Intended for

Tennessee Duck River Development Agency

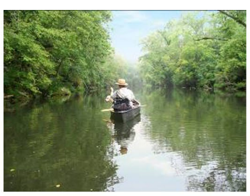
Document type

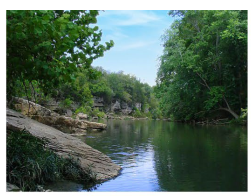
Draft Plan

Date

September 2026

Duck River Regional Drought Management Plan 2026





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Duck River Regional Drought Management Plan 2026

Project name	**Duck River Agency Regional Drought Management Plan Update**
Project no.	**1940121966**
Recipient	**David Money, Angie Brown**
Version	**1**
Date	**August 07, 2026**
Prepared by	**Nathan Boyd**
Checked by	**Hannah Somers**
Approved by	**Tom Dumm**
Description	**Update to O'Brien and Gere's 2013 draft of the Duck River Agency Regional Drought Management Plan. This update reflects new proposed drought triggers that were developed from prior work and the Duck River Basin drought exercise held on May 6, 2026.**

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Tables

Figures

Glossary of Terms

ARAP	Aquatic Resource Alteration Permit
BCUD	Bedford County Utility District
CBER	Center for Business and Economic Research
CIP	Capital Improvements Program
CWA	Clean Water Act
D/DBP	Disinfectants/Disinfection Byproducts
DMP	Drought Management Plan
DRA	Tennessee Duck River Development Agency
DRATAC	Duck River Agency Technical Advisory Committee
DRUC	Duck River Utility Commission
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
fps	Feet per Second
FY	Fiscal Year
gpm	Gallons per Minute
HAAs	Haloacetic Acids
HCP	Habitat Conservation Plan
IESWTR	Interim Enhanced Surface Water Treatment Rule
L	Liter
MCL	Maximum Contaminant Level
MG	Million Gallons
mgd	Million Gallons per Day
mg/L	Milligrams per Liter
NEPA	National Environmental Policy Act
MCBPU	Marshall County Board of Public Utilities
psi	Pounds per Square Inch
SDWA	Safe Drinking Water Act
SRF	State Revolving Fund
SWTR	Surface Water Treatment Rule
TDEC-DWR	Tennessee Department of Environment and Conservation – Division of Water Resources
THMs	Trihalomethanes
TNC	The Nature Conservancy
TWRA	Tennessee Wildlife Resources Agency

TVA	Tennessee Valley Authority
TUA	Tullahoma Utilities Authority
μg/L	Micrograms per Liter
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEDA	U.S. Economic Development Administration
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant
7Q10	Seven-day Consecutive Low Flow with a Recurrence Interval of Ten Years

Acknowledgements

The Tennessee Duck River Development Agency (DRA) acknowledges the following for their participation in this effort:

Water Systems
Bedford County Utility District
Centerville Water System
Columbia Power and Water Systems
Duck River Utility Commission
HB&TS Utility District
Lewisburg Water and Wastewater
Manchester Water Department
Maury County Water System
Shelbyville Power, Water and Sewerage System
Spring Hill Water Department
Tullahoma Utility Board

Federal Agencies
Natural Resource Conservation Service
Tennessee Valley Authority
U.S. Fish and Wildlife Service
U.S. Geological Survey
U.S. Army Corps of Engineers

State Agencies/Committees
Tennessee Department of Agriculture
Tennessee Department of Environment and Conservation
Tennessee Wildlife Resources Agency
Henry Horton State Park

Non – Government Organizations
Duck River Conservancy
Duck River Watershed Society
Harpeth Conservancy
The Nature Conservancy
Southern Environmental Law Center
Tennessee Wildlife Federation

Community Members
Higher Pursuits
Citizens At-Large

Municipals
Bell Buckle
Centerville

Chapel Hill
Columbia
Hickman County
Lewisburg
Manchester
Shelbyville
Spring Hill
Tullahoma
Wartrace

Strategic Team
George Rest, Ramboll
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Hannah Somers, Ramboll
Nathan Boyd, Ramboll
Steve Nebiker, Western HydroLogics

1. Planning Process for Drought Management Plan

1.1 Purpose

The purpose of the Tennessee Duck River Development Agency's (DRA) Regional Drought Management Plan (DMP) is to ensure that stakeholders utilizing water supply sources in the Duck River region (Figure 1) plan appropriately to mitigate drought impacts and respond in an organized, timely, and appropriate manner in the event of a drought-related water shortage. This DMP is an update to the original 2013 draft plan which was one of the five recommended water supply alternatives in the DRA's Comprehensive Regional Water Supply Plan (March 2011). The need for future DMP updates will be periodically considered in consultation with DRA's stakeholders. Changes to water supplies, withdrawal/discharge permit requirements, status of the Duck River Watershed Habitat Conservation Plan and associated take permits are *examples* of potential drivers for future DMP updates. The approach presented in this DMP is a combination of drought mitigation and drought response:

- Drought mitigation refers to an assessment and subsequent action taken well in advance of a drought in order to lessen the impacts.
- Drought response (or water supply shortage contingency) outlines a thoughtful and useful pattern for how to respond to a shortage.

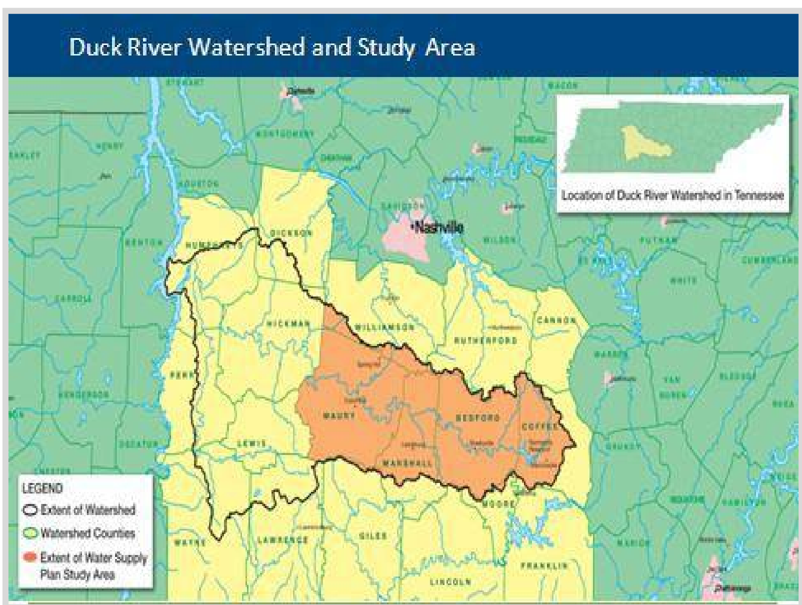


Figure 1 Duck River Watershed

This document serves as an updated regional drought management plan. For specific drought management information related to the potential impacts on the public water system customers, please refer to the drought management plans developed by each public water system for their designated service area.

The Regional Drought Management Plan prepared in 2013 serves as the foundation for this 2026 update. The DMP identifies the processes relevant to drought planning such as quantifying and justifying drought triggers (e.g., reservoir elevations or river flows) and establishing roles and responsibilities during drought response. These processes were established in 2013 and agreed upon by the DMP Task Force based on a "work session" approach similar to the one used to develop the DRA's Comprehensive Regional Water Supply Plan.

On February 28, 2022, the DRA entered a settlement agreement with TDEC and other parties in which it agreed to update the 2013 DMP "to address minimum flows required in the Duck River required in the Duck River to the extent required to comply with the Water Quality Control Act and the Endangered Species Act for all existing and proposed withdrawals" not later than May 2027.

On November 20, 2024, Tennessee Governor Bill Lee issued Executive Order 108, establishing the Duck River Watershed Planning Partnership ("Partnership") to support sustainable management of the Duck River through stakeholder collaboration concerning efforts such as water conservation, habitat protection, water loss management, and drought preparedness while maintaining responsible economic growth. The Executive Order directed TDEC in collaboration with DRA to update the DMP. The Partnership, which includes stakeholder agencies such as TDEC, DRA, TVA, and other watershed stakeholders, is tasked with developing watershed management recommendations and advising state leaders on policies that promote the long-term resilience of the Duck River Watershed. In November 2025, the Partnership released their interim recommendations which included the following items as brought forward by the Partnership's Drought Management workgroup:

- Incorporate comprehensive drought monitoring analysis in the Duck River
- **Revise the Duck River Regional Drought Management Plan**

To meet this recommendation, a DMP Update Task Force was established and met several times including a workshop conducted on May 6, 2026. The workshop brought together approximately 30 representatives from water utilities, state and federal resource agencies, conservation organizations, and other stakeholders to evaluate the region's preparedness for future drought conditions. Western HydroLogics facilitated the first half of the workshop, which took an in-depth look at hydrologic impacts of use during drought, utilizing the Duck River hydrologic model developed using the proprietary modeling software known as OASIS. The results of this exercise are discussed in **Appendix A** and were used in this plan to update drought triggers, demand reduction measures, roles and responsibilities, operational responses, and resiliency measures.

The second half of the workshop focused on the collective governance of the Duck River during drought conditions and helped identify stakeholder roles and responsibilities, individual and collective response actions, communications needs, opportunities for collaboration, and potential initiatives to improve long-term system resilience. A summary of these discussions is provided in **Appendix B**. The outcomes of this discussion were not incorporated directly into the operational framework of this DMP update. Instead, they have been preserved in **Attachment 1** as future preparedness, governance, resilience, and communications considerations that may inform future updates to the Regional Drought Management Plan and other watershed planning efforts.

DRA tasked Ramboll with incorporating these outcomes into an updated DMP. The DRA stakeholders determined that some of the outcomes from the workshop require future studies before they can be implemented. **Appendix B** covers these implementation considerations in more detail.

The most significant changes in this 2026 DMP update relative to the 2013 draft include the following:

- Both Normandy Reservoir water level and Duck River flows were identified as drought triggers as opposed to reservoir water level triggers only.
- Ability to use more water storage capacity in Normandy Reservoir by upgrading pumps to allow water to be obtained from the lowest gates on the Duck River Utility Commission (DRUC) intake in Normandy Reservoir.
- TVA's recent Normandy Dam release optimization changes.
- Increases in water demand reduction targets at defined drought severity levels.

A change to the persistence levels of triggers to move in and out of drought stages. This watershed-level drought management plan provides baseline drought triggers and response actions that utilities within the Duck River Watershed should incorporate into their respective drought management plans. This plan does not constitute the exclusive range of options for preparing for/responding to drought in the region. Utilities should independently and jointly examine opportunities to advance drought resilience and response beyond the triggers, actions, and planning requirements included in this plan.

The subsequent chapters of this report describe these items in more detail.

1.2 Authority to Activate Drought Management Plan Responses

During the 2007/2008 drought, the water systems in the Duck River region collectively invoked water use restrictions and the regulatory and water resources agencies initiated a cutback in the downstream releases from Normandy Reservoir following much deliberation and establishment of a flow and habitat monitoring program at several locations along the Duck River. As part of the 2013 DMP, TDEC and the water resource management agencies outlined water quality and habitat monitoring programs to inform drought response decisions (Section 4).

The Executive Director of the DRA does not have the authority to activate local utility drought management plan responses. However, each of the following water systems represented by the DRA have the authority and the obligation pursuant to their aquatic resource alteration permits and/or state drinking water rules to activate drought responses. These utilities include:

- Manchester Water Department

- Tullahoma Utility Board
- Shelbyville Power, Water and Sewerage System
- Bedford County Utility District
- Lewisburg Water and Wastewater
- Spring Hill Water Department
- Columbia Power and Water Systems

Consequently, when the drought triggers described in Section 3 are present, this DMP is activated and the Executive Director of the DRA, in consultation with TDEC and other members of the DMP Task Force (see description of DMP Task Force in Section 4.2), will notify the water systems. At the outset of the drought, the Executive Director of the DRA will initiate discussions with the DMP Task Force regarding DMP implementation.

1.3 DMP Task Force Members

At the outset of the DRA's 2013 Regional DMP, DRA assembled a DMP Task Force to assist with development of the 2013 DMP. The DMP Task Force listed below reflects a multi-disciplinary team of stakeholders, water managers, advocacy groups, and independent experts. To facilitate ongoing updates, the current contact information for those filling these roles is provided in **Appendix C**.

- TDEC-DWR
- TWRA
- USFWS
- TVA
- USGS
- DRA
- TNC
- Tullahoma Utilities Authority
- Manchester Water & Sewer Department
- Duck River Utility Commission
- Shelbyville Power, Water and Sewerage System
- Bedford County Utility District
- Lewisburg Water and Wastewater
- City of Spring Hill, Tennessee
- Columbia Power and Water Systems
- Ramboll
- Western HydroLogics

2. Water Supply and Demand

2.1 Water Supply Characteristics

The Duck River Agency represents seven water utilities which serve approximately 250,000 municipal customers. Additionally, DRA utilities serve commercial, industrial, and agricultural water users including car manufacturers, food processing plants, and other businesses. In addition to public and private water supply needs, the river provides a wide range of other beneficial uses including recreation and is home to an excellent fishery and some of the most biologically rich freshwater habitat in North America.

The Duck River has been impounded since the mid-1800s. Currently, there are four low head dams located on the Duck River which were constructed in the early 1900s:

- Cortner Mill near Normandy (drainage area = 214 square miles at approximately Duck River Mile 245.1)
- Shelbyville (drainage area = 425 square miles at Duck River Mile 221.4)
- Lillard Mill near Milltown (drainage area = 919 square miles at Duck River Mile 179.2)
- Columbia (drainage area = 1,206 square miles at Duck River Mile 133.5)

Figure 2 Normandy Reservoir

Normandy Reservoir is located in Bedford and Coffee Counties about 1.5 miles upstream of Normandy, Tennessee and was constructed in 1976 by the Tennessee Valley Authority (TVA) based on a request from the Tennessee Duck River Development Agency (DRA). Normandy Reservoir was designed to provide a variety of recreation, water supply, flood control and water quality benefits both upstream and downstream from the dam. Normandy Reservoir releases are the primary source of water for the Duck River upstream of Columbia during severe droughts. Below are defining characteristics of Normandy Dam:

- Located in the upper portion of the Duck River watershed between Shelbyville and Manchester (Duck River Mile 248.6) and is fed by the Duck River.
- 2,248 feet in length and approximately 95 feet in height.
- Storage volume is roughly 38 billion gallons at a Summer/Fall (June-November) pool level of 875 feet and 28 billion gallons at a Winter/Spring (December-May) pool level of 864 feet.
- Drainage area is roughly 195 square miles.

The Tennessee Valley Authority (TVA) manages and operates Normandy Reservoir, including the dam and its releases. TVA operates Normandy Reservoir based on an operating rule curve (Figure 3) for flood control and to meet all State designated uses for the Duck River, including domestic water supply, industrial water supply, fish and aquatic life, recreation, livestock watering and wildlife, irrigation, and trout stream (seasonal trout fisheries below Normandy Dam). Normandy Reservoir flood guide elevations are:

- Summer/Fall (June-November) pool level of 875 feet
- Winter/Spring (December-May) pool level of 864 feet for flood control

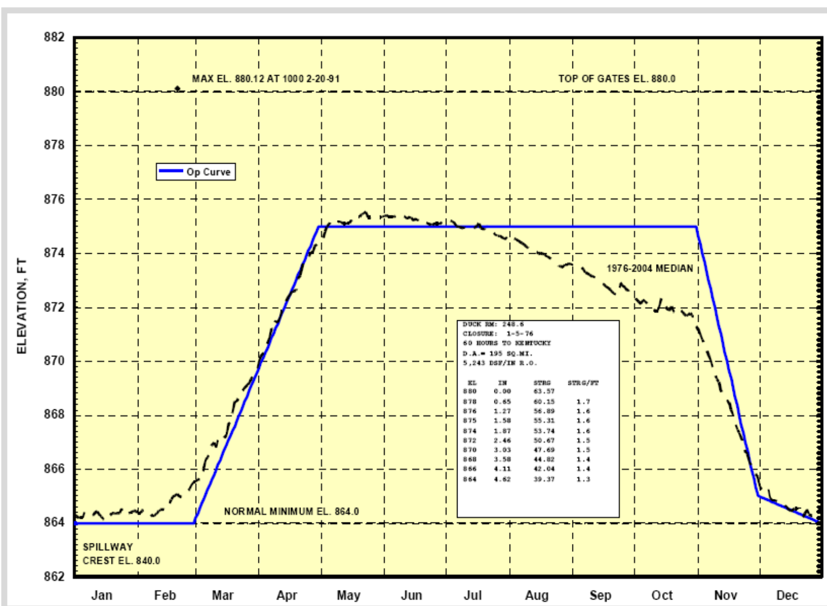


Figure 3 Normandy Reservoir operating rule curve

Public water systems upstream from Normandy Dam (primarily Tullahoma and Manchester) are served by the Duck River Utility Commission's (DRUC) water intake located in Normandy Reservoir while downstream water systems meet their needs with direct withdrawals from the Duck River. Normandy Reservoir (Figure 2) and the Duck River supply virtually all of the public water supply needs in the five-county planning area.

The following direct public water supply withdrawals occur along a 116-river-mile segment of the Duck River downstream of Normandy Dam (Duck River Mile 248.6) to Columbia:

- Shelbyville Power, Water and Sewerage System - Duck River Mile 221.9
- Bedford County Utility District - Duck River Mile 202.4
- Lewisburg Water and Wastewater - Duck River Mile 181
- Spring Hill Water Department - Duck River Mile 166
- Columbia Power and Water Systems - Duck River Mile 133.9
- Marshall County Intake (Proposed)

Future public water supply needs for the region were estimated for DRA's 2013 Comprehensive Regional Water Supply Plan and updated in 2025 utilizing the OASIS model developed by Western HydroLogics (formerly HydroLogics). The model was utilized to evaluate the current and projected water demands under the following reservoir and river constraints:

- Normandy Reservoir
  - Release from Normandy Reservoir to maintain 25.8 mgd (40 cfs) minimum instantaneous flow just downstream of the dam.
- Shelbyville
  - Release from Normandy Reservoir to maintain 77.5 mgd (120 cfs) weekly average flow coupled with a minimum instantaneous threshold flow at Shelbyville (December through May) at Duck River Mile 221.4.
  - Release from Normandy Reservoir to maintain 100.2 mgd (155 cfs) weekly average flow coupled with a minimum instantaneous threshold flow at Shelbyville (June through November) at Duck River Mile 221.4.
  - 6.5 mgd (10 cfs) allocation for Shelbyville's water supply intake at Duck River Mile 221.9.

Figure 4 Columbia Dam on Riverside Drive

- Columbia
    - Columbia Power and Water System's Aquatic Resource Alteration Permit (ARAP) identifies the following permit conditions:
        - Columbia Power and Water System's maximum instantaneous withdrawal rate shall be limited to 20 mgd (30.9 cfs) at Duck River Mile 134.05.
        - Columbia Power and Water System's maximum instantaneous withdrawal rate shall be limited to 32 mgd (49.5 cfs) at Duck River Mile 100.
        - Columbia Power and Water System's maximum combined withdrawal rate for the two intakes will not exceed 32 mgd.
        - Columbia Power and Water System's withdrawal shall not result in a reduction of flow in the Duck River of less than 64.6 mgd (100 cfs) as measured downstream of the intake at Duck River Mile 133.9 (Figure 4).

2.2 Public Water Supply Problems Encountered During Severe Droughts

The Duck River Agency's DMP focuses on the Normandy Reservoir and the Duck River supplies which serve the public water systems in the Duck River region. During severe droughts, the public water systems may experience the following issues associated with their intake structures:

- Normandy Reservoir
    - Lower reservoir water levels will likely cause higher raw water temperature and possibly taste/odor issues.
    - Low water levels may require use of the bottom gate in the DRUC intake which withdraws water directly from the bottom of the reservoir. Manganese, iron and low dissolved oxygen levels could be a significant problem at the bottom of the reservoir.
- Duck River
    - Organics and algae often increase on the Duck River during severe droughts. Water utilities may experience decreased filter run hours during these events.

- Disinfectant/Disinfection By-Products (DBPs) may increase which may be caused by lower quality raw water.
- More algae related issues at low flows could make treating the raw water more difficult.

The public water systems in the Duck River region provide water that is excellent in quality and meets drinking water standards even during severe drought events when treatment is often more complex and costly.

In addition to the problems often experienced by the water systems during droughts, information on irrigation withdrawals from the Duck River for agriculture and golf courses is limited. Significant unmeasured withdrawals may have altered Duck River flows during past severe droughts. Field monitoring during severe drought indicate impacts to aquatic life and habitat in a section of the Duck River downstream of the remnants of the lower Hardison Mill Dam (Duck River Mile 165.8).

2.3 Aquatic Habitat Impact and Water Quality Problems Encountered During Severe Droughts

The potential impacts of low flow on the habitat in the Duck River are an important concern. The Duck River is the longest river contained within the borders of Tennessee and provides habitat for one of the most diverse collection of fish, freshwater snails and mussels, and crayfish in the United States. The watershed drainage area of the Duck River is quite large; however, the limestone terrain – with sinkhole plains and sinking streams – reduces the amount of surface water available, particularly in times of drought (Environmental Assessment, Normandy Dam Drought Response Release Schedule Change, TVA, October 2007). Extremely low river flows during times of drought reduce available river habitat, increase water temperatures, and decrease the dissolved oxygen levels present for aquatic plants and animals. All of these conditions have been observed by agency partners during past severe droughts and continue to be concerns which must be monitored in future drought situations.

Drought conditions can result in extreme low flows which stress aquatic life, reduce available habitat, and exacerbate water quality issues. Because the Duck River provides important habitat for a variety of state and federally listed species, managing instream flows for habitat and water quality needs are critical objectives. As part of the environmental assessments conducted by TVA during the 2007/2008 drought, the government agency partners determined that reductions in Normandy Reservoir releases did have the potential to negatively affect water quality and habitat, but that these effects would be mitigated by closely monitoring river conditions and modifying the flows based on monitoring results (Environmental Assessment, Normandy Dam Drought Response Release Schedule Change, TVA, October 2007 and Supplemental Environmental Assessment, Normandy Dam Drought Response Release Schedule Change, TVA, February 2008). In addition to these actions, TDEC is leading a multi-year study of the instream flow and habitat needs for the Duck River through the development of the Duck River Watershed Habitat Conservation Plan (HCP). This plan and the work conducted to complete the plan will help provide important information about the requirements of fish and mussel species during low flow and extreme low flow events. The data from the HCP will help guide future monitoring efforts in the river, particularly during times of drought.

Limited information on instream flows for maintenance of critical habitat for threatened and endangered species was documented in the Supplemental Environmental Assessment Normandy Dam Drought Response Release Schedule Change, TVA, February 2008 (Supplemental EA). Because so many listed species are found in the reach below Shelbyville, potential impacts to the instream habitat in this segment resulting from flow reductions at Shelbyville are a concern. In the Supplemental EA, data from surveys, gages, and observations of mussels at the site were used as the basis for TDEC's recommendation that the releases from Normandy Dam ensure that the flow at the Milltown gage be maintained at no less than 165 cfs (approximately 107 mgd).

2.4 Potential Sources of Uncertainty for Water Supply

Due to the inherent differences in the characteristics of the water supplies in the Duck River region, the possible sources of uncertainty that affect the assessment of the adequacy of supply (i.e., level of risk) are multi-faceted and include:

- Water withdrawals at Shelbyville. TVA has a flow target of up to 10 cfs to meet the water supply withdrawals at Shelbyville. Water demands vary throughout the day and season which makes it difficult for TVA to predict the quantity of water to release from Normandy Reservoir to match the Shelbyville water demand 27 miles downstream.
- Losses underground from river system below Shelbyville. Prior studies by USGS have indicated that there may be a significant "loss" of flow underground (up to 30% reduction during low flow periods) in the segment of the Duck River below Shelbyville. The magnitude of this loss under changing river flow conditions as well as the location of its return to the Duck River (if any) is not well understood.
- Inflows from tributary streams. Localized thunderstorms in the tributary streams to the Duck River below Normandy Reservoir can create the impression of "excess" releases from Normandy Reservoir because they can produce flows above the target levels at Shelbyville. Localized drought conditions downstream of the dam can also affect flow targets.
- Changes in return flows. The difference between the amount of water withdrawn and water returned to the source (or discharge) by the wastewater treatment plant is usually taken to represent "consumptive use". The model assumes that the percentage of return flow from each of the wastewater plants will remain unchanged in the future.
- Accuracy of USGS stream gage data. The USGS calibrates the streamflow gages on the Duck River on a monthly basis while the flows in the river at Shelbyville must be met on an average weekly basis and Columbia's existing intake must continuously be met (i.e., instantaneous basis).
- Variability of drought events. A drought more severe than the critical drought that occurred in the previous 100 years of record will occur in the future.
- Climate change. Shifts within the hydrologic cycle due to climate change are expected in the future, but the site-specific impacts in the Duck River region are not well defined at this time.
- Changes in irrigation withdrawals. Irrigation withdrawals tend to be highest when conditions are dry. The model accounts for historic irrigation withdrawals by using actual stream gage data and assumes that the percentage of irrigation withdrawal will remain unchanged in the future.

In summary, the possible sources of uncertainty that affect the assessment of the adequacy of supply are many-fold and include not only demographics and water use, but uncertainty regarding weather, hydrology, accuracy of stream gaging, and many other factors. While the uncertainty of some of these factors can be mitigated, many cannot and therefore must be addressed in some other fashion such as optimization of existing water supplies or development of new supplies as outlined in the structural and non-structural recommendations in the Duck River Agency's Comprehensive Regional Water Supply Plan.

In March 2025, TVA evaluated whether changes to Normandy Reservoir operations could improve its ability to meet water supply and drought management objectives in the Normandy Reservoir Optimization of Reservoir Releases Final Environmental Assessment. While TVA began optimizing releases from the reservoir in June 2025, uncertainty regarding reservoir refill conditions highlights the need to consider drought mitigation strategies.

2.5 Regional Public Water Demand Characteristics

Due to the inherent differences in the characteristics of the water supplies for the public water systems served by Normandy Reservoir and the Duck River, the OASIS model was used in the DRA's Comprehensive Regional Water Supply Plan to separately evaluate the adequacy of: (1) Normandy Reservoir for its public water systems (i.e., Manchester and Tullahoma), and (2) the Duck River for Shelbyville and the downstream public water systems to Columbia.
Table 1 presents the estimated 2023 average annual water demands used as inputs to the DRA OASIS model. While peak demands (e.g., maximum day) can be higher than these annual averages, peak demands do not occur concurrently. For example, some of the DRA utilities have historically experienced their peak day demands in the summer, while others typically experience their peak day demands in the winter. Further study may be beneficial to better understand the factors contributing to the variation in peak day demands among the utilities.

Table 1 2023 Average Day Water Demand Projections Used in the OASIS Model (Million Gallons per Day)

Water System	2023
Coffee County	
Tullahoma Utilities Board	3.5
Manchester Water and Sewer Department	3.6
Bedford County	
Shelbyville Power, Water, and Sewerage System	4.5
Bedford County Utility District	2.0
Marshall County	
Lewisburg Water and Wastewater	3.4

Maury/Southern Williamson	
Spring Hill Water System	3.6
Columbia Power and Water Systems	12.3
Total	**32.9**

2.6 Potential Non-Customer Demand During Droughts

Many of the seven water systems in the Duck River region have legal arrangements in place with other water utilities to provide water to these entities (i.e., wholesale customers). In addition, interconnections exist between the seven public water systems represented by the Duck River Agency. Refer to drought management plans developed by each water system in the Duck River region for a discussion of partnerships that are in place for obtaining additional water via interconnections.

In addition to partnerships with neighboring water systems, many of the water systems represented by the Duck River Agency had requests for water from non-customers during the 2007/2008 drought.

Table 2 summarizes how each of the water systems dealt with provisions for water for non-customers in the region needing water for failed wells and livestock watering.

Table 2 Drought Management Plan potential for non-customer use

Entity	Non-customer Requests
Coffee County	
Duck River Utility Commission	Numerous requests were received including by public officials on behalf of citizens with wells that went dry. Water was provided to customers on request, and they were allowed to come to the water plant and haul water. There were no charges for the water. No records were kept of the number of customers or volume of water as it was insignificant to the DRUC. DRUC intends to respond only on request. See Manchester and Tullahoma responses.
Tullahoma and Manchester	Tullahoma had requests for water service in rural areas that were on wells. Those that were in the TUB service area were sold taps and became customers (approximately 10 customers). No bulk water was given away during the drought.
Bedford County	
Shelbyville	Three non-customers requested water during the drought, and the water was picked up at the Water Plant in known quantities, supervised by plant operator.

Entity	Non-customer Requests
Bedford County Utility District (BCUD)	There were several wells and springs in the BCUD's service area that went dry. BCUD sold taps to residents where water was available to meet human and other needs. BCUD provided water at the Water Treatment Plant for residents to obtain water for livestock and other non-potable uses. The Bedford County Fire Services filled tanks at one of their stations in Wheel. Fire Services hauled some water to residents that had no way of hauling water. Very few people came to the water plant to get water and non-customers picked up less than 100,000 gallons. BCUD did not keep detailed records.
Marshall County	
Lewisburg	There were requests for water from non-customers during the 2007/2008 drought due to wells and springs going dry and for livestock watering. Lewisburg Water and Wastewater did not supply any water directly from their department. The Marshall County Emergency Management Agency hauled water to residents that needed water for household purposes, swimming pools and livestock watering. Area farmers and residents received water from the Marshall County Board of Public Utilities (MCBPU) which is a contracted wholesale purchaser of water from Lewisburg Water. The MCBPU maintained records of water used during the drought. Water was given to residents at no cost for those who provided their own containers and did their own hauling. The Marshall EMA purchased water from Lewisburg Water and Wastewater which they hauled to their customers who paid the standard rate for water and delivery. The MCBPU set up water stations for residents to receive water.
Maury/Southern Williamson	
Spring Hill	Spring Hill had one customer that requested water for his cattle. The customer hauled water by his own means, and the volume was approximately 1,000 gallons.
Columbia	Columbia sold some bulk water to farmers and customers who had wells to go dry. Additional water was sold to the public golf course by making additional water taps – they were restricted by the size of the taps.

3. Plan Management Phases and Responses

3.1 Triggers And Stages for Drought Management Plan

3.1.1 Drought Triggers and Stages

One of the most significant components of the Duck River Agency's DMP is the establishment of trigger points (i.e., the points at which certain drought response actions are required) for the region with identified corresponding actions. Drought management actions are intended to be triggered on an as-needed basis and not limited to drought of record conditions or when "all else fails." Because drought management responses do not actually produce any new water, the purpose of drought responses is to extend existing water supplies so that they will last throughout the drought period and to protect classified uses in the Duck River. At the outset of a drought, it is impossible to accurately predict its duration or severity. In addition, drought response measures come at a cost. Consequently, most providers have drought plans with multiple stages that reflect the threat of drought damage.

As a drought begins and intensifies, triggers need to be able to provide advance warning while minimizing false alarms; that is, be able to detect incipient drought conditions yet provide some assurance that drought conditions were progressing (i.e., becoming more severe) before implementing actions. For a drought receding, indicators need to be conservative assuming more severe drought conditions while avoiding prolonged restrictions; that is, to be able to provide assurance that drought conditions were receding (i.e., becoming less severe) and recovering long term, before lifting restrictions or rescinding responses.

The drought of 2007/2008 highlighted the Duck River region's dependence on the water stored in Normandy Reservoir to meet all State designated uses. The dramatic decrease in rainfall during the 2007/2008 drought, combined with the multiple uses of the reservoir and the river, caused record low water levels in Normandy Reservoir (42% full) that resulted in temporary changes in dam operation to protect designated water uses. Because most of the water in the Duck River region upstream of Columbia originates from Normandy Reservoir during severe drought events, the water level of Normandy Reservoir is the key "bottom line" result of the factors affecting supplies (i.e., soil moisture, streamflow, water use, release requirements, etc.). Consequently, water levels in Normandy Reservoir were determined to be an important trigger for the Duck River region's water supplies during droughts.

Additionally, this update identifies flow-based triggers that complement the forecast-based Normandy Reservoir elevation triggers. The intent is to recognize that drought conditions in the Duck River system can develop in more than one way. In some situations, Normandy Reservoir storage may remain near the TVA operating guide curve while lower-basin flows decline downstream of Shelbyville due to limited tributary inflow, losing reaches, and downstream withdrawals. In other situations, a regional drought may reduce both inflows to Normandy Reservoir and downstream flows, requiring a broader regional response. Using both Duck River flows at Milltown and Normandy Reservoir water elevations allows the DMP to account for both types of drought conditions.

The two proposed triggers, flow in the Duck River at the Milltown USGS gage and predicted water elevation at Normandy Reservoir, are based on conditions identified in the ARAPs, existing infrastructure, and the May 2026 drought exercise. Current ARAPs reference a 175 cfs threshold at Milltown below which water withdrawals from the Duck River that are not "grandfathered" must cease and implementation of the permittee's drought plan is required, in addition to compliance with the regional drought plan. Upcoming studies, including the Habitat Conservation Plan (HCP), will help refine and inform flow thresholds for the Duck River. The Normandy Reservoir water elevation trigger of 864 feet is based on the depth of the DRUC intake and the need to be below the winter guide curve elevation.

A drought stage is activated when either the Duck River flow at Milltown or the Normandy Reservoir water elevation trigger condition is at or below the respective thresholds, whichever one occurs first. Similarly, a stage is rescinded when the Duck River flow trigger at Milltown or Normandy Reservoir water elevation trigger is no longer crossed, whichever occurs last. There are four drought stages, 1 – Awareness, 2 – Voluntary, 3 – Mandatory, and 4 – Emergency, that each have associated triggers and required actions. The stages are outlined in Table 3. A flow-triggered stage is initiated when Milltown gage flow remains below the trigger threshold for three (3) consecutive days. An elevation-triggered stage is initiated when Normandy Reservoir elevation is at or below the trigger threshold for fourteen (14) consecutive days.

Table 3 Drought Management Plan Triggers and Stages

		Triggers		Action
Stage/ Trigger	**Response**	3-day Average Milltown Flow (cfs)	Normandy Reservoir Elevation (ft)	Demand Reduction Goal*
1	Awareness	<175	<864	N/A
2	Voluntary	<165	<860	10%
3	Mandatory	<147	<855	20%
4	Emergency	<147	<850	30%

*Demand reductions are based on the 7-day average demand prior to entering each drought stage.

Stage 1 – Awareness stage acts as a monitoring period where Milltown flow is < 175 cfs or Normandy elevation is <864 ft. While no demand reduction is required at this stage, utilities are made aware of possible demand reductions if any subsequent stages are triggered.

Stage 2 – Voluntary stage is triggered when Milltown flow is < 165 cfs or Normandy elevation is <860 ft. The demand reduction goal of 10% for utilities is voluntary but encouraged to aid in restoration of an appropriate river flow or reservoir elevation. It should be noted that while Stage 2 represents voluntary restrictions, it is recommended that during this stage, especially when severe drought is imminent, utilities evaluate imposing their own mandatory reductions/use restrictions in accordance with their individual plans. Gradual imposition of restrictions prepares citizens for the potential for more stringent water demand cuts and may avert need for more stringent cuts.

Stage 3 – Mandatory stage triggers required action for utilities where Milltown flow is <147 cfs or Normandy elevation is <855 ft. This stage triggers the required water demand reduction goal of 20% to be implemented by utilities.

Stage 4 – Emergency stage is triggered when Normandy elevation is <850 ft. A 30% demand reduction goal is required to be implemented by utilities. Stage 4 elevation conditions are expected very infrequently.

3.1.2 Movement Between Drought Stages

The following triggers when are used for moving into (i.e., progressing) and out of (i.e., receding) drought stages.

- Drought Progressing:
  - A flow-triggered stage is initiated when Milltown gage flow remains below the trigger threshold for three (3) consecutive days. Once the threshold is reached, the applicable stage is implemented immediately.
  - An elevation-triggered stage is initiated when predicted Normandy Reservoir elevation is at or below the applicable threshold for fourteen (14) consecutive days.
- Drought Receding:
  - A flow-triggered stage ends when the Milltown flow exceeds the applicable flow threshold for at least three (3) consecutive days.
  - An elevation-triggered stage ends when Normandy Reservoir elevation is above the applicable threshold.

3.1.3 Demand Reduction Goals for Drought Stages

Water use restrictions for customers served by the public water systems are included in Stages 2 through 4 of the DRA’s drought management plan. Detailed descriptions of the restricted and prohibited activities are presented in the drought management plans for each Duck River Technical Advisory Committee (DRATAC) water system.

Stage 2 is intended to increase awareness of emerging drought conditions and encourage early conservation efforts before more significant restrictions become necessary. The voluntary demand reduction goal of 10 percent may be achieved through a variety of utility-specific actions tailored to local circumstances. These efforts could include public education campaigns, enhanced communication regarding the importance of water conservation, municipal and utility-led conservation practices that demonstrate leadership by example, efforts to reduce avoidable water use, and increased attention to system efficiency such as leak detection and repair. Utilities may impose additional demand restrictions based on local conditions or capacity, such as limits on timing of landscape irrigation. The objective of this stage is to promote a culture of conservation, encourage customer participation, and help preserve available water supplies while minimizing disruption to water users.

Stage 3 reflects conditions that require a more coordinated and structured response to reduce water demands and protect regional water supplies. At this stage, utilities will implement measures necessary to support the DMP's mandatory demand reduction goal of 20 percent. The specific actions selected may vary among utilities based on local needs, operational considerations, and regulatory requirements. Potential approaches could include targeted restrictions on discretionary water use, limitations on activities such as landscape irrigation or vehicle washing, enhanced customer outreach, and increased monitoring of water use trends. The intent is to achieve meaningful reductions in demand while maintaining essential public health, safety, and economic functions.

Stage 4 represents severe drought conditions requiring the highest level of response under the Regional Drought Management Plan. Enhanced coordination and oversight may be warranted during emergency conditions, including the designation of a water conservation coordinator or commissioner to help facilitate communications, track implementation of response measures, and support coordination among participating entities. Actions at this stage could also include intensified water quality monitoring (reservoir and in-stream), expanded public outreach, implementation of mandatory conservation requirements, and enforcement of applicable restrictions where necessary. Because emergency drought conditions can present unique and rapidly changing challenges, the specific measures employed may evolve based on available information, local conditions, and the collective judgment of responsible agencies and water providers.

3.2 Response and Resiliency Efforts

Drought mitigation refers to an assessment and subsequent action taken in advance of a drought in order to lessen the effects of impacts on water suppliers and end users (e.g., development of new supply sources, etc.). In the Duck River Agency's Comprehensive Regional Water Supply Plan (March 2011), Duck River stakeholders reduced a list of 40 potential water supply alternatives to the following non-structural and structural components shown in Figure 5:

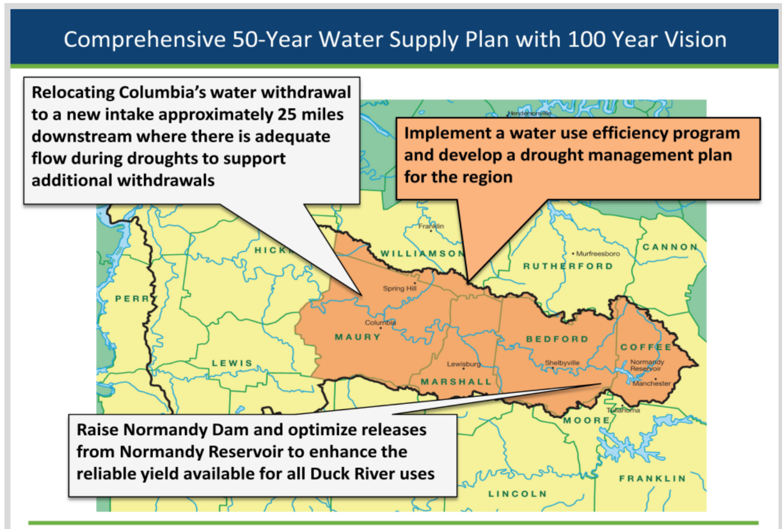


Figure 5 Initiatives Identified in 2011 Comprehensive Regional Water Supply Plan

- Non-Structural Components:
  - **Drought Management Plan** – Develop and implement a regional drought management plan.
  - **Water Use Efficiency Program** – Develop and implement a water use efficiency program.
  - **Optimize Normandy Reservoir Releases** – Optimize releases from Normandy Reservoir to preserve storage in the reservoir for periods when it is most needed.
- Structural Components
  - **Normandy Reservoir Capacity Improvements (NRCI)** – A feasibility study completed in 2013 identified potential reservoir capacity improvements to help meet future water demands in the Duck River Basin. Although TVA determined in 2014 that projected demands did not justify advancing the project at that time, the NRCI remains a potential long-term water supply enhancement. More recently, efforts have focused on modifying DRUC's Normandy Reservoir intake which would allow the reservoir to be drawn down further during drought conditions, providing additional water storage for downstream water supply and environmental flow needs. The intake modifications are a major contributor to the lower elevation triggers in this update relative to the 2013 DMP. In FY2025, DRA and DRUC executed a $3 million funding agreement for intake improvements, with initial funding provided to begin engineering and material procurement.

- **New intake on the Duck River for Columbia Power and Water Systems** – Relocate Columbia's water withdrawals to a new intake approximately 25 miles downstream, near Williamsport, where there is adequate flow in the river during droughts to satisfy Maury County's projected needs. This component addresses the potential deficit in Maury County and southern Williamson County with a local, highly reliable supply and will eliminate their sole reliance on Normandy Reservoir during a severe drought. Columbia Power & Water Systems (CPWS) is leading project development, including engineering, transmission line design, and permitting. In FY2025, DRA**obligated** $**10** million to assist CPWS in funding the project. A**ll** permitting and engineering activities have been completed. CPWS anticipates begining construction during September 2026.

Aside from these pre-existing efforts, DRA has recently engaged in stakeholder discussions to identify other opportunities to further develop drought response and resiliency initiatives. In general, these discussions focused on resilience planning, water-use efficiency, communications and outreach, drought preparedness, regional coordination, governance development, and communications responsibilities. The highest priority initiatives identified for this drought management plan update include:

- Define low flow restrictions on utility withdrawals based on information from the Habitat Conservation Plans (HCP), as this study is likely to inform adaptive updates to the flow triggers.
- Novel water storage solutions (e.g., quarries, tanks) to help manage flow variability downstream of Normandy Dam.
- Leak detection to reduce non-revenue water promotes water-use efficiency and provides a means to reduce water withdrawal without decreasing municipal water demands.
- Investigating utility interconnectivity is important because it provides alternate means for the Duck River water utilities to satisfy their demands. "Alternate" is defined as infrastructure needed to deliver water to customers with fewer raw water intakes near critical habitats.

A detailed summary of these initiatives and their potential timeframes is provided in **Appendix B**.

4. Plan for Implementation – Activation, Monitoring, and Responses

Chapter 4 describes how the Regional DMP moves from drought-stage identification to coordinated implementation by DRA, the DMP Task Force, DRATAC, and the participating water systems. During a drought event, a water system may have overlapping responsibilities, including supporting regional coordination, providing technical input, monitoring and reporting water use, implementing demand-reduction measures, enforcing local restrictions, and communicating with customers. The stage-by-stage summary below is intended to provide a sequential reference for utilities as drought conditions progress or are rescinded, while the sections that follow provide more detailed guidance on activation, task force roles, monitoring, water use restrictions and enforcement, and public notices. Components of this chapter regarding response may be modified according to statewide guidance or in accordance with statewide efforts at the time of implementation. A quick guide to drought stages, triggers, and associated actions is provided in **Appendix E**.

- **Stage 1 - Awareness:** During Stage 1, individual utilities can expect the DRA Executive Director to initiate discussions with the DMP Task Force and to provide opportunities for task force participation related to drought monitoring and public communication decisions. Utilities can also support the DMP Task Force through technical assistance provided through DRATAC. For more information, refer to Sections 4.1, 4.2, and 4.4.
- **Stage 2 - Voluntary Response:** During Stage 2, utilities can continue participating in the DMP Task Force to build consensus on drought monitoring and communications and can continue providing technical assistance through DRATAC. At the individual water system level, utilities can refer to content in this chapter related to demand-reduction responses and monitoring. Utilities may also consider implementing voluntary demand-reduction measures consistent with their individual drought management plans and monitoring water use trends by customer category to help target conservation messaging and programs. Additional information regarding demand reduction objectives is provided in Section 4.3.
- **Stages 3 and 4 - Mandatory Response:** During Stages 3 and 4, utilities can remain engaged in the DMP Task Force process and continue providing technical assistance through DRATAC. Utilities should expect increased coordination and data sharing with DRA and the DMP Task Force. Individual water systems should notify and monitor customers in their service areas regarding restricted and prohibited activities. Utilities may also find it particularly useful to refer to the enforcement activities within their authority in Section 4.3.
- **Drought Rescinded:** Once drought conditions are rescinded, utilities should continue participating in the DMP Task Force process to support consensus on drought monitoring and communications and should continue to provide technical assistance through DRATAC as needed. Individual water systems should notify customers in their service areas that drought conditions and associated response actions have been rescinded or modified, as applicable.

4.1 Representative Responsible for Activation of Drought Stages

The Duck River Agency recognizes that the level of communication and individuals involved (i.e., Mayor, fire department, hospitals, etc.) will depend on the severity of the conditions. The Duck River Agency will serve as the representative for the region and will coordinate with the DMP Task Force along with TDEC and other agencies as necessitated. Table 4 identifies the representatives from the water systems that will have the responsibility for implementing demand reductions under various stages of the drought.

Table 4 Water system representatives

Entity	Contact	Phone Number
Coffee County		
Tullahoma	General Manager	931-455-4515
Manchester	Director	931-728-1273
Duck River Utility Commission	Manager	931-455-6458
Bedford County		
Shelbyville	General Manager	931-684-7171
BCUD	General Manager	931-684-1667
Marshall County		
Lewisburg	Superintendent	931-359-6831
Maury/Southern Williamson		
Spring Hill	City Administrator	931-489-5791
Columbia	General Manager	931-375-7601

The Duck River Agency will routinely coordinate the drought status with the DMP Task Force. The process for declaring or changing the drought stage will be as follows:

- At the outset of the drought (Stage 1 Awareness), the Executive Director of the DRA will initiate discussions with the DMP Task Force regarding development of hydrologic forecasts for the region's water supply sources using the OASIS model to understand the impact of utility demands on the river and inform utility operations during drought. Additional models should be utilized in conjunction with the OASIS model to understand ecological and other impacts as well.
- Based on discussions with the DMP Task Force, the Duck River Agency will send an email to communicate the DMP Task Force's decision on declaration of Stages 2 through 4.
- Throughout the drought, the Duck River Agency will provide weekly email updates on the status of the water supplies and work with the DMP Task Force to monitor and reach agreement on the current drought stage.

Subsequent to the DMP Task Force's receipt of the email from the Duck River Agency on the drought stage, the responses outlined in this DMP will be invoked or maintained. Water systems may assess their individual circumstances and determine that alternative drought stages should be invoked for their individual water system.

4.2 Drought Management Plan Task Force and Their Roles

As part of this DMP, the DRA formed a Drought Management Plan Task Force for the Duck River region to address drought-related decisions as needed. Representatives on the DMP Task Force include regulatory agencies, water resources agencies, water system representatives, organizations, and independent experts. One of the primary roles of the DMP Task Force will be to review available information on the status of water resources in the region and reach consensus on whether the drought indicators and water sources indicate that the region should enter into or exit a drought stage. It will also be the DMP Task Force's responsibility to decide when a notification will be released for a drought stage for the region. To facilitate ongoing updates, the current contact information for those filling these roles is provided in **Appendix C**.

For successful, proactive drought responses and lessened drought impacts, it is imperative that all the agencies and water systems continue to work together to manage the increasingly complex, interrelated and diverse uses of our water resources. The key roles of various entities during drought events were identified in TDEC's Drought Management Plan (Revised February 2010) and are summarized in 5. The roles and responsibilities of the various entities involved in the Duck River Agency's DMP are outlined in the remainder of this section.

Table 5 Key roles during drought events

Entity	Key Roles during Drought Events
TDEC	- Determine drought intensity - Communicate drought information via website - Require development of Community DMPs - Manage wastewater discharges - Provide guidance on Community DMPs - Encourage regional water resources management planning - Provide technical assistance related to water monitoring* - Provide regulatory oversight - Communicate with other state, regional, and federal agencies
Water Resources Technical Advisory Committee	- Inform TDEC of impacts and responses - Inform the public - Relay drought information - Technical assistance
Water systems	- Develop drought management plans - Identify planned responses - Identify risks

Entity	Key Roles during Drought Events
	- Address all uses - Communicate with the public - Report conflicts
Local Governments	- Assist with planning - Implement drought responses - Inform the public
TN Emergency Management Agency	- Facilitate the Drought Task Force - Manage emergency drought situations
TN Department of Agriculture	- Emergency designations - Participate in Water Resources Technical Advisory Committee - Assistance to the public - Preventing fires during drought periods - Communication
TWRA	- Work with TDEC to monitor aquatic life - Work with TDEC to enforce protections of aquatic life - Provide data on conditions - Inform TDEC of impacts and responses - Exchange information - Assist with communications plans - Monitor endangered and sensitive species response
Tennessee Department of Transportation (TN DOT)	- Provide data on conditions - Inform TDEC of impact and responses - Exchange information on drought responses - Assist with communications plans
Tennessee Commission on Intergovernmental Relations (TACIR)	- Participate in Water Resources Technical Advisory Committee - Assist with communications plans
Federal agencies	- Participate in Water Resources Technical Advisory Committee - Provide data on conditions - Assist with communications plans - Assist all entities with implementation of plans - Monitor endangered and sensitive species response - Communicate with public - Implement drought responses
Private sector	- Evaluate sources and uses - Identify risks - Identify measures in case of restrictions - Communicate with TDEC

Entity	Key Roles during Drought Events
	- Monitor drought and implement drought responses

*** Action included in DRA's DMP but not shown in TDEC's Drought Management Plan (Revised February 2010).**

4.2.1 Drought Monitoring

In terms of monitoring, DRA will be responsible for the following activities during drought events:

- Supply sources. DRA will monitor the status of the Duck River region's water supplies during drought events (i.e., Normandy Reservoir water levels, Duck River flows, and drought stage) and conduct water supply forecasts using the OASIS model to predict the status of water supplies if the drought persists. DRA will provide weekly updates on the status of the region's water sources to the DMP Task Force via email.
- Drought status. DRA will rely on information provided by TDEC, TVA, USGS, TWRA, USFWS, the U.S. Drought Monitor produced by the National Drought Mitigation Center (NDMC) and the National Integrated Drought Information System Drought Data Dashboard to assess watershed drought conditions. The Drought Monitor was released in 1999 and was developed to provide a weekly assessment of drought conditions across the United States on a general scale. The Drought Monitor is one of the most convenient and widely used drought monitoring indices to alert officials and the public of potential drought impacts. It is based on a synthesis of indices, outlooks and other inputs from the United States Department of Agriculture, National Oceanic and Atmospheric Administration, National Climatic Data Center and NDMC. In the map in **Error! Reference source not found.**, the *U.S. Drought Monitor -* Tennessee provides a declaration of drought intensities across the state. It also includes some historical drought data for the state.

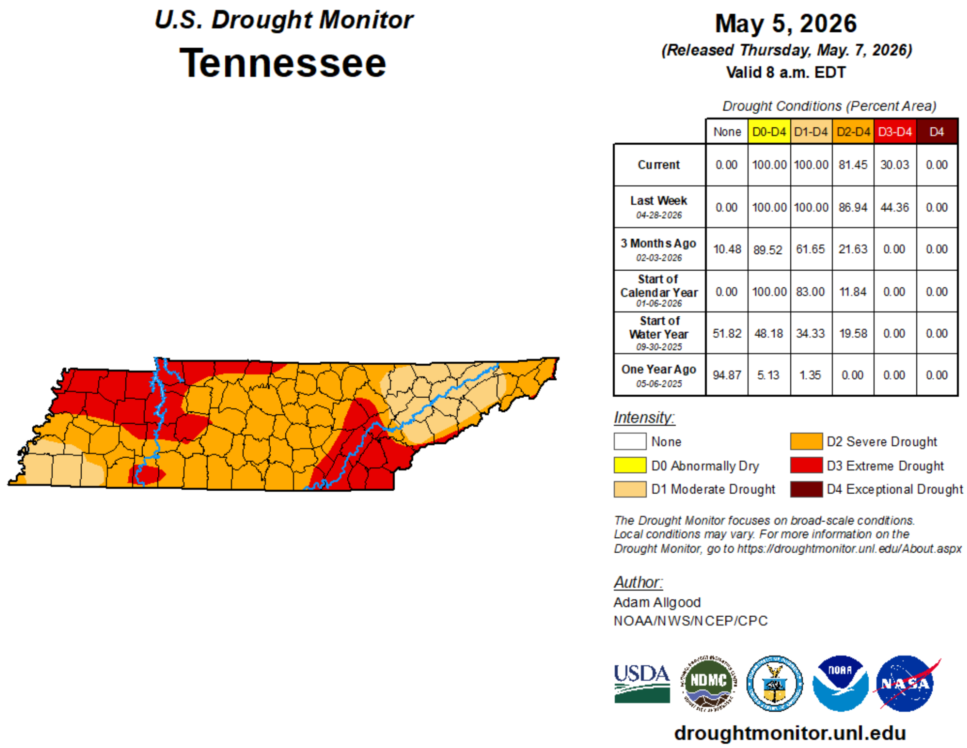


Figure 6 U.S. Drought Monitor for Tennessee for May 5, 2026 (National Drought Mitigation Center)

The Drought Monitor focuses on broad-scale conditions. Local conditions, or the situation for a specific community water system, may vary from the drought intensity designation for a region. It is critical for community water systems to have drought management plans that are specific to their circumstances.

4.3 Water Use Restrictions and Levels of Enforcement for Drought Management Stages

The water systems in the Duck River region have the authority to activate and enforce violations of drought responses. Detailed descriptions of restricted and prohibited activities for the drought stages are described in the drought management plans for each water system.

4.4 Public Notices

At the outset of the drought as agreed upon by the DMP Task Force, the DRA will be responsible for notifying state and local agencies as well as community leaders which may include:

- Agencies

    - NRCS
    - County EMA
- Organizations
    - Farmers Bureau
- Community Leaders
    - City mayors
    - County mayors
- Legislators
    - State Representatives
    - State Senators

Public notifications on the stages of the drought will be conveyed to the public through a variety of media sources (i.e., newspapers, radio, television, Internet, etc.). Media releases from DRA will be reviewed by the DMP Task Force and then a recommendation will be made for date of release. The DRA will also designate a page on their website for drought alerts, communication issues and education. DRA recognizes that water systems will endeavor to convey an accurate and consistent message on the status of the drought event to their water customers based on their individual circumstances. It will be the responsibility of each water system to notify and monitor customers in their service areas of restricted and prohibited activities. Each water system has identified in their individual DMPs the specific media sources which will be contacted.

5. Review, Evaluate, and Update the Drought Management Plan

5.1 Plan For Evaluating Effectiveness and Incorporating Changes

A drought plan, like a fire evacuation plan, will be most effective if exercised regularly. Like a fire drill, a virtual drought exercise can show new people and remind veterans how the details of the plan and roles of the stakeholders are defined. But unlike a fire drill, the stakeholders for the virtual drought exercise are apt to find the conditions have changed; water uses diversify and intensify in the years between droughts, and new stakeholders must be brought into the process. When droughts do occur, the plan will be tested, and stakeholders will have a unique and valuable opportunity to learn if they consciously record the events during the drought and compare them to their expectations.

A *Virtual Drought Exercise* can be designed to test the Drought Management Plan Strategy based on a recent historic drought. The Virtual Drought Exercise should have the following elements:

- Facilitator – explains the rules and manages time spent on negotiations.
- Participants – stakeholders in the DRA's Regional Drought Management Plan.
- Media – member of the press to represent the needs or influence of the media.
- Data – synthesized for the simulation exercise may include forecasts, water demands, reservoir storage volume, etc. Uncertainties of real droughts will be included to solicit responses such as river irrigation withdrawals, precipitation changes, streamflow losses in the Duck River, etc.
- OASIS model – facilitator uses model results to track performance based on decision-making and to estimate the impacts from alternative management decisions.

Although the DRA's Regional Drought Management Plan has well-defined triggers and responses for each stage of the drought response, using them still requires human monitoring and judgment. It is recommended that additional Virtual Drought Exercises be conducted periodically, especially following major regulatory or hydrological changes in the Duck River watershed.

5.2 Expiration Date and Update Period for Plan

The Duck River Regional Drought Management Plan was adopted by:

____

on

____

and will be reviewed and updated (as needed) based on ongoing discussions with TDEC and other stakeholders.

Appendices

Appendix A – Workshop Outcomes: Western HydroLogics Report

Summary of Drought Exercise

Steve Nebiker of Western HydroLogics (WH) conducted a half-day drought exercise on May 6, 2026 at the TDEC office using the gaming mode of the Duck River OASIS model. Around 30 people participated, representing different agencies (DRA, TVA, TDEC, TWRA), interest groups (TNC, SELC), and concerned citizens and other stakeholders on the Duck River.

The goal of the exercise (game) was to develop a set of drought-related triggers and actions as part of a regional Drought Management Plan and fulfill the Executive Order 108 deadline to have a finalized plan in place by the end of the year. The triggers and actions would include coordination with stakeholders on drought monitoring (and studies like habitat surveys), declarations, and enforcement. Given the dry conditions in the basin to begin the year, the game was undertaken in advance of the typical drought season to better prepare for a potentially worsening drought.

The objectives of the game included (1) informing participants about the water resource dynamics of the basin; (2) identifying data and indicators to help make decisions about drought; (3) understanding people's risk tolerance, or willingness to accept risk, as drought conditions develop; and (4) improving communication channels between the various stakeholders.

WH selected a three-year drought period from 2006 to 2008, using historic hydrology based on gaging data that extend back about 100 years, but the calendar years were only revealed to participants at the end of the game. The game involved sequencing at discrete time intervals through the period and having participants help make decisions on corrective action that could be taken to mitigate drought conditions. The decisions focused on the timing and extent of adjustments to releases from Normandy Reservoir and water supply withdrawals. At the end of the game, the results were contrasted with what would have transpired had they followed the draft regional Drought Management Plan from 2013 which had never been adopted.

The "system" that was simulated is consistent with the current conditions simulation run from the OASIS model, which captures current water supply demands and wastewater returns, current operating policies – including the Normandy operating guide and "Optimization" of Normandy releases-- and infrastructure. WH explained that OASIS is a mass balance model that accounts for, and tracks, the flow of water throughout the system and storage of water, in this case in Normandy, and that attributes like wetted perimeter and reservoir drawdown can be derived from the model's default variables of flow and storage. Given its near-term implementation, and its significance on water supply reliability, WH modified the game to provide for a normal withdrawal depth for DRUC down to 840 feet in Normandy, instead of the current 850 feet.

The operating (guide) curve is set lower in the winter months (a minimum of 864 feet) to store floodwaters which typically arrive during the winter and spring season, and to a higher level (a maximum of 875 feet) in the summer months when low flows and droughts tend to develop. In most years, the reservoir refills to the summer guide curve. WH mentioned that the curve has changed since Normandy became operational in the 1970s, and was raised five feet in the winter months (from a minimum of 859 to 864 feet) in the 1980s to more easily refill to the summer curve. [TVA participants in the game indicated that TVA is revisiting the winter guide curve and whether it could be raised further to add storage reliability].

The critical operating parameter in the system is the Shelbyville flow target (winter/summer), which historically has been driven around wastewater assimilation ("7Q10", or the lowest required 7-day flow occurring once every 10 years). The Optimization protocol, introduced in June 2025 by TVA, changes the target to be a weekly target rather than an instantaneous one, resulting in more efficient use of Normandy storage. Historically, TVA would err on the side of providing more flow (a buffer) than the target to account for the time of travel and uncertainty of local inflow between the dam and Shelbyville. A shift to a weekly target would allow TVA to eliminate the buffer, thus leaving more water in storage. [An instantaneous target is still required, but it is well below the weekly target. This was ignored during the game since when the tributary inflow between the dam and Shelbyville is low during drought, the higher weekly target will need to be met throughout the week]. Due to the presence of federally threatened and endangered species, an Environmental Assessment (EA) was required to implement the changed release approach, and TVA demonstrated that the Optimization protocol is "not likely to adversely affect" federally-designated habitat. The Finding of No Significant Impact (FONSI) in March 2025 cleared the way for TVA to implement the Optimization.

Since the drought plan actions focus on adjustments to releases and demand reductions, thereby influencing streamflows, WH indicated to the participants that the outcomes from the exercise might require an additional EA, or potentially other reviews like NPDES permitting for wastewater assimilation, and that triggers and actions for the finalized Regional Drought Plan for this year would be grouped into two categories: (1) those that could be implemented immediately; and (2) those that would require additional review, and potentially additional studies and data collection.

In preparation for the game, WH leveraged the detailed studies as part of the EA for the Optimization protocol, including the water quality modeling performed by TDEC and the wetted perimeter studies, both done to evaluate impacts on aquatic habitat in the river, with emphasis on the mussel species which make the Duck River unique. WH distilled these analyses down to the key water quality parameters of dissolved oxygen and ammonia toxicity, both driven by water temperature and flow, and the physical parameter of habitat access using wetted perimeter at various locations along the river. Wetted perimeter surveys focused on Tarpley Bluff and Lillards Mill which captured the upstream and downstream end of the critical habitat area and where the wastewater discharges are concentrated.

WH provided a wide range of indicators to identify developing drought conditions in the basin, including trailing indicators of streamflow, days of reservoir supply remaining, and the widely-referenced Drought Monitor, plus leading indicators like the federal Drought Outlooks, La Nina and El Nino Outlooks, and forecasts of precipitation and Normandy reservoir storage. The storage forecasts are unique to OASIS, and WH explained how these are generated by simulating each year of historic hydrology through the model and producing a probability distribution of projected storage out one year based on the starting storage on the day of the forecast. These forecasts greatly change the calculus of when to take drought-related actions, and WH has found in its drought exercises with other clients that the additional insights afforded by the forecasts provide for more timely response in severe droughts, and less reactive response in moderate droughts, thus striking a better balance between maintaining reliability of the system while minimizing the costs and other impacts associated with drought response.

WH set the stage for the exercise by explaining the overall system dynamics, the competing uses in the basin (flood control, water supply, habitat protection, wastewater assimilation, and recreation), and what actions could be taken to protect these uses, namely adjustment of Normandy releases and reducing water supply demands. WH explained the OASIS plots that tracked developing drought conditions in the basin, and the impacts of any actions taken by the participants, with focus on Normandy storage, the Shelbyville flows, and flows at Milltown. Milltown flow is an important metric since most ARAP permits make reference to a 175 cfs threshold at Milltown below which future water withdrawals may be curtailed and/or implementation of the permittee's drought plans (stage 2) is required while still complying with the regional drought plan.

TDEC acknowledged at the outset of the game that the 175 cfs is a placeholder until further studies like the Habitat Conservation Plan are completed. WH noted that the game is using current annual average withdrawals, subject to a monthly pattern that leads to higher levels in the summer and lower in the winter, but does not capture peak daily withdrawals on which the ARAP permits set limits. Peak withdrawals are not easy to model since their timing is not always predictable, are short-lived, and may vary in timing from one utility to another. The resulting monthly withdrawals used in the game are representative of usage as drought conditions unfold, which typically are measured over weeks to months and not days.

WH also explained the role of wastewater in impacting river flow. Much of the water use in the Duck River is non-consumptive, meaning that a significant portion of the water withdrawn from the river is returned as wastewater to the river. Demands and wastewater returns were tracked in the game.

Year 1 of the exercise (lower basin drought):

Since the Duck River is a relatively large basin, with competing needs largely downstream of the major source of regulation at Normandy which is in the headwaters, a common occurrence is development of drought conditions and relatively low flows in the reaches below Normandy. The identification of relatively low flows is particularly challenging on the Duck, especially as it relates to the flows needed to support the mussel habitat (some of which can burrow vertically in the channel, some of which can move laterally as flows drop), and these insights will come from further studies. However, the 175 cfs threshold at Milltown reflected historical incidents of mussel stranding and potential "take", or harm or loss to habitat. (TDEC has indicated that stranding can also occur at other flows, so it can be a moving target). Other stakeholders downstream of Normandy have historically voiced concern about the imbalance of flows between upper and lower basin, with normal flows upstream and low flows downstream.

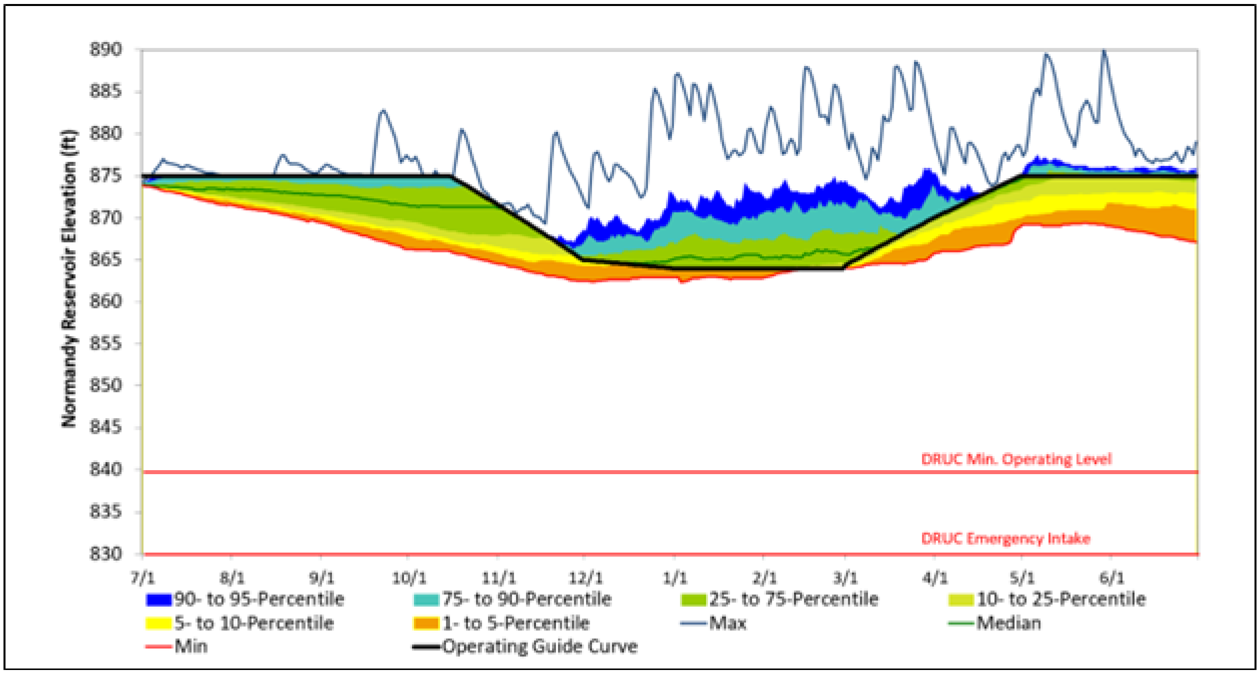
Year 1, based on the historical hydrology associated with 2006, provided an opportunity for WH to survey the participants about this upstream/downstream balance and what actions could be taken to mitigate a downstream drought. The information conveyed to the participants included flows downstream of Shelbyville, as well as storage in Normandy. The distinction of flow location is important. Regardless of downstream flow conditions, Normandy is releasing to a Shelbyville target, so the relatively low flows would only be seen downstream of Shelbyville that depend solely on tributary inflow to sustain the river flow. These low flows can be compounded by losing reaches where water is lost to the limestone aquifers. Thus, Shelbyville flows are not indicative of drought. Normandy storage, however, is indicative of drought since water must be released from storage in drought to meet the target.

In year 1, starting in July, inflows to Normandy were not unusually low, and as a result, storage in Normandy was close to the TVA summer operating guide curve. However, flows downstream, as shown to the participants as we sequenced through the first year (see below), started to decline. The focus was on flows at Milltown (in pale blue), relative to the 175 cfs threshold (also shown in pale blue). Columbia flows (in black) are also shown, since Columbia withdrawals are contingent on a 100 cfs flowby, but they remained relatively high.

The resource agencies indicated concerns with declining flows at Milltown (now below about 250 cfs), and that dropping down to a 175 cfs threshold could impose significant stress on the mussel habitat. To address this concern, WH offered them the only means of bolstering flows in the river – increasing the releases from Normandy by using a higher surrogate target at Shelbyville, and/or reducing water supply withdrawals.

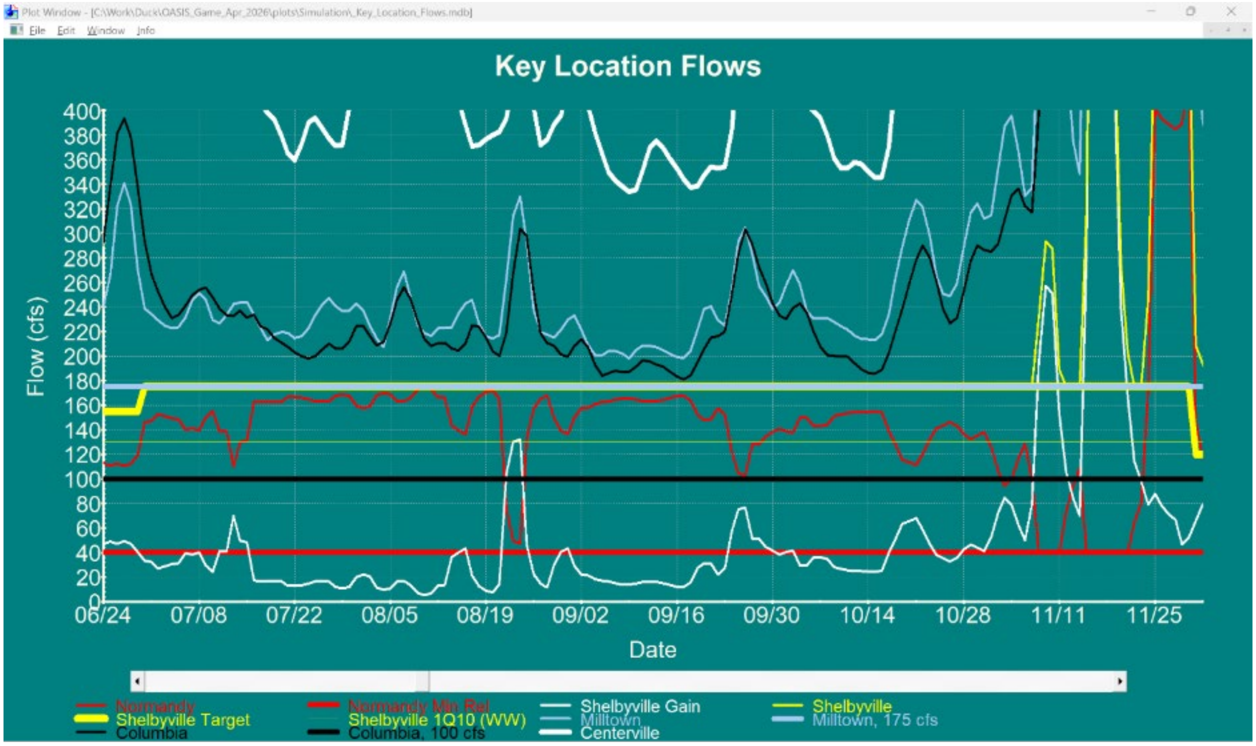
WH pointed out that prior to the Optimization, TVA typically released an extra 20 cfs as a buffer to meet what was then an instantaneous target, and that raising the target in the game an additional 20 cfs would not be any different than years past. As for demand reductions, WH demonstrated the benefit to streamflow would be very small. Even with a 10% reduction to demand (as measured by demand downstream of the Shelbyville target since demand upstream of the target is controlled by Normandy), the savings in flow would only be about 3 cfs, and even less when accounting for the amount of wastewater returned. Importantly, WH conveyed to the participants the cost to the utilities associated with any demand reductions, estimated at $3300/cfs of water withdrawn, representing the difference between the sale of water and the cost to treat it. At a 3 cfs reduction, this would be equivalent to $10,000 a day of lost revenue, which can quickly become onerous to the utility as the weeks unfold.

WH provided a storage forecast to the participants on July 1 of year 1, assuming no adjustment to Normandy releases. In this case, the forecast is based on simulation of the current release policy (Optimization) based on a repeat of the past 100 years of hydrology. The key piece of information conveyed to the group is that even in a repeat of the driest years in the record (with the worst outcome, “Min”, represented by the red line denoting the bottom of the band), Normandy would return to its winter pool guide curve by March 1.



WH then showed how the band would shift with an increase of 20 cfs to the Shelbyville target in the "summer" period (defined by TVA as June to November) from the current 155 cfs to an adjusted 175 cfs. The adjustment focused on this period since Milltown flows would likely return to high flows in the winter/spring months when inflows typically rebound. Therefore, the forecast assumed the winter target (120 cfs) would not be adjusted.

The forecast showed small impacts on storage during the summer period, and importantly, a similar return to the winter guide curve by March 1, meaning the risk to Normandy storage from the additional releases should be small.



WH implemented this change in July and showed the impacts below playing out over the "summer" period through the end of November, at which time the Shelbyville target returned to its normal "winter" target of 120 cfs.

Year 1 of the game played out with stabilization of flow at Milltown, consistently above the 175 cfs threshold, with no significant impacts to Normandy storage as predicted in the July storage forecast plot.

A candidate set of triggers and actions to address this scenario of a lower basin drought developing is provided below.

Scenario: Lower-basin drought

Trigger: Declining Milltown flows (say 1 week average below 250 cfs) and Normandy elevation close to its historical average or close to its summer guide curve

Action: Increase the summer Shelbyville target by 20 cfs to 175 cfs.

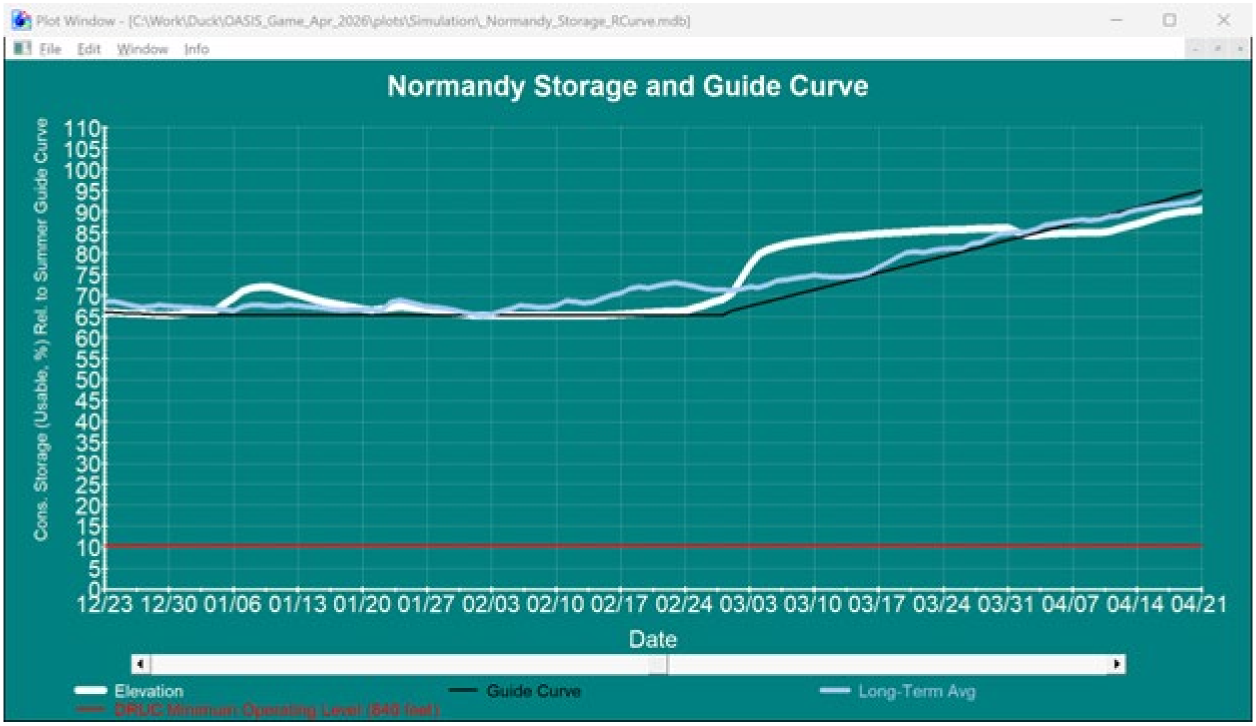
Adoption for the 2026 Drought Management Plan? No (since it would require an Environmental Assessment)

Year 2, Spring (regional drought):

In the spring (March) of the second year of the game, the Drought Monitor and inflows to Normandy revealed the early onset of drought. Normandy had returned to its winter guide curve, but the prospect of continuing dry conditions prompted WH to offer an operational scenario that could provide a very cost-effective way of adding system reliability: reservoir surcharging. In this case, rather than releasing extra water to stay at the operating curve, hold the water in storage and release only what is required from the dam to meet its instantaneous minimum (40 cfs, which TVA clarified in the game as being fixed year-round and not varying between 40 and 50 cfs depending on the season) or the higher amount to meet the Shelbyville target.

After WH showed the precipitation forecast, which indicated no significant rainfall that could cause TVA any flooding concerns, WH sought input from TVA participants if they would consider surcharging. TVA replied they would likely surcharge if their forecasts showed something similar, and reflects an evolution of their operating approach toward more dynamic reservoir operations. Although not known to the participants, the second year in the exercise represented the 2007 drought, and it should be noted that TVA did not adopt this approach at the time.

In the game, WH implemented the surcharge, holding back water for about a month until it was no longer possible to keep the reservoir at the guide curve and still meet the Shelbyville target. Flows downstream of the target were normal. The plot of the reservoir storage is shown below, here expressed relative to the summer guide curve. The surcharging occurred from mid-Feb (when storage was 65%) until the end of March (when it reached 85%). Had this not been done, 20% of the storage would have been emptied early on so that the reservoir could return to the guide curve. During this time, there was no major inflow event that raised the flood risk to Normandy, which is the ruling criterion for whether to keep the lake at the winter operating guide elevation.



A candidate set of triggers and actions to address this scenario of an early regional drought is provided below.

Scenario: Early-year regional drought (April or earlier)

Trigger: Inflows to Normandy relative to historic percentiles

Action: Surcharge

Adoption for the 2026 Drought Management Plan? No (since it would require an Environmental Assessment, and would require TVA to do a flood risk analysis)

Year 2, remainder of year (regional drought):

By summer, drought was intensifying. The Drought Monitor showed increasing severity, moving to higher stages (D2 and beyond). However, because of the surcharge, Normandy storage in June was still at 90%, or about 973 feet. Nonetheless, forecasts of reservoir storage showed that there was a small chance (less than 5%) that the reservoir would not return to the winter operating curve by March 1, and levels then could possibly be 10 to 15% lower (about a foot or two) below the curve, raising concerns about dealing with a multi-year drought should the following year be dry. In the interim period, the forecasts showed storage in Normandy could drop to a low of 50% by November. Although DRUC expressed concern about the declining storage, and being well below the long-term average, the participants decided to stay the course for two more months and continue with normal operations. During this time, and consistent with residential outdoor watering in the basin, WH increased the municipal withdrawals an additional 10% due to above-average temperature and minimal rainfall.

By August, storage reached 80% (or 868 feet). The days of supply remaining (DSR) – a commonly used indicator in the water supply business— had dropped to 180 days, or six months. Since DSR had not been an indicator used before in this basin, in part because Normandy operation is multi-purpose, WH explained how it was calculated. DSR is the number of days that Normandy could sustain the water supply withdrawal from the lake (for DRUC, down to its regular intake depth) and the Shelbyville target, without any inflow to the reservoir. As shared with the group, WH typically develops drought plans to ensure a minimum DSR of at least 60 to 90 days to accommodate droughts that may be worse than in the historical record.

Despite a healthy six months of storage remaining, DRUC staff were concerned about multi-year droughts which can occur in this basin. The decision was taken to invoke demand reductions, even if the relative impacts were shown previously to be small. There was consensus among all water suppliers attending the game (including DRUC, Bedford, and Columbia) that the restrictions would be implemented region-wide as part of a regional drought response. Considered here as stage 1 regional drought response, the targeted demand reduction was 5%.

By September, storage had dropped to 70%, and it was decided that stage 2 regional drought response would be implemented, with a total demand reduction of 10%. By October, storage had dropped to 60%, and it was decided that stage 3 drought response would be implemented, with a total demand reduction of 15%. With each month, WH tallied the lost revenue to the utilities from cutbacks to water use.

WH also conveyed to the group downstream impacts of the drought, with tributary inflows dropping quickly, to the point that flows at Milltown were getting close to the 175 cfs target, and Columbia flows were dropping to within 40 cfs of the 100 cfs flowby. WH also showed the impacts to water quality (dissolved oxygen and ammonia) and wetted perimeter. Water quality impacts were not significant, but a loss of wetted perimeter of 15 to 20% from normal levels were a cause for concern for some participants.

Since this was a regional drought, and preservation of storage was critical, there was little relief available to mitigating low flows downstream. WH showed that demand reductions had little benefit on raising streamflows, and that the costs of those restrictions were becoming significant (by this time nearing $1 million in lost revenue). However, it was recognized that in an extreme drought, with the storage trajectory tracking along the worst droughts in the record, that the pain would need to be “shared” between humans and the environment.

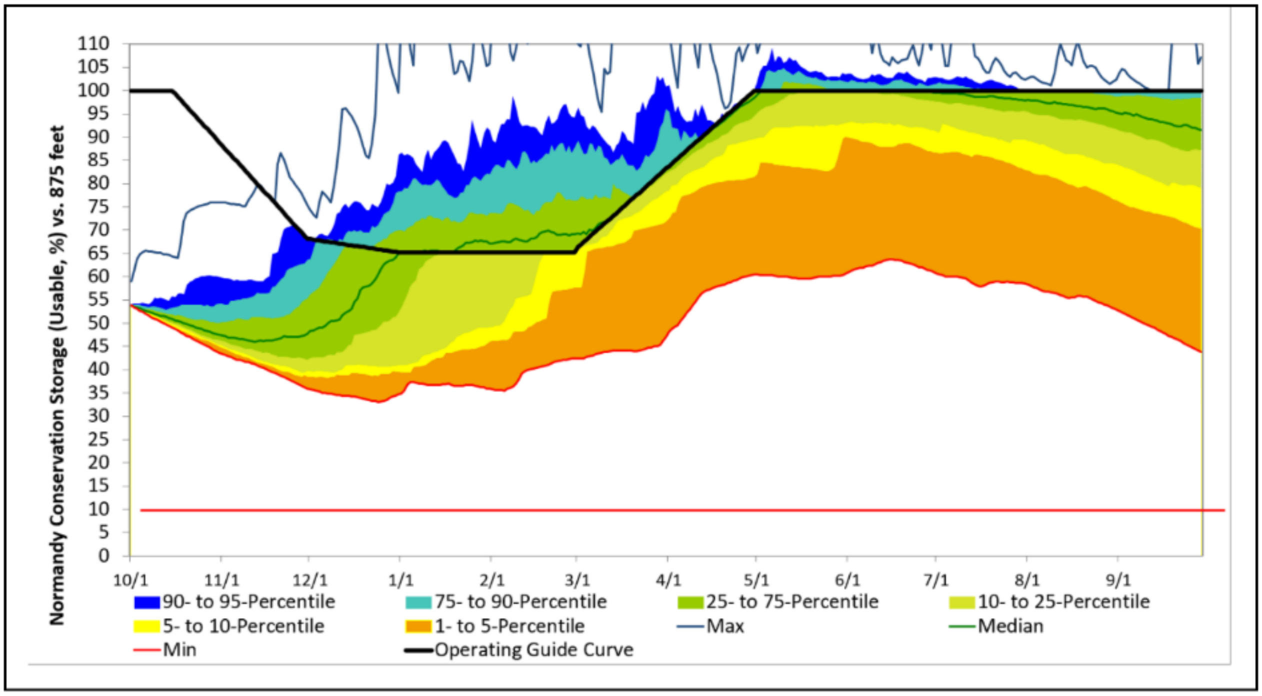
A candidate set of triggers and actions to address this scenario of a developing regional drought is provided below.

Scenario: Intensifying regional drought

Trigger: Storage or elevation in Normandy Reservoir, forecast-based (with forecasts run by DRA), meaning take action when there is an x% chance of reaching y% storage in z months, rather than when storage actually reaches y% storage

Action: Demand restrictions

Adoption for the 2026 Drought Management Plan? Yes (since it is not causing a reduction in streamflows)



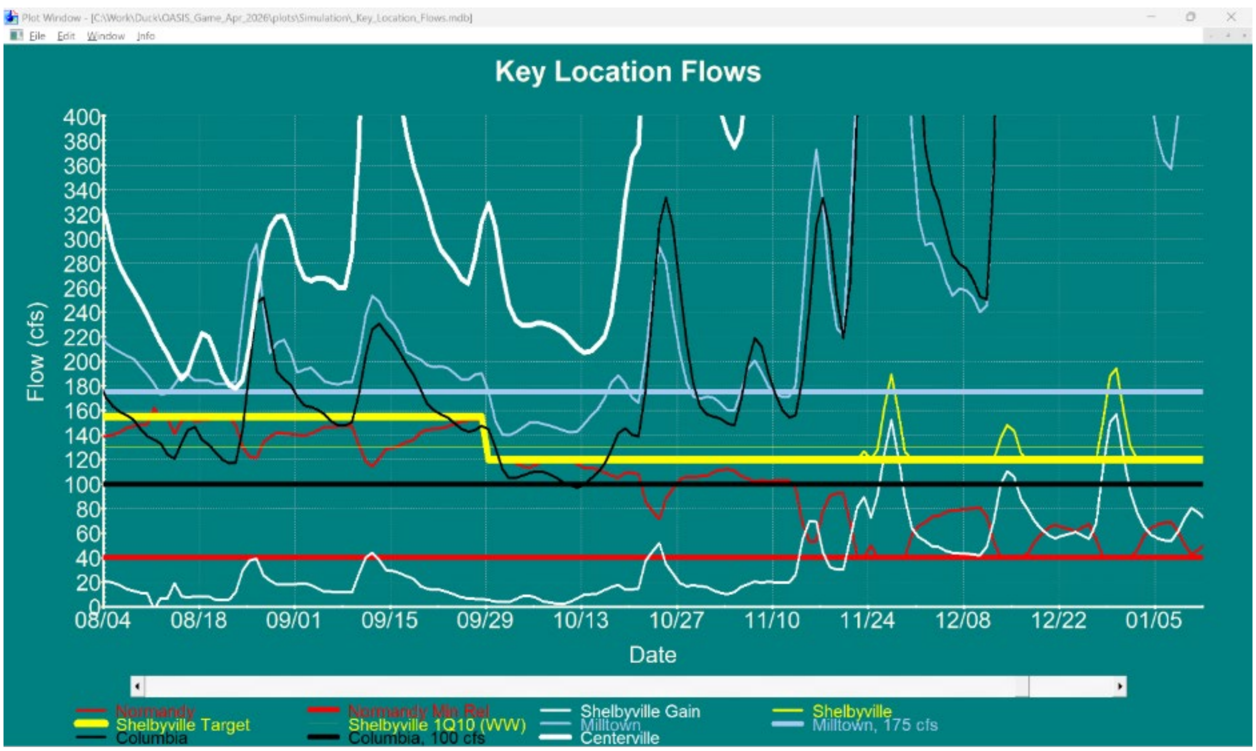
WH provided the group a forecast of reservoir storage in October, when storage had dropped to less than 60%. (The 10% red line is the DRUC intake at its new normal withdrawal depth of 840 feet). The forecast showed a significant chance of not refilling to the operating curve, and that in the next few months, followed by a year from now, storage could drop to 40% or lower if the lowest flow year(s) occurred.

In an attempt to provide an adequate reserve even if the worst drought played out, and to address other concerns like increased costs to treat the water in a declining pool, WH suggested reducing the Shelbyville target by 35 cfs to match the “winter” target of 120 cfs. We provided the group with another storage forecast to highlight the benefit of this reduction on preservation of storage.

WH pointed out that the water quality impacts and the wastewater assimilation concerns are reduced as water temperature drops, and typically by October (and true as well in this drought), water temperatures are below 70 degrees Fahrenheit. WH showed ammonia toxicity during this time was not a concern. WH pointed out that the Shelbyville “summer” target includes two months (October and November) where water temperatures are far from summer-like, and even with a reduction in flow of 35 cfs, the studies and modeling to date suggested that it would have little water quality impact.

With 35 cfs reduction in flows, however, and flows already relatively low downstream at Milltown and Columbia, such a reduction in flow could impact water withdrawals downstream and wetted perimeter. In both cases, the impacts were not deemed to be significant enough to hold off on cutting back releases (although it was mentioned that perhaps the Shelbyville targets could have been reduced gradually starting a few months earlier). Again, until further studies are conducted, identifying the correct sequencing of release reductions is difficult.

Starting October 1, WH reduced the Shelbyville target to 120 cfs, effectively shifting the winter target two months earlier. Resulting flows downstream are shown below. For the first half of the month, October flows at Milltown drop below the 175 cfs threshold and Columbia drops close to its 100 cfs flowby.



Then flows rebound from local runoff, and the impacts of the flow reduction from Normandy diminish. Although there may have been impact at lower flows on habitat stranding, the duration and time of year may play an important role, with short duration events in cooler temperatures potentially acceptable. [If not, considering this extreme drought, an effort to relocate habitat may have been needed, and that would be another consideration for the Drought Management Plan actions.]

WH showed that even at these lower flows, the impacts on dissolved oxygen and ammonia toxicity (again based on TDEC modeling) were small. As for wastewater assimilation, notably at the Shelbyville location for which the targets are ostensibly set, the lower temperatures corresponding to the reduced flow (and the water quality modeling TDEC did) should not have created any wastewater assimilation concerns, although ultimately that would require NPDES review.

A candidate set of triggers and actions to address this scenario of a significant regional drought is provided below.

Scenario: Significant regional drought

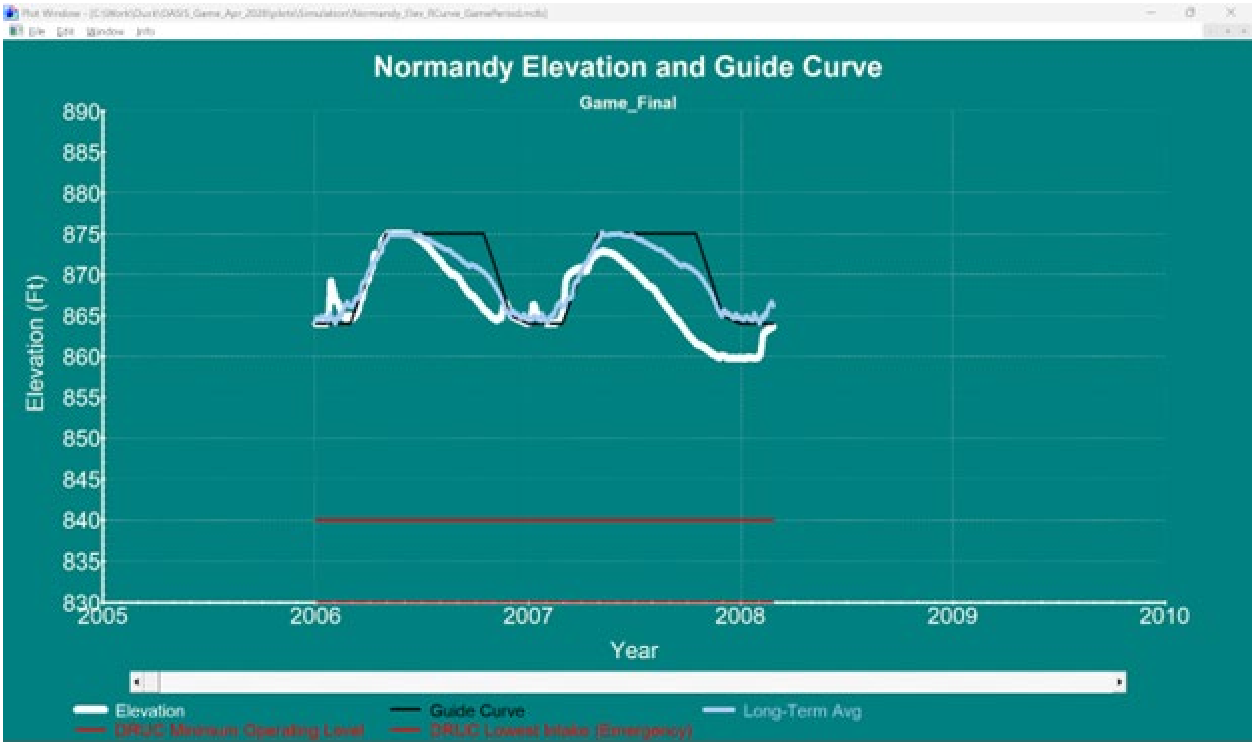
Trigger: Storage or elevation in Normandy Reservoir, forecast-based, meaning take action in October when there is an x% chance of not refilling to the operational guide curve within z months

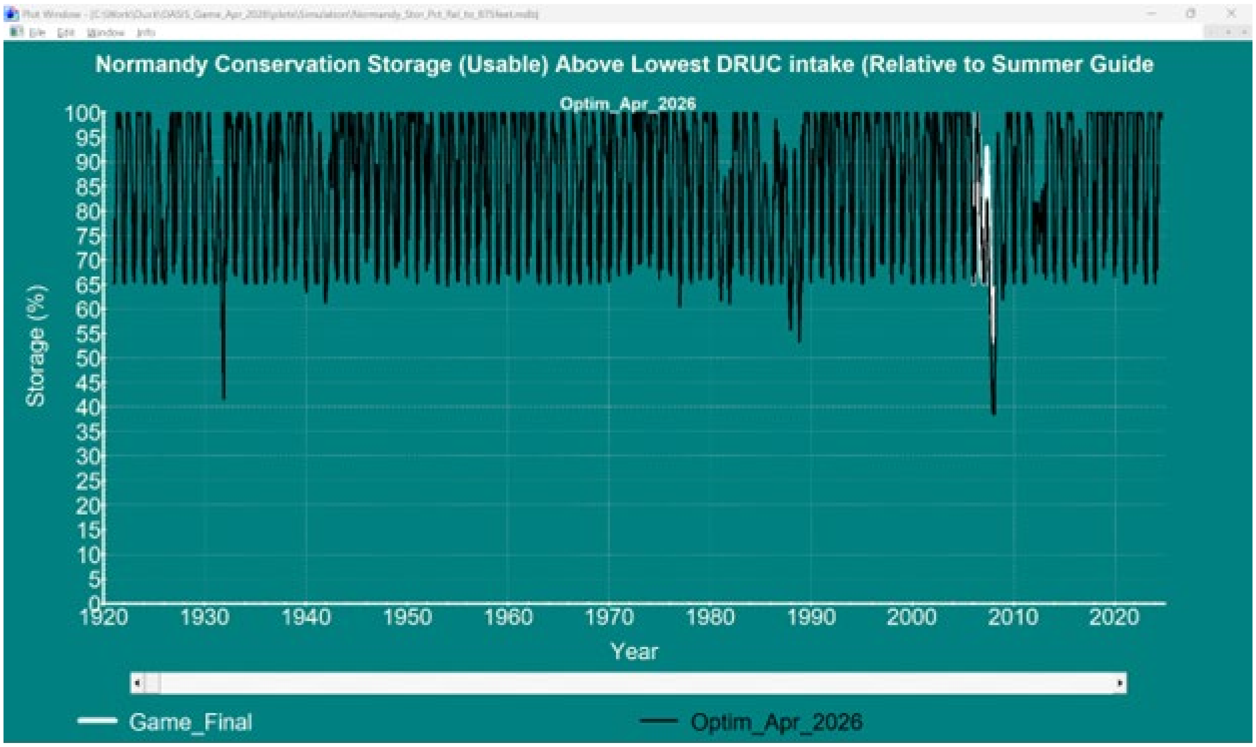
Action: Reduce Shelbyville summer target down to the winter target

Adoption for the 2026 Drought Management Plan? No (since it would require an Environmental Assessment)

Starting in November, inflows begin to rebound and the drought eases. Storage rebounds within a few months and closes in on the operations curve. Participants decided to be cautious and keep the 15% demand restrictions in place throughout, citing the extreme nature of the drought and wanting to avoid starting the following year at a storage deficit.

The summary of the exercise in terms of storage (and now the associated years revealed to the participants) is shown below. Minimum storage occurred at the end of the second year (2007) and beginning of the third year (2008), with storage reaching 55% (or elevation 860 feet). Storage in the second year was well below the long-term average. In the actual 2007/08 drought, the minimum elevation in Normandy reached 852 feet. Also, actual releases during that drought were sharply curtailed below the seasonal targets to preserve storage. The dramatic difference in this exercise is the decision to surcharge the reservoir leading into the drought, which was not done in actuality.

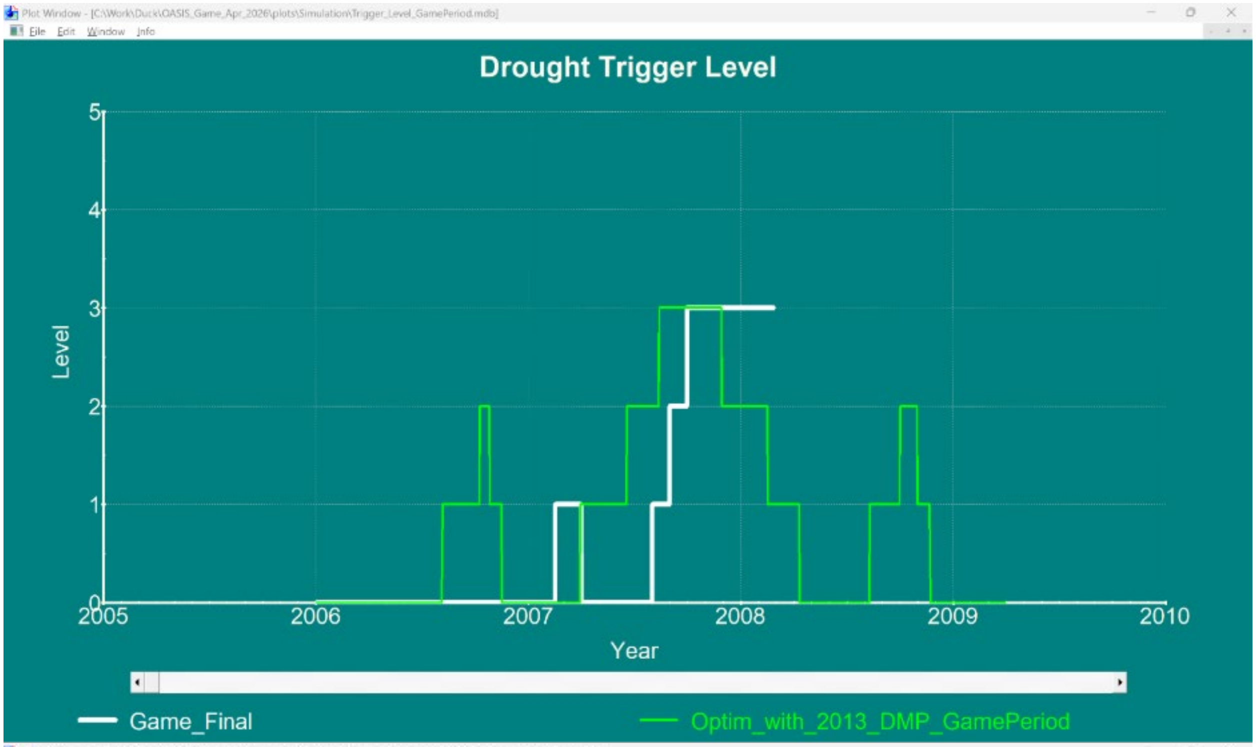

Normandy Elevation and Guide Curve
Game_Final
890
885
880
875
870
865
860
855
850
845
840
835
830
Elevation (Ft)
2005
2006
2007
2008
2009
2010
Year
Elevation
Guide Curve
Long-Term Avg
DRJC Minimum Operating Level
DRJC Lowest Intake (Emergency)

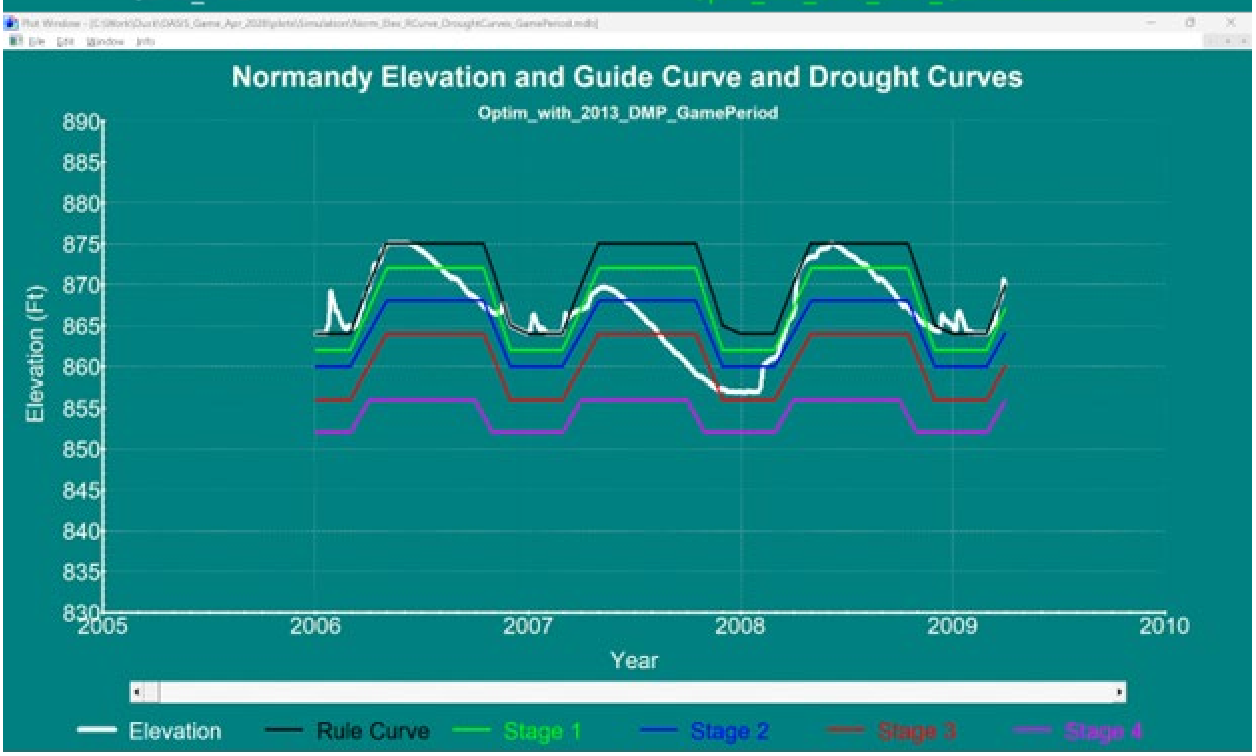


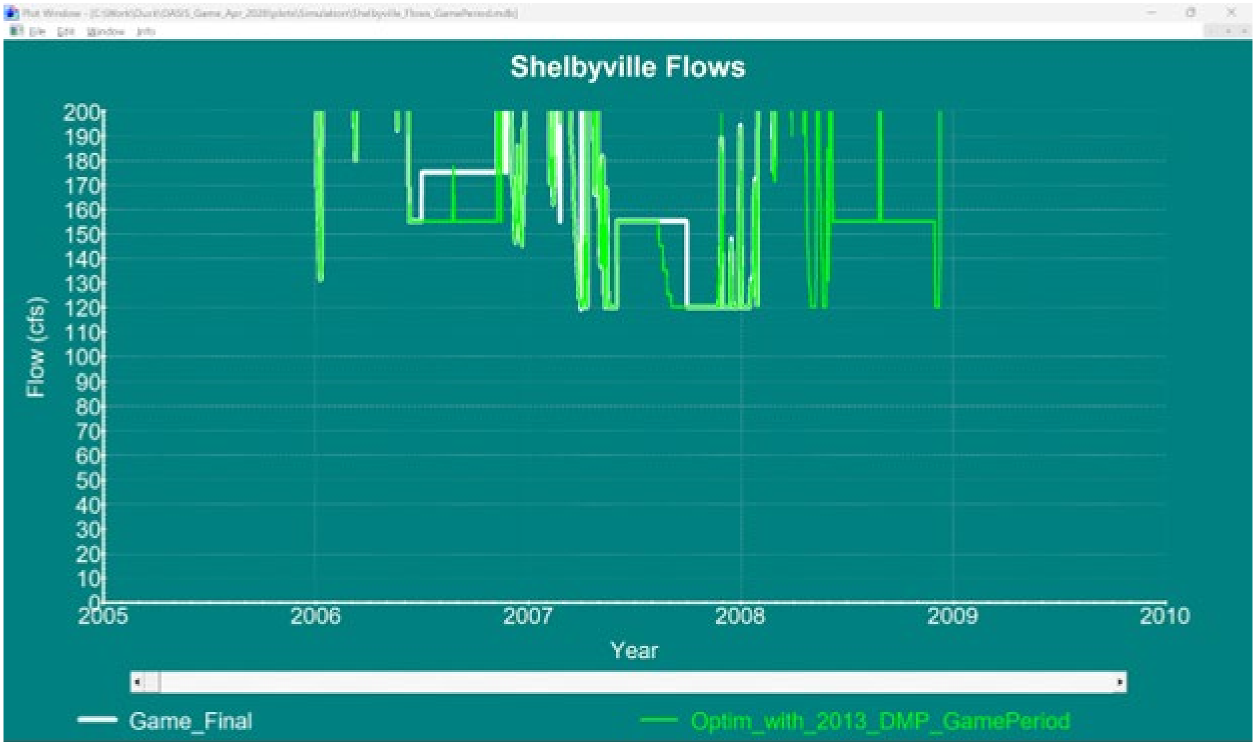
To put the drought event (white line in the plot below) in context, WH overlay the full historic inflow record (black line) using the current conditions OASIS run. The current simulation run does not have any drought plan actions included. The plot points out a few things: (1) the 2007-08 drought was one of the most severe on record, as most participants were already aware; (2) the resulting storage in the drought, due to the surcharge and to a lesser extent cutbacks to the Shelbyville and the demand reductions, provided for 15% gain in storage compared to not taking any drought actions; and (3) in most years, there is plenty of storage remaining in Normandy to address any lower basin drought concerns (which might prompt higher releases from Normandy as simulated in year 1 of the exercise).

The triggers and actions will be tested by WH over this full hydrologic record, with an effective plan balancing the importance of maintaining sufficient reliability (and reserve) in the worst droughts while minimizing the frequency of hitting the triggers.

At the end of the exercise, WH showed how the decisions in the game compared to what would have happened If they had followed the draft 2013 Drought Management Plan. The plots below show the following: 2013 draft plan triggers (drought curves) and simulated storage; trigger activation and duration; and Shelbyville flows.


Drought Trigger Level
Level
Year
Game_Final
Optim_with_2013_DMP_GamePeriod


Normandy Elevation and Guide Curve and Drought Curves
Optim_with_2013_DMP_GamePeriod
Elevation (Ft)
Year
Elevation
Rule Curve
Stage 1
Stage 2
Stage 3
Stage 4



The results indicate some differences. First, participants were willing to hold off on demand restrictions by several months as compared to following the draft 2013 plan. This was probably a combination of a few factors: (1) storage leading into the second year of the drought was higher due to the surcharge, with about feet of higher elevation in the game as a result; (2) forecasts provided them with better insight on risks to Normandy storage, and were willing to hold off on taking action even if lake levels dropped below a certain level; and (3) the DRUC intake level that is now regularly accessible has been lowered from 850 to 840 feet, providing more comfort to participants to allow the lake to draw down more.

With the draft 2013 plan (shown as the green line), using drought curves tied to lake levels (and not forecasts of lake levels), the triggers were routinely hit. Demand reductions were slightly lower in the draft plan, but they were in place for a shorter period overall. Participants stated that the full set of restrictions during the game would stay in place until the reservoir refilled to the guide curve, so that was a significant change, and reflected a willingness on restrictions, that once initiated, to maintain them to minimize the risk of a multi-year drought.

Lastly, the 2013 plan called for reductions to the Shelbyville target in stage 3, with weekly reductions of 10 cfs from the summer down to the winter target. We initiated the reduction immediately, but waited until the lower temperature month of October to do that.

Appendix B – Workshop Outcomes: Near-term & Long term Drought Mitigation

		Stage 1 ADVISORY	Stage 2 WATCH	Stage 3 WARNING	Stage 4 EMERGENCY
TRIGGERS	Community/ NGO's	Mild US Drought Warning Flow Threshold	Flow threshold/Reservoir Elevation Mussel Strandings	**Flow threshold/Reservoir Elevation**	Flow threshold/Reservoir Elevation
	Federal Agencies	Precipitation Runoff Forecasts trend Dry	Prolonged Below Normalflow & Precipitation D0-D1 by inflows & Storage	Potential Adverse Impacts	
	State Agencies				
	Utilities	TVA GuideCurve Seasonal Water Increase USGS Stream Guage			
LEVERS	Community/ NGO's	Legal Action Assumption: Community influence Assumption: Scientific Expertise			
	Federal Agencies	Assumption: Normandy Releases			
	State Agencies	Assumption: ARAP Enforcement			
	Utilities	Cutoffs Proposed: Rate Structures for Conservation & Drought			
2026	Community/ NGO's	**Public Education** Timely Messaging	Grassroots Organization Temper Public Panic w/ Science	**Public Education & Outreach**	
	Federal Agencies	Propagation **Surcharge** Habitat & Species monitoring	Communication w/ Utilities & Peers concerning Lake Levels	Hydrologic modeling **FIRO (Forecast, Inform River Ops)** Short-term flow modifications Technical assistance with scientific input	
	State Agencies	Awareness	Communication to withdrawals concerning DMP activation Conservation Awareness Notify Other state Agencies (TDA, TEMA) Communications to Public Update Drought Website	**Notify/ Coordinate with EPA, TVA, Other Federal agencies** **Weekly Meetings with TEMA & TVA affected Agencies** Communications with Public, state Communications with withdrawers Communications with TAUD **Suspend Regulations**	
	Utilities	**Public Education**	Public Education Lead by Example Water Reduction Smart Landscaping **Native Plants** **Smart Flushing** **Leak Detection**	Forced Reduction **No Car Washing** No Irrigation	Collect WQ Data Interbasin Transfer Mandatory Water Conservation Commissioner Enforcement Discretion Alternate Source Approval Require Water Provision Funding Enforcement
2-5 yrs	Community/ NGO's	Provide Reports	Public Pressure		

	Federal Agencies	Propagation Species salvage planning **Guide Curve Adjustment**	Planning Documents	**Adaptive Management** **Flow Reductions** **HCP**	Adaptive management Step 2 Flow Reductions Step 2 Species Salvage operations
	State Agencies	Incentivize Water Loss Reduction Incentivize Non-potable Reuse **Define Low flow cuts through HCP** **Improve Monitoring Networks**			
	Utilities	**Water Storage Solutions** **Lagoons** **Tanks**	**Investigation Utility Interconnectivity** Investigate Indirect Reuse		
	Community/ NGO's	Advocate for Headwater Protection **Advocate for Groundwater Permitting**	**Advocate for restoration of isolated wetland protection** Advocate for land use Management Planning	**Advocate for Irrigation Policies in all counties** **Fund/ Help fund citizen science effort around the Duck**	Advocate for SRF Programs Advocate for Water Reuse Programs Advocate for Off stream Reservoir
	Federal Agencies	**Propagation** Recovery			Future hard infrastructure (what is it?)
	State Agencies	SRF Drought Project Funding Potable Reuse Rules **Enhanced WW Treatment to account for drought**			
Long-Term	Utilities	**Raise Normandy** **Tennessee River Pipeline** **Indirect Reuse**			

Drought Response/ Risk Distribution
Building System Resilience
Voted as high priority

Appendix C – Drought Task Force

Contact	Role	Entity	Email Address
Regulatory Agencies			
Sherry Glass	Manager – Columbia Environmental Field Office	TDEC-DWR	Sherry.Glass@tn.gov
Chad Augustin	Program Manager, Natural Resources – Columbia Environmental Field Office	TDEC-DWR	chad.augustin@tn.gov
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April Grippo	DWR Director/Designee	TDEC-DWR	April.Grippo@tn.gov
Chuck Yoest	Columbia Regional Director for External Affairs	TDEC	ChuckA.Yoest@tn.gov
Water Resources Agencies			
Brittany Bajo-Walker	Statewide Mollusk Conservation Coordinator	TWRA	Brittany.Bajo-Walker@tn.gov
Dan Elbert	Ecologist	USFWS	Daniel_elbert@fws.gov

Contact	Role	Entity	Email Address
Gary Springston	Water Supply Manager	TVA	glspringston@tva.gov
James Everett	River System Operations Manager	TVA	Jheverett@tva.gov
Rodney Knight	Director – USGS Lower Mississippi-Gulf Water Science Center	USGS	rrknight@usgs.gov
Water Systems (DRATAC)			
Dale Willis	Vice President – Water/Wastewater	Tullahoma Utilities Authority	dwillis@tullahomautilities.com
Lonnie Foley	Director	Manchester Water & Sewer Department	lfoley@cityofmanchestertn.gov
Randal Braker	General Manager	Duck River Utility Commission	manager@druc.org
Jason Reese	General Manager	Shelbyville Power, Water and Sewerage System	jreese@shelbyvillepower.com
Kevin Mayhorn	General Manager	Bedford County Utility District	Kevin@bedfordutility.com
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Jeremy Vanderford	Assistant General Manager, Water	City of Spring Hill, Tennessee	jvanderford@springhilltn.org
Jack Baxter	Interim Chief Executive Officer	Columbia Power and Water Systems	Jack.Baxter@cpws.com
Organizations			
David Money	Executive Director	DRA	David@DuckRiverAgency.org
Mark Thurman	Director of Conservation Collaboration	TNC	mark.thurman@tnc.org
Independent Experts			

Contact	Role	Entity	Email Address
George Rest	Senior Officer, Water Resources	Ramboll	George.Rest@Ramboll.com
Thomas Dumm	Senior Technical Manager, Water Resources	Ramboll	Thomas.Dumm@Ramboll.com
Steven Nebiker	Senior Associate	Western HydroLogics	Steve.Nebiker@westernhydrologics.com

Appendix D – DMP Update Task Force Member List

Name	Organization	Workshop Table
Frank Cartwright	Bedford County Utilities	Operator - Reservoir
Kevin Mayhorn	Bedford County Utilities	Operator - Reservoir
Ronnie Lokey	Bell Buckle	Operator - Reservoir
Chad Dotson	Centerville Water System	Operator - River
Donny Groves	Chapel Hill	Operator - River
Lance Holdorf	Citizen At-Large	Community Support & Recreation
Savannah Jobkar	Citizen At-Large	Community Support & Recreation
Lonnie Foley	City of Manchester	Operator - Reservoir
Doug Jones	Duck River Conservancy	Community Support & Recreation
Elizabeth Bratton Dixon	Duck River Conservancy	Community Support & Recreation
Jamie Sain	Duck River Utility Commission	Operator - Reservoir
Randal Braker	Duck River Utility Commission	Operator - Reservoir
Kevin Vann	Duck River Watershed Society	Community Support & Recreation
Grace Stranch	Harpeth Conservancy	Community Support & Recreation
Ryan Jackwood	Harpeth Conservancy	Community Support & Recreation
Shaun Rainone	Henry Horton State Park	Community Support & Recreation
Dawn Nelson	Higher Pursuits	Community Support & Recreation
Jan Seufert	Higher Pursuits	Community Support & Recreation
Caryl Giles	Lewisburg Water Dept.	Operator - River
Trigg Cathey	Lewisburg Water Dept.	Operator - River
Chad Dennis	Marshall County Board of Public Utilities	Operator - River
Todd Shultz	Maury County Water System	Operator - River
Jason Reese	Shelbyville Power, Water, and Sewerage System	Operator - Reservoir

Name	Organization	Workshop Table
John Freeman	Shelbyville Power, Water, and Sewerage System	Operator - Reservoir
Stephanie Biggs	Southern Environmental Law Center	Environment & Conservation
Dan Allen	Spring Hill Water	Operator - River
Jeremy Vanderford	Spring Hill Water	Operator - River
Rich Cochran	TDEC WW	State Policy - Water
Wade Murphy	TDEC WW	State Policy - Water
Danny Rochelle	TDRA Board Hickman County Representative	Community Support & Recreation
Mark Thurman	The Nature Conservancy	Environment & Conservation
Rob Bullard	The Nature Conservancy	Environment & Conservation
Peter Murrey	TN Department of Environment and Conservation	State Policy - Other
Chad Augustine	TN Department of Environment and Conservation	State Policy - Other
Elaine Boyd	TN Department of Environment and Conservation	State Policy - Other
Crystal Stacey	TN Department of Environment and Conservation	State Policy - Water
Will Pride	TN Department of Environment and Conservation	State Policy - Water
Brock Glass	TN Department of Environment and Conservation	State Policy - Water
April Grippo	TN Department of Environment and Conservation	State Policy - Water
Robby Baker	TN Department of Environment and Conservation	State Policy - Water
Andy Holt	TN Dept of Agriculture	State Policy - Other
Ryan King	TN Dept of Agriculture	State Policy - Other
Doug Murphy	TN Duck River Development Agency	Environment & Conservation
Angie Brown	TN Duck River Development Agency	Floater
David Money	TN Duck River Development Agency	State Policy - Water
Amanda Turk	TN Valley Authority	Upstream & System Operators
Gary Springston	TN Valley Authority	Upstream & System Operators

Name	Organization	Workshop Table
James Everatt	TN Valley Authority	Upstream & System Operators
Matthew Higden	TN Valley Authority	Upstream & System Operators
William Douglas White	TN Valley Authority	Upstream & System Operators
Jason Miller	TN Wildlife Resources Agency	State Policy - Other
Josh Campbell	TN Wildlife Resources Agency	State Policy - Other
Brian Alford	TN Wildlife Federation	Environment & Conservation
Horace Tipton	TN Wildlife Federation	Environment & Conservation
Dale Willis	Tullahoma	Operator - Reservoir
Tim Wilder	US Army Core of Engineers	Upstream & System Operators
Valerie McCormick	US Army Core of Engineers	Upstream & System Operators
Dan Elbert	US Fish and Wildlife Service	Environment & Conservation
Rodney Knight	US Geological Survey	Upstream & System Operators
Jeremy Garrett	Wartrace	Operator - Reservoir
Steve Nebiker	Western HydroLogics	Upstream & System Operators

Appendix E – DMP Reference Summary Table

Stage	Triggers		Action	
	3-day Average Milltown Flow (cfs)	Normandy Reservoir Elevation (ft)*	Demand Reduction Goal**	Roles
1 - Awareness	<175	<864	N/A	**DRA:** Monitors the status of the region's water supplies, conducts water supply forecasts, and initiates discussions with DMP Task Force. **Water Systems:** Provides technical input in DMP Task Force via DRATAC, leads public education, and notifies customers on drought stage changes (progressing and rescinding). **State Agencies:** Provides information to monitor drought conditions and provides regulatory oversight.
2 – Voluntary	<165	<860	10%	**DRA:** Monitors the status of the region's water supplies, conducts water supply forecasts, and continues discussions with DMP Task Force to build consensus on drought monitoring and communications. **Water Systems:** Implements voluntary conservation measures such as limits on landscaper irrigation, continues public education, notifies customers of drought stage changes (progressing and rescinding), and monitors water use trends consistent with individual drought management plans. **State Agencies:** Provides information used to monitor drought conditions, monitors and enforces protection of aquatic life, and provides regulatory oversight.
3 – Mandatory	<147	<855	20%	**DRA:** Monitors the status of the region's water supplies, conducts water supply forecasts, and continues coordination with DMP Task Force to implement mandatory drought monitoring and communications. **Water Systems:** Implements mandatory restrictions on discretionary water use, enhances public outreach, notifies customers of drought stage changes (progressing and rescinding), and monitors water use trends consistent with individual drought management plans. **Federal/State Agencies:** Provides information used to monitor drought conditions, monitors and enforces protection of aquatic life, informs river operations, and notifies and coordinates with federal agencies.
4 - Emergency	<147	<850	30%	**DRA:** Monitors the status of the region's water supplies, conducts water supply forecasts, tracks implementation of emergency drought monitoring and communications plans, and may designate water conservation coordinator to help facilitate communications. **Water Systems:** Implements mandatory conservation and restriction requirements, expands public outreach, notifies customers of drought stage changes (progressing and rescinding), and monitors water use trends consistent with individual drought management plans. **Federal/State Agencies:** Provides information used to monitor drought conditions, monitors and enforces protection of aquatic life, informs river operations, and notifies and coordinates with federal agencies.

*Based on a 14-day persistence below or above the reservoir elevation for drought progressing and drought rescinding, respectively (See Section 3.1.2).

**Demand reductions are based on the 7-day average demand prior to entering each drought stage (See Section 3.1.1).

Attachments

Attachment 1 – White Paper: Considerations for governance before, during, and after drought

Attachment 1

DRAFT

Considerations and Recommendations for Future Drought Planning in the Duck River Watershed

September 2026

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Contents

Introduction

The challenge addressed by this attachment is not identifying when drought occurs. Triggers, indicators, and forecasts can help answer that question. The challenge addressed here is understanding how people, organizations, and institutions interpret changing conditions, coordinate actions, distribute risk, and respond collectively once scarcity emerges.

Stakeholders managing a shared resource often experience the same drought conditions and rely upon much of the same information describing those conditions. They do not, however, necessarily share the same risks, responsibilities, authorities, or impacts, and therefore their interpretations of that information may differ significantly.

Effective governance is the process of coordinating action across those differences.

This attachment explores the ingredients of effective governance of a shared resource, particularly as they relate to drought management, and documents observations, lessons learned, and future considerations emerging from development of the 2026 Duck River Regional Drought Management Plan (DMP).

The 2026 update to the Duck River Regional Drought Management Plan focused on establishing an operational framework for responding to drought conditions through defined triggers, drought stages, responsibilities, and response actions. During development of the update, however, stakeholders repeatedly identified issues that extend beyond drought response and into broader questions of preparedness, governance, communication, coordination, and long-term watershed resilience.

Stakeholders generally agreed that drought management requires more than identifying conditions under which restrictions should be implemented. The planning process highlighted differences in how organizations interpret drought conditions, how risk should be distributed during times of scarcity, how communication should occur among stakeholders and the public, and how long-term resilience should be developed to mitigate the impacts of drought. These topics generated considerable discussion during the drought exercise and subsequent stakeholder meetings but were ultimately beyond the scope of the operational updates incorporated into the DMP.

This attachment also preserves observations, concepts, and recommendations that emerged during development of the 2026 Drought Management Plan update but could not be incorporated into the operational DMP because they require additional discussion, stakeholder coordination, governance development, implementation capacity, research, or future planning efforts. The purpose of this attachment is to document those concepts, preserve institutional knowledge generated through the planning process, provide context for future updates, and identify opportunities for continued collaboration, preparedness, and watershed resilience. Inclusion of these concepts does not constitute adoption of any specific governance structure, planning framework, or policy recommendation. Rather, they are presented as considerations to inform future discussions, planning efforts, and updates to the DMP.

The planning process demonstrated that successful drought management depends upon more than identifying drought conditions. It requires governance structures, common understanding, implementation capacity, communications pathways, and resilience sufficient to support coordinated action once scarcity emerges.

1. Scarcity, Risk, and Shared Resources

Collaborative water management during and concerning normal conditions differs significantly from collaborative water management during and concerning times of scarcity.

Executive Order 108 established the Duck River Watershed Planning Partnership (Planning Partnership) and directed stakeholders to develop collaborative strategies related to sustainable water management, drought resilience, habitat conservation, water-loss reduction, regionalization, and public engagement throughout the watershed. Throughout the Planning Partnership process, stakeholders routinely worked together on issues such as conservation, monitoring, education, habitat protection, infrastructure planning, and water-use efficiency. While disagreements occasionally arose, these discussions generally focused on improving future watershed conditions while access to the resource remained largely unconstrained. As a result, collaboration was often relatively frictionless because stakeholders were not yet being asked to share risk associated with resource scarcity.

Scarcity changes the nature of the conversation.

During planning discussions focused on normal operations, stakeholders are often evaluating opportunities for collective benefit and long-term improvement. During drought discussions, however, stakeholders must also consider how risk associated with a limited resource should be distributed among competing interests, responsibilities, and uses. As a result, the same stakeholders who readily collaborate under normal conditions may interpret information differently and approach decision-making from increasingly protective positions as scarcity and risk increase.

Drought introduces scarcity into the system. Scarcity creates risk. As risk increases, stakeholders become increasingly focused on protecting the resources, responsibilities, and communities under their care. Utilities become concerned about maintaining reliable water service. Resource agencies focus on protecting aquatic habitat and water quality. Agricultural users become concerned about irrigation supplies and crop production. Communities become concerned about economic impacts and quality of life. The result is that collaboration, while still necessary, often becomes more difficult precisely when it is needed most.

One of the most important observations from the drought exercise was that stakeholders do not simply interpret drought differently because they possess different information; stakeholders often interpret the same information differently because they have different responsibilities. A declining reservoir level, reduced streamflow, or a negative precipitation outlook may represent entirely different risks depending on the stakeholder viewing the information. A utility may view declining soil moisture as an indicator of increased customer demand. Agricultural producers may view the same conditions as an immediate threat to crop production. Resource agencies may interpret the signal as an indicator of ecological stress. Community organizations may view it as a warning of future restrictions or economic impacts. The data itself remains unchanged, but the meaning assigned to that data varies according to the interests, responsibilities, and risks associated with each stakeholder.

Analysis of coordinated collaborative partnerships in western water management found that successful collaboration often emerged when stakeholders developed a shared understanding of the resource system, the challenges facing that system, and the ways their actions affected one another (Brown, 2021). Partnerships formed not simply because participants possessed data, but because they developed a common understanding of what the information meant and how resource conditions influenced their respective responsibilities.

Drought therefore functions as a stress test of both the physical resource and the governance systems responsible for managing that resource. It reveals whether stakeholders have sufficient understanding, communication pathways, implementation capacity, trust, and resilience to respond collectively under conditions of stress. It also reveals where governance structures, communications strategies, infrastructure, or resilience investments may be insufficient.

Viewed through this lens, it can be argued that drought management is not fundamentally a trigger problem. Triggers identify conditions under which actions should occur. The more difficult challenge is establishing governance structures capable of supporting stakeholders in developing common understanding, coordinating actions, distributing risk appropriately, and maintaining collaboration even when scarcity creates competing priorities.

2. Understanding the Resource

Effective governance of a shared resource begins with an understanding of the resource itself. While drought discussions often focus on water withdrawals, conservation measures, reservoir levels, and drought-response actions, governance decisions can only be as effective as the understanding of the entire system being governed.

One of the primary observations from the planning process was that stakeholders often discuss the Duck River as a single resource system while interacting with very different portions of that system. Water providers, agricultural users, environmental organizations, regulators, federal agencies, and community members each experience different parts of the watershed and different consequences of drought conditions. As a result, the effects of drought and water-management decisions are not necessarily experienced uniformly throughout the basin.

For the Duck River, understanding the resource requires recognition that the watershed is not hydrologically uniform. The effects of a water withdrawal, reservoir release, conservation program, infrastructure project, or drought-response action are not distributed equally throughout the system. Certain river reaches gain flow from groundwater while others lose flow to surrounding geologic formations. Reservoir releases may have significant influence in one portion of the river yet provide more limited benefits in another. Similarly, some withdrawals may affect conditions primarily at a local scale while others may have consequences further downstream.

Such differences suggest that effective drought governance requires an understanding of the hydrogeologic systems within the watershed and the ways those systems interact. While political boundaries are useful for administration and representation, the most meaningful management boundaries do not always coincide with county lines, utility service areas, or regulatory jurisdictions. Instead, they frequently follow hydrologic and hydrogeologic conditions that determine how water moves through the watershed and how one user's actions influence another.

Future planning efforts may therefore benefit from identifying hydrogeologically connected management zones within the watershed and evaluating how actions taken within those zones affect both upstream and downstream conditions. Such an approach may help stakeholders better understand where management actions have influence, where collaboration is most needed, and which users are directly affecting one another during drought conditions.

Development of hydrogeologically informed management zones may also support future monitoring, modeling, infrastructure planning, conservation efforts, and drought preparedness initiatives. A clearer understanding of the physical boundaries of influence within the watershed may provide a more effective foundation for future governance discussions than reliance solely on political or organizational boundaries.

In this way, understanding the resource is not simply a technical exercise. It is also a prerequisite for effective governance. Understanding the system's boundaries, constraints, areas of influence, and vulnerabilities provide the foundation upon which future collaboration, preparedness, resilience, and drought management efforts can be built.

3. Governance Levels and Collaborative Management of Shared Resources

As with most shared natural resources, governance of the Duck River already occurs at multiple levels. The challenge facing the watershed is not the absence of governance, but rather improving coordination between existing governance levels and ensuring that decisions made at one level support actions occurring at other levels.

Collaborative governance research suggests that complex resource systems often require multiple layers of decision-making operating simultaneously. Ostrom (1990) described such arrangements as **Nested Enterprises**, recognizing that effective management of shared resources frequently requires coordination among actors operating at different levels of authority and responsibility.

For purposes of this discussion, governance of the Duck River can be viewed through three primary levels: **Policy, Operational, and Action**. These levels have been adapted from Margerum and Robinson's (2015) collaborative governance framework to reflect management of a shared water resource system such as the Duck River watershed.

Policy Level Governance

Policy-level governance refers to interactions between governmental entities and organizations responsible for managing, regulating, or protecting the resource.

Examples include:

- Tennessee Department of Environment and Conservation (TDEC)

- Tennessee Valley Authority (TVA)
- Tennessee Wildlife Resources Agency (TWRA)
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Army Corps of Engineers (USACE)
- Permit requirements
- Habitat Conservation Plan requirements
- State and federal laws and regulations

At this level, governance focuses primarily on defining guardrails, expectations, regulatory obligations, and desired outcomes. These entities are generally not responsible for day-to-day operation of water systems but instead establish the framework within which resource users and operators function.

The central questions at the Policy Level are:

What limits must be protected, and what actions are required to protect them?

Examples include minimum flow requirements, permit conditions, endangered species protections, reservoir operating requirements, and other legal or regulatory obligations.

Agencies at this level not only define what must occur within the resource system, but also possess the authority to enforce those requirements.

Operational Level Governance

Operational-level governance occurs where organizations responsible for managing the resource coordinate with one another while balancing the needs of multiple resource users and resource-dependent interests.

Examples of resource operators include:

- Water utilities
- Power utilities
- Agricultural producers
- Reservoir operators

Examples of resource users and resource-dependent interests include:

- Water and power utilities
- Agricultural users
- Recreational users
- Ecological systems and species dependent on the resource

Examples of convening organizations include:

- Tennessee Duck River Agency (DRA)
- Drought Task Force
- Future resilience groups
- Watershed partnerships

This level of governance is particularly important because it is where stakeholders begin coordinating actions around shared challenges and shared outcomes.

At the Operational Level, participants begin asking questions such as:

- How do our actions affect one another?
- How do we coordinate drought response?
- How should risk be distributed?
- How can resilience be improved?
- What information should be shared?
- What incentives and consequences are necessary to reduce unsustainable use?

Research on coordinated collaborative partnerships in western water management found that long-term collaboration often emerged when stakeholders recognized their dependence on a shared resource and the value of coordinated action (Brown, 2021).

Collaboration is not created simply by encouraging stakeholders to work together. It emerges when stakeholders recognize that a shared challenge affects their interests, that their actions influence one another, that coordinated action offers meaningful benefits, and that collaboration is feasible relative to the costs of acting independently. In this sense, collaborative governance is not created through structure alone. It emerges when stakeholders perceive sufficient value in working together to address a shared problem.

Collaboration happens at this level when operators understand how their use impacts one another and recognize that coordinated action can improve outcomes that are difficult to achieve independently.

The central question at the Operational Level is:

What shared actions reduce our individual risk while improving the condition of the resource?

Action Level Governance

Action-level governance refers to the end users of the resource. These stakeholders are not generally responsible for establishing policy or operating the resource itself but instead receive benefits from the resource or seek to influence how it is managed.

Examples include:

- Utility customers
- Community organizations
- Conservation organizations
- Citizens

The Action Level is where actual resource demand occurs.

While utilities, agencies, and resource managers often develop a sophisticated understanding of drought conditions and resource constraints, many end users experience drought differently. Water is frequently experienced as an on-demand service rather than a shared and limited resource.

As a result, customers often respond primarily to:

- Water bills
- Property impacts
- Lawn conditions
- Garden conditions
- Irrigation needs
- Business impacts

rather than:

- Reservoir levels
- Streamflow conditions
- Habitat impacts
- Regional water shortages

Customers may perceive the costs associated with compliance differently than utilities or resource managers, particularly when restrictions threaten assets, investments, or activities that are personally important to them.

This distinction is important because customer behavior ultimately influences withdrawals and overall demand placed upon the resource.

The central question at the Action Level is:

What affects and what protects my interests?

One implication of this governance framework is that collaboration often becomes easier at the Operational Level than at the Action Level. Utilities and resource managers generally understand how their actions affect one another because they interact directly with the resource. End users, however, are often disconnected from the physical condition of the river and reservoir system and may not fully understand how their individual actions contribute to collective outcomes.

This observation becomes particularly relevant when considering drought communications and conservation behavior and is discussed in greater detail later in this attachment.

Connecting the Governance Levels

An effective drought-management system requires all three governance levels to function together.

Policy-level governance establishes the rules and constraints under which the system operates and may also provide support to lower governance levels when barriers cannot be addressed through local action alone.

Operational-level governance provides the mechanism through which stakeholders evaluate risk, coordinate actions, share information, develop resilience, and translate policy requirements into management actions.

Action-level governance ultimately determines how much water is withdrawn from the resource and whether individual behaviors align with broader watershed objectives.

Failure at any one level can undermine the effectiveness of the others. Conversely, when these levels are aligned, stakeholders are better positioned to manage scarcity, distribute risk, and maintain both water-supply reliability and environmental stewardship during periods of drought.

The workshop discussions repeatedly demonstrated that stakeholders do not lack tools, data, or expertise. Rather, the challenge is ensuring that information, responsibilities, and actions remain coordinated across all three levels of governance, both in preparation for drought and in response to drought conditions. This coordination forms the foundation for collaborative drought management and provides the basis for the governance considerations discussed in subsequent sections.

4. Building Common Understanding

In *The Danger of Self-Evident Truths*, Nobel Prize-winning economist Elinor Ostrom observed that successful collaboration depends upon development of a common understanding of the resource, the risks facing that resource, and the ways in which users affect one another (Ostrom, 2000). Research on coordinated collaborative partnerships in western water management confirmed that common understanding was one of the most significant drivers of partnership formation and long-term collaboration. Stakeholders were often able to move from competition toward cooperation only after developing a shared understanding of resource conditions, future risks, and opportunities for feasible improvement (Brown, 2021).

An important lesson emerging from the Duck River drought planning effort is that stakeholders frequently operate from the same data but draw different conclusions. During discussions of drought conditions, participants repeatedly interpreted signals differently according to their responsibilities and dependence on the resource. Low streamflow, declining reservoir elevations, reduced soil moisture, habitat impacts, customer demand, and weather forecasts each carried different implications depending on the stakeholder evaluating the information.

This distinction becomes particularly important during drought because scarcity increases risk. As risk increases, stakeholders naturally place greater emphasis on protecting the systems, resources, and responsibilities under their care. Utilities become concerned about maintaining reliable customer service. Resource agencies become concerned about aquatic habitat and species protection. Agricultural users become concerned about irrigation supplies and crop production. Community organizations become concerned about economic and social impacts. These concerns are all reasonable responses to scarcity, but they can create additional challenges when stakeholders attempt to reach agreement on drought response actions.

The planning process demonstrated that stakeholders generally agreed on the goals of drought management, including protection of water supplies, protection of aquatic resources, and reduction of drought impacts. Disagreement tended to arise not around goals, but around interpretation of conditions and subsequently timing and implementation of responses. Stakeholders often agreed that action should occur while disagreeing about what indicated action should occur, how quickly and frequently action should occur, and how associated risks should be distributed. This observation suggests that effective drought governance is not primarily limited by a lack of data, models, or technical expertise. Rather, it is often limited by differences in how stakeholders interpret information and how those interpretations influence decision-making.

Under conditions of scarcity, common understanding extends beyond recognition that drought conditions exist. Effective governance requires development of a shared understanding regarding how stakeholders can move forward while continuing to fulfill their respective responsibilities, obligations, authorities, and constraints. In this sense, common understanding is not simply agreement regarding current conditions, but also agreement regarding a path forward under those conditions.

The workshop discussions also demonstrated that common understanding does not occur automatically. It must be intentionally developed through regular communication, shared analysis, collaborative exercises, and discussion of both current conditions and future risks. In western water partnerships, feasibility studies often served this purpose by creating a common set of facts that participants could use to understand resource conditions and evaluate potential solutions. Participants may not have agreed on every issue, but they generally developed a shared understanding of how the system functioned, how actions affected the resource and one another, and that without collaboration, the system would ultimately underserve current and future needs (Brown, 2021).

This observation has important implications for future drought planning efforts in the Duck River watershed. A drought management framework that relies solely on triggers, forecasts, and response actions may identify when drought conditions exist, but it does not necessarily create a shared understanding of what those conditions mean or the consequences of responding independently versus responding collaboratively. Similarly, technical tools and models can provide increasingly accurate information regarding hydrologic conditions, but those tools alone cannot resolve differences in interpretation among stakeholders. Effective governance therefore requires ongoing processes designed to build common understanding before drought conditions become severe.

The annual preparedness and operations process discussed later in this attachment is intended to serve this function. Its purpose is not simply to review forecasts or discuss drought indicators. Rather, its purpose is to create opportunities for stakeholders to develop a shared understanding of current conditions, future risks, and potential responses before scarcity intensifies. In doing so, stakeholders build familiarity with one another's concerns, constraints, and perspectives while strengthening the relationships necessary for effective collaboration (Ostrom, 2000).

Ultimately, successful drought governance depends upon more than agreement regarding triggers or response actions. It depends upon a shared understanding of the resource system, recognition that stakeholders experience risks differently, and acceptance that drought introduces challenges that must be managed collectively. Developing and maintaining this common understanding is therefore one of the most important functions of any long-term drought governance framework.

One of the most important observations emerging from the planning process is that stakeholders frequently agreed on goals while differing in their interpretation of conditions, timing of actions, and implementation approaches. This distinction repeatedly surfaced throughout the DMP update process and helps explain why governance, communications, common understanding, and preparedness remain critical components of effective drought management.

5. Collaborative Governance Framework

The preceding sections established three key observations. First, drought introduces scarcity, and scarcity introduces risk. Second, stakeholders frequently interpret the same conditions differently because they hold different responsibilities and experience different risks. Third, development of common understanding is a prerequisite to effective collaboration. Together, these observations suggest that drought management requires more than technical triggers and response actions. It requires governance structures capable of supporting communication, collective decision-making, coordination, and collaboration across multiple levels of governance (Ostrom, 1990).

During development of the DMP, stakeholders repeatedly expressed uncertainty regarding who should communicate, who should coordinate, what actions should occur, and how decisions should be made when conditions deteriorate. While the DMP establishes operational triggers and response actions, it does not fully address how stakeholders collaborate before, during, and after drought events. This distinction is important because drought planning and drought governance are related but fundamentally different activities.

Planning defines what may occur. Governance determines how people work together when difficult decisions must be made.

If common understanding, communication, coordination, and stakeholder engagement are necessary conditions for effective drought governance, then a practical question emerges: how can those conditions be maintained over time? One concept discussed during the planning process was a framework that separates collaborative governance, drought response, and annual preparedness activities into distinct but complementary functions.

This concept generated substantial discussion during development of the 2026 DMP update and received significant interest from several members of the Drought Management Task Force. However, the scope of work required to fully evaluate, develop, and implement the concept exceeded the time available during development of the DMP. Given the time available during the update process, the concept could not be fully explored or implemented and is therefore documented here as a potential framework for future consideration.

Document 1: Collaborative Agreement

The purpose of a collaborative agreement is to establish how stakeholders work together.

Rather than focusing on drought triggers or operational actions, this document would define expectations regarding communication, participation, collaboration, and decision-making. The intent is not to eliminate disagreement. Stakeholders will naturally possess differing priorities, responsibilities, and perspectives. Instead, the purpose is to establish a framework for managing disagreement, building common understanding, and maintaining collaboration during periods of elevated risk.

One potential approach would be to organize the agreement around principles similar to those identified by Ostrom (1990) in research concerning long-enduring collaborative resource institutions. These principles include:

1. Clearly defined roles and responsibilities.
2. Rules that reflect local conditions.
3. Opportunities for collective decision-making.
4. Monitoring of both the resource and agreed-upon actions.
5. Graduated responses when commitments are not met.
6. Accessible processes for resolving conflict.
7. Recognition of the right of stakeholders to organize.
8. Acknowledgment that governance occurs through multiple nested levels rather than through a single authority.

The purpose of such an agreement would be to create the institutional and relational foundation necessary for collaboration under increasingly stressful conditions.

Document 2: Regional Drought Management Plan

The Regional Drought Management Plan serves a different function.

Rather than defining how stakeholders work together, the DMP defines:

- Drought stages.
- Triggers.
- Responsibilities in drought.
- Monitoring requirements during drought.
- Response actions.
- Demand-reduction goals.

The DMP establishes minimum expectations and operational guardrails.

Its primary purpose is to answer:

What happens when drought conditions occur?

Under this framework, the DMP remains relatively stable over time. Modifications occur through periodic review and formal updates, but the document itself serves as a consistent regional reference point.

Document 3: Annual Preparedness and Operations Process

The third component is an Annual Preparedness and Operations Process.

The primary purpose of the Annual Preparedness and Operations Process is to maintain a common operational understanding of current conditions and emerging risks before drought conditions require coordinated action. Rather than waiting until scarcity creates conflict, the process provides stakeholders with a recurring opportunity to interpret information together, discuss risk, evaluate preparedness, and identify opportunities for coordination before conditions become severe.

This process is fundamentally different from revising the DMP. Its purpose is not to change triggers or rewrite drought stages. Instead, it provides a structured opportunity for stakeholders to evaluate conditions, discuss future risks, and develop a common understanding of emerging issues before drought conditions arise or increase in severity.

Potential topics reviewed annually may include:

- Seasonal climate outlooks.
- Reservoir forecasts.
- Streamflow projections.
- Drought probability assessments.
- Utility demand projections.
- Planned withdrawals and discharges.
- Habitat concerns.
- Planned communications activities.
- Lessons learned from previous years.

The outcome of this process would be an annual summary describing current conditions, anticipated risks, preparedness activities, and any recommended operational considerations.

More importantly, the process itself serves a governance function. Regular interaction allows stakeholders to improve understanding of organizational responsibilities, strengthen communication pathways, evaluate emerging risks, and develop familiarity with one another's operational concerns. Research on collaborative partnerships suggests that recurring interaction and prior experience working together are important contributors to developing and maintaining long-term collaboration (Brown, 2021).

Why Ongoing Collaboration Matters

One lesson emerging from both collaborative governance research and the DMP update process is that collaboration becomes more difficult during periods of scarcity. As risk increases, stakeholders become increasingly focused on protecting the systems, resources, and responsibilities under their care. The planning process demonstrated that stakeholders often agreed on desired outcomes while differing on implementation approaches, timing of actions, and distribution of risk. These differences become increasingly important as scarcity intensifies.

Collaborative governance research suggests that long-term partnerships are most effective when relationships, communication pathways, and common understanding are established before severe resource constraints emerge (Brown, 2021; Ostrom, 2000). Waiting until drought conditions become severe before initiating collaborative discussions increases the likelihood of conflict, misunderstanding, and ineffective coordination.

A recurring preparedness and operations process provides an opportunity to build those foundations proactively rather than reactively. The process also creates a mechanism for continuously improving understanding of the resource system and identifying opportunities to increase resilience before scarcity occurs. Because resilience reduces the amount of risk that must be managed and distributed during drought, investments in resilience may also improve the ability of stakeholders to pursue collaborative solutions during periods of stress.

The concepts outlined above are provided for future consideration. Their inclusion here is not intended to prescribe a specific governance structure, but rather to document one potential framework for sustaining collaboration, preparedness, and adaptive learning over time.

6. Utility Drought Preparedness and Implementation Capacity

Utility Public Health Responsibilities

Water utilities were originally established to provide reliable access to safe drinking water and to protect public health. As communities grew during the nineteenth and twentieth centuries, advances in water treatment, filtration, and disinfection dramatically reduced the spread of waterborne disease and established many of the public-health protections now considered fundamental to modern society (U.S. Environmental Protection Agency, 2000).

This historical context is important because utilities continue to carry a primary responsibility for maintaining reliable delivery of safe drinking water while complying with regulatory requirements, maintaining infrastructure, planning for future demands, and preparing for drought and other emergencies. As a result, utility decision-making during drought often reflects a balancing of multiple responsibilities, including public health, regulatory compliance, system reliability, environmental stewardship, affordability, and long-term resilience.

Understanding these responsibilities provides important context for discussions regarding drought management and water conservation. Utilities are not simply managing water demand during drought; they are managing critical infrastructure systems that communities depend upon for public health, economic activity, fire protection, and everyday use.

Utility Preparedness, Response, and Implementation Capacity

One of the recurring themes identified throughout development of the Regional Drought Management Plan was the distinction between possessing a drought management plan and possessing the capacity to implement that plan effectively.

The DMP establishes regional drought stages, triggers, coordination mechanisms, and broad expectations for drought response. In short, the DMP provides a framework for coordinated action at the Operational Level of governance while facilitating coordination with stakeholders operating at the Policy and Action levels. However, as discussed previously, effective resource management occurs across all levels of governance.

Utilities remain responsible for implementing customer-facing actions at the Action Level of governance, including conservation programs, communications strategies, enforcement measures, operational modifications, emergency response procedures, and long-term drought preparedness within their individual service areas. As a result, effective drought response ultimately depends not only on the quality of the regional plan and coordination between Policy and Operational levels of governance, but also on the quality and practicality of utility-specific implementation plans and the effectiveness of coordination between Operational and Action levels of governance.

During development of this DMP, stakeholders noted that Tennessee already provides guidance for development of community water system drought management plans. However, developing and maintaining an effective drought management plan can be a significant undertaking, particularly for smaller utilities with limited planning, engineering, administrative, or financial resources. The challenge is often not the absence of guidance, but rather translating that guidance into an actionable plan that utility personnel can realistically implement during both normal operations and drought conditions.

Understanding what should be done during drought is fundamentally different from possessing the personnel, resources, authority, funding, and organizational capacity needed to carry out those actions. Effective drought preparedness therefore requires attention not only to planning, but also to implementation capacity.

This distinction mirrors observations discussed earlier in this attachment. Policy-level governance may establish expectations and constraints, and regional planning efforts may define coordinated actions, but implementation ultimately occurs through the organizations responsible for operating water systems and interacting directly with end users. As a result, the effectiveness of any regional drought-management strategy is strongly influenced by the implementation capacity of individual utilities.

An additional observation arising from the planning process was the relationship between the DMP and utility-specific drought management plans. The DMP frequently relies upon utility drought plans to implement customer-facing drought actions, while some utility plans may reference the DMP for drought-stage declarations and regional coordination. While this relationship is appropriate and expected, it highlights the importance of ensuring that utility-specific plans contain sufficient operational detail regarding implementation, communications, conservation measures, emergency supplies, enforcement procedures, and customer engagement.

Future planning efforts may therefore benefit from a structured utility drought preparedness and implementation program designed to help utilities move beyond compliance and toward operational readiness.

One potential model is a utility drought planning cohort. Under such an approach, utilities would participate in a facilitated planning process designed to help them develop, evaluate, update, and implement utility-specific drought management plans. Rather than asking utilities to independently navigate planning requirements, participants could work through the process together while receiving access to templates, examples, planning tools, worksheets, peer-learning opportunities, and technical assistance.

Potential components of such a program could include:

- Model drought management plan templates.
- Worksheets and planning tools.
- Communications templates.
- Demand reduction planning tools.
- Emergency supply evaluation tools.
- Interconnection evaluation checklists.
- Utility-to-utility learning opportunities.
- Facilitated workshops and technical assistance.

A cohort approach may also provide an opportunity for utilities to identify implementation gaps and future needs. For example, utilities could evaluate questions such as:

- Do we have an effective communications strategy?
- Do we have adequate emergency supplies?
- Are interconnections available?
- Have we evaluated drought-specific rate structures?
- Do we have the staffing and resources required to implement drought restrictions?
- How would we communicate conservation expectations to customers?
- What improvements should be prioritized over the next five years?

These discussions would not only assist utilities in developing drought plans but would also generate valuable information regarding common barriers to implementation across the watershed.

The planning process also highlighted that implementation barriers are not always technical in nature. Utilities may recognize the need for additional staffing, infrastructure investment, water-loss reduction programs, monitoring improvements, or resilience initiatives but lack direct authority to approve the budgets, rates, or capital expenditures necessary to pursue those efforts. Future planning efforts may therefore benefit from evaluating the relationship between utility governance structures, financial decision-making, and long-term drought resilience. Effective implementation depends not only on identifying appropriate actions, but also on ensuring that utilities possess the institutional capacity needed to pursue them.

Importantly, the purpose of such a cohort would not be to replace Tennessee's drought planning guidance. Rather, it would serve as a mechanism for translating guidance into implementation. Similar approaches have proven successful in other areas of the water industry where improvement programs rely on repeated engagement, peer learning, facilitated implementation, and continuous improvement rather than one-time planning efforts.

Potential partners for development and delivery of such a program could include:

- Tennessee Department of Environment and Conservation (TDEC)
- Fleming Training Center
- Tennessee Association of Utility Districts (TAUD)
- Duck River Agency
- Kentucky-Tennessee American Water Works Association (KY-TN AWWA)
- Utility subject matter experts
- Planning and engineering consultants

A long-term benefit of this approach is that it creates a repeatable implementation framework that can be refined and replicated. Once developed and tested, the framework could potentially be applied in other Tennessee watersheds, providing a practical mechanism for improving drought preparedness and implementation capacity statewide.

Ultimately, effective drought management depends not only on identifying drought conditions, but also on an organization's ability to respond when those conditions occur and effectively coordinate actions across agencies and governance levels. Building implementation capacity therefore represents an important component of long-term drought resilience and may warrant future consideration by utilities, watershed organizations, and state agencies.

7. Behavioral and Collective Action Considerations

Observation

Recent drought conditions in the Colorado River Basin provide useful examples of behavioral and conservation challenges that may be relevant to future drought planning discussions. Utilities throughout the region generally maintain mature conservation programs, advanced metering systems, customer outreach programs, and extensive conservation experience. Nevertheless, some utilities continued to struggle to achieve desired conservation targets during severe drought conditions.

Denver Water requested approximately 20 percent reductions in customer water use and reportedly achieved reductions substantially below that target. Similarly, Castle Rock escalated from voluntary conservation measures to stronger drought restrictions after customer demand continued to exceed conservation objectives established within its drought management framework. In public reporting, some residents cited concerns regarding landscaping investments and property appearance as factors influencing their willingness to reduce outdoor water use.

One possible explanation for these outcomes involves visibility of source-water conditions. Many customers served by Colorado utilities are physically separated from the reservoirs, watersheds, and groundwater systems that provide their water supply. As a result, drought may be experienced primarily through utility communications, restrictions, and rate structures rather than through direct observation of declining resource conditions.

The experience of the Duck River Utility Commission (DRUC) during the 2007-2008 drought may provide a useful point of comparison. During that drought, DRUC reportedly experienced approximately 20 percent reductions in customer demand. One possible explanation is that many customers were located in close proximity to Normandy Reservoir and could directly observe declining reservoir levels and diminished recreational opportunities. In that case, the impacts of drought were not only communicated; they were visible.

While additional research would be necessary to determine whether source-water visibility significantly influences conservation participation, the comparison raises an important question: does direct observation of resource conditions affect how customers perceive drought risk and the urgency of conservation actions?

These examples do not necessarily predict outcomes within the Duck River watershed; however, they suggest that awareness of drought conditions alone may not be sufficient to produce desired conservation outcomes. They also illustrate that while drought triggers can identify when action should occur, they do not guarantee that users will respond as intended. As a result, drought management ultimately becomes a behavioral challenge as much as a technical one. Drought response depends not only on the availability of water, but also on how stakeholders and customers perceive risk, interpret information, and modify behavior under conditions of scarcity.

Customers and other end users may experience drought differently, particularly when they are physically separated from the source water on which they depend. For example, customers located near a reservoir may directly observe declining water levels, reduced recreational opportunities, and other visible indicators of drought. These observations create both a real and perceived cost associated with inaction.

In contrast, users who do not directly observe source-water conditions may experience drought primarily through utility restrictions, increased costs, landscaping impacts, or communications from their utility. Consequently, they may evaluate drought differently than water managers and resource agencies responsible for maintaining long-term system reliability.

Rather than observing reservoir conditions, streamflow reductions, or habitat impacts, customers may instead observe:

- Lawn conditions.
- Landscape stress.
- Agricultural production impacts.
- Water bills.
- Property values.
- Business impacts.
- Recreational impacts.

As a result, customers may respond primarily to impacts affecting their immediate interests rather than broader watershed conditions. This difference in perspective creates a challenge for drought management because customer behavior ultimately determines a significant portion of total demand placed on the resource.

Potential Factors Affecting Conservation Behavior

Demand Hardening

Literature from the American Water Works Association (AWWA) discusses the concept of demand hardening, which occurs when water-conservation and efficiency programs successfully reduce discretionary water use over time.

As systems become more efficient and customers adopt efficient fixtures, landscaping practices, and conservation measures, the remaining water use becomes increasingly tied to essential activities rather than discretionary uses. When water use is already reduced to essential or near-essential activities, achieving additional reductions during drought may become progressively more difficult because fewer discretionary uses remain available for reduction.

Demand hardening provides another possible explanation for differing conservation outcomes among utilities. Communities that have invested heavily in conservation for decades may simply have less discretionary demand remaining than communities where efficiency gains have not yet been fully realized.

Future planning efforts may benefit from evaluating how much additional water conservation is realistically achievable in communities that have already implemented substantial conservation programs.

Visibility of Resource Conditions

As discussed above, another potential factor is visibility of drought impacts.

Individuals are generally more responsive to conditions they can directly observe than those they cannot. Reservoir drawdown, visible reductions in streamflow, exposed shorelines, recreational impacts, impacts to species, and agricultural impacts may influence behavior differently than reports, forecasts, or drought declarations.

This observation may be particularly relevant within the Duck River watershed because not all users experience drought conditions in the same way. Some users may have direct visibility into source-water conditions, while others experience the resource primarily through utility services and communications.

Future research may help determine whether increasing visibility of source-water conditions influences conservation participation and, if so, how source-water visibility can be increased for users who are physically disconnected from the resource.

Collective Action Challenges

Drought also introduces collective-action challenges at the Action Level.

When water becomes scarce, customers may face a conflict between protecting individual interests and contributing to broader conservation objectives. Examples may include:

- Protecting landscaping investments.
- Maintaining recreational opportunities.
- Maintaining agricultural productivity.
- Protecting business operations.
- Preserving quality of life.

Under these circumstances, individuals may prioritize protection of assets under their direct control while assuming that broader system management is the responsibility of others.

This behavior should not necessarily be viewed as irrational. Rather, it reflects differences in perceived risk, responsibility, and priorities. Customers often respond to the costs they perceive most directly and immediately. When the cost of conservation is perceived to exceed the cost of continued use, participation in collective conservation efforts may become more difficult to achieve.

However, when many individual users behave in this manner simultaneously, collective conservation goals become more difficult to achieve.

While collective action may be challenging to achieve among individual customers, opportunities may exist to engage larger water users such as industrial customers, commercial complexes, municipal users, agricultural users, and homeowner associations in coordinated conservation initiatives.

Shared Understanding and Collective Stewardship

The planning process repeatedly highlighted the importance of understanding how individual actions affect the larger resource system.

Research on collaborative governance found that successful partnerships often emerged when participants understood their dependence on a shared resource, recognized the benefits of coordinated action, and appreciated the consequences of inaction (Brown, 2021). While these findings were developed in organizational settings, similar concepts may have relevance at the Action Level of Governance.

End users may be more likely to participate in conservation efforts when they understand how individual actions influence overall system performance and how the actions of others affect conditions they care about.

Future Research Opportunities

The observations discussed above suggest opportunities for future research focused on conservation participation during and in preparation for drought.

Potential questions include:

- How much additional water conservation is realistically achievable in highly efficient communities?
- How does visibility of source-water conditions influence customer behavior?
- What role do perceptions of fairness play in water-conservation participation?
- What communication strategies produce measurable behavioral change?
- How do customers balance individual interests against system-wide conservation goals?
- How can collective-action principles be applied to drought response?

Potential partners could include:

- American Water Works Association (AWWA).
- Water Research Foundation (WRF).
- Universities.
- Behavioral scientists.
- Communications specialists.
- Watershed organizations.

The objective of such research would not simply be to improve water-conservation messaging. Rather, the goal would be to better understand how customers experience drought conditions, how they interpret risk, and how governance systems can encourage movement from individual preservation toward collective stewardship of shared resources.

Key Observation

One lesson emerging from both the workshop and external case studies is that drought management is not solely a question of identifying when a drought exists. Triggers and forecasts help identify conditions, but successful drought management ultimately depends upon how people respond to those conditions.

The challenge is not simply developing better drought triggers. The challenge is developing systems that help users recognize shared risk, understand their role within the larger resource system, and participate in collective action when scarcity occurs. In this way, drought becomes not only a test of infrastructure and water supplies, but also a test of governance, communication, and collective action.

8. Communications Considerations

Communication emerged as one of the most consistently discussed themes throughout the drought planning process. While stakeholders generally agreed on the importance of drought communication, significantly less agreement existed regarding who should communicate, what information should be communicated, and how communication should occur across the various levels of governance.

One observation from the planning process is that communication serves different purposes depending on the level of governance involved. At the Policy Level, communication is primarily intended to establish expectations, explain regulatory requirements, provide information regarding drought conditions and resource protection, and assess regulatory compliance. At the Operational Level, communication supports coordination, information sharing, interpretation of system conditions, and collaborative decision-making among resource operators. At the Action Level, communication is intended to influence behavior, encourage participation, explain restrictions, and help users understand how their decisions affect both the resource and other users of the resource.

The planning process revealed an important distinction between technical communication and behavioral communication. Utilities, resource agencies, and technical professionals often communicate using streamflow measurements, reservoir levels, precipitation forecasts, withdrawal data, and resource-modeling outputs. While such information is necessary for planning and decision-making, it is not always meaningful to the general public. Customers tend to be more concerned with how drought affects issues directly relevant to their lives, including water availability, restrictions, utility bills, landscaping, recreation, agricultural production, and economic activity. Consequently, a technically accurate message may not necessarily be an effective message.

This distinction is reflected in AWWA drought communications guidance. Rather than focusing exclusively on dissemination of technical information, AWWA emphasizes understanding audiences, tailoring communications to specific groups, utilizing trusted messengers, building partnerships, avoiding drought fatigue, and focusing on desired outcomes rather than awareness alone. Effective drought communication therefore requires more than providing information; it requires translating information into meaningful and actionable messages for the intended audience.

The drought exercise also highlighted the importance of communication pathways between stakeholder groups. Utilities are generally responsible for communicating directly with customers and implementing drought restrictions. Regulatory agencies communicate requirements and expectations to utilities. Federal and state resource agencies communicate information regarding habitat, water quality, and environmental conditions. Conservation organizations and community groups frequently possess communication channels and community relationships that may not be available to utilities or regulators. These organizations may therefore play an important role in amplifying conservation messages, building public awareness, and translating technical information into terms that resonate with customers.

The planning process and review of external case studies also suggest that communication may be influenced by how directly users experience resource conditions. Customers located near reservoirs, recreational resources, or visibly stressed river systems may perceive drought differently than customers who experience drought primarily through utility communications, restrictions, and billing information. Future communications strategies may therefore benefit from considering not only what information is communicated, but also how users experience and visualize the condition of the resource itself.

Future planning efforts may benefit from establishing a communications framework that clearly identifies:

- Who communicates with whom.
- What information is communicated.

- When communications should occur.
- How technical information should be translated.
- Which groups are best positioned to deliver particular messages.
- How communication flows vertically between governance levels.
- How communication flows horizontally among participating organizations.

Such a framework could be developed as part of future preparedness planning efforts and incorporated into annual preparedness activities. Developing communication expectations before drought occurs may help reduce confusion, improve consistency, and strengthen stakeholder coordination when conditions deteriorate.

An additional opportunity identified during the planning process is the development of coordinated water-conservation messaging. While utilities remain responsible for implementing customer-facing programs and restrictions, conservation organizations, educational institutions, community groups, and other stakeholder organizations with influence at the Action Level may be able to assist with outreach and public engagement efforts. Future planning efforts may therefore benefit from identifying opportunities to leverage existing communication networks and trusted community relationships in support of drought preparedness, water conservation, and habitat stewardship objectives.

Finally, communications should not be viewed solely as a drought-response function. Ongoing communication between drought events provides opportunities to:

- Increase awareness of watershed conditions.
- Build public familiarity with communication channels and information sources.
- Explain how the resource system functions.
- Strengthen relationships among stakeholders.
- Reduce future conflict during shortages.
- Build support for resilience initiatives.
- Improve preparedness before drought conditions occur.

In this sense, communication serves a dual purpose. It provides a mechanism for managing drought when conditions deteriorate, but it also provides a mechanism for building preparedness and resilience before drought occurs. Effective communication therefore represents both a drought-response tool and a long-term resilience strategy.

9. Resilience and Risk Distribution

One of the recurring themes identified throughout the drought planning process was the relationship between resilience and risk. While drought management plans frequently focus on triggers, restrictions, and response actions, stakeholders repeatedly discussed ways to reduce future drought vulnerability through investments in infrastructure, system efficiency, coordination, communication, and preparedness.

At a fundamental level, resilience and risk are directly related. As resilience increases, overall system risk decreases and the amount of risk borne by individual stakeholders is reduced. Conversely, when resilience is limited, risk to both the resource system and individual users increases. Under these conditions, drought forces stakeholders to make increasingly difficult tradeoffs regarding resource allocation, environmental protection, customer needs, and economic activity. Governance becomes more difficult because stakeholders are asked to absorb greater levels of risk in order to protect the larger system and ensure its long-term sustainability.

The Duck River watershed currently possesses a variety of strengths, including diverse stakeholder participation, ongoing collaboration, conservation initiatives, and substantial technical expertise. At the same time, workshop discussions identified several areas where additional resilience may reduce future drought vulnerability, including:

- Water-use efficiency improvements.
- Water-loss reduction initiatives.
- Utility interconnections.
- Emergency supply options.
- Additional storage opportunities.
- Improved monitoring networks.
- Water reuse opportunities.
- Enhanced communications and preparedness planning.

Many of these opportunities were discussed as long-term initiatives because they require additional study, funding, regulatory review, infrastructure investment, and stakeholder collaboration before implementation. Nevertheless, participants repeatedly identified them as important tools for reducing future drought risk.

Resilience as Capacity Creation

An important observation emerging from the planning process is that resilience should not be viewed solely as protection against drought. Many resilience investments create additional capacity within the broader water-management system.

For example:

- Water-loss reduction reduces unnecessary withdrawals.
- Water-conservation programs reduce baseline demand.
- Infrastructure improvements increase operational flexibility.

- Interconnections provide redundancy.
- Monitoring improvements improve situational awareness.
- Water reuse reduces system demand and increases redundancy.

Collectively, these efforts create capacity that can help utilities, agencies, and communities respond more effectively during future drought conditions.

The value of these initiatives is often not limited to efficiency gains alone. Rather, resilience investments create capacity that can subsequently be deployed to improve reliability, drought preparedness, environmental stewardship, operational flexibility, and long-term planning efforts.

Conservation, Resilience, and Growth

Investments in water conservation and efficiency often create additional capacity within a water system. However, creation of capacity does not automatically result in long-term resilience. Newly created capacity may be preserved to reduce drought vulnerability, used to improve system reliability, or allocated to support future growth and development.

Historically, many communities have used conservation gains, infrastructure improvements, and operational efficiencies to support additional growth and development. While growth is an important and legitimate objective, stakeholders noted that resilience gains also provide opportunities to improve drought preparedness, maintain reserve capacity, and reduce future resource risks.

This raises an important planning consideration:

How should newly created capacity be used?

Future planning efforts may therefore benefit from evaluating not only how resilience is created, but also how resilience is maintained over time. If newly created capacity is fully reallocated to support additional demand, the long-term resilience benefits of conservation and efficiency investments may be diminished.

A related question emerged repeatedly throughout the planning process:

How much of the capacity created through resilience efforts should be dedicated to growth, and how much should be retained to improve long-term reliability and drought preparedness?

The purpose of raising this question is not to advocate for a particular policy outcome. Rather, it is to recognize that resilience investments often create benefits that extend beyond drought management itself and that future planning efforts may benefit from explicitly considering how those benefits are allocated over time.

Cost, Capacity, and Resilience

An important observation emerging from the planning process is that resilience is not created or maintained without investment.

Increasing resilience generally requires investments in infrastructure, operations, planning, monitoring, communications, water-conservation programs, staffing, or governance capacity. These investments can reduce future risk, increase operational flexibility, and improve system performance during drought conditions. At the same time, they require financial resources, organizational capacity, and long-term commitment to implementation.

Future planning efforts may therefore benefit from explicitly evaluating the relationship between risk, resilience, and cost. Drought is often discussed in terms of hydrology and environmental conditions; however, scarcity also exposes financial, operational, and institutional vulnerabilities.

As agencies tasked with protecting public health, utilities must continue providing safe and reliable drinking water and sanitation services as their primary responsibility. State and federal agencies must continue fulfilling regulatory obligations. Stakeholders must maintain the organizational capacity necessary to participate in planning, coordination, and response activities regardless of hydrologic conditions.

The Planning Partnership and DMP development process identified numerous opportunities to increase resilience, including water-loss reduction, infrastructure improvements, monitoring systems, utility interconnections, storage alternatives, water reuse, communications initiatives, and conservation programs. Each has the potential to reduce future drought risk. Each also requires investment.

Future resilience planning may therefore benefit from considering a broader question:

What level of investment is appropriate to reduce future drought risk, and how should those investments be prioritized?

The purpose of this question is not to advocate for any specific project or funding mechanism. Rather, it is to recognize that resilience planning inevitably involves balancing present costs against future reductions in risk.

Utility Financial and Institutional Capacity

The planning process also highlighted that resilience challenges are not solely technical in nature.

Utilities are often expected to maintain infrastructure, improve efficiency, reduce water loss, implement drought-response measures, support water-conservation initiatives, and improve system resilience. While these objectives may be broadly supported, implementation frequently depends on financial decisions made through governing boards, elected officials, or other oversight bodies.

As a result, utilities may identify operational needs and resilience opportunities while lacking direct authority to approve the rates, budgets, staffing levels, or capital expenditures necessary to pursue those improvements. This can create a disconnect between identification of risk and the ability to address that risk.

This observation mirrors challenges discussed elsewhere in this attachment, where authority, responsibility, and implementation capacity are not always aligned across governance levels.

Future planning efforts may therefore benefit from evaluating whether existing governance, financial, and institutional structures adequately support long-term resilience objectives. Potential areas for consideration include:

- Utility financial planning.
- Asset management programs.
- Rate-setting practices.
- Resilience funding mechanisms.
- Long-term infrastructure investment strategies.
- Roles and responsibilities of governing bodies overseeing water systems.

The purpose of this observation is not to advocate for any specific governance or funding approach. Rather, it is to recognize that successful resilience planning depends not only on identifying technical solutions, but also on maintaining the institutional, organizational, and financial capacity necessary to implement them.

Utility Revenue, Conservation, and Long-Term Resilience

An important consideration identified during the planning process is the relationship between conservation objectives and utility financial sustainability.

Water utilities are often encouraged to reduce demand through conservation programs, improve efficiency, reduce water loss, and increase drought resilience. These objectives are generally aligned with long-term resource stewardship and can reduce future drought risk. However, many utilities rely primarily on water sales to generate the revenue necessary to operate and maintain critical infrastructure, employ qualified staff, comply with regulatory requirements, and fund future capital improvements as well as ongoing infrastructure operations and maintenance.

As conservation programs become more successful, utilities may experience reduced water sales and reduced revenues. While reduced consumption is often desirable from a resource-management perspective, it can create financial challenges when utility rate structures remain heavily dependent upon volumetric water sales.

This relationship creates an important planning consideration. Resilience efforts often require additional investment in infrastructure, staffing, planning, monitoring, communications, and system improvements while simultaneously encouraging conservation measures that may reduce a utility's traditional source of revenue used to fund those same resilience investments.

Future planning efforts may therefore benefit from evaluating approaches that support utility financial sustainability along with long-term resilience objectives. Potential areas of consideration include:

- Rate structures that support both conservation and financial sustainability.
- Revenue-stabilization mechanisms.
- System development fees and growth-related cost recovery.
- Infrastructure funding strategies.
- Asset-management programs.
- Policies that ensure growth pays for growth.
- Financial frameworks that support drought preparedness and resilience investments.

The purpose of this observation is not to advocate for a particular rate structure or funding approach. Rather, it is to recognize that successful conservation, resilience, and drought preparedness efforts depend upon financially sustainable utility systems capable of maintaining critical infrastructure and implementing long-term resilience initiatives.

In this sense, conservation planning, financial planning, capital planning, and resilience planning should not be viewed as separate activities, but rather as interdependent components of long-term utility sustainability.

Balancing Adaptability and Stability

Another consideration identified during the planning process is the need to balance adaptability with stability.

Resilience requires governance structures that can adapt to changing conditions, incorporate new information, and continuously improve planning processes. At the same time, excessive complexity, excessive meeting requirements, or highly burdensome planning obligations may discourage participation and reduce long-term stakeholder engagement.

As future resilience initiatives are developed, stakeholders may wish to consider implementation approaches that:

- Leverage existing organizations and partnerships.
- Build on existing programs.
- Utilize repeatable templates and processes.
- Reduce administrative burden where possible.
- Create clear and achievable pathways for participation.

This consideration is particularly important because long-term collaboration ultimately depends upon continued stakeholder willingness to participate. A resilience framework that is technically robust but administratively burdensome may struggle to achieve sustained participation over time.

Building Resilience Before Drought Occurs

A final observation from the planning process is that resilience is most valuable before drought conditions emerge.

Once drought begins, stakeholders focus increasingly on distributing risk, protecting critical resources, and minimizing impacts. While those activities are necessary, they are inherently reactive. Resilience efforts, by contrast, provide opportunities to reduce risk before scarcity occurs.

In this sense, drought serves as a test of the resilience that has already been built. Drought management is the ability to sustain the health of the resource and the communities, economies, and ecosystems that depend upon it during periods of scarcity.

Drought does not create resilience; it reveals whether resilience has already been built.

The effectiveness of future drought response efforts will depend in large part on the investments, relationships, preparedness activities, governance structures, communications networks, and implementation capacity developed before drought conditions are encountered.

For this reason, drought planning should not be viewed as a stand-alone activity. Rather, drought planning, resilience planning, conservation planning, infrastructure planning, communications planning, and preparedness planning should be viewed as interconnected activities that collectively support long-term stewardship of the watershed. This interdependence may represent one of the most important observations emerging from the Planning Partnership and provides a useful framework for future watershed planning efforts.

10. Summary of Key Observations and Future Considerations

The 2026 Drought Management Plan update demonstrated that the Duck River watershed does not lack drought-management tools, technical expertise, or stakeholder commitment. Rather, the planning process revealed opportunities to improve how information is interpreted, how risk is distributed, how stakeholders coordinate actions, and how resilience is developed over time.

The workshop discussions repeatedly demonstrated that stakeholders often agreed on desired outcomes while differing on implementation approaches. As a result, one of the primary lessons emerging from the DMP planning process is that the challenge is not simply identifying drought conditions, but developing the governance structures, implementation capacity, communications pathways, and preparedness processes necessary to respond effectively when those conditions occur.

The DMP planning process further demonstrated that drought response and drought resilience are related but distinct activities. Drought response focuses on actions taken during periods of scarcity, while resilience focuses on reducing vulnerability before scarcity occurs. Both are necessary; however, resilience planning often requires longer time horizons, greater coordination, broader participation, and additional investment than can reasonably be incorporated into an operational drought management plan.

Key observations emerging from the DMP planning process include:

Understanding the Resource

Effective governance depends upon understanding the resource being governed. Future discussions may benefit from continued efforts to improve understanding of the watershed's hydrologic, hydrogeologic, ecological, operational, and institutional characteristics.

Governance Occurs at Multiple Levels

Management of the Duck River already occurs through interconnected Policy, Operational, and Action levels of governance. Improving coordination among these levels may be as important as improving technical drought-management tools themselves.

Common Understanding Supports Collaboration

Stakeholders frequently interpreted the same information differently because they experienced different risks and held different responsibilities. The planning process demonstrated that common understanding is not automatic and may require ongoing communication, shared analysis, preparedness activities, and collaborative discussion.

Preparedness Extends Beyond Planning

Possessing a drought management plan does not necessarily imply an ability to implement that plan effectively. Utilities may benefit from continued efforts focused on implementation capacity, preparedness, training, technical assistance, and operational readiness.

Human Behavior Influences Drought Outcomes

The planning process and external case studies suggest that drought management is not solely a technical challenge. Customer behavior, perceptions of risk, communication approaches, and collective-action challenges all influence conservation outcomes and drought-response effectiveness.

Communication Is a Governance Function

Communication supports more than public outreach. It also helps stakeholders coordinate actions, establish expectations, share information, interpret conditions, and maintain relationships before drought conditions become severe.

Resilience Reduces Future Risk

Stakeholders identified numerous opportunities to reduce future drought vulnerability through investments in infrastructure, efficiency, planning, monitoring, communications, preparedness, and organizational capacity. Resilience planning may therefore provide opportunities to reduce risk before scarcity occurs rather than solely responding to impacts after they emerge.

Resilience Requires Capacity

The planning process also highlighted that resilience is not created without investment. Financial resources, institutional structures, governance arrangements, staffing, and organizational capacity all influence the ability of utilities, agencies, and stakeholders to implement resilience initiatives and sustain them over time.

Financial Sustainability Supports Resilience

Long-term drought resilience depends not only on technical solutions, but also on the financial and institutional capacity needed to implement them. Utilities must balance conservation objectives, infrastructure needs, regulatory responsibilities, and public-health obligations while maintaining the revenue necessary to operate and sustain critical systems.

From Information to Coordinated Action

The planning process suggests that successful drought management depends less on identifying increasingly precise triggers and more on developing governance structures capable of translating information into coordinated action. While technical improvements remain important, long-term success will ultimately depend on common understanding, implementation capacity, communications, preparedness, and resilience.

Final Observation

The planning process ultimately revealed that planning concerning drought, resilience, conservation, infrastructure (Capital Improvement Projects and Operations and Maintenance), communications, and preparedness are not separate activities. Rather, they are interconnected components of long-term watershed stewardship.

Many of the concepts discussed in this attachment require additional discussion, research, coordination, confirmation and evaluation before implementation. However, preserving these observations provides a record of lessons learned during development of the 2026 Drought Management Plan update and may help inform future discussions regarding drought preparedness, watershed governance, resilience, and long-term stewardship of the Duck River watershed.

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