

Drought Management Planning: A Guide for Water Providers

June 2020

The CWCB developed this document as a means to assist water providers with local drought planning. The effort aims to recommend drought mitigation and response planning steps in developing local plans through a framework that is useful to statewide water providers that vary by geography, size, water supply sources, and financial and staff capacity resources.

This is an update to the original document developed in 2010. Primary enhancements of the 2020 update include the refinement of planning steps based on lessons learned from both planning efforts and droughts since 2010, the addition of recent case studies, and improved usability. The guidance reflects current planning practices and resources and includes on integration of drought plans with other planning efforts to build community resiliency.

Users may find that some information is not applicable to their water supply system or they lack sufficient data to address all of the recommended steps. The document is intended to be used to the extent that it is beneficial to individual providers. This guide is not intended for the planning of catastrophic supply interruptions.

Prepared by: Wood Environment & Infrastructure Solutions, Inc. and INTERA



TABLE OF CONTENTS

Key Terminology.....	2
Section 1 Introduction.....	4
1.1 THE CREEPING PHENOMENA: DROUGHT, CLIMATE, AND THE ARID WEST	4
1.2 DROUGHT IMPACTS.....	4
1.3 DROUGHT MANAGEMENT PLANNING	5
1.4 RELATED PLANNING EFFORTS AND INTEGRATION	6
1.5 DOCUMENT ORGANIZATION	7
Section 2 Drought Management Planning Steps.....	8
2.1 STEP 1: PLANNING PROCESS, PLAN OBJECTIVES AND OPERATING PRINCIPLES.....	9
2.1.1 Drought Planning Committee	9
2.1.2 Goals, Objectives and Operating Principles.....	11
2.2 STEP 2: DROUGHT VULNERABILITY ASSESSMENT	12
2.2.1 Historical Drought Assessment.....	12
2.2.2 Identifying and assessing future vulnerabilities.....	15
2.3 STEP 3: DROUGHT MONITORING	16
2.4 STEP 4: DROUGHT STAGES, TRIGGERS, AND RESPONSE TARGETS.....	18
2.4.1 Drought Stages	19
2.4.2 Trigger Points.....	20
2.4.3. Response Targets	22
2.4.4. Summary of Considerations	22
2.5 STEP 5: DROUGHT MITIGATION AND RESPONSE STRATEGIES	23
2.5.1 Overview of Mitigation and Response Strategies.....	23
2.5.2 Supply-Side Mitigation and Response Strategies.....	25
2.5.3 Demand-Side Mitigation and Response Strategies.....	26
2.5.4 Coordination with Other Entities.....	28
2.5.5 Selection of Mitigation and Drought Response Strategies	28
2.5.6 Mitigation Action Plan	30
2.5.7 Public Drought Education Campaign Framework.....	31
2.6 STEP 6: STAGED DROUGHT RESPONSE PROGRAM	32
2.6.1 Summary of Staged Drought Response Program Considerations.....	33
2.6.2 Public Drought Campaign Plan	34
2.7 STEP 7: DROUGHT RESPONSE OPERATIONAL AND ADMINISTRATIVE FRAMEWORK	36
2.7.1 Drought Declaration Process	37
2.7.2 Implementation of the Staged Drought Response Program.....	37
2.7.3 Enforcement of the Staged Drought Response Program.....	38

2.7.4 Revenue Implications and a Financial Budgeting Plan	39
2.7.5 Monitoring Drought Response	40
2.8 STEP 8: PLAN APPROVAL AND ADOPTION	41
2.8.1 Public Review Process	41
2.8.2 Plan Adoption or Promulgation	42
2.8.3 Periodic Review and Update.....	42
Section 3 Drought Plan Template.....	42
3.1 ORGANIZATIONAL TIPS FOR DROUGHT MANAGEMENT PLANS.....	42
3.2 HOW TO USE THE TEMPLATE	43
3.3 TEMPLATE FOR A DROUGHT MANAGEMENT PLAN	44
Section 4 Drought Planning Case Studies and Examples	53
References.....	77
Appendix A Worksheets	78

Key Terminology

The following are key terms used throughout the document defined in the context of water shortage planning.

Aridity – The degree to which a climate lacks effective, life-promoting moisture. Measured by comparing long-term average water supply (precipitation) to long-term average water demand (evapotranspiration), aridity is considered climatologically permanent, while drought is temporary.

Aridification – The gradual change of a region from a wetter to a drier climate

Drought – In the most general sense, drought is a deficiency of precipitation over an extended period time, resulting in a water shortage for some activity, group, or need. Drought may be classified as meteorological, agricultural, socioeconomic, hydrological or flash drought:

Meteorological drought – Commonly defined by a period of below average precipitation. Meteorological measurements are the first indicators of drought.

Agricultural drought – When there is not enough soil moisture to meet the needs of a particular crop or water supply to maintain livestock operations. Agricultural drought happens after meteorological drought but before hydrological drought, and is commonly the first economic sector to be impacted.

Hydrological drought – Below average surface and subsurface water supplies, measured as streamflow or lake, reservoir, and groundwater levels. A time lag exists between reduced precipitation and reduced streams, rivers, lakes, and reservoirs levels. As such, hydrological measurements are not the earliest indicators of drought.

Socioeconomic drought – Occurs when a drought impacts health, well-being, and quality of life, or when a drought starts to have an adverse economic impact on a region.

Flash drought - Relatively short periods of warm surface temperature and anomalously low and rapid decreasing soil moisture that can usually be classified into two categories: heat wave and precipitation deficit flash droughts. Single season droughts over some portion of the State are quite common.

Drought Management Planning – Planning for the conditions under which a drought-induced water supply shortage occurs and specifies the actions that should be taken in response. May include the development of mitigation actions to lessen drought impacts.

Drought Mitigation – Refers to actions taken in advance of a drought that reduce potential drought-related impacts.

Drought Response - Refers to actions taken during a drought that reduce impacts.

Municipal Water Efficiency Plans (WEP) – The Water Conservation Act of 2004 (HB04-1365) requires all covered entities (i.e., retail water providers that sell 2,000 acre-feet or more on an annual basis) to have a state-approved water efficiency plan that contains certain required minimum plan elements

Resiliency – The ability of water systems to adapt and continue providing adequate levels of service in the face of changing circumstances and drivers.

Safe yield or firm yield – The maximum volume of water that can be delivered by an entire system over a realistic hydrologic period that includes the drought records.

Stakeholder – For the purposes of this guidance document a stakeholder represents an entity that is independent of the water provider that has a vested interest in water use or drought mitigation and response.

Water Conservation – Water conservation is the minimization of water loss or waste. The goal of water conservation is to use only the amount of water necessary to complete a task or meet a need. Water conservation can be achieved through policies, programs, and practices designed to encourage less water use.

Water Efficiency – Water efficiency refers to strategies or technologies that facilitate using less water to accomplish an activity. Low flow toilets and showerheads are examples of technologies that increase water efficiency. Water efficiency improvements are typically accomplished via a combination of programs, policies and engineered products or solutions.

Water Shortage – When supply is reduced to a level that cannot support existing demands. Natural forces, system component failure or interruption, or regulatory action may cause these water shortages.

Water Supply Reliability – The ability of a water supply system to meet the needs of its customers during times of stress. The reliability of a provider’s water supply system depends on a multitude of factors such as specific water source(s), seniority of water rights, storage capacities and amounts, and rate of customer demand growth. *Note: While drought management planning efforts may not implicitly involve a water supply reliability assessment, the same terms and concepts used for water supply reliability planning should be incorporated into the drought management planning to avoid potential confusion and help streamline parallel drought and water supply reliability planning processes.*

Absolute Reliability – This is similar to safe yield or firm yield. It is a measure of how well a water supply system performs during a critical drought, based upon historic hydrologic data.

Design Reliability – Applies a “factor of safety” to the absolute reliability. For example, less storage than actually exists may be assumed for water supply reliability modeling purposes or hypothetical hydrology may be applied that includes more severe droughts.

Reliability Criteria – Allowable shortages and their respective frequencies that a water provider is willing to tolerate without failing in its service commitment to customers.

Section 1 Introduction

“We can’t see it ignite, like a fire, or predict where it is likely to touch down, as we do a tornado. Like its natural hazard cousins, it can leave a trail of destruction. And while we might refer to a fire’s crackle or the roar of a tornado, it does not announce its arrival.” – National Drought Mitigation Center

1.1 THE CREEPING PHENOMENA: DROUGHT, CLIMATE, AND THE ARID WEST

Known as the “creeping phenomena,” drought can appear quickly or slowly, last for a season or decades, and can occur locally or regionally. In Colorado, and any semi-arid region of the world, drought is a natural and wholly expected phenomena. While droughts can be characterized as emergencies, particularly through the lens of the populations and economies impacted, droughts typically occur slowly without a distinct beginning or end. Unlike floods or forest fires, the typically gradual onset provides water managers and affected industries time to respond and adapt – so long as the political will and resources to plan and prepare for an effective response in advance of a drought exists.

Regardless how the word *drought* is defined to indicate a lack of available water, the term contains a notion of impermanence – that the conditions are temporary. A significant body of work exists considering the effect of climate change on long-term water availability in the western United States. This work indicates the extended drought patterns of the last two decades may persist for decades to come – a deepening baseline *aridification* under peaks of more severe *drought*.

Even moderate increases in precipitation will not be sufficient to overcome the drying signal. Across the state, average yearly temperature has increased by 2°F in the last 30 years, and by 2.5°F in the last 50 years. Projections show an additional 2.5°F to 5°F increase for Colorado by mid-century. This warming affects the timing of snowmelt and peak runoff, which are trending to occur earlier. Related trends include increases in heat waves and wildfires, longer irrigation seasons, and decreases in annual streamflow—especially in the state’s southern basins.

While a large amount of uncertainty exists around how the warming trajectories may translate to physical conditions across Colorado’s complex topography, it is clear the current climate is not stationary and responsible water supply planning efforts will take into account this uncertainty. Planning approaches that rely on notions of hydrologic history repeating itself are inherently flawed. The process of drought planning today can build the foundation for more responsive communities and economies in a drier future – empowering decision-makers to develop neighborhoods, invest resources, and recover from disasters in ways that reduce impacts from the next drought.

1.2 DROUGHT IMPACTS

Colorado gets new water supplies from only one source: precipitation, in the form of rain, hail, or snow. Given natural variations in Colorado’s geography and climate patterns, single season droughts over some portion of the state are quite common, yet it is rare for all of Colorado to be deficient in moisture at the same time.

The effects of drought vary based on where in the state it occurs, when it happens, and how long the conditions persist. Hydrologic conditions constituting a drought for water users in one location may not

constitute a drought for water users elsewhere. That is to say, drought is not merely a natural event (less precipitation than normal); it is also dependent on the demand people place on water supplies (water shortage). Drought is one of the few hazards with the potential to directly or indirectly impact the entire population of the state, be it from water restrictions, higher water and food prices, reduced air or water quality, or restricted access to recreational areas.

Drought impacts are wide-reaching and may come in different forms, such as economic, environmental, and/or societal. The most significant impacts associated with drought in Colorado are those related to water-intensive activities such as agriculture, wildfire protection, municipal usage, commerce, tourism, recreation, and wildlife preservation. A reduction of electric power generation and water quality deterioration are also potential effects.

The hydrology and water resources of Colorado, and hence the economy of the state, are extremely sensitive to climate. Multifaceted stress on water supply such as irrigation, municipal demands, mandated biological (in-stream) flows, and the increasing need for hydropower, coupled with climate variability and change, are increasing the importance of supply forecasting and demand management to both water managers and business markets.

1.3 DROUGHT MANAGEMENT PLANNING

Droughts are a natural phenomenon of Colorado’s climate and as such Colorado municipal water providers (providers) must anticipate and plan for droughts. The need for drought planning was emphasized for many providers from 2001 to 2003, during Colorado’s most intense drought since streamflow recording began. In 2002, Colorado streamflows were the lowest in over 100 years of records and tree ring data suggests flows were the lowest in 300 to 500 years. Although the 2001 to 2003 drought was relatively intense, evidence indicates that droughts of this magnitude will occur again.

In 2004, the Colorado General Assembly passed House Bill 04-1365, which expanded the mission and duties of CWCB’s Office of Water Conservation and Drought Planning (OWCDP) to reflect the State’s involvement in drought mitigation and response planning and the need to provide more information relating to drought and water conservation to water users, the public, media, and state officials. Local drought planning is promoted by encouraging and assisting communities to prepare and implement drought management plans, as such, the purpose of this guidance document.

The main objective of drought management planning is to preserve essential public services and minimize the adverse effects of a water supply emergency on public health and safety, economic activity, environmental resources, and individual lifestyles. Effective drought management plans remove the

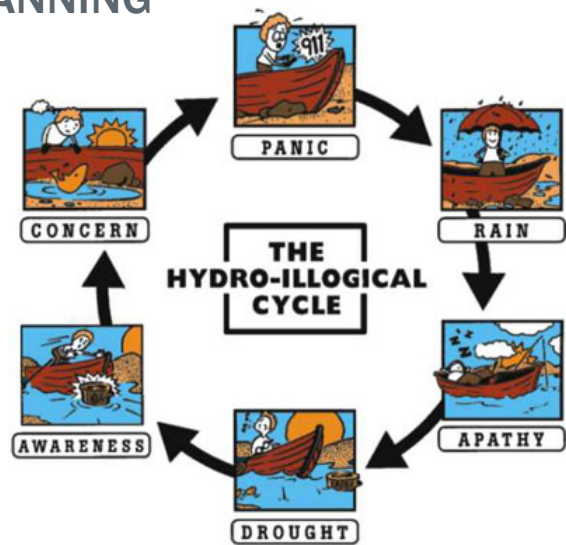


Figure 1. *Why Plan?* Many water users react to droughts in the manner depicted here. During normal or wet years, water users are apathetic to drought planning and do not take action to prepare for the inevitability of the next drought. Logically, during crisis is the worst time to make a plan – a time when mitigation measures should be enacted, not devised. *Source: National Drought Mitigation Center*

“crisis” from drought response efforts, reduce the hardship caused by water shortages, and raise public confidence in the actions taken to address the water supply shortage.

In summary, drought management planning is based on the following principles:

- Periods of below average precipitation will occur and are unpreventable; therefore, it can be anticipated that drought-related water shortages will occur at some point in time.
- The potential risks and impacts of drought can be considered and evaluated in advance of the actual event.
- Response measures can be determined and implementation procedures defined in advance to avoid, minimize, or mitigate the risks and impacts of drought-related shortages.
- Drought management planning includes drought mitigation and drought response planning.

1.4 RELATED PLANNING EFFORTS AND INTEGRATION

Before embarking on the development of a new drought management plan it is recommended to review current local or regional plans that may already relate to or address drought within the jurisdiction. With this understanding, a planning team can focus effort where it is needed most and draw reference to (rather than rewrite) prior knowledge or components of related plans. For example, if drought mitigation measures already outlined in multi-hazard mitigation plans, water efficiency plans, or sustainability plans, the planning team may want to focus the drought management plan on monitoring and response and cross reference related documents that already address drought mitigation.

In addition to complementing existing plans, new drought plans should be coordinated with the [2018 Colorado State Drought Plan](#) which serves as a useful reference regarding: previous droughts; actions taken by the State in responding to droughts; state-level drought monitoring, triggers, indices, and thresholds; and mitigation and response measures.

Other statewide plans such as the [2015 Colorado Water Plan](#), [2015 Colorado Resiliency Framework](#), and [2018 Colorado State Hazard Mitigation Plan](#) are strong references to provide context and language on the purpose, need, and statewide drought history and vulnerability.

Drought planning commonly overlaps with the following related regional, county, or municipal efforts:

Other Water Plans

Drought planning and water shortage management, water supply reliability, and water efficiency (or water conservation) planning are closely interrelated yet often separate efforts. See [Key Terminology](#) to distinguish the unique purpose of each process.

- Water Efficiency Planning
- Water Supply Reliability Planning
- Basin Implementation Plans (regional)

Other Emergency or Hazard Mitigation Plans

- Water Shortage Emergency Planning
- Emergency Operations Plans
- FEMA Multi-Hazard Mitigation Planning

Other Integrated Plans

- Climate Action or Adaptation Plans
- Sustainability Plans
- Capital Improvement Plans
- Land Use or Comprehensive Plans

1.5 DOCUMENT ORGANIZATION

This Guidance Document is organized into the following sections:

- **Section 1.0 Introduction:** Details the general purpose, scope, and general organization of the document.
- **Section 2.0 Drought Management Planning Steps:** Introduces the eight steps common to drought management planning and provides a detailed description of each step.
- **Section 3.0 Drought Plan Template:** Provides a template for a drought management plan that corresponds with the eight-step drought management planning process detailed in Section 2.0. This section also provides lists of recommended content and corresponding level of importance for each of the eight planning steps. Providers may use this template as an organizational checklist to ensure that information important to their drought management planning effort is incorporated into the final plan.
- **Section 4.0 Case Studies and Examples:** This section provides case studies related to drought plans and links them with the planning steps outlined in Section 2.
- **Appendix A:** Provides a series of worksheets that providers may use as a toolkit to generate ideas, organize information, and format data for direct incorporation into their plans. Similar to the Guidance Document, all worksheet content is not applicable to every provider. Providers should use the worksheets to the extent beneficial to their situation.

Section 2 Drought Management Planning Steps

This section details a step-by-step process providers may use in developing drought management plans, while Section 3 provides a corresponding template that an entity may directly utilize as a framework for a plan. The drought planning process consists of the following eight drought planning steps as summarized in Table 1 below.

Table 1: Overview of Planning Steps

Step	Purpose
Step 1: Planning Process, Plan Objectives and Operating Principles	Get organized to prepare the plan in a collaborative fashion
Step 2: Drought Vulnerability Assessment	Determine how drought has impacted and could impact the jurisdiction in the future
Step 3: Drought Monitoring	Identify how is drought systematically monitored
Step 4: Drought Stages, Trigger Points, and Response Targets	Identification of drought stages and corresponding drought trigger points and response targets
Step 5: Drought Mitigation and Response Strategies	Identification and selection of a combination of mitigation and response strategies
Step 6: Staged Drought Response Program	Lays out a systematic response to varying levels of drought
Step 7: Drought Response Operational and Administrative Framework	Identifies the who, what, when and how of implementing the plan during a drought
Step 8: Plan Approval and Adoption	Establish formal processes to review, approve, and update the drought management plan

2.1 STEP 1: PLANNING PROCESS, PLAN OBJECTIVES AND OPERATING PRINCIPLES

Step 1 focuses on the preliminary actions needed to initiate the development of a drought management plan. Ideally, this includes an interactive stakeholder process that facilitates the inclusion of a variety of perspectives during plan development. This also includes the development of plan objectives and operating principles that reflect the values of the provider and stakeholder group. These objectives and operating principles facilitate a guidance framework for the development and implementation of the plan.

2.1.1 DROUGHT PLANNING COMMITTEE

Drought management plans are most effective when developed collaboratively. Plans that are developed within a “vacuum” of only one or a few people may not have the necessary buy-in, and risk the potential of community conflicts or water supply system complications when water supplies are stressed during times of drought. A drought planning committee (Drought Committee) that includes participants from the water provider’s organization should be organized and involved throughout the development of the plan. An interactive, collaborative plan development process can provide valuable insight and the perspectives necessary for an effective, comprehensive drought management plan.

In order for the Drought Committee to reflect the multidisciplinary nature of drought, it is recommended that the Drought Committee consist of decision makers and representatives throughout the local government. At a minimum, this should include senior staff representing key water-related departments such as parks, water and wastewater treatment facilities, etc. All departments potentially affected by drought should be also considered as potential committee members. For instance, the financial, planning, and public works departments could be affected if water bill formats are to be modified, revenue changes are seen in response to a drought or additional capital improvements are needed or accelerated, such as leak repair or well maintenance. Sustainability offices can provide perspective on integration with related plans and initiatives. Emergency Management can provide perspective on integration with related plans and resources needed in extreme droughts. Public affairs/public information office can provide input on messaging and communication during drought. Fire departments provide perspective on maintaining effective flows for public safety, and law enforcement may be engaged in the monitoring and enforcement of water restrictions during drought. It is recommended for the resiliency of ongoing programs that department and staff roles are identified in the plan, rather than specific names of people who may eventually change positions, move on or retire.

The Drought Committee’s membership will vary for each individual provider. Smaller providers whose water system staff consists of one to three people may have a much smaller Drought Committee than a provider supplying water to a major metropolitan area. The following list may be used as a starting point in identifying members of the Drought Committee. Depending on the organizational structure of a particular water provider, one individual may hold several of these roles and responsibilities.¹

¹ The majority of staff presented in this list were taken directly from the State of California’s Urban Drought Guidebook 2008 Updated Edition developed by the Department of Water Resources.

Role	Sample Responsibilities
City / General Manager	provide overall direction on the drought response
Drought Response Team Leader	lead the coordination, gather and disseminate information; make key support staff assignments, clarify roles, and communicate with broad array of interested parties
Water Treatment Manager	provide guidance on treatment operations and capabilities
Water Quality Manager	provide guidance on drinking water quality and quality issues related to potential alternative supplies
Water Resources Manager	provide guidance on water source availability, water rights yields, reservoir storage levels, and opportunities for use of non-potable water
Finance Manager	provide cost estimates for supply alternatives and demand reduction programs, customer database improvements and bill format changes, expected lost revenue estimates, recommend rate changes, and use of the revenue stabilization fund
Conservation Manager	provide water use reduction measures management, cost estimates to achieve demand reductions, and act as a liaison with green industry and large water users
Planning / Engineering Manager	lead efforts for new connection water use projections, new and expanded supply infrastructure, interconnection planning, and water quality treatment improvements
Operations Manager	oversee meter reading frequency, meter accuracy, and system water loss audit and repair
Customer Service	provide current information about the state of the program to customers
Administrative staff	hire staff, purchase equipment, and negotiate union contract adjustments
Legal staff	review legality of program, rate changes, interagency agreements and contracts, and the need for board or council approval of actions
Communications / Public Information Officer	oversee messaging, customer relations, media relations, press releases, and coordination with wholesale customers
Environmental Review and Permitting	reviews supplemental supply projects and prepares environmental documentation

MEETINGS

It is recommended that a minimum of two meetings be held with the Drought Committee as the plan is being developed. These meetings should focus on the development of the drought management plan objectives and operating principles and facilitate a means to collect and review data and receive feedback on specific aspects of the plan. The Drought Committee should also have an opportunity to review and comment on the final drought management plan. The Drought Committee could also be activated during times of drought to coordinate and implement specific drought response activities and make recommendations to appropriate decision makers. Once the plan is developed, a best practice is to meet even during non-drought times, as this keeps communication lines open, allows newcomers to the group to catch up prior to emergency and identifies gaps in planning as new information and research becomes available (See Section 2.8.3 for how future meetings can be integrated into the plan’s periodic review and update process).

STAKEHOLDER AND PUBLIC ENGAGEMENT

While it is highly recommended that a public review process take place at some point in the plan development (see Step 8), there are many forums in which this may occur. Also, other governmental agencies and key water users (defined as stakeholders) may need to be consulted to ensure the Plan is coordinated with other planning efforts and response actions. Key stakeholders that could be impacted by the Plan and other interested members of the public and special interest groups may be included in the Drought Committee or an advisory committee. This could include:

- large water users from key business and industry,
- recreational users – golf course manager(s),
- representatives from non-profit groups,
- large homeowner associations, school districts

A public advisory group could also be developed to review the plan development during key stages. A general public review process involving the distribution of the draft Drought Plan and/or public meetings are also options.

2.1.2 GOALS, OBJECTIVES AND OPERATING PRINCIPLES

As previously mentioned, the Drought Committee should initially be tasked with development of a set of drought management plan goals, objectives and operating principles. The plan goals and objectives should clearly state the purpose of the plan. Goals are typically broad, overarching statements, while objectives are more specific statements about how the goals will be achieved. Some plans may have a singular goal or overarching “mission statement.” It is recommended to cross reference or make ties to other community plans that might have related goals, including comprehensive plans, local hazard mitigation plans, strategic plans, or city council goals. The drought operating principles should provide a set of guidance criteria that the Drought Committee can return to while developing the plan and also when making decisions in times of a drought. The operating principles reflect the water use priorities for the provider and community. The American Water Works Association (AWWA) Drought Management Handbook provides the following list of questions when developing objectives and operating principles.²

- Which water uses should be restricted during drought conditions? Which water uses can tolerate drought conditions better than others?
- Should potential drought restrictions apply across-the-board or be directed only to certain water uses? Should non-essential uses be banned?
- What about water uses that are often overlooked during droughts, such as recreation and instream uses? How should fish and wildlife and other environmental concerns be incorporated into the plan?
- What legal or institutional requirements affect the community? Do minimum flow requirements exist for certain streams? Do reservoir conservation requirements need to be met? Are there sufficient streamflows for waste assimilation purposes? Do these requirements conflict with other water uses?

² Source: AWWA. 2002. Drought Management Handbook. pg 4.

- What effect would priority-setting have on water cost and on equity considerations such as equal access to water service?

These questions are not applicable to all providers. Similarly, there are likely additional factors not mentioned here that providers should consider when developing drought objectives and principles. Nevertheless, it is essential that a provider's water use priorities are reflected in either the objectives or operating principles. It is also important to consider how much water savings each restricted area is going to realistically achieve, so that effort and objectives are focused appropriately.

Generally, a water provider's priorities will assume essential human needs are the primary priority with economic, quality of life, and environmental considerations as secondary priorities. The following list is an example of typical water use priorities, with the first priority being the highest then decreasing sequentially in importance:

1. Health and safety – interior residential, essential commercial, school use, sanitation, hospitals, and firefighting;
2. Commercial and industrial – use necessary to maintain economic base and protect jobs;
3. Water for new construction;
4. Large landscaping features on public parks – direct water to trees and shrubs;
5. Large residential landscaping features – direct water to trees and shrubs; and
6. Outdoor residential turf irrigation.

The plan objectives and operating principles play an important role in guiding the development and implementation of the mitigation and response strategies outlined in Steps 5 and 6. The drought management plan will be most effective if these objectives and principles generally reflect the values of a provider's service area. Having these priorities detailed in the plan will provide the foundation for further planning and drought response decision making, and can be used to explain to the public and local business and industry when and why curtailments are necessary.

Step 1 case studies and additional examples of objectives from various plans can be referenced in Section 4.

2.2 STEP 2: DROUGHT VULNERABILITY ASSESSMENT

The purpose of a drought vulnerability assessment is to understand past and potential drought impacts and vulnerabilities to focus the plan on adequate and appropriate response and mitigation. A vulnerability assessment includes a review of impacts experienced and lessons learned from past droughts followed by an assessment of the risks and vulnerabilities that may be experienced in future droughts. Vulnerability assessments can be scalable. The level of effort can vary from a qualitative summary of historical impacts and water supply reliability planning efforts, to a more sophisticated quantitative assessment of water supply vulnerabilities. This information is helpful in selecting the drought mitigation and response strategies described in later planning steps.

2.2.1 HISTORICAL DROUGHT ASSESSMENT

Water supply reliability is a function of how well supplies meet demands over time and under various hydrologic conditions. During times of drought, available water supplies typically decrease. Demands may either increase in response to less rainfall and higher outdoor evapotranspiration rates or decrease due to drought response measures such as outdoor watering restrictions. Information from historic drought

events can provide important benchmarks and insight for projecting and planning for future drought conditions. This includes an assessment of the historic frequency, duration, and spatial extent of past droughts as well as characterizing demands, supply availability, storage, and impacts during these drought periods.

The questions listed in this section assist with characterizing historical droughts and associated water supply availability and water demands. This provides a means to evaluate past drought conditions and response with the intention of informing the planning effort for future droughts. It is recommended that these questions be reviewed on a qualitative basis, and if resources are available and proven to be useful, on a more thorough quantitative basis to better inform future planning efforts.

UNDERSTANDING HISTORICAL DROUGHT EXTENT, INTENSITY AND DURATION

There are a variety of drought related resources, indices, and hydrologic data that can be used to identify and characterize drought. Understanding past drought data can be an important part of recognizing emerging drought in the future. Step 3 of this guidance document discusses drought indicators that can be used to characterize drought. The Colorado Drought Mitigation and Response Plan has a summary of drought indicators typically used to monitor drought at the state level, as well as historic drought periods and can be a useful reference to begin researching past drought impacts. Another source of historic drought information may be local multi-hazard mitigation plans. The National Drought Mitigation Center's online Drought Impact Reporter tool may also be a useful starting point. It provides a compendium of drought impacts since 2010 across various sectors, searchable by county. The Drought Risk Atlas tool is another resource. It allows a user to select weather monitoring station and view data for a number of drought indices. Frequency statistics of drought thresholds, drought period information and index comparisons are also available

The following questions can be useful when assessing past drought indicator data:

- What drought indicators and data may be used to characterize historic drought periods (i.e., percentage snowpack, streamflows, etc.)?
- How can these data be used to characterize the severity, frequency, and spatial extent of previous droughts?

UNDERSTANDING WATER SUPPLY SITUATION DURING HISTORICAL DROUGHTS

The extent to which a water supply system is affected by drought depends on a variety of factors. These include the severity and duration of a drought event, specific water supply sources, seniority of water rights, drought storage reserves, and drought mitigation and response measures in place to address potential shortages. Providers can learn a great deal about their water supply systems and envision how they may behave during future drought conditions by assessing water supply availability and storage during historic drought periods.

The following type of data may be useful in characterizing historical drought conditions: water treatment plant production, reservoir storage and releases; supplies available through direct flow water rights; river call records; wholesale water supply allocation; groundwater levels and well production data and supply leases and purchases.

The following questions can be useful when assessing water supplies during a drought:

- What changes were observed in the availability of water supplies (e.g., direct flows, storage amounts, groundwater levels, etc.) during previous droughts?
- How did these changes correlate to the identified drought indicators and data?
- Are there other factors that contributed to water supply availability (i.e., mechanical issues or water quality) during the drought?
- What were the impacts to the water supply system? Were there water supply shortages? If so, what were the magnitude of shortage(s)?
- How did the water provider respond to the water supply shortages in the past? What changes did the water provider make to the water supply system in the past to make up for these shortages? Were these effective? Why or why not?
- Were there water quality, infrastructure or operational factors or other factors that may have caused or influenced the magnitude of shortage?
- What were the lessons learned from previous droughts that are still relevant today and to future droughts?

UNDERSTANDING WATER DEMANDS DURING HISTORICAL DROUGHTS

Changes in water demands during historic drought periods are a valuable data source to assess customer water use behavior and total water demands changes that may occur during future droughts. In dry periods in summer months, outdoor watering demands usually increase in response to an increase in temperatures and lack of precipitation. The increase in demands can be tempered and typically reduced with mandatory outdoor irrigation restrictions, depending on the severity of restrictions. Water demand data can also be used to evaluate the effectiveness of historic drought mitigation and response efforts.

The following questions can be useful when assessing water demands during a drought:

- What changes, if any, were observed in customer water demands during the period of drought? Is there a notable increase or decrease in demands? It is often useful to look at unit demands such as per capita demands to assess this trend. Also, differentiating between indoor and outdoor water demands can be useful.
- What response measures were implemented during past droughts to reduce demands? For example, were voluntary or mandatory water restriction enacted? How were these enforced? Was the public well informed of the drought conditions and response measures?
- Can general relationship(s) be established between drought response measures implemented in the past and their corresponding demand reductions? If so, is there sufficient data available to evaluate the effectiveness of specific drought response measures that were implemented?

There are a variety of ways in which water demand trends can be evaluated. Such techniques include evaluating total annual water demands, disaggregated indoor and outdoor water demands, unit water demands (e.g. per capita demands), etc. Additional information on water demand evaluations is provided in CWCB’s Municipal Water Efficiency Guidance Document.

RECORDING HISTORICAL DROUGHT IMPACTS

Droughts can impact water providers in a variety of ways. Table 2 provides an example of historical drought impacts. This foundational information is useful when identifying how the system may be vulnerable to drought in the future and during selection of future drought mitigation and response strategies discussed in Step 5. A series of worksheets have been developed to assist with this process that are captured in Appendix A. Worksheet A provides a detailed list of potential drought impacts that providers may use to record historic drought impacts and identify corresponding mitigation and response measures previously implemented to address the impact. Worksheets B and C list potential drought mitigation and response strategies. Providers may use this list to identify specific measures and response strategies implemented during past periods of drought.

Table 2: Excerpt of Drought Related Impacts on Water Providers

Drought Related Provider Impacts
Loss of revenue from reduction in water sales
Reduction in well production
Reduction in storage reserves
Disruption of water supplies
Degraded water quality
Higher water treatment costs
Sediment and fire debris loading to reservoirs following a wildfire
Increased costs and staff time to implement drought plan
Increased data/information needs to monitor and implement drought mitigation plan
Costs to acquire/develop new water supplies/water rights transfers
Costs to further reduce water demands
Public favorable/unfavorable perception of provider regarding drought response
Scarcity of equipment and other water related services (i.e., contractors to repair wells)

In addition to these impacts, there are a variety of secondary community, societal, economic, environmental, and recreational impacts that can affect the community. For example, severe drought and accompanying water restrictions that prohibit the establishment of new vegetation can economically harm nurseries and landscaping businesses that rely on installing new landscapes for their business. Towns, cities and counties may also explore these secondary impacts, if they may be informative to future water supply and drought planning efforts.

2.2.2 IDENTIFYING AND ASSESSING FUTURE VULNERABILITIES

Vulnerability to a drought and water shortage is a combination of how reliable a provider’s water supplies are during droughts and how prepared a provider is for meeting the challenges associated with water shortages. This assessment may be broken into the following components.

- Understanding the reliability of the provider’s water supply portfolio and water supply reliability planning efforts in relation to drought and water efficiency planning;
- Assessing future vulnerabilities, including vulnerabilities that may be mentioned in other state and local planning efforts.

A recommended resource is Annex B of the Colorado Drought Mitigation and Response Plan which has a detailed, sector-based drought vulnerability assessment. Sectors analyzed include municipal and industrial, agriculture, energy, environmental, recreation and socioeconomic. Analysis is refined to the county level for most sectors. Another important reference is Annex C of this plan, which discusses climate change implications and a summary of projected hydrologic responses to climate change for each of the state’s major drainage basins.

WATER SUPPLY RELIABILITY AND DROUGHT PLANNING

Water supply reliability may be defined as the ability of a water supply system to meet the needs of its customers during times of stress. The reliability of a provider’s water supply system depends on a multitude of factors such as specific water source(s), seniority of water rights, storage capacities and amounts, and rate of customer demand growth. Many providers throughout the State have found it necessary to assess the reliability of their supplies under stressed drought conditions to ensure that they have sufficient supplies to meet anticipated current and future water demands.

In contrast, drought management planning generally focuses on the mitigation actions and response strategies a provider may implement to lessen drought impacts. Nevertheless, water supply reliability planning is an important component of ensuring sufficient supplies during times of drought. While water supply reliability planning is beyond the scope of this document, the development of drought management plans should closely tie with water supply reliability planning. Conversely, future water supply reliability planning efforts may be enhanced through the insight gained from the development of a drought management plan.

ASSESSING FUTURE DROUGHT VULNERABILITIES

The review of historical drought impacts coupled with existing federal, state, county and local planning efforts available is not only key to ensuring a coordinated water shortage response effort, but also can bring to light drought vulnerabilities that the water provider may not have been aware of. Understanding the full spectrum of how the water provider may be vulnerable to drought and water shortages, improves the ability for the provider to have appropriate response strategies in place for when a water shortage occurs.

[Worksheet A](#) provides a list of potential impacts that can adversely affect water providers during a future drought. These resources may be used to identify potential future drought-related impacts for drought planning purposes. [Worksheet A](#) also provides a means to prioritize and rank the perceived severity of the vulnerability.

Section 4 has several case studies related to this Step including examples of vulnerability assessment from planning efforts completed by Aurora, Thornton and Castle Rock.

2.3 STEP 3: DROUGHT MONITORING

Step 3 defines how drought is monitored for the jurisdiction. To accurately assess drought conditions and the potential severity of a drought, it is imperative that providers closely monitor drought indicator data.

The types of indicators will vary by jurisdiction, based on the water supply portfolio and the geographic setting.

The following is a list of common drought indicators that may be used by providers to characterize current and historic hydrologic conditions and assess drought severity relative to normal hydrologic conditions.

Table 3: Example of Common Drought Indicators

	Indicator/Source	Description
Composite	U.S. Drought Monitor	Provides a weekly national drought summary and map. The map uses a drought severity classification system to illustrate drought conditions around the country
	Colorado Modified Palmer Drought Index (CMPDI)	A standardized index based on soil moisture
	Evaporative Demand Drought Index (EDDI)	This index captures the signals of water stress at weekly and monthly timescales which may be useful in detecting flash drought
Metrologic	Standardized Precipitation Index (SPI)	Probability index based on precipitation
	Precipitation records	Precipitation records within a specific watershed
Hydrologic	Surface Water Supply Index (SWSI)	Describes drought severity where availability is driven by winter snow accumulation and subsequent melt. The input variables of this index are being modified to only include observed streamflows, forecasted streamflows, and reservoir storage data
	Observed streamflows	Streamflows recorded at key gage locations
	Natural streamflows	Observed streamflows adjusted to account for upstream water diversions and importations
	Reservoir levels	Reservoir surface elevation and/or storage in key reservoirs
	Storage levels	Storage in water tanks
	Snowpack	Snow depth, percentage water content, percentage of annual average snowpack
Other	Snowpack sublimation	Loss of snowpack characterized by snow turning directly into water vapor without passing through the liquid stage
	Groundwater levels	Groundwater level elevations
	Administration of the river	Call data during the drought period
	Soil moisture content	Soil moisture is the water that is held in the spaces between soil particles; Climate Prediction Center soil moisture maps and Crop Moisture Index
	Evapotranspiration rates	Sum of evaporation and plant transpiration from the Earth, often measured with remote sensing methods.
	Demand monitoring	Water supply index to factor in increased demands on available supplies

Additional resources that may be useful in monitoring drought are listed below.

- NRCS Streamflow Outlooks
- NOAA Climate Prediction Center (CPC) Climate Outlooks (Temperature and Precipitation)
- NOAA CPC Monthly & Seasonal Drought Outlooks
- ENSO (La Nina/El Nino)
- NIFC Wildfire Outlooks
- Colorado Climate Center Webinar
- Colorado Water Availability Task Force Updates (drought, wildfire, climate, etc.)

The intensity of the monitoring effort will vary seasonally and annually. Typically, wet springs and winters with high snowfall amounts will not require a significant amount of monitoring outside of recording snowfall and precipitation events. However, intense monitoring efforts and internal discussions among water resources staff will likely be necessary in early spring and summer following winters with below average snowfall.

The following components of a drought monitoring system should be defined:

- Identification of drought indicator data monitored on an annual and seasonal basis and how this data is acquired.
- General schedule of when the monitoring is conducted including monitoring frequency. Address how the intensity of monitoring may change during abnormally dry seasons.
- Drought forecast conditions. Providers may incorporate drought indicator data to develop their own models or methodology to forecast drought conditions or rely on other regional/neighborhood forecasts.
- Entities or staff responsible for monitoring and forecasting drought conditions.
- Protocol for recording and archiving monitoring data.

[Worksheet E](#) provides a template for monitoring framework and can help identify appropriate drought indicators and thresholds/trigger points and related case studies can be reference in Section 4.

2.4 STEP 4: DROUGHT STAGES, TRIGGERS, AND RESPONSE TARGETS

Step 4 incorporates information from the previous steps to develop a set of drought stages that are essentially water supply alert levels representative of the severity of drought and how it affects a provider's system. Generally, trigger points are identified for each drought stage with corresponding response targets. Trigger points are drought indicator threshold values that differentiate drought stages (i.e., reservoir levels, numbers of days water supply left in storage, percentage of average snowpack). Trigger points may incorporate a variety of different drought indicators to provide water providers and government agencies with flexibility in making a drought stage determination. Response targets are generally water use reduction goals established by the provider for each individual stage.

Table 4 provides an example that might be used by a water provider to define drought stages, trigger points, and response targets. In this example, the initial drought stage, called “watch,” is representative of an initially stressed water supply system where reservoir storage is 80 percent of the average storage normally observed in May. This stage has a targeted water savings of 10-15 percent. Stage 2 (warning) and Stage 3 (critical) necessitate an increasingly higher level of drought response. Stage 4 is representative of emergency conditions when reservoir storage is less than 25 percent of average requiring significant actions by the customers and the provider to maintain sufficient supplies for essential needs. Effective drought management plans initiate response actions prior to a Stage 4 level in order to avoid emergency conditions. Nevertheless, if a drought is severe enough (especially for long durations), Stage 4 responses could be unavoidable.

Table 4: Example of Drought Stages, Trigger Points and Response Targets

Drought Stage	Trigger Point Reservoir Storage on May 15	Response Target Water Use Reduction Goal
Stage 1 – Watch	Less than 80 percent of average	10-15 percent
Stage 2 – Warning	Less than 65 percent of average	15-25 percent
Stage 3 – Critical	Less than 40 percent of average	25-40 percent
Stage 4 – Emergency	Less than 25 percent of average	40 percent

Other examples of drought stages, trigger points, and response targets can be referenced in Section 4 and [Worksheet F](#) in Appendix A.

2.4.1 DROUGHT STAGES

The drought stages identified in in this step are an important component of the staged drought response program developed in Step 6. Generally three to five stages are recommended. This range sufficiently captures the variability of drought conditions without being overly burdensome. Programs with only two drought stages may jump too quickly from a warning level to a crisis situation while more than five stages could be tedious to implement.

The names of the drought stages can influence how the drought message is conveyed to and received by the public. For instance, a drought stage prematurely named “emergency” could result in a higher level of public concern than necessary. Conversely, a drought stage termed moderate when severe watering restrictions are implemented can undermine the public message to save water. Some providers may find it beneficial to establish a sequence of descriptive terms for water supply alert levels, such as “advisory,” “moderate,” “severe,” and “emergency.” Other providers that want more flexibility in portraying the drought stage when a drought actually occurs may find more generic terminology such as Stage 1, 2, 3, and 4 to be suitable.

Providers should also be aware of the public drought terminology used by neighboring municipalities. Discontinuity and public confusion can result if a municipality in a “crisis” drought stage is surrounded by entities that are only of a “moderate” stage. Although water supply availability can drastically differ among neighboring providers, many benefits can be achieved by coordinating the general drought message with nearby entities, especially for media coverage purposes. It is important to note that the media carries a large part of messaging during drought. Most large media sources in Colorado are located in Denver but broadcast statewide.

2.4.2 TRIGGER POINTS

Some providers may find it beneficial to develop trigger points during the drought planning process in advance of a drought. Others may find it more conducive to maintain the flexibility of declaring a drought and corresponding drought stage when the drought occurs using real-time drought indicator data. Flexibility can also be achieved by expressing trigger levels as ranges. For example, a drought plan could say that Stage X occurs when reservoirs are between Y percent full and Z percent full on a given date.

Trigger points established prior to a drought, such as those in Table 4, guide the declaration of drought and corresponding drought stages. Provided there is a high degree of confidence that the trigger points are reliable and representative of the water provider's system, this approach can offer the following advantages:



- Trigger points can remove some of the immediate liability of deciding on whether a drought should be declared.
- There can often be political pressure to declare or not declare a drought. Pre-established drought triggers can help alleviate this political pressure and enable decision makers to declare a drought based on sound scientific and engineering studies.
- The trigger points can be used as a tool to ensure the public that the provider has a good understanding of the water supply system and has proactively developed an accurate means to measure and address drought.
- Drought triggers may also be presented as ranges as opposed to the discrete values shown in Table 4. For instance, a trigger point range of 75 percent to 80 percent of average reservoir storage could be assigned to a Stage 1 drought. This offers the provider more flexibility regarding when to declare a drought. For instance, a Stage 1 drought could be declared at 80 percent or at 76 percent of average reservoir storage depending on the provider's assessment of other drought related factors.

Providers that prefer to take a more real-time approach in declaring a drought and drought stages often do so in order to maintain an even higher level of flexibility with their decision making. Flexibility can be important for the following reasons:

- The general “appearance” and effects a particular drought may have on a provider's water supply system can vary dramatically depending on the severity, spatial extent, and duration of the drought, coupled with the fact that droughts are often unpredictable.
- Given the variable nature of droughts, it can be difficult to develop specific trigger points that clearly represent the impact that a drought can have on the water supply system and the impact may change during the course of the drought.

- There can be significant changes in a community between when the trigger points were developed and when a drought occurs. This is particularly true for municipalities experiencing high growth rates. Water demands can significantly increase, outdating the trigger points.
- The media may incorrectly interpret trigger points and unnecessarily heighten the public's concern. Furthermore, a provider may find it necessary to adjust the predetermined trigger points to account for unforeseen conditions. This could inadvertently reduce confidence in the provider, if the media chooses to "hold the provider to the original numbers."

If trigger points are used, they do not need to be considered as hard and fast rules to be used in all situations. Every drought is different in its characteristics, so trigger points can be used to give an indication that a drought of concern might be developing. The trigger points can then be used in conjunction with other relevant real-time data to determine if a drought declaration should be made.

Considerations when developing triggers include the following:

- What is the likelihood that the trigger could happen and under what level of water shortage severity (e.g. likelihood of the reservoir elevation, streamflow, groundwater elevation in dropping)?
- How often are water use restrictions needed and how much water savings is needed?
- When should drought reserves (if available) be activated?
- What climatic and drought indicators are currently used where thresholds could be developed to help inform the appropriate drought stage?
- Do the proposed drought triggers cover all types of droughts? What other drought indicators are important to monitor to ensure that a full picture of the shortage is captured?
- Providers should also closely track infrastructure maintenance and modifications that could impacts the severity of a water shortage. For instance, if a reservoir is planned to go off-line temporarily for maintenance, how could this influence supply availability if a drought occurs?

At a minimum, providers using a "real-time declaration approach" should identify the drought indicator data that are monitored on a regular basis and would likely be used to determine drought severity. For both cases, it is important to discuss the timeframe of when the drought indicators/trigger points are relevant for predicting drought. For example, the drought triggers shown in Table 4 specify a reservoir level on May 15 during the spring runoff. Providers relying on mountain snowpack typically rely on the monitoring of snowpack conditions most heavily in March and April for drought prediction purposes when the mountains generally receive the greatest amount of moisture just prior to runoff.

Some of the types of drought indicator data that providers may reference are discussed in Step 3 as well as in Worksheet E. Worksheet E provides a means to specify drought indicators that are currently monitored and select additional beneficial indicators. Worksheet E also provides a column to designate the drought indicators used to develop the trigger points and specify the timing of when drought indicators/trigger point should be especially adhered to when monitoring drought. Two template table options are provided where providers can fill in the drought stages, triggers, and response targets.

It is important for providers to ensure that the official drought declaration and corresponding drought stage designation occur in a timely manner. If a drought is declared too late or actions are not taken early enough to reduce water use, supplies can be severely depleted and strict water restrictions and economic impacts may be required that could have been avoided. Conversely, premature drought declarations can result in unnecessary mandatory water restrictions and associated impacts while customers lose confidence in the provider.

2.4.3. RESPONSE TARGETS

Response targets or goals specify the level of action necessary to conserve water. As with the drought stages and triggers, it is important that response targets appropriately reflect the severity of a drought and are representative of supply conditions. They also should be realistic water use reduction goals. Targets that are too high may require unnecessary hardship, while targets that are not high enough may not elicit an adequate response.

Response targets may simply specify an absolute amount of savings (acre-feet) or a percentage of savings as compared to normal conditions. Annual and/or seasonal water use reduction response targets may be developed. When developing such response targets, it is helpful to understand how much water use is being used for outdoor irrigation versus indoor use. For example, if 50% of a jurisdiction's annual water use goes towards drought, a 50% targeted water savings under a severe drought situation could imply that almost all outdoor irrigation is prohibited. Alternatively, response targets may also be established as a group or type of actions that might be taken as a result of a drought with a particular severity, such as "Level 1 Restrictions" or "Voluntary requests to reduce water use."³ Targets for individual customer types can also be developed.

A response target can be defined once a drought is underway and its severity is known. However, there are benefits to developing response targets prior to a drought occurrence based on water supply planning and/or water system modeling. For instance, it is important to assure that there is sufficient water savings targets to stretch supplies during water shortages. During drought, savings achieved through outdoor watering restrictions may be used for more essential indoor uses. If the amount of irrigated turf is reduced in advance of a drought through efficiency measures, a reduced "water savings potential or buffer" through outdoor irrigation savings is available during times of drought. It is important for providers to have a reserve of supplies available during drought. That could be savings achieved through the reduction of outdoor irrigation where sufficient saving can be achieved, but could also entail a combination of reserves such as reservoir storage, groundwater, agricultural leasing arrangements with farmers, etc.

2.4.4. SUMMARY OF CONSIDERATIONS

In summary, the following questions are beneficial to review when developing drought stages, trigger points, and response targets:

³ Note: These actions are not to replace the staged drought response program discussed in Step 6 (Section X). For instance, a response target of "Level 1 Restrictions" may have a corresponding staged drought response program detailing the specific Level 1 Restrictions such as voluntary restrictions to lawn watering to two times a week and hand watering of large landscape features.

- How many drought management stages are appropriate for the provider’s water system and, if the stages are named, what names best represent the general message conveyed to the public for each stage?
- Should trigger points be developed during this drought management planning effort (in advance of a drought) or be determined at the onset of a drought in order to maintain decision-making flexibility? Or is there a balance of the two approaches that is more useful for the provider’s drought response effort?
- If trigger points are not established, what process will the provider use to determine the need to declare a drought and adjust drought stages? Details of this process in the Drought Response Operational and Administrative Framework, as described Step 7.
- What are the goals for a program responding to a particular stage of drought? Will response targets or goals be stated in terms of the amount of water reduction needed or in terms of the type of response actions taken?
- Will response targets be established for each drought stage before a drought occurs or will the specific goals be established once the degree of response required by a particular drought is known? Customer use data for at least the past five years should be evaluated before identifying response targets.
- What level of water supply planning will be used to support the definition of drought response targets prior to a drought? What hydrologic and water system data will be useful to compile and document in preparation for decision making during a drought?
- Do specific procedures need to be identified to “come out of a drought?” In other words, can certain criteria be developed to indicate that a drought is over? What procedures are necessary to de-escalate a drought stage?

2.5 STEP 5: DROUGHT MITIGATION AND RESPONSE STRATEGIES

This step involves the screening and selection of drought mitigation and response strategies. These strategies include actions that may be implemented to address potential impacts either prior to a drought (mitigation) or in direct response to a drought (response strategies). In Step 6, the selected response strategies are refined into specific response measures that focus on specific actions to be taken for identified drought severity levels.

2.5.1 OVERVIEW OF MITIGATION AND RESPONSE STRATEGIES

Common drought mitigation and response activities are listed in Table 5 (See also [Worksheets B](#) and [C](#)). As previously discussed, drought mitigation is typically defined as long-term actions that can be taken prior to a drought’s occurrence. However, some of the items identified in Table 5 may be considered both mitigation and response strategies. The distinction between mitigation and response depends on the timing and how the provider intends to implement the strategy. For instance, the rehabilitation of wells

(i.e. restoring the production of wells to their most efficient condition through various treatments and construction methods) can be viewed as mitigation if done routinely to ensure that wells are at their maximum production level when a drought occurs. Conversely, well rehabilitation may be a response strategy if wells are rehabilitated following declaration of a drought.

Table 5: Common Mitigation and Response Strategies

Mitigation and Response Strategies	Long-term Mitigation Actions	Short-term Response Strategy
Monitor drought indicators (snowpack, streamflow, etc.)	X	X
Improve accuracy of runoff and water supply forecasts	X	
Identify state and federal assistance	X	X
Provide emergency water to domestic well users		X
Establish drought reserves	X	
Draw from drought reserves		X
Rehabilitate operating wells	X	X
Increase use of recycled/reclaimed water	X	X
Utilize ditch water or treated effluent for irrigating landscaping/parks	X	X
Build new facilities to enhance diversion or divert new supplies	X	
Implement a cloud seeding program	X	X
Conduct water distribution system audits	X	X
Repair leaks in water distribution system	X	X
Reduce water distribution system pressure		X
Replace inaccurate meters	X	
Educate customers on how to save water	X	X
Install water saving fixtures, toilets, and/or appliances	X	
Reduce street cleaning, sidewalk and driveway washing		X
Limit outdoor watering to specific times of the day	X	X
Limit number of watering days per week	X	X
Convert sprinkler to low volume irrigation where appropriate	X	X
Enforce indoor water restrictions		X
Enforce reduction of water-cooled air conditioning		X
Turn off indoor and outdoor ornamental fountains		X
Require car washes to install water recycling technology and/or other Best Management Practices (BMPs)	X	X
Establish water shortage pricing	X	X

Water providers generally have two ways to respond to drought: acquire additional supplies and reduce demand. Mitigation and response strategies that focus on the management of water supplies and the water supply system are generally referred to as supply-side actions; whereas demand-side mitigation and response strategies focus on actions the provider can take to encourage reductions in their customer water demands. This section provides a background on commonly implemented supply- and demand-side mitigation and response strategies.

2.5.2 SUPPLY-SIDE MITIGATION AND RESPONSE STRATEGIES

A comprehensive list of supply-side mitigation and response strategies are provided in [Worksheet B](#). These supply-side mitigation and response strategies include

- Supply elements of a drought management plan and other plan;
- Leverage existing assets through infrastructure upgrades and existing system flexibility;
- Expand water supply portfolio with new sources;
- Seek opportunities to collaborate with other entities to increase supplies
- Increase water use efficiency; and
- Emergency response.

Many of the items listed above can be difficult to implement quickly, requiring proactive planning prior to a drought. Some of these actions also involve balancing environmental and jurisdictional considerations and if the supply reserves are used, these supplies must eventually be replenished. Despite the inherent difficulties, even minimal supply augmentation programs have been helpful in water shortage situations. Developing extra water supplies increases utility credibility with customers by demonstrating that the water supplier is maximizing its efforts to deal with the water shortage. Also, supply augmentation can provide a water shortage buffer in case of multi-year shortages or can be used to minimize the amount of demand reduction needed to meet temporary supply deficits.



Providers should also demonstrate a visible commitment to efficient water use, both before and during droughts. Actions that make a provider's operating system more efficient and save water set a good example for the public and can foster community buy-in through leadership. System water audits can identify major water losses. Once a provider quantifies their system losses, leak detection, repair programs, and a possible meter replacement program may be instituted. Municipalities can also coordinate fire department pressure checks with main flushing to accomplish both tasks with the same water. Water suppliers can reduce system pressure as permitted by fire-fighting standards and to the extent that water quality is not threatened from potential groundwater inflow to treated water distribution piping.

Other water supply augmentation supply options include the blending of lower quality water with higher quality supplies or special treatment devices may be installed. Groundwater wells can often be deepened and the pump-rate increased for limited periods of time. In some groundwater basins it may be possible during emergencies to temporarily increase the annual amount pumped. Well drillers often have waiting lists for their services during water shortages, so planning ahead can help ensure increased groundwater production when it is needed. It may also be possible to attract new recycled water customers during a drought. During extreme shortages, expensive new water supplies may be the only supply-side solution to meeting demands.

Brackish water nano-filtration, temporary pipelines, and even water importation by train or truck may become necessary. Nano-filtration can also be used to improve the quality of legally reusable water for drinking water purposes.

A diversification of water supply sources and system redundancy can increase the resiliency of a provider's water supply portfolio during drought. The acquisition of a diverse, resilient supply with ample reserves during a drought often requires years of planning and forethought while the evaluation of supplemental supplies for a drought ideally occurs prior to the shortage. Water re-use technologies and related policy is continuing to evolve, allowing for more options for providers to stretch available supplies. Drought mitigation and water supply reliability planning should ideally be an ongoing process where providers understand their water supply availability and demands could be during drought and are prepared to meet those needs. See section 2.2.2 Identifying and assessing future vulnerabilities for more information on water supply reliability planning.

2.5.3 DEMAND-SIDE MITIGATION AND RESPONSE STRATEGIES

In addition to supply-side, demand-side mitigation and response strategies are necessary to conserve existing water supply during a drought. Demand reduction is the most straightforward way to address water shortages. Curtailment of water demand is directed at supplier and customer uses that are inefficient, wasteful, or able to be temporarily reduced or suspended. With proper planning, local water demands can be quickly and flexibly reduced, with relatively low cost in response to drought through the use of watering restriction programs and appropriate water rate structures coupled with focused public information programs. In 2002, Colorado cities and towns reduced their normal water demand by an average of about 10 percent or 100,000 acre-feet. Municipal demand reduction in 2002 allowed cities to cope with an extraordinary drought while sustaining only relatively minor, temporary damages.⁴ Some of these reductions have since become permanent, representing a changing ethic of how communities in Colorado use water and understand water scarcity. A comprehensive list of options for demand-side strategies, listed by customer type, is provided in [Worksheet C](#).

Actions to reduce water use during a drought can be taken by water providers themselves before asking customers to do the same. This demonstrates leadership and can be used to foster community support. One example is to reduce or stop turf irrigation and install low volume irrigation systems for shrubs and trees at all agency facilities. It is important to communicate both proactive and reactive steps taken by the utility, for example with a short story on the provider's website or social media. When appropriate, providers can implement water theft prevention programs, generally targeting street cleaners, water trucks, and construction sites. These programs save water and have high visibility. Thus, they complement the public education programs. "Water pirating" may become more common when local private wells go dry, especially in rural and foothill regions with inadequate supplies, and the need for water greatly increases. Customers will then be motivated to request a "hook-up" from their local provider.

Many demand-side strategies may be implemented as voluntary measures, be incentive-based (i.e., rebates/giveaways), or be mandatory. Voluntary outdoor watering restrictions are commonly used throughout the State during a drought. Often voluntary restrictions are elevated to mandatory when a drought is more severe and is usually needed if water saving targets are greater than 15 percent.⁵ Rationing, where water providers are allocated a certain amount of water a billing period may also be used. Customers that exceed this allocation are charged a penalty. Rationing allotments can be applied to

⁴ Luecke, Daniel F., Morris, John and Hydrosphere Resource Consultants. 2003
⁵ AWWA Manual M60

all customers with no consideration of individual circumstances or be customized to individual customers or groups of customers based on certain traits (e.g. similar sized homes and yards). Customized programs can be much more time intensive for staff and require relatively sophisticated metering and databases. Rationing programs are most successful when they are transparent, and the allotments are considered fair. Alternately a water provider may have water budgets for larger users; these can be adjusted for times of water scarcity and have the potential to result in significant water savings.

Providers can also implement new pricing structures during a shortage to incentivize lower water demands. These changes can take time to adopt and therefore are most effective as a part of the Drought Plan and formally adopted prior to a shortage. Such rate structures could be an inclining block rate structure where rates for indoor use for health and safety are lowest and additional uses (e.g. outdoor irrigation) are higher. Higher seasonal rates during the irrigation season can also reduce non-essential outdoor use. These types of pricing structures generally require sufficient water demand data to develop reasonable water use allotments for indoor and outdoor water use. Drought surcharges may also reduce demand and maintain adequate revenues to meet financial obligations. Such a drought surcharge would only be instituted during a water shortage and eliminated following the drought. Excess-use charge fees may also prove to be useful to enforce rationing, where customers are charged a fee if their use exceeds their rationing allotment. It is critical that price changes accompany consistent public messaging on what the price change is, why the change is being made and anticipated future changes when the water shortage changes. Pricing changes should also consider equity issues, be feasible for data management systems and staff to manage, be transparent, work in tandem with other drought response measures and consider public input. See section 2.7.4 Revenue Implications and a Financial Budgeting Plan on for more details.

WATER EFFICIENCY STRATEGIES AND DROUGHT PLANNING

Water efficiency planning focuses on achieving lasting, long-term improvements in water use efficiency while reducing overall water demands. It involves a combination of water efficiency strategies for reducing water demand regardless of whether there is a drought.⁶ Water efficiency strategies contribute to the reduction of water demands during drought and consequently may be considered drought mitigation. For example, irrigation audits and retrofits for parks in wet and normal years can improve sprinkler efficiency, reducing irrigation demands at all times including during drought. Whether a particular strategy is defined as solely water efficiency, drought mitigation, drought response, or a combination of any of these depends on the timing of the measure, how the measure is implemented by the provider, and the permanency of the change in water use.

Table 6 lists examples of water efficiency measures that may be implemented for long-term drought mitigation or solely as a temporary drought response strategy. Some of these strategies could be used to a limited degree as water efficiency measures or more extensively as voluntary or mandatory drought response measures. Well-coordinated water efficiency and drought plans are linked together, identifying strategies and actions that both serve as drought mitigation and water efficiency while also differentiating response strategies and actions that are only implemented in periods of a water shortage. It is recommended that components of a water efficiency plan that also provide long-term drought mitigation benefits be incorporated as drought mitigation in the drought management plan.

⁶ In contrast drought response strategies typically focus on short-term temporary savings during a water shortage.

Table 6: Examples of Water Efficiency Measures, Drought Mitigation, and Drought Response Strategies

Water Efficiency Measures	Drought Strategies	
	Long-term Mitigation	Short-term Response Strategy
Irrigation audits for parks and open spaces	X	X
Install water saving fixtures, toilets, and/or appliances	X	
Eliminate/reduce turf and landscaping irrigation	X	X
Reduce irrigation on parks and landscaping	X	X
Limit outdoor watering to specific times of the day	X	X
Limit number of watering days per week	X	X
Set time limit for watering	X	X
Prohibit watering during certain times of the year		X
Conversion of sprinkler to low volume irrigation where appropriate	X	
Identify high water use customers and develop water saving targets	X	X
Water budgets for large users	X	X

2.5.4 COORDINATION WITH OTHER ENTITIES

Providers may greatly benefit by coordinating mitigation and response strategies with other entities in developing supply- and demand-side response strategies. This includes coordinating demand-response strategy programs and conveying a consistent regional drought message, developing supplemental supply purchases and agency interconnections, and coordinating regional demand reduction strategies and/or projects. The providers can share the cost of emergency supplies and improve demand reduction media messages and program costs. Coordination with other entities also means being aware of regional plans here as well and making sure response and relief strategies are coordinated.

Working with developers can also be critically important for communities that are experiencing a lot of growth and are relying on the economic stimulus that comes from the growth. During water shortages the additional growth and demand for construction water can place additional strain on a system. Water providers can institute offset programs where developers collaboratively work with the provider in funding long-term water efficiency programs and/or temporary reduction programs that exceed the new water demand. Additionally, new customers could be encouraged to voluntarily adopt demand-reduction measures with a tap fee discount. Under extreme and exceptional droughts deferment of new development or landscaping installations is justifiable.

2.5.5 SELECTION OF MITIGATION AND DROUGHT RESPONSE STRATEGIES

Providers may find that several screening iterations may be necessary to develop a final list of feasible drought mitigation and response strategies. This Guidance Document recommends the following sequential screening steps:

1. Select preliminary mitigation and response strategies;
2. Conduct screening of the selected mitigation and response strategies;

3. Identify additional mitigation and response measures that could have been effective in addressing historical drought impacts identified in Step 2; and
4. Assess and refine combination of strategies as a whole.

PRELIMINARY SELECTION OF MITIGATION AND RESPONSE STRATEGIES

Worksheets B and C provide a means to select preliminary supply- and demand-side mitigation and response strategies and specify whether the selected actions are to be implemented as mitigation or as response strategies. *Worksheet C* also provides a means to identify whether a demand-side strategy is to be promoted on a voluntary basis, encouraged through incentives, or mandated, and whether it will be included in coordination efforts with other entities. At this step of the planning process (Step 5), a demand-side strategy could be selected for implementation on a voluntary and mandatory basis. Step 6 further refines these strategies into measures where, for instance, water restrictions may be implemented on a voluntary basis for mild drought conditions and be mandatory under severe drought conditions.

SCREENING OF MITIGATION AND RESPONSE STRATEGIES

A series of factors should be considered when selecting and evaluating mitigation and response strategies. *Worksheets B and C* also provide a means to assign a “ranking value” to the selected mitigation and response strategies according to how well each mitigation measure and response strategy meets the following factors:

- *Technical feasibility* – Is the selected mitigation or response strategy technically feasible and will it work as intended? Can implementation occur in a timely manner? Is there staff to implement the action?
- *Perceived benefits* – Will the selected mitigation or response strategy provide an adequate amount of water supplies and/or water savings?
- *Cost effectiveness* – How does the implementation cost compare with the benefits? This may simply be a qualitative assessment or quantitative comparison of ratios of implementation costs to the water savings cost benefit.
- *Public acceptance* – How favorably will the public react to the selected mitigation/response strategy? A review process of alternative means to engage the public would be beneficial to assess general public acceptance.
- *Environmental sensitivity and extraneous other impacts* – What are the environmental benefits/costs to implementing the mitigation and/or response strategy? Is there an environmental issue or other extraneous impacts that should be further considered?

REFINEMENT OF COLLECTION OF MITIGATION AND RESPONSE STRATEGIES

The final step of this process evaluates the selected group of mitigation and response strategies to ensure that the final combination meets the following criteria:

- Compatible with the provider’s water supply system and is feasible from an implementation standpoint;

- Consistent with the operating principles and objectives of the drought management plan;
- Fairly represents the needs of affected individuals and groups; and
- Sufficiently addresses potential water shortages and future impacts.

Refinements may be necessary later on in the drought planning process to ensure that these criteria still adequately meet or enhance certain aspects of the mitigation and drought response program. For instance, a provider may learn that drought surcharges inadvertently harm lower income families. In this situation, adjustments may be made to the drought surcharge rates or they may be eliminated altogether.

2.5.6 MITIGATION ACTION PLAN

Mitigation typically occurs prior to a drought. Given the unpredictable nature of droughts, the sooner providers are able to carry out mitigation efforts, the sooner they will be prepared for a drought that could occur any year. Mitigation action plans should provide sufficient guidance to carry out the mitigation effort. They can either be in the form of a document defining the details of mitigation actions or simply be a general mitigation schedule.

At a minimum, mitigation plans should include the general actions necessary to implement each of the mitigation items selected and detail: a schedule of milestones that a provider can realistically meet; division/staff responsible for administration of the project; and funding sources. An example of a mitigation schedule is provided in Table 7. Alternately, this section could reference and summarize mitigation actions in related planning mechanisms (e.g. multi-hazard mitigation plan, water efficiency plan, sustainability plan etc.).

Table 7: Example of a Mitigation Action Plan

Mitigation	Implementation Activities	Milestone Deadlines	Administration	Funding
Finalize Drought Management Plan	Plan reviewed by City Council	July 2020	Water resources planning division	General fund
Update Conservation Plan	Consolidate monitoring data	March 2021	Water conservation division	General fund
	Draft Plan Completed	June 2021	Water conservation division	General fund
Construction of additional storage for drought reserves	Drought Storage Reserves Feasibility Study	October 2020	Water resources planning division	General fund
	Complete permitting	October 2021	Water resources planning division	General fund
	Complete construction	September 2022	Operations and facilities	Bonds
Increase use of reclaimed water	Expand reclamation facility	September 2023	Operations and facilities	Bonds
	Develop storage and distribution system	June 2024	Operations and facilities	Bonds

A template of a mitigation schedule similar to the example above is provided in [Worksheet H](#).

2.5.7 PUBLIC DROUGHT EDUCATION CAMPAIGN FRAMEWORK

A public drought education campaign (public drought campaign) is one of the most common ways to combat a water shortage and is essential to a drought management plan. Water savings achieved from a campaign can range from 5 to 20 percent depending on the time, money and effort expended.⁷ Public drought campaigns raise awareness of the severity of a water shortage and can significantly reduce demand by influencing customer behavior. Public drought campaigns alone can result in water savings ranging from five to twenty percent, depending on the time, money, and effort spent.⁸ These campaigns also complement other demand-side response strategies, resulting in higher water savings than could occur without public education.

There are a variety of synergistic benefits to coordinating conservation education programs and public drought campaigns. Many of the messages and information conveyed in a conservation education program are similar to public drought campaigns. Furthermore, conservation education programs and public drought campaigns target similar audiences. Despite these similarities, the public drought campaign and conservation program should be distinguished from each other. Public drought campaigns focus on drought-related information and increase in level of seriousness during drought periods.

When developing a public drought campaign from scratch or modifying an existing public campaign, it is beneficial to review any past public drought campaign efforts and establish a basic framework for the campaign. The framework serves as a guidance tool for developing a detailed public drought campaign plan which is discussed in Step 6 of this drought management planning process. The framework identifies the following:

- Target audiences;
- Communication tools used to convey drought information;
- Primary messages to be conveyed; and
- Opportunities for coordinating with other entities.

The following recommendations are important to consider when developing the public drought campaign framework:⁹

- *Provide information to local decision makers* regarding why certain actions are needed, why special arrangements for communication and coordination will be called for, and the possible need for both emergency funds and emergency powers.
- *Encourage governmental bodies* (e.g., park and fire departments, universities, recreational facilities and other water-dependent agencies) to provide leadership by taking timely actions to reduce demand and provide examples to the public. Government actions can go beyond the efforts being asked of the public and occur quickly and at the initiation of the agencies themselves. The provider takes the lead and works with local elected officials and the media to promote cooperation and

⁷ AWWA Manual M60. 2019.

⁸ California's Urban Drought Guidebook 2008 Updated Edition developed by the Department of Water Resources

⁹ These recommendations are taken directly from California's Urban Drought Guidebook 2008 Updated Edition. Pp 102-103. Developed by the Department of Water Resources

commitment from governments in its service area. Governments are willing to respond, especially if given technical guidance.

- *Provide detailed information to industry, schools, retailing, and other groups* that are asked to comply with specific use restrictions. Also, call upon these groups to suggest alternatives to the proposed rationing program that might achieve an equivalent level of demand reduction with potentially less economic harm. Innovative ideas have been generated by the private sector in past droughts. At a minimum, this approach will help ensure willing participation by demonstrating a genuine interest in their perspective.
- *Provide frequent briefings to the press and other public communication media* to ensure timely, consistent and accurate communication. Provide updated information on water supply conditions and outlooks as conditions evolve. Be especially watchful for human interest stories. Telling the media of specific instances of an individual or group making sacrifices for the common good is a way the water supplier can show appreciation for conservation efforts.
- *Coordination with other entities* to coordinate consistent drought-related messages from providers in the region, particularly in the same media markets. There are frequently significant differences in the supplies available to adjacent providers. If customers served by one provider are asked to reduce their water use as much as 30 percent while their neighbors served by another provider are only asked to conserve 10 or 15 percent, the equity of the program will be questioned. Coordination with other entities on the messages delivered to the public can help alleviate potential conflicts and improve overall water savings on a regional level.
- *Convey progress* – of ongoing drought response efforts and success of these efforts including updated estimates on the amount of water being saved through community efforts and how that relates to the response targets.

Public drought campaigns can incorporate a great deal of creativity and there are multiple drought-related messages and techniques to convey this information. Establishing a community advisory committee (e.g. community ambassadors) can be helpful in developing meaningful messaging that will resonate with the public and help general community buy-in. A list of initial ideas is provided in [Worksheet D](#), which consists of a matrix designed to help develop the initial framework. Additional ideas may be obtained from case studies in Section 4 and from other drought management plans posted on [CWCB's website](#)¹⁰.

2.6 STEP 6: STAGED DROUGHT RESPONSE PROGRAM

The staged drought response program specifies the drought response measures required when a drought occurs. These response measures include actions taken by the provider and by individual customers identified in Step 5. These response measures are laid out by drought stage and generally increase in intensity from the initial warning stage (Stage 1) to the most critical drought stage.

It is important that the combinations of response options for each stage are appropriate for the severity of the water shortage. The actions taken should be adequate to deal with the drought situation while

¹⁰ <https://cwcb.colorado.gov/drought>

minimizing impacts on economic activity, environmental resources, and the lifestyle within a region, to the extent feasible.

The response strategies selected in Step 5 provide the initial means to develop individual response measures for each drought stage. Table 8 provides an example of response strategies and the corresponding response measures for a three-staged drought program. The response measures increase in water saving potential from mild drought conditions for Stage 1 to more severe conditions for Stage 3. [Worksheet G](#) provides a means to list the Step 5 selected response strategies and develop corresponding staged drought response measures similar to the example shown in Table 8.

Table 8: Response Strategies and Corresponding Drought Measures

Example Response Strategies	Drought Measures		
	Stage 1	Stage 2	Stage 3
Serve water in restaurants only upon request	Restaurants and catering businesses will be asked to voluntarily restrict serving water with meals except on customer's request.	Restaurants and catering businesses shall not automatically serve water with meals but may serve water when a customer requests it.	Restaurants and catering businesses shall not automatically serve water with meals but may serve water when a customer requests it.
Limit number of watering days per week	Customers will be asked to voluntarily reduce outdoor water use.	Water shall be limited to two days per week according to a watering schedule.	Water shall be limited to one day per week according to a watering schedule.
Establish percent water use reduction goals	Customers in the high public use category shall manage water use in a way that reduces their seasonal water use by 10 percent.	Customers in the high public use category shall manage water use in a way that reduces their seasonal water use by 20 percent.	Customers in the high public use category shall manage water use in a way that reduces their seasonal water use by 40 percent.

The drought management plans posted on CWCB’s website provide numerous examples of staged drought response programs. These plans can be used to generate ideas and formulate a new plan. [Worksheet G](#) provides a template for providers using a similar format.

Although enforcement is discussed in greater detail in Step 7, it is important to mention here that staged drought response plans often summarize how the response measures will be enforced for each individual stage. This places a level of responsibility on the customer.

A consolidated table summarizing the drought stages, triggers, response targets, response measures, and corresponding enforcement is also an effective means to convey information to the public. It also serves as a useful quick reference for internal purposes that could be distributed as a “stand alone” summary of the drought management plan. Staged drought response tables may be distributed to the public, posted on the provider’s website, or included in an executive summary to the drought management plan.

2.6.1 SUMMARY OF STAGED DROUGHT RESPONSE PROGRAM CONSIDERATIONS

Prior to finalizing the staged drought response program, it is worthwhile to review the following considerations to help ensure that the program will be effective and appropriately address drought:

- Do the response measures and enforcement appropriately reflect the drought management plan's objectives and principles developed in Step 1?
- Is implementation and enforcement of the staged drought response program feasible and realistic? Will it likely meet the response targets? Are any adjustments necessary to make the staged drought response program more compatible with the provider's water supply system?
- What is the timeline between when the measure is implemented and when water savings are realized? Does this timing fit within the staged drought response targets?
- Does the program provide sufficient flexibility if response measures and/or drought stages need to be adjusted during a drought in order to address unforeseen conditions? Particular focus should be placed on how the staged drought response plan is presented in the drought management plan. One suggestion is to include text in the plan stating that "the staged drought response plan is based on the best available information to date and future adjustments may be necessary prior to or during drought periods to sufficiently address water shortages."
- How receptive is the public to the staged drought response plan? How severe are the cost implications on the customer?
- Does the staged drought response plan fairly represent the needs of affected individuals and groups? Are some groups adversely affected more so than others? Can adjustments or compensation be made to address a potential issue?
- How will the effectiveness of the response measures be monitored? Monitoring is important to ensure that the response program is effectively meeting its targeted goals and in identifying adjustments that can be made to further enhance the program.

2.6.2 PUBLIC DROUGHT CAMPAIGN PLAN

Detailed public drought campaign plans may be developed as a component of the staged drought response program. These plans lay out the specific public drought campaign activities by individual drought stage. Detailed public response programs can also be developed just prior to a drought declaration to appropriately address up-to-date conditions. Providers may also simply develop public drought campaign guidelines for each stage and then develop the detailed plan prior to the drought declaration.¹¹

Regardless of when the detailed public drought campaign is developed, it is important to continue a certain level of public drought education in average water years. This maintains public awareness of Colorado's semiarid climate and its susceptibility to drought, which can shorten the public response time when a drought does occur. As an example this could be incorporated into general water conservation/water efficiency messaging campaigns.

¹¹ The public drought campaign framework in Step 4 should be used to develop the detailed public drought campaign plan.

The remainder of this section provides tips on the implementation of public drought campaigns and can be useful when developing a detailed campaign¹².

- Provide information to the public on a regular basis about the water supply situation, what actions are being proposed or being taken, how those actions will mitigate supply shortages, and how well customers are meeting program goals.
- When appealing to customers for water use reductions, act equitably, credibly and consistently. Demonstrate to the public that the provider is doing everything possible to minimize the shortage. Pursue supply options vigorously; if new supplies are too costly or not achievable in a short time, communicate that fact. Publicity about changes in provider operation and maintenance practices that conserve water is helpful. Also, provide accurate information concerning supply status (i.e., reservoir and ground water levels), water use reductions, and other pertinent information to all company personnel, especially those briefing the media or involved with public education, as well as meter readers and billing department employees. Photos of reservoir levels can help convey the reality of the drought and the need for conservation measures.
- Development of a public information campaign may specify a timeframe for conveying drought information.
- In dealing with the media, have one person speak for the provider. Immediately respond to media inquiries to maintain communication links and to avoid media representatives seeking alternative, less informed information sources. Good communication provides opportunities for a water supplier to tell its story and ensures that knowledgeable people will be called upon to speak on the issues. Partnerships with major media outlets are recommended.
- Before developing water shortage related public information strategies, there are several important issues to keep in mind about program focus and content. First, emphasize that the water supply situation is unpredictable and may change from month to month. No one can be certain when the situation will improve. Even if precipitation increases, the effect on the water supply may not be immediate. The provider needs to proceed cautiously by starting demand reduction programs early and avoid relaxing any measures too soon. Also, customers need to realize that the drought impact is not uniform across a state or region and that the problem will be more severe in some areas and less severe in others.
- Some classes of customers may carry the burden of coping with the water shortage more than others. Some groups with high potential for reduction may be asked to reduce water use more than others, but avoid discrimination within a class of customers. Landscape irrigation may have to be curtailed. Conversely, it may be decided to minimize water reductions to commercial or industrial users. It may prove valuable to invite some representatives from these customer groups to the table during the drought planning process.

¹² California's Urban Drought Guidebook 2008 Updated Edition developed by the Department of Water Resources

- Make the public aware of the impact of the water shortage on water system costs as early as possible. Reduced water sales will obviously reduce revenue. Most providers have fixed costs on the order of 75 to 80 percent of their total budget and the public needs to know this. There may be significant additional costs incurred for purchasing water, conservation programs, emergency pumps, pipes, other equipment, increased water quality testing, and other water shortage related activities. These costs will be borne by the system users. Additional information on drought and budget revenue implications is provided in Section 2.7.4 Revenue Implications and a Financial Budgeting Plan.
- Avoid being placed in an adversarial position. Focus on the emergency at hand without blame implied toward the provider's management or a customer class. It is important to tailor the public information program to the type of community served. For large decentralized areas, methods that allow the water supplier to reach many customers relatively inexpensively such as websites, email, direct mail, bill inserts, and media advertisements are appropriate. Smaller, close knit communities with central business districts may also be well served by a central information center.
- Public information programs provide long-term benefits by increasing the customers' understanding of their water use and of the provider's operations. Such an understanding will be useful in generating public support for future efforts regarding rate increases or new efficiency and supply projects.
- When undertaking any public information effort, it is crucial that the information be accurate and consistent and that requested use reductions be commensurate with the seriousness of the situation. In other words, the customer must understand what the trigger conditions are, what the consequences of the different stages of drought are, and how the emergency measures will help relieve or minimize the problem.
- Simple ways to convey complex information will be beneficial, such as a drought "thermometer" as a visual aid to communicate the level of drought.
- Putting public health and safety at the forefront of messaging and priorities can help to serve to unify and equitize the shared strain.
- Restrictions and cutbacks may create unhappy customers looking for someone to blame. It will be important to train call center staff to be prepared with messaging such as why they might be paying more for less and the logic behind the surcharges.
- Droughts also provide a messaging opportunity to discuss watershed management and how it provides additional yield.
- Placing emphasis on the provider focusing on minimizing water distribution system losses can show accountability and responsibility in supply management

2.7 STEP 7: DROUGHT RESPONSE OPERATIONAL AND ADMINISTRATIVE FRAMEWORK

Step 7 addresses the operational and administrative framework for implementation of the drought management plan. Implementation involves carrying out a mitigation plan, monitoring drought indicators on a regular basis, following drought declaration protocols, implementation and enforcement of the staged drought response program, revenue planning, and monitoring of the drought response effort and making appropriate changes when necessary. It is important that the general processes, schedule, and roles and responsibilities are defined in advance to facilitate an effective drought response and avoid/minimize drought related impacts.

2.7.1 DROUGHT DECLARATION PROCESS

The plan should outline who declares drought, and how that is communicated to key water users and the public. The appearance and nature of droughts can be variable and, as previously discussed, providers may find it difficult to develop a set of hard and fast rules to declare an official drought. Whether specific trigger points are clearly defined prior to a drought or left to the expertise of the provider and existing drought indicator data, the general decision making process for publicly declaring a drought and a drought stage should be clearly outlined including the following:

- General guidelines used by the staff to assess drought conditions. This may include pre-determined drought trigger points, real-time drought indicator data, existing storage and projected demands for the season and judgment based on past experience, and understanding of the provider's water supply system.
- Identify decision makers (i.e., city council/board) responsible for officially declaring a drought.
- If the decision makers are not the same people responsible for drought monitoring and assessment, develop a protocol for how drought information from water resources staff is conveyed to the decision makers. This could be facilitated through the development of a stakeholder drought management team similar to Drought Committee discussed in Step 1, a series of meetings among staff and decision makers, official report(s) documenting drought conditions and recommendations, etc.
- Identify the person responsible for delivering the official drought declaration and corresponding drought stage to the public.
- Describe the timing of when the decision makers are informed of a potential upcoming drought and, subsequently, when a drought may be officially declared to the public, initiating the staged drought response program. Timing may vary on a drought-by-drought basis depending on various conditions of a particular drought. Disclose considerations taken regarding the timing of when to inform the public.

Identify procedures needed to “come out of a drought.” Can certain criteria be developed to indicate that a drought is over? What procedures are necessary to de-escalate a drought stage?

2.7.2 IMPLEMENTATION OF THE STAGED DROUGHT RESPONSE PROGRAM

The implementation of the staged drought response program can require significant coordination among different departments and staff. It is essential that a series of guidelines and roles and responsibilities for

implementation of the program are clearly identified. The following factors should be considered when developing a set of guidelines and roles and responsibilities:

- Staff responsible for administering and implementing the staged drought response program. Additional staff may need to be hired.
- Primary staff responsible for communicating the drought message to the public. This needs to be a clear and consistent message communicated through a variety of established media channels including traditional media (radio, tv, newspapers, billboards) and social media.
- Staff responsible for administering and implementing the public drought campaign. Additional staff may need to be obtained depending on the scale of the program.
- Communication and coordination protocol among entities/staff administering the public drought campaign, staged drought response program, and drought monitoring. This may be developed in advance of a drought or defined more specifically at the onset of a drought when staff are initiating the staged drought response program. At minimum, regular staff meetings and communication will be necessary among all involved personnel to ensure that the program is properly carried out.

Worksheet 1 provides a template for noting staff and corresponding roles and responsibilities.

2.7.3 ENFORCEMENT OF THE STAGED DROUGHT RESPONSE PROGRAM

Mandatory response strategies such as water restrictions often necessitate a means of enforcement beyond simple education in order for customers to appropriately respond. Warnings, citations, fines, and, in severe cases, installation of flow restrictors inhibiting a customer's water use or terminating service altogether are common enforcement mechanisms. The severity of a penalty should increase with the number of violations.

Providers may need to use existing staff or hire temporary staff to patrol the service area and enforce drought response measures. These patrollers can be referred to by a variety of names. Denver Water has used "Water Savers" while other ideas include "water cops" or "waste busters." The main focus of these patrollers is to educate the customers on saving water and offer assistance; however, citations and penalties should also be delivered when warranted to enforce the program. Patrollers also offer a visible reminder to the public of the seriousness of the situation.

There are a variety of other tools that can be used to encourage compliance with mandatory response measures. Photos or videos made during periods when irrigation is not allowed can also be a useful tool in demonstrating to managers and non-residential property owners that their irrigation systems are in need of repair or adjustment. Conversations local government employees have in the community can also influence customer behavior. Customer phone and web-based hotlines can also be effective. Community members can report the location of infractions which can save a great deal of time and money by targeting monitoring efforts and increase the credibility of the provider if response is quick. However, one disadvantage of this approach is that tensions among a community can be intensified if neighbors use the reporting system as a means to "get back" at another neighbor or conversely a neighbor who is reported takes the report personally. Police may also be used as an effective means to communicate the

conservation message; however, police are generally not used for enforcement purposes unless there is a specific problem with a customer.

The level of enforcement and corresponding amount of resources a provider uses for enforcement increases with each drought stage. For instance, a Stage 1 warning level may not warrant severe enough conditions for the cost expenditure to hire additional staff for enforcement. However, Stage 3 critical conditions may necessitate the need for temporary staff to patrol the service area and assess penalties for infractions.

An appeal process for customers charged of violations is also recommended. This enables customers to present their case and be considered for an exemption depending on the circumstances. Policy conditions should be developed to specify conditions under which exceptions can be made for certain violations. For instance, under certain providers' plans, a customer served a citation for irrigating new turf grass may be exempt from the water restrictions for the early drought stages. Alternatives may also be provided to customers instead of paying a fine such as a mandatory water conservation classes, interior and exterior water use efficiency retrofits, water audits, etc.

SUMMARY OF ENFORCEMENT PLAN COMPONENTS

The following components need to be considered when developing an enforcement plan. Some of these components may involve specific decisions more appropriately made just prior to a drought declaration. However, it is important that each of these components is addressed during this planning process.

- Develop enforcement policies appropriate for each drought stage.
- Identify the level of monitoring/patrolling necessary for each drought stage. Who will be responsible for patrolling the service area and issuing citations? Will additional temporary staff need to be hired? What training will be necessary?
- Identify how information on the enforcement will be conveyed to the public.
- Develop an appeals process and possible exemptions to enforcement procedures under certain circumstances.
- Identify who is responsible for administration of the enforcement effort and approving exceptions to the enforcement policy.

2.7.4 REVENUE IMPLICATIONS AND A FINANCIAL BUDGETING PLAN

A reduction in customer water use can result in a revenue shortfall for providers. Increased costs associated with implementation of the staged drought response program can further intensify the shortfall. As the staged drought response program is developed and implemented, it is important to consider the provider's current financial situation and plan accordingly.

Revenue budgets may be balanced by either raising water rates and/or imposing drought pricing structures such as an excess-use-charge if a provider is enforcing rationing or by imposing a drought surcharge. Providers may also consider establishing financial reserves for drought/emergency situations, borrow funds and seek any available external drought funding assistance. Another option is to use water budget rates to reduce use while keeping revenue nearly whole during initial stages of the drought.

Regardless of the method(s) selected to incorporate into a revenue program, the following steps may be used to evaluate and balance the budget:

- Estimate lost revenue by projecting the amount of water use reduction. The staged response targets may be incorporated into this evaluation if they are representative of actual water savings.
- Estimate additional costs incurred by the drought. This may include additional expenses necessary for new drought supplies, increased water quality monitoring, administration and enforcement of the staged drought response program, drought public campaign, enforcement etc.
- Determine whether water rate adjustments or surcharges are necessary and at what associated amounts.
- If water rates need to be raised, educate the public why the rates are being raised and why additional resources are needed to conserve and manage supplies during times of drought.
- Compare actual revenue with forecast revenue and adjust water rates/surcharges appropriately.

2.7.5 MONITORING DROUGHT RESPONSE



Step 3 addresses the monitoring of drought indicators which should be done on a routine basis. However, during drought or a water shortage the frequency of monitoring and type of data collected may increase. [Worksheet F](#) provides a means to record total projected water demands and allocate these demands by priority to assess water savings achieved.

Monitoring also provides the information and data necessary to focus drought management plan improvements on actions that best increase the effectiveness of the overall plan. Monitoring is both an ongoing and post-drought evaluation process. Ongoing monitoring may include testing components of the drought management plan when a drought is not occurring. This could simply involve an exercise where staff presents what they would do in the event of a drought according to their roles specified in the drought management plan. This exercise can provide valuable insight into coordination difficulties among staff and departments, shortcomings of the drought management plan, and conflicting interpretations of the plan itself. Furthermore, staff changes can result in confusion of roles and responsibilities and an activity that help staff work this out can significantly improve the provider's internal response to drought when a drought does occur.

It is important for staff to record experiences and data collected during the drought to inform future planning processes. Monitoring data provides a means to assess the effectiveness of the drought mitigation and response measures during a drought, make adjustments to the response measures if necessary, and develop recommendations for updating and improving the plan. Documentation and thorough collection of monitoring data are critical to ensure that the lessons learned from past droughts remain within the institutional memory.

The staff/departments responsible for data collection, evaluation, and providing recommendations to the decision makers should be disclosed in the drought management plan and the type of monitoring data collected should also be specified. This may include the following:

- *Demand data* – Comparison of average historical demand data to demands during a drought provides insight into the effectiveness of the drought response measures.
- *Lessons learned* – Key issues, challenges, and concerns during implementation of the staged drought response plan.
- *Conditions of the water supply system* – This may include reservoir levels, water treatment plant production, call data, water obtained from direct flow rights, storage rights, groundwater pumping, etc. This information is crucial to carefully managing the system during periods of shortages and generating data that may be applied to future drought planning efforts.
- *Public perceptions and response to the drought* – Public opinion can be gathered in a variety of ways during and immediately following a drought. This includes documenting comments provided at public meetings or public city council/board meetings, electronic emails/letters sent to the provider, formal public surveys, etc.
- *Administrative staged drought response program data* – This may include the number of citations delivered to customers, number of incentives distributed, number of hotline calls received, etc. Records should also be maintained on the level of effort the staff put into facilitating the staged drought response measures and public education campaign.

2.8 STEP 8: PLAN APPROVAL AND ADOPTION

Step 8 involves the formal processes necessary to review, approve, and update the drought management plan. This includes a public review process and approval by the local government (i.e., city council/board).

2.8.1 PUBLIC REVIEW PROCESS

A public review process is important to the development of effective drought management plans. This process can reduce future objections and conflict during drought periods and also help ensure that the plan reflects the general values of the community. Providers should follow the appropriate rules, codes, or ordinances to make the draft drought management plan available for public review and comment. If there are no rules, codes, or ordinances governing the entity's public planning process, then each provider should publish a draft plan, give public notice of the plan, make such plan publicly available, and solicit comments. CWCB guidance is to make the plan available for a period of not less than 60 days.

The public may be involved in a variety of ways during the development of the drought management plan. Key public representatives can be included on the Drought Committee or a separate public advisory group can be developed to discuss key elements of the plan during its development. A public advisory group and/or frequent public meetings during a drought may prove beneficial in addressing public questions and conflict. Such a group should include sectors of the community most impacted by the drought including industry, tourism, landscapers, golf courses, parks, etc. Other considerations may include diverse, non-standard audiences or existing social groups and various businesses. Public meetings and outreach can help ensure an appropriate level of inclusion and feedback.

Prior to final approval of the plan, the public should have the opportunity to review and comment on the plan. Draft plans can be presented on the provider's website, emailed, and available in hard copy at the

provider's office. Public meetings, workshops, or open houses can also be scheduled to address public feedback. An example case study for Durango is provided in Section 4.

2.8.2 PLAN ADOPTION OR PROMULGATION

Decision makers including city council/board members should have an opportunity to review drought management plans and comment before the document is finalized. Plans that are officially approved or adopted tend to hold more credit when a drought arises than documents that decision makers have not had an opportunity to review and discuss. The drought management plan itself should document the approval or formal adoption of the plan.

Implementation of the drought management plan can require the development of new policy. For example an official drought declaration policy authorizing a specific staff member or elected official to declare the drought may be necessary. Water wasting ordinances and enforcement policies may also be necessary. As the drought management plan is being developed, it is important to identify the specific policy necessary for implementation, draft the policy, and have the policy approved through official processes. This ensures that the plan can legally be implemented in times of drought. Official agreements with entities the provider may coordinate with during a drought may also help speed response time when a drought occurs.

2.8.3 PERIODIC REVIEW AND UPDATE

Drought management planning is most effective when viewed as an ongoing process rather than a discrete process that results in a shelved document only reviewed at the onset of a drought. That said, it is recommended that the drought management plan be updated, at a minimum, every five years. It is recommended that the following is included in a drought management plan:

- Frequency of when the plan is to be updated;
- Anticipated date of the next plan update; and
- Who is to take the lead in initiating the plan update and collect monitoring data.

Section 3 Drought Plan Template

This section provides recommendations on the organization and content of drought management plans according to the eight common drought planning steps introduced in this guidance document. A template for a drought management plan is also provided that may be used as a starting point by entities developing their own plans.

3.1 ORGANIZATIONAL TIPS FOR DROUGHT MANAGEMENT PLANS

Drought management plans are important documents water management staff and decision makers rely on to implement drought mitigation and appropriately respond to a drought. These plans can also be an important tool in managing public expectations and behavior during times of a drought. The following items address how the planning document may be organized to best meet the needs of the public,

decision makers, and water management staff. Please note that these items are merely tips that providers may incorporate into their planning process and not requirements.

- *Executive summary* – Executive summaries provide an effective means to convey the basic information excluding the onerous details that only the water management staff may be concerned with. These summaries can be directed towards the public, media, and decision makers. At a minimum, executive summaries should address: the selected drought mitigation measures; staged drought response program; drought stages, triggers, and response targets; and the information and process used by the decision makers to declare a drought. Condensed fact sheets may also be useful in conveying the highlights of the plan to the public and decision makers.
- *Multiple documents* – Some providers may find it appropriate to split the drought management plan into two documents. The first document may provide the basic content of the plan and be written in layman terms for the public, media, and decision makers, while the second more detailed version could provide the technical details and background needed by water management staff to implement the plan.
- *Appendices* – Appendices are another means to separate detailed technical information from the rest of the document. These may include documentation of drought specific policies and ordinances, detailed water supply reliability planning data incorporated into the drought management plan, detailed historical demand and water supply data, etc.
- *Example Drought Management Plans* – Drought management plans submitted to the State are posted on CWCB’s website. These plans may provide additional ideas on organization and report format.

3.2 HOW TO USE THE TEMPLATE

Providers throughout the state have a diverse portfolio of water rights and water supply sources and are presented with unique drought-related challenges. Drought management planning must be customized to the needs of each individual entity and also fit within the financial constraints dedicated to developing a drought management plan. For example large municipal providers that have complex water supply systems and a large customer base will likely require more detailed plans than a small provider with a relatively simple system and limited budget for drought planning.

This template provides a framework that local governments or special districts may use to develop drought management plans. The template is organized according to the eight-step planning process discussed in Section 2. The template includes checklists of recommended content. Providers may use these checklists to ensure that they are including all applicable information in their plans. Some of this information will not be applicable to certain organizations, while others may not have the resources to develop a detailed plan that includes all of the recommended information. Furthermore, the organizational structure may not be suitable for all providers. Modifications to the template to better reflect a provider’s system and needs are anticipated and acceptable.

The objective of the template is to not lay out a list of “requirements” water providers must include in their plans, but rather present a list of possibilities and allow the provider to decide what information is

applicable and beneficial for their drought management purposes. However, there are *essential* items necessary for development of effective drought management plans.

- *Essential* – This information is necessary for effective drought mitigation and response planning and must be included in the drought management plan to be approved by the State.
- *Beneficial* – While not essential, this information provides added value to the effectiveness of drought planning and may be necessary for some providers.

The template should be used in conjunction with the detailed drought planning information in Section 2 and worksheets provided in the appendix. These worksheets are noted in the template where appropriate and provide a useful resource for generating ideas, organizing information, and formatting data for direct incorporation into the plan.

3.3 TEMPLATE FOR A DROUGHT MANAGEMENT PLAN

1.0 Introduction and Planning Process

This section introduces the concept of drought management planning and provides a general background on service area and existing water supplies. Information on historical drought planning efforts and how the drought plan relates to other plans could also be addressed. An executive summary could be placed before the introduction to summarize the key aspects of the plan, if desired.

1.1 Drought Management Planning Overview

Objective: Provide a general description of the drought management plan and drought. Background information is provided in Section 1.

- Description of purpose and scope. (beneficial)
- General description of a drought. See Section 1.2. (beneficial)

1.2 Drought Planning Committee

Objective: The members and size of the Drought Committee will vary among providers. Larger providers will likely have a more involved stakeholder process than smaller providers with limited drought planning resources and staff. This section provides an overview of the stakeholder process. See Section 2.1.1 for more information.

- Role of the Drought Committee in the development of the drought management plan. (essential)
- Drought Committee members including their job title and description of expertise. (essential)
- Importance of a stakeholder process. (beneficial)
- Explanation of the Drought Committee selection process. (beneficial)
- Summary of the Drought Committee planning meetings held during the drought management plan development process. (beneficial)
- Appendix containing meeting materials (meeting agendas, minutes, presentations, etc.) (beneficial)

1.3 Historical Drought Planning Efforts

Objective: Describe historical drought planning efforts, as applicable. (beneficial)

- Overview of historical drought planning efforts. (beneficial)
- Explanation of modifications made to the current drought planning effort and how this plan is an improvement to historical efforts. (beneficial)

1.4 Relationship to Other Planning Mechanisms

Objective: Provide an overview and cross reference related planning efforts. For example drought mitigation, response planning, and conservation planning are closely interrelated processes. County multi-hazard mitigation plans may be a source of information on drought history and vulnerability and often contain mitigation action strategies that may benefit or enhance local planning efforts. Effective planning coordinates related planning efforts and builds resiliency.

- Description of how the drought management plan is coordinated with the State Drought Plan and other local plans, including county or municipal level multi-hazard mitigation plans and emergency operation plans, water management plans, sustainability plans, basin implementation plans etc. to reduce redundancy and capitalize on joint efforts. (essential)

1.5 Profile of Existing System

Objective: Provide an overview of the existing system and service area. This should be fairly general information and does not entail disclosure of “sensitive” information that could result in future public safety concerns.

- Profile of service area – map or description of the service area and discussion of key water related infrastructure (e.g., water treatment plants, reservoirs, well fields, etc.) (beneficial)
- Profile of existing supplies – general overview of the provider’s water supplies, storage facilities, and other supply information applicable to drought planning. (beneficial)
- Customer profile – average annual retail water delivered to customers (acre-feet), number of homes/customers within the service area, and profile of customer types (e.g., percentage of industrial, commercial, single residential, etc.) (beneficial)

1.7 Goals, Objectives and Operating Principles

Objective: Introduce the basic goals, objectives and operating principles of the plan and describe how these objectives are integrated into the broader water management planning efforts or other strategic, comprehensive or mitigation plans. See Section 2.1.2 for more information.

- List of the goals, objectives and operating principles. (essential)
- Discussion of how the objectives and operating principles reflect water use priorities during periods of a drought. (beneficial)
- List of water use priorities (i.e., a) essential water needs, b) social or economic impacts, and c) nonessential uses such as outdoor irrigation). (essential)
- Discussion of how the operating principles were incorporated into the plan development and how these principles will be considered during implementation (i.e., “The operating principles are reflective of the community’s values and will be reviewed prior to implementing mandatory water use reductions.”) (beneficial)

2.0 Drought Impact and Vulnerability Assessment

This section provides an overview of historical droughts and corresponding changes to supplies and demands, historical impacts and lessons learned from previous droughts. Water supply planning efforts and future drought vulnerabilities are also addressed. While the availability of historical data will vary among providers, the main objective of this section is to consolidate available data to provide insight for projecting and planning for future drought conditions. Section 2.2 provides useful background material on this section.

2.1 Historical Drought Impact Assessment

Objective: Assess historical water supplies and demands from previous droughts and discuss historical drought impacts, mitigation and response measures taken to reduce the impacts. Provide as much beneficial detail as possible based on available historical data and institutional memory. See Section 2.2.1 for additional information.

- Discussion of significant historical droughts and how they affected water supplies. This may include information on past reservoir levels, precipitation, streamflows, snowpack, groundwater levels, wholesale supplies, water quality issues, etc. Provide tables/figures that assist in describing historical conditions (i.e., hydrographs). The bulleted questions in Section 2.2.1 can be a useful in addressing this item. [\(essential\)](#)
- Mitigation measures historically implemented to minimize drought impacts. Mitigation measures taken prior to a drought to avoid or reduce impacts during a drought. Demand- and supply-side historical mitigation measures may be identified using [Worksheets B and C](#), respectively. [\(essential\)](#)
- Impacts experienced during historical droughts or current drought. [Worksheet A](#) provides a list of drought related impacts and a means to identify historical and current impacts. [\(essential\)](#)
- Available drought-related economic loss data and any additional information useful for characterizing historical impacts. This may also be provided in a supplemental document as an appendix. [\(beneficial\)](#)
- Description of historical changes to water demands because of drought and/or drought response/mitigation measures. Provide applicable quantitative data if available. This may include total water demands, per capita water demands (gpcd), demands by customer type, indoor and outdoor usage, etc. The bulleted questions in Section 2.2.1 can be a useful in addressing this item. [\(beneficial\)](#)
- Drought response measures implemented during previous drought(s) and overall effectiveness of these measures. Demand- and supply-side historical response measures may be identified using [Worksheets B and C](#), respectively. [\(essential\)](#)
- Lessons learned from previous drought(s) and recommendations for how implementation of drought mitigation/response measures should be altered to better respond to future drought. [\(beneficial\)](#)

2.2 Identifying and Assessing Future Vulnerabilities

Objective: Provide an overview on water supply planning efforts to improve water supply reliability during drought and address potential future drought impacts. See Section 2.2.2 for additional information.

- Potential impacts that could occur during future droughts. [Worksheet A](#) may be used a tool to help identify potential impacts. [\(essential\)](#)
- Summary of provider's water supplies and ability to reliability meet projected water demands during drought. This may include an overview of water supply reliability planning efforts such as the acquisition of new supplies to meet growing demands, raw water master planning studies, key terminology used to define water supply reliability (e.g. firm yield), etc. [\(essential\)](#)
- Description of how water supply reliability planning is related to the availability of supplies and vulnerability during drought. [\(beneficial\)](#)
- Discuss how longer term climate trends and climate change may stress available supplies. [\(essential\)](#)
- If applicable, address how climate change has been incorporated into water supply reliability planning. [\(beneficial\)](#)

- Discuss how drought might have other detrimental impacts to watershed health, public health, and the local economy. (beneficial)
- Discussion of the relative priorities assigned to the potential impacts/vulnerabilities. This information may be best represented as a table listing the potential impacts and corresponding priority with follow-up discussion. **Worksheet A** provides a means to record these priorities. (beneficial)

3.0 Drought Monitoring

This section provides an overview of climate, weather, hydrologic and other pertinent drought indicator data monitored on a routine basis. It also discusses the approach used to monitor drought indicators, including the schedule, monitoring methodology, and roles and responsibilities of the entities/staff responsible for monitoring the drought indicators. See Section 2.3 and **Worksheet E** for additional information.

- List of selected drought indicators monitored on a routine basis and description of how these indicators are reflective of water supply conditions Include monitoring schedule (frequency data is monitored). (essential)
- Summary of how drought indicators will be monitored and general frequency of monitoring. Address critical times of year when monitoring is particularly important for identifying drought conditions (i.e., reservoir storage near the end of runoff). (essential)
- If applicable, significance of the selected drought indicators or relative significance of each. In other words, why were these indicators selected as opposed to other drought indicators, and why are some more representative of the community's water supply. (beneficial)
- Entities/staff responsible for drought monitoring. (essential)
- Protocol for recording and archiving monitoring data. (beneficial)

4.0 Drought Stages, Trigger Points, and Response Targets

This section presents the drought stages, trigger points, and response targets and how they are incorporated into a drought declaration and response effort. Information is also provided on how these drought stages, trigger points, and response targets were developed and challenges related to the unpredictable nature of drought. Section 2.4 provides useful background material on this section.

4.1 Drought Stages, Trigger Points, and Response Targets

Objective: Present the drought stages, response targets and, if applicable, corresponding drought trigger points. This should also include an explanation of how drought indicators and/or drought trigger points are used to determine and declare drought stages to the public. See Section 2.4 for additional information.

- Presentation of the drought stages and, if applicable, corresponding drought trigger points and response targets (water savings). The tables included in **Worksheet F** may be used to present the drought stages, trigger points, and response targets. (essential)
- Explanation of how the drought stage depends upon the severity of the drought and that the amount of water that must be saved increases with the severity of the drought. For example, Stage 1 may involve voluntary saving measures while Stage 3 may require significant mandatory reduction of outdoor lawn watering. (beneficial)
- Describe approach used to develop the drought trigger points and response targets. (beneficial)
- Discussion of how the drought indicators, triggers, and other pertinent data are incorporated into the decision-making process of declaring a drought. (essential)
- Advantages and disadvantages of declaring a drought early versus delaying declaration of a drought stage until later in the season. Address the balance between prematurely declaring a drought and waiting too long to respond. (beneficial)

- Discussion of the necessity for flexibility in declaring a drought stage (i.e., a multi-year drought could result in water shortages greater than anticipated requiring drought stages, trigger points, and response targets to be adjusted accordingly). (beneficial)

5.0 Drought Mitigation and Response Strategies

This section discusses the development and selection of drought mitigation and response strategies. As discussed in Section 2.3.1, drought response measures often achieve temporary savings through changes in customer behavior during a drought. This may involve mandatory water restrictions for certain types of water use on a temporary basis. Drought mitigation generally applies to measures taken prior to a drought to avoid or reduce impacts during a drought. Section 2.5 provides useful background material on this section.

5.1 Drought Mitigation Measures and Action Plan

Objective: Introduce existing and planned drought mitigation measures. These measures should be integrated into water supply management planning efforts and operations prior to a drought in order to reduce the severity of future droughts. This section also includes the schedule and procedures necessary to implement the mitigation. See Sections 2.5.2 and 2.5.6 for additional information.

- Worksheets B and C** list potential mitigation actions and provide a means to select and screen measures. **Worksheet A** facilitates the development of new mitigation actions that specifically address pre-identified potential impacts. These processes are described in greater detail in Section 2.5.5. (beneficial)
- Worksheet H** provides a means to summarize the majority of information listed below in a table.
- Introduce difference between drought mitigation and drought response planning. (beneficial)
- List of drought mitigation measures, or if applicable, related plans and measures that address drought mitigation. (essential)
- Discussion of the criteria used to select the mitigation measures. Section 2.5.5 provides a list of suggested criteria. (beneficial)
- If conservation is being considered as a component of drought mitigation, discussion of how the existing conservation measures provide drought mitigation. See Section 2.5.3 for additional discussion. (essential)
- Steps necessary to implement each mitigation action. (essential)
- Milestone deadlines. (essential)
- Entities/staff responsible for administrating the mitigation action. (essential)
- List of funding sources. (beneficial)

5.2 Supply-Side Response Strategies

Objective: Provide an overview of the supply-side response strategies. See Section 2.5.2 for additional information.

- List of the selected supply-side response strategies. Supply-side strategies listed in **Worksheet B** may be used as an initial reference source for generating strategy ideas. Specific details related to each strategy should be included. For example, if the “lower reservoir intake strategy” is selected, information should also be provided on the specific reservoir(s) in which the intake will be lowered. (essential)
- Discussion of the criteria used to select the supply-side strategies. Section 2.5.5 provides a list of suggested criteria. (beneficial)
- Discussion of how the selection process is reflective of the Step 1 objectives and operating principles. (beneficial)

5.3 Demand-Side Response Strategies

Objective: Provide an overview of the demand-side response strategies taken when drought is imminent or occurring. See Section 2.5.3 for additional information.

- List of the selected demand-side response strategies. Demand-side strategies listed in **Worksheet C** may be used as an initial reference source for identifying strategies. This worksheet is also useful for identifying whether the strategy is to be implemented on a voluntary, incentive, or mandatory basis. For example, strategies may be voluntary for a Stage 1 drought and elevated to mandatory under more drought severe conditions. Coordination with other entities may also be beneficial and can be noted in **Worksheet C**. Similar to the supply-side strategies, details related to the future implementation of each strategy should be included. (essential)
- Discussion of the criteria used to select the demand-side strategies. Section 4.4.2 provides a list of suggested criteria. (beneficial)
- Discussion of how the selection process is reflective of the Step 1 objectives and operating principles. (beneficial)

5.4 Drought Public Information Campaign

Objective: Provide the drought public campaign framework. See Section 2.5.2 for additional information.

- List of the public drought campaign goals. (beneficial)
- Discussion of how the public drought campaign will be differentiated from the public conservation education program and how synergistic benefits can be developed between the two programs. (beneficial)
- General components of the public drought campaign. This includes the types of audiences to be targeted, communication tools to be used to convey drought related information, specific key information to convey, and opportunities for future synergies. **Worksheet D** may be used to develop this framework. (essential)
- Pre-scripted messages targeted towards the public to be released through public information outlets during various drought stages. These could be detailed in an appendix. (beneficial)

6.0 Staged Drought Response Program

This section outlines the drought response measures corresponding to each of the drought stages developed in Step 5. See Section 2.6 provides useful background material on this section.

- Supply- and demand-side response measures by drought stage. **Worksheet G** may be used to divide the strategies into individual measures according to drought stage. **Worksheet G** provides a template for presenting the supply- and demand-side measures. (essential)
- Provide a summary table that highlights the drought stages, trigger points, response targets and a summary of drought response measures for insert into an executive summary, quick-reference sheet, fact sheet for public distribution, etc.) (beneficial)
- Provide detailed staged public drought campaign plan if the provider chooses to include a detailed public drought campaign plan as a component of the staged drought response program. If appropriate, this may be an appendix or supplemental document. See Section 2.6.1 and **Worksheets G and D** for additional information. (beneficial)

7.0 Drought Response Operational and Administrative Framework

This section addresses the coordination necessary to fully implement the drought management plan. This includes drought indicator monitoring, drought declaration protocols, implementation and enforcement of the staged

drought response program, revenue planning, and monitoring of the drought response effort and making appropriate changes when necessary.

7.1 Drought Declaration Process

Objective: Describe the decision-making process necessary to publicly declare a drought and the corresponding drought stage and how this information is conveyed to the public. See Section 2.7.1 for additional information.

- Summary of guidelines (e.g., trigger points and/or drought indicator data) used by staff to evaluate drought conditions. [\(essential\)](#)
- If applicable, approach and/or resources used to forecast drought. [\(beneficial\)](#)
- Decision maker(s) responsible for declaring a drought and corresponding drought stages. [\(essential\)](#)
- If applicable, protocol for conveying drought information and recommendations from staff to decision makers. [\(beneficial\)](#)
- Discussion of importance in identifying and declaring drought in a timely manner. Address timing of when decision-makers are informed and, subsequently, when the public is informed of a drought declaration. [\(essential\)](#)
- Staff or entity responsible for announcing drought declaration to the public. [\(essential\)](#)

7.2 Implementation of the Staged Drought Response Program

Objective: Describe the roles and responsibilities of implementing the staged drought response program. See Section 2.7.2 for additional information.

- Entities/staff responsible for administering the staged drought response program. [\(essential\)](#) *Worksheet I* provides a template for noting staff and corresponding roles and responsibilities.
- If applicable, discuss additional staff that would need to be hired. [\(beneficial\)](#)
- Staff responsible for administering the drought public campaign. [\(essential\)](#)
- Communication and coordination protocol among entities/staff. [\(essential\)](#)

7.3 Enforcement of the Staged Drought Response Program

Objective: Describe the policy, roles and responsibilities, and activities necessary to enforce the drought response plan. See Section 2.7.3 for additional information.

- Enforcement policies appropriate for each drought stage. *Worksheet G* provides options of how the specific enforcement policies and/or activities may be presented. [\(essential\)](#)
- Identify the level of monitoring/patrolling necessary for each drought stage. Who will be responsible for patrolling the service area and issuing citations? Will additional temporary staff need to be hired? What training will be necessary? [\(beneficial\)](#)
- Identify how information on the enforcement will be conveyed to the public. [\(beneficial\)](#)
- Develop an appeals process and possible exemptions to enforcement procedures under certain circumstances. [\(beneficial\)](#)
- Identify who is responsible for administration of the enforcement effort and approving exceptions to the enforcement policy. [\(beneficial\)](#)

7.4 Revenue Implications and Financial Budgeting Plan

Objective: Discuss the potential for revenue loss when customers reduce water use in response to drought and how this will be addressed. Quantitative estimates of revenue implications, water rate adjustments, or other budgetary modifications can be an involved and highly technical process that may be beyond the scope and

financial resources for this effort. If the provider chooses to not pursue a detailed financial revenue analysis as a component of this Plan, this section should, at minimum, outline the steps and resources necessary to address this issue if revenues should be significantly impacted from future drought response efforts. See Section 2.7.4 for additional information.

- Introduction to how the reduction in water use can reduce revenue and financially stress providers. (beneficial)
- Estimates and/or qualitative discussion of potential revenue reductions and how this would impact the average residential and business customer. (beneficial)
- Financial resources necessary to implement the response programs, including the public drought campaign, stated drought response program, and any additional funds necessary to intensify drought monitoring efforts. (essential)
- Describe the strategies for addressing revenue losses. Include the general timing of when these strategies would be implemented relative to the declaration of a drought. (essential)
- Detailed estimates of potential revenue loss and specific actions taken by the provider to mitigate these losses (i.e., create a special fund prior to the drought to offset revenue losses during the drought, drought surcharges or raise water rates). Provide the assumptions and details of the financial analysis in an appendix or supplemental document. (beneficial)
- Discuss how the drought surcharges and/or water rate increases would be conveyed to the public. (beneficial)

7.6 Monitoring of Drought Response

Objective: Describe the data collection and assessment activities in place to monitor the overall effectiveness of the plan. See Section 2.7.5 for additional information.

- Refer to Section 3 where drought monitoring protocol is provided. Describe any changes that may occur with this protocol during a drought. For instance, does the frequency of monitoring increase? (essential)
- Describe any additional drought indicators that you may collect as assess during drought. For instance, does demand monitoring increase during drought to assess water savings being achieved? (essential)
- Schedule an exercise to test the implementation of the Plan. (beneficial)
- Data to be collected. This should include demand data, lessons learned, conditions of the water supply system during the drought (e.g., storage amounts), public perceptions and general response to the drought, and administrative staged drought response program data (e.g., number of citations delivered). (essential)
- Staff/entities responsible for the data collection, evaluation, and recommendations on Plan improvements. (essential)

8.0 Plan Adoption

This section addresses the public review and formal adoption process for the necessary ordinance(s) and agreement(s) of the Plan. Information is also provided on the maintenance and anticipated update of the Plan. Section 2.8 provides useful background material on this section.

8.1 Public Review Process

Objective: This section summarizes the public's role in development of the Plan. See Section 2.8.1 for additional information. A public review process is necessary to ensure that the public has had an opportunity to review and comment on the Plan. Providers should follow the appropriate rules, codes, or ordinances to make the draft Plan available for public review and comment. If there are no rules, codes, or ordinances governing the entity's public planning process, each provider should publish a draft Plan, give public notice of the Plan, make such plan publicly available, and solicit comments from the public for a period of not less than 60 days (if CWCB funded) after the

date on which the draft Plan is made publicly available. Reference shall be made in the public notice to the elements of a Plan that have already been implemented.

- Description of the public review process and how the public may access the Plan. (essential)
- If members from the general public are on the Drought Committee, describe their involvement. (beneficial)
- Summary of public comments and meetings held during the Plan development process. (beneficial)
- Appendix of the public meeting minutes and public comments and how those comments were addressed within the Plan. (beneficial)

8.2 Plan Adoption or Promulgation

Objective: Briefly summarize the formal process for Plan adoption including any ordinances that needed to be adopted. Note: For some water suppliers, formal approval of its Plan may not be desirable. See Section 2.8.2 for additional information.

- Government body that either approved or officially adopted the Plan. (essential)
- Date of approval/adoption. (essential)
- Potential conflicts/issues with the approval/adoption. (beneficial)
- Copy of the official approval/adoption document in appendix. (beneficial)
- Summary of the ordinance(s) and policy necessary to implement the Plan. This may include policy changes to: facilitate the formal declaration of a drought; implement and enforce the staged drought response program and drought public campaign; and adopt revenue changes, etc. (essential)
- Official agreement(s) needed with other entities for drought-related coordination purposes. (essential)
- Official copies of the ordinance(s) and/or official agreement(s) may be included in an appendix. (beneficial)
- Challenges encountered to develop and approve the ordinance(s) and/or official agreement(s). (beneficial)

8.3 Periodic Review and Update

Objective: Summarize the anticipated timing of Plan updates and the processes that will occur to facilitate the update. See Section 2.8.3 for additional information.

- Frequency of when the Plan will be updated. Recommend every five years. (essential)
- Anticipated date of the next update. (essential)
- Staff responsible for taking the lead in initiating the Plan update and collecting appropriate data. (essential)
- Process of how the recommendations for Plan improvements will be incorporated into updated plans. (beneficial)

9.0 Suggested Appendices

This section provides a list of appendices that may be applicable to include with the Plan.

- Drought Committee meeting materials (e.g., meeting agendas, minutes, presentations, etc.) (beneficial)
- Public drought campaign pre-scripted messages. (beneficial)
- Supplemental technical information and data. This may include studies on demand reduction and revenue impacts, historical drought impact studies/reports, or supplemental data/information on the water supply vulnerability assessment, etc. (beneficial)
- Public meeting minutes and comments. (beneficial)
- Official copies of the adopted ordinance(s) and/or official agreement(s). (beneficial)
- Copy of the Plan approval document. (beneficial)

Section 4 Drought Planning Case Studies and Examples

This section contains a collection of drought planning case studies and examples that may prove to be a useful reference for water providers that are beginning to develop a plan, or in the review and update of an existing plan. Case studies are organized by the related planning step. These are summarized in the following table.

Table 9: Case Studies and Examples Crosswalk with Drought Planning Steps

Drought Planning Step	Case Study and Examples
Step 1: Planning Process, Plan Objectives and Operating Principles	1a - Parallel Development of Drought and Water Efficiency Plan for the Town of Erie 1b - Examples of Objectives from Various Plans
Step 2: Drought Vulnerability Assessment	2a - Aurora Water Lessons Learned From the 2002 Drought 2b - Water Supply Reliability Planning, Climate Change and Drought 2c - Thornton Drought Scenario Planning 2d - Town of Castle Rock Drought Management Plan
Step 3: Drought Monitoring	3 - City of Durango Drought Management Plan
Step 4: Drought Stages, Trigger Points, and Response Targets	4 - Town of Castle Rock Drought Management Plan
Step 5: Drought Mitigation and Response Strategies	5a - The Dolores Project Drought Contingency Plan 2018 5b - Fish Creek Critical Community Wildfire Watershed Protection Plan 5c - Cape Town Water Crisis 5d - Colorado Springs Utilities 2013 Drought Response 5e - 2002 Drought Response and Coordination Examples 5f - Agricultural Water Transfers/Alternative Transfer Methods
Step 6: Staged Drought Response Program	6 - Grand Valley and Clifton Drought Response Plan 2018
Step 7: Operational and Administrative Framework	7a - Thornton Drought Management Plan
Step 8: Plan Approval and Adoption	8a - City of Durango Public Review Process 8b - Thornton Tabletop Exercises and Gaming Forum

STEP 1 PLANNING PROCESS, PLAN OBJECTIVES AND OPERATING PRINCIPLES

Case Study 1a: Parallel Development of Drought and Water Efficiency Plans for the Town of Erie

Related Section: [2.1.1 Drought Planning Committee](#)

The Town of Erie is updating their Water Efficiency Plan in parallel with their Drought Management Plan in 2020, with anticipated finalization in 2021. Updating these plans simultaneously capitalizes on efficiencies while also ensuring that the plans are mutually reinforcing and priorities are well integrated. The Planning Team for both efforts consists of Town staff from a variety of departments including parks and recreation, sustainability, finance, economic development, utilities, and land use planning. This provides opportunity for Town Staff to make informed decisions from a common technical platform and develop how the Town approaches water savings in a comprehensive manner considering wet, average, and dry years. The Planning Team is determining the amount of water savings, corresponding water saving actions, and public messaging they want to achieve under wet and average conditions when not in a water shortage response period as part of the Water Efficiency Plan. They will then focus on the water savings, corresponding actions, and public messaging under water supply shortages as part of the Drought Management Plan.

Case Study 1b: Examples of Objectives from Various Plans:

Related Section: [2.1.2 – Goals, Objectives and Operating Principles](#)

Denver Water Objectives: The goal of the Denver Water Board’s drought response is to maintain the health, safety and economic vitality of the community to the extent possible in the face of drought/water shortages. Source: Denver Water. Denver Water. *Chapter 15 – Drought and Water Shortage Response from Denver Water’s Operating Rules*. 2020.

Longmont Objectives: The purpose of the City of Longmont’s 2017/2018 Water Supply & Drought Management Plan is to manage the City’s Water Supply and to anticipate, identify and respond to drought in the St. Vrain Creek watershed area. This plan addresses the impacts of drought on raw water availability and provides recommendations on how to respond. This plan also formalizes the City’s planning for future droughts. Source: City of Longmont. *2018/2019 Water Supply & Drought Management Plan*. April 12, 2018.

Examples of Objectives and Water Use priorities:

The objectives of the City of Durango Municipal Drought Management Plan, developed collaboratively by the Drought Committee, are:

1. Plan and Prepare:

- Protect the public health and safety and minimize the adverse effects of a water supply shortage through drought planning and preparedness.
- Identify past and potential drought impacts and vulnerabilities to inform the planning process.

2. Identify and Monitor:

- Provide guidelines to identify, anticipate, and monitor drought conditions.

- Determine drought severity through a clear definition of indicators, stages and triggers.

3. Respond, Mitigate and Communicate:

- Provide comprehensive and flexible guidance for drought response, allowing for an appropriate range of actions to respond.
- Provide effective communication, drought awareness, and response information to water customers, the public and governmental departments/agencies, so they clearly understand the situation and the actions taken.
- Preserve essential public services during any level of drought severity from mild to critical emergency conditions.
- Reduce the impacts of future droughts through long-term mitigation strategies.

4. Evaluate and Update:

Provide an efficient means to monitor and improve the effectiveness of the Plan over time.

The Drought Committee prioritized the City's water usage into five categories, ranked from highest to lowest priority:

1. Health and Safety
2. Business Indoor Use
3. Maintain athletic fields and high use/high priority parks
4. Maintain medium priority parks
5. Upkeep of low priority/low use parks

STEP 2 DROUGHT VULNERABILITY ASSESSMENT

Case Study 2a: Aurora Water Lessons Learned From the 2002 Drought

Related Section: [2.2.1 Historical Drought Assessment](#)

During the 2002 drought, Aurora Water's storage declined to 25 percent of total capacity. Aurora Water learned that they were not sufficiently prepared for droughts as extreme as experienced in 2002. In response, Aurora Water developed a variety of tools to enhance water supply forecasting and planning guidance during drought periods. This included a Drought Contingency Plan, a water supply forecasting model based on reservoir levels, and an annual water management plan that sets the water restrictions and level of enforcement for the upcoming year. The 2002 drought also initiated the development of the Prairie Waters Project which increases Aurora Water's ability to reuse their legally reusable return flows.

Case Study 2b: Water Supply Reliability Planning, Climate Change and Drought

Related Section: [2.2.2 Identifying and Assessing Future Vulnerabilities](#)

Several Colorado municipal water suppliers are moving away from water supply planning based on firm yield to planning based on reliability criteria. Firm yield planning often does not incorporate assumptions of deliberately-reduced water demands during droughts (e.g. mandatory water restrictions), but assumes that normal water deliveries will be made under all conditions until a water system is pushed to its limits, often as modeled against performance during an historic multi-year drought. The water system is then designed to meet this limit. Reliability-based water planning considers droughts to be expected natural events with an occurrence interval that can be determined from the historic record. It is then assumed that measures will be taken during drought periods to reduce water demand by predetermined amounts.

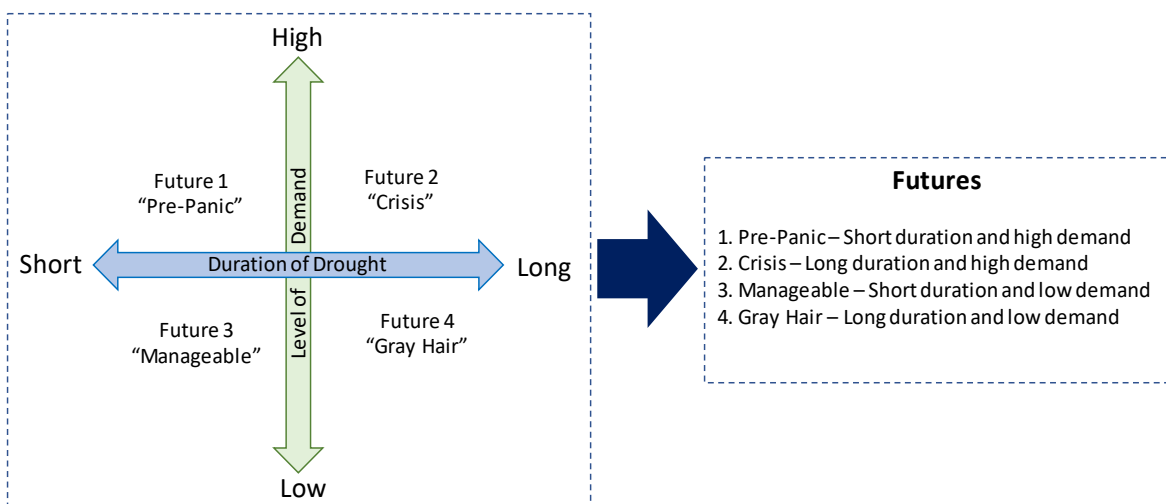
The water system is then designed so that the acceptable frequency of drought-related water supply reductions is not exceeded based on historical data.

Climate change has introduced greater uncertainty into the planning efforts. An increasing number of providers are no longer relying on the historical record for water supply reliability planning, but rather assuming that the climate will be different in the future. Instead of assuming stationarity where the historical record is used, providers are using a variety of methods to simulate how the climate may alter water supply conditions in the future. Generally, this entails using a hydrology record for planning purposes that is typically drier with more extreme droughts than the historical records. Techniques used include the use of tree-ring paleohydrology data, altered hydrology data based on down-scaled global climate change models and developing synthetic hydrology data where the worse-case historical drought is repeated sequentially for a number of years simulating an intense drought of duration that exceeds this historical record.

Case Study 2c: City of Thornton Drought Scenario Planning

Related Section: [2.2.2 Identifying and Assessing Future Vulnerabilities](#)

Scenario planning is commonly used as a planning technique to foster a broad context for testing the implications of various future outcomes. The City of Thornton conducted a scenario planning exercise to inform the 2019 update of their drought management plan. The objective of the exercise was to determine how Thornton can best address drought-related impacts during a range of possible drought scenarios using a forwarding-thinking, outside-of-the-box, collaborative approach. This exercise was carried out during two workshops attended by city staff members on the Planning Team. During the exercise, participants identified environmental, political, social, technological and economic factors that could have key future implications on Thornton’s ability to respond to drought. These factors informed the development of the four drought-related futures shown in the figure below. These futures provided a contextual background to develop and prioritize a list of drought vulnerabilities, mitigation strategies and drought response strategies for inclusion in the Plan. Ultimately 17 new drought vulnerabilities, 14 new drought mitigation strategies and 15 new drought response strategies were developed which were not considered through other planning efforts. Source: City of Thornton Drought Management Plan. 2019.



City of Thornton Drought Vulnerability: Table 10 provides the City of Thornton’s drought vulnerabilities based on priority where priority 1 influences the reliability and quality of water supplies while priority 3 may not necessarily impact water availability but can impact quality of life.

Table 10: Future Vulnerability to Water Shortages

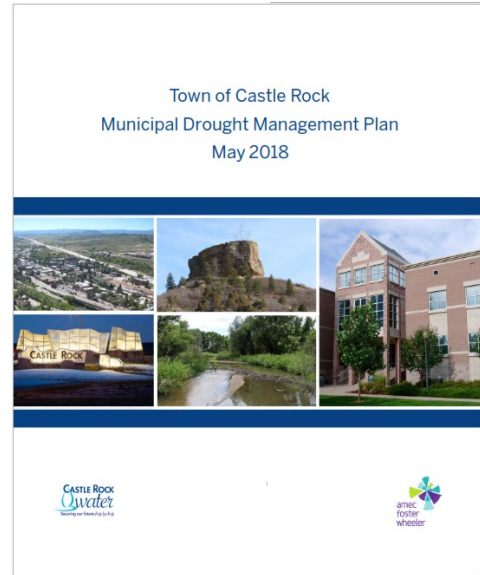
Themes					Potential Future Water Shortage Impacts
Infrastructure/ e/	Financial	Water Quality	Landscaping	Community/ Political	
Priority 1 Impacts					
X	X				Funding not available for needed CIP projects to help mitigate for drought
X					Significant delays in planned water projects
X					Harm to infrastructure from past events (e.g. floods)
X					Compromised storage to provide reserves during drought (e.g. damage to reservoir from flood prior to drought)
X					CIP project or maintenance that temporarily compromises system during drought
	X				Costs to acquire new supplies (e.g. leases)
		X			Degraded drinking water quality (taste and odor). TDS and other water quality degradations occur due to concentration from low reservoir levels. Also, typically the best sources of water are used first, with sources of lesser quality remaining.
				X	Community buy-in to making behavioral changes necessary to save water during drought
				X	Population exceeds growth projections increasing water demands above planning levels
X					Low stream flows result in more senior calls on the river
X					Reduction in storage reserves
X					Disruption of water supplies
X					Reduction in municipal well production
Priority 2 Impacts					
	X				Costs to increase water use efficiency during a shortage
	X				Loss of revenue from reduction in water sales
	X				Increased costs and staff time to implement drought plan
	X				Economic conditions can influence Thornton’s resources in addressing a shortage
	X				Increase in staff resources to monitor and implement shortage response

Themes					Potential Future Water Shortage Impacts
Infrastructure/ e/	Financial	Water Quality	Landscaping	Community/ Political	
	X	X			Higher water treatment costs (e.g. need for additional chemicals)
	X	X			Large scale drought can reduce availability of water treatment chemicals and increase costs
X		X			Wildfire in region which can result in sediment loading in the Poudre and Clear Creek basins causing water quality issues
			X	X	Impacts to commercial water users that must reduce water use
				X	Air quality effects particularly from wildfire throughout the State and intermountain west
			X	X	Loss of trees and other landscaping in parks
X			X		Outdoor water demands are higher from temperature increases and longer growth season
				X	Political will of promoting drought resiliency can influence ability to respond to drought (e.g. policy can be slow in responding to a drought situation)
				X	Health impacts from higher temperatures
Priority 3 Impacts					
			X	X	Outdoor aesthetics, recreation, environment impacts such as pond odor, low flow in streams, etc.
			X	X	Loss of vegetation in parks and outdoor spaces, weeds invading, expense to replace it
				X	Heightened awareness about water efficiency lowers water demands
				X	Public favorable or unfavorable perception of Thornton regarding shortage response
				X	Community push back (e.g. water rates are exceeding what some customers can afford)

Case Study 2d: Town of Castle Rock Drought Management Plan

Related Section: [2.2.1 Historical Drought Assessment](#) and [2.2.2 Identifying and Assessing Future Vulnerabilities](#)

The Town of Castle Rock relies primarily on groundwater but is diversifying its water supply portfolio in part to ensure adequate supplies for the future and during times of scarcity, as well as reduce reliance on groundwater withdrawals. The Town has set a goal of having 75% of its water supply come from renewable alluvial and surface water supplies by 2050. This change in water sources potentially exposes the Town to more impacts from future drought. However, for this reason, the Town undertook a drought management planning effort that considered past drought impacts and future vulnerabilities. When considering historical drought impacts, the Town had relatively minor impacts from the 2002 or 2012 droughts due to the available groundwater resources. The more significant impacts were air quality from nearby significant wildfires such as the Hayman fire. More recently, the Town had experienced a “flash” drought during May and June 2017. This short but intense stretch of very hot and dry conditions caused excessive demands on the Town’s limited water storage. The Town was challenged in keeping up with water demands, requiring additional groundwater pumping. In response to these conditions, the Town enacted additional water restrictions for residents, homeowners’ associations, and commercial/industrial customers.



Castle Rock’s Drought Management Plan also included a discussion on future vulnerabilities related to climate change, informed with statewide studies prepared by the CWCB. The historical and potential drought impacts were captured in a table, based on worksheets from the CWCB Municipal Drought Plan Guidance Document which was modified for the needs of the Town. The table also identified potential mitigation and response actions. This helped inform the development of these actions and the timing of implementation according to the Town’s staged drought response plan.



Excerpt of Table Displaying Historical and Potential Future Drought Impacts of the Utility

Historical, Existing, and Potential Drought impacts	Historical Impact	Ranking of Drought Impact Severity*	Potential Impact Priority	Mitigation Action	Response Strategies
Water Provider					
Loss of revenue from reduction in water sales	x	M	M	Utilize reserves.	Budget for reserves.
Reduction in municipal well production	x	L	L	Implement watering restrictions to reduce demand.	Decrease reliance on ground water.
Reduction in storage reserves	x	L	L	Implement watering restrictions to reduce demand.	Minimize reduction.
Disruption of water supplies	x	L	L	Restore services and lift restrictions as soon as possible.	Minimize disruptions.
Degraded raw water quality	x	L	L	Curtail diversion of alluvial wells.	Pump Denver Basin Wells. Use non-shallow aquifer sources.
Higher water pumping costs	x	L	L	Return to normal operations as soon as possible. Budget for additional staff time. Budget for reserves.	Budget for additional costs.
Increased costs and staff time to implement drought plan	x	M	M	Return to normal operations as soon as possible. Budget for additional staff time. Budget for reserves.	Budget for increased costs.

Historical, Existing, and Potential Drought impacts	Historical Impact	Ranking of Drought Impact Severity*	Potential Impact Priority	Mitigation Action	Response Strategies
Increased data/information needs to monitor and implement drought management plan	x	M	M	Return to normal operations as soon as possible. Budget for additional staff time. Budget for reserves.	Utilize staff to address data/information needs.
Costs to acquire/develop new water supplies/water rights transfers	x	L	L	Proactively acquire and develop additional supplies.	Budget for and take advantage of sensible opportunities.
Costs to increase water use efficiency	x	L	L	Increase public awareness of the need.	Implement over a long period of time.
Public favorable/unfavorable perception of provider regarding drought response	x	L	L	Increase public education.	Maintain transparency and education efforts.
Scarcity of equipment and other water related services (e.g., contractors to repair wells)	x	L	L	Emergency services contract.	Utilize multiple contractors.

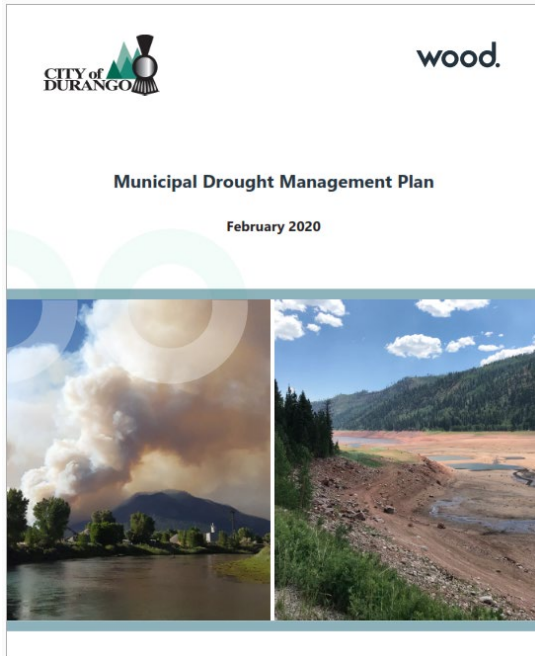
Historical, Existing, and Potential Drought impacts	Historical Impact	Ranking of Drought Impact Severity*	Potential Impact Priority	Mitigation Action	Response Strategies
Community and Societal					
Domestic landscaping stressed or killed	x	L	L	Drought tolerant landscaping.	Continue to implement drought tolerant landscaping.
Public landscaping stressed or killed	x	L	L	Drought tolerant landscaping.	Continue to implement drought tolerant landscaping.
Reduced firefighting capability	x	L	L	Minimize restrictions.	Maintain storage for firefighting at all times.
Cross-connection contamination as a result of lower pressures			L	Increased sampling.	Maintain positive pressure in system at all times.
Increased pollutant concentrations			L	Increased sampling and monitoring.	Meet primary drinking water standards at all times.
Reduced quality of life	x	L	L	Minimize restrictions.	Drought planning.
Loss of human life (e.g., heat stress)			L	Minimize restrictions. Restore services as soon as possible.	Minimize restrictions. Restore services as soon as possible.
Public safety from wildfires			L	Maintain firefighting capabilities.	Maintain firefighting capabilities.
Increased disease caused by wildlife concentrations			L	Minimize restrictions.	Minimize restrictions.
Mental and physical stress	x	L	L	Minimize restrictions. Increase education.	Minimize restrictions. Increase education.

Historical, Existing, and Potential Drought impacts	Historical Impact	Ranking of Drought Impact Severity*	Potential Impact Priority	Mitigation Action	Response Strategies
Increased political conflict	x	L	L	Minimize restrictions. Transparency.	Minimize restrictions. Transparency.
Reduction or modification of recreational activities	x	L	L	Minimize restrictions.	Minimize restrictions.
Unequal distribution of drought response measure implementation	x	L	L	Minimize restrictions. Increase education. Drought planning.	Minimize restrictions. Increase education. Drought planning.
Heightened awareness about water conservation	x	L	L	Increase education.	Increase education.
Change in water use behavior to conserve water	x	L	L	Increase education.	Increase education.
Re-evaluation of social values (priorities, needs, rights)	x	L	L	Drought planning.	Drought planning.

STEP 3 DROUGHT MONITORING

Case Study 3: City of Durango Drought Management Plan

Related Section: [2.3 Drought Monitoring](#)



The City of Durango took a comprehensive and thoughtful approach to incorporate a more structured and systematic way of drought monitoring within the city’s Drought Management Plan. Prior to the 2019 planning effort, drought monitoring was accomplished by various departments and personnel looking at different indicators such as Snotel sites, streamflow, and local weather stations, without a coordinated and systematic method to it. The planning committee wanted to specifically differentiate short- and long-term indicators, and even consider longer regional climate trends, to inform drought decision making. Short-term indicators that directly relate to City water supply are identified in the plan, including consideration for “flash drought” conditions that might acutely affect supplies. Nearby communities’ drought stages or water availability, storage, and quality conditions is also a monitoring consideration. The result was a structured process documented within the plan, with example tables shown

below. The tables provide a useful reference for new city staff or staff newly designated as having a role in drought monitoring, providing clarity on how the City monitors drought and the key indicators.

Direct Drought Monitoring – Short-Term Indicators

Drought Indicators	Type of Data	Timing/ Key Dates	Responsible Staff
Reservoir Levels	Levels and conditions in the main Terminal Reservoir, City Reservoir No. 1, and the new Nighthorse Reservoir. Lemon Reservoir’s levels would also be used for long-term monitoring as it is a smaller and less used reservoir for water resources in Durango.	May-October	Utilities – Water Treatment Superintendent
Snowpack	SNOTEL Snowpack, precipitation, temperature, and other climatic conditions related to snow accumulation. Specific SNOTEL sites of interest to Durango’s water supply include: Stump Lakes (site 797)	November-June Key date: April 1 snowpack	Utilities - Water Treatment Superintendent

Drought Indicators	Type of Data	Timing/ Key Dates	Responsible Staff
Stream flow	Streamflows including average daily flow rates and discharge statistics of the main water resource streams. Both the Florida River and Animas River have USGS gages at Durango and near the city available for data collection. Specific gages include: Florida River – above and below Lemon Reservoir Animas River at Durango	May-October; Weekly during drought	Utilities - Water Treatment Superintendent
Weather Station Data	These are land-based stations where observations are collected that include details on temperature, dew point, humidity, precipitation, wind speed, atmospheric pressure, and other such weather-related components. Specific stations include: Durango Airport City Hall.	May-October; Weekly during drought	Utilities – Water Treatment Superintendent Parks and Recreation – Asst. Parks Dir. City Engineer

Supplemental Drought Monitoring – Regional and Long-Term Indicators

Drought Indicators	Type of Data	Timing
U.S. Drought Monitor	Aggregate of a variety of indices, data, and expert opinion updated on a weekly basis.	Weekly
Dust-On-Snow Monitoring	Colorado’s Dust-on-Snow Program (CODOS) operates on behalf of Colorado and regional water management agencies and could be a resource of data related to monitoring the presence or absence of dust layers at various sites throughout the state. With these data sources Durango will be able to better analyze the potential of snowmelt timing, influences on snowmelt, and snow runoff rates during melting season. Other local sources for dust-on-snow monitoring are also available.	November-June
Nearby Communities’ Water Availability and Drought Conditions	The ability to factor in nearby communities’ drought or water availability, storage, and quality conditions will be useful in determining potential short- and long-term effects on the City, even if these external conditions may not directly affect Durango’s water supply or other secondary impacts and resources. See also www.coh2o.co .	Monthly during drought
General Water Quality Monitoring	Quality monitoring currently conducted for the Animas River. Soon to come online with the completion of phase 2 of Florida River Headgate Improvements.	May-October

Drought Indicators	Type of Data	Timing
Colorado's Division of Water Resources (DWR) Calls History Data and Decision Support System Resources	"Calls" are ways to communicate administrative statuses of natural stream systems, particularly priorities of water rights within streams, in order to make water available to various water rights holders.	May-October
NRCS and DWR Surface Water Supply Indices	The Natural Resources Conservation Service (NRCS) and Colorado's DWR use surface water supply indices (SWSI) by basin, as indicators of surface water supply conditions across the state. The SWSI compares total volume of water in a basin against volumes available in the same month of previous years. These volume metrics can take into account streamflows, forecasts, and reservoir storages in the basins.	Year round
NRCS Runoff Forecasts	The NRCS publishes precipitation and snowfall accumulation information with known probabilities based on past records, that are useful in predicting runoff forecasts and help potentially predict future drought. Various levels of probability are available with these forecast products.	Spring
Standardized Precipitation Index (SPI)	This index is commonly used to characterized meteorological drought on various timescales, so that the index can portray soil moisture on short timescales and groundwater and even reservoir storage at longer timescales. Some key strengths of this SPI are that it relies on precipitation information to relate to drought or abnormal wetness and is less complex than other indices such as the Palmer Drought Severity Index (PDSI).	Monthly at various time scales; 6 month and 36 month useful for short- and long-term monitoring
NOAA's U.S. Seasonal Drought Outlook	The National Oceanic and Atmospheric Administration (NOAA) publishes a seasonal drought outlook product that informs, at state or regional levels in the U.S., of drought tendencies and patterns based on probability studies, and short- and long-term statistical and dynamical forecasts. Areas of improvement or where drought may be becoming worse are highlighted in the generated maps.	Three-month outlook updated monthly

Drought Indicators	Type of Data	Timing
<p>Additional resources provided by CWCB and Water Availability Task Force and Drought Impact Task Forces associated with The Colorado Drought Mitigation and Response Plan</p>	<p>The Colorado Water Availability Task Force (WATF) is the state’s drought monitoring collective of climate and water experts. Periodic summary reports of categorize conditions related to snowpack, reservoir storage and streamflow by major basins statewide. Long term projections are also discussed, as well as insight into El Nino and La Nina conditions.</p> <p>During drought, specific Impact Task Forces may be activated to assess impacts to sectors such as municipal water, agriculture etc. Periodic summary reports can inform statewide response efforts.</p> <p>In addition, the 2018 Colorado Drought Mitigation and Response Plan contains useful climate change and paleo climate analyses and resources by major water basin, which can provide insight for Durango’s long-term climate monitoring goals.</p> <p>The Colorado Water Conservation Board (CWCB) maintains a drought response website (www.coh2o.co) with a variety of drought monitoring information and data updated on a regular basis. This site will be assessed to identify monitoring information/data useful for the City’s drought monitoring purposes, as it supplies a variety of municipal water supply and restriction alerts based on drought conditions.</p>	<p>Quarterly drought summaries or more frequent during drought</p>
<p>National Drought Mitigation Center’s Drought Risk Atlas</p>	<p>This NDMC tool helps identify drought recurrence intervals based on local climate stations. This tool provides flexible climatological data that can be scaled down to offer more applicable insight in regional and local contexts, as well as varying temporal station analysis records.</p>	<p>Variable</p>
<p>Reclamation Reservoir Forecasts</p>	<p>The US Bureau of Reclamation</p>	<p>Monthly</p>
<p>Durango Animas River Corridor Management Plan</p>	<p>General guidelines on water quality monitoring, standards, potential stakeholder processes to follow given certain drought situations, etc.</p>	<p>Quarterly</p>
<p>Major infrastructure or water supply service interruptions</p>	<p>Information on major interruptions to water services or infrastructure that may prevent water from being pumped, processed (e.g. sanitized), or delivered to users, including water conveyance or storage infrastructure that may need maintenance or upgrading to prevent water shortages.</p>	<p>A relatively robust SCADA tracking of supply at the headgate, delivery to the reservoir, then treatment processing. To be enhanced through smart metering.</p>

STEP 4 DROUGHT STAGES, TRIGGER POINTS, AND RESPONSE TARGETS

Case Study 4: Town of Castle Rock Drought Management Plan

Related Section: [2.4.2 Trigger Points](#)

An outcome of the Town of Castle Rock’s vulnerability assessment and planning effort previously noted was the calculation of a water supply index (WSI). The WSI is used as a running index to track supply and demand and define thresholds for the five drought stages in the plan. The WSI calculation includes the following:

$$WSI = \frac{Supply}{Demand} = \frac{Deep\ groundwater + Alluvial\ wells + Surface\ water + WISE}{Maximum\ daily\ demand}$$

(Note: WISE, which stands for Water, Infrastructure and Supply Efficiency, is a regional partnership that provides new supply by combining unused capacities in Aurora Water’s Prairie Waters Project with unused water supplies from Denver and Aurora and is another source for the Town).

The WSI can be used to track supply versus demand on a daily basis when needed, and can inform when conditions similar to the 2017 “flash” drought might warrant activation of the plan in the future. The Town will use the seven-day rolling average of the continuously-calculated WSI as the basis for a drought declaration. The rolling average is used to smooth the variations in the WSI calculation, so that day-to-day fluctuations in the WSI do not unnecessarily trigger a drought declaration. Once the WSI drops below the trigger point guidelines shown in the table below and Town staff observe the WSI trend to be stagnant and hence not improving (e.g. the trajectory of the line is either flat or going down), an appropriate drought stage shall be called.

Table 11: Drought Stages, Trigger Point Guidelines and Response Targets

Drought Stage	WSI	Response Targets ¹³	Key Restrictions
Advisory	1.09 to 1.05	10% water savings	Voluntary water use reductions.
Watch	1.04 to 1.00	25% water savings	Outdoor watering limited to 2 times per week. This includes a 2x/wk limit on hand watering and no exemptions for “Water Wise” customers.
Warning	0.99 to 0.95	40% water savings	Outdoor watering limited to 1 time per week. This includes a 1x/wk limit on hand watering and no exemptions for “Water Wise” customers.
Emergency	0.94 to 0.90	50% water savings	All outdoor watering/irrigation banned.
Critical/Crisis	<0.90	60+% water savings	All outdoor watering/irrigation banned, plus some indoor water use restrictions.

¹³ Percentage water savings is measured as the most recent month or months of total retail water sales divided by the retail water sales used in the original WSI calculation.

STEP 5 DROUGHT MITIGATION AND RESPONSE STRATEGIES

Case Study 5a: The Dolores Project Drought Contingency Plan 2018 - Dolores Water Conservancy District

Related Section: [2.5.6 Mitigation Action Plan](#)

The Dolores Water Conservancy District prepared the Dolores Project Drought Contingency Plan to reduce the impacts of drought for users of the Dolores Project by implementing mitigation and response actions to decrease these impacts. The Dolores Project is a Bureau of Reclamation multi-purpose project located in Dolores and Montezuma counties in southwest Colorado. The District used a Reclamation Water Smart grant to fund the plan's development. The plan includes detailed mitigation actions, categorized by structural and non-structural that may be implemented prior to a drought to build long-term resiliency. The mitigation actions include detailed descriptions of various storage and infrastructure improvements, and the necessary agencies involved for implementation. A summary table excerpt is shown below. Included with each action is a summary of any public stakeholder concerns that arose from a public review process.

Table 15. Potential Structural Mitigation Actions

Section	Action	Description
<i>FRE Actions</i>		
5.1.1.1	Control Valves	The need for isolation valves exists in the delivery system to handle water fluctuations.
5.1.1.2	Connect Irrigated Lands near Casino directly to Rocky Ford Lateral	Connect existing irrigated lands near the Ute Mountain Casino in Towaoc to the Rocky Ford Lateral.
<i>MVIC Actions</i>		
5.1.2.1	Measuring Stations with Remote Monitoring in MVIC Delivery System	Satellite measuring stations in MVIC delivery system to reduce operational spills.
5.1.2.2	Upgrade Canal Communication System	Convert canal communication system control to a digital SCADA system.
5.1.2.3	Piping Improvements for Existing Infrastructure	Priority piping improvements for MVIC delivery system. This action includes three site specific projects.
5.1.2.4	MVIC Service Area On-Farm Efficiency Improvements	On-farm efficiency improvement opportunities exist in the MVIC service area.
5.1.2.5	Hydropower Development Opportunities	Potential hydropower development exists on MVIC facilities.
<i>DWCD Actions</i>		
5.1.3.1	Dove Creek Canal	Routinely monitor and address clay liners for erosion.
5.1.3.2	Full Service Allocation Area On-Farm Efficiency Improvements	On-farm efficiency improvement opportunities exist in the FSA irrigated lands.
5.1.3.3	Hovenweep Delivery System Improvements	The need for Hovenweep delivery system high pressure improvements.
5.1.3.4	Promote Crops that Use Less Water	Promote crops other than alfalfa to become more resilient against droughts.
<i>Storage Actions</i>		
5.1.4.1	New Plateau Reservoir & Pump Storage Project	Construction of a new reservoir to increase water supplies for the fishery and M&I.
5.1.4.2	Increase Totten Reservoir Inflow	A pumpback project to pump water from McElmo Creek back to Totten Reservoir for Project uses.
5.1.4.3	Totten Reservoir pump to THC	A pumpback project to pump water from Totten Reservoir into the THC for Project uses.
5.1.4.4	Groundhog Reservoir Enlargement/Increased Capacity	Enlargement of Groundhog for additional pool of water for use as drought mitigation.
<i>Other Structural Actions</i>		
5.1.5.1	Pump San Juan River Water to FRE	A pumpback project to pump water from the San Juan River to FRE.
5.1.5.2	Hydropower Development Opportunities	Potential hydropower development exists within the Project's delivery system.
5.1.5.3	McElmo Creek Irrigation Actions	Proposed actions to stabilize the water supply to McElmo Creek irrigators.

Acronyms:

FRE: Ute Mountain Ute Farm and Ranch Enterprise; MVIC: Montezuma Valley Irrigation Company; DWCD: Dolores Water Conservancy District; THC: Towaoc Highline Canal

Case Study 5b: Fish Creek Watershed Wildfire Protection Plan

Related Section: [2.5.2 Supply-Side Mitigation and Response Strategies](#)

The cumulative impacts of climate change, overgrown forests, and pest infestations is resulting in an increased frequency of wildfire, particularly during drought. Wildfire is a growing concern for Colorado water managers with surface water systems in forested watersheds. The community of Steamboat Springs receives 90 percent of its drinking water supply from Fish Creek Basin, a heavily forested watershed, where wildfire poses a threat to maintaining water supplies. The City of Steamboat Springs and Mt Werner Water and Sanitation District finalized its Fish Creek Critical Community Wildfire Watershed Protection Plan in 2019 to increase the Steamboat Springs community's resiliency to wildfire and mitigate potential impacts. The plan development included a collaborative stakeholder process, fire-behavior modeling tools, watershed risk mapping and sediment and water quality analyses to define and prioritize site specific measures both within the water supply system and watershed for implementation pre, during and post wildfire. These measures are intended to protect critical drinking water supply and quality, water supply infrastructure and watershed health. Recommended actions include the maintenance and enhancement of natural features that serve to mitigate wildfire and postfire impacts, fuel reduction and treatment projects in high use corridors and recreational areas, postfire hydrologic/sediment controls, community education on the source of their drinking water and risk of wildfire, and collaboration with partners. Projects and upgrades were also recommended for the Fish Creek Filtration Plant to increase the resiliency of the facility if faced with treating fire-contaminated water.

Source: RESPEC. [Fish Creek Critical Community Watershed Wildfire Protection Plan](#) (CWP). September 2019. Prepared for: City of Steamboat Springs and Mt. Werner Water and Sanitation District. Prepared by: RESPECT Consulting & Services, Inc. Anchor Point Group, LLC, and Carollo Engineers.

Case Study 5c: Cape Town Water Crisis

Related Section: [2.5.3 Demand-Side Mitigation and Response Strategies](#)

In January 2018, the City of Cape Town officials announced that the city of 4 million people was three months away from running out of water. April 12, 2018 was labelled "Day Zero," when the reservoirs supplying the city would fall below 13.5 percent. Such an announcement was brought on by three consecutive years of low rainfall. Reservoir water levels had been declining since 2015. The crisis peaked during mid-2017 to mid-2018 when reservoir levels were below 30 percent of capacity.

"Day Zero" designated the day when Level 7 water restrictions in the city's contingency plan would be initiated. Under such restrictions the city's water supply would have mainly been shut off. Two hundred centralized water centers would have been set up throughout the City and all residents would have had to wait in line to collect their daily ration of water equivalent to about a two-minute shower. The announcement alone, resulted in a 30-percent decrease in residential consumption after a steady but slower decline in demand in earlier stages of the drought.

Following the announcement, some relief to urban supplies was obtained in February 2018 when water allocations to farmers were reduced coupled with farmers agreeing to not divert water stored for agricultural water use, allowing more water for urban consumption. The City increased water tariffs; increased enforcement on prohibitions to large water users; prohibited use of city water for swimming pools, lawns and other non-essential uses; and ratcheted up its drought awareness campaign. Weekly updates on regional reservoir levels were published, electronic boards were displayed on freeways to notify drivers of how many days of water supply Cape Town had left, and a city-wide water map was

launched to show water consumption on a household level. This allowed people to compare their water consumption relative to their neighbor and the rest of the city. The city also implemented a new water-pressure system in January, saving roughly 10 percent of overall municipal water use.

The heightened outreach prompted significant community response. The city's weekly water report status was a regular topic of discussion on the radio and social gatherings. Water saving techniques were published by government and civic organizations and people traded such techniques on social media. Techniques typically used by the poor, water strapped areas in the city, gained momentum in wealthier areas. Businesses initiated "dirty shirt" challenges to see who could go the most days without washing their shirt and signs saying "If it's yellow, let it mellow..." became a regular occurrence in public places.

By March 2018, the city reduced its daily water use by more than half. This fall in demand coupled with average level rains observed for the first time in four years in June 2018, allowed for the continued postponement of "Day Zero." In September 2018, reservoir levels rose to close to 70 percent, enabling the city to begin easing water restrictions and the worse of the crisis was over.

Source: [Wikipedia](#). Accessed: May 12, 2020.

Source: Alexander, Christian. Cape Town's "Day Zero" Water Crisis, One Year Later. April 12, 2019. City Lab. Access at: <https://www.citylab.com/environment/2019/04/cape-town-water-conservation-south-africa-drought/587011/>. Accessed: May 12, 2020.

Case Study 5d: Colorado Springs Utilities 2013 Drought Response

Related Section: [2.5.7 Public Drought Education Campaign Framework](#)

During the 2013 drought, Colorado Springs Utilities (Springs Utilities) implemented mandatory water restrictions, water rate surcharges and a successful integrated public relations program to educate water customers and influence water use behavior. The drought response resulted in the achievement of Springs Utilities' community water-savings goal one month earlier than forecasted while customer satisfaction increased from 58 percent to 76 percent. Research on customer drought communication previously collected from surveys within Springs Utilities' service area was used to develop the public relations program that empowered customers to save water for not only their own reasons, but to protect the safety and health of the entire community.

The program focused on an integrated campaign that drove home the extreme drought conditions and need to act, maintain positive customer perception, and deliver key messages. Such key messages addressed climate and the environment; water restrictions and enforcement; rate or surcharge changes; customer opportunities to conserve and save water; and value of water and the water system. Many were responsible for implementation of the campaign including corporate communications who led mass communications and regular updates to drought implementation and management teams; subject matter experts; business managers that provided strategy for key business areas including restaurants, golf courses, apartments, etc.; executive leadership that engaged community leaders and stakeholders; and agency vendors who provided specialized services.

The program leveraged community partnerships to underscore the severity of drought conditions and need to respond in a responsible manner. Media engagement was enhanced to ensure that the drought response was integrated into regular news coverage. Social media platforms connected customers to tips, ideas, videos, checklists and other customers to share favorite water-saving tips. In addition, a variety of other communication and messaging tools were utilized including signage on billboards, bus shelters, public transits, utilities vehicles; utilities and community events; E-newsletters and direct mail; business collateral such as signs and table tents; promotional items including magnets, stickers, etc.;

contests; and K-12 education. Total costs for communications including media production and media buying was \$1.2 million which was less than half the expenditure for the 2002 drought response.

Source: Colorado Springs Utilities. 2013 Drought Response Communications Program. Colorado Springs Utilities. Every drop counts: Colorado Spring Utilities exceeds goals, rebuilds community's water supply.

Case Study 5e: 2002 Drought Response and Coordination Examples

Related Sections: [2.5.4 Coordination with Other Entities](#) and [2.5.7 Public Drought Education Campaign Framework](#)

In 2002 providers invoked a variety of drought clauses included in contracts that allowed them to increase municipal supplies through mechanisms such as reduction of bypass requirements and interruption of agricultural leases. Denver Water invoked drought reservations that allowed it to reduce its minimum flow bypasses at its Fraser Basin points of diversion and at Strontia Springs Reservoir and to stop others' irrigation diversions temporarily above Williams Fork Reservoir. The City of Boulder invoked a drought reservation clause in its instream flow agreements with the CWCB in order to use senior water rights for municipal purposes. Boulder had previously conveyed these rights to the CWCB for instream flow purposes, but had retained ownership of the right to use the water in a drought.

Other examples of response actions that occurred during the 2002 drought include:

- Lafayette traded Colorado-Big Thompson (CBT) water to Boulder for Boulder's Baseline Reservoir water. This trade allowed each city to give up water that it controlled, but could not easily use in exchange for water that was more directly deliverable.
- Eldora ski area acquired a lease on CBT water and traded that water to Louisville in exchange for using some of Louisville's Marshall Reservoir water for increased snowmaking diversions from South Boulder Creek.

Regional Outdoor Irrigation Group: Denver Water initiated the development of an Outdoor Irrigation Work Group near the end of 2002 to prepare for potential drought conditions in the spring and coordinate efforts concerning key drought-related matters. This Work Group consisted of 12 entities, the majority being municipalities in the northern Front Range. Outdoor irrigation recommendations were developed advocating a two-day per week water schedule, limited watering between 10:00 am and 6:00 pm, and regular monthly communication.

Case Study 5f: Agricultural Water Transfers/Alternative Transfer Methods

Related Section: [2.5.2 Supply-Side Mitigation and Response Strategies](#)

Agricultural water transfers also provide a means for municipalities to acquire additional supplies in preparation for droughts. Purchase and leaseback transfers are one of the most common types of agricultural transfers in Colorado. Municipalities in Colorado usually purchase agricultural water rights without any commitment in the sale agreement to lease use of the water back to the seller when it is not needed for municipal use. Many municipalities lease any excess annual water supplies they have acquired in this manner to agricultural users, possibly including the original seller, under short-term leases, but curtail agricultural leasing programs in drought years. However, purchase agreements with leaseback provisions are becoming more common. In a purchase/leaseback agreement, a municipality

purchases agricultural water rights with the agreement that it will lease back water to the selling farmer under predetermined hydrologic conditions (i.e., wet and normal years), and reserves the right to use the water for municipal purposes during dry periods. Interruptible supply agreements are another means for municipalities to expand water supplies during a drought. Under these arrangements, the farmer owns the agricultural water rights and temporarily transfers this water to municipalities during dry periods. Current water law allows interruptible supply agreements to be approved by the State Engineer without Water Court approval as long three transfers or less occur in a ten-year period. Agricultural water transfers require that the acquired water rights be relatively senior water rights or have associated reservoir storage in order to realize sufficient water yields during dry periods.

In 2016, Larimer County acquired a farm using public open space resources with the goals of conserving a viable, irrigated farm in perpetuity, offsetting the purchase costs through piloting a water-sharing agreement, and providing a catalyst for a viable model for future alternative transfer methods. After acquiring the farm, Larimer County secured a CWCB Alternative Agricultural Water Transfers Method (ATM) Grant to hire a consultant team to compile the water, agricultural, and legal knowledge needed to design an agreement that would work for both the farm and a municipality, while meeting the above stated goals. The project team met with multiple water providers with the City and County of Broomfield, ultimately agreeing to pursue a water-sharing agreement. The City and County of Broomfield and Larimer County agreement is a combination sale of 115 Colorado Big Thompson (CBT) units and an interruptible water supply agreement for 80 CBT units. The parties determined that an interruptible water supply could be an effective way to meet drought-year municipal water demands while maintaining water supplies for the farm during normal/wetter years.

STEP 6 STAGED DROUGHT RESPONSE PROGRAM

Case Study 6: Grand Valley and Clifton Drought Response Plan 2018

Related Section: [2.6 Staged Drought Response Program](#)

The City of Grand Junction, Clifton Water District, and the Ute Water Conservancy District have developed a Drought Response Plan which is directly tied to their Regional Water Conservation Plan. The plan describes a Drought Response Information Project (DRIP) committee that was formed to provide public education on responsible water use and conservation. The committee includes the three domestic water providers as well as the Orchard Mesa Irrigation District, Tri River Area CSU Extension Horticulture Program and the National Weather Service. The Drought Response Plan utilizes the US Drought Monitor to guide drought declarations and ties response stages to the Drought Monitor categories. A synopsis of the staged drought response program and related Drought Monitor categories is shown below:

- Awareness Restrictions (D0-D2): Ongoing water conservation messaging and Regional Water Conservation Plan implementation activities
- Voluntary Restrictions (D2-D3): On-going intensive water conservation
- Mandatory Restrictions (D3-D4): Mandatory water use reductions and an Emergency Drought Rate is imposed

STEP 7 OPERATIONAL AND ADMINISTRATIVE FRAMEWORK

Case Study 7a: City of Thornton Drought Management Plan

Related Section: [2.7.5 Monitoring Drought Response](#)

During a water shortage the City of Thornton will closely monitor its water demands to evaluate how well the community is saving water and whether additional actions may be needed to promote or enforce water savings. The following two demand monitoring techniques are implemented to monitor demand. They address the combined effect of drought and drought response (e.g., water restrictions), where increased temperatures and lower precipitation can increase the consumptive use of outdoor vegetation yet water restrictions can lower outdoor water use.

1. Comparison of current monthly per capita demands to average historical monthly per capita demands - For example, the per capita demand in June of 2021 may be compared to the average historical per capita demand observed in June from 2012 to 2020. This information can provide an indication of how well the community is saving water compared to what they have been saving in the past.
2. Comparison of monthly demands to what demands would be assuming an increase in evapotranspiration (ET) – Statistical methods using historical demand, temperature and precipitation data may be used to estimate what monthly demands would be based on current weather conditions.¹⁶ This information can help decipher how well the community is saving water given the current drought and weather conditions.

STEP 8 PLAN APPROVAL AND ADOPTION

Case Study 8a: City of Durango Public Review Process

Related Section: [2.8.1 Public Review Process](#)

Prior to finalization of the Plan the City of Durango and specifically the Utilities Department prepared a “Public Review Draft” of its Municipal Drought Management Plan in September of 2019. A public comment period was opened on the 11th of September 2019 and continued for more than 60 days until November 15th, 2019. This process was important in developing an effective plan that reflects the community’s values and could mitigate potential user conflicts during a future drought event. The City sent out emails to large consumers, used social media, and posted on its website that a draft Drought Management Plan was available for the public to review and comment. An online comment form was posted with the draft. Ten comments were received; many of them were supportive of watering restrictions during times of drought, as well as support for drought mitigation including xeriscaping, water reuse and conservation. The public comments in their entirety, along with the City’s response to each comment, is included and documented in an appendix to the plan.

Case Study 8b: City of Thornton Tabletop Exercises and Gaming Forums

Related Section: [2.8.1 Public Review Process](#)

Tabletop exercises are traditionally used to test the implementation of a plan so that roles and responsibilities are clearly understood and shortcomings can be addressed in the plan prior to an actual event. These exercises and related gaming forums can also be of value to engage stakeholders in

planning processes. During the update of its Drought Management Plan in 2019, the City of Thornton conducted a drought tabletop exercise with members of the public. During the exercise, participants were asked to assume it was March and were presented with climate data suggesting that the city was entering a drought period. Community members had to decide the appropriate drought stage to declare (e.g. Stage 1 Moderate vs Stage 3 Extreme) and select corresponding levels of water restrictions. Water restrictions could be voluntary or mandatory and differ in severity depending on individual priorities and type of landscaping (e.g. residential turf lawns, school playgrounds, established trees, parks, golf courses, gardens, etc.). Participants were also asked to provide ideas on how the city can best educate and encourage the community to save water during drought. After participants presented their plans, it was revealed that the climate data presented during the exercise was from the 2012 drought. Community members indicated that the exercise was a fun interactive way to learn about Thornton's Drought Management Plan update. It also provided the community a means to understand the decision-making challenges the city undergoes when monitoring and declaring drought and provided the city more insight into the community's values and messaging needs.

References

Alexander, Christian. Cape Town's "Day Zero" Water Crisis, One Year Later. April 12, 2019. City Lab. Access at: <https://www.citylab.com/environment/2019/04/cape-town-water-conservation-south-africa-drought/587011/>. Access on: May 12, 2020.

American Water Works Association. 2002. *Drought Management Handbook*. ISBN: 1-58321-207-8.

American Water Works Association. 2019. *Drought Preparedness and Response Second Edition*. ISBN: 9781625763334.

California Department of Water Resources Office of Water Use Efficiency and Transfers. 2008. *Urban Drought Guidebook 2008 Updated Edition*.

CDM. 2007. Colorado's Water Supply Future Statewide Water Supply Initiative - Phase 2. Prepared for: Colorado Water Conservation Board.

City of Aurora, Aurora Water. 2008. *Drought Contingency Plan*.

City of Boulder, Colorado. 2003. *Drought Response Plan*. Volumes 1 and 2.

City of Durango. 2020 Municipal Drought Management Plan. February 2020.

City of Longmont. *2018/2019 Water Supply & Drought Management Plan*. April 12, 2018.

City of Thornton. City of Thornton Drought Management Plan. 2019. Prepared by: INTERA Corporation. Prepared for: City of Thornton.

Wikipedia. Accessed: May 12, 2020. https://en.wikipedia.org/wiki/Cape_Town_water_crisis

Clifton Water District, City of Grand Junction, Town of Palisade and Ute Water Conservancy District. 2003. *Drought Response Plan*.

CWCB. 2010. Drought Planning and Information and Drought Mitigation Planning. CWCB website. Assessed January 25, 2010.

CWCB. 2018. Colorado Drought Mitigation and Response Plan.

Denver Water. *Chapter 15 – Drought and Water Shortage Response from Denver Water's Operating Rules*. 2020.

Dolores Water Conservancy District. 2018. The Dolores Project Drought Contingency Plan.

Flory, J. E., and T. Panella. 1994. Long-term water conservation and shortage management practices: Planning that includes demand hardening. Prepared for California Urban Water Agencies.

Headwaters Corporation. 2009. *2009 Drought Toolbox Scoping Report*. Prepared for: CWCB Office of Water Conservation and Drought Planning. July 24, 2009.

Knutson, Cody et al. 1998. *How to Reduce Drought Risk*. Western Drought Coordination Council. March 1998.

Luecke, Daniel F., Morris, John and Hydrosphere Resource Consultants. 2003. *What the Current Drought Means for the Future of Water Management in Colorado*.

RESPEC. *Fish Creek Critical Community Watershed Wildfire Protection Plan (CWP)²*. September 2019. RESPEC Consulting & Services, Inc. Anchor Point Group, LLC, and Carollo Engineers.

Town of Castle Rock. 2018. Town of Castle Rock Municipal Drought Management Plan. May 2018

University of Colorado, Boulder, National Oceanic and Atmospheric Administration and Western Water Assessment. 2009. *The 'Dealing with a Drought: Adapting to Climate Change' Workshops*. A Report for the Colorado Water Conservation Board.

Wilhite, Donald L., ed et al., 2005. *Drought and Water Crises: Science, Technology, and Management Issues*. CRC Press. Pp 93-135. Accessed from National Drought Mitigation Center Website: http://drought.unl.edu/plan/handbook/10step_rev.pdf. Accessed on January 26, 2010.

Appendix A Worksheets

See separate spreadsheets.