State of Nevada

Water Conservation

Planning Guide

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Department of Conservation and Natural Resources
Bradley Crowell, Director

Division of Water Resources
Adam Sullivan, P.E., Acting State Engineer

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Introduction

The original version of this guide was published in 1991, which coincided with the revision to the Nevada Revised Statutes (NRS) requiring that suppliers of water develop water conservation plans. Since then, the NRS governing the contents of a water conservation plan have been revised in multiple legislative sessions. Over time, the requirements have included greater emphasis on quantitative metrics. This guide provides information about water conservation plan requirements as of 2019. New and updated plans are reviewed and approved by the Nevada Division of Water Resources (NDWR) per NRS 540.

In addition to this guide, other resources are available to assist in the creation of a complete and useful water conservation plan. Low-cost technical assistance is available through one or more organizations contracted with the Nevada Division of Environmental Protection (NDEP). NDEP's Office of Financial Assistance staff can guide you to these resources. Additionally, the approved plans posted on NDWR's website can provide ideas for your system's plan. Finally, NDWR staff in the Water Planning and Drought Resiliency Section are available to discuss your concerns and provide feedback as requested.

Purpose and Goals

The goal of this revised Water Conservation Planning Guide is to provide public and private entities, from the individual and the small water supplier up to the large governmental and quasi-governmental water purveyors, with basic guidelines for drafting or revising a water conservation plan that will comply with industry standards and meet NRS and Nevada Administrative Code (NAC) regulations. An effective water conservation plan is a functional and dynamic tool for implementing water conservation measures specific to a water delivery system, helping to ensure a reasonable supply of water to the water purveyor, and in a broader sense, to our state as a whole.

There is a difference between planning and having a documented plan. Water conservation planning is an on-going iterative *process* that produces a *product*—a water conservation plan. The plan itself should be a living document to guide the water system manager/operator in current conservation practices. As the plan is implemented, the planning process should include a review of the plan to see which components do and don't work. The plan should be revised on a routine basis, with new industry standards in mind or as changes occur to the water system.

Water conservation is not simply a goal unto itself, but a means to an end. Water conservation planning and drought planning should be implemented not in times of drought or emergency, but before these times of drought in order to protect the water system owner and customers from shortfalls in supply and harsh controls on demand. Water conservation planning is about adding another tool on the water supplier's tool belt, to handle increasing demand, decreasing supply, or a mixture of both. This guide is about helping the water purveyor create and refine this tool, although every plan should be customized to the specific water system.

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1.0 Reasons for Water Conservation

While many natural resources are vital to people's way of life, water is essential to life in all biological forms. As Nevada is the driest state in the United States of America, our water resources are that much more precious. Without careful planning, Nevada's citizens may find opportunities diminishing due to a lack of available water. As the demand for water grows, either new supplies must be developed (supply side management) or future demands need to be controlled (demand side management). Water conservation planning is considered demand side management and can assist in the more efficient use of currently available water resources.

Currently, almost all of the state's available surface water has either been appropriated or is under adjudication[1]. Groundwater in many of the state's individual hydrographic basins is fully allocated, especially those with large populations, and many more hydrographic basins may reach a fully allocated status in the near future. As local underground water sources become strained, large population centers have sought water resources from outlying basins for import.

With its arid climate and limited water supply, Nevada is quite susceptible to drought. It is rare that the state has an "average" year. Often a given year sees wet or dry extremes, making water supply highly variable. In wet years, it might not be possible to capture or store the "surplus" water, and in dry years the water simply isn't available. Furthermore, the development of new water supplies often comes at a very high cost (e.g. treatment plants, wells, pipelines, or pump stations). However, effectively implemented water conservation programs can increase available water through reduction in demand. Through demand side management, a water purveyor can stretch the current supply to meet demands and reduce the high capital expenditures

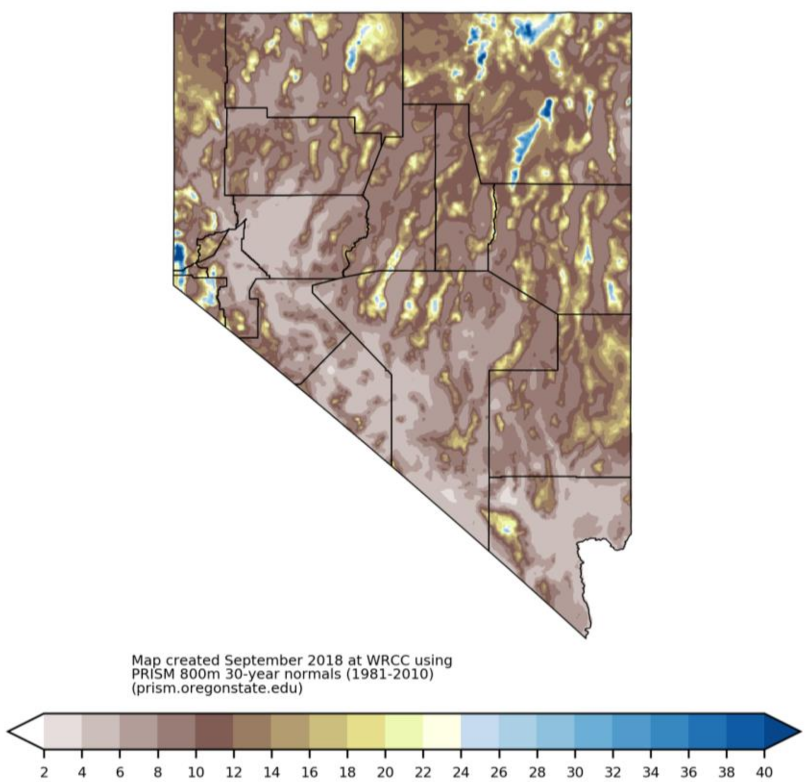


Figure 1.1. Average annual precipitation in Nevada.

[1] Adjudication is a legal process through the judicial courts system to determine who has a valid water right claim.

needed to find new supplies. Even if development of new water supplies or increased treatment capacity will be needed in the future, conservation can serve to delay such costs, providing the needed time to plan and finance those projects. Cost/benefit analysis should always be performed when investigating a water resource enhancing project, whether it is supply or demand side management.

The benefits of water conservation are not solely water savings, but also include:

- ◊ Savings in energy used to convey water supplies.
- ◊ Savings from not building or enlarging water supply reservoirs, or from prematurely developing new groundwater sources.
- ◊ Savings in the cost of water and wastewater treatment, including plant operation costs and chemical costs.
- ◊ Savings in eliminating or postponing expansion of water and wastewater treatment plants by the implementation of water saving measures.
- ◊ Guarding and planning for dry periods.
- ◊ Enhancing the environment by increasing or maintaining stream flows and reservoir water levels, reducing drawdown stresses on groundwater, and reducing wastewater volumes.
- ◊ Preserving recreational and sporting activities by increasing or maintaining stream flows and reservoir water levels.
- ◊ Improving drought preparedness or resiliency, and margins of safe/dependable yields.
- ◊ Educating customers and the public about the value, scarcity, and permitted limits of water resources.

(Nevada, 1991, p. 1.2 and USEPA, 1998, p. 45)

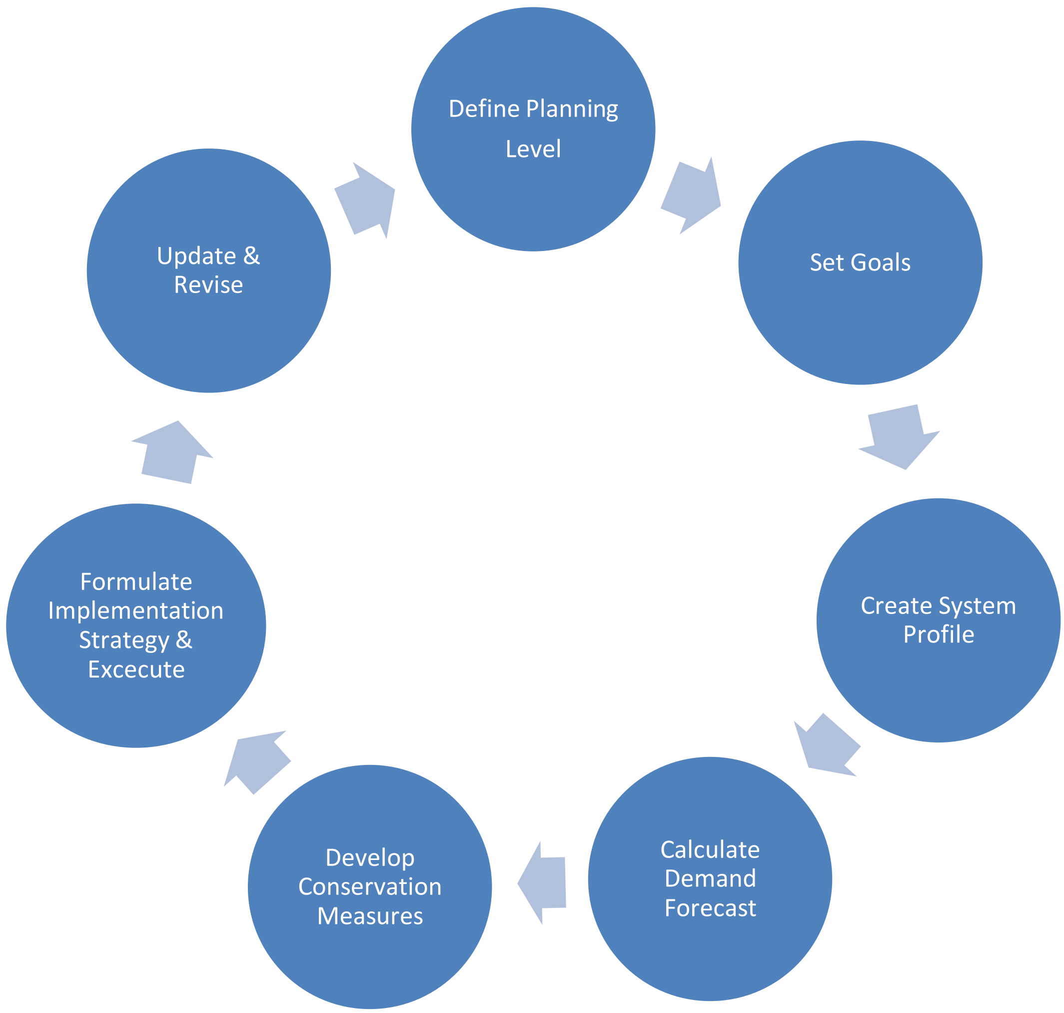
<u>Myths</u>
Conservation:
- ***Eliminates the need to develop more water.***
- ***Will cost purveyors revenue.***
- ***Water is wasted.***
- ***Results in major lifestyle changes.***

(Utah, 2012)

The bottom line is that Nevada is largely desert and is the driest state in the United States. Average annual precipitation is less than ten inches, and in many regions of the state less than five inches. Solutions to growth cannot be strictly supply-side enhancements, since those resources are at best fixed, and at worst declining due to overuse or climate change. Long term solutions must also focus on the demand side, and that means water conservation.

2.0 Water Conservation Planning Process

There is no "right" approach to water conservation planning, but a good framework will facilitate the process. Several sources provide an outline for the conservation planning process (see 8.2 Recommended Resources). These sources tend to have common elements such as establishing a goal, developing a system profile, forecasting supply and demand, considering existing and proposed measures, implementing the plan, and reevaluating the plan. This planning guide presents the following steps:



2.1 Set Planning Level

Not all water systems are the same; they can range from small or rural systems to large interconnected urban systems. Thus, water system managers must decide on the level of appropriate planning based on the current and future demands of their water system. The United States Environmental Protection Agency (USEPA) Water Conservation Plan Guidelines publication provides tiered guidelines for what measures to take based on the size of the water system (USEPA, 1998, pp. 39, 42). While this is a helpful guide, the water manager must be careful to still comply with NRS Chapter 540, as well as NRS chapter 704 if the utility is an Investor Owned Utility (IOU) regulated by the Public Utilities Commission of Nevada (PUCN). For example, pressure management is given as an "intermediate guideline" by the EPA, but NRS § 540.141(1)(c) states that this must be addressed in a water conservation plan. Also, the EPA guidelines are not absolutes; a smaller system that is metered and has extensive records may find it feasible to perform more sophisticated demand forecasts or to implement a formal leak detection program. As each element of the plan is approached, consider who, what, when, where, why, and how the specified actions will be carried out.

2.2 Establish and Revisit Goals

In order to guide the planning process and develop a water conservation plan, goals should be decided upon as something measurable (e.g. reduce cost by 10%, delay facility construction until 2035, etc.), rather than something vague (e.g. reduce water use, reduce leaks). If the goal is quantifiable, then it can be determined how quickly the goal is being met and at what point the goal is met. Objectives that support achieving the goal should likewise be measurable (e.g. if the goal is to delay expansion of a water treatment facility by 10 years, then an intermediate supporting objective might be to reduce production of water by 5% through conservation measures). For each objective, a performance measure should be determined so that the manager can evaluate the effectiveness of a conservation measure.[2] This is achieved through monitoring and evaluation, two components that should be included in the conservation plan. Such metrics can be difficult or impossible to determine on unmetered systems. Metered distribution can provide the detail needed to determine individual uses, uses by type, identify leaks, changes in water use, etc. (see more detail in Chapter 6).

Water Conservation Plan Nexus

NRS § 540.141(1)(c) requires that the water conservation plan include goals for acceptable levels of water loss and a plan for analyzing how the supplier will progress toward those goals.

Additionally, suppliers servicing ≥500 connections must set measures to evaluate the effectiveness of the plan, per NRS § 540.141(2)(a).

During a periodic review process, the goals should be examined. Have they been achieved? If so, are there new goals or other goals that can be focused on? If not, what objectives are not being met and why? Do the objectives need to be reexamined? Revisit the water conservation goals whenever a goal is met or an objective is achieved or whenever a critical performance indicator is missed. Evaluate what measures are effective and which should be abandoned. The goals and the means to achieve the goals may change over time as circumstances change.

[2] Note that "measure" is being used in two senses: First, to indicate a gauge and, second, to express an action. Often the latter use occurs in planning documents but both the former and the latter are used in NRS § 540.141 and are expressed here in both senses despite the potential for confusion.

2.3 System Profile

The water system manager should take an inventory of existing resources and capabilities, with intent to answer the following questions:

- ◊ What is the current service area and population?
- ◊ What is the annual water supply (all sources)?
- ◊ How susceptible is that supply to climate variability (wet/dry years)?
- ◊ What are the type and number of service connections?
- ◊ What is the annual water demand and type of demand?
- ◊ What is the peak demand?
- ◊ What is the pricing system?
- ◊ What planning is already in place?
- ◊ What other conditions affect water supply or demand (e.g. are shortages common, is growth at a high rate, or are facility improvements planned)?
- ◊ What conservation measures are already in place and how effective are they?
- ◊ What facilities are planned and how does those affect future supply?
- ◊ What water rights exist or can be secured, and how do those affect future supply?

The U.S. EPA Water Conservation Plan Guidelines document provides helpful worksheets for answering these questions, with three versions based on the level of detail required (USEPA, 1998, pp. 48-49, 67-69, 107-109).

2.4 Demand Forecast

Demand forecasting should never be considered a guarantee of future conditions, but can at best be a useful projection based on certain assumptions or anticipated circumstances. Depending on whether those assumptions are true or if the circumstances are met, the accuracy level of the forecast will ultimately be proven in the long run. For each water system, the system manager must take into consideration what types of forecasting are suitable for the plan. For example, if the system is strictly for a residential service area, a per capita or per connection forecast may serve well enough. On the other hand, a city with a variety of residential, commercial, industrial, recreational, or other uses may have one sector outpacing another in terms of demand. A per capita or per connection forecast might prove limited for such a case. Any forecast should consider 5- to 10-year time intervals.

Water Conservation Plan Nexus

NRS § 540.131(4)(c) requires that the water conservation plan be updated every five years, which should be kept in mind when considering a relevant timeframe for demand forecasts.

In making the demand forecast, planners should consider conservation measures that are already in place, but not those conservation measures proposed to be implemented by the plan being developed. That may include existing plumbing fixture requirements and the associated effects to water usage. Planners should also consider population projections, but may need to further consider land-use planning and construction estimates. A small single use (or predominately single use) system may be able to gain a useful insight from a demand forecast accounting for the whole system. For larger or multiple use systems, a demand forecast by type of use will be of greater benefit (USEPA, 1998, pp. 50-52, 70-72, 110-113).

Some resources for selecting a forecast method or model are available. The U.S. EPA Water Conservation Plan Guidelines document (USEPA, 1998, p. 111) discusses the IWR-MAIN computer model (USACE, 1996, p. K1-K5) for forecasting. Means to utilize this model are discussed in various literatures (see 8.2 Recommended Resources). Software such as Microsoft Excel can also be used for analyzing data (Wong, 2009). *Forecasting Urban Water Demand* from the American Water Works Association provides a discussion on the selection of demand forecasting methods (Billings, 2008, pp. 35-41). *Water Resource Economics* provides techniques and discussions from an economics viewpoint (Griffin, 2006).

The level of detail depends on the size of the system and the resources available to the managers. This is why determining the level of planning is a vital first step (see Section 2.1 above).

2.5 Conservation Measures

Existing conservation measures should be identified under the system profile (see Section 2.3 above). If a measure has been effective, then continuation or expansion of the measure is likely warranted. Conversely, if a measure is not effective, it should be revaluated, modified, or discontinued. This guide further elaborates on potential conservation measures in Chapters 4 (education), 5 (indoor, outdoor, and agricultural conservation measures), and 6 (supply management).

Each measure should be judged by certain criteria to assess performance with respect to an objective or goal. The U.S. EPA Water Conservation Plan Guidelines provide a list of possible criteria (USEPA, 1998, p. 54). These criteria can be categorized broadly as:

◊ Monetary
◊ Social
◊ Legal/Regulatory
◊ Environmental

When considering which conservation measures to implement, a cost-benefit analysis should be performed. An estimate of the total implementation cost should be compared to the anticipated water savings in order to

Water Conservation Plan Nexus

NRS § 540.141(1)(b) requires specification of water conservation measures required to meet the needs of the service area. This is a key component of the plan in which the supplier describes the conservation policies it is committed to, whether by choice or by law.

assess the cost effectiveness of a specific conservation measure. The water manager may also wish to compare the cost of implementing the program to the savings from avoiding supply-side costs such as delays in capital improvements, reduction in pumping, etc. (Nevada, 1991, pp. 3.1-3.8 and USEPA, 1998, pp. 54-55). A literature review may also provide guidance as to which measures will be most effective. One study that may be an informative resource is "Do Residential Water Demand Side Management Policies Measure Up? An Analysis of Eight California Water Agencies" (Renwick, 2000).

Appropriate conservation measures can now be selected, utilizing the understanding of past successes and failures, cost effectiveness, and system demands. By inventorying the water system and making demand forecasts in the first part of the planning cycle, it then becomes easier to decide upon conservation measures make the most sense.

2.6 Implementation Strategy

Water Conservation Plan Nexus

NRS § 540.141(1)(f) requires that a schedule for carrying out the conservation plan be included. If all measures are implemented simultaneously, it may be difficult to determine which measures were responsible for effecting the most (or most cost-effective) water conservation. Consider the benefits of staged implementation.

Planning is an ongoing process, but a timetable for meeting specific objectives and goals, as well as conducting routine actions will provide some direction for implementation. Schedules should include monitoring and evaluation tasks. Additionally, successful implementation will require adequate staff to complete the necessary tasks, and a plan to delegate that work. The planning process should consider any factors that could affect the implementation of conservation measures (USEPA, 1998, p. 58). This could be permitting requirements, long-term implementation challenges, staffing needs, or other hurdles to overcome.

The U.S. EPA Water Conservation Plan Guidelines document provides helpful worksheets for laying out a schedule and addressing public involvement, monitoring, evaluation and plan updates (USEPA, 1998, pp. 59, 98-99, 140-141).

2.7 Updates and Revisions

Revisit and revise the water conservation plan. An existing plan should provide the groundwork for going through the above six steps in a continual planning process. The water conservation plan can be updated to meet current needs, and to address future needs as they become redefined over time. New data and technological advances should be considered during plan updates.

Water Conservation Plan Nexus

NRS § 540.141(2)(a) requires that the water conservation plan include provisions relating to measures for evaluating the effectiveness of the plan. The establishment of performance metrics related to conservation objectives, will guide decision making for the system manager.

To satisfy the requirements of NRS 540.131 § (4)(c), the revision process is to be done every five years. However, if there are any major changes in the water system or measures are not meeting objectives, then a more frequent revision may be appropriate. For PUCN-regulated utilities, NRS § 704.6624(3)(b) requires periodic updating of the plan to reflect the changing needs and conditions of the service area. Each such revision must be filed with the PUCN and made available for inspection by members of the public within 30 days after its adoption.

Water Conservation Plan Nexus

NRS § 540.131(4) requires that the water conservation plan be revised every five years but may be revised from time to time to reflect the changing needs and conditions of the service area.

3.0 Water Conservation Plan Requirements per NRS §§ 540.121 through 540.151.

No single plan can meet the requirements for all suppliers of water. To satisfy a particular supplier's needs, a plan must be suited to that supplier. A large urban utility will have a different approach to water conservation than a small rural water system, but the general approach to developing a water conservation plan that satisfies NRS 540 will be the same.

NRS §§ 540.121 through 540.151, inclusive, define a supplier of water and provide specific requirements for the contents of water conservation plans. Note that joint plans are acceptable for suppliers within common geographic areas. Staff in NDWR's Water Planning and Drought Resiliency Section review the plans to check for all required components before issuing plan approval. This chapter of the Water Conservation Planning Guide will list the required plan elements with basic guidelines. The following chapters provide additional details for how to use the information presented in the previous chapters to satisfy these statutory requirements. A checklist is provided in Appendix A to assist the supplier of water in confirming that all the provisions of NRS §§§ 540.141, 540.145, and 540.151 are addressed in the water conservation plan. Some of the NRS-required plan elements may not be applicable to certain suppliers. In these cases, it is recommended that the plan include text pointing out which elements are not applicable and a brief statement explaining why.

NRS §§ 704.662 through 704.6624, inclusive, define water conservation plan requirements for rate-regulated IOU suppliers of water and provides specific requirements for the contents which need to be reviewed by the PUCN. Per the Commission's Order in Docket 15-05019, the PUCN only has jurisdiction over rate-regulated water utilities. Private co-op and non-profit water systems will need to gain plan approval through NDWR. It is up to the water purveyor to determine which set of statutes the water system must adhere to.

3.1 NRS § 540.141(1)(a) Public Education

NRS § 540.141(1)(a) requires provisions relating to public education methods that increase awareness of the limited supply and need to conserve water in Nevada, encourage reduction in the size of lawns, and promote the use of arid and semi-arid climate adapted plants. These should be the minimum requirements of any public education program. Chapter 4 provides a discussion on three targets for education: employee, student, and adult.

3.2 NRS § 540.141(1)(b) Specific Conservation Measures

NRS § 540.141(1)(b) requires a plan to contain specific conservation measures to meet the needs of the service area, including any required by law. Chapter 5 includes a discussion of possible conservation measures, beyond those specifically required by other portions of NRS 540.

3.3 NRS § 540.141(1)(c) Management of Water; Goals for Water Loss

NRS § 540.141(1)(c) requires that the plan address the management of water to identify and reduce loss in water supplies, inaccuracies in water meters, and high pressure in the system. This includes requirements to establish goals for an acceptable level of water loss, and a clear plan which shows how the supplier will progress towards that level. The nature of a supplier's water loss goals will depend upon access to metered data. Chapter 6 of this guide discusses possible system management practices, along with ways to determine and improve system water loss.

3.4 NRS § 540.141(1)(d) Reuse of Effluent

NRS § 540.141(1)(d) requires consideration of management strategies which could increase the reuse of effluent, as applicable for both indoor and outdoor uses. See Chapter 5 for reuse ideas. This requirement may not apply to certain water suppliers.

3.5 NRS § 540.141(1)(e) Drought Contingency Plan

NRS § 540.141(1)(e) requires that a drought contingency plan be a component of the water conservation plan in order to ensure a reliable supply of potable water during extended dry periods. Chapter 7 discusses effective drought contingency planning.

3.6 NRS § 540.141(1)(f) Schedule

NRS § 540.141(1)(f) requires that a schedule for implementing the plan be included. Rather than hand-waving this requirement by stating that all measures are in effect, the planner's best interests may be served by considering things such as: staged implementation of conservation measures, scheduling reviews of objectives and goals, and stating timeframes for evaluations of the water system or conducting audits. Additionally, any stated conservation goals should have an explicit timeframe for achievement.

3.7 NRS § 540.141(1)(g) Installation of Meters on All Connections

NRS § 540.141(1)(g) requires a specific plan which will help the supplier to progress towards metering all connections. Metering is one of the most important tools available for water conservation and monitoring progress toward conservation goals. Chapter 6 includes further information on water meters and developing an approach for fully metering a system.

3.8 NRS § 540.141(1)(h) Standards for Water Efficiency

NRS § 540.141(1)(h) requires that a plan recognize existing water efficiency standards, or explicitly set stricter standards, for any new developments within a service area. A plan should state water efficiency standards for fixtures, appliances, and fittings for indoor and outdoor water use. New development generally includes construction, reconstruction, redevelopment, conversion, structural alteration, relocation, or enlargement of any structure which adds or increases the number of service units; it also includes any use or extension of the use of land which increases the number of service units. Chapter 5 offers some discussion of water efficiency standards for both indoor and outdoor uses.

The U.S. EPA WaterSense program offers some of the most stringent efficiency standards nationwide. Nevada's requirements for the use of WaterSense fixtures were established in 2019 in AB 163 and are stated in NRS § 278.582, 338.193, 461.175, and 489.706. These standards must be incorporated into each county and city's building code. More information on efficiency is linked in Section 8.2 of this guide.

3.9 NRS § 540.141(1)(i) Tiered Rate Structures

NRS § 540.141(1)(i) requires a discussion of tiered rate structures for water pricing to further promote the conservation of water. All suppliers with metered water systems should consider implementing a tiered rate structure if one is not already in place, or offer reasoning for not doing so. The plan must also include an estimate of how the tiered rate structure will impact the consumptive use of water. Chapter 6 includes further information regarding water pricing and rate structures.

3.10 NRS § 540.141(1)(j) Watering Restrictions by Time

NRS § 540.141(1)(j) requires a planner to set watering restrictions based on the time of day and the day of the week. Including information on how those restrictions may be implemented, monitored, and enforced is beneficial to the plan. Such restrictions may be implemented as a full-time or seasonal conservation measure, or contingent on drought conditions. Watering restrictions are discussed more in Chapters 5 and 7.

3.11 NRS § 540.141(2)(a) Measures of Effectiveness

NRS § 540.141(2)(a) requires that for any supplier of water providing service to 500 or more connections, the plan include measures for evaluating the effectiveness of the plan or joint plan. Evaluation is discussed as part of the planning process in Chapter 2, and also in Chapter 5.

3.12 NRS § 540.141(2)(b) Savings Estimate

NRS § 540.141(2)(b) requires that for any supplier of water providing service to 500 or more connections, the conservation plan include an estimate of the annual quantity of water expected to be conserved due to each conservation measure described in the plan. The savings must be expressed in gallons of water saved annually. Although this is a potentially challenging requirement, it is not an impossible task. For example, savings estimated for an average household can be extrapolated to the whole service area, or a percentage of the service area. If data exist for previous measures implemented by the water system, then a reasonable estimate can be derived from these data. For measures such as retrofits or turf buy-backs, the difference between old and new water use can provide a basis for an estimate, assuming the level of participation can be reasonably estimated. One resource to assist with water savings estimates is Appendix B in the EPA Water Conservation Plan Guidelines (1998), listed in 8.2 Recommended Resources.

This requirement may be documented in its own section or for instance, incorporated into the description of the individual conservation measure.

3.13 NRS § 540.145 Requirements to Calculate Water Loss

NRS § 540.145 became effective on January 1st, 2020. It lays out the requirements for a supplier of water to calculate and report system water loss, with different specifications depending on the size of the entity. Suppliers which serve water to 3,300 persons or more must conduct a water loss audit in accordance with the methodology and software of the American Water Works Association and include those results in the conservation plan. Suppliers which serve fewer than 3,300 persons must calculate and report the amount of water delivered by the supplier to the distribution system, and the amount of water that was billed to customers for each year. Chapter 6 of this guide discusses water loss calculations in greater detail.

Any supplier of water that has previously submitted its respective water loss results must include a comparison of recent and past results in its current plan. An analysis of any progress made towards stated goals for acceptable water loss, pursuant to NRS § 540.141 (1)(c), must also be included in the conservation plan. A transient water system, as defined in NRS § 445A.848, is not required to calculate or include water loss calculations in its conservation plan.

3.14 NRS § § § 540.151(1) Conservation Incentives

NRS §§ 540.151(1)(a) through 540.151(1)(c) require that the supplier adopt a plan to provide incentives for customer conservation actions, specifically: to encourage water conservation in the service area, retrofit existing structures with water conserving plumbing fixtures, and install water efficient landscaping. Those incentives may be included within the stated conservation measures of the plan, or stated in a separate section. Although conservation incentives are typically thought of as monetary, any number of other options exist. Some additional suggestions for conservation incentives are discussed in Chapter 5 of this guide. NDWR reviews the conservation incentive plans for informational purposes only.

4.0 Public Education

> ***"One of the most critical components of a [water conservation] program is a robust education and outreach program that reaches water provider employees, school children and adults. Furthermore, investments in public and targeted education have high water conservation returns and public awareness tends to build political support and participation."***
>
> ***(Georgia, 2007 p. 3)***

Depending on the needs and resources of the water supplier, the opportunities for educating users or the general public can vary greatly. From a simple poster or pamphlet, to classes taught in grade school or seminars at community events, education programs are important because individual conservation can have a considerable aggregate impact at relatively minimal cost. Additionally, some form of customer education is often a necessary first step towards achieving any of the conservation measures listed in Chapter 5.

Although effective, a supplier shouldn't rely solely on water savings from a public education campaign. While it is possible (and often necessary during drought) that education will stimulate customers to quickly adopt conservation practices, a more realistic view often considers long term program impacts. Conservation education and outreach can help establish a culture of water wise stewards, which over time will result in behavioral change and effective conservation actions such as replacing high-water-use landscaping or inefficient fixtures. These long-term cultural changes can be some of the most valuable impacts from an effective conservation-focused public education program. Three audiences to consider for education programs are discussed in the sections below.

4.1 Employee Education

Water conservation education can begin with employees. By adopting a staff water conservation policy or including water conservation as a component of standard operating procedures, the water system manager can emphasize the importance of water conservation. Performing water audits can also be a form of education, in which staff learn about where water losses can occur and become better prepared to handle or anticipate problems (see Section 6.1). Finally, providing educational materials or opportunities (classes, professional seminars, etc.) can help improve the employee's conservation knowledge; this includes having them read the supplier's water conservation plan (Georgia, 2007 pp. 4-5).

4.2 Elementary School Education

An elementary school education program serves to introduce water resource terminology and water conservation practices to young students. It is less likely to be an option with smaller or more rural water systems, but large systems such as municipal or quasi-governmental bodies have opportunities and resources to introduce water conservation education into an elementary school program. The following is an outline of steps for implementing an elementary school education program and the learning objectives that should be met by such a program.

<u>Steps for implementing an elementary school education program:</u>

1. Set up a water conservation education committee. Members could include a local government representative (chairperson), school district curriculum coordinator, local cooperative extension agent, and water utility representative(s).
2. Hold a public meeting with the water conservation education committee to discuss objectives to be accomplished through a water conservation education program.
3. Identify if funding will be necessary to accomplish an education program, and what sources may exist (e.g. local government, local water utility, etc.).
4. Obtain or create educational materials and establish media contacts.
5. Establish dates by which a program will be initiated, completed, and repeated.
6. Implement the education program.

(Nevada, 1991)

In-school learning objectives:

1. The students should be able to describe the hydrologic cycle in terms of evaporation, condensation, and precipitation. They will also be able to describe the importance of potable water to life. The students will be able to explain where drinking water comes from; what happens to wastewater in their community; and the relationship of drinking water and wastewater to the hydrologic cycle.
2. The students will be able to recognize sources of pollution, and how to prevent the pollution of groundwater and surface water supplies. The students should also be able to explain how water conservation helps with water quality and provides environmental benefits.
3. The students should gain an understanding of the costs involved in providing water, and how efficiency and conservation can reduce these costs by delaying infrastructure improvements, treatment costs, etc. The students should also gain an understanding of how conservation in the home can provide long-term savings.
4. The students will be able to explain the importance of water conservation and participation in water conservation activities. They will learn how to inform others and continue their own education regarding water conservation.
5. Students will understand the concepts and/or definitions of acre-feet, aquifer, conservation, cubic feet per second, gallons per minute, groundwater, hydrologic cycle, in-stream flow, irrigation, liquid, native vegetation, pollution, solid, surface water, vapor, wastewater treatment, water treatment, water quality, water quantity, and xeriscape.

(Nevada, 1991 and Georgia, 2007)

4.3 Adult Education

There are many effective ways of encouraging conservation through public education. One of the simplest and least costly forms is bill inserts. Pamphlets that explain how an individual consumer can reduce their water use (and their water bill in a tiered rate system), may give the consumer the motivation to take action. Another insert could explain how to read a water meter. When providing an insert to explain implemented water restriction(s), clearly explain why such restriction(s) are necessary. Reason may include: to accommodate peak demand, to reduce costly infrastructure upgrades, or to mitigate drought conditions. Bill inserts should emphasize the benefits to the customer when water conservation is practiced.

> **Water Conservation Plan Nexus**
>
> NRS § 540.141(1)(a) requires a plan have public education methods to increase public awareness of the limited supply of water and the need to conserve water, and to encourage reduction in the size of lawns and the use of arid and semi-arid plants. These should be the *minimum* requirements of any public education program.
>
> NRS § 540.131(2) provides that as part of the procedure for adopting a plan, the supplier of water shall provide an opportunity for any interested person to present written views and recommendations on the plan.

With some minor additions, the water bill itself can also serve to help educate customers. Explain on the bill how the current rate could be reduced through conservation measures. For example, detail how a tiered rate structure will allow a disproportionate decrease in charges with respect to a decrease in water use (see Section 6.2 for explanations of pricing systems), or provide a note of what the bill would have been had the customer used only enough water to stay within the lower tier of an inclining block pricing system.

In our current high-tech world, a webpage with information on water conservation programs offered by the supplier of water, links to helpful sites like WaterSense, University of Nevada Cooperative Extension, xeriscape guidance, native plant guides, etc., can also help serve to educate customers and perhaps the public at large.

Another way to educate adults is by including the public in the planning process (USEPA, 1998, p. 45). This can be through an invitation to review and comment on a proposed water conservation plan, or by providing meetings in which conservation information is presented and comments are accepted. Inclusion in the water conservation planning process will encourage participation by giving people a say in that process.

One free resource for outreach and education material is the EPA WaterSense program. Water utilities are eligible to become WaterSense partners. The program provides it partners with a large variety of materials, many of which can be customized by the water supplier to best suite their customers. Webinars and newsletters provide additional information from other communities that can spark new ideas for yours.

4.4 List of Common Public Education Methods

a. School education programs

b. Bill stuffers

c. Newsletters

d. Media relations, direct mail, and marketing materials

e. Advertising campaigns (newspaper, radio, TV, web, billboards, bus signs, etc.)

f. Informational and educational websites

g. Social media (Facebook, Twitter, etc.)

h. Water festivals and public events

i. Informational billing (customer feedback on water use patterns, leakage, money saving and rates)

j. Conservation kit giveaways

k. Seminars, trainings, classes, and demonstrations

l. Public inclusion in the conservation planning process

(Colorado WaterWise and Aquacraft, Inc., 2010)

5.0 Specific Conservation Measures

This chapter describes water conservation measures other than education (Chapter 4) or system management (Chapter 6). Many of these are end-user conservation measures which rely on voluntary behaviors, product upgrades, or mandatory behavior changes through ordinances and enforcement. The measures are presented below in four categories: indoor, outdoor, agricultural, and system wide. While a number of possible measures are provided, this is by no means an exhaustive list of options.

Water Conservation Plan Nexus

NRS § 540.141(2) requires that for suppliers of a certain size, the plan include measures to evaluate the effectiveness of the plan and estimates of the amount of water that will be conserved for each conservation measure specified in the plan. The estimates are to be in terms of gallons of water saved annually.

Effective conservation measures will vary depending on the supplier, location, primary type of customer, size of system, etc. Thus, it is important that any plan outlines a means to assess the success of various conservation measures, so that long-term resources can be dedicated to those actions which are most beneficial. This will need to be continually monitored and assessed over time.

The process of deciding which conservation measures to enact should begin with water savings estimates for each measure. These can be calculated from pre-existing supplier data or estimated from other available resources (see Chapter 8). A cost-benefit analysis should be performed, and those measures which are estimated to be the most cost-effective for water savings should be the measures implemented (more in Section 2.5).

Establishing performance metrics for each conservation measure is important so that a manager can evaluate their effectiveness. This is achieved by monitoring and evaluating the amount of water used before and then after implementation. It is easiest and often most practical to evaluate one conservation measure at a time. By implementing one conservation measure at a time, the effect of each measure can be independently monitored and calculated, though effects may build on each other and impacts become less distinguishable with increased time and complexity.

It is much easier to determine conservation metrics with a fully metered water system, which can provide information regarding individual uses, conservation success by user type, changes in water use and loss, or even the success of multiple conservation measures enacted simultaneously for separate users. In contrast, information from an unmetered system will be much less detailed, although the main/master meter(s) can still provide insight into overall reductions in water use over time.

Certain conservation measures may already be adopted in local ordinances and should be listed as conservation measures in the plan. For many water suppliers, this list will include ordinances for water-using fixtures in new developments. Any associated compliance monitoring and penalties for violations of local water codes should be described. Additional examples of water use regulations that may pertain to the service areas include:

- ◊ Restrictions on nonessential uses, such as lawn watering, car washing, filling swimming pools, washing sidewalks, and irrigating golf courses.
- ◊ Restrictions on commercial car washes, nurseries, hotels, and restaurants.
- ◊ Bans or restrictions on once-through cooling.
- ◊ Bans on non-recirculating car washes, laundries, and decorative fountains.
- ◊ Bans on certain types of water use or practice.

(USEPA, 1998, p. 154)

A diversity of additional conservation measures can be implemented. For example, consider:

- ◊ Real time metering and/or usage spike alerts for customers
- ◊ Local partnerships to enhance water conservation efforts
- ◊ Staff dedicated to conservation programs
- ◊ Conservation committees

5.1 Indoor Water Conservation

Indoor water conservation applies to all residential, commercial, and industrial buildings. Local government, in cooperation with the local water utilities, plays an important role in influencing community water conservation practices. Some measures may be voluntary, implemented through education programs or incentives. Other measures may be mandatory, implemented through water system rules, local government ordinance, or other authority. The plan should differentiate between the voluntary measures the supplier will encourage customers to abide by and the mandatory measures that the supplier and/or municipality have implemented.

Residential water conservation measures:

1. Voluntary indoor water audits are offered by the water supplier. Alternatively, provide customers with the information needed to perform their own audits or leak checks.
2. Actively recommend and encourage customers to voluntarily adopt less wasteful habits (education based):
   a. Do not run water while brushing teeth or shaving.
   b. When possible, take short showers instead of baths. Long showers will reduce or negate the benefit of showering over filling a tub.
   c. When preparing food, use a bowl of water for peeling and cleaning vegetables rather than running the tap.
   d. Keep water in a container in the refrigerator for drinking to avoid running the tap to get cool water.

e. When washing dishes by hand, soak and wash them in the filled basin rather than under running water. Rinse them under the tap after they are cleaned.

f. Run the dishwasher when full. If the dishwasher has such a capability, run on "top rack only" when washing just a few dishes (on the top rack, obviously).

g. Minimize the use of the garbage disposal to reduce water use.

h. Wash only full loads of laundry or use the load-size adjustment to match the appropriate load. Likewise, do not use more detergent than necessary (see the instructions for the detergent; this is not only important for reducing the amount of soap in the wastewater system but will improve the longevity of clothes).

i. Instead of throwing old ice down the drain, place some in the containers of potted plants.

3. Actively encourage or require replacement or adjustment of fixtures with water-saving options (incentivized or mandated):

j. Toilets:

    i. Install a new toilet with consideration for a low-flow model. Modern toilets are effective and use considerably less water per flush than those of decades past. Some models have half and full flush capabilities. WaterSense certified toilets use no more than 1.28 gallons per flush.

    ii. Consider retrofitting the existing toilet with water saving devices.

        1. Use a weighted jug or toilet dam in the toilet's tank and place the device in a location that won't interfere with the flushing mechanism.

        2. Install a low flush replacement system. Some products have half and full flush capabilities.

3. Install an adjustable fill valve.

k. Install WaterSense certified faucets and reduce the maximum flow rate to 1.5 gallons per minute.

l. Install low-flow or WaterSense certified showerheads that restrict the maximum flow rate to 2.0 gallons per minute.

m. Insulate hot water lines to reduce heat loss and the need to run the water longer to reach the appropriate temperature.

In 2019, Assembly Bill 163 amended plumbing fixture minimum standards for residential, commercial, industrial, and certain public structures. If the EPA WaterSense program has established a final product specification for a type of toilet, shower apparatus, faucet or urinal, then new construction, expansions, and renovations on these structures must install toilets, shower apparatuses, faucets, and urinals that have been certified under the WaterSense program. Structures constructed ≥50 years ago are exempt.

Maintain fixtures:

n. Repair leaky faucets, pipes, toilet valves, etc.

<u>Industrial water conservation measures:</u>

1. Voluntary water audits for large-volume water users offered by the water supplier.
2. Actively encourage or require replacing or adjusting fixtures with water-saving options:

a. Toilets:

i. Install a new toilet with consideration for a low-flow model. Modern toilets are effective and use considerably less water per flush than those of decades past. WaterSense certified toilets use no more than 1.28 gallons per flush. Some models have half and full flush capabilities.

ii. Consider retrofitting the existing toilet with water saving devices.

1. Use a weighted jug or toilet dam in the toilets tank and place the device in a location that won't interfere with the flushing mechanism.
2. Install a low flush replacement system. Some products have half and full flush capabilities.
3. Install an adjustable fill valve.

b. Install WaterSense certified faucets and reduce the maximum flow rate to 1.5 gallons per minute.

c. Install low-flow or WaterSense certified showerheads that restrict the maximum flow rate to 2.0 gallons per minute.

   d. Insulate hot water lines to reduce heat loss and the need to run the water longer to reach the appropriate temperature.

3. Maintain fixtures:
   a. Regularly check for and promptly repair leaky faucets, pipes, toilet valves, nozzles, etc.
4. Incorporate processes for reusing and recycling water to minimize the amount of make-up water required. Even if the industrial application cannot reuse the water, it may be usable for other industries, agriculture, or groundwater recharge.
5. When non-potable water is acceptable, use alternative sources such as treated effluent.
6. Use another material (such as a liquid salt or refrigerant fluid) that may be used in lieu of water.
7. Consider other industrial practices in which water can be conserved. For example, inspecting and retrofitting cooling towers may be relevant measures at some facilities.

5.2 Outdoor Water Conservation

Outdoor water conservation applies to all residential, commercial, and industrial facilities. Again, local government, in cooperation with the local water utilities, plays an important role in influencing community water conservation practices. Some measures may be voluntary, implemented through education programs or incentives. Other measures may be mandatory, implemented through water system rules, local government ordinance, or other authority. The plan should differentiate between the voluntary measures the supplier will encourage customers to abide by and the mandatory measures that the supplier and/or municipality have implemented.

Outdoor water conservation measures (via education, incentives, or mandates):

1. Voluntary turf water audits and suggested watering regimes offered by the water supplier.
2. Supplier provides guidance on when to begin or end landscape watering based on conditions.
3. Lawns
   a. Minimize lawn size for existing or new construction.
   b. Restrict or set mandates for the proportion of landscaping that can be lawn.
   c. Have automatic watering systems which require rain or moisture detectors.
   d. Maintain irrigation systems to reduce leaks and failures.
4. Other landscapes

    a. Encourage xeriscape or native plant landscaping.
    b. Use mulch of at least three inches to reduce evaporation.
    c. Use only porous weed barrier.
    d. Install automated drip irrigation systems.
    e. Maintain irrigation systems to reduce leaks and failures.

5. Other water uses
    a. Restrict washing of vehicles on nonporous surfaces such as driveways.
    b. Limit washing of vehicles to commercial facilities with recycling systems.
    c. Restrict washing of sidewalks.
    d. Require hoses to have operator-controlled spray valves so water is not running when not manually used.
    e. Require use of treated effluent/re-use water for water features such as fountains or ponds. Most of the water should be recycled in such features.
    f. Restrict or ban swimming pools, or require covers to minimize evaporation loss.
    g. Use treated effluent for dust control and construction.
    h. Consider methods to minimize water lost during hydrant flushes

6. Water use ordinances or restrictions
    a. Create time of day or day of week water schedules.
    b. Restrict water waste by not allowing excess water to run onto nonporous surfaces or into storm drains.
        i. In some instances, such as in the Las Vegas area, water entering storm drains can, in part, be returned to drinking water sources (e.g. Lake Mead) and credited for future withdrawal.
    c. Hire personnel to monitor water use, report waste, and work with offenders to solve water waste.
    d. Implement a community monitoring/reporting system for water users to report and enforce water waste violations.

See the recommended resources (Section 8.2) for a variety of helpful literature and websites that provide advice for irrigation systems, xeriscape planning, and landscape design.

5.3 Agricultural Water Conservation Beyond the scope of this document?

Agricultural water conservation should be initiated by water districts, extension offices, and conservations districts. Technical assistance can come from these agencies or other agencies such as the Natural Resource Conservation Service (NRCS).

Efficient, economical control of irrigation and drainage water on the farm will provide the necessary crop irrigation and leaching requirements, maintaining soil conditions suitable for plant growth while preventing degradation of downstream water quality. Certain grazing and farming practices can further provide water savings and enhance drought resiliency.

Agricultural Water Management Practices:

1. Agriculture Water Planning
    a. Process design where inventory and analysis results in custom fit practices, measures and methods; or
    b. Use of standard practices where a selection is made from a list of canned or fixed methods, measures or practices such as the ones listed in this plan.
2. Planning Criteria
    a. All facilities and their use, including the diversion and discharge of water, *must conform to applicable state law and environmental regulations (e.g. water rights)*.
    b. Know the amount of water that should be applied to each crop.
    c. Apply water as infrequently and for as long a duration as proper irrigation scheduling allows to minimize total erosion and runoff.
    d. Apply water uniformly by measuring flow, carefully grading land and designing effective irrigation systems.
    e. Avoid applying fertilizers, biocides or amendments in the irrigation water when the runoff cannot be confined to the farm.
    f. Develop a tail water recovery system, including a good drainage system.
    g. Utilize sediment retention basins such as specific basins, regulating reservoirs or small check basins in the drain ditches.
    h. Utilize vegetated buffer strips or drainage-ways. Another alternative is to use runoff from row crops to irrigate close growing crops.
    i. General irrigation system design considerations include soil (agricultural and foundation) characteristics, crop water requirements, material (equipment and supplies) availability, irrigation and drainage water flows, on-farm management capabilities and relative cost effectiveness of implementation.

j. Specific determinations necessary include water application amount and rate, leaching requirement, system capacities, optimum slopes and/or hydraulic gradients, facility sizes and configuration, time of irrigation set and uniformity of application.

3. Maintenance

a. Perform regular preventative maintenance on all facilities.

b. Repair or replace facilities as required.

(Nevada, 1991)

5.4 Conservation Incentives

Adopting incentives for customer conservation actions can be a useful method for reducing water use. Such programs have proven to be even more effective than education-based programs. Water providers frequently provide rebates for those consumers that are willing to change from older to newer technology (such as low-flush toilets or low-flow showerheads), convert to water efficient landscaping, or otherwise demonstrate lower water usage. Tiered pricing structures are one example of a water conservation incentive. Other examples might include lawn/turf buy-back programs, subsidies for fixture replacements or retrofits, or even slightly reduced rates for those customers who are cooperative with other conservation programs (and can somehow show this effort). Penalties can also be a form of incentive, and some communities have implemented the use of water conservation monitoring staff or water waste hotlines to cite those who continue to waste the resource.

Water Conservation Plan Nexus

NRS § 540.151(1) inclusive, requires each supplier of water to develop a plan to provide incentives for water conservation in the service area, to retrofit existing structures with water efficient plumbing fixtures, and for the installation of landscaping which uses a minimal amount of water. Although improving drought resiliency, reducing wear/tear on water infrastructure, and reduced water bills are all incentives to conserve, the supplier is encouraged to be more direct and clearer in its defined incentives program.

Not all suppliers may have the resources or funding to implement such incentive programs. In such situations, creative use of other incentivizing mechanisms is encouraged. Non-monetary incentives might include: choosing a house with the best water-efficient landscaping to be featured in the local newspaper each month, a drawing to have lunch with a prominent local figure for customers who have upgraded to more efficient fixtures, or partnering with a local landscaping company/nursery/agency to organize an annual native plant and xeriscape sale. As with any implemented conservation practices, all incentive programs should be monitored and further evaluated for long-term effectiveness.

6.0 Management of Water

A supplier's management actions can play a large role in water conservation. The primary water management goals should be to reduce water losses throughout a system, improve water quantity accounting, and adopt fundamental pricing structures which encourage customer conservation. Each of these considerations are discussed more in the sections below.

6.1 Utility System Water Audits

The principle behind a water audit is to collect data for all water traveling in the system. This provides the water manager with knowledge of where water is going and provides an estimate of water losses. For best conservation practices, it goes without saying that limiting water losses should be a priority. Nationwide, the average water system loss is around 16%, with estimates that up to 75% of that quantity is recoverable (USEPA, 2013).

Water Conservation Plan Nexus

Calculating water loss is an integral part of any conservation plan, and audits/reporting are explicitly required under NRS § 540.145. Water audits can also help managers meet the provisions of NRS § 540.141(1)(c), which require a plan for identifying and reducing the leakage in the water supply and inaccuracies in water meters. Water audits can also help the manager evaluate the effectiveness of the conservation plan as required under NRS § 540.141(2)(a).

The American Water Works Association (AWWA) provides various resources related to water loss control, including free software for performing water audits utilizing a methodology developed jointly by the International Water Association and AWWA. The software is used by suppliers throughout the country and offers a standardized way of comparing results over time and between entities. Nevada, along with several other states, mandates water loss reporting for all suppliers. Utilization of the AWWA software is required for Nevada suppliers that serve more than 3,300 customers annually, while smaller suppliers can provide more rudimentary calculations and estimates. The water audit software can be found through a link in Section 8.2 Recommended Resources, or by searching the AWWA website online.

In its most simplistic definition, water loss is the difference between the quantity of water supplied to the distribution system and the amount received by customers at their connecting ends. This difference is called real loss, which is defined as the actual physical loss of water, most often occurring during transmission, distribution, or post-treatment storage (Figure 6.1). Apparent losses are another category of loss and are often greater than real loss. Apparent losses can be attributed to unauthorized and unmeasured consumption, metering inaccuracies, or data/calculation errors; in other words, they are lost revenue. From the water conservation standpoint, focusing on minimizing real losses is key.

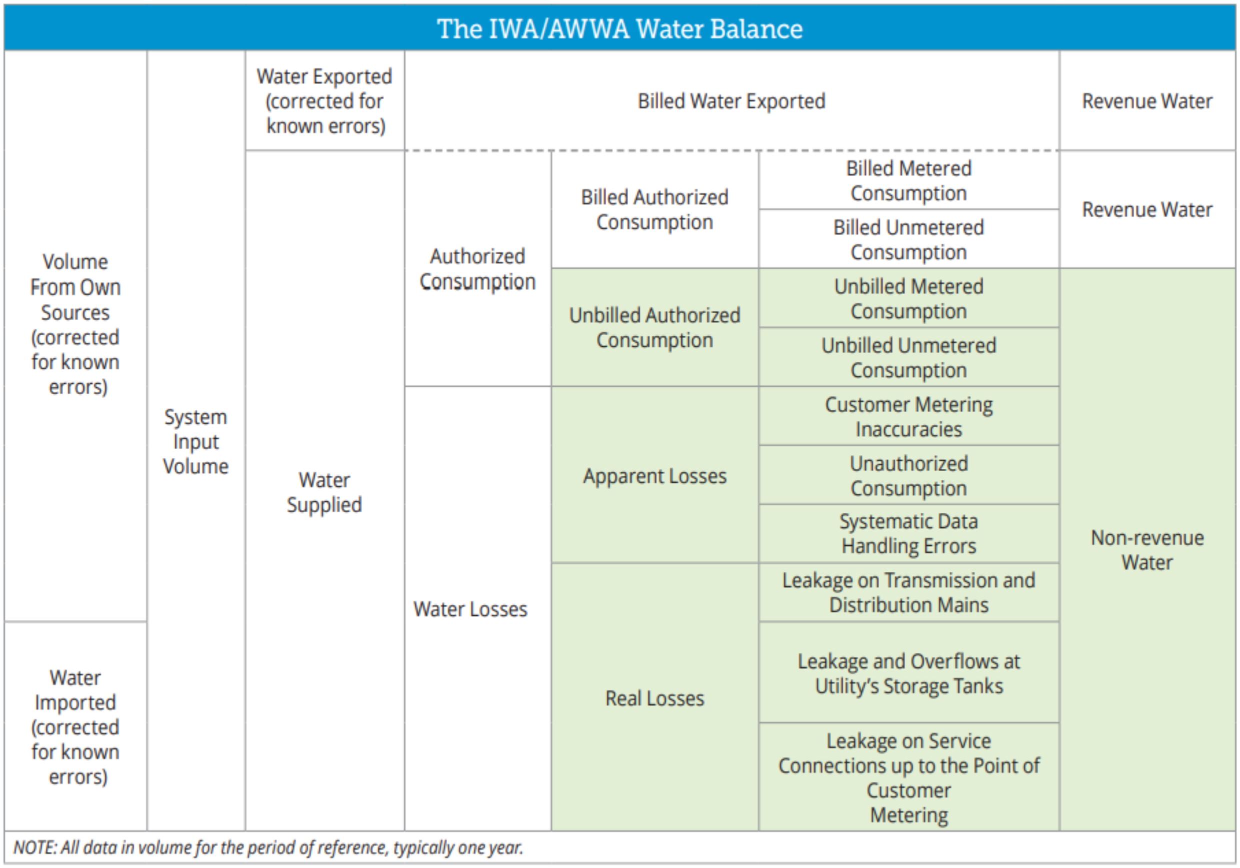


Figure 6.1. Water distribution system water balance breakdown. Credit: AWWA

Loss calculations can be easily performed for a fully metered system, taking the difference between customer deliveries and treated water being supplied to the distribution system. These calculations may be more straightforward on a smaller and less complex system. Water meters are incredibly important for performing these calculations on any system, using any method, hence why a fully metered system is one goal that must be addressed in a water conservation plan (see Section 6.4). Without meters, a supplier must instead find other coarser methods for estimating water loss.

Another approach for performing water accounting and loss audits has been outlined in U.S. EPA Water Conservation Plan Guidelines (USEPA, 1998). The first step is to determine the total amount of water produced. This is the water metered or otherwise measured from the production source (well, canal, etc.). Factors such as meter accuracy and transmission losses should be considered. The next step is to determine where the water is going. There are two broad categories. First, "Account Water" is the water that is metered and billed to customers. This might be subdivided into the class of customer: residential, commercial, industrial, agricultural. Second, "Non-account Water" is water that is not billed. The Non-account Water category can be further subdivided into water that is metered or unmetered. Metered Non-account Water is likely public use water that is not billed to customers. For example, water may be supplied by a county purveyor to a county park. Unmetered water is neither metered nor billed. The use may be authorized, such as fire hydrant flushing/fire fighter training, or it may be unauthorized use. In the latter case, the unauthorized water use may be identifiable or unidentifiable. "Identifiable Unauthorized Use" could be accounting errors, malfunctioning controls, illegal connections, meter inaccuracy, etc. What remains is "Unaccounted-for Water", which would be water losses and leaks that could not be accounted for or identified (USEPA, 1998).

Once the audit is completed, goals and a plan of action can be formulated to reduce losses in the system. Auditing is a repeated process that provides the means to quantify water loss and to ultimately gauge the success of conservation measures.

6.2 Utility System Water Pricing

Proper pricing of water deliveries can influence water use. Similar to the economics which drive sales of most goods and services, water demand is responsive to pricing changes. The response tends to be greater when more discretionary water use occurs, such as for landscape irrigation or swimming pool use (Renwick, 2000). Figure 6.1 illustrates four typical rate schemes: flat, seasonal, inclining and declining.

Water Conservation Plan Nexus

NRS § 540.141(1)(i) requires an assessment of tiered rate structures for the pricing of water to promote conservation, including estimates for how those rates will impact water conservation.

A "flat" rate does not change in unit price with respect to demand or quantity used and is typically found in un-metered water systems. It is the simplest type of rate, and easiest to understand, but will not reflect the actual cost of water. The flat rate structure neither encourages conservation nor discourages it.

"Seasonal" rates are the same as the flat rate in terms of unit cost, except the rate varies between summer months (growing vegetation season) and winter months (dormant vegetation season). This does serve to reflect an increased demand of water in the summer, and thus can better reflect the actual costs of water. However, similar to the flat rate structure, it neither promotes nor deters water conservation, except perhaps to curtail some summer use.

A "declining block" rate structure reduces the unit price of water as more is consumed. The idea is the same as getting a discount for buying a good in bulk. However, from a water conservation standpoint, it is the exact opposite of the desired approach to reduce water use. This model might make sense if the good being sold could increase its supply, and in turn reduce the unit cost to the supplier. However, water supplies are typically a fixed or even decreasing quantity, and when supply can be increased, the infrastructure and operational costs generally increase as well (more wells and needed infrastructure expansions, higher pumping costs, increased maintenance, etc.). Thus, the declining block rate structure is infrequently used, and quite impractical for water suppliers.

Finally, we have an “inclining block” rate structure, a billing method commonly utilized for water pricing, and the most useful for encouraging customer conservation. In this structure the unit price of water begins low, then increases at specific quantity thresholds. As water use rises, so does the rate. The idea is to keep water prices low and affordable for basic necessities (indoor uses like drinking, cooking, washing, etc.), but send a clear price signal that additional water uses (landscaping, swimming pool, fountain, long showers, etc.) are not necessities but rather luxuries.

In addition to any quantity-based rates, most suppliers charge a fixed-fee or base price which may help to cover costs for maintaining infrastructure, future upgrades, or paying off past improvements. A base price will not directly help with conservation objectives but may ensure that necessary expenses are covered regardless of customer water use and associated impacts to quantity-based rates. A billing structure that appears ideal in terms of water conservation must still account for variability in how the customers might use water, and how the system will generate revenue for operational costs and for capital improvements.

The Carson City Water Conservation Plan (Carson City, 2018) provides a comparison of inclining rate structures, analyzing which will send a signal to customers that increased use will begin to sharply increase average price per gallon (Figure 6.2). Even with an inclining rate block, the average price per gallon will initially decline with increased use, until the higher tiers are met

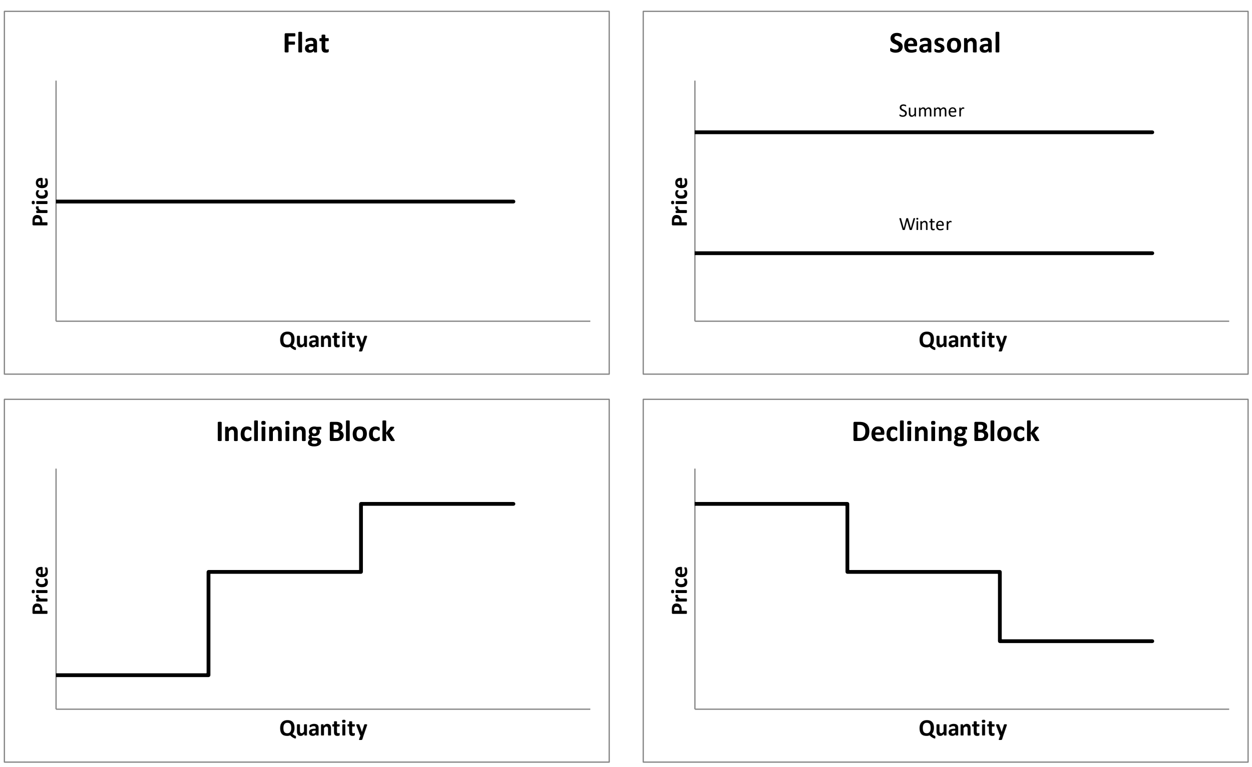


Figure 6.2. Types of rate blocks for marginal prices. Credit: Carson City Public Works

and begin to contribute towards overtaking the base price (Figure 6.2). Marginal cost per unit of water is important for establishing the rate block, but the average cost per unit is ultimately more important. When customers view their bill, it is the usage and the price that they will examine. To effectively portray the message that higher usage will be disproportionately higher in price, the rate structure should demonstrate a sharp increase when consumption reaches high levels.

"Because consumers respond to what they see on their monthly bill, the most effective inclining block rate structures are those that send a strong price signal to customers as consumption increases."

(Carson City, 2018 p.16)

Consider the three curves presented in Figure 6.3, which all represent inclining rate blocks. Depending on when and how steeply the changes in rate occur, the average price per unit volume curve is distinct. Scenario "C" does little to encourage conservation, because overall it still reflects a decrease in unit cost per gallon consumed. Scenario "A" shows the sharpest change as consumption enters a new tier, but this may be a difficult pricing structure to operate under depending on the system's circumstances. Scenario "B" also demonstrates the impacts of distinct tiers but is less severe than Scenario "A" and ultimately may be more practical for a water system to implement. Each water supplier will need to determine a customized level of block increase that works for its particular system and customer base.

Any rate structure based on per-unit pricing will require customer metering and sub-metering in order to operate effectively. Simply put, water meters are necessary for implementing a conservation-minded rate structure. This is yet another reason why a fully metered system is one goal discussed in this guide (see Section 6.4), and a stated conservation plan requirement per the NRS.

Additional resources may provide a more thorough review of this complex subject. The USEPA's *Case Studies of Sustainable Water and Wastewater Pricing* (2005) describes sustainable pricing for better management practices, full-cost pricing, efficient water use and protection of watersheds. Another practical document for water pricing from the USEPA is *Setting Small*

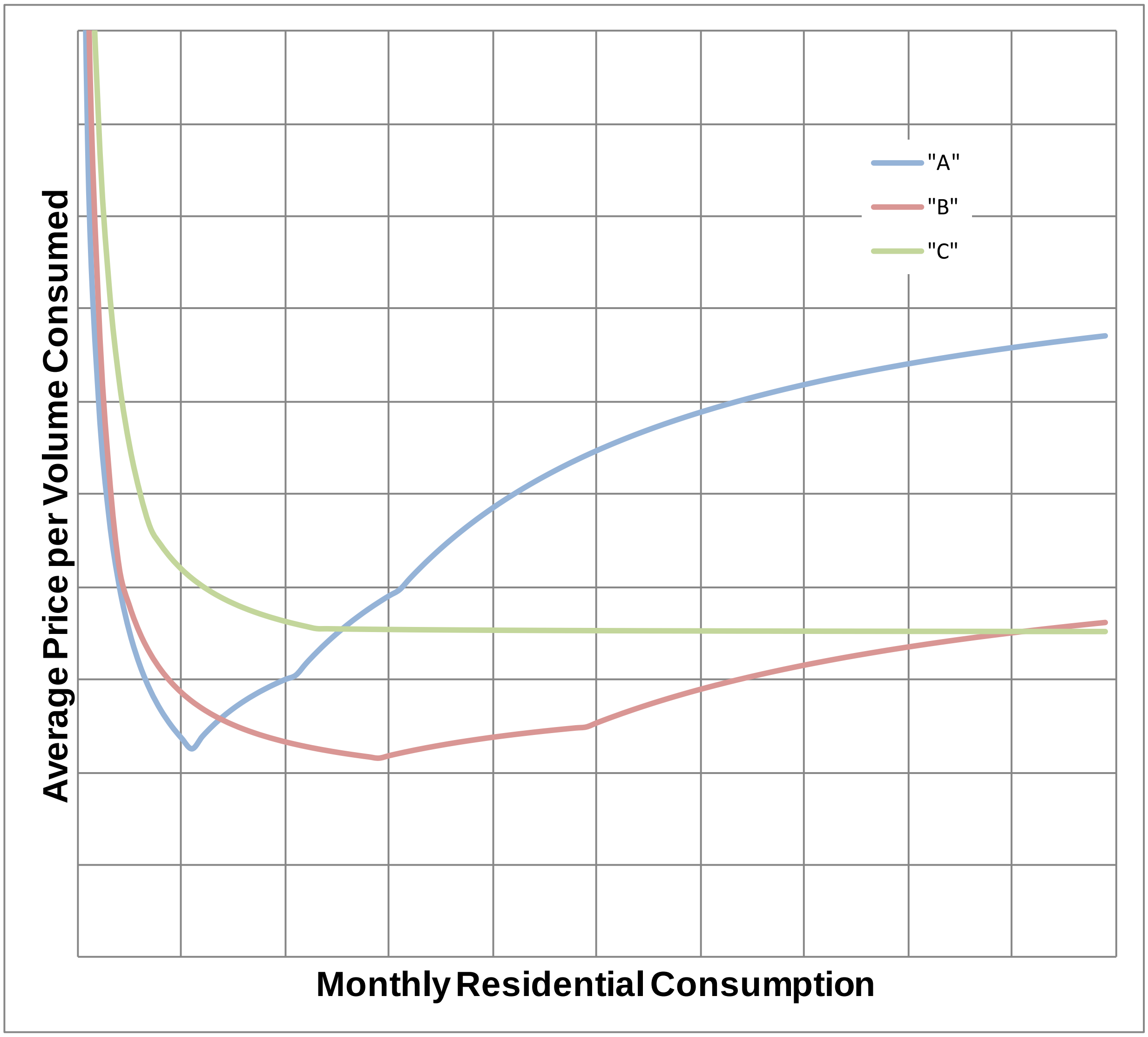


Figure 6.3: Representative Curves of Average Price Per 1000 Gallons Consumed, for Different Increasing Block Rate Structures. Credit: Carson City Public Works

Drinking Water System Rates for a Sustainable Future (2006). That guide explains why pricing should be set to match the actual cost of water and how to make such calculations. It details a seven step process which can serve small water systems well in the development of a pricing scheme, including information regarding rates to meet water conservation objectives, allowing for sufficient resources to provide high quality water, gradual rate increases for customers, and sustainability of infrastructure.

6.3 Water Pressure

From the U.S. EPA *Water Conservation Plan Guidelines* (1998, p. 151):

"Reducing excessive pressures in the distribution system can save a significant quantity of water. Reducing water pressure can decrease leakage, amount of flow through open faucets, and stresses on pipes and joints which may result in leaks. Lower water pressure may also decrease system deterioration, reducing the need for repairs and extending the life of existing facilities. Furthermore, lower pressures can help reduce wear on end-use fixtures and appliances."

Water Conservation Plan Nexus

NRS § 540.141(1)(c) requires, in part, that the plan has provisions for identifying and reducing high pressure in water supplies.

Through pressure zone management, pressure reducers, and supervisory control and data acquisition (SCADA), a water system can control the pressures delivered to customers to minimize excess flow rates or minimize the volume of water loss.

The target for system pressure in residential areas should be no more than 80 pounds per square inch (psi). However, the management of water pressure should not override other considerations such as system integrity or quality service to customers (USEPA, 1998, p. 151). In Nevada, NAC 445A dictates the pressure requirements for water systems. Per NAC 445A.6711, the static pressure at the lowest ground elevation of the zone should not exceed 100 psi.

6.4 Metering and Sub-Metering

Water Conservation Plan Nexus

NRS § 540.141(1)(g) requires a plan for progressing towards the installation of meters on all connections, which is a necessary step for meeting many of the other stated requirements. NRS § 540.141(1)(c) requires, in part, that the plan has provisions for identifying and reducing inaccuracies in water meters. A meter replacement program can help achieve this objective.

In order to effectively carry out many of the water management practices described in earlier sections, universal metering is necessary. This means that every connection be metered, on both the supply and demand sides. Accurate metering will enable audits, water accounting/loss control, and implementation of a conservation-conscious rate structure. Additionally, metered customers will be able to see a history of their water use (or even view it in real time), helping to gain education and understanding of water quantities, and increasing water use awareness.

Fully metering a water system can be an expensive and time-consuming task. However, the associated costs can be covered in the long run through the benefits of metering, such as an effective quantity-based rate structure (see Section 6.2). Additionally, grants and low-interest loans may be available through NDEP and other agencies to assist in financing meter installation projects.

Today, a plethora of different water meters and metering technology exist, ranging from high-tech to simplistic. The least expensive water meters may require in-person manual reading, while other options include touch read systems, drive-by read capability, and remote reading through fixed networks. A supplier should perform a cost-benefit analysis of each option prior to creating a metering plan. Such an analysis might include factors such as: assessment of the required installation costs, long-term staff required for meter reading, and reliability/replacement costs and maintenance. A different metering system may be ideal for each different supplier.

Accurate meters are a vital component of universal metering, making scheduled maintenance or a meter replacement program important tasks to plan for. Meters can be tested intermittently, or only when they may be suspected of providing incorrect readings. Many water meters have a predicted useful lifespan of 15 to 20 years, so an effective plan considers that timeframe, the associated costs of replacement, the necessary labor, and the time it would take to replace each meter. The necessary costs of such a program can be covered by determining an adequate water rate structure for the supplier. Additionally, it is most common for old water meters to under-register measurements, and the potential for revenue loss can be staggering in a system with a large number of meters significantly under-registering. At that point, the cost of meter replacement may be less than the loss of revenues with continued use of the old meters.

7.0 Drought Contingency Plan

Drought conditions can be extremely difficult to manage for an unprepared water supplier. Along with water quantity, the effects drought can have on water quality, public health, agriculture, transportation, wildfire, and ecosystems are important to consider. Planning for drought begins with an understanding of the classifications or types of drought have been defined. The various drought categorizations often interact or occur sympathetically in response to each other.

Meteorological drought is typically the first type of drought recognized, defined by a lack of precipitation compared to a "normal" or average amount and the duration of the dry period. A meteorological drought is not necessarily problematic to water supplies, but just implies that precipitation for a particular region has been below normal. For a water supplier, it is important to recognize the start of a meteorological drought, and what level of severity will begin to impact management practices.

A second category of droughts involves meteorological drought impacts to human uses of water. These types of droughts begin when typical human activities start to see adverse effects from prolonged dryness. Hydrologic drought is generally defined as shortfalls to surface or subsurface water supplies due to meteorological drought. Agricultural drought links characteristics of meteorological drought to many different agricultural impacts. Finally, socioeconomic drought regards the supply or demand of goods, and how those link with elements of other drought types. The onset timing of hydrologic, agricultural, and socioeconomic droughts may lag behind the timing of dry periods, as it can take longer for precipitation deficiencies to show up in reservoirs, groundwater levels, streamflow, etc. (Wilhite and Glantz, 1985).

Additional categories of drought have been recognized in recent years. Ecological drought refers to when natural ecosystems are affected by drought. Induced droughts involve a water shortage due to over-drafting or overuse of the normal water supply. Induced drought can be simple to avoid by restricting water use to the amount which is replenished naturally every year (called perennial yield). This management policy is a major challenge for western states.

Water Conservation Plan Nexus

NRS § 540.141(1)(e) requires a contingency plan for drought conditions, which ensures a supply of potable water.

Water conservation and drought contingency are not synonymous, though water conservation can be a powerful tool to help avoid and mitigate drought. Often, increased emphasis on conservation measures or actions like curtailment of certain types of water use will be the most cost-effective solutions during a water shortage. Secondary plans may necessitate building cash reserves, making agreements with neighboring water suppliers, having back-up systems and supplies in place, or other emergency provisions. A proactive drought contingency plan, in conjunction with active conservation measures, will allow for smooth handling of a drought situation without needing to operate in crisis management mode. Any contingency plan should consider plausible worst-case conditions.

While the State Drought Response Plan is an important document to reference, its purpose is to provide a strategy for interagency cooperation at the state level (Nevada, 2012). For a water system manager, a more specific plan is required, suited to the needs of the system and the community it serves. Including stakeholders in the drought contingency planning process can also be helpful for gaining support in its implementation (Shepherd, 1998). For further guidance, Wilhite (2005) provides a ten-step plan for drought contingency planning. The National Drought Mitigation Center has also compiled a wealth of drought planning resources on its website, listed in 8.2 Recommended Resources.

7.1 Drought Determination

The first part of any drought contingency plan should include provisions for determining a drought situation. As with any natural disaster, it is extremely important to recognize the point at which mitigative actions must be taken, and act expediently in response. However, the onset of a drought can be challenging to define, and the exact qualities that define a drought are often unique to a region or water supply. Thus, it is sensible for suppliers to define the severity of drought based on when they anticipate their particular system will be adversely impacted by dry conditions.

Some ways that suppliers could quantify and monitor drought impacts on their particular system might include checking reservoir levels, seasonal snowpack determinations, monitoring streamflow forecasts, monitoring groundwater level measurements, and tracking soil moisture levels. Analyzing historical data and maintaining strong record keeping could help to gain understanding of which conditions might eventually to lead to a problematic water supply situation and set appropriate triggers for certain actions.

According to the State Drought Response Plan, counties may be classified as being part of the Drought Watch Stage, Drought Alert Stage, or Drought Emergency Stage (Nevada, 2012). A similar framework of stages could be effective in a water supplier's drought plan. The classifications in the State plan partially rely on information compiled in the U.S. Drought Monitor, which synthesizes multiple data sources on weekly basis to produce a map of drought intensities across the country. Drought intensity levels are broken into five categories:

D0 Abnormally Dry
D1 Drought – Moderate
D2 Drought – Severe
D3 Drought – Extreme
D4 Drought – Exceptional

Once water suppliers have considered the data relevant to monitoring their water supply situation and the thresholds for taking action, the response framework (including water supply contingency measures) can be further developed.

7.2 Water Restrictions

One demand-side approach to mitigating drought is to implement progressively more stringent restrictions on water use, generally tied to the determined drought response levels discussed in

Section 7.1. Each response tier should include a list of appropriate voluntary and mandatory conservation measures for water users. It may be appropriate to specify voluntary and mandatory actions for multiple categories of water users (e.g. residential vs. parks and golf courses vs. schools and government buildings). As the water supply situation worsens, consider how to shift from an emphasis on voluntary customer conservation measures to mandatory actions and prohibitions on certain water-consuming activities.

Initial response may consist of increased outreach to promote customers' awareness of the situation. Additional responses may include increased enforcement of already active conservation measures (e.g. actions such as prohibiting use of water for washing cars, sidewalks); another step may include establishing stricter day/time schedules for landscape watering. The next level of drought response might include a direct request for customer cutbacks, stating an achieved goal for water use curtailment (e.g. 10% reduction in customer use for June, July, and August). A supplier would likely achieve such a goal through increased customer education techniques, advertising, and other public outreach methods. At the most severe stages, mandatory prohibitions and curtailment for certain non-essential uses should be considered in the plan.

7.3 Alternative Supply

As a secondary approach to help guarantee a supply of potable water under very dry conditions, a water system may seek an alternative supply. Examples of such supply sources are:

- ◊ Conjunctive use of surface and underground supplies
- ◊ Additional surface water storage or aquifer storage and recovery
- ◊ Metered inter-ties with neighboring water systems for water sharing
- ◊ Back-up wells or deepening of production wells

Seeking alternative supplies may be most akin to a typical capital improvement project. As with any water-related improvement, the water system manager must consider issues such as water rights, funding, and environmental regulations. A robust drought contingency plan outlines options to overcome such hurdles, or even tackles them prior to the onset of an emergency situation. If there is a strong likelihood that alternative supplies may be needed frequently (or are the most cost-effective drought options), then a supplier should have systems in place to utilize those supplies immediately.

8.0 References

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8.2 Recommended Resources

https://www.awwa.org − The American Water Works Association provides a variety of educational and technical resources.

https://www.awwa.org/Resources-Tools/Resource-Topics/Water-Loss-Control − The American Water Works Association website for water loss control, including links for download of the auditing software required to perform loss audits.

https://www.drought.gov/ − The US Drought Monitor shows current drought intensity stage determinations across the United States. The website provides easy-to-use interactive tools to communicate drought conditions and impacts.

https://drought.unl.edu/Home.aspx − The National Drought Mitigation Center website provides planning tools, social media resources, and other educational content.

https://www.epa.gov/watersense - WaterSense is an EPA program that is both a label for water-efficient products and a resource for helping save water.

https://www.epa.gov/watersense/water-conservation-plan-guidelines - EPA *Water Conservation Plan Guidelines* in pdf format.

https://www.epa.gov/sustainable-water-infrastructure/pricing-and-affordability-water-services - Pricing and rate structures resources from the EPA, with a focus towards pricing water to support aging infrastructure and to represent the scarcity of water.

https://planning.erdc.dren.mil/toolbox/index.cfm – The U.S. Army Corps of Engineers planning toolbox is an online tool that can help with a variety of planning tasks and decision-making challenges.

https://www.usace.army.mil/corpsclimate/Climate_Preparedness_and_Resilience/Update_Drought_Contingency_Plans/ – U.S. Army Corps of Engineers, Drought Contingency Plans. Gives links to several reports discussing climate change, droughts, and planning under the context of both.

https://www.iwr.usace.army.mil/Portals/70/docs/iwrreports/94nds8.pdf – U.S. Army Corps of Engineers, Institute for Water Resources, September 1994: Managing Water for Drought (IWR Report 94-NDS-8).

www.nrcs.usda.gov – The Natural Resource Conservation Service (NRCS) not only has educational resources on its website, it provides certain technical assistance that farmers and ranchers may find of use.

https://ndep.nv.gov/water/financing-infrastructure − The Nevada Division of Environmental Protection's Office of Financial Assistance manages grants, loans, and technical assistance programs for drinking water, wastewater, storm water, and non-point source water systems across the state.

http://water.nv.gov/WaterConservationPlans.aspx − The Nevada Division of Water Resources posts approved plans, this guide, and the water conservation plan checklist on this page of its website.

https://www.snwa.com/importance-of-conservation/conservation-facts-and-achievements/index.html − Some facts and achievements regarding SNWA's conservation programs over time. Includes links to other SNWA conservation webpages as well.

http://tmwa.com/conservation − This webpage on the Truckee Meadows Water Authority website provides a variety of helpful information, including water saving tips, educational materials, and a landscape guide.

https://www.irrigationtutorials.com − Website has many useful articles on installing and maintaining irrigation systems (including drip irrigation), and also provides tips, suggestions and instructions for water efficient landscaping (how and when to irrigate in windy areas, reducing loss due to low head drainage from sprinklers, use of automatic sensors and controllers, etc.).

www.wateruseitwisely.com/ − This Arizona website provides tips and links to other resources that may prove to be a useful reference in water conservation education programs.

https://conservewater.utah.gov/templates.html − Utah Division of Water Resources Conservation Program provides some good examples of water conservation plans. Though the plan requirements in Utah differ from those in Nevada, the resources here may be utilized to strengthen plans for Nevada water suppliers.

Appendix A: Water Conservation Plan Checklist

WATER CONSERVATION PLAN REVIEW CRITERIA

Name of Entity:

Reviewed By: **Date:**

NRS 540.141
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(1) Provisions relating to:

(a) Methods of public education to:

☐ ☐ 1. Increase public awareness of the limited supply of water and the need to conserve water.

☐ ☐ 2. Encourage reduction in the size of lawns and the use of arid and semiarid plants.

☐ ☐ (b) Specify water conservation measures required to meet the needs of the service area.

(c) The management of water to identify and reduce water loss in water supplies, inaccuracies in water meters and high pressure in water supply, including:

☐ ☐ 1. Goals for acceptable levels of water loss in water supplies.

☐ ☐ 2. A plan which analyzes how the supplier will progress towards goals.

☐ ☐ (d) The management of water to, where applicable, increase the reuse of effluent.

☐ ☐ (e) A drought contingency plan that ensures a supply of potable water.

☐ ☐ (f) A schedule for carrying out the plan or joint plan.

☐ ☐ (g) A plan for how the supplier of water will progress towards the installation of meters on all connections.

☐ ☐ (h) Standards for water efficiency for new development.

☐ ☐ (i) Tiered rate structures for the pricing of water to promote the conservation of water, including, without limitation, an estimate of the manner in which the tiered rate structure will impact the consumptive use of water.

☐ ☐ (j) Watering restrictions based on the time of day and the day of the week.

(2) A plan from a supplier providing service for 500 or more connections must include provisions relating to:

☐ ☐ (a) Measures to evaluate the effectiveness of the plan or joint plan.

☐ ☐ (b) For each conservation measure specified in the plan or joint plan, an estimate of the amount of water that will be conserved each year as a result of the adoption of the plan or joint plan, stated in terms of gallons of water.

NRS 540.145

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(1) For water systems that are *not* categorized as transient as defined by NRS 445A.848, plans must be adopted or updated according to NRS 540.131 and:

(a) If serving 3,300 persons or more, submit results of a water loss audit using American Water Works Association software and methodology

or

(b) If serving less than 3,300 persons, includes calculations for the amount of water delivered by the supplier, and the amount of water billed to customers.

(2) If the supplier previously submitted water loss audit results and is submitting a plan update, the supplier must also submit:

(a) A comparison between the new and previous water loss audit.

(b) An analysis of any progress made by the supplier towards the established goals for acceptable water loss.

(3) If supplier previously submitted calculations and is submitting a plan update, supplier must also submit:

(a) A comparison of new and previous calculations.

(b) An analysis of any progress made by the supplier toward the established goals for acceptable water loss.

NRS 540.151

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(1) Provide incentives

(a) To encourage water conservation.

(b) To retrofit existing structures with plumbing fixtures designed to conserve water use.

(c) For the installation of landscaping that uses a minimal amount of water.

Notes: