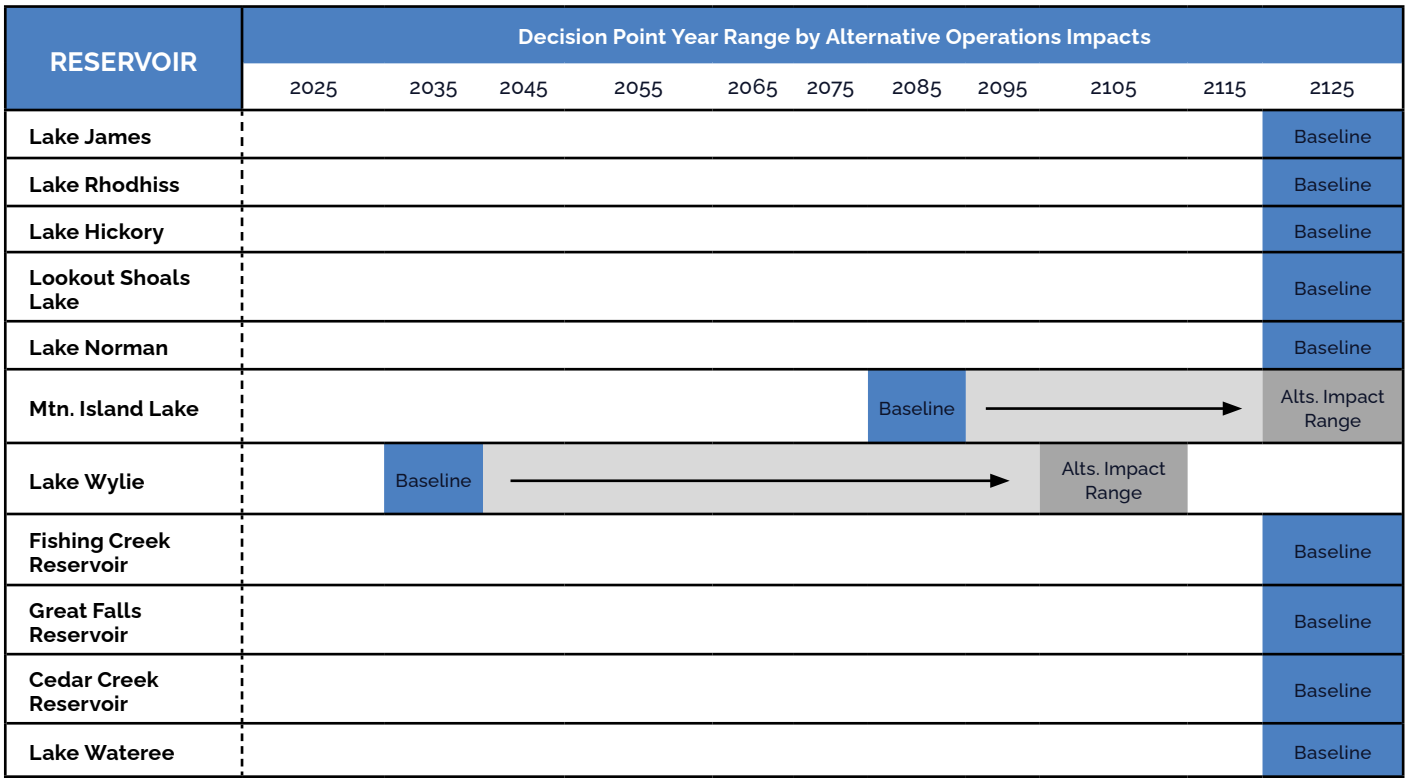


Figure E-5 presents the decision point year summary by Basin for the range of future water demand conditions (top) and after employing alternative reservoir operations (bottom).

IBT SCENARIO

IBTs are a component of water use in the Basin, representing the movement of water across basin boundaries to meet regional demand. The IWRP evaluates current IBTs and transfers associated with future demand projections to understand their influence on system performance. IBTs affect reservoir reliability at the subbasin level by altering the balance between withdrawals and return flows, particularly in areas with high demand and limited storage.

A scenario analyzing the return of all out-of-Basin discharge flows to the Basin shows that, while not practical across the board, such an alternative would improve access to water and extend drought response in select locations. For example, at Lake Wylie, a full return of all IBT discharges would reduce the number of consecutive days with lake levels at least 0.5 foot below the Critical Reservoir Elevation in a repeat of the Drought-of-Record from 42 days to 4 days. While certainly an improvement, this hypothetical scenario shows that IBTs are an important planning consideration but their complete elimination, if that was possible, would not represent a standalone solution to future water supply challenges. A broader portfolio of supply-side, demand-side and drought management options will be needed to avoid all accessibility problems in the eleven-reservoir system throughout the 50-year planning horizon.

These results demonstrate that planning pressures do not emerge simultaneously across the Basin, and that future water supply challenges are driven more by the location and timing of demand growth than by total system storage alone.

Surface water quantity, reservoir performance, drought response, and planning thresholds are evaluated in detail in Section 4 of the full report, with supporting demand projections in Section 3 and groundwater context in Section 6.

Key findings related to water quantity and reliability include:

- Basin-wide water supply remains generally robust, but sensitivity varies across reservoirs and service areas.
- Water supply reliability depends on access to storage and coordinated operations, not storage volume alone.
- Existing drought management protocols (LIP) are a critical strength of the system and remain effective across a wide range of future planning scenarios.
- Planning pressures emerge at different times and locations rather than simultaneously across the Basin, therefore further evaluation is needed to modify LIP Stage Minimums and Critical Intake Elevations for specific reservoirs.
- While an evaluation scenario demonstrates that returning all IBT discharge flows to the Basin could improve system performance, particularly at the subbasin level, the scenario also reinforces that the removal of all IBTs is not a standalone solution to resolve all water accessibility concerns in the Basin. A broader portfolio of supply-side, demand-side, and drought management options will be needed.
- Organizations pursuing future IBTs or IBT modifications shall comply with the U.S Supreme Court Settlement Agreement approval processes including an environmental impact statement to evaluate reasonable alternative approaches.
- Regional coordination is key to preserving the Basin-wide water supply, which is made more complex through the regulation of IBTs at the sub-basin level within North Carolina. Reducing such sub-basin focused regulation provides more flexibility to manage water transfers with major Basins and encourages Basin-wide cooperation and coordination.

Water Quality and Hydrologic Response Signals

Water quality outcomes in the Basin are closely linked to watershed conditions and hydrologic response. The IWRP evaluates how future land use patterns, climate variability, and changing flow regimes influence sediment, nutrient, and contaminant loading to streams and reservoirs over time.

Modeling results indicate that existing water quality impairments persist under future conditions, with risks intensifying in different ways depending on hydrologic context. Under wetter climate futures, increased runoff and higher peak flows result in greater storm-driven transport of sediment and nutrients, elevating concerns related to erosion, reservoir sedimentation, and nutrient loading. These conditions increase the frequency and magnitude of episodic loading events that can degrade downstream water quality.

Under drier futures, longer-duration low-flow periods result in higher in-stream and reservoir contaminant concentrations, even when total loads remain similar or decline. These conditions increase stress on aquatic systems and can exacerbate water quality challenges during extended drought periods, particularly in receiving waters downstream of urbanized catchments.

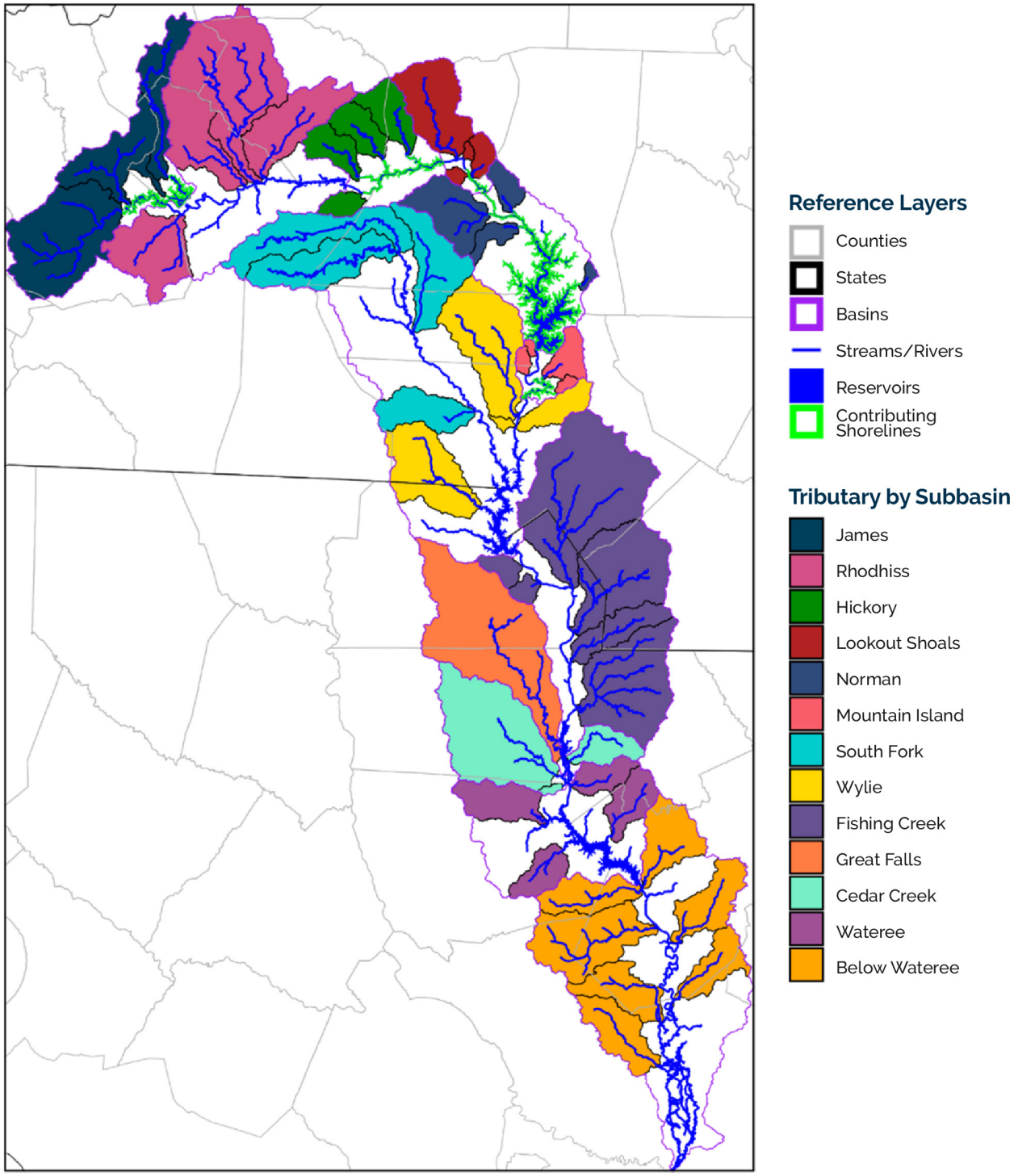


Figure E-6. Tributaries Identified as Providing Highest Loadings of Sediment and Nutrients within Each Subbasin

A consistent and important finding of the IWRP is that water quality risks are spatially concentrated. For many reservoirs, a small number of tributaries contribute a disproportionate share of total sediment and nutrient loading, as presented in Figure E-6. In some cases, a limited subset of catchments accounts for the majority of modeled phosphorus or sediment delivery, making targeted watershed strategies significantly more effective than uniform Basin-wide approaches.

Sediment dynamics are uneven across the Basin. Loading is highest in upper, headwater subbasins, particularly in the James and Rhodhiss subbasins, where erosion rates are elevated and contribute a disproportionate share of sediment entering the stream network. In contrast, middle Basin areas such as Lake Norman and Lake Wylie exhibit much lower baseline sediment generation. However, even in systems with lower average rates, individual catchments can experience extreme erosion during storm events, reinforcing the importance of both location and event-driven processes in shaping overall sediment impacts.

Groundwater conditions were also evaluated as part of the IWRP. While groundwater resources provide important local supply and contribute to baseflow, they do not function as a Basin-wide substitute for surface water. Groundwater–surface water interactions influence localized resilience, particularly during drought conditions.

Key findings related to water quality and hydrologic response include:

- Water quality outcomes are shaped by the interaction of land use, flow variability, and climate conditions.
- Wetter futures increase pollutant transport and flood-related risks, while drier futures increase concentration-related stress.
- A small number of tributaries account for a large share of downstream impacts, making targeted interventions highly effective.
- Sediment loading is highest in upper headwater subbasins (particularly James and Rhodhiss), while middle Basin areas experience much lower baseline rates, though localized extreme erosion events remain a key driver of overall loading.
- Groundwater contributes to local resilience but does not offset Basin-wide surface water risks.

Detailed water quality evaluations are presented in Section 5 of the full report, with hydrologic context provided in Sections 3 and 4 and groundwater analysis in Section 6.

Portfolio of Recommendations

The Portfolio of Recommendations translates the analytical findings into a coordinated, Basin-wide set of actions organized around four complementary categories. Together, they emphasize acting early, targeting investments where they matter most, and strengthening coordination across jurisdictions and sectors.

The recommendations are structured to address multiple dimensions of system performance, including reservoir operations, watershed conditions, water demand, and data and coordination needs. While individual recommendations vary in scale and applicability, they are intended to function collectively as part of a flexible and adaptive planning framework.

Key elements of the portfolio include:

A. **Policy, Legislative, and Regulatory Actions:** Align laws, regulatory frameworks, and leadership accountability so Basin-level water management is supported rather than constrained. Priority themes include reducing unintended barriers created by IBT regulations, strengthening and aligning riparian buffer protections

across the Basin, and ensuring clear agency leadership responsibility for implementing interstate agreements and Basin-wide planning objectives.

B. Planning and Coordination: Strengthen regional coordination so land use, conservation, and water supply planning work together instead of in silos. The IWRP demonstrates that watershed change and growth patterns drive future risk; therefore, planning and investment decisions must be evaluated at the subbasin scale, not solely within political boundaries. Elevating conservation and source water protection as shared regional priorities, and measuring whether strategies are working, is essential to long-term resilience.

C. Technical and Program Actions: Use better data, smarter operations, and targeted strategies to manage risk proactively. Key actions include expanding Basin-wide monitoring, improving data consistency, updating reservoir and intake information, and prioritizing investments that reduce water loss, improve efficiency, and address sediment and nutrient hot spots.
Implementation should be guided by subbasin-scale priorities identified in the IWRP, focusing on high-contributing tributaries and aligning land management approaches with local watershed conditions. Improving system performance before expanding infrastructure consistently provides greater long-term benefit and flexibility.

D. Drought Planning and Response: Strengthen drought preparedness so action occurs earlier, coordination improves, and resilience increases. The Low Inflow Protocol remains a cornerstone of Basin management, but the IWRP identifies opportunities to act sooner, improve participation, update contingency plans, adjust drought stage response mechanisms, and prepare intake infrastructure for lower water levels, including key systems in Lake Norman, Mountain Island Lake, and Lake Wylie, where projected conditions indicate earlier or more frequent vulnerability. Proactive drought planning reduces risk far more effectively than reactive emergency response.

Taken together, the Portfolio of Recommendations provides a structured set of planning options rather than a fixed set of actions or implementation requirements. The timing, sequencing, and applicability of individual strategies will vary by location and over time. The portfolio is intended to support ongoing evaluation and adaptive decision making as future conditions, priorities, and information evolve.

Summary Perspective

The IWRP builds on decades of collaborative planning in the Catawba–Wateree River Basin and provides an updated, comprehensive assessment of how the system may perform under future growth and climate variability. The analyses demonstrate that the Basin's water resources can continue to support a wide range of uses over time, provided that planning and effective timely actions are coordinated, adaptive, and informed by shared data.

A central conclusion of the IWRP is that no single entity can manage future water challenges alone. The Basin's reservoirs, tributaries, utilities, and watersheds are physically and operationally interconnected, and actions taken in isolation can create unintended downstream consequences.

The greatest gains in water supply reliability and water quality protection come from focusing together on the highest priorities, sharing data and tools, and coordinating decisions across jurisdictional boundaries. Implementing the IWRP will require sustained collaboration among utilities, states, regulators, local governments, conservation partners, and water users-along with adequate resources and policy support.

The IWRP itself is a product of that collaboration. Maintaining this shared approach is essential for translating technical insight into practical outcomes and ensuring that the Catawba-Wateree River Basin and the hard-working river at its core continues to serve communities, economies, and ecosystems well into the future.