DROUGHT PLANNING GUIDEBOOK

A Resource for Water Systems in the Palmetto State

Guidance for Reviewing and Updating Drought Management Plans and Response Ordinances

Presented by
The South Carolina State Climatology Office within the
S.C. Department of Natural Resources

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Last Updated in May 2024

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CHECKLIST FOR REVIEWING & UPDATING A DROUGHT PLAN

THE QUESTIONS BELOW PROVIDE A QUICK CHECKLIST OF THINGS TO CONSIDER WHEN REVIEWING AND UPDATING THE PLAN. ALL THESE TOPICS ARE EXPLAINED IN DETAIL THROUGH THIS DOCUMENT.

01. When was the plan last updated?

02. Is the listed point of contact still valid?

03. Are employees aware of what tasks and actions are their responsibility in each drought phase?

- Have new employees started since the last drought plan update?
- Are those tasks still valid for successful drought response?

04. Are water supplies (source and amount) still the same as when the plan was last updated?

05. If you provide wholesale water, does the customer's plan account for your drought plan; or if you buy wholesale water, does your plan account for your provider's drought plan?

06. Are water demands still the same as when the plan was last updated?

07. Are plan triggers still valid and do triggers include Drought Response Committee Declarations?

08. Are water reductions (gallons/day or gallons/month) at each drought phase effective for supply conservation?

09. What communication is outlined in the plan that accounts for communication within a water system (e.g. employees, customers, etc.) and outside the water system (e.g. wholesale providers/customers, emergency connections, media)?

- Does your plan state that it will notify the South Carolina Department of Natural Resources when there are changes to enacted conservation levels (both worsening and improving)?

10. Are the violation fees calibrated to effectively get non-compliant customers to reduce water use?

OVERVIEW OF BEST PRACTICES

Below is a condensed version of the best practices in this document and reinforce the ten questions provided in the pervious section. These two sections work together as a quick reference for what needs to be considered for plan review and update and the best practices that would help with drought response success. All these best practices are discussed in more detail in the document.

LOCAL LEVEL PLANNING

Having local level drought plans provides each water system with an operational procedure for responding to drought, which accounts for the unique needs of the water system. This is a proactive approach as the plan takes steps for reducing the system's specific risks before the event occurs (Chapter 3 – Getting Started: Drought Planning Frameworks).

REVIEWING THE PLAN

> Review the plan every two years or every time there is a major change to the system.
>
> **DYKE SPENCER, POWDERSVILLE WATER**
> Chapter 4 – Review, Update, and Approve the New Plan

ADOPTING THE NEW PLAN

After the updated plan is adopted, communicate with customers about changes to the plan and why those changes occurred. Communicating with customers about changes to the plan increases education and outreach for drought management and response (Chapter 4 – Review, Update, and Approve the New Plan).

TRIGGERS

WHOLESALE WATER CUSTOMERS

Water systems that buy their water supplies from entities that already have triggers, it is important to use them as well. This provides continuity between the water providers and water customers (users) for drought response. While the provider's triggers don't need to be the only triggers a purchasing water system has, they should be included (Chapter 7 – The Operations of the Drought Response Plan).

SYSTEM SPECIFIC TRIGGERS

> Specific and quantifiable triggers are critical so that our drought plan can trigger on conditions specific to our sources rather than generalized conditions being felt across a county or drought management area [based on Drought Response Committee county drought designations.

JASON THOMPSON, CHARLESTON WATER

Chapter 7 – The Operations of the Drought Response Plan

MULTIPLE TRIGGERS

Have multiple triggers that are used to determine drought levels, and no one trigger supersedes another. Any one of the indicators can hit the designated trigger point to initiate a change in drought phase. This allows for structured flexibility for a water system to appropriately respond to drought periods based on multiple system specific factors, including supplies, demands, and infrastructure. The range of triggers should also include Drought Response Committee county drought declarations but should not solely rely on them (Chapter 7 – The Operations of the Drought Response Plan)

REVERSE TRIGGERS

Have reverse triggers. Reverse triggers are for easing water restrictions or drought severity phases as conditions begin to improve. Reverse trigger thresholds should be different from the regular triggers. This allows for more substantial recovery of supplies to occur before changing drought levels and minimizes the possibility of frequently moving between drought levels, causing challenges for effective drought response and management (Chapter 7 – The Operations of the Drought Response Plan).

WATER CONSERVATION

Water systems should apply conservation targets that ensure essential water uses and demands can be met, while also are achievable targets. If conservation targets are too low, water supplies may not be protected enough, resulting in impacts. Contrastingly, if conservation targets are too high, the desired outcome of the plan may not be achievable, also resulting in impacts. It's important to find the optimal target between these two points, which will be different for every water system (Chapter 7 – The Operations of the Drought Response Plan).

OPERATIONAL TASKS

Create a list of actions for each drought phase, as well as an assignment for who is responsible for each task. The list of actions increases with each drought phase, as response and management need to increase to reduce impacts and ensure adequate water supplies. This proactive approach increases the effectiveness of drought management and response as it gives clear direction of who is responsible for what during different drought phases, so that all needed tasks are carried out effectively (Chapter 7 – The Operations of the Drought Response Plan).

COMMUNICATION

WITHIN THE WATER SYSTEM

- Water systems should have a dedicated page on their website that provides conservation tips.
- When change drought phases explain 1) why this change is taking place, 2) what to expect, and 3) potential consequences of not conserving water.
- Coordinate with the media to explain changes to drought phases and needed response, so that media sources have the facts about what they are reporting.
- Coordinate with needed decision makers to ensure cooperation between the water system and jurisdictional partnerships for needed drought messaging and response.
- Educate customers on water use, where customers can find their monthly water use, and what monthly water use they should strive for to meet conservation targets.
- Have multiple systems to regularly communicate with customers to increase the reach of information as well as the timing of information.
- (Chapter 7 – The Operations of the Drought Response Plan).

OUTSIDE THE WATER SYSTEM

- For those that sell wholesale water, tell your purchasers when you enter different drought phases so that they are aware of changes in supply and needed water curtailment. Likewise, for those that purchase wholesale water, inform your seller when you enter different drought phases so they are aware of changes to purchase. This includes reduced purchases due to lower demands and increased purchases to meet demands.
- For systems that have emergency supply connections, inform your connections when you enter drought phases so they are aware and account for emergency supply deliveries in their supply budgets.
- The river basin plans provide an avenue of regional drought communication for a shared resource among multiple stakeholder types. Communicating drought conditions with a River Basin Council (RBC) allows for 1) information sharing for impacts and response in the river basin for consistent drought management across multiple water user types; and, 2) the RBCs to provide drought information to the South Carolina Drought Response Committee.
- (Chapter 7 – The Operations of the Drought Response Plan).

FINES

Fines should cause customers to want to lower their water bill. Therefore, the first fine should start out at an amount that gets the customer's attention regarding the monthly bill amount. This will be different for every water system as income levels vary between

water systems. Some systems send a warning for the first violation rather than imposing a fine. However, the first imposed fine should be more than $5 or $10 dollars, as a customer may not even notice a change in their bill. The violation fine needs to be something that will catch the customer's attention. In plans that have been updated more recently, the first violation with a cost is usually $50 or $100. Monetary costs should increase with each violation accrued.

Water systems should give themselves the flexibility to terminate service to customers who refuse to comply with water conservation. Generally, this option is only needed after multiple violations. However, it allows water systems to have stronger enforcement for those customers that refuse to cooperate. It also provides some monetary benefits, as customers may need to pay extra fees to get the water restored.

(Chapter 7 – The Operations of the Drought Response Plan).

TIERED RATE SYSTEM

Include a tiered rate structure in the severe drought phase. This provides the water system with the optional management strategy of increasing water use rates during a severe drought. The first tier is based on typical, average monthly water use (Chapter 7 – The Operations of the Drought Response Plan).

PARTNERSHIPS

Create partnerships for back-up or emergency supplies before a drought.

Use the South Carolina Rural Water Association's (SCRWA) resources. SCRWA provides on-site technical assistance, training, and resources for water and wastewater systems. One cooperative resource they help coordinate is the SC Water/Wastewater Agency Response Network (SCWARN), which is a network of utilities that share personnel and other resources through agreements to prepare and respond to natural disasters (https://www.scrwa.org/scwarn.html). SCRWA has also provided resource assistance to water utilities during drought periods, such as providing their drone to water systems to investigate any water blockages upstream that may hinder flows near the intake.

Get involved with the river basin planning process. The state's river basin planning allows for multiple stakeholder groups to come together, evaluate water availability over the next 50 years (through scenario planning), and make recommendations on how to ensure all stakeholders have access to the water, even under drought periods. This process allows for multi-stakeholder partnership building, as well as providing an agreed upon regional approach to water management during drought periods.

Communicate with S.C. Department of Transportation (SCDOT). Spartanburg Water communicates with SCDOT for when road maintenance is scheduled so they can reduce cost for infrastructure repairs. The saved cost allows the money to be used for other system needs.

(Chapter 8 – Mitigation: Taking Current Steps to Reduce Future Impacts).

1. WHY DO WE NEED ANOTHER DROUGHT PLANNING GUIDE?

The State routinely exercises for natural and man-made hazardous events, but prior to 2017, the state had never conducted an exercise for drought or water shortage emergencies. In 2017, the state conducted its first exercise for drought and water shortage, followed by another in 2019, both in the form of table-top exercises. The goals of these exercises were:

01. Identify and understand the strengths and breaking points in the S.C. Drought Response Act, state drought regulations, S.C. Emergency Operations Plan drought annex, and local drought plans and procedures.

02. Improve awareness of local, state, and federal players in South Carolina's drought response.

03. Identify key mission areas of each state Emergency Support Function.

04. Collect ideas for strategies for future exercises.

Through these exercises, four types of key needs were identified:

01. Plans and Procedures, specifically reviewing and updating the state- and local-level drought plans and policies.

02. Communication, specifically for promoting information sharing, enhancing awareness of regional and local drought issues, and facilitating better working relationships across different agencies.

03. Education and Awareness, specifically developing education and training modules for decision-makers and the public to learn more about drought.

04. Data and Information, specifically identifying and developing information that could enhance drought response and planning.

Although these table-top exercises identified the need to update local-level drought plans

Hope Mizzell leads a drought planning table-top exercise in 2016.

and ordinances (for water systems), many water systems across the state have not updated their plans and ordinances since 2003, when they were required to create them. While the current "model drought management plan and response ordinance" (http://scdrought.com/pdf/South_Carolina_Model_Drought_Management_Plan_and_Ordinance.pdf) provides a template for water systems to create a plan and ordinance, it does not indicate why specific steps should be taken. Although there are multiple drought planning resources available, it would take time to review all these guidance materials and then apply them to a water system's plan. Therefore, the South Carolina State Climatology Office, with input from SC American Water Works Association (SC AWWA) and SC Rural Water Association (SCRWA), and multiple water suppliers, has created this drought planning guide as a sister document to the "model drought management plan and response ordinance" to:

01. Provide drought planning guidance that fits with the SC Drought Response Program, allowing for water systems to create a more robust drought plan and ordinance.

02. Through case studies, provide examples of what proactive steps some water systems are taking to reduce drought risk in South Carolina, and how those steps can be transferable to other water systems in the state.

03. Create a resource that serves as a living document to address the key needs of the table-top exercises from 2017 and 2019.

Water systems should use this document when reviewing and updating their drought plan and ordinance to apply a suite of best-practices for reducing drought impacts through proactive management and response.

2. DROUGHT AS A NATURAL HAZARD

Drought is a natural part of almost all of Earth's climate. Simply put, drought is a hazard that leads to a reduction of expected water availability, potentially leading to water shortages that cannot meet demand. However, drought is anything but simple. Rather, it is the most complex natural hazard as it differs from all other natural hazards for multiple reasons.

First, drought does not have a universal definition. Rather, drought can be defined by distinct water needs (e.g., meteorological, agricultural, hydrological, socio-economic and ecological). Generally, most droughts start as rainfall deficits that lead to inadequate water requirements for the other four sectors. Drought does not equitably affect different sectors through time, as precipitation deficits generally affect agriculture before water systems or ecology.

Second, the onset and abatement of droughts are not easy to determine, as impacts may start out slow and increase over time for months, seasons or years. Furthermore, a few rain events may not end a drought period, as soil moisture or hydrological conditions may take multiple rain events to return to normal.

Third, drought impacts are generally non-structural, as opposed to other natural hazards such as floods, hurricanes or earthquakes. Lastly, drought impacts can be spread over large areas, generally reducing the water availability for a river system, leading to geographical challenges for adequately meeting water demands. This can also lead to inequitable impacts as stakeholders upstream may not feel the same impacts as those downstream.

DROUGHT IN SOUTH CAROLINA

Drought is usually not the first natural hazard associated with South Carolina, as water resources are generally abundant throughout the state. However, drought is a natural part of South Carolina's climate and the state has experienced multiple drought periods since the established climate record starting in 1895. Figure 1 shows the Palmer Drought Severity Index (PDSI) timeseries for South Carolina from 1895 through 2023, indicating multiple drought periods, particularly in the 1920s, 1930s, 1950s, 1980s, as well as the more recent droughts in 1998-2002, 2007-2009, and 2010- 2012. The PDSI is a long-term drought index that calculates how precipitation, temperature and available water content in the soils compared to normal over a nine-month period. The PDSI is calculated each month, with dry values as negative values and wet values as positive. The farther the index value is from zero, the more intense the conditions are. Each drought event in South Carolina is different, with some only lasting a season or a single year, while others last for multiple years. Different types of droughts (Short-term, long-term and flash droughts) result in different types of impacts across multiple sectors.

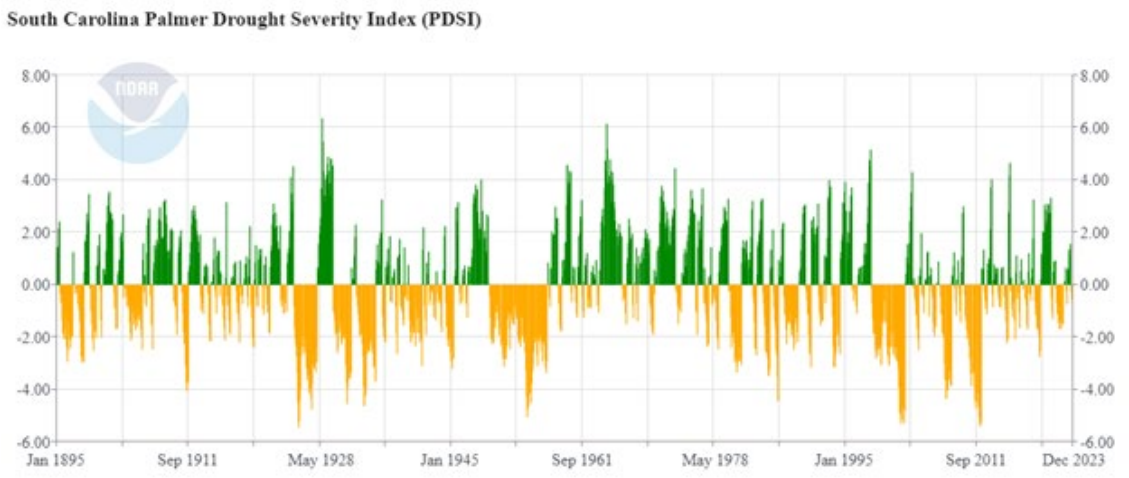


Figure 1. Palmer Drought Severity Index time series for South Carolina 1895-2023.

Corn Crop under stress from drought conditions in 2022.

SHORT-TERM DROUGHTS

In South Carolina, short-term droughts typically start as limited precipitation that results in inadequate replenishment of soil moisture, allowing for crop and pasture conditions to deteriorate. Sometimes temperature exacerbates these conditions through increased evapotranspiration, meaning that precipitation is not replenishing soil moisture and the soil is also losing moisture to the atmosphere. These types of drought events can lead to agricultural impacts and allow for the increased threat of wildfire and spread.

LONG-TERM DROUGHTS

While less frequent, long-term or multi-year droughts affect South Carolina as well, such as the 1950-1957, 1999-2002, and 2007-2009 droughts. When conditions are continuously dry for enough time, hydrologic conditions and water resources can be negatively impacted to the point that water supplies need to be closely managed, conserved, and even rationed for some uses. Generally, these types of drought are more regional in nature, where larger geographic areas are experiencing drought conditions, which can affect multiple watersheds, water basins, or even multiple states. It is these long-term events that local level water suppliers need to prepare for and develop drought plans to implement for water conservation when water supplies become strained.

(LEFT) Drought conditions in 2008 caused low flow conditions on the Tugulo River.

(RIGHT) Lowered Water levels on Lake Hartwell in 2008 due to drought.

FLASH DROUGHT

Flash droughts are periods when drought conditions intensify rapidly. Flash drought can refer to the onset of a drought, which quickly develops, or rapid intensification of conditions during an ongoing drought period. Although there is no standard definition of flash drought, particularly regarding time and intensity, the physical parameters that denote a flash drought period are constant. Flash droughts generally consist of below normal precipitation, in conjunction with abnormally high temperatures (such as heat waves) and wind. Being in the humid Southeast, another factor that can cause or contribute to flash droughts are low dew point temperatures during periods of higher temperatures (summer) which can increase evapotranspiration rates.

While flash droughts are generally related to agricultural impacts, flash droughts can also impact water supplies. The increased temperatures and evapotranspiration can affect surface water supplies in a more rapid manner. Furthermore, periods of above normal temperatures can cause water demands to rise, for both human needs as well as increased irrigation for vegetation health. This rise in water demand can simultaneously cause water supplies to drop.

Poor pasture conditions in Abbeville County during the flash drought in Fall 2019.

3. GETTING STARTED: DROUGHT PLANNING FRAMEWORKS

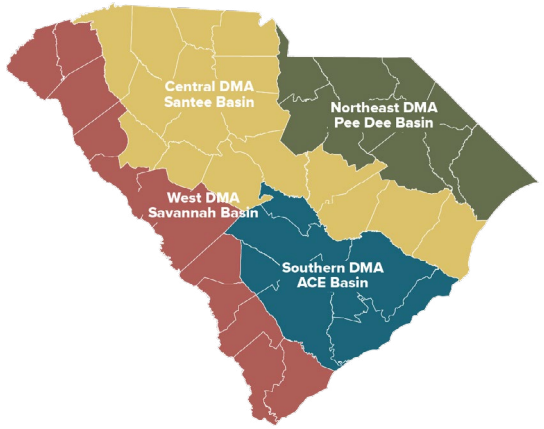
There are various ways jurisdictions can plan for drought. At the state level, drought planning can come in the form of a stand-alone plan, as part of a water plan or even part of emergency management plans. This approach is also applicable for smaller-sized jurisdictions (e.g. basin, county, or municipality). In South Carolina, drought planning with regulations takes place at the state and local levels. It also takes place at the river-basin level, but these drought planning efforts do not have regulative authority.

DROUGHT PLANNING IN SOUTH CAROLINA

STATE LEVEL

The state of South Carolina does not have a stand-alone drought plan, but has Legislation (South Carolina Drought Response Act, 2000) and a state-level response plan that is part of the state's Emergency Operations Plan (EOP). The Drought Response Act (http://scdrought.com/pdf/South_Carolina_Drought_Response_Act.pdf) is the state statute and supporting regulations (http://scdrought.com/pdf/South_Carolina_Drought_Regulations.pdf) that establish the state-level drought response program. The legislation outlines and defines the Drought Response Committee (DRC), which consists of five state agencies and 48 local representatives, the four Drought Management Areas, the drought severity levels (normal, incipient, moderate, severe, and extreme), the DRC's role in declaring drought levels and enforcement of drought response at the local level, and local level requirements for drought planning and response. More information is available at scdrought.com.

The state's EOP has a specific section for drought response (Appendix 10). This section was first added to the state's EOP in 2017, with the purpose of detailing how South Carolina's Emergency Management Division (EMD) will take over and respond to drought when the event is beyond the scope of the DRC to handle (https://www.scemd.org/em-professionals/plans/emergency-operations-plan/).



Map of the Drought Response Committee Drought Management Areas

PUBLIC WATER SUPPLIERS

The South Carolina Drought Response Act requires all public water suppliers to create a local drought management and response plan. "Municipalities, counties, public service districts, special purpose districts, and commissions of public works engaged in the business or activity of supplying water for any purpose shall develop and implement drought response ordinances or plans where authority to enact ordinances does not exist. The ordinances or plans must be consistent with the State Drought

Response Plan, implemented through the regulations adopted pursuant to this chapter" [South Carolina Drought Response Act, Section 49-23-90].

The supporting regulations of the Drought Response Act states that the S.C. Department of Natural Resources (SC DNR) and SC Department of Health Environmental Control (SC DHEC) shall develop and distribute a model drought management plan and response ordinance (http://scdrought.com/pdf/South_Carolina_Model_Drought_Management_Plan_and_Ordinance.pdf) for public water suppliers. These local ordinances and plans shall be consistent with the model plan and supporting regulations and must:

A. include a description of alternate supply sources, including time, costs, and problems associated with putting alternate sources online;

B. include a water use reduction plan and schedule for moderate, severe, and extreme drought for each category as appropriate;

C. include an implementation plan and ordinance, as appropriate; and,

D. ordinances and plans must be submitted to SCDNR for review.

Not all water systems have the same type of authority. Water systems that are part of a local government may have the ability to legally enforce drought ordinances as a part of the local laws. Water systems that are not part of a municipality, and run independently, may not have the ability to enforce an ordinance. However, they do have authority over the services they provide with the ability to enforce water restrictions, encourage water conservation, impose fines, and terminate service to customers that do not follow the terms of service. Most water systems in the state that are not connected to a local government still use the "ordinance" section of the plan. However, if a water system feels that it cannot have an ordinance because it is not part of a local government, the water system should have a drought management plan that includes all the authoritative and enforcement components of an ordinance. If you have questions about this, please reach out to drought@dnr.sc.gov. The South Carolina State Climatology Office within SCDNR can provide clarification and guidance.

LOCAL LEVEL DROUGHT PLANNING IS A "BEST PRACTICE"

Beyond the legal requirement for public water suppliers to have a local drought plan, there are two additional and equally important reasons to have a local level drought response plan. First, while the requirement for local level plans focuses on drought response (reaction based), having these plans ahead of time is actually a mitigation strategy (proactive based). Having a plan before a drought period provides an operational plan for preparation and action before the event takes place. Second, each water system has unique characteristics (e.g. water supplies, water demands, water infrastructure, etc.) meaning its risk to drought is unique. Having a local level plan should aim to reduce a water system's drought risk through management that accounts for a system's unique characteristics.

ADDITIONAL DROUGHT PLANNING EFFORTS IN THE STATE

SOUTH CAROLINA WATER PLAN

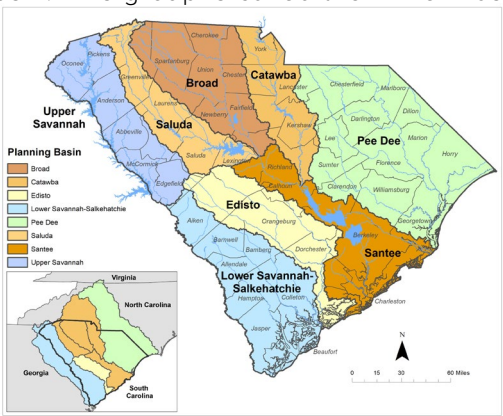
The first edition of the South Carolina Water Plan was published in 1998 and was subsequently updated in 2004 to incorporate experiences and knowledge gained from the severe, statewide drought of 1998–2002. The 2004 Water Plan highlighted the need for water planning on a regional level. In 2019, the South Carolina Department of Natural Resources published the South Carolina State Water Planning Framework (Planning Framework) under the guidance of the Planning Process Advisory Committee (PPAC). The Planning Framework describes the process of developing regional water plans, now formally called River Basin Plans, that will support the development of a new State Water Plan. River Basin Plans are being developed for the eight river basins in the state – Broad, Catawba, Edisto, Lower Savannah-Salkehatchie, Pee Dee, Saluda, Santee, and Upper Savannah.

More information on South Carolina State Water Planning:

- First edition of the South Carolina Water Plan (1998) https://hydrology.dnr.sc.gov/pdfs/water-plan/SCDNR_Water_Plan_1998.pdf
- Updated South Carolina Water Plan (2004) https://hydrology.dnr.sc.gov/pdfs/water-plan/SCWaterPlan2.pdf
- South Carolina State Water Planning Framework https://hydrology.dnr.sc.gov/water-planning-framework.html
- Planning Process Advisory Committee (PPAC) https://hydrology.dnr.sc.gov/ppac.html

SOUTH CAROLINA RIVER BASINS

The state is currently conducting water planning at the river basin level, which will then be used in the update to the next state-level water plan. The river basin planning areas generally follow the major river basins of the state and consist of a multi-sectoral stakeholders that develop a plan that meets the water needs of users in each basin. This group is called the "River Basin Council" (RBC) and one exists (or will exist) for each basin. The RBCs are responsible for creating each specific river basin plan. The plans are built on the RBC's consensus, providing an agreement among the different stakeholder groups for what steps each basin can take to ensure adequate water supplies for the next 50 years. The river basin plans focus on water supply, evaluating different water-use scenarios to assess if and how water supplies will be stressed over the next 50 years. The plans work towards drought preparedness by evaluating water availability, assessing where water shortages and impacts may occur due to natural processes and increasing demands. Furthermore, each RBC can provide recommendations for improving drought planning response efforts in each basin. Information for each basin's planning efforts can be found here: https://hydrology.dnr.sc.gov/river-basin-planning.html.



The eight major river basins in South Carolina.

EXAMPLE

The Broad River Basin Plan (https://hydrology.dnr.sc.gov/broad-basin-planning.html) makes five recommendations for drought planning and response in the basin (page. 8-7 and 8-8). These recommendations work to improve local drought response as well as provide a more regionalized approach so that drought response reduces impacts across the basin. The recommendations are:

01. Water utilities review and update their drought management plans and response ordinance every five years.

02. When water utilities update their drought management plan response ordinance, they look for opportunities to coordinate response actions with neighboring utilities.

03. Water utilities coordinate their drought response messaging.

04. Water utilities should consider drought surcharges on water use during severe and/or extreme drought phases.

05. When drought occurs, water users and those with water interests should report drought impacts through the Conditions Monitoring Observer Reports (CMOR) Tool (https://droughtimpacts.unl.edu/Tools/ConditionMonitoringObservations.aspx).

U.S. ARMY CORPS OF ENGINEERS (USACE) AND THE SAVANNAH RIVER

Along the Savannah River, the USACE manages three reservoir projects: Hartwell, Richard B. Russell, and J. Strom Thurmond. These reservoirs are operated for flood damage reduction, hydropower, recreation, fish and wildlife, water quality, water supply, and navigation. However, the navigation component became inactive in the mid-1980s. In 1989, the USACE created the Savannah River Basin Drought Contingency Plan (SRBDCP) with the purpose of addressing the operations of the reservoirs during drought and to assist South Carolina and Georgia in drought contingency planning with respect to their water management responsibilities for the Savannah River Basin. Due to multiple, significant drought events since 1989, the USAC updated the SRDBCP in 2006, 2011, and 2012 based on impacts that stressed supplies and then current management strategies.

Hartwell and Thurmond reservoirs each have four levels of drought (denoted as drought levels 1, 2, 3, and 4), which are based on reservoir levels (specific for each). As different drought levels are reached, flows out of Thurmond Reservoir are reduced. The reduction in flows is a balance for keeping adequate water in the system of reservoirs for meeting water demands, as well as meeting water demands below the system of reservoirs. Here, water demands are not just related to supply, but have additional considerations, such as water levels/salinity levels in the Savannah Harbor, which are affected by reduced flows from the reservoir system. Water systems that get some or all their water from these reservoir systems typically use USACE drought levels as triggers (plan thresholds for action) for water conservation.

For more information about the USACE Savannah River system, please visit: https://water.sas.usace.army.mil/GMAP/

Lowered water levels on Lake Hartwell in 2008 due to drought.

FEDERAL ENERGY REGULATORY COMMISSION LOW INFLOW PROTOCOLS AND DROUGHT MANAGEMENT ADVISORY GROUPS

Hydropower operators may be subject to a Low Inflow Protocol (LIP) (or a drought response plan) based on their Federal Energy Regulatory Commission (FERC) license. An LIP establishes procedures for water use reductions during low inflow periods. While most FERC licenses will prescribe how reservoir elevations and/or downstream releases of water can be reduced in response to low inflows or drought conditions, a few will also provide an LIP to address reductions of water withdrawals by local water users. Three such LIPs affecting South Carolina water users are provided in the FERC licenses for the Catawba-Wateree, Keowee-Toxaway, and Yadkin-Pee Dee hydroelectric projects.

Under the current license for the above named projects, hydropower licensees created Drought Management Groups (DMAGS) based on partnerships and agreements among water users and regulatory agencies (state and federal) to implement water conservation measures during drought periods. The DMAGs are voluntary advisory groups formed and tasked with working with the licensee when the LIP is initiated. The DMAGs meet as necessary to foster a basin-wide response to a ow inflow condition. The LIP provides trigger points and procedures for how the project will be operated by the licensee, as well as water withdrawal reduction measures and goals for other water users during periods of low inflow. The three South Carolina DMAGS include the Catawba-Wateree DMAG (CW-DMAG), the Keowee-Toxaway DMAG (KT-DMAG), and the Yadkin-Pee Dee DMAG (YPD-DMAG).

Water suppliers that are part of these DMAGs and get their water supplies from the reservoir system agree to use the LIP as the triggers or a component of their triggers in their drought plans. Therefore, South Carolina water systems in DMAGs need to fulfill the LIP requirements for water conservation in their drought plans, as well as meet the drought planning requirements of local water suppliers outlined in the South Carolina Drought Response Act and supporting regulations. For water suppliers in the KT-DMAG, they must also consider the USACE drought levels as these are factored into their LIP. To meet both the LIP and the South Carolina requirement, most water suppliers use the South Carolina model drought management plan and response ordinance as their planning framework and then use the LIP as further justification for the plan.

More information, please see the resources for each DMAG:

- Catawba-Wateree
  https://www.duke-energy.com/community/lakes/drought-management-advisory/catawba-wateree-dmag
- Keowee-Toxaway
  https://www.duke-energy.com/community/lakes/drought-management-advisory/keowee-toxaway-dmag
- Yadkin-Pee Dee
  https://www.duke-energy.com/community/lakes/drought-management-advisory/yadkin-pee-dee-dmag

THREE PILLARS OF DROUGHT MANAGEMENT

The International Drought Management Programme (IDMP) created the three pillars of drought management to provide a robust approach for increasing drought preparedness for multiple types of jurisdictions. Each pillar provides an essential function in drought preparedness, working best when they are used together. Figure 2 shows the linkages between each of the pillars.

PILLAR 1) RISK AND IMPACT ASSESSMENT

The goal of a risk and impact assessment is to determine the primary historical, current, and likely future impacts associated with drought and to assess the root cause of these impacts. Drought risk and impact assessments are directed at gaining an understanding of both the natural and human processes associated with drought and the impacts that occur. An outcome of Pillar 1 is the creation of a risk profile for each sector, region, population group or community.

PILLAR 2) MONITORING AND EARLY WARNING

A drought monitoring and drought early warning system (DEWS) is the foundation of effective proactive drought policies. A DEWS identifies water supply and demand trends, detects the emergence or probability of occurrence, and the likely severity of drought and its impacts. Effective drought monitoring and DEWS should integrate all relevant data related to supply (water system specific) as well as water-use data in assessment of current and future drought and water supply conditions. In addition, monitoring should also include impacts to help calibrate assessments of severity for local areas. This assessment can then trigger appropriate mitigation and response actions that have been identified in Pillar 3.

PILLAR 3) MITIGATION, PREPAREDNESS, AND RESPONSE

Drought mitigation, preparedness, and response comprise the appropriate measures and actions aimed at reducing the risk to drought and reducing the impacts of droughts. The goals of this pillar are to determine 1) appropriate mitigation and response actions aimed at risk reduction; 2) the identification of appropriate triggers to phase in and phase out response actions; and 3) finally, to identify which system employees are responsible for carrying out needed response actions.

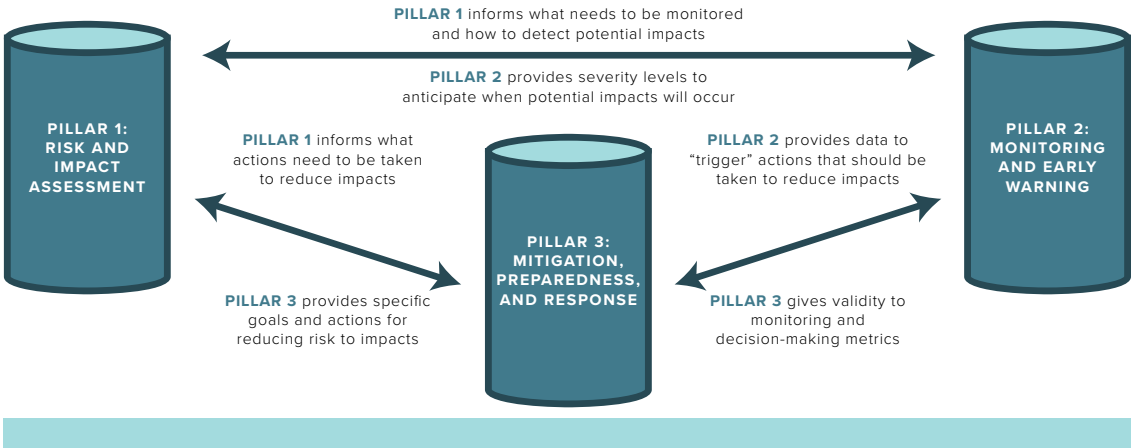


Figure 2. Three pillars of drought management and how they support each other.

4. REVIEW, UPDATE, & APPROVE THE NEW PLAN

A proactive, mitigation approach to drought planning is regularly reviewing, updating, and approving plan changes. Reviewing the plan should happen at least annually but is typically not a laborious task. Updating the plan takes place less often, such as every five to 10 years, but takes more effort as it reevaluates the characteristics of the water system, changes to monitoring and early warning, and plan actions for reducing impacts. Approving the plan should happen after each review and update cycle. These three components are described in more detail below.

REVIEWING THE PLAN

There are two types of plan review, before a drought and after a drought. Before a drought, plans should be reviewed on an annual to biennial basis to ensure that all metrics of the plan are still valid (system characteristics, monitoring, and plan goals and actions) and that all responsible personnel for plan actions know their responsibilities for each drought phase (tasks and communication). Water systems should also review their plans when the S.C. Drought Response Committee declares their respective county into incipient drought status, so that if drought severity increases, water systems can take effective action to minimize impacts.

BEST PRACTICE FOR REVIEWING THE PLAN

Dyke Spencer from Powdersville Water provided some “lessons learned”, and he said to “make it a practice to look at it [the plan] every two years or every time you make a major system change.”

For water systems that purchase wholesale water, take this “lesson learned” a step farther and review the plan any time the wholesale provider makes changes to their system or drought plan. For systems that provide wholesale water, inform wholesale customers of any system or plan changes that could affect drought management and response.

It is also worthwhile to review the plan right after a drought period. This will allow a water system to identify what did or did not work. Drought planning is an iterative process. Reviewing the plan for what did or did not work will only help to strengthen a plan during its next update, which will help improve drought management and response in the future.

Powdersville Water’s water supply tanks.

UPDATING THE PLAN

Updating the plan can range from small changes, such as adjusting the point of contact, shifting personnel responsibilities, to larger changes, such as redoing a risk assessment, changing monitoring metrics, or changing plan actions. Generally, plans should be updated at least every five to 10 years. However, the time between updates will vary for each water system, based on system changes, lessons learned from past events, and system resource capabilities for plan updates.

CASE STUDY: TOWN OF CLOVER

The town of Clover updated its drought management plan and ordinance in 2021. The plan was updated to follow the drought management plan from its wholesale supplier (Two Rivers Utilities/city of Gastonia, N.C.), while also following the South Carolina model drought management plan and response ordinance. Clover noted three positive outcomes from updating its plan.

01. It reassesses if the plan can manage a drought, answering the questions "Are the plan actions achievable, and can the current version plan still manage the size of the current system?"

02. It reassigns roles and responsibilities during a drought, reducing chaos during a stressful period.

03. It increases coordination and communication with partners and decision makers, providing easier translation between the drought planning and response language between North Carolina and South Carolina.

The town of Clover did not find this plan update process laborious nor lengthy. Two town staff members updated this plan, spending between 25-30 hours on the process over a six-month period. These two staff members stated that using their resources helped tremendously in making the process easy. These resources included, the previous plan, the Two Rivers Utilities/City of Gastonia current drought plan and working with the S.C. State Climatology Office within SCDNR.

Town of Clover's water supply tank.

The Broad River Basin Council (RBC) also found it important that water systems review and update their plans. The Broad River Basin Plan (https://hydrology.dnr.sc.gov/broad-basin-planning.html) makes five recommendations for drought planning and response in the basin (8-7 and 8-8). The first recommendation is "Water utilities review and update their drought management plans and response ordinance every five years." Although the Broad RBC works to ensure that the basin has adequate water supplies for the next 50 years, even during drought periods, it notes that protecting and ensuring adequate water supplies during drought periods starts with local-level efforts.

After a water system completes the update process of their plan, they need to send that plan to the S.C. State Climatology Office for review. This is to make sure that the update meets the requirements of the South Carolina Drought Response Act), the supporting regulations, and the model drought management plan and response ordinance (http://scdrought.com/pdf/South_Carolina_Model_Drought_Management_Plan_and_Ordinance.pdf). However, water systems do not need to wait until the update process is complete to reach out to the Climatology Office for review. The office will be happy to help with the update process at any point. For questions about how to update your plan or to send your updated plan in for review, please email drought@dnr.sc.gov.

APPROVING THE PLAN

Not all water systems have the same type of governing body. Some may report to a town council while others have a board of directors. Regardless, the governing body will need to approve and sign off on the plan. It is important to get the governing body to understand why changes needed to be made to the plan. Things to include:

- Changes in personnel or responsibilities.
- Changes to the system, such as water supplies, water agreements, changes in demand, changes to what needs to be monitored.
- Lessons learned from previous drought periods and what needs to change in the plan to address past issues.
- Other? Any other items that indicate why an update is needed.

BEST PRACTICES AFTER APPROVING THE UPDATED PLAN

After the updated plan is adopted, communicate with customers about the plan. This could be through a mail out, email, text, or social media where customers can interact with the new plan and see what has changed. Another option would be to set up a town hall meeting (or at the next scheduled town hall meeting) to talk to customers about the changes to the plan and why those changes occurred. Communicating with customers about changes to the plan increases education and outreach for drought management and response.

5. INFORMATION GATHERING & DROUGHT RISK ASSESSMENT

A drought event is not the sole cause of impacts; rather, impacts are caused by the interactions of a drought period and characteristics of a location. The purpose of conducting a drought risk assessment is to understand what water system characteristics are susceptible to drought impacts, why (and when) they are susceptible, and how to minimize impacts to these susceptible characteristics in the future. While all locations within South Carolina have experienced drought, each water system has its own drought risk. The risk assessment process serves two main purposes.

01. It allows each water system to identify and inventory its characteristics.

02. It allows each water system to calculate drought risk through evaluating how system characteristics are more or less vulnerable (or susceptible) to drought periods, leading to impacts.

There are multiple types of risk assessments (sometimes referred to as vulnerability assessment). The approach discussed in this section provides a simpler approach and factors to assess regarding drought risk. Below, three components that are discussed for this type of risk assessment. The first two: Hazard and vulnerability are variables that are quantified to understand risk. Risk is a product of the interactions of the hazard and vulnerabilities which lead to impacts.

Section 3, Point C (Description of Water System Layout, Water Sources, Capacities and Yields, page 4) of the model drought management plan and response ordinance (http://scdrought.com/pdf/South_Carolina_Model_Drought_Management_Plan_and_Ordinance.pdf) provides a water system a space to discuss characteristics of the water system. The risk assessment is the first of the three pillars of drought management and is a key component to all successful drought plans, as it identifies what system characteristics are vulnerable and why. Furthermore, it provides context to what should be monitored (pillar 2: monitoring and early warning) and provides further rationale for having a plan, as well as what actions will be taken before, during and after a drought to reduce impacts to vulnerable system characteristics (pillar 3: preparedness, mitigation, and response).

Drought conditions in November 2023 caused water levels to drop and expose the river bank on the Broad River near Parr Reservoir.

HAZARD

The hazard component of a risk assessment accounts for the probability of experiencing drought events, considering intensity and duration. The drought hazard is not uniform across South Carolina. Therefore, it is important to quantify the drought hazard for your water system. Although there are multiple types of drought indices to evaluate past drought periods in terms of duration and severity, probably the easiest indicator to detect the onset of drought conditions in South Carolina is monitoring precipitation. When reduced precipitation results in reduced streamflows, lake levels and groundwater levels, water supplies may reach a point when they can no longer adequately meet all demands. Below are some available datasets assessing drought hazard for different geographic areas across the state.

- NOAA's Climate at a Glance https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/
- U.S. Drought Monitor https://droughtmonitor.unl.edu/
- Carolinas Precipitation Patterns & Probabilities https://www.cisa.sc.edu/atlas/index.html
- Drought Risk Atlas https://droughtatlas.unl.edu/
- National Integrated Drought Information System https://www.drought.gov/
- USGS – SC Active Water Level Network
- USGS Drought Streamflows

VULNERABILITY

Generally, vulnerability are characteristics (attributes) of a location that enhance or reduce the potential for impacts. However, as vulnerability factors change through time, vulnerability can increase or decrease. For example, a system that is able to acquire more water supplies may lower its vulnerability to drought. When assessing vulnerability, please consider the following questions in relation to water supplies, water demands, and water infrastructure, and how they could increase or decrease vulnerability to drought periods.

EXAMPLE

Charleston Water System has three sources of water: Goose Creek Reservoir, Bushy Park Reservoir, and the Edisto River. The first two are north of Charleston in the Cooper River Basin, while the last is northwest of Charleston in the Edisto River Basin. Since Charleston has water supplies in different basins, the different supply sources may be disproportionately affected during a drought period.

WATER SUPPLIES:

- What type of water supply do you have (surface water or groundwater) and how is it affected by droughts?
- What are the geographic conditions of your water supplies, regarding:
  - If you have multiple sources of water in different locations, they may be affected differently during a drought period.
  - Where are you located in the watershed and how will you be affected by upstream demands, or how will you affect downstream supply?
    - If you are a coastal community, how could saltwater intrusion affect supply?
- How do water supplies fluctuate throughout the year and how would that affect the impacts during a drought period?
- How have your sources of water supplies changed since the last plan update, which could increase or reduce impacts during the next drought period?

Lake Blalock is one of water supply sources for Spartanburg Water.

WATER DEMANDS

- What are the different demand types for your jurisdiction, as well as:
  - What is the percentage of water-use sectors and how are they individually affected during drought periods?
  - What is the maximum, average and minimum water use by sector and does it fluctuate throughout the year (e.g. monthly or seasonal)?
  - Which demands are consumptive and which are non-consumptive?
  - Which water demands are deemed essential, and which are non-essential and are they different from those outlined in the South Carolina Drought Regulations (Section 121-11.10 Curtailment of Water Use during Droughts, pages 10-12)?
- How have water demands changed since the last plan update, regarding:
  - Overall water demands?
  - Sectoral water demands?

EXAMPLE

At Inman-Campobello Water District (ICWD) there has been an increase in outdoor, residential water use due to a change in development style. Newer style development creates smaller lots, allowing for more households to afford to water their lawns. With more households having higher outdoor water use, it has caused residential demands to increase per household, in turn increasing the demands of the water system. This is not unique to ICWD, as denser, smaller residential lots are typical for new developments in South Carolina. This type of change in water demand would change the vulnerability of a system to droughts.

Yard irrigation is a typical, non-essential, residential water demand.

WATER INFRASTRUCTURE:

- What interconnections do you have, regarding:
  - If you sell water to another system, does their drought plan align with yours (before and after an update)?
  - If you buy water from another system, does your plan account for your supplier's drought plan?
  - Do you have emergency supply connections to get water if your supplies are reduced or not accessible?
- How old is your infrastructure, regarding:
  - Are your pipes more susceptible to leaks or breaks due to age, and how would that lead to impacts during a drought period?
  - If your pumps are older, are they more susceptible to damage or breaking if their use is increased when water levels are low, or demand is higher?
- What type of infrastructure do you have?
  - Do you have technology in your system that allows for quick detection of leaks and where they are occurring, or how much water a customer is using?
  - How much of your system has new development or has houses with higher water efficiency, which can help to reduce water demands?

OTHER?

- Are there other attributes of your system that could either increase or reduce vulnerability?

RISK

The combination of the natural hazard and vulnerability that allow for impacts to a system is called risk. Each water system's drought risk is unique because each has different characteristics that can enhance or reduce potential impacts. The best way to evaluate drought risk is to analyze how drought has impacted your water system in the past, why those impacts took place, and at what drought severity those impacts took place. If your water system doesn't have a record of past drought impacts, the resources below provide a starting point for more generic, local-level impacts.

Leaks cause water loss and hinder water conservation during droughts.

- Drought Impact Reporter https://droughtreporter.unl.edu/
- Condition Monitor Observer Reports (CMOR) https://droughtimpacts.unl.edu/Tools/ConditionMonitoringObservations.aspx
- Visual Drought Atlas https://droughtimpacts.unl.edu/Tools/VisualDroughtAtlas.aspx
- Media Drought Index https://go.unl.edu/droughtnews
- Drought Tweets https://go.unl.edu/droughttweets
- CoCoRaHS Condition Monitoring Reports https://www.cocorahs.org/Maps/conditionmonitoring/

While these databases contain good impact information, site specific drought impact information can be hard to find. If these databases do not contain impacts for a specific system, the list below provides more generic type questions to consider regarding impacts that water systems could face during drought.

WATER SYSTEM OPERATION IMPACTS (HISTORIC, EXISTING, AND POTENTIAL)

- Could drought periods cause disruptions to accessing needed water supplies (e.g. water levels falling below water intakes or groundwater levels falling below pump levels)?)
  - If so, what are the costs of lowering water intakes, drilling deeper (or new) wells, or acquiring new water supplies?
- Could droughts lower water supplies to a level where water intakes must work harder (loss of efficiency and/or running time)?
  - If so, does that increase the costs of operation?
  - If intakes are working harder for a long enough period, could that damage or break infrastructure?
- Could droughts cause issues with water quality, resulting in higher treatment costs?
- Could droughts cause a reduction in revenue due to reduced water use from customers?

(TOP) Drought conditions in 2007 were so severe for Lake Marion that some boats lost their normal water access.

(MIDDLE) Warning sign for Boats for low water levels on Lake Marion in 2007.

(BOTTOM) Fires near residential areas in Horry County 2009, which were caused by drought conditions.

COMMUNITY IMPACTS (HISTORIC, EXISTING, OR POTENTIAL; RELATING TO SOCIETY, THE ECONOMY, OR THE ENVIRONMENT)

- Could drought cause impacts to landscape companies, nurseries, or other stakeholders that focus on landscaping (e.g. golf courses) due to curtailment of non-essential water use and water conservation?
- Could drought cause an increase in wildfire potential in your jurisdiction or could reduced water supplies cause barriers to firefighting capabilities?
- Could drought cause public health concerns through reduced air quality (dust, pollen, or smoke from fires), reduced water quality (from reduced supplies), or vector borne illnesses (from reduced surface water levels leading to stagnant water)?
- Could drought cause impacts to tourism and recreation, specifically those related to water?
- Could drought cause impacts to natural resources, such as wildlife, habitats, forestry?

AMERICA'S WATER INFRASTRUCTURE ACT OF 2018 (AWIA)

The America's Water Infrastructure Act of 2018 requires community water systems (CWS) serving more than 3,300 people to assess their risk to and resilience to malevolent acts and natural hazards. The U.S. Environmental Protection Agency (EPA) has multiple resources for CWS of multiple sizes for assessing risk and resilience (https://www.epa.gov/waterriskassessment), as they are responsible for certifying water systems for completing a risk and resilience assessment. Through this requirement for CPWs serving 3,300 people, many water systems may have already collected system characteristics that relate to vulnerability. This information can be used in relation to drought (hazard) information to assess drought risk, which would save time and resources conducting a new vulnerability assessment from scratch.

6. DROUGHT MONITORING & EARLY WARNING

Drought monitoring is the approach of watching how water supplies or inputs to water supplies (e.g. precipitation) change over a specified time; and if those changes result in below normal water supplies to meet water demands. However, since drought can affect available water in the atmosphere, on the land surface (topsoil moisture, rivers, and reservoirs), and under the earth's surface (subsoil moisture and groundwater), there are multiple ways to monitor for drought. Generally, drought is monitored in three broad categories: meteorology, soil moisture and hydrology (which accounts for surface water and groundwater). Beyond these categories, there are two different approaches to monitoring drought: indicators and indices. Indicators are physically measured variables used to describe drought conditions. Indices are computational representations of drought conditions. A good, comprehensive resource for drought monitoring is the Handbook of Drought indicators and Indices (https://www.droughtmanagement.info/literature/GWP_Handbook_of_Drought_Indicators_and_Indices_2016.pdf).

Drought monitoring is the second pillar of the three pillars of the drought management planning framework. Drought monitoring provides rationale for the plan, through data that shows how water supplies and demands can change through time and how those can lead to impacts during a drought "We cannot manage what we do not monitor" is a strong phrase for promoting the value of drought monitoring. If changes in water supplies are not monitored, how can the appropriate steps be taken to reduce drought impacts?

STATE-LEVEL DROUGHT MONITORING

Per the Drought Response Act of 2000 and supporting regulations, the South Carolina Drought Response Committee (DRC) uses seven different indicators to evaluate drought severity across the state, with each indicator having a threshold for the four drought severity levels. The use of these seven indicators allows for the state to evaluate drought conditions in a robust manner, because these seven indicators evaluate precipitation, soil moisture, wildfire risk, surface water and groundwater levels. The Standardized Precipitation Index, Crop Moisture Index, Palmer Drought Severity Index, Keetch Byram Drought Index , and United States Drought Monitor are all discussed in the Handbook of Drought Indicators and Indices, while the streamflow and groundwater metrics are based on specific statistics for each site. Table 1 shows the drought indicators quantified for the four drought severity levels as specified in the S.C. Drought Response Act supporting regulations.

The DRC convenes when conditions warrant the committee to meet. During a meeting, the DRC members evaluate the seven indicators and local impacts and then vote for the county-level classifications. Counties can be classified in normal conditions or incipient, moderate, severe, or extreme drought. When a county is declared in either moderate, severe, or extreme status, the local water suppliers within that county are encouraged to enact their local drought management plan and ordinance as needed. Therefore, the drought indices the state uses for drought monitoring have a direct effect on local level response to drought.

INDICATOR	DROUGHT PHASE			
	INCIPIENT	MODERATE	SEVERE	EXTREME
PALMER DROUGHT SEVERITY INDEX (PDSI)	-0.50 to -1.49	-1.50 to -2.99	-3.00 to -3.99	≤ -4.00
CROP MOISTURE INDEX (CMI)	0.00 to -1.49	-1.50 to 2.99	-3.00 to -3.99	≤ -4.00
STANDARD PRECIPITATION INDEX (SPI)	0.00 to -0.99	-1.00 to -1.49	-3.00 to -3.99	≤ -2.00
KEETCH-BYRUM DROUGHT INDEX (KBDI)	300 to 399	400 to 499	500 to 699	≥ 700
U.S. DROUGHT MONITOR (USDM)	D0	D1	D2	≥ D3
AVERAGE DAILY STREAMFLOW	111%-120% of the minimum flow for 2 consecutive weeks (CW)	101%-110% of the minimum flow for 2 CW	Between the minimum flow and 90% of the minimum flow for 2 CW	≤ 90% of the minimum flow for 2 CW
GROUNDWATER, STATIC LEVEL IN AQUIFER	between 11-20ft above trigger level for 2 consecutive months (CM)	between 1-10ft above trigger level for 2 CM	between trigger level and 10ft below for 2 CM	≤ 10ft below the trigger level for 2 CM

Table 1. Drought indicators and severity levels outlined in the South Carolina Drought Response Act.

LOCAL-LEVEL DROUGHT MONITORING

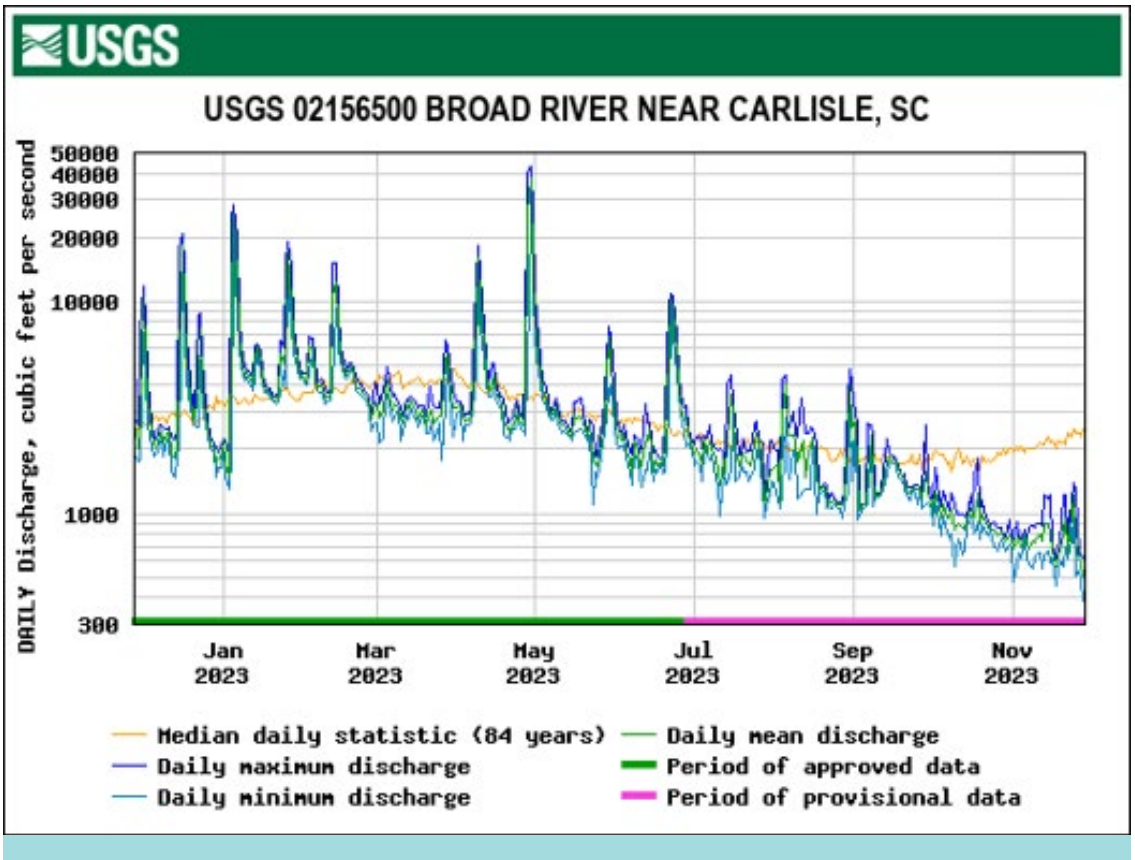
As a water system, it may be easy to pick what is monitored (i.e. supplies), but selecting how they are monitored (e.g. specific levels or changes in supplies and/or demands throughout the year) should relate to the findings of the risk assessment. At the Very least, they should relate to the information in Section 3, Part C (Description of Water System Layout, Water Sources, Capacities and Yields, page 4) of the model drought management plan and response ordinance (http://scdrought.com/pdf/South_Carolina_Model_Drought_Management_Plan_and_Ordinance.pdf). Furthermore, the risk assessment may shed light on other metrics that need to be monitored. For example, a water system may closely monitor streamflows when accounting for supplies, but including precipitation in the monitoring process may be beneficial as well, as it could indicate when streamflows could fall below normal or when demands may increase, which would also impact supply. Relating

monitoring with the risk assessment will allow a water system to take actions to reduce impacts.

Since each water system is different regarding supplies and system characteristics, it is impossible to provide specific monitoring metrics that would be applicable to each water system in the state. However, there are a few things that would be ideal to consider when setting up monitoring metrics for a water system.

- Having multiple physical parameters for monitoring, such as precipitation, streamflows, groundwater.
- Including demand monitoring as an indicator, as demand increases or spikes can negatively impact available supplies in both drought and non-drought periods.
- Including impacts to infrastructure that may cause issues with supplies.
- For those who purchase wholesale water from another system, including the provider's available supplies or monitoring metrics may help inform the purchaser of changes in incoming supplies.
- For those who sell wholesale water to another system, including the purchaser's demand metrics may help inform the provider's changes in demand, affecting overall supply.
- Other? There may be other factors that are necessary to monitor that are specific to a water system, which may have been identified during the risk assessment.

The different parameters that a water system chooses to monitor should be based on supplies and characteristics of each system. If a water system doesn't monitor all its characteristics, then that water system cannot adequately respond to a drought. We cannot manage what we do not monitor.

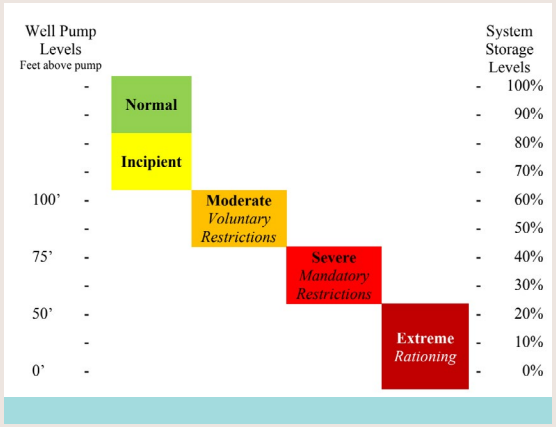


Hydrograph of the USGS streamgage on the Broad River near Carlisle, showing low flows in November 2023.

EXAMPLES OF DIFFERENT DROUGHT MONITORING METRICS FOR SOME WATER SYSTEMS IN SOUTH CAROLINA.

MOUNT PLEASANT WATERWORKS

- Average system storage levels drop to specific levels.
- Well pumping levels fall to specific elevation above any pump.
- For severe and extreme drought phases only: When water pressure is reduced to certain PSI and storage levels drop for a certain time frame.



Mt. Pleasant Waterworks drought plan's triggers for corresponding drought phases.

SPARTANBURG WATER

- U.S. Drought Monitor Conditions for Spartanburg County with further consideration that drought can be localized.
- Streamflows entering the storage reservoir system from the South Pacolet River drop to a certain level for a certain timeframe.
- Daily water demands exceed a certain threshold of the system's reliable capacity or a certain demand of million gallons per day.
- For severe and extreme drought phases only:
  - Reservoir levels or system demands create undue water quality issues.
  - Voluntary and/or mandatory water restrictions from the previous drought alert phase do not meet the water reduction goals.

INMAN-CAMPOBELLO WATER DISTRICT

- When flows at the Broad River raw river intake fall to a specific level for a certain time frame.

TOWN OF CLOVER

- Enacting water conservation when wholesale water supplier (Two Rivers Utilities, City of Gastonia, North Carolina) enacts its water conservation plan.
  - Two Rivers Utilities has three monitoring metrics based on its agreement with Catawba-Wateree Management Group (CWWMG) and Low Inflow Protocol (LIP).
    - a Total Storage Index (created by the CWWMG).
    - U.S. Drought Monitor (three-month average).
    - U.S. Geological Survey (USGS) streamflow gauges.

7. THE OPERATIONS OF THE DROUGHT RESPONSE PLAN

This section applies the information from the previous sections to actual plan operations or taking data and science and applying it to policy and action. This is where the three pillars come together, where the risk assessment (pillar 1) and drought monitoring (pillar 2) inform what actions a water system needs to take to prepare (pillar 3). In addition, the plan will provide procedures (pillar 3) that minimize risk (pillar 1) as well as provide validity to what needs to be monitored (pillar 2) to set any actions into motion.

Covered in this section are the purpose of the plan, plan triggers, plan actions for water conservation, water system communication (internal and external), and enforcement. Through these topics are the inclusion of case studies and "best practices" for drought response from participating water systems in South Carolina, highlighting what they identified as helpful for successful drought response. These water systems provided their best practices through interviews with the S.C. Climatology Office during the development of this document.

PURPOSE OF THE PLAN

The purpose of a drought management plan should be the establishment of procedures a water system will use to prepare for and respond to drought periods to minimize impacts. The model drought management plan and response ordinance (http://scdrought.com/pdf/South_Carolina_Model_Drought_Management_Plan_and_Ordinance.pdf) provides language that all water systems can use as their purpose of the plan (Section I: Declaration of Purpose and Intent). Using this verbatim or as a template will satisfy the purpose of the plan, regarding the state requirement of water systems in the Drought Response Act and supporting regulations.

> The purpose of this document is to establish a plan and procedures for managing water demand and evaluating supply options before and during a drought related water shortage. The intent is to satisfy the requirements of the Drought Response Act of 2000 (Code of Laws of South Carolina, 1976, Section 49-23-10, et seq., as amended) with the goal of achieving the greatest public benefit from domestic water use, sanitation, and fire protection and to provide water for other purposes in an equitable manner. Therefore, the _____ (water system) has adopted this Drought Management Plan and Drought Response Ordinance that provide the policies and the authority to fulfill this obligation. The Drought Management Plan outlines the framework by which _____ (water system) will internally prepare for water shortages. The Ordinance provides the regulations by which the _____ (water system) will manage and control its customer water usage during various levels of a drought.

TRIGGERS

All successful drought plans have drought triggers, which are thresholds (trigger points) when action is taken to increase water conservation to avoid impacts or ease water restrictions because impact potential has decreased. Triggers take the data from the risk assessment and from monitoring and put them into action. The risk assessment informs what needs to be monitored to reduce impacts, while drought monitoring applies severity levels for indicators and indices of when impacts may occur. Therefore, a trigger point is based on a specific drought indicator or index value (threshold) when impacts are likely to occur.

Because each water system's characteristics are unique, triggers should be specific to each water system. Each water system should include plan triggers for all the characteristics that affect supply (including demands), as well as including trigger points for different drought severity levels. Below are examples of severe drought triggers from Mt. Pleasant Waterworks and Spartanburg water. These two systems provide great examples as they have multiple monitoring indicators with associated triggers.

MT. PLEASANT WATERWORKS SEVERE DROUGHT PHASE TRIGGERS:

01. Drought Response Committee (DRC) declaration, or

02. Average system storage levels fall below 40% for 48 hours, or

03. Well pumping levels less than 75 feet above pump in one or more wells

04. Rationing when water pressure has been reduced to 40 psi and water storage levels drop below 20% for 48 hours.

SPARTANBURG WATER SEVERE DROUGHT PHASE TRIGGERS:

01. Total usable raw water storage availability for the production of drinking water from Lake Bowen and Municipal Reservoir #1 is projected to be less than 150 days;

02. Drought Response Committee declaration; or

03. The Governor of South Carolina mandates implementation of this phase;

04. Other factors considered:

A. A water shortage that could, in the judgment of the Spartanburg Water System threaten the health and safety of the customers of the Spartanburg Water System;

B. Moderate drought phase voluntary water restrictions do not result in meeting the goal of 15% water use reduction within a reasonable time;

C. U.S. Drought Monitor conditions for Spartanburg County with further consideration that drought can be localized;

D. Stream flow entering the storage reservoir system from the South Pacolet River drops below 19 cfs for 48 hours;

E. Daily water demand exceeds 80% of the systems reliable capacity or 43.2 million gallons per day;

F. Reservoir levels or system demands create undue water quality issues.

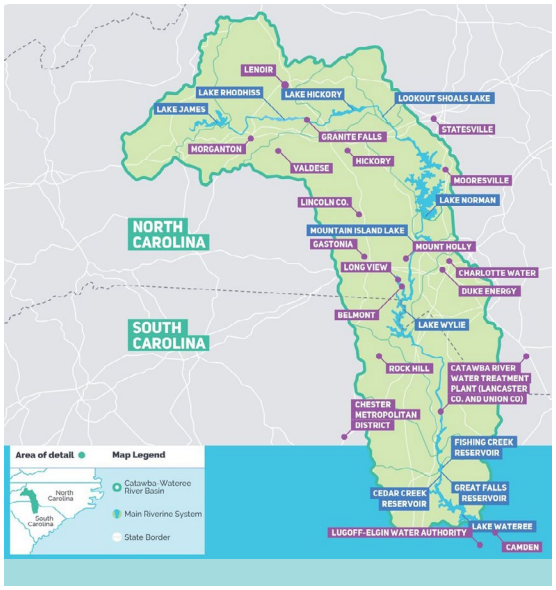
While water systems generally create triggers based on their local water supplies, some water systems may use triggers that have already been created by entities that provide or manage water (as discussed in Chapter 3). This includes systems that wholesale water, the U.S. Army Corps (USACE), and Drought Management Advisory Groups (DMAGS). Pre-existing triggers that come from entities that wholesale water will be specific to each situation and sale agreements. Water systems that get their water resources from the USACE operated reservoirs use the triggers outlined in the Savannah River Basin Drought Contingency Plan (SRBDCP), while water systems that are part of one of the three DMAGs use the DMAG Low Inflow Protocol (LIP) triggers (which is different for each).

BEST PRACTICE FOR TRIGGERS

Water systems that purchase wholesale water should use their supplier's drought triggers as well as any triggers that are specific to their own water system (e.g. demands). This provides continuity between the water providers and water customers (users) for drought response. While the provider's triggers don't need to be the only triggers a purchasing water system has, they should be included.

More information about about USACE and DMAG triggers are provided in the links below

- U.S. Army Corps of Engineers Savannah District https://water.sas.usace.army.mil/GMAP/
- Drought Management Advisory Groups
  - Catawba-Wateree https://www.duke-energy.com/community/lakes/drought-management-advisory/catawba-wateree-dmag
  - Keowee-Toxaway https://www.duke-energy.com/community/lakes/drought-management-advisory/keowee-toxaway-dmag
  - Yadkin-Pee Dee https://www.duke-energy.com/community/lakes/drought-management-advisory/yadkin-pee-dee-dmag



A map showing the members and water supplies of the Catawba-Wateree Water Management Group.

Water systems may also add additional triggers during the river basin planning process. River Basin Councils (RBC) may create triggers for basin stakeholders to enact water conservation when water supplies in the basin reach a certain point. If an RBC creates triggers for basin-wide water conservation, it will be located in "Chapter 8 Drought Response" for each river basin plan. The Edisto RBC created its own triggers for water curtailment that is shared among the largest water users in the basin. The triggers are based on median low flows of the Edisto River at Givhans Ferry. Table 8-6 of the Edisto River Basin Plan (https://hydrology.dnr.sc.gov/pdfs/basin-planning/Edisto%20River%20Basin%20Plan_2023_Reduced.pdf, page 8-10), provides the triggers and reduction goals for surface water withdrawals, which is provided below in Figure 5.

INCREMENTAL PERCENT BELOW 20% OF MEDIAN FLOW	EDISTO RIVER FLOW RANGE (CFS) AT GIVHANS FERRY		REDUCTION GOAL FOR SURFACE WATER WITHDRAWALS
	LOWER	UPPER	
0-20%	266	332	20%
20-40%	199	266	40%
40-60%	133	199	60%
60-80%	66	133	80%
80-100%	0	66	100%

01. The trigger for curtailment will be based on running 7-day average flows at Givhans Ferry.

02. The strategy only applies to surface water users whose cumulative (from all intakes) peak monthly withdrawal has exceeded 60 million gallons per month (MGM) in any of the previous 12 months. Those meeting this definition are referred to as the "largest users" in the context of this strategy.

03. When triggered, the reduction in surface water withdrawals will apply to each of the largest user's peak monthly withdrawal from the last 12 months.

04. The reductions in withdrawals specified in the strategy are voluntary.

05. The strategy is intended to be implemented over time and is contingent upon available funding.

06. Methods to meet the desired withdrawal reductions are at the discretion of each user.

07. The low flow strategy does not apply to surface water users who have existing agreements with SCDHEC to shift withdrawals from surface water to groundwater or vice versa, based on agreed-to triggers.

08. The low flow strategy does not set any new (lower) limits for new surface water withdrawals permitted in the basin.

Figure 5. Triggers used in the Edisto River Basin Plan.

Another type of trigger that is worth considering is the Drought Response Committee (DRC) county status declarations. This allows coordination between the local and state-level for drought response, where the DRC can tell how dry a county is based on climatological and hydrological drought indices and the water system can decide if those indices relate to needed water curtailment based on their water supply levels. However, while the DRC county declarations should be included as a plan trigger, it should not be the only trigger a water system has for entering different drought phases. The DRC uses multiple drought indices that capture more broad scale conditions for drought severity and generally do not indicate the specific amount of water a water system has.

BEST PRACTICE FOR TRIGGERS

Jason Thompson of Charleston Water and a member of the DRC states: “Specific and quantifiable triggers are critical so that our drought plan can trigger on conditions specific to our sources rather than generalized conditions being felt across a county or drought management area”.

One of Charleston’s water supply tanks

For water systems that don’t have drought triggers of their own, a good starting place is Section III: Drought Management, D. Identification of Water System Specific Drought or Water Shortage Indicators of the model drought management plan and response ordinance (page 4 and 5). This provides fill-in-the-blank options for a water system to consider.

BEST PRACTICES FOR TRIGGERS

01. Have multiple triggers that are used to determine drought levels, and no one trigger supersedes another. Any one of the indicators can hit the designated trigger point to initiate a change in drought phase. This allows for structured flexibility for a water system to appropriately respond to drought periods based on multiple system specific factors, including supplies, demands, and infrastructure. The range of triggers should also include Drought Response Committee drought declarations but should not solely rely on them.

02. Have reverse triggers. Reverse triggers are for easing water restrictions or drought severity phases as conditions begin to improve. Reverse trigger thresholds should be different from the regular triggers. For example, Lake levels need to be 10 feet below target to reach drought level 1, but lake levels need to improve to 7 feet below to come out of drought level 1. This allows for more substantial recovery of supplies to occur before changing drought levels. This approach minimizes the possibility of frequently moving between drought levels, which causes challenges for effective drought response and management.

WATER CONSERVATION

In the model drought management plan and response ordinance, the model ordinance provides a list of water conservation actions for non-essential water uses through the moderate, severe, and extreme drought phases (pages 8 - 13). The list of conservation actions increases with each drought severity level. In addition, the target for residential, other water use, and total system water conservation changes with each drought severity level. See Table below.

DROUGHT PHASE	WATER REDUCTIONS BY CATEGORY		
	RESIDENTIAL	COMMERCIAL, INDUSTRIAL, INSTITUTIONAL, & IRRIGATION	TOTAL SYSTEM
MODERATE	20%	15%	15%
SEVERE	25%	20%	20%
EXTREME	30%	25%	25%

Table 2. Water Conservation goals for each drought phase in the model drought management plan and response ordinance.

Beyond actions outlined in the model drought management plan and response ordinance, each water system should explore water conservation actions that meet the needs of their system characteristics. Each water system should review the provided action items for curtailing non-essential water use in the model drought management plan and response ordinance and determine if those actions are enough to meet their specific reduction targets. If not, then other action items may be needed.

BEST PRACTICE FOR WATER CONSERVATION

Water systems should also apply conservation targets that ensure essential water uses and demands can be met, while also remaining achievable. If conservation targets are too low, water supplies may not be protected enough, resulting in impacts. Contrastingly, if conservation targets are too high, the desired outcome of the plan may not be achievable, also resulting in impacts. It's important to find the optimal target between these two points, which will be different for every water system. The table below shows the total system water reductions for Spartanburg Water and town of Clover for the different drought phases. These two examples show how each tailored water conservation targets for the different drought phases based on their specific needs.

DROUGHT PHASE	SPARTANBURG WATER CONSERVATION TARGETS	TOWN OF CLOVER CONSERVATION TARGETS
INCIPIENT	none	5%
MODERATE	15%	15%
SEVERE	30%	20%
EXTREME	50%	30%

Table 3. Water conservation targets by drought phase for Spartanburg Water and town of Clover.

OPERATIONAL TASKS

Each drought phase, there are multiple operational tasks that need to be done to ensure adequate water supplies to meet essential water demands. These tasks include, but are not limited to:

- increased monitoring of supplies and demands
- increased leak detection to protect supplies
- Increased monitoring of supplies and demands and leaks
- Evaluating effectiveness of water conservation
- Preparing and disseminating drought information accordingly, such as to customers, partners, and the media
- Conducting water system drought meetings for decision making
- adding surcharges or fines to the bills of customers who don't adhere to water restrictions

Developing a list of operational tasks that need to be completed during different drought phases, as well as who is responsible for those tasks, and putting them into the drought plan will increase effective drought management and response.

BEST PRACTICES FOR OPERATIONAL TASK

Mt. Pleasant Waterworks has a list of actions for each drought phase, as well as an assignment for who is responsible for each task. In the moderate, severe, and extreme drought phases, tasks are grouped by type (administrative and operations). The list of actions increases with each drought phase, as response and management need to increase to reduce impacts and ensure adequate water supplies.

This proactive approach increases the effectiveness of drought management and response as it gives clear direction of who is responsible for what during different drought phases, so that all needed tasks are carried out effectively.

DROUGHT PHASE	NUMBER OF TASKS	ROLES NEEDED TO COMPLETE TASKS
INCIPIENT	3	3
MODERATE	15	6
SEVERE	43	7
EXTREME	45	7

Table 4. Number of tasks per drought phase outlined in the Mt. Pleasant Waterworks Drought Plan.

COMMUNICATION

Communication during a drought period should include multiple entities, both within and outside of a water system. Within a water system, drought management and response needs to be conveyed to customers, the media, as well as any decision makers (such as a town council) about why drought response is needed and how it will be managed. This can also be considered education and outreach during a drought period.

BEST PRACTICES FOR COMMUNICATION WITHIN THE WATER SYSTEM

01. Water systems should have a dedicated page on their website that provide conservation tips

- **EXAMPLE:** Inman-Campobello Water District's Conservation Tips (https://www.icwd.org/conservationTips.html)
- **EXAMPLE:** Lancaster County Water and Sewer District's Leak Detection (https://www.lcwasd.org/water-leak-detection)

02. When changing drought phases, explain:

- Why this change is taking place.
- What to expect, such as needed conservation, and how to participate.
- Potential consequences of not conserving water, including financial reasons for the customer as well as overall impact to the water system.

03. Coordinate with the media to explain changes to drought phases and needed response, so that media sources have the facts about what they are reporting.

04. Coordinate with needed decision makers to ensure cooperation between the water system and jurisdictional partnerships for needed drought messaging and response.

05. Educate customers on water use, where customers can find their monthly water use, and what monthly water use they should strive for to meet conservation targets.

06. Have multiple systems to regularly communicate with customers to increase the reach of information as well as the timing of information (examples below are from Spartanburg Water)

- Lake Alerts: This is an email and text alert that allows information to go out as needed to anyone that signs up. Generally, information includes information about Lake Bowen, Lake Blalock, and Municipal Reservoir #1, but does include information about drought. Available at https://www.spartanburgwater.org/lakealerts).
- Healthy Lakes Newsletter: Quarterly newsletter that provides information happening within Spartanburg Water. Available at (https://www.spartanburgwater.org/Healthy-Lakes-newsletter).

Communication with entities outside the water system is just as important as communication inside the water system. This is especially true if drought conditions become more regional, causing more widespread impacts. Some external communication is required, such as reporting to S.C. Department of Natural Resources when a water system enters the moderate, severe, or extreme drought phase (per the model drought management plan and ordinance). Other external communication is not required but is a best practice for successful drought response and management.

BEST PRACTICES FOR COMMUNICATION OUTSIDE THE WATER SYSTEM

01. For those that sell wholesale water, tell your purchasers when you enter different drought phases so that they are aware of changes in supply and needed water curtailment. Likewise, for those that purchase wholesale water, inform your seller when you enter different drought phases so they are aware of changes to purchase. This includes reduced purchases due to lower demands and increased purchases to meet demands.

02. For systems that have emergency supply connections, inform your connections when you enter drought phases so they are aware and account for emergency supply deliveries in their supply budgets.

03. The river basin plans provide an avenue of regional drought communication for a shared resource among multiple stakeholder types. Communicating drought conditions with a River Basin Council (RBC) allows for 1) information sharing for impacts and response in the river basin for consistent drought management across multiple water user types; and, 2) the RBCs to provide drought information to the South Carolina Drought Response Committee.

The Broad RBC at one of their monthly meetings during the planning process.

ENFORCEMENT

Getting customers to reduce water use is challenging. Typically, the most effective way to get customers to conserve is to increase the price of water for those that don't meet conservation targets. The model drought management plan and response ordinance provides two avenues for increasing costs: fines and a tiered rate structure for excessive water use.

FINES

The model drought management plan and response ordinance provides a section on fines (F. Enforcement of Restrictions, page 13 and 14). This section allows the water system to impose fines (violation surcharges) on customers that are not meeting conservation targets, with increasing costs per violation. Not only is this a good approach for getting customers to reach conservation targets, it also provides an avenue for a water system to recoup revenue during drought periods, when overall revenue is typically down due to lower use.

BEST PRACTICE FOR FINES

01. Fines should cause customers to want to lower their water bill. Therefore, the first fine should start out at an amount that gets the customer's attention regarding the monthly bill amount. This will be different for every water system as income levels vary between water systems. Some systems send a warning for the first violation rather than imposing a fine. However, the first imposed fine should be more than $5 or $10 dollars, as a customer may not even notice a change in their bill. The violation fine needs to be something that will catch the customer's attention. In plans that have been updated more recently, the first violation with a cost is usually $50 or $100. Monetary costs should increase with each violation accrued.

02. Water systems should give themselves the flexibility to terminate service to customers who refuse to comply with water conservation. Generally, this option is only needed after multiple violations. However, it allows water systems to have stronger enforcement for those customers that refuse to cooperate. It also provides some monetary benefits, as customers may need to pay extra fees to get the water restored. Below are examples from three water systems.

- **SPARTANBURG WATER:** upon the fourth violation, the water system shall impose a penalty of $500 and/or terminate water service. If water service is terminated, the customer must pay an additional $50 to have water service reinstated, plus any other costs incurred by the water system in discontinuing or reinstating the service.
  First violation: warning, second violation: $50, and third violation: $100.
- **INMAN-CAMPOBELLO WATER DISTRICT:** upon the fourth violation, the customer's water service shall be terminated and restored only after the payment fee of $500 is received in addition to all other previously assessed fees.
  First violation: warning, second violation: $50, and third violation: $200.
- **MT. PLEASANT WATERWORKS:** upon the third violation, the customer's water service shall be terminated and restored only after payment of a surcharge of $500 in addition to all previously assessed surcharges.
  First violation: $100 and second violation: $300.

Spartanburg Water has their own law enforcement to protect their lakes. These officers are also authorized to help enforce water restrictions of the system's drought plan.

TIERED RATE STRUCTURE FOR EXCESSIVE WATER USE

In the extreme drought phase, the model drought management plan and response ordinance lists a tiered rate structure for excessive water use as a conservation measure (pages 12 and 13). This provides water systems with the option to charge more for each block of water used. While this provides another financial incentive for customers to reduce water, it also provides water systems with an opportunity to recoup income during a drought event.

BEST PRACTICES FOR TIERED RATE STRUCTURE

Include a tiered rate structure in the severe drought phase. This provides the water system's with the optional management strategy of increasing water use rates during a severe drought. Both Inman-Campobello Water District and Spartanburg Water use the tiered rate structure in their severe and extreme drought phases, where the first tier is based on typical, average monthly water use.

INMAN-CAMPOBELLO WATER DISTRICT SEVERE DROUGHT STAGE TIERED RATE STRUCTURE		
TIER 1	0-5,000 gallons per month (G/M)	Regular Rate
TIER 2	5,000-12,000 G/M	2 times regular rate
TIER 3	Over 12,001 G/M	3 times regular rate

Table 5. Inman-Campobello Water District severe drought stage tiered rate structure.

SPARTANBURG WATER SEVERE DROUGHT STAGE TIERED RATE STRUCTURE		
TIER 1	0-5,600 G/M	Regular Rate
TIER 2	5,601-7,600 G/M	2 times regular rate
TIER 3	7,601-9,600 G/M	3 times regular rate
TIER 4	Over 9,601 G/M	4 times regular rate

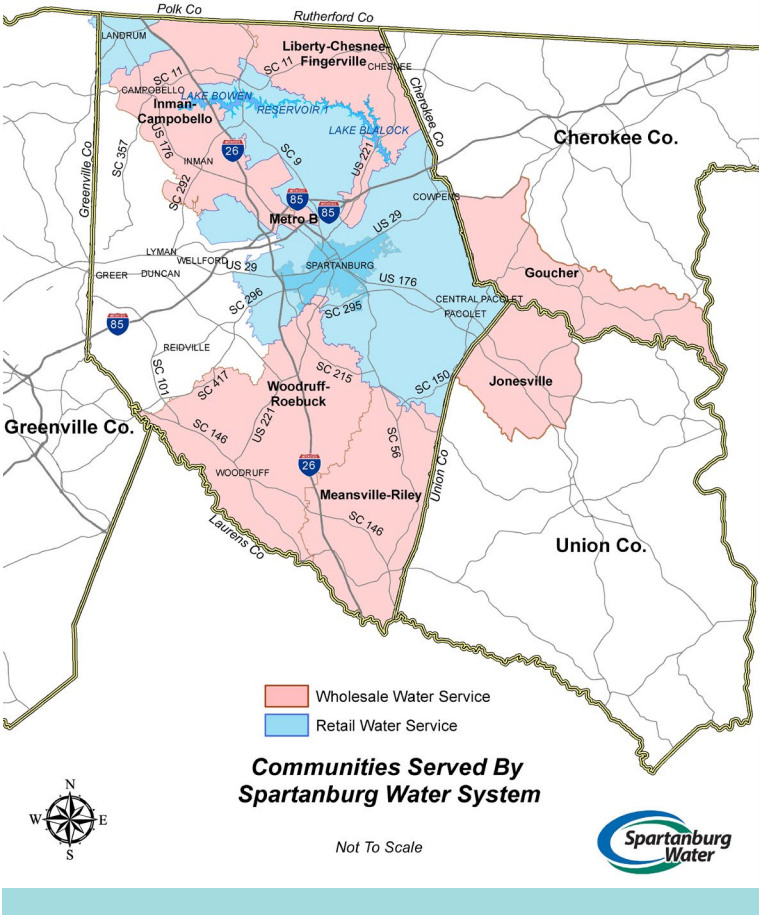
Table 6. Spartanburg Water severe drought stage tiered rate structure

8. MITIGATION: TAKING CURRENT STEPS TO REDUCE FUTURE IMPACTS

Mitigation is taking steps to reduce future risk and impacts. This section focuses on mitigation, particularly on additional actions that should be considered in your drought planning efforts.

PARTNERSHIPS AND COOPERATIVE AGREEMENTS

Emergency inter-connections allow a water system to deliver the needed supplies to another water system through existing infrastructure. Creating these agreements and infrastructure before a drought helps to mitigate any localized water supply problems that may arise.



Map of Spartanburg Water's retail and wholesale water service.

BEST PRACTICES FOR PARTNERSHIPS

01. Create partnerships for backup or emergency supplies before a drought. Powdersville Water District has six connections to three separate sources of surface water. Greenville Water is the primary source (wholesale) while Anderson Regional Joint Water System and Easley Combined Utilities serve as auxiliary / backup sources. In addition, Powdersville Water District expects to update their drought plan and ordinance when Greenville Water updates their plan, to provide consistency in management and response between the two systems.

02. Use the South Carolina Rural Water Association's (SCRWA) resources. SCRWA provides on-site technical assistance, training and resources for water and wastewater systems. One cooperative resource they help coordinate is the S.C. Water/ Wastewater Agency Response Network (SCWARN), which is a network of utilities that share personnel and other resources through agreements to prepare and respond to natural disasters (https://www.scrwa.org/scwarn.html). SCRWA has also provided resource assistance to water utilities during drought periods, such as providing its drone to water systems to investigate any water blockages upstream that may hinder flows near the intake.

03. Get involved with the river basin planning process. The state's river basin planning allows for multiple stakeholder groups to come together, evaluate water availability over the next 50 years (through scenario planning) and make recommendations on how to ensure all stakeholders have access to the water, even under drought periods. This process allows for multi-stakeholder partnership building, as well as providing an agreed upon regional approach to water management during drought periods. While not all water systems in a basin can be on a river basin council (RBC), due to the size of each RBC, all water systems are able to participate in the meetings and the process and provide their suggestions to the RBC during the creation of the plan, as well as during drought periods for needed management and response.

04. Communicate with S.C. Department of Transportation (SCDOT). Spartanburg Water communicates with SCDOT for when road maintenance is scheduled so they can reduce cost for infrastructure repairs. The saved cost allows for the money to be used for other system needs.

The Saluda RBC at one of their monthly meetings during the planning process.

REGULARLY REVIEWING AND UPDATING THE PLAN

Section 4 of this document discusses the value of regularly reviewing and updating the plan. However, it is worth noting it here again as a mitigation approach. Taking time to review and update the plan is a routine approach to make sure that roles, responsibilities, communication, plan objectives, and plan functions perform as needed to minimize risk and impacts during the next drought period.

INVESTING IN TECHNOLOGY

Investing in technology, including both infrastructure and software, can increase the information receiving capabilities of a water system. While there are many different types of technologies for water systems, this section focuses on technology that relates to gathering information on water demands or water loss. Conducting water audits are important both before a drought and during a drought. While conducting a water audit during a drought period may be more related to drought, the infrastructure and capabilities to conduct an audit need to be in place before a drought. Water audits provide information about water use in a system, such as water loss to leaks, demands by sector, demands changes through the year. The findings of a water audit can identify if and where leaks are taking place, which can help save water loss during drought periods. Water audits can also help answer some of the demand questions in the risk assessment (see section 5: Information Gathering and Drought Risk Assessment). Understanding the dynamics of water demand before a drought can help for targeted management during a drought period, such as which customers are the largest water users and how information can be targeted to them for conservation (discussed in Section 7: The Operations of the Drought Plan, communication within the water system). The American Water Works Association provides tools and information on water audits at https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Loss-Control.

An example of smart water meter for more precise water use measurements.

Other technologies like Supervisory Control and Data Acquisition (SCADA) or Advanced Metering Infrastructure (AMI) provide real-time information at specific nodes in the system. This can be helpful for identifying leaks in the distribution system or leaks at a customer's location. These types of technologies can be expensive investments. However, other types of natural hazards can cause impacts to water supplies. The use of technology can help with reducing impacts to these natural hazards as well. Below are some natural hazards that can impact water supplies.

NATURAL HAZARDS THAT CAN IMPACT WATER SUPPLIES

- **DROUGHT:** When supplies are strained, identifying and reducing leaks can help conserve water resources.
- **EXTREME HEAT:** Water demands typically increase when temperatures increase. When temperatures (particularly in the summer) are elevated for a time, such as a heat wave, demands can increase, which can cause supplies to drop. It can also have a compound effect on supply when extreme heat occurs simultaneously with drought, where drought has caused supplies to drop and the extreme heat causes demands to increase, which causes further strain on supplies. It is also a good practice to monitor for extreme heat as well as directly monitoring demand during extreme heat events for needed response if supplies drop to a certain level. This is especially true for water systems that use demand levels as a trigger for drought response and water conservation.
- **EXTREME COLD:** Although winter in South Carolina is relatively mild compared to other parts of the United States, extreme cold events do occur. When they do, it can cause damage to water infrastructure leading to water loss. This happened in late December 2022, when most of the state experienced minimum temperatures below 10 degrees F, causing pipes in residential and commercial locations to freeze and then burst. Because of holiday travel, multiple busted pipes and water loss caused strain on water supplies. Water systems with AMI technology were able to quickly identify which properties had busted pipes and could stop the water loss.
- **HURRICANES AND FLOODS:** Hurricanes and floods can cause significant damage to the landscape, which can lead to damage to water infrastructure. If damage occurs to infrastructure during a hurricane or flood, technology, such as SCADA, can identify where damage and water loss is taking place, allowing for more targeted response and minimizing disruptions to water delivery.

HAVING EDUCATION AND OUTREACH MATERIALS CREATED BEFOREHAND

Drought periods that strain water supplies are stressful for water systems. Having pre-made education and outreach materials will save time in sending out needed information. Inman-Campobello Water District has a webpage on conservation tips (https://www.icwd.org/conservationTips.html) and Lancaster County Water and Sewer District has information on leak detection (https://www.lcwasd.org/water-leak-detection). This means that these two water systems do not have to spend time creating resources for customers during a drought; rather, they can send them to their respective resources. However, there are other types of pre-made education and outreach materials you may want to create ahead of time.

BELOW ARE A FEW EXAMPLES:

01. Having pre-made information (e.g. mailouts, emails, text alerts and social media) that discusses what phase of drought the water system is in, why it is in that phase (particularly if the system has multiple triggers), and what action is needed. It is also worth including the possibilities of fines or excessive rate charges (from the tiered rate system) if the water system has entered the severe or extreme drought phase. Since response actions and conservation targets change with each drought phase, it would be worthwhile having a pre-made template covering these topics for each drought phase (incipient, moderate, severe and extreme).

Spartanburg Water's newsletter discussing plans for the annual drawdown of Lake Bowen and Lake Blalock.

02. Create information to help customers understand their water use and bill. Particularly, how much water they use each month or where that information can be found, as well as how water is priced and how much they are using. A lot of customers do not look at the details of their bill. This means they may not know what their water use is, how much they need to conserve, or how much their rates could increase if they have excessive water use during a drought period.

03. Create information on the U.S. Drought Monitor (USDM) and your water system. While most water systems do not use the USDM as plan trigger, it is a national drought monitoring tool that the media typically uses. The USDM depicts drought severity and extent across the United States, focusing on broad scale conditions and includes all types of drought (meteorological, agricultural and hydrological, as well as accounting for economic, ecological and societal impacts). Therefore, the USDM may depict drought while the water system has not yet encountered drought conditions or impacts, causing confusion. Having pre-made materials about the USDM's depiction of drought and actual drought conditions for a water system may help with communication to customers as well as the media. The USDM is a very complicated process and product. Any water system that would like help creating pre-made outreach materials about the USDM, feel free to contact Elliot Wickham at wickhame@dnr.sc.gov. He is the water resources climatologist in the South Carolina Climatology Office and is the state's lead for providing input to the USDM each week. He would be happy to help any water systems that want help creating USDM communication.

04. Other. Each water system is unique, facing its own communication and outreach needs. Water systems should create any outreach materials that discuss previous issues during drought that can be mitigated through outreach and communication.

9. CONCLUDING REMARKS

The South Carolina Climatology Office would like to thank Kirsten Lackstrom and the Carolinas Integrated Science and Assessments (CISA) program (funded through NOAA's Regional Integrated Science and Assessments (RISA) program). The CISA program funded the drought table-top workshops in 2017 and 2019, and Kirsten started the conversations with participating water systems. Kirsten's efforts initiated the creation of this document.

The South Carolina State Climatology Office would like to also thank all the participating water systems as well as the South Carolina chapter of the American Water Works Association and South Carolina Rural Water Association for all their support, expertise, and time they spent answering our questions. This process allowed us to create a resource that includes insights from those that manage water systems, in hopes that this document contains informative material for water systems as they update their drought management plans and ordinances.

This resource is set up as a living document. We encourage water systems to share their experiences with drought management and response, such as approaches that have or have not worked in the past. We would like to include these experiences in this resource to provide more “best practices” that can be transferable to other water systems in the state.

Please email drought@dnr.sc.gov, with questions about this guide, if you need help updating your plan or for how to submit your updated plan to SCDNR and if you would like to share your best practices. This email goes directly to Hope Mizzell, state climatologist, and Elliot Wickham, water resources climatologist.

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Total Cost: $0.00
Total # of Copies: 15
Total Cost per Copy: $0.00

24-14190