City of Aspen

Aspen Maroon Creek Penstock Lining Project

WaterSMART: Water and Energy Efficiency Grants for FY 2021

Funding Opportunity BOR-DO-21-F001

Prepared By:
City of Aspen
Project Manager: Ryan Loebach
Utilities Department
130 Galena Street
Aspen, CO 81611
Ryan.loebach@cityofaspen.com
970.309.9750

September 16, 2020

CITY OF ASPEN

Table of Contents

Figures

Tables

1. EXECUTIVE SUMMARY

1.1 APPLICATION INFORMATION

Submittal Date	September 16, 2020
Applicant	City of Aspen, Colorado Ryan Loebach, Senior Project Manager Utilities Department 130 Galena Street Aspen, CO 81611 970-309-9750
Funding Group	I
Grant Funding Requested	$480,232.30
Total Project Budget	$3,001,451.90
Project Duration	February 2021 through December 2021 (11 months)
Estimated Project Completion Date	December 31, 2021
Project Location	Existing pipeline diversion off Maroon Creek located in the Roaring Fork River Basin and located south of Aspen, Colorado. Project location is not located on a Federal facility.

1.2 PROJECT SUMMARY

The City of Aspen, Colorado (Aspen or the City) is a home-rule municipality that owns and operates its water utilities, providing treated (potable) water to all customers in the service area and raw water for hydroelectric production, irrigation, and snowmaking purposes to a small subset of customers. The City is an active leader in water conservation and efficiency in the State of Colorado and is committed to sustainable water use practices and programs both locally and regionally. Aspen Water Utility provides service to approximately 4,000 accounts located inside and outside of the Aspen Municipal boundary. The City of Aspen will be upgrading a section of critical pipeline infrastructure that provides raw water from Maroon Creek to the City's raw water storage reservoir located at its water treatment plant site and to a 400 kilowatt (kW) hydroelectric generation facility. Maroon Creek is one of the City's primary potable supply sources and is the primary supply source for hydroelectric power generation. The existing pipeline is unlined reinforced concrete pipe and prestressed concrete cylinder pipe. The original design of this pipeline would allow a certain amount of leakage, and this estimated leakage has increased over time. The City will line approximately 6,235 linear feet of pipeline and add manholes for additional operational access to the pipeline. Lining materials will be selected through the project design phase which is currently underway. The intent of this project is to greatly reduce water being lost through the existing pipeline. This will benefit the environment through increased streamflow from reduced diversions, increase energy

production through the City's hydropower plant, reduce damage to areas impacted by water leaking from the system, and improve infrastructure access through the addition of manholes.

2. PROJECT LOCATION

The City of Aspen, Colorado is located at 39.1911 degrees N, 106.8175 degrees W in Pitkin County. Aspen is situated in the upper reaches of the Roaring Fork Valley near the confluences of the main stem of the Roaring Fork River with Hunter Creek, Castle Creek, and Maroon Creek at an elevation of approximately 7,900 feet. The Roaring Fork River is a tributary to the Upper Colorado River, as shown in Figure 1[1] below.

Aspen is located along Colorado State Highway 82 approximately 20 miles west of Independence Pass. The incorporated area (within the municipal boundary) consists of approximately 3.83 square miles. However, at this time, the total service territory is approximately 8.5 square miles, and includes unincorporated areas served by Aspen.

The Aspen Maroon Creek Penstock Lining Project (Project) is located south of the City along the City's existing Maroon Creek Intake Pipeline. The section of pipeline being affected is from the City's Maroon Creek headgate (39.163 degrees N, 106.88087 degrees W), running north along approximately 6,235 linear feet of pipeline, ending at the City's control structure near the Maroon Creek Hydropower Plant (MCHP) (39.177 degrees N, 106.8646 degrees W). See map included as Attachment 1.

[1] U.S. Department of the Interior – Bureau of Reclamation

Figure 1: City of Aspen General Location Map

3. TECHNICAL PROJECT DESCRIPTION

3.1 PENSTOCK LINING FOR PIPELINE IMPROVEMENTS AND ADDITIONAL MANHOLE ACCESS

Aspen's water supply system is unique in that Aspen does not currently have a large storage reservoir like most local water systems. Aspen's supplies are direct-flow water rights which are directly impacted by seasonal fluctuations and environmental conditions. This coupled with Aspen's social and environmental commitment to sustainability, and their location near the headwaters of the Roaring Fork Watershed, drive Aspen to actively promote projects and programs that support the efficient and sustainable use of water. Aspen's municipal Water Efficiency Plan (WEP) identified an Enhanced Water Loss Control Program as a key foundational water efficiency program. This includes recommendations for ongoing water loss audits and subsequent projects and programs to reduce the identified losses. One such water loss that has been identified by the City is on its Maroon Creek raw water intake pipeline.

The City owns senior water rights on Maroon Creek decreed for electrical energy generation, municipal and domestic purposes, and irrigation. The City diverts its Maroon Creek water right into its Maroon Creek Intake Pipeline (Maroon Creek Pipeline), which delivers the water to either the City's Maroon Creek Hydropower Plant (MCHP) or to the City's Water Treatment Facility (WTF) by way of a small raw water storage facility on the site of the WTF. The stretch of pipeline between the City's intake and the hydropower plant has seen increasing levels of water loss over recent years, at times surfacing around roads that share the pipeline alignment. While the pipeline's original design and construction anticipated some level of leaking, the losses seen in this infrastructure has far exceeded the City's acceptable levels.

The Colorado Water Conservation Board (CWCB) has a junior instream flow water right decreed on Maroon Creek at the City's diversion location. As a policy, Aspen is committed to supporting this instream flow water right to the extent practical for the City to meet all municipal demands that protect the health and safety of its customers.

The City will be improving a section of critical pipeline infrastructure that provides raw water from Maroon Creek, a perennial stream located upgradient from the City, to the City's raw water storage reservoir and to a 400-kW hydroelectric generation facility. The City's raw water storage reservoir is used to supply the City's potable water treatment facility and potable water to the City's customers. The section of pipeline to be improved is approximately 6,235 linear feet of reinforced concrete pipe (RCP) and prestressed concrete cylinder pipe (PCCP) installed nearly 47 years ago, running between the Maroon Creek Diversion and the hydropower plant (see Figure 2). The pipeline is installed within a rugged mountain valley environment. The first 1,350 feet of pipeline meanders through a wooded, forest meadow. The next 4,785 feet the pipe is installed within the Maroon Creek Road right-of-way until the pipe comes to a control structure where water can be sent to the hydroelectric facility, about 100 feet from the control structure.

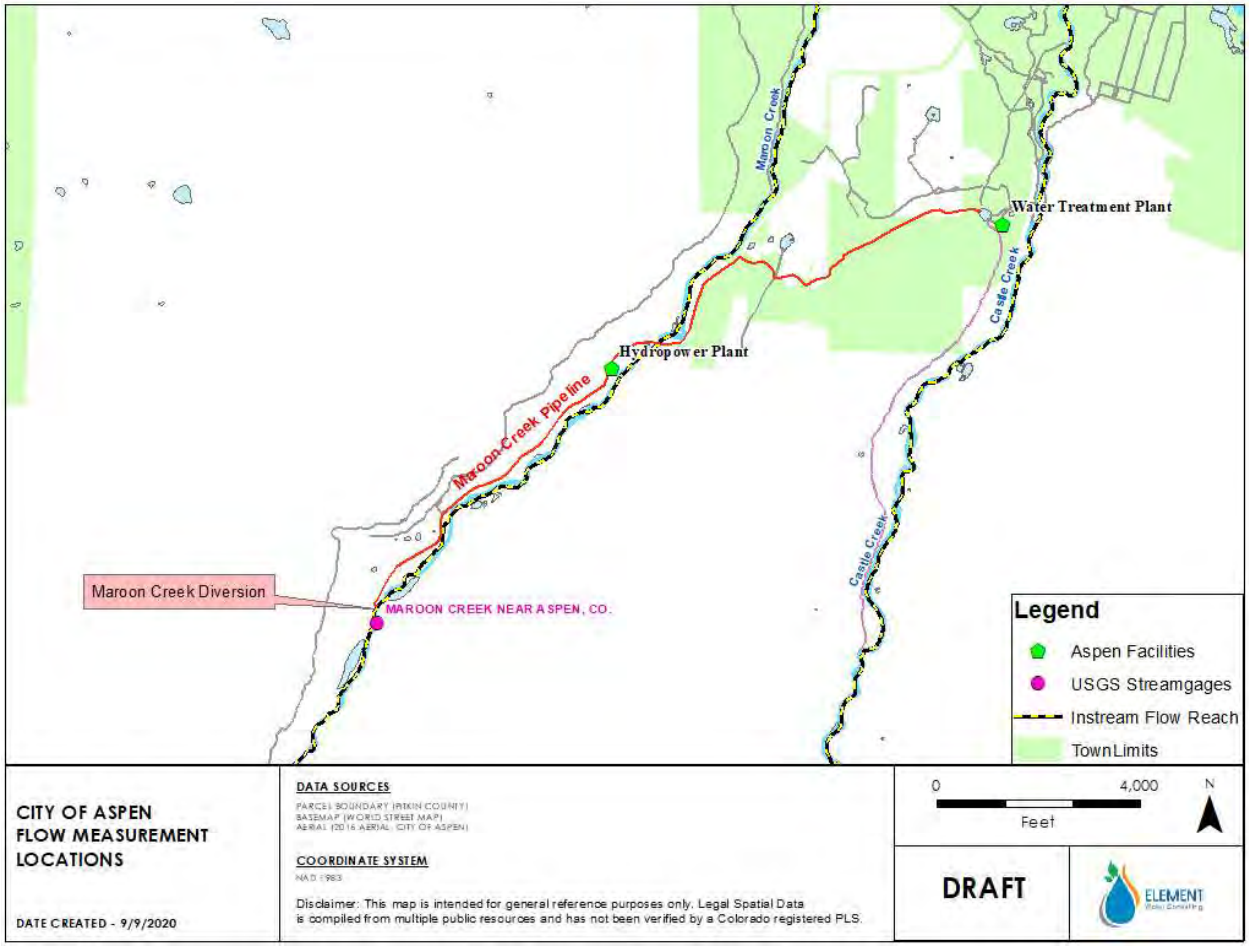


Figure 2: Maroon Creek Diversion and Infrastructure Location Map

The following improvements will be made to the existing Maroon Creek pipeline through the proposed project:

1. Installation of five additional access manholes and expansion of the man access port diameter for six existing manholes.
2. Reduction in total number of pipe joints from about 750 total joints to about 20 total joints.
3. Installation of designed pipe lining to improve system hydraulics, resulting in a smoother internal surface. The current pipeline has an effective Hazen-Williams coefficient of about 75. After lining and associated improvements, the effective Hazen-Williams coefficient will be around 140.

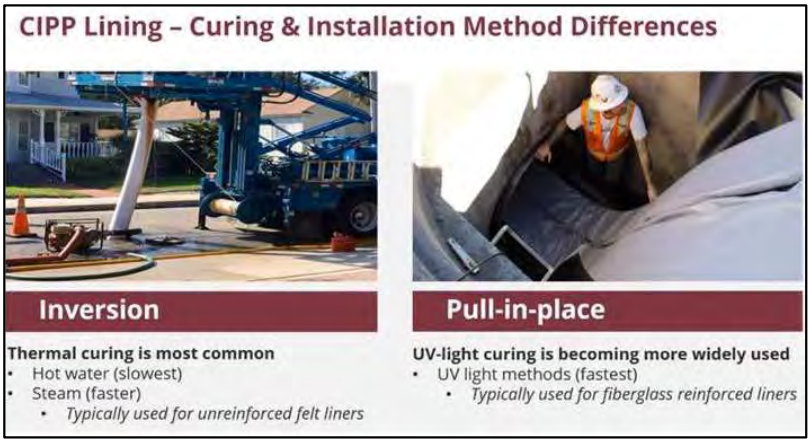
At the time of this application, the City has contracted Murraysmith & Associates Engineering (MSA) to plan and design the Penstock Lining Project. To date, MSA has begun preliminary designs and opinions of cost, which are presented herein. MSA will support the City in developing a Request for Proposal and will help select the contracting team that will complete the lining construction. Specific details on project materials, equipment, and specifications will be developed during the design phase, which is planned to be completed by February 2021. MSA will be retained after design completion to assist the City in permitting and bidding the project. Upon selection of a contractor to install the pipe lining and manhole infrastructure, MSA will be perform construction phase oversight of the project.

The project will start with a detailed survey of the pipeline features to confirm the location of existing horizontal and vertical bends, identify creek crossings, material type, material location, joint location, pipeline diameter, and profile along the planned rehabilitation length. The pipeline condition will then be accessed to aide pipeline rehabilitation designers in choosing pipeline lining type and if lining will need to be structural (e.g. will it be capable of supporting itself versus relying on the concrete substrate for support). Additional access manholes will be designed and placed in order to facilitate the pipeline rehabilitation and to provide more access points along the pipeline. Current access consists of only five access manholes within the entire 6,235 linear feet of pipeline. This means that much of the pipe is inaccessible for inspection and maintenance to support reliable operations.

The design engineers shall provide a bid package detailing the location and sizes of access manholes, the type of pipe lining, and where pipe lining can be structural or non-structural based on pipe operating pressures and existing concrete pipe condition. Design engineers will work with the City to obtain project approval from the Federal Energy Regulation Commission (FERC) for compliance with Chapter 12 – Water Conveyance of the FERC's "Engineering Guidelines for the Evaluation of Hydropower Projects".

Construction will start with excavation at manned access points first. Design engineers estimate an additional five manholes will be necessary to complete the work. The three most upstream manholes will be constructed within a wooded, forest meadow. Access to these locations will likely be difficult and a new temporary road may be required to allow access for construction crews and equipment. Two additional manholes installed within Maroon Creek Road will complete the additional access points. A preliminary alignment map included as Attachment 2 showing the locations of the existing manholes is included.

Pipe lining will be cured-in-place pipe (CIPP) constructed of high-density polyethylene (HDPE). CIPP is a trenchless rehabilitation/renovation method that involves the installation of a felt or reinforced fabric sleeve that has been impregnated with a thermosetting polymer resin, made of HDPE, into an existing pipeline. The thermosetting resins can be cured using hot water or ultraviolet (UV) light. The impregnated tube can be installed via inversion methods that employ air pressure, or via pull-in method using a winch and requires access points at both ends of the pipe reach to be rehabilitated. This technique can be designed to provide structural support depending on the needs of the system, condition of the host pipe, and integrity of the surrounding backfill or soil matrix. The CIPP liner wall thickness is varied to achieve a



structural versus non-structural lining; a thicker liner wall thickness is used to provide structural support where the host concrete pipe has structural integrity issues.

Access points will remain as open trenches to allow for liner installation and curing in manageable segments. Once each liner segment is cured, all new pipe segments will be joined with a vertical tee and bolt-on flange at each access point. A single continuous pipeline will be formed, and the pipeline will be pressure tested. Once the pressure test has passed, a concrete manhole will be constructed around each vertical tee. CIPP pipe joints will be thermally welded together at access points to create a continuous pipe. Each new CIPP man access or air release valve connection shall be a bolted, flanged connection with gasket. There will be far fewer joints in the same 6,235 ft when the pipeline is lined compared to existing conditions. There are a total of approximately 750 pipe joints along the length of the existing pipeline.

3.2 Evaluation of Savings and Benefits and Reporting

Actual savings associated with the Penstock Lining Project will be quantified by analysing available flow measurement data and comparing historic calculated system losses to calculated losses following the completion of the pipeline improvements described above. Hydropower production data will also be evaluated for increased efficiencies and total energy production increases. Technical and administrative assistance for grant management and reporting requirements will be included through the duration of the project. Quantified savings utilizing available data will be documented and provided in the interim and final reports as required by this grant program.

4. TECHNICAL PROPOSAL: EVALUATION CRITERIA

4.1 QUANTIFIABLE WATER SAVING (30 POINTS)

Describe the amount of estimated water savings. *For projects that conserve water, please state the estimated amount of water expected to be conserved (in acre-feet per year) as a direct result of this project.*

The Aspen Maroon Creek Penstock Lining Project is expected to save approximately **360 acre-feet** of water on average annually. This represents **2% of the City's total average annual raw water diversions from Maroon Creek**. This is based on a system mass balance calculation to estimate water loss in the pipeline and represents a conservative estimate of potential savings. Savings are calculated as a function of flow through the pipeline, so additional savings are anticipated at higher flows.

Describe current losses: *Please explain where the water that will be conserved is currently going (e.g., back to the stream, spilled at the end of the ditch, seeping into the ground)?*

Conserved water will increase streamflow in Maroon Creek by reducing the amount of water diverted for municipal use and hydropower generation at the City's Maroon Creek headgate. By reducing the loss in the pipeline, the City will need to divert less water at the headgate to meet the same demands at the MCHP and the WTF. The City of Aspen currently does not have a large-scale storage system, so resulting flow increases will impact neighboring communities and the native ecosystem. In addition, the City's commitment to operate its Maroon Creek diversion to protect CWCB instream flows downstream of its municipal diversion will be supported by the higher flows resulting from the reduced water loss through the pipeline. The reduction in leaks along this raw water pipeline will benefit the local Maroon Creek streamflow, the Roaring Fork River, and the Colorado River Basin. Conserved water also increases Aspen's supply resiliency by reducing the City's vulnerability to low streamflow periods associated with hydrological variability and natural disasters.

Describe the support/documentation of estimated water savings:

The following measurements were relied upon to calculate estimated water loss through the Maroon Creek Pipeline:

1. Flows in Maroon Creek above the Maroon Creek pipeline diversion via USGS streamflow gage 09076000 Maroon Creek Near Aspen, CO[2].
2. Flows in Maroon Creek below Maroon Creek pipeline diversion.
3. Flows from the Maroon Creek pipeline into the City's hydropower plant.
4. Flow measured from the Maroon Creek pipeline into the City's water treatment facility WTF.

Figure 3 below shows the location of the Maroon Creek diversion, Maroon Creek Pipeline, and the flow measurement locations. Using these measurements, a mass balance equation was applied using daily

[2] https://waterdata.usgs.gov/co/nwis/uv/?site_no=09076000&PARAmeter_cd=00065,00060

measurement data from 2019 to estimate total water loss through the entire Maroon Creek Pipeline. Note that there is a constant operational flow of 1 cfs at the City's WTF.

$$USGS\ Streamflow\ (1) - Flow\ Below\ Diversion\ (2) = Maroon\ Creek\ Diversion$$

$$Maroon\ Creek\ Diversion - Hydroplant\ Flow\ (3) - WTF\ Flow\ (4) - 1\ cfs\ Operational\ Flow = Calculated\ Loss$$

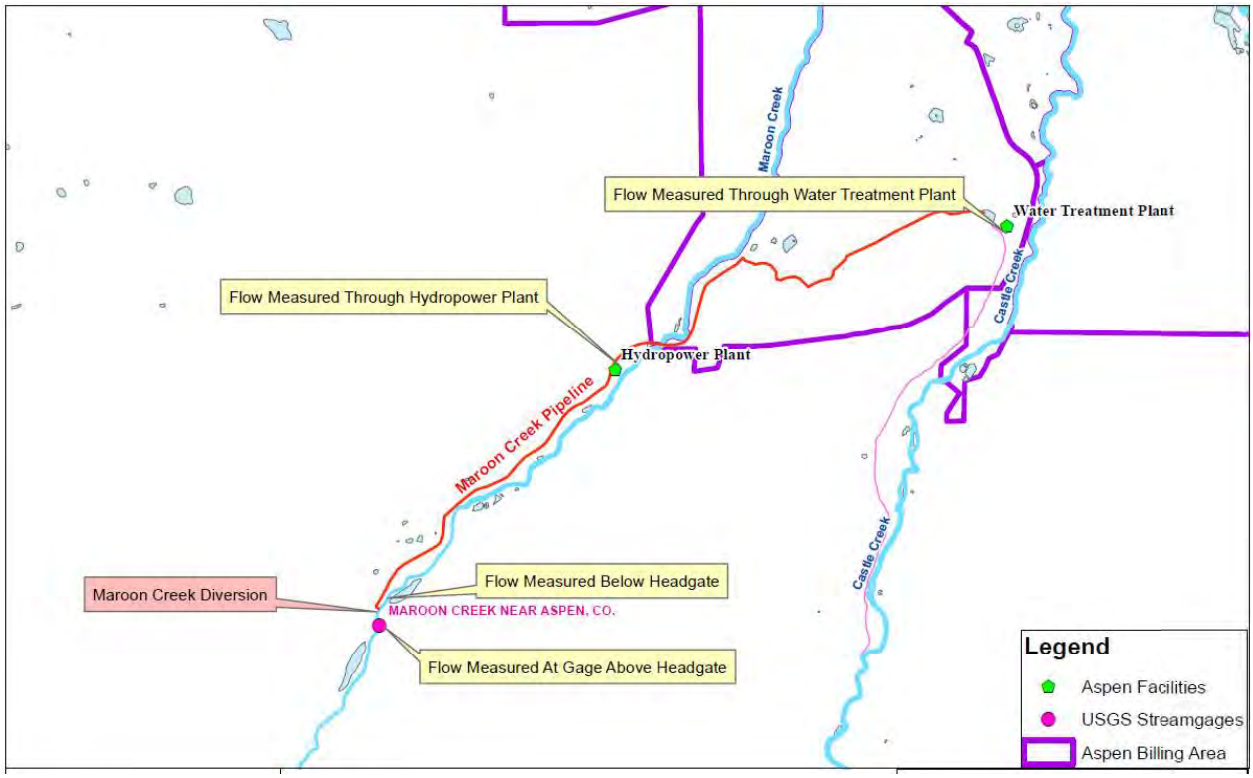


Figure 3: Maroon Creek Flow Measurement Locations.

This mass balance provides an initial calculated pipeline loss through the entire length of the Maroon Creek Pipeline, from the Maroon Creek Diversion to the WTF. The calculated loss varies monthly and is highly dependent on flow levels in the pipeline. According to AWWA M11, there is allowable leakage of 10 gallons per inch of diameter per mile of pipeline each day (see below). For the reach of Maroon Creek pipeline subject to lining improvements through this Project, this equates to about 2 acre-feet per year of allowable leakage. The calculated loss from the equations above were adjusted by this allowable leakage. Based on observations from City staff, the minimum loss through this section of pipeline had likely exceeded this rate over the full life of the pipeline and increasing over time.

> For steel pipe with gasket-sealed joints, M11 recommends a test allowance of 10 gal/in-dia/mile/day. If the pipe has welded joints or mechanical couplings, M11 recommends allowing "no significant leakage." Because the term "no significant leakage" could be interpreted differently by contractors than by project owners, the next revision of AWWA C604 (currently being reviewed at the committee level) will recommend a test allowance of 10 gal/in-dia/mile/day for pipe with gasket-sealed joints, welded joints, or mechanical couplings.

Based on monthly data, the calculated loss in the pipeline varied from 0% of the Maroon Creek diversion volume to 24% of the diversion amount, depending on time of year and magnitude (higher % loss was calculated at the lower flows). Consideration of measurement errors and leaks in other system infrastructure likely account for part of this calculated loss and represent all loss through the pipeline. Based on the above calculations and ranges of calculated system loss as a percentage of diversion volume, available pipeline loss studies, potential for losses occurring outside of the Project pipeline section, and physical observations by system operators, it is estimated that approximately 2% of the City's Maroon Creek diversions are lost through the section of pipeline that will be lined for system improvements. This is a total of about 360 AF per year and is considered a conservative estimate. Because this represents calculated loss in the Project area and already considers the allowable leakage volume, the estimated water savings from the Penstock Lining Project is projected to save approximately this volume of water. Typical water loss on a treated water distribution system averages 16%[3] and can far exceed this. Because the components on this raw water system are much less complicated, a loss of about 2% is a reasonable and conservative estimate. Note that the savings above are based on average annual flows over the past eight years. The range of savings can be between 230 AF per year up to nearly 470 AF per year depending on flow magnitude using this methodology.

4.2 WATER SUPPLY RELIABILITY (18 POINTS)

1. Will the project address a specific water reliability concern? Please address the following:

Explain and provide detail of the specific issue(s) in the area that is impacting water reliability, such as shortages due to drought, increased demand, or reduced deliveries. Will the project directly address a heightened competition for finite water supplies and over-allocation (e.g., population growth)?

The City of Aspen relies on flows stemming from the Colorado River in the Roaring Fork Watershed for all supplies. Flows in the Roaring Fork Watershed is critical to the maintenance of a healthy environment and provide water supplies to a large residential population in Aspen and nearby municipalities. The natural hydrology of the watershed is driven by snowmelt from the mountainous headwaters; however, streamflows are affected by water diversions for direct flow and storage purposes. Water diversions include transbasin appropriations that are 100% depletive to the Roaring Fork Watershed as well as local diversions with variable degrees of consumptive use. As with other high mountainous regions in the semi-arid southwestern United States, the Roaring Fork Watershed experiences a wide range of climatic

[3] "EPA: Water Audits and Water Loss Control for Public Water Systems". https://www.epa.gov/sites/production/files/2015-04/documents/epa816f13002.pdf

conditions from year to year as well as from season to season. The Roaring Fork Watershed is "over-appropriated", which means that at some or all times of the year, there is insufficient water to meet all demands. Under these circumstances, diversions are curtailed as needed under the prior appropriation system. Water is scarce in dry years and competing water demands have the potential to adversely impact the natural environment by reducing flows in some natural waterways. The municipal water providers in the Roaring Fork Valley, apart from Snowmass Water and Sanitation District, have limited storage, making them more dependent on the seasonal snowmelt and runoff conditions and more vulnerable to drought and water restrictions when snowpack is below normal. Plans to reduce usage are necessary so that supply will be enough to meet demands during periods of drought. Anticipated savings in demands influenced by the Penstock Lining Project will contribute to these targeted reductions within the Roaring Fork Watershed. This is supported by the 2015 Roaring Fork Regional Water Efficiency Plan.

As population and tourism increase in the Aspen area, municipal water demands will continue to increase while the available supplies remain constant. Reductions in water loss on the City's raw water intake off Maroon Creek will allow the City to utilize this "lost water" as an increase in its municipal supply into the future while staying within legal diversion limits. Currently, the City must divert more water than is ultimately available for hydropower generation and/or treatment for municipal supply due to water lost through the Maroon Creek Pipeline. If the City's diversion amount stays the same, the amount of water available to the City after the pipeline system improvements will be greater without impacting the stream. Alternatively, the City can reduce its stream diversions to meet current demands because of the decrease in water loss through the pipeline.

Describe how the project will address the water reliability concern? In your response, please address where the conserved water will go and how it will be used, including whether the conserved water will be used to offset groundwater pumping, used to reduce diversions, used to address shortages that impact diversions or reduce deliveries, made available for transfer, left in the river system, or used to meet another intended use.

In August 2020, the City finalized its municipal Drought Mitigation and Response Plan ("DMRP"). The DMRP defines drought response stages and associated water use reduction goals and measures to achieve reduction goals. Response measures are based on a defined priority ranking of end uses, of which hydroelectric power generation from Maroon Creek diversions is ranked the lowest priority use within Aspen's system. This means that, in the event of a drought or water shortage stage declaration, one of the first uses to be impacted is hydroelectric power. If water loss between the Maroon Creek diversion and the hydropower plant is reduced or eliminated, there is the potential that a water shortage declaration can be mitigated or postponed. Because the use on Maroon Creek's system will be among the first impacted by a water shortage, increasing the efficiency within this system will directly influence the timing and initial response to a drought. This also results in more water being left in the Creek during times when water is most scarce, supporting instream flow maintenance and downstream water demands.

The reduction of water loss realized through the implementation of the Penstock Lining Project will directly support the City's commitment to protect the instream flow right on Maroon Creek by leaving more flows in the stream via reduced diversions. Because the City has very little storage, reduced demands will result in reduced diversions, leaving water in the river system.

Conservation and the efficient use of surface water supplies in the Roaring Fork Watershed is a primary focus of the 2015 Roaring Fork Regional Water Efficiency Plan developed by a group of municipal users in

the Watershed, including the City of Aspen. This project supports the Regional focus by reducing water losses and more efficiently using existing water supplies, contributing to the reliability of water supplies locally within the Maroon Creek watershed as well as within the Roaring Fork.

Provide a description of the mechanism that will be used, if necessary, to put the conserved water to the intended use.

Water saved through the reduction in water loss from this project will either be diverted and put to use at a higher efficiency than existing conditions or will be left in Maroon Creek, increasing local flows. Aspen's highest priorities, as defined through the City's DMRP, are to meet its municipal demands and to protect instream flows. After these uses are met, water will be delivered to the hydropower plant for energy production. Any water not diverted for the City's uses will be left in the stream, supporting instream flows and increasing available supplies for other more junior water users downstream.

Indicate the quantity of conserved water that will be used for the intended purpose.

Implementation of the Penstock Lining Project is expected to result in an average savings of approximately **360 AF** annually. Additional efficiency in the pipeline allows the City to use nearly all its diverted supply to produce hydropower and continue to meet the City's municipal potable water demands. This also helps the City support instream flow rights and native flows in Maroon Creek, which protects the natural environment.

2. Will the project make water available to achieve multiple benefits or to benefit multiple water users? Consider the following:

Will the project benefit multiple sectors and/or users (e.g., agriculture, municipal and industrial, environmental, recreation, or others)?

Water saved through this project will benefit the following sectors:

1. Agricultural: property owners located near the Maroon Creek diversion rely upon this source for agricultural uses. Reduction of water lost through the City's pipeline will reduce the City's senior diversions, leaving more water in the stream for more junior agricultural water rights.
2. Municipal: reducing the amount of raw water loss within the existing Maroon Creek pipeline will make more of the diverted supplies available to Aspen to treat and meet its municipal demands.
3. Energy: reducing the amount of raw water loss within the existing Maroon Creek Pipeline will make more of the diverted supplies available to Aspen for energy production through the City's hydropower plant. Increased hydraulic efficiency through the pipeline is expected to increase energy production by decreasing hydraulic head and increasing the pipe's Hazen-Williams coefficient.
4. Environmental: reducing the City's Maroon Creek diversion will increase flows downstream of the diversion, protecting CWCB decreed instream flows which were designed to protect natural habitat and native ecosystems.
5. Recreational: Maroon Creek is used for fishing and recreational boating. Maintaining a minimum instream flow supports these recreational activities. Better management of the City's Maroon Creek supplies through water loss reduction allows the City to continue its support of instream flows in this area.

- *Will the project benefit species (e.g., federally threatened or endangered, a federally recognized candidate species, a state listed species, or a species of particular recreational, or economic importance)? Please describe the relationship of the species to the water supply, and whether the species is adversely affected by a Reclamation project.*

There are no federally threatened or endangered species in Pitkin County. Many lakes and streams in Pitkin County contain Colorado River Cutthroat Trout, which is a Colorado species of special concern due to its limited numbers and fragile ecosystem requirements. Aspen's commitment to supporting the instream flows decreed in Maroon Creek will protect the Colorado River Cutthroat Trout as well as other aquatic species and plant life through increased flows in Maroon Creek resulting from the Project's water savings.

- *Will the project benefit a larger initiative to address water reliability?*

The Colorado Water Plan has projected municipal, industrial, and agricultural water demands through 2050 and paired those demands with available supplies. Any projects that will increase local efficiency help to narrow any projected supply gap within the local watershed. Reducing water loss in the Maroon Creek pipeline will allow the City to meet its municipal and hydropower demands with a lower diverted volume, reducing the need to develop additional supplies in the future to meet growing demands. This is part of a larger effort to reduce demands and protect supplies in the Colorado River Basin and throughout the State.

3. Does the project promote and encourage collaboration among parties in a way that helps increase the reliability of the water supply?

- *Is there widespread support for the project?*

This project is directly supported by the City of Aspen and its water users, the Colorado Water Conservation Board (CWCB), Pitkin County, the Roaring Fork Conservancy, and WaterNow Alliance. Additionally, general support for addressing water loss and for improving water infrastructure is identified in the Colorado Water Plan as conservation strategies and demand reduction measures. The CWCB and the Colorado Water Plan support water management activities including comprehensive water loss management programs and savings tracking and estimating tools.

The Roaring Fork Regional WEP, developed through collaboration with 5 water utilities and other local agencies in the Roaring Fork Watershed, including the City of Aspen, identifies water loss control, including management of real water losses, as a targeted program to address regionally. As Aspen proceeds with its Penstock Lining Project, neighboring communities will see increased flows in Maroon Creek and the Roaring Fork watershed due to water savings.

- *What is the significance of the collaboration/support?*

The CWCB is currently implementing the Colorado Water Loss Initiative to provide free training and technical support to urban water providers throughout Colorado, along with recommended next steps for water loss reduction and revenue recovery. Aspen has already conducted preliminary AWWA M36 water loss audit analyses, which is the tool being used for the CWCB trainings. The City of Aspen's initiative to take steps to reduce water loss is exemplary of the water smart management being promoted by the CWCB. Ongoing support from the CWCB has provided funding opportunities to the City to advance other water efficiency programs and projects that bolster the City's WEP. While this program focuses on water

loss within potable systems, the Penstock Lining Project directly supports water efficiency on the raw water side of a potable supply. Any water savings benefit the City and support water loss control.

As discussed above, the Regional WEP strongly supports efforts including advanced water loss initiatives within the Roaring Fork Region. As Aspen moves forward with this Project, other municipalities collaborating under the Regional WEP will have exposure to Aspen's process, experience, and ultimately the outcome of a pipeline efficiency improvement project through the Penstock Lining.

- *Is the possibility of future water conservation improvements by other water users enhanced by completion of this project?*

Yes. Aspen is a leader in the Roaring Fork Watershed in conservation and efficiency practices. The City has historically paved the way for the region, taking on new and innovative efficiency programs and measures locally. Over the past few years, Aspen has developed Water Efficient Landscaping Standards[4], requiring that professional landscapers have an approved certification and implementing a water budget requirement for new landscaping, among other landscaping and irrigation requirements. Aspen also adopted and has conducted multiple professional landscaper certification courses through the Qualified Water Efficient Landscaper ("QWEL") Certification Program[5]. This required modifications to materials for local conditions and requirements. Both the Standards and the certification program development were identified in the Regional WEP and were financially supported by the CWCB through the Water Efficiency Implementation grant program. Aspen has these adopted programs and measures as outlined under the Regional WEP, creating a local program that can be expanded to serve the regional partnership. Aspen has also initiated full advanced metering for all its municipal customers through an AMI project supported through a prior awarded WaterSMART Grant. As Aspen implements these programs and measures, the City provides lessons-learned and other first-hand information to its municipal partners within the Roaring Fork Regional WEP working group. This information is often relied upon by these neighboring utilities in pursuing their own local programs. Programs and projects implemented by Aspen allow the City to lead by example among the surrounding communities. Local water loss programs, like Aspen's AMI project and the Penstock Lining Project, can provide locally quantified water savings and implementation strategies for other communities to establish their targeted goals and identified local implementation strategy through similar programs.

4.3 IMPLEMENTING HYDROPOWER (18 POINTS)

Describe the amount of energy generated. *For projects that implement hydropower systems, state the estimated amount of energy that the system will generate (in kilowatt hours per year). Please provide sufficient detail supporting the stated estimate, including all calculations in support of the estimate. Please explain how the power generated as a result of this project will be used, including any existing or planned agreements and infrastructure.*

Improvements made to the Maroon Creek Pipeline will contribute to increased energy production at the MCHP in two ways: 1) increased flow sent to the MCHP in an amount equal to the water loss reduction realized through the Project, and 2) increased head due to a lower dynamic head loss through a HDPE

[4] https://www.cityofaspen.com/199/Landscape-Ordinance
[5] https://www.cityofaspen.com/1195/Qualified-Water-Efficient-Landscaper-Pro

pipe versus an aged concrete pipe. The following equations were applied to estimate the increased energy production resulting from increased pipeline efficiency and lower head loss:

$h_{100ft} = 0.2083\ (100 / c)^{1.852}\ q^{1.852} / d_h^{4.8655}$ (1)

where

h_{100ft} *= friction head loss in feet of water per 100 feet of pipe* (ft_{h20}/100 ft pipe)

c = Hazen-Williams roughness constant

q = volume flow (gal/min)

dh = inside hydraulic diameter (inches)

Power = [Delta Pressure (psig) * Flow (gpm)]/1714

Increased hydropower production is directly related to flow through the plant. Using various flows and calculated hydropower efficiencies at each flow, Table 1 below shows the calculated increase in hydropower production based on the Penstock Lining Project improvements.

Table 1:Estimated Hydropower Production Increases

Added Power (kW) at Flow and Delta P
3.4 @ 16.5 cfs & 60% hydropower efficiency
20.8 @ 31.3 cfs & 69% hydropower efficiency
75.3 @ 46.4cfs & 72% hydropower efficiency

4.4 Complementing On-Farm Irrigation Improvements (10 Points)

The proposed project does not include on-farm irrigation improvements.

4.5 Department of the Interior Priorities (10 Points)

Department Priorities

Creating a conservation stewardship legacy second only to Teddy Roosevelt

The City of Aspen is committed to the efficient and effective use of water as a precious resource. The City takes seriously its responsibility of being located at the headwaters of the Roaring Fork Watershed in the Upper Colorado River Basin, protecting the quality and availability of water through the river system downstream. Aspen has adopted a policy to maintain streamflows in the creeks downstream of its diversion structures at flow rates at or above the Colorado Water Conservation Board's decreed instream flow rights for the protection of the fishery and the associated aquatic habitats in those streams. It has become the first utility in the State of Colorado to adopt the Qualified Water Efficient Landscape ("QWEL") Certification Program and has recently adopted some of the most rigorous Water Efficient Landscaping and Irrigation Standards in the state. The City takes very seriously its stewardship and leadership position as a water utility.

Utilizing our natural resources

In addition to the ongoing efforts through projects and programs to most efficiently utilize its water resources, the City of Aspen was the first city west of the Mississippi to have hydroelectric powered streetlights. It was built to service the mines in the area and municipal power was an afterthought. Today, the City of Aspen electric system uses 100% renewable energy (46% hydroelectric, 53% wind power, 1% landfill gas). The City is currently transitioning all electrical services to AMI, which will save energy and build a foundation for energy conservation programs in the future. This project is expected to save 1,320,000 KWH annually. System improvements resulting from the Penstock Lining Project include increased supplies at the City's Maroon Creek Hydropower Plant, allowing for a potential increase in hydroelectric power generated for and by the City. Additionally, reduction of water lost through the City's raw water infrastructure highlights the City's commitment to the efficient and responsible management of water as a limited natural resource.

Restoring trust with local communities

The City has been working directly with the property owner at the Maroon Creek headgate and along the first 1,000 feet of pipe for the last 30 years on pipeline and headgate maintenance. Water lost through the Maroon Creek pipeline in its current condition has been impacting this property. The City continues to act as a good neighbor by offering ongoing mitigation for leaks, and through this project implementation, will provide a long-term solution to leak impacts on this property.

Modernizing our infrastructure

The Maroon Creek Penstock Lining Project will upgrade the City's raw water supply delivery system for the City's municipal and hydropower supplies from Maroon Creek, which will modernize the utility's water delivery infrastructure. The pipeline as it exists today does not meet today's standards. The lining along the defined stretch of pipeline will allow this infrastructure to exceed its original design capabilities.

Reclamation Priorities

Leverage Science and Technology to Improve Water Supply Reliability to Communities

The Maroon Creek Penstock Lining Project will utilize current materials and processes to improve the reliability and efficiency of the City's Maroon Creek raw water supplies for hydropower and municipal uses. These materials and installation processes will be selected based on specific system needs and an in-depth evaluation and design by MSA to utilize scientifically developed and proven lining materials and recommended processes for installation.

Address Ongoing Drought

In August of 2020, Aspen declared a Stage 2 drought for only the second time since developing a staged drought response program. This came on the heels of the City finalizing a municipal Drought Mitigation and Response Plan (DMRP) which provides detail on how the City will respond to droughts. The DMRP defines the City's water use priorities and how it will systematically curtail certain uses during a drought. The City's lowest priority use is hydropower generation. This means that in times of shortage, the City will first reduce or cease deliveries of its Maroon Creek water for hydropower generation to allow the City to use these supplies to meet municipal demands. By improving its delivery infrastructure from its Maroon Creek diversion, the City may save enough water to postpone initiation of a drought declaration or reduce

the amount of curtailment on its hydropower generation from the increase in available water supply that had historically been lost through the Maroon Creek Pipeline.

4.6 IMPLEMENTATION AND RESULTS (6 POINTS)

Does the applicant have a Water Conservation Plan and/or System Optimization Review (SOR) in place? *Please self-certify or provide copies of these plans where appropriate to verify that such a plan is in place.*

Yes, the City of Aspen has a State Approved Municipal Water Efficiency Plan ("WEP")[6]. Enhanced Water Loss Control was identified as programs recommended for implementation under this WEP. The work described in this application directly supports this conservation program, as described in earlier sections. The City is also one of the primary participants in the Roaring Fork Regional WEP. The City's WEP is included as Attachment 3.

Provide the following information regarding project planning:

(1) Identify any district-wide, or system-wide, planning that provides support for the proposed project. This could include a Water Conservation Plan, SOR, Drought Contingency Plan or other planning efforts done to determine the priority of this project in relation to other potential projects.

Aspen's WEP provides support for the proposed project through the identification and prioritization of an Enhanced Water Loss Control program. The WEP identifies leak detection and water loss control as fundamental water efficiency practices for all water utilities. While the WEP focuses on quantifying treated system losses, the City has expanded its water loss program to include evaluation of all City water infrastructure. The Regional WEP also identifies Water Loss Control Technical Assistance as a critical program for conservation in the Roaring Fork Watershed.

In August 2020, the City finalized its municipal Drought Mitigation and Response Plan ("DMRP"). The DMRP defines drought response stages and associated water use reduction goals and measures to achieve reduction goals. Response measures are based on a defined priority ranking of end uses, of which hydroelectric power generation from Maroon Creek diversions is ranked the lowest priority use within Aspen's system. This means that, in the event of a drought or water shortage stage declaration, one of the first uses to be impacted is hydroelectric power. If water loss between the Maroon Creek diversion and the hydropower plant is reduced or eliminated, there is the potential that a water shortage declaration can be mitigated or postponed. Because the use on Maroon Creek's system will be among the first impacted by a water shortage, increasing the efficiency within this system will directly influence the timing and initial response to a drought. This is included as Attachment 4.

At the time of this application, the City is developing an Integrated Resources Plan ("IRP") that is evaluating existing supplies, future water demands, and infrastructure to support the City's long-range planning. This effort includes evaluation of uses by supply, including Maroon Creek as one of the City's primary potable water supplies. Potential modifications of use by water supply will be investigated, including opportunities to expand the City's use of raw water as a non-potable supply. Reducing the water loss from Maroon

[6] https://www.cityofaspen.com/DocumentCenter/View/466/City-of-Aspen-Municipal-Water-Efficiency-Plan-2015-PDF

Creek increases the available supplies for the City's use. This supply is decreed to allow potable, irrigation, and hydropower generation uses, which makes this the most diverse of the City's water supplies.

The Roaring Fork Watershed Plan is the product of over four years of effort by more than a hundred people, representing dozens of agencies, governments, and interests throughout the Roaring Fork Valley and beyond. The Plan is the culmination of countless meetings, conversations, debates, and iterations, all of them aimed at creating a document that will be meaningful and useful to both water managers and the general public. This plan ultimately led to the development of the Roaring Fork WEP and includes goals and priorities that are directly supported by the penstock lining project. One such goal is pursuit of a water conservation campaign that benefits rivers. The reduction in demands, as previously described, will result in lower diversion volumes from Maroon Creek with more water being left in the stream.

(2) Describe how the project conforms to and meets the goals of any applicable planning efforts and identify any aspect of the project that implements a feature of an existing water plan(s).

Locally, the Penstock Lining Project is supported by the City of Aspen Municipal WEP and the Roaring Fork Regional WEP, as described in previous sections. Statewide, the CWCB and the Colorado Water Plan ("CWP") identify and support water management activities including comprehensive water loss management programs and watershed health. The CWP strives to not only manage, but to protect the State's water resources.

E.1.6.2. Subcriterion F.2— Performance Measures

Provide a brief summary describing the performance measure that will be used to quantify actual benefits upon completion of the project (e.g., water saved or better managed, energy generated or saved).

The City maintains measurements at the locations described in Section 4.1 of this application and the USGS gage on Maroon Creek just above the City's diversion remains active. Staff will internally maintain the calculations described in Section 4.1 to track potential calculated loss through the Maroon Creek Pipeline system. The reduction in loss calculated over time will be attributed to the pipeline improvements associated with the Penstock Lining Project. It is anticipated that a reasonable initial estimate of actual water savings using this method will be quantifiable within a year of construction completion. Ongoing calculated savings will be tracked, and any continued loss will be investigated in this system. Additionally, hydropower produced at the City's plant will be monitored and any increase in energy production will be quantified to reflect greater system efficiency.

E.1.6.3. Subcriterion F.3— Readiness to Proceed

Applications that include a detailed project implementation plan (e.g., estimated project schedule that shows the stages and duration of the proposed work, including major tasks, milestones, and dates) will receive the most points under this criterion.

- *Identify and provide a summary description of the major tasks necessary to complete the project. Note: please do not repeat the more detailed technical project description provided*

in Section D.2.2.4.; this section should be focused on a summary of the major tasks to be accomplished as part of the project.

- *Describe any permits that will be required, along with the process for obtaining such permits.*
- *Identify and describe any engineering or design work performed specifically in support of the proposed project.*
- *Describe any new policies or administrative actions required to implement the project.*

Please also include an estimated project schedule that shows the stages and duration of the proposed work, including major tasks, milestones, and dates. Milestones may include, but are not limited to, the following: complete environmental and cultural compliance; mobilization; begin construction/installation; construction/installation (50% complete); and construction/installation (100% complete)

The City is currently working with design engineers MSA to prepare specifications, design, and support for a request for proposal for the Penstock Lining Project construction. The following major phases are required for project completion, following the survey, assessment, and design that are not included in this grant application:

1. Permitting: this will be led by MSA and the City and will include the FERC permitting process to be initiated following final design.
2. Mobilization: this will be led by the selected contracting team, who will work closely with the City to obtain any site access and will include traffic control and erosion control
3. Construction/Installation: this will be led by the selected contracting team, who will work closely with the City to complete pipeline preparation work, install and improve manhole access, and complete transmission main liner installation.
4. Acceptance Testing: this will be led by the selected contracting team in conjunction with MSA and the City and will initiate following installation completion.
5. Grant Management and Reporting: this will be led by a separate contracting team to support grant management, reporting requirements, and estimates of actual observed water savings attributed to the Project.

The following is a general schedule based on major implementation phases. This schedule will be refined by the selected contractors following bidding for the construction and implementation of the penstock lining project.

	2021										
	Feb	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Permitting/Bid											
Mobilization											
Construction/Installation											
Acceptance Testing											
Grant Management and Reporting											

Figure 4: Project Schedule

4.7 NEXUS TO RECLAMATION PROJECT ACTIVITIES (4 POINTS)

Is the proposed project connected to Reclamation project activities

The proposed project is not connected to Reclamation project activities.

4.8 ADDITIONAL NON-FEDERAL FUNDING (4 POINTS)

State the percentage of non-Federal funding

$$\frac{\$2{,}521{,}219.60\ Non-Federal\ Funding}{\$3{,}001{,}451.90\ Total\ Budget} = 84\%\ Non-Federal\ Funding$$

Source	Amount
Costs to be reimbursed with the requested Federal Funding	$480,232.30
Costs to be paid by applicant	$2,521,219.60
Value of third-party contributions	$-
Total Project Cost	$3,001,451.90

5. ENVIRONMENTAL AND CULTURAL RESOURCES COMPLIANCE

To allow Reclamation to assess the probable environmental and cultural resources impacts and costs associated with each application, we have included responses to the following list of provided questions focusing on the NEPA, ESA, and NHPA requirements.

Will the proposed project impact the surrounding environment (e.g., soil[dust], air, water [quality and quantity], animal habitat)? Please briefly describe all earth-disturbing work and any work that will affect the air, water, or animal habitat in the project area. Please also explain the impacts of such work on the surrounding environment and any steps that could be taken to minimize the impacts.

It is likely that the City will only need to pursue a permit for work that is crossing and encroaching on Maroon Creek, which represents a relatively small portion of the pipeline length. Most of the work is going to be trenchless (non-destructive) rehabilitation of the existing pipeline. Most of the earthwork will be in conjunction with the installation of new access manholes, which will be located through the ongoing design efforts. It's likely these locations will be determined by early to mid-November as it relates to this component of design. These access locations will be utilized by the pipe lining contractor to stage their pull and receipt of the liner. Mitigation events include erosion control best practices such as straw waddles and silt fencing, trench excavation dewatering treatment with geotextile bags to reduce sediment load in the environment, and site restoration and revegetation in any area that disturbance occurs. Based on planned work and mitigation efforts, there are no impacts anticipated. All areas that are disturbed will be revegetated upon completion.

Are you aware of any species listed or proposed to be listed as a Federal threatened or endangered species, or designated critical habitat in the project area? If so, would they be affected by any activities associated with the proposed project?

No threatened or endangered species or designated critical habitat will be affected by any activities associated with the Project. Pitkin County does not contain any federally listed threatened or endangered species. Many lakes and streams in Pitkin County contain Colorado River Cutthroat Trout, which is a Colorado species of special concern due to its limited numbers and fragile ecosystem requirements. Based on current preliminary assessments, there will be no impacts to Cutthroat Trout habitat during project implementation. The City will carefully identify aquatic and wetlands plants that are not to disturbed and will be replaced if any impacts occur.

Are there wetlands or other surface waters inside the project boundaries that potentially fall under CWA jurisdiction as "Waters of the United States?" If so, please describe and estimate any impacts the proposed project may have.

It is anticipated that portions of the pipeline not in the road and where additional manhole access is necessary could be located within wetlands. MSA shall identify locations where wetlands exist and will choose manhole access locations carefully to avoid wetland disturbance and limit the need for nationwide permits through the USACE. Should a permit be required, the City will work with MSA to obtain necessary permits. If any wetlands disturbance area measures greater than a 1/10th of an acre or if stream banks are disturbed during manhole construction, the project will be subject to permitting requirements. In this case, the City may need to obtain a United States Army Corp of Engineers (USACE) Nationwide Permit(s)

to obtain permission to disturb wetlands or streams beds to facilitate manhole access points within the first 1,350 linear feet of pipeline.

When was the water delivery system constructed?

The earliest parts of Aspen's original water delivery system were constructed in the late-1800s. In 1956, the City of Aspen began operating the Municipal Water Utility. In 1957, Aspen voters approved a bond proposal adopting a plan for acquisition and improvement of the water works system and for repayment of the costs incurred in the acquisition and improvement program. The existing Maroon Creek Pipeline was constructed in 1973.

Will the proposed project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, or flumes)? If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously.

There will be no modification of or effects to any portion of an irrigation system because of this project.

Are any buildings, structures, or features in the irrigation district listed or eligible for listing on the National Register of Historic Places? A cultural resources specialist at your local Reclamation office or the State Historic Preservation Office can assist in answering this question.

There is no anticipated impact to any buildings, structures, or features listed or eligible for listing on the National Register of Historic Places.

Are there any known archeological sites in the proposed project area?

There are no known archeological sites in the proposed project area.

Will the proposed project have a disproportionately high and adverse effect on low income or minority populations?

There will be no disproportionately high or adverse effects on low income or minority populations because of this project.

Will the proposed project limit access to and ceremonial use of Indian sacred sites or result in other impacts on tribal lands?

The proposed project will not impact tribal lands or access to/ceremonial use of Indian sacred sites.

Will the proposed project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area?

The proposed project will not contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area.

6. REQUIRED PERMITS OR APPROVALS

Applicants must state in the application whether any permits or approvals are required and explain the plan for obtaining such permits or approvals.

Note that improvements to Federal facilities that are implemented through any project awarded funding through this FOA must comply with additional requirements. The Federal government will continue to hold title to the Federal facility and any improvement that is integral to the existing operations of that facility. Please see P.L. 111-11, Section 9504(a)(3)(B). Reclamation may also require additional reviews and approvals prior to award to ensure that any necessary easements, land use authorizations, or special permits can be approved consistent with the requirements of 43 CFR Section 429, and that the development will not impact or impair project operations or efficiency.

The entire section of Maroon Creek Pipeline to be improved for this project is considered a penstock, which is a pipeline supplying water to a hydropower facility. Penstocks are subject to Chapter 12 of the Federal Energy Regulation Commission (FERC) titled "Engineering Guidelines for the Evaluation of Hydropower Projects". Design engineers shall work with the City to obtain project approval from the FERC to comply with these requirements.

It is anticipated that portions of the pipeline not in the road and where additional manhole access is necessary could be located within wetlands. The pipe lining design team shall identify locations where wetlands exist, choose manhole access locations carefully to avoid wetland disturbance and limit the need for nationwide permits through the USACE. If construction of these manhole will disturb greater than a 1/10 of an acre of wetlands will be subject to permitting requirements. In this case, the City may need to obtain a United States Army Corp of Engineers (USACE) Nationwide Permit(s)to obtain permission to disturb wetlands or streams beds to facilitate manhole access points within the first 1,350 LF of pipeline. Should a permit be required, the City will work with the design engineers to obtain necessary permits.

It is likely that the City will only need to pursue a permit for work that is crossing and encroaching on Maroon Creek, which represents a relatively small portion of the pipeline length. Most of the work is going to be trenchless (non-destructive) rehabilitation of the existing pipeline. Currently, the City and MSA are working through the survey base mapping and are compiling information to develop a dewatering and assessment plan for the pipeline. This plan will be used to show means and methods as well as timeline for the initial pipeline assessment. After this step is completed (around mid-October), MSA will begin development of design alternatives, which will result in a better understanding of locations a USACE permit will be required.

The City has an access and utility easement for the entire Maroon Creek Pipeline and the river headgate. This easement predates the existing roadway as a previous version of the pipeline was a wood staved pipe dating back to the late 1800s. The City owns the land where the hydropower plant is located. The City will work closely with landowners, Pitkin County, and the selected contractor to mitigate any impacts and will include traffic control on Maroon Creek Road. The City will work with Pitkin County and the U.S. Forest Service to maintain traffic flow along the road to the Maroon Bells wilderness area and Maroon Creek Lake visitor's area; a popular tourist destination where most access is via a bus reservation.

7. OFFICIAL RESOLUTION

The next Council meeting will be held on October 13th, 2020, during which an Official Resolution will be presented and signed. This will be provided in support of this grant application upon completion.

8. PROJECT BUDGET

The project budget includes:

(1) Funding plan and letters of commitment (N/A)
(2) Budget proposal
(3) Budget narrative

8.1 FUNDING PLAN AND LETTERS OF COMMITMENT

Describe how the non-Federal share of project costs will be obtained. Please identify the sources of the non-Federal cost share contribution for the project, including:

The City of Aspen will fund the non-Federal share of project costs from their Enterprise Fund for Water Utility which is fully funded through revenue from monthly billing, tap fees, permit review fees, and other miscellaneous revenue sources.

In addition, please identify whether the budget proposal includes any project costs that have been or may be incurred prior to award. For each cost, describe:

No project costs associated with the penstock lining project construction will be incurred prior to award.

Table 2: Total Project Cost: Summary of Federal and Non-Federal Funding Sources

Funding Source	Amount
Costs to be reimbursed with the requested Federal Funding	$480,232.30
Costs to be paid by applicant	$2,521,219.60
Value of third-party contributions	$-
Total Project Cost	**$3,001,451.90**

8.2 BUDGET PROPOSAL

Table 3: Proposed Project Budget

Budget Item Description	$/Unit	Quantity	Quantity Type	Total Cost
Salaries and Wages				
Ryan Loebach, Senior Project Manager	$ 51.70	250	Human Resource	$ 12,925.00
Tyler Christoff, Director of Utilities	$ 69.22	20	Human Resource	$ 1,384.40
Fringe Benefits				
Travel				
Equipment				
39-inch Diameter Pressure-Rated UV Cured CIPP Liner	$ 240.00	6,235	LF	$ 1,496,400.00
Supplies and Materials				
Manholes - Equipment Only	$ 6,500.00	6	EA	$ 39,000.00
Contractual/Construction				
Grant Management, Savings Quantification, and Reporting	$ 40,000.00	1	EA	$ 40,000.00
Pipeline Preparation				
Dewatering - Drain, Pumps, Hoses, Man Hrs, and Appurtenances	$ 2.00	6235	LF	$ 12,470.00
Clean and Preparation for Liner	$ 9.00	6235	LF	$ 56,115.00
CCTV Inspection - Camera, Inspection Video	$ 4.50	6235	LF	$ 28,057.50
Remove Weko-Seals	$ 20,000.00	1	LS	$ 20,000.00
Manhole Access Installation				
Construction Staging and Access (Per Manhole)	$ 12,000.00	6	EA	$ 72,000.00
Connection, Welding, and Appurtenances (Per Manhole)	$ 2,500.00	6	EA	$ 15,000.00
Transmission Main Liner Installation				
CIPP Liner Staging and Installation	$ 60.00	6235	LF	$ 374,100.00
Transmission Main Inspection and Testing	$ 15,000.00	1	LS	$ 15,000.00
Mobilization & Staging (3%)	$ 68,000.00	1	EA	$ 68,000.00
Construction Administration (2.75%)	$ 62,000.00	1	EA	$ 62,000.00
Contractor OH&P (15%)	$ 356,000.00	1	EA	$ 356,000.00
Contingency (10%)	$ 273,000.00	1	EA	$ 273,000.00
Third-Party Contributions				
				$ -
Environmental and Regulatory Compliance Costs				
Traffic Control				
Barricades and Signage	$ 2,000.00	2	EA	$ 4,000.00
Flaggers	$ 350.00	40	hrs	$ 14,000.00
Erosion Control				
Silt Fence	$ 2.50	3,200	LF	$ 8,000.00
Vehicle Tracking Control	$ 3,000.00	3	EA	$ 9,000.00
Riprap and Bank Stabilization at River Crossings	$ 5,000.00	1	EA	$ 5,000.00
Reseeding and Site Restoration at Existing and Proposed MH Access Location	$ 2,500.00	8	EA	$ 20,000.00
Other				
				$ -
Total Direct Costs				**$ 3,001,451.90**
Indirect Costs				
Administrative Rate	Percentage	$base		$ -
TOTAL ESTIMATED PROJECT COSTS				**$ 3,001,451.90**

8.3 BUDGET NARRATIVE

The budget narrative provides a discussion of, or explanation for, items included in the budget proposal. The types of information to describe in the narrative include, but are not limited to, those listed in the following subsections.

8.3.1 SALARIES AND WAGES

The salaries and wages include staff time to administer and manage the project and to coordinate contracting entities. The Project Manager for this project is Ryan Loebach, Senior Project Manager for the Utilities Department at the City of Aspen. Mr. Loebach will be responsible for working with consultants on the development and submittal of a fully completed form SF-425 Federal Financial Report, an interim program performance report, and the final performance report to Reclamation upon completion of the project. Mr. Loebach will be responsible for all technical design and installation management for the full Pipe Lining Project and will coordinate directly with the selected contracting team. Tyler Christoff, Director of Utilities, will provide support to Mr. Loebach as needed through the duration of the project. Labor rates and estimated hours included in this proposal are included in Table 2. Hourly rate represents staff direct hourly wages. Hours spent directly contributing to this project will be tracked and reported as a portion of the matching fund contributions.

8.3.2 FRINGE BENEFITS

No fringe benefits are included in this project budget.

8.3.3 TRAVEL

Travel is not anticipated for this project.

8.3.4 EQUIPMENT

39-inch diameter pressure-rated UV cured CIPP liner is needed to complete the penstock lining portion of the project. The associated liner materials are cost by the linear foot, which is currently estimated at 6,265 linear feet at this time. This will be purchased by the selected contractor prior to installation and will be based upon design specifications developed by MSA during the current design phase.

8.3.5 MATERIALS AND SUPPLIES

Supplies required for each of six new manholes will be purchased through the selected contractor and each manhole with all required components is priced at over $5,000 each. These materials will be purchased by the selected contractor prior to installation and will be based upon design specifications developed by MSA during the current design phase.

8.3.6 CONTRACTUAL

The City will select, through a competitive bid process, a contractor to complete construction and installation of the penstock lining, improvement of five existing manholes, and addition of six manholes through the select reach of the Maroon Creek Pipeline. Costs will include the following major installation efforts:

- Pipeline preparation, including dewatering, cleaning and preparation for liner, CCTV inspection, and removal of Weko-seals.

- Manhole access installation, including construction staging and access, and connection, welding, and appurtenance installation.
- Transmission main liner installation, including CIPP liner staging and installation, and transmission main inspection and testing.
- Mobilization and staging.
- Construction administration.
- Contractor overhead and profit.
- Contingency at 10%.

The City will work with a consultant to complete all required reporting and grant management efforts to support the City should a grant be awarded. This will include evaluation of water savings resulting from the Project's system improvements.

8.3.7 Third-Party In-Kind Contributions

No work included with this project will be accomplished by third-party contributors.

8.3.8 Environmental and Regulatory Compliance Costs

Materials and efforts associated with traffic control and erosion control will be included under this grant request. The following costs are anticipated:

- Traffic control, including barricades, signage, and flaggers.
- Erosion control, including silt fence, vehicle tracking control, riprap and bank stabilization at river crossings, and reseeding and site restoration at existing and proposed manhole access locations.

All costs associated with additional permitting requirements will be the responsibility of the City and will not be included under this grant funding request.

8.3.9 Other Expenses

None.

8.3.10 Indirect Costs

No indirect costs are included in this project budget.

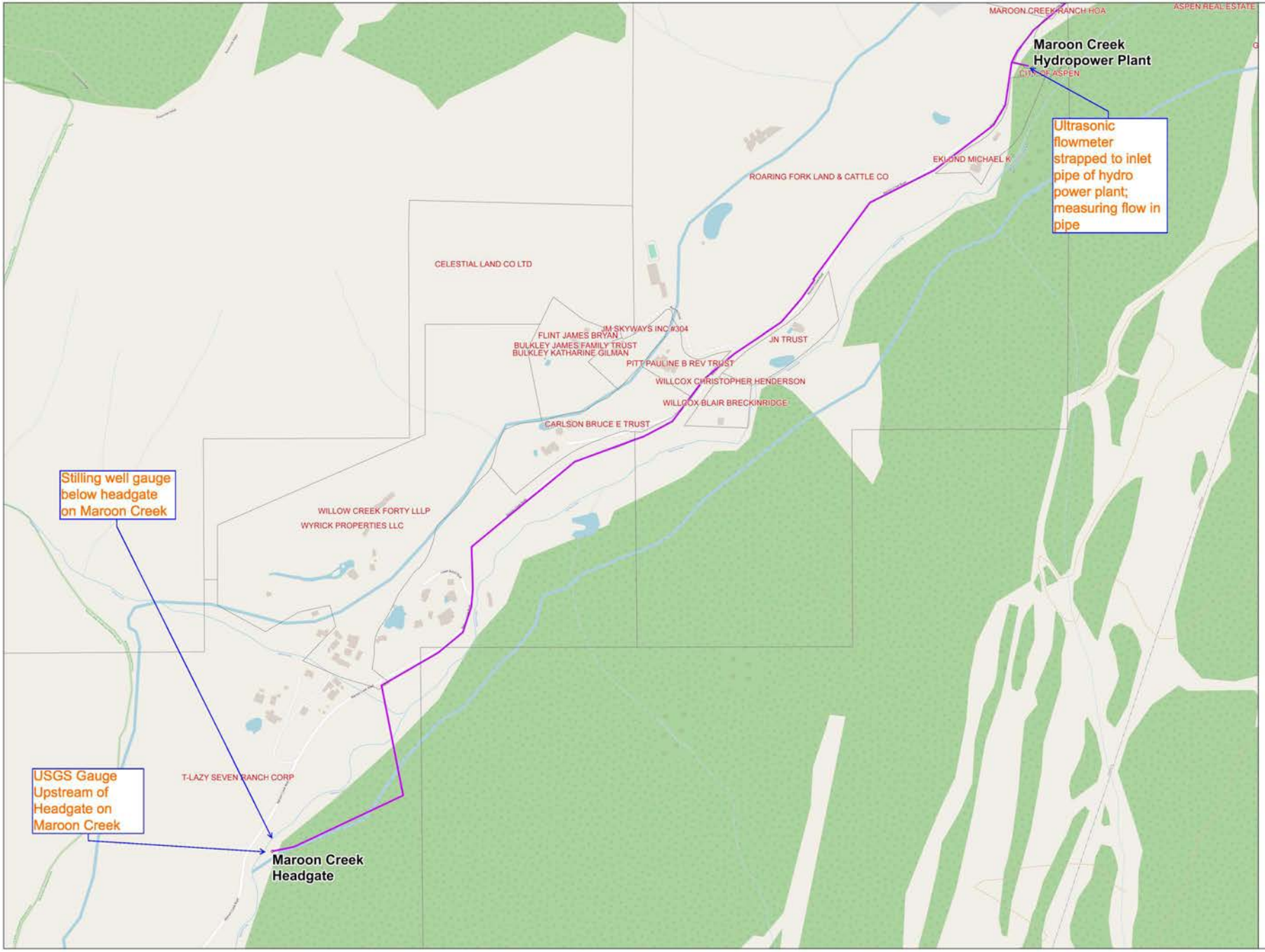
9. LETTERS OF SUPPORT

Rick Lofaro, Roaring Fork Conservancy District

Cynthia Koehler, WaterNow Alliance

Kevin Reidy, Colorado Water Conservation Board

G.R. Fielding, Pitkin County



Maroon Creek Pipeline: Headgate to Maroon Creek Hydropower Plant

UTILITIES
CITY OF ASPEN

6/23/2020

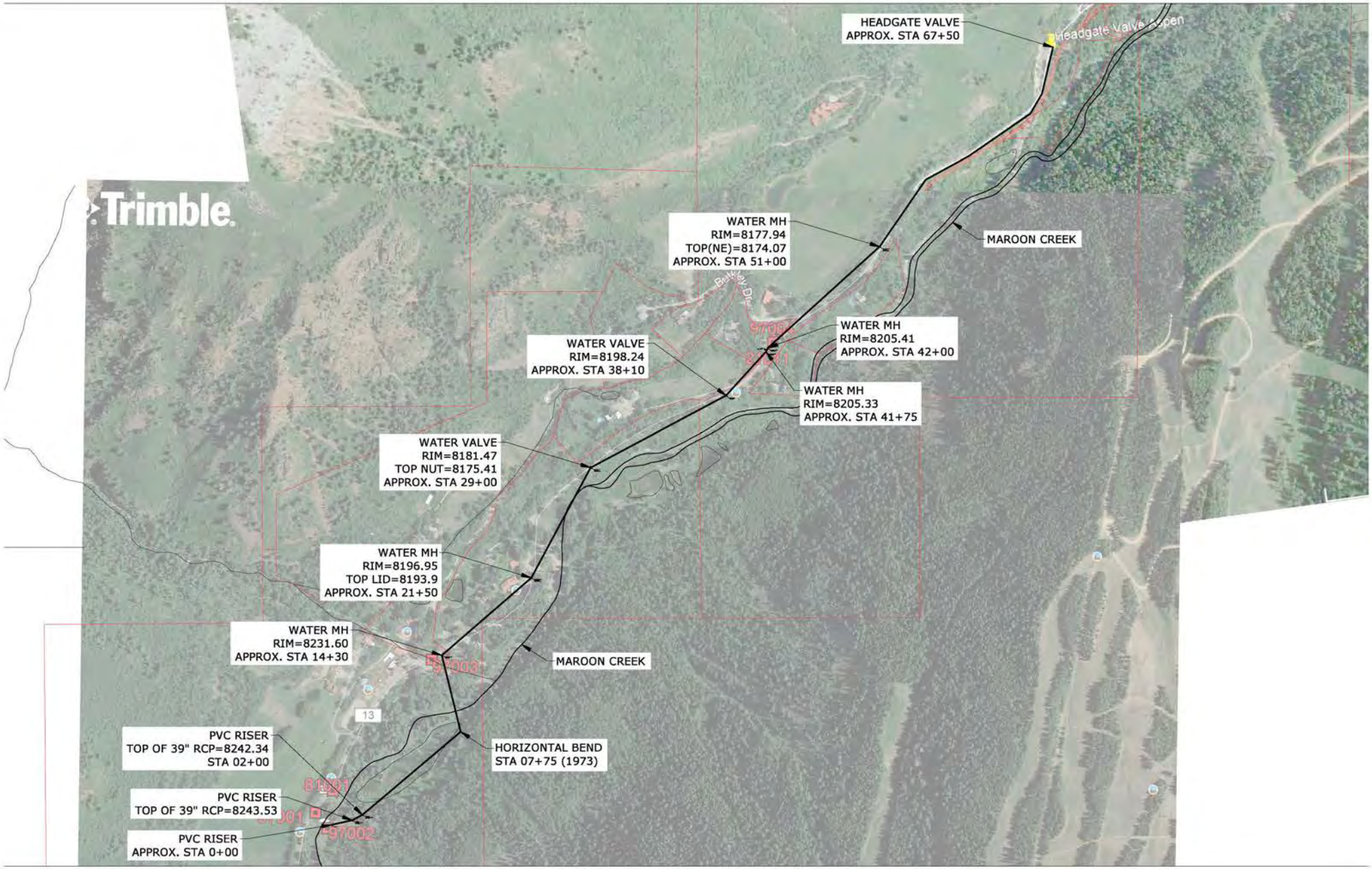
- Raw Water Pipeline
- Maroon Creek Headgate
- Maroon Creek Hydropower Plant
- Pitkin Parcels

N

0 500 Feet

1 inch equals 250 Feet

This map/drawing/image is a graphical representation of the features depicted and is not a legal representation. The accuracy may change depending on the enlargement or reduction.


HEADGATE VALVE
APPROX. STA 67+50
Headgate Valve Open
WATER MH
RIM=8177.94
TOP(NE)=8174.07
APPROX. STA 51+00
MAROON CREEK
WATER MH
RIM=8205.41
APPROX. STA 42+00
WATER VALVE
RIM=8198.24
APPROX. STA 38+10
WATER MH
RIM=8205.33
APPROX. STA 41+75
WATER VALVE
RIM=8181.47
TOP NUT=8175.41
APPROX. STA 29+00
WATER MH
RIM=8196.95
TOP LID=8193.9
APPROX. STA 21+50
WATER MH
RIM=8231.60
APPROX. STA 14+30
MAROON CREEK
PVC RISER
TOP OF 39" RCP=8242.34
STA 02+00
HORIZONTAL BEND
STA 07+75 (1973)
PVC RISER
TOP OF 39" RCP=8243.53
PVC RISER
APPROX. STA 0+00

Municipal Water Efficiency Plan

City of Aspen, Colorado

ELEMENT Water Consulting & WaterDM

October 21, 2015

MUNICIPAL WATER EFFICIENCY PLAN

City of Aspen, Colorado

THE CITY OF ASPEN

PREPARED BY

ELEMENT
Water Consulting

P.O. BOX 140785
DENVER, CO 80214

AND

WaterDM
DEMAND MANAGEMENT

1339 HAWTHORN AVENUE
BOULDER, CO 80304

October 21, 2015

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AF	acre-feet
AF/yr	acre-feet per year
AMI	automated metering infrastructure
AWC	average winter consumption
cfs	cubic feet per second
CII	commercial, institutional, and industrial
City	City of Aspen
CWCB	Colorado Water Conservation Board
ECU	equivalent capacity units
deg F	degrees Fahrenheit
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
MG	million gallons
MGD	million gallons per day

Report cover photograph taken from Red Mountain, provided by City of Aspen staff.

ACKNOWLEDGEMENTS

The development of the City of Aspen Water Efficiency Plan was a collaborative effort funded by a CWCB grant as part of the Roaring Fork Watershed Regional Water Efficiency Plan. The project has been supported through the financial and in-kind participation of the following stakeholders:

- City of Aspen;
- Town of Basalt;
- Town of Carbondale;
- City of Glenwood Springs;
- Snowmass Water and Sanitation District;
- Colorado Water Conservation Board;
- Ruedi Water & Power Authority;
- Roaring Fork Conservancy;
- Community Office for Resource Efficiency;
- Colorado River District.

City of Aspen staff provided access to detailed datasets and system information that facilitated the preparation of this Water Efficiency Plan. The consultant team would like to thank the following staff members and affiliated consultants for their time and input on this document:

- Lee Ledesma (City of Aspen)
- Phil Overeynder (City of Aspen)
- William Dolan (City of Aspen)
- David Hornbacher (City of Aspen)
- Jeff Rice (City of Aspen)
- Ashley Perl (City of Aspen)
- Valerie Forbes (City of Aspen)
- Tyler Benton (Wilson Water Group)
- Cynthia Covell (Alperstein & Covell, P.C.)

EXECUTIVE SUMMARY

PROFILE

The City of Aspen ("City" or "Aspen"), Colorado, located in Pitkin County, is a municipality established in 1881. Aspen is a Home Rule Municipality that operates under a council-manager governmental structure. Aspen is located in the upper reaches of the Roaring Fork Valley near the confluences of the main-stem of the Roaring Fork River with Hunter Creek, Castle Creek, and Maroon Creek at an elevation of approximately 7,900 feet. Aspen is located along Colorado State Highway 82 approximately 20 miles west of Independence Pass. The incorporated area (within the municipal boundary) consists of approximately 3.83 square miles. However, at this time, the total service territory is approximately 8.5 square miles, and includes unincorporated areas served by Aspen. The City's year-round, full-time service area population was approximately 10,506 residents as of 2014.

Aspen owns and operates its own water utilities. It provides treated (i.e. potable) water to all customers in the service area and raw water for irrigation and snowmaking purposes to a small subset of customers. Aspen obtains it treated water supply primarily from the surface water sources of Maroon Creek and Castle Creek, and the City also uses three groundwater wells as a supplemental supply. Aspen has adopted a policy to maintain streamflows in the creeks downstream of its diversion structures at flow rates at or above the Colorado Water Conservation Board's decreed instream flow rights for the protection of the fishery and the associated aquatic habitats in those streams.

POPULATION

According to the 2010 Census, the full-time population within the municipal boundary of Aspen was 6,658 people, up from 5,914 full-time residents as reported in the 2000 Census. The City also has contracts to provide water service to areas outside of the municipal boundary, and after adding these full-time residents, the total number of year-round, full-time residents served was approximately 8,895 in 2000 and 10,016 in 2010. The City uses a preferred planning growth rate projection of approximately 1.2% per year, under which the year-round, full-time service area population is projected to increase to approximately 11,285 people in 2020 and 13,496 people in 2035.

Due to tourism and seasonal population fluctuations, the 2013 peak month population was estimated to be approximately 36,540 people. When compared to historical data, the peak month population is approximately 3.5 times the full-time service area resident population.

WATER DEMAND FORECASTS

As part of the water efficiency planning process, three distinct treated water demand forecasts were prepared. The forecasting addresses treated water use only, and does not attempt to forecast future water use associated with raw water delivery or reclaimed water use. Each

forecast considers impacts from future increase in population, but assumes the same proportion of permanent to seasonal residents/visitors that exists today. Furthermore, the forecasts do not factor in impacts from additional future climate change beyond the impacts included in recent water use data.

First, a baseline demand forecast starting from 2015 and going out to 2035 was prepared. **This baseline forecast did not include the impact of water conservation of any kind, even passive water savings, and was developed only to assess the adequacy of future supplies with the current unit rate of water use but under a higher population, and to demonstrate the impact of anticipated efficiency improvements.** The baseline treated water demand used in forecasting was 3,377 acre-feet per year (AF/yr) and under the baseline forecast, is expected to increase by 803 AF/yr to 4,180 AF/yr in 2035.

A second treated water demand forecast through 2035 includes the impact of passive efficiencies from Colorado legislation, and federal plumbing codes and standards. This forecast found that City water demands will increase to 4,137 AF in 2035, or 43 AF less than under the baseline forecast.

A third forecast was prepared that includes the anticipated impact of the City's planned water efficiency program measures described in this plan. Under this forecast, treated demand increases to just 3,597 AF in 2035. Compared with the original baseline forecast, if the elements of this plan are fully realized, then it is estimated that treated water demand at 2035 will be reduced by 583 AF as a result of passive and active water conservation measures in Aspen.

These forecasts form the core of the Water Efficiency Plan and are the forecasts upon which estimated conservation savings are based. The analysis completed for this water efficiency plan indicates that the likely yield of the City's direct flow water rights is around 26,850 AF in a dry year; however, some of the City's water rights are decreed for irrigation use only, and cannot be used as part of the City's treated water supply. The maximum annual treated water use in Aspen over the past 5 years was 3,220 AF in 2012 and the range of forecast future demands in the year 2035 are from 3,597 AF to a maximum of 4,180 AF. While the historical dry year yield of the City's water rights appear sufficient to meet current and forecast future demands, the dry year supply figure is misleading. The City, unlike many Colorado municipalities, does not have a significant water storage component to its water system that would allow it to store water supplies when they are available, and release stored water when it is needed. Storage allows a water provider to retime deliveries of water supplies to match water deliveries with demands.[1] Without storage, the City is dependent upon streamflow availability at its river

[1] Aspen holds decreed conditional storage rights on Castle Creek and Maroon Creek, but environmentally-sensitive construction of these reservoirs will be extremely costly, so Aspen is first implementing other options

diversion points. Streamflow is susceptible to annual variation and changing conditions, including diurnal streamflow fluctuations, as well as catastrophic events such as landslides, fires or other events that can prevent diversion from Castle Creek or Maroon Creek for some period of time. For Aspen, the water supply is most vulnerable in the late summer, after the snowmelt runoff period when landscape irrigation demands are still high. Furthermore, the available water supply is limited by Aspen's commitment to actions to protect decreed instream flows, continue the effectiveness of conservation programs, as well as to implement water supply improvements already underway. These limitations are addressed in more detail in Section 5.1.1.

CLIMATE CHANGE IMPACT ON WATER USE AND HYDROLOGY

Recent climate change forecasts for the Aspen region indicate a warming trend throughout the year, including irrigation season temperature increases, with potential for more precipitation to occur as rain rather than snow (Lukas et al. 2014). While it is becoming more common to consider potential climate change impacts on water supply planning, the likely impacts on water demands are less well understood. Some climate change impacts on water demands may already be included in the forecasts provided in this plan, because recent water demands are utilized to project future water demand patterns and the recent demands reflect actual consumption patterns based on current climate conditions. Regular updates to these projections and this plan can assist in better understanding both demand-side and supply-side impacts from future climate change. Without conducting a more detailed investigation of potential climate change impacts on both supplies and demands, a sensible approach to water demand forecasting in a changing climate is to regularly update and refine demand projections based on actual current conditions. In addition to tracking changes in water use, tracking changes in hydrology (such as base flow conditions that are reached earlier in the year) would benefit water conservation efforts by focusing attention on the need to reduce water usage during peak water use periods, recognizing that peak water use periods may shift as a result of climate change.

WATER EFFICIENCY PLANNING PROCESS AND GOAL SETTING

The City carefully developed this Water Efficiency Plan in accordance with the Colorado Water Conservation Act of 2004 so that it meets or exceeds all statutory requirements according to Colorado Revised Statute § 37-60-126. The City utilized the Colorado Water Conservation Board (CWCB) *Municipal Water Efficiency Plan Guidance Document* dated July 2012 to inform and guide the development of this plan.

To fulfill Colorado's statutory water conservation planning requirements, a series of water conservation program scenarios were developed that incorporated a wide variety of indoor and

---

discussed in this plan in its effort to efficiently provide a legal, reliable water supply to its customers. The timing, cost and ultimate configuration of the storage reservoirs will continue to be evaluated.

outdoor efficiency measures that have been cost-effective when implemented in other Colorado utility service areas. A number of indoor water conservation measures have already been implemented in Aspen. Therefore, for Aspen, a focus on outdoor water efficiency is the most appropriate and cost-effective approach to implement in the future. The following water efficiency measures have been identified as providing a reasonable cost savings for the utility or customers by reducing water demands:

- Landscaping regulations for new development,
- Water Shortage ordinance,
- Slow the Flow landscape water audits,
- Garden-in-a-Box price buy-down,
- Xeriscape educational seminars,
- Conservation pricing, and
- On-going customer education and information.

The City has demonstrated a long-term commitment to wise water stewardship and responsible and efficient use of its water resources. The City has established an average water efficiency goal of approximately 28 AF (0.7%) reduction in treated demand per year compared with a continuation of current demand. By 2035, it is estimated that this program will reduce treated demand by about 583 AF – an overall 14% reduction in demand.

Based on careful analysis of current treated demands and expected growth, the City believes this level of savings to be realistically achievable. This goal will be re-evaluated on a regular basis, as Aspen intends to update the Water Efficiency Plan every seven years. This means that at least two plan updates, and possibly more, are expected to be completed before 2035, affording ample opportunity to update and refine the City's efficiency program and goals as needed.

WATER EFFICIENCY PROGRAM

In 2006, the City added a Utilities Efficiency Division including a dedicated staff manager. The Utilities Administrative division oversees the water efficiency program with support from other staff members. In addition, the City hires outside contractors to assist in implementing certain water efficiency program activities such as leak detection. The City has demonstrated a commitment to water use efficiency, and has implemented many fundamental and proven water conservation measures including metering, a conservation-oriented water rate structure, utility water loss reduction (including water-saving equipment indoors), and public education and information about water efficiency.

The City approved its first water conservation plan in 1996, as an element of the larger Water Management Plan. While the 1996 plan did not contain all of the necessary elements to meet approval by the CWCB, it was quite progressive for the period. Aspen's water conservation and

efficiency plan is being updated as part of the City's participation in the Roaring Fork Watershed Regional Plan.

WATER EFFICIENCY PLAN APPROVAL

A 60-day public review period was conducted and to the extent possible, comments were incorporated in this plan. On September 28, 2015, the Aspen City Council adopted the plan with the updates included in this final version of the plan. On October 21, 2015, the City received official notification that the plan was approved by the Colorado Water Conservation Board.

ROARING FORK REGIONAL WATER EFFICIENCY PLAN

The City of Aspen is the most upstream utility participating in the regional water efficiency planning effort. Aspen's Water Efficiency Plan has potential to directly impact flows in the upper Roaring Fork River basin, although Aspen cannot guarantee that water it saves through conservation efforts will benefit the entire reach of the Roaring Fork to the extent that other downstream water users may divert that water out of the river. One of the benefits of Aspen's water savings under this Water Efficiency Plan will be to strengthen its ongoing commitment to benefit and enhance streamflow in the upper Roaring Fork River basin as demonstrated by its 1980 lease of its senior Hunter Creek Flume & Pipeline water right to the CWCB for instream flow, its intergovernmental agreement with the CWCB to operate the City's Castle Creek water rights in a manner that allows the decreed minimum streamflow to be maintained under most conditions, participation in the "Forbearance Agreements" with the Colorado Water Trust in which Aspen bypasses a portion of its Wheeler Ditch water right during the irrigation season when the instream flow is not satisfied, and other activities. The City is interested in regional partnership to improve water efficiency and is committed to assisting with the implementation of the Roaring Fork Regional Water Efficiency Plan.

1. PROFILE OF EXISTING WATER SUPPLY SYSTEM

1.1 OVERVIEW[2]

The Aspen area was originally discovered by the Ute Indians and called "Shining Mountains". The first silver miners arrived in the Roaring Fork Valley in the summer of 1879 and set up camp at the foot of Aspen Mountain. Before a permanent settlement could be established, news of a nearby Indian uprising prompted Colorado's Governor Frederick Pitkin to urge the settlers to flee back across the Continental Divide for their safety. Most of them did, and only a handful of settlers remained in the Roaring Fork Valley during the winter of 1879. Those that remained attempted to organize the camp and passed a resolution to respect the claims of those who had fled, as well as the claims of those settlers who stayed. This action transformed the small group of settlers into a "sovereign" body in the eyes of the State of Colorado and recognized that the rules of local mining districts under the federal mining law of 1866 were to be followed. The citizens had begun the process of organizing themselves into a political body.

The City of Aspen, Colorado is a municipality that was incorporated in 1881. Aspen is a Home Rule Municipality that operates under a council-manager governmental structure. First christened Ute City, the town of 300 residents was renamed Aspen in 1880. By 1891, Aspen had surpassed Leadville as the nation's largest single silver producing mining district. The demonetization of silver in 1893 led to Aspen's decline as a mining town. During the silver boom days of the 1890s, Aspen's population grew to 12,000 citizens. After the silver bust in the early 1900s, as few as 700 people remained in Aspen. Reborn as a ski town in the 1940s, Aspen was also molded into a cultural center.

Aspen is located in the upper reaches of the Roaring Fork Valley near the confluences of the main-stem of the Roaring Fork River with Hunter Creek, Castle Creek (**Figure 1**), and Maroon Creek at an elevation of approximately 7,900 feet. Aspen is located along Colorado State Highway 82, approximately 20 miles west of Independence Pass. The mean annual precipitation in Aspen is 24.6 inches, and the mean temperature from May to September is 63.2 °F (WRCC 2014).

[2] Historical information was obtained from http://www.aspenpitkin.com/Exploring-the-Valley/History/.

Figure 1. Photograph of Castle Creek.

The City is expanding slowly and has a preferred long-term planning growth rate projection of 1.2 percent per year. It is estimated that the year-round, full-time population of Aspen's service area will increase to approximately 11,285 people in 2020 and 13,496 people in 2035.

1.2 Regional Setting

The Roaring Fork Watershed is located within the Colorado River Basin in central Colorado on the west side of the Continental Divide. The watershed includes the Sawatch, Collegiate and Elk Mountain Ranges and 8 peaks exceeding 14,000 feet in elevation. Snowmelt from the mountainous headwaters contributes to the streamflow in three primary rivers (Roaring Fork, Fryingpan, and Crystal) that eventually contribute to the flow in the Colorado River in the City of Glenwood Springs. The drainage area of the Roaring Fork watershed is approximately 1,450 square miles.

According to the State Water Supply Initiative (SWSI, 2010), the Colorado River Basin has a projected 2035 M&I water supply gap of 40% with respect to projected water demands. The Colorado River Basin supplies water to over 30 million people in the arid southwest, with the Roaring Fork Watershed contributing about 991,100 AF to the Colorado River per year (USGS, 2013).

The Roaring Fork Watershed experiences a wide range of climatic conditions from year-to-year as well as from season to season. Climatological records provide evidence of recurring major

droughts in Colorado of various length and intensities. Water suppliers in the West accommodate this uncertainty through reservoir storage, consideration of "firm yields" in estimates of water availability, raw water supply development, and "demand side" strategies such as voluntary or mandatory restrictions on outdoor water usage. Plans to reduce usage are necessary to stretch the available water supply to help meet future demands and sustain supplies during periods of drought.

Water supply systems in the Roaring Fork Watershed are at risk from possible forest fire, floods, failure of dams/mains/wells, and contamination of all or part of the raw water supply. In order to respond to emergency or drought situations, contingency plans are typically designed for implementation of mandatory water use restrictions in stages that minimize impacts to the economy, life-styles, and environment of the community.

1.3 WATER SUPPLY AND RELIABILITY

Aspen owns and operates its own water utilities with the exception of the wastewater treatment plant, which is maintained by the Aspen Consolidated Sanitation District. The City of Aspen Water Department (**Figure 2**) provides a legal, reliable supply of safe, high quality drinking water. City staff maintain raw water deliveries to the water treatment plants (WTPs) in sufficient quantities to meet system demands. Staff also perform operations and maintenance functions for the treatment facility, booster stations, pump stations, vaults and storage tanks, and the Thomas Reservoir located adjacent to the treatment plants. Crews perform routine laboratory testing and reporting per the Colorado Department of Public Health and Environment (CDPHE) guidelines and requirements.

Figure 2. Photograph of City of Aspen Water Department.

The City utilizes water from five primary sources: Maroon Creek, Castle Creek, Little Nell Well, Mill Street Well, and Rio Grande Well. Aspen has a long history of commitment to protecting instream flows. In 1980, Aspen entered into an agreement with the CWCB to allow the City's very senior 15 cfs Hunter Creek Flume and Pipeline water right to be used for instream flows on Hunter Creek, and the water court approved that use. In 1993, the City Council adopted water management policies intended to provide for current and future municipal water needs while at the same time maintaining decreed minimum streamflows and aquatic habitat. Aspen has an intergovernmental agreement with the CWCB to protect the natural environment of Castle Creek by operating the City's water rights on Castle Creek in a manner that will allow the decreed minimum streamflow of 12 cubic feet per second to be maintained under all but the most severe drought conditions, or emergencies. Although Aspen does not have a similar agreement regarding Maroon Creek, Aspen also operates its senior Maroon Creek water rights in a way that protects the decreed instream flows. More recently, Aspen negotiated temporary "Forbearance Agreements" with the Colorado Water Trust in 2013 and 2014, under which Aspen agrees to not divert a portion of its senior Wheeler Ditch water right during the irrigation season when the CWCB's decreed instream flow in the Aspen reach of the Roaring Fork River is not being satisfied.

1.3.1 Treated Water Supply

Aspen has two river sources of raw water supply for its treated water system. The primary supply intake is on Castle Creek and another intake on Maroon Creek is generally used as a supplemental supply. These diversions are conveyed to the City's WTPs located on the city-owned Thomas property. Both intakes utilize "run of the river" and are not currently backed up by a significant raw water storage reservoir. All water delivered to the WTPs is first delivered to the Leonard Thomas Reservoir (**Figure 3**) before undergoing treatment. The capacity of Leonard Thomas Reservoir is 13 acre-feet (AF) or 4.2 million gallons (MG). Aspen also has water rights and a water treatment facility on Hunter Creek, which is presently not operational because there is adequate treatment capacity for the Castle Creek and Maroon Creek diversions. Since the supplies from Castle Creek and Maroon Creek, backed up with the wells, meet Aspen's current needs, and the Hunter Creek Flume and Pipeline water right is being used for instream flow protection, Aspen does not have current plans to operate the Hunter Creek plant in the immediate future.

Figure 3. Photograph of Leonard Thomas Reservoir.

The treated water system is also supplemented by three municipal groundwater wells located in the downtown area that are treated at the source: Little Nell Well, Mill Street Well, and Rio Grande Well. The groundwater wells have a combined capacity of approximately 3.0 million gallons per day (MGD). The wells can be used during drought periods when the City wants to reduce diversions from its surface water sources for quality reasons or to protect decreed instream flows when streamflows are approaching the instream flow thresholds. Well water can also be used for other municipal purposes. Water produced from the groundwater wells does not meet the water quality standard for fluoride level, so the water must be blended with other supplies or used for non-potable purposes.

The City of Aspen's water distribution system consists of 16 separate pressure zones. The pressure zones are supplied by 14 water storage tanks that are fed by 14 pumping stations and the three wells. The water distribution system is comprised of approximately 73.2 miles of water mainlines that range in size from 24" to 4" in diameter.

1.3.2 Raw Water Supply

Aspen’s raw water (i.e. non-potable) system, managed by the City of Aspen Raw Water Division, provides an irrigation supply to the City of Aspen golf course, selected parks, and limited private

properties. The City uses raw water supplies for maintenance of "aesthetic features" such as fountains, the City malls, and many of the City's street trees located along the ditch system.

On the east end of downtown, the City operates the Wheeler, East Aspen, and Durant ditch system, which provides water for the downtown mall, fountains and aesthetic features, and stormwater cleaning at Rio Grande Park. At the west end of downtown, the City operates the Si Johnson Ditch which provides water for street trees as well as providing raw water service for irrigation of private properties, including Aspen Institute. Outside of the City's boundaries, water which originates from Aspen's Castle Creek and Maroon Creek rights and is delivered to the Leonard Thomas Reservoir is used as a supply for irrigation for the Meadowood common area, as well as the hospital and medium-density housing developments in the area. Raw water from Leonard Thomas Reservoir is also used as the source of supply for snowmaking operations at the Aspen Ski Resort.

The Holden and Marolt ditch systems are also operated by the City from diversion points on Castle Creek. These ditch systems provide water for irrigation of the Municipal Golf Course, the Marolt Open Space, the Red Butte Cemetery, and numerous private properties comprising the Castle Creek Homeowner Association.

The City operates the Maroon Creek hydroelectric plant which utilizes water diverted at the Maroon Creek headgate near the T-Lazy-7 Ranch and returns it to Maroon Creek approximately ½-mile south of the entrance to the Aspen Highlands Ski Area. Maroon Creek diversions are primarily made for hydroelectric generating purposes; however, diversions are also conveyed to the WTPs when necessary to supplement or, at times, to replace diversions from Castle Creek.

1.3.3 Water and Wastewater Treatment

The City currently has two filtration plants in operation, which are referred to as the West and East Treatment Plants, or collectively as the "WTPs" in this document. The West Treatment Plant was constructed in 1965 and has a design capacity of 8 MGD; the East Treatment Plant was constructed in 1985 with a design capacity of 12 MGD. The water treatment facilities are located adjacent to one another and receive raw surface water diversions from both Castle and Maroon Creeks. Each stream has a dam and inlet structures with underground pipelines that convey water to the 13 AF receiving reservoir, Leonard Thomas Reservoir, located at the site of the WTPs. The Castle Creek Pipeline is approximately two miles in length and the Maroon Creek Pipeline is about five miles in length. The WTPs collectively produce approximately 1.0 billion gallons of treated water per year, or approximately 3,070 AF/yr.

City staff indicate that both plants are in excellent condition and have the capacity to supply the City with 100% of its treated water demands at this time. The City has an additional treatment plant, with a design capacity of 0.5 MGD, located off Hunter Creek Road on Red Mountain. That plant is not currently in use. The Hunter Creek facility was constructed to treat water from Hunter Creek during times when that source of supply was necessary. As noted above, the Hunter Creek supply is not currently needed for treated water uses, and is being used for

instream flow protection. The City does not plan to use this water plant in the foreseeable future.

Each treatment plant is designed to operate with pretreatment, filtration, and disinfection before distribution. Pretreatment is accomplished through chemical addition to the raw water before it enters the sedimentation basin or the clarification basins. The chemicals react with the water to cause the sediment particles to attach to each other thus becoming larger and heavier causing the sediment to fall out of suspension prior to filtration. In the filter plant, polymers are added to aid the filters in separating out the remaining small particles in the water. The water is then filtered. Fluoride and chlorine are added before the water goes to the 2 MG contact tank. The 2 MG contact tank allows time for the chlorine to react (disinfect) with the remaining bacteria and microscopic organisms before going out into the distribution system. In order to keep up with requirements of the CDPHE, a serpentine curtain has been installed in order to increase the contact time of the water with chlorine. This baffle has been in use since 1994.

1.3.4 Capacity and Reliability

For water supply planning purposes, the City of Aspen uses the critically dry year of 1977 which is on par with the more recent critically dry years of 2002 and 2012 and is a good representation of the firm yield of the City's water rights from both Maroon and Castle Creeks under current climate conditions. The City's water consultant has estimated the dry year firm yield of the City's water rights based on the following assumptions (Wilson Water Group 2014):

- Water diverted from Maroon and Castle Creeks is used in addition to the yield from one of the three wells[3] currently in place.
- Year-round instream flows of 14.0 cfs on Maroon Creek and 13.3 cfs[4] on Castle Creek are met, which include the CWCB instream flow water rights and additional instream flow on Castle Creek that the City of Aspen plans to maintain.
- Maximum capacity of the water treatment plant is approximately 30.9 cfs (20 MGD).
- Irrigation requirements are based on historical diversions from 2011-2013 and totaled 32 cfs. This represents diversions through the Holden, Marolt, and Si Johnson Ditches. Irrigation diversions were assumed to take place May through October.

Based on these assumptions, the annual firm (1977) water supply available for treated and raw water irrigation diversions from Castle Creek and Maroon Creek is estimated to be around 26,850 AF/yr at current infrastructure capacities. However, the City does not have a storage component that would allow it to retime water supplies to match water deliveries with demands. Rather the City is dependent upon streamflow availability, which is susceptible to annual variability and changing conditions, as well as daily variability. For Aspen, the water supply is most vulnerable in the late summer, after the snowmelt runoff period has ended, and

[3] The analysis limits the yield to one of the three wells due to current water quality-related pumping limits.
[4] The Castle Creek instream flow decree is for 12 cfs but the City intends to maintain a flow of 13.3 cfs.

when landscape irrigation demands are still high. Under historical hydrology patterns, and considering Aspen's goal of protecting decreed instream flows as described above in addition to continued raw water diversion for irrigation, the daily firm yield of the treated water system is estimated to be around 7.8 MGD.

While the City's supplies appear to be sufficient for current and future demands under historical hydrology conditions, without storage, a change in the volume or timing of streamflow and/or demand growth beyond the levels currently projected (this plan considers growth in demand through 2035 while the City's water planning extends to 2065) would result in the City having a water supply issue in dry years. For example, **Figure 4** below shows a potential municipal demand scenario in the year 2065[5], based on the City's water planning and forecasting that is conducted independent of this water efficiency plan. As depicted, this scenario would result in a significant water supply shortage during the late summer if the water supply was similar to a historical critically dry year such as 1977.[6] This emphasizes the importance of demand management, particularly for landscaping purposes.

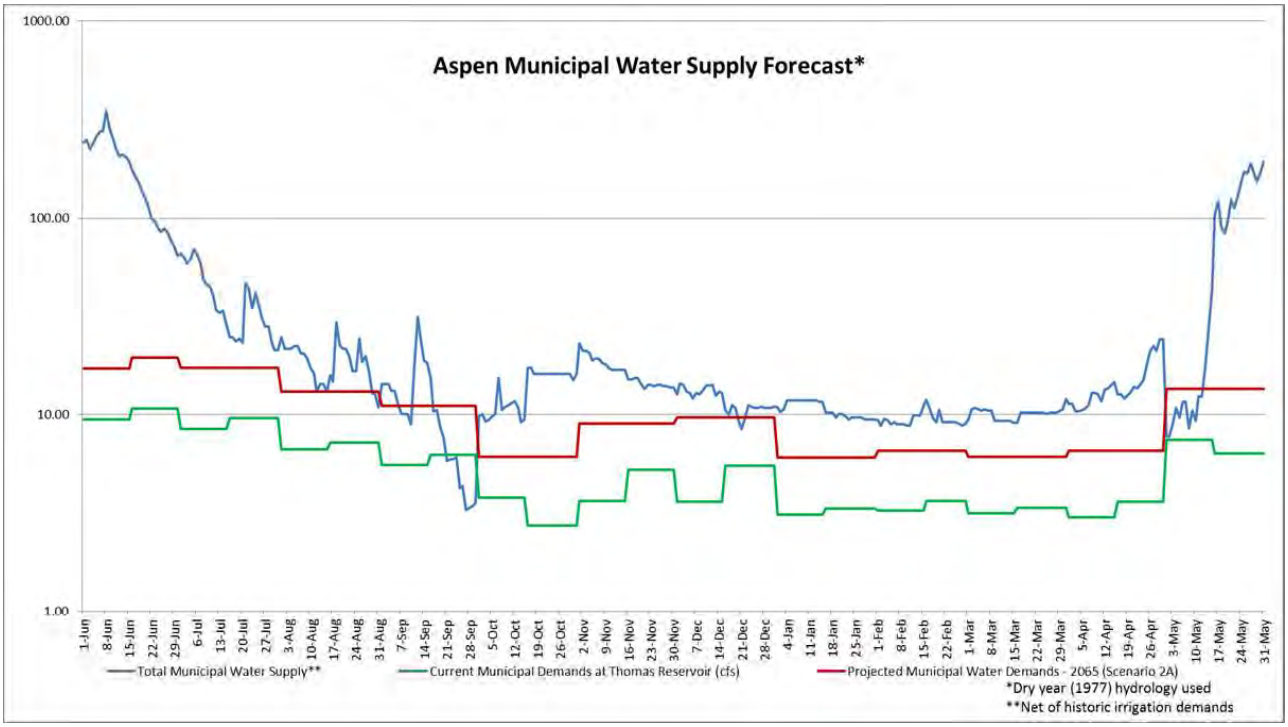


Figure 4. Potential Municipal Demand Scenario in the Year 2065.

[5] The 2065 projected municipal water demand shown in Figure 4 does not include use of reclaimed water.
[6] This projection does not include storage in the Castle Creek Reservoir or Maroon Creek Reservoir, for which Aspen holds conditional storage rights. Because of the very high cost and complexity of constructing these reservoirs to be both environmentally-sensitive and to provide water when Aspen needs it, the current planning scenario does not include these reservoirs. However, Aspen continues to study the cost and timing of these reservoirs, and the conditional decrees remain an important component of Aspen's portfolio of water rights.

1.3.5 Current and Proposed Water Supply Projects

Earlier studies indicated that Aspen's available water supply would be fully utilized to meet anticipated treated and untreated water needs by the mid-1990's and that it would be necessary to develop surface water storage expeditiously in order to meet the continuing growth within the service area. Actual growth has closely matched earlier growth projections; however, an aggressive water conservation program has reduced the amount of water used to a point where surface water storage can be deferred. The following is a current list of projects being implemented, or considered for implementation.

1.3.5.1 Reclaimed Water System

Aspen's Reclaimed Water System is being constructed to increase the availability of water in Castle Creek by shifting a portion of the diversions for the Aspen Golf Course and other irrigation demands to utilize treated wastewater effluent as a source of supply rather than to rely exclusively on delivery of water from Castle Creek. This shift will free up an additional 1.0 MGD of supply from Castle Creek, which can be used to supply the treated water system that relies on this same source of supply. At the same time, it also contributes to the City's commitment to maintain instream flows of 13.3 cfs on Castle Creek for aquatic habitat, even during critically dry periods. The Reclaimed Water System will be completed in 2015. It is anticipated that this system will increase the available raw water supply by approximately 12% over the current rated capacity. On an equivalent capacity unit (ECU) basis, the available supply will be increased from 18,250 to approximately 20,400 ECU when the Reclaimed Water System is online. At historical growth rates of approximately 200 ECUs per year (net), this implies that the next source of supply beyond the reclaimed water project would need to be brought on line in approximately a 10-year period, or by approximately 2025. Note that neither the demand forecasts nor the supply estimates for this water efficiency plan include the use of reclaimed water.

1.3.5.2 Roaring Fork Supply

The City of Aspen may eventually need to develop and utilize its water rights that allow for the diversion of water directly from the Roaring Fork River for municipal treated water uses. Constraints associated with the use of this water supply for treated water uses include the need to meet water quality standards and the need to pump developed supplies up to the gravity zone that supplies Aspen's core area. It is likely that more extensive water treatment, including micro-filtration, would be necessary for this source since multiple prior uses may have degraded source water quality. Land availability for facilities necessary for this alternative is also constrained due to the developed nature of sites near the river.

1.3.5.3 Salvation Ditch Pumpback

This alternative source of supply would require developing an agreement with the owners and users of the Salvation Ditch to exchange water from its current point of diversion on the Roaring Fork River for a new supply diverted from the Roaring Fork River below its confluence with Maroon Creek. A new water right for this location would be used to pump water into the

Salvation Ditch and replace existing Salvation Ditch diversions with a substitute supply. The water exchanged from the Salvation Ditch would be used to supply a new (or replacement) water treatment facility. Candidate treatment plant sites include the City's existing Hunter Creek Treatment Plant site.

1.3.5.4 Wellfield Development

Development of the City's alluvial groundwater supplies has been impeded by several water quality issues, including the adoption of a fluoride standard and the presence of higher levels of radionuclides. The water quality restrictions currently limit the extent that these wells can be utilized as a treated water supply. While it may be possible to blend water from the alluvial wells with other sources of supply or otherwise treat this water supply to a level that fully complies with drinking water standards, currently the amount of water that can be produced from the three wells during a critical dry period is less than previously assessed. Modifications to the wells and distribution system, or further treatment, could be employed to reduce the limitations on well use. Also the City has converted irrigation systems on selected parks and open spaces to accept water from the existing wells, thereby freeing up treated water currently used for this purpose.

Development of bedrock wells with completion depths greater than 1,000 feet may provide an additional source for Aspen's supply of treated water. Feasibility analyses are needed to assess the viability of developing this groundwater resource.

1.3.5.5 Reservoir Storage

The potential need for surface storage of snowmelt runoff from Castle and Maroon Creeks has been included in the City's Water Management Program since the 1960's. After the Fryingpan-Arkansas Project's western slope compensatory storage facility was moved from the originally-proposed Aspen Reservoir site to the Ruedi Reservoir site, Aspen appropriated the Castle Creek and Maroon Creek Reservoir water rights. Aspen has always known that these are expensive, difficult reservoirs to construct, and in the mid-1990s, staff, with the approval of City Council, determined to focus on leak detection and repair, conservation, and development of a well system to reduce water demand from the creeks, thereby deferring further into the future the need for this reservoir storage. The development of surface water storage at specific sites identified in conditional water rights held by the City for this purpose is expected to eliminate water shortage conditions, even if there is a significant shift in the amount or timing of snowfall accumulation and runoff due to factors such as climate change.

2. WATER DEMANDS AND HISTORICAL DEMAND MANAGEMENT

As part of the water efficiency planning process, three distinct treated water demand forecasts were prepared. The purpose of these forecasts was to present a range of reasonable estimates of treated water demand for Aspen through the year 2035, given anticipated population growth, and to estimate the impact of the water conservation measures that occur both

"passively" as a result of compliance with national and state plumbing codes and standards and "actively" as a result of specific programs and measures to be implemented by the City. These forecasts were also used for the important purpose of evaluating the adequacy of Aspen's water supply system to meet future demands.

The first step in the forecasting process was to gather data and information on the history of treated water demands and conservation in Aspen. Through a careful review of these data and information, a baseline demand for Aspen was established. Next, historical population data were used to establish the baseline population, and Aspen planning data were used to forecast population growth out to 2035. This section of the Aspen Water Efficiency Plan describes historical water demands and demand management efforts in the City.

2.1 Demographics and Service Area Characteristics

The City of Aspen provides both treated and raw water service to a total of approximately 3,870 customer connections within the City and in adjoining areas through service contracts. Aspen typically experiences seasonal population changes, associated with non-permanent residents and visitors. The weeks before/of Fourth of July and Christmas typically result in the highest water demands. With events like X Games, the City's population can increase up to a total of 100,000 consumers.

Aspen's metered customer connections are the primary focus of this water efficiency plan, but a number of additional customers are served by the City's water system. The water requirements of these customers (described in section 2.1.1) are also considered and accounted for in the demand forecasts presented later in this plan.

2.1.1 Additional Customers and Raw Water Sales

Approximately 8% of the treated water Aspen produces each year is provided for snowmaking and other purposes briefly described below.

- The City provides treated water for snowmaking at Aspen Mountain. Aspen Highlands receives raw water for snowmaking from the City via the Thomas Raw Water System.
- The City provides treated water to approximately 80 homes in West Buttermilk. This demand is metered in bulk by the City.
- The City has a small amount of bulk water sales each year for filler hydrant draw permits, typically related to construction.
- The City also has approximately 72 flat rate unmetered customers, typically for construction projects before a permanent meter is installed.

In addition to municipal treated water, the City provides untreated water from its irrigation ditch rights to the municipal golf course, selected municipal parks and for use by private landowners under raw water agreements. The City is currently evaluating use of its groundwater wells for the irrigation of some municipal parks to reduce the demand on raw surface water supplies.

2.1.2 ECUs

Aspen has a comprehensive system of record-keeping for water demand factors based on a fixture count (toilets, lavatories, outside irrigation, etc.) of each residence and business connected to the treated water distribution system. These fixtures are then converted to ECUs as a measure of the water demand expected from existing and new development. Aspen's Water Department has determined that an ECU can be approximated by a one bedroom, one bathroom home with a fully equipped kitchen, an exterior hose bib, and a ¾-inch domestic service line. The current inventory of ECUs connected to the system as of February 2014 is approximately 17,300, including wholesale supply contract deliveries. As a result of tracking water demand factors for building permits for all new construction and remodels, as well as limiting the total water demand in all new extraterritorial water service contracts, the City has a relatively accurate estimate of existing and anticipated future water demand factors on the treated water distribution system.

2.1.3 Metered Customers

Metered water customers are the primary focus of this water efficiency plan. To better understand water use among different categories of customers, Aspen uses the following customer category assignments for its water service accounts.

- Single family residential (detached single family homes)
- Multi-family with 2-4 units
- Multi-family with greater than 5 units
- Commercial
- City facilities
- Other – Irrigation Only

Customer information is stored in the utility's customer billing system.

2.2 HISTORICAL WATER DEMANDS

Total treated water demand for Aspen's system (including snowmaking, West Buttermilk bulk deliveries, etc.) was 3,220 AF in 2012 and 2,955 AF in 2013 as shown in **Table 1** below. Annual metered treated water use in the City of Aspen, the focus of the demand analysis for this efficiency plan, has ranged from 2,568 AF to 2,752 AF over the last 5 years (Table 1). Metered treated use was within 4% of the average in each of the 5 years, which suggests that the system demands fluctuate very little on an annual basis. Increases in population over the last five years have not caused a resultant increase in water demands (Table 1). These changes are typical of

municipal demand trends across the United States, which have generally declined or held steady in recent years even as population has increased. The City's current water rate structure, water efficiency program, national plumbing codes and standards, and programs like EPA WaterSense contribute to this decrease in per capita water use.

Baseline treated water demands of 3,186 AF/yr, (2,661 AF/yr for City customers and 525 AF/yr for snowmaking, West Buttermilk, etc.) were selected for use in forecasting future demand in Aspen as shown in Table 1.

Table 1. **Annual Treated Water Deliveries from 2009 through 2013 and Baseline for Forecasting.** (AF/yr unless noted otherwise).

	City of Aspen Water Customers							Additional Water Sales				
Year	Full-Time Population (#)	Single-Family Res.	Multi-Family Res.	Comm.	City Facilities	Other - Irrig. Only	**Total**	Unmetered Sales (Est.)	Snow Making (Aspen Ski Co.)	West Buttermilk	Bulk Water Sales	Total
2009	9,897	1,210	446	760	132	68	**2,616**	295	126	-	6	**-**
2010	10,016	1,289	497	785	115	66	**2,752**	273	142	-	6	**-**
2011	10,136	1,245	458	668	125	72	**2,568**	218	146	45	6	**2,983**
2012	10,258	1,390	485	647	129	85	**2,736**	246	151	81	6	**3,220**
2013	10,381	1,265	483	626	124	75	**2,573**	110	192	73	6	**2,955**
BASELINE	10,318	1,280	484	697	125	75	**2,661**	246	192	81	6	**3,186**

An estimated breakdown of indoor and outdoor historical metered treated water demands of all City customers in Aspen based on periodic consumption data provided by City staff are shown in **Table 2**. Typically, about 57% of the annual water demand in Aspen is for indoor purposes and 43% is for outdoor irrigation.

Table 2. City Customers, Total Treated Indoor and Outdoor Water Deliveries from 2009 through 2013.

Year	Indoor (AF/yr)	Outdoor (AF/yr)	% Indoor	% Outdoor	Temp (deg F)
2009	1,626	990	62%	38%	41.5
2010	1,535	1,217	56%	44%	41.8
2011	1,485	1,083	58%	42%	40.1
2012	1,515	1,221	55%	45%	41.4
2013	1,415	1,157	55%	45%	39.7
5-YR AVG	**1,515**	**1,133**	**57%**	**43%**	**40.9**

Aspen's metered treated consumption data were further disaggregated by water use sector as shown in **Table 3**. Indoor and outdoor demands for each category were estimated using a standard average winter consumption (AWC) approach where indoor use from the winter months (January, February, and December), when there is typically no outdoor irrigation occurring, is used to estimate indoor use for the entire year. Indoor use is then deducted from the total to estimate outdoor use.

Table 3. Sectoral and Seasonal Treated Water Deliveries from 2009 through 2013 (AF/yr).

Year	Residential		Multi Family (2 4 units)		Multi Family (5+ units)		Commercial		City Facilities		Other Irrig. Only	Total	Unmetered Sales (Est.)	Snow Making (Aspen Ski Co.)	West Butte rmilk	Bulk Water Sales	Total[1]
	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	-	-					
2009	538	672	63	28	305	52	643	117	78	54	68	**2,617**	295	126	-	6	-
2010	469	821	61	65	303	69	641	144	62	53	66	**2,754**	273	142	-	6	-
2011	455	791	65	30	303	60	596	72	66	58	73	**2,570**	218	146	45	6	**2,985**
2012	518	873	62	38	307	78	559	89	69	59	85	**2,736**	246	151	81	6	**3,220**
2013	449	817	61	40	292	90	548	79	65	59	75	**2,574**	110	192	73	6	**2,955**
Avg.	**486**	**795**	**62**	**40**	**302**	**70**	**598**	**100**	**68**	**57**	**73**	**2,651**	228	151	66	6	**3,053**

[1]Totals are not available for 2009 and 2010, therefore the average total water deliveries are based on the average for 2011 through 2013.

As with most municipalities in Colorado, the City of Aspen's demands are higher during summer months due to outdoor water use. **Figure 5** shows the average monthly metered treated water demands over the past 5 years from 2009 to 2013 by water use sector versus the mean monthly temperature (WRCC 2014). As a result of outdoor water use, all water use sector demands increase during summer months from June through October. The residential pattern correlates particularly well with temperature during summer months, and the peak usage in July is 6.4 times the AWC. Multi-family residential and commercial water usage increases during summer months to a lesser degree, as evidenced by the peak monthly usage being 2.1 and 1.8 times the AWC, respectively. The peak city facilities usage exceeds the AWC by a factor of 4.0 in July, which suggests there is a fair amount of outdoor irrigation or other seasonal water uses. The distribution of treated sector demands in Aspen are also very consistent between years, as shown in **Figure 6**.

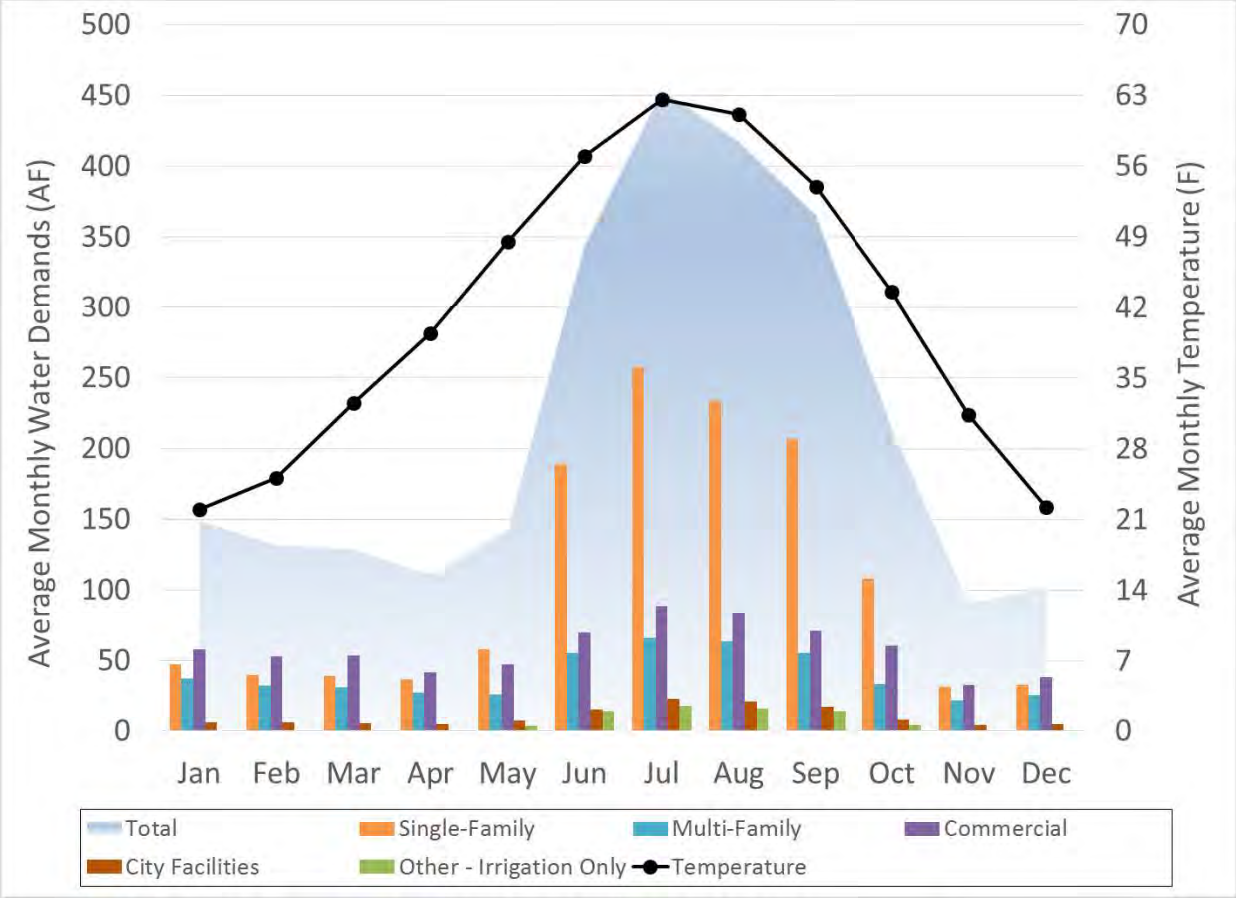


Figure 5. City of Aspen, Average Monthly Metered Treated Demands by Sector from 2009 through 2013.

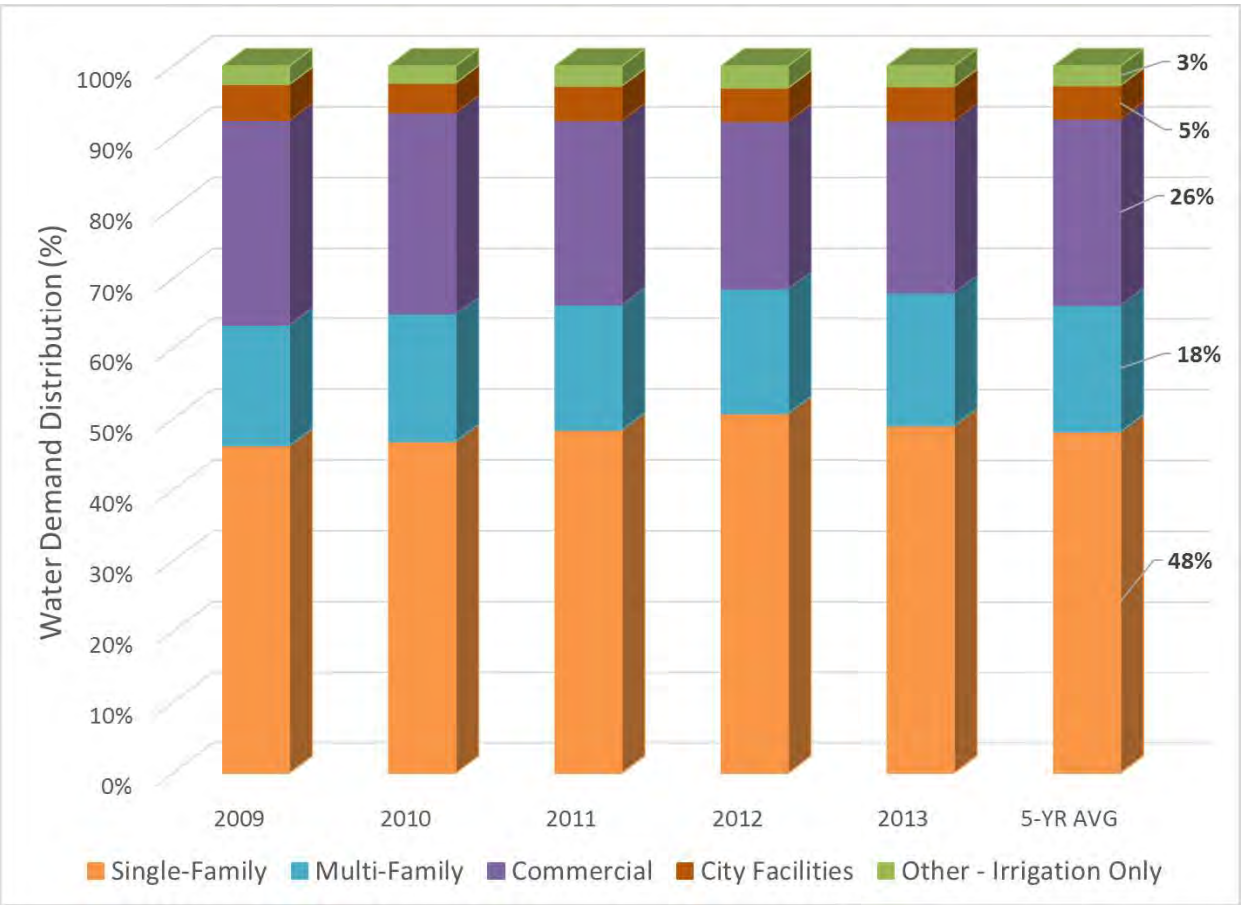


Figure 6. Distribution of Treated Metered Demands by Sector from 2009 through 2013.

In 2013, residential demand (single-family and multi-family) accounted for approximately 68% of the annual treated water demand for the City of Aspen water customers shown in Table 1. Commercial customers accounted for 24% of the treated demand, and the other categories (city facilities and irrigation) accounted for the remaining 8%. A pie chart showing the distribution of 2013 water usage including the additional water sales (unmetered, snowmaking, West Buttermilk, and bulk sales) is presented in **Figure 7**.

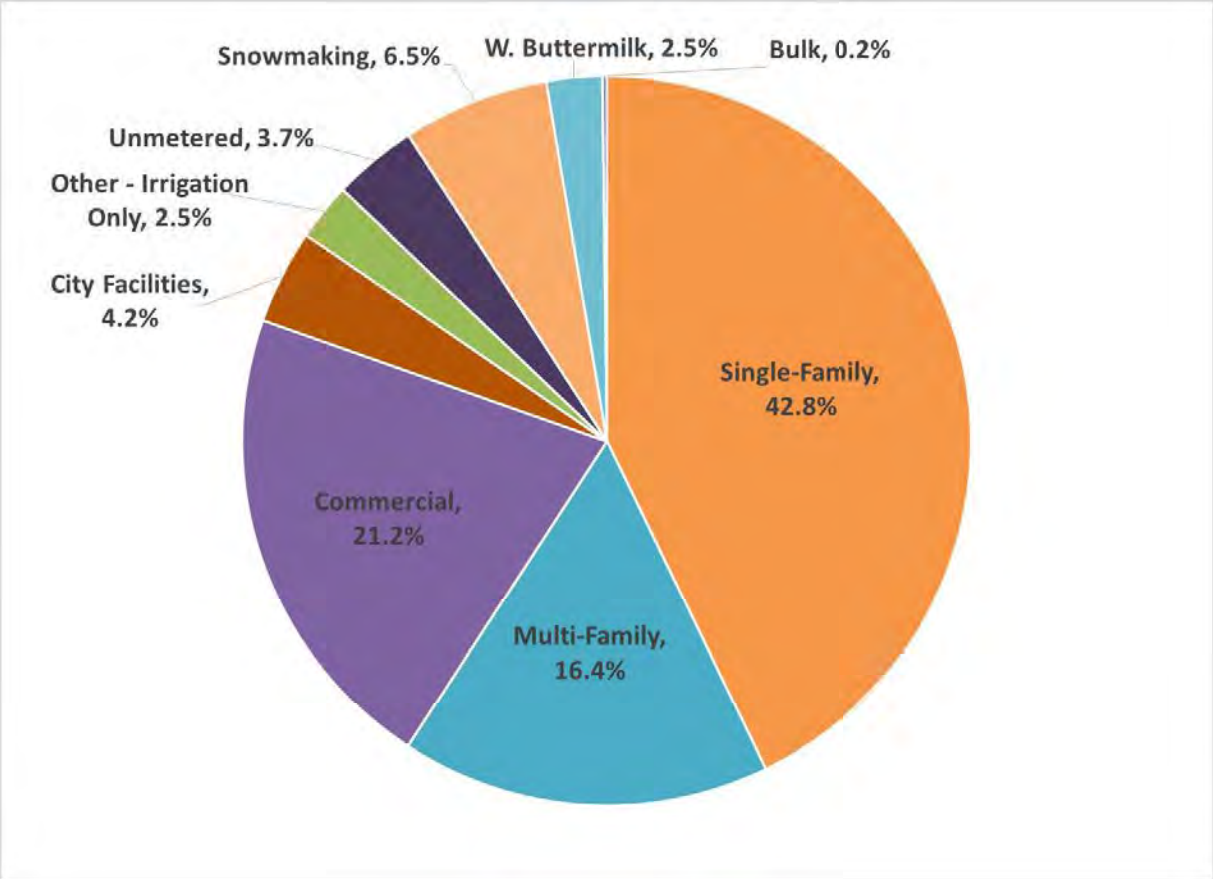


Figure 7. Distribution of Annual Water Use by Sector in 2013.

A pie chart showing the percentage of connections in 2013 by water use sector in Aspen is provided in **Figure 8**. Residential customers (single-family and multi-family) are most prevalent in Aspen, accounting for 84.5% of all service connections. Commercial customers account for 11.0% of connections, dedicated irrigation accounts account for 2.0% of connections, and the remaining accounts are attributed to city facilities connections.

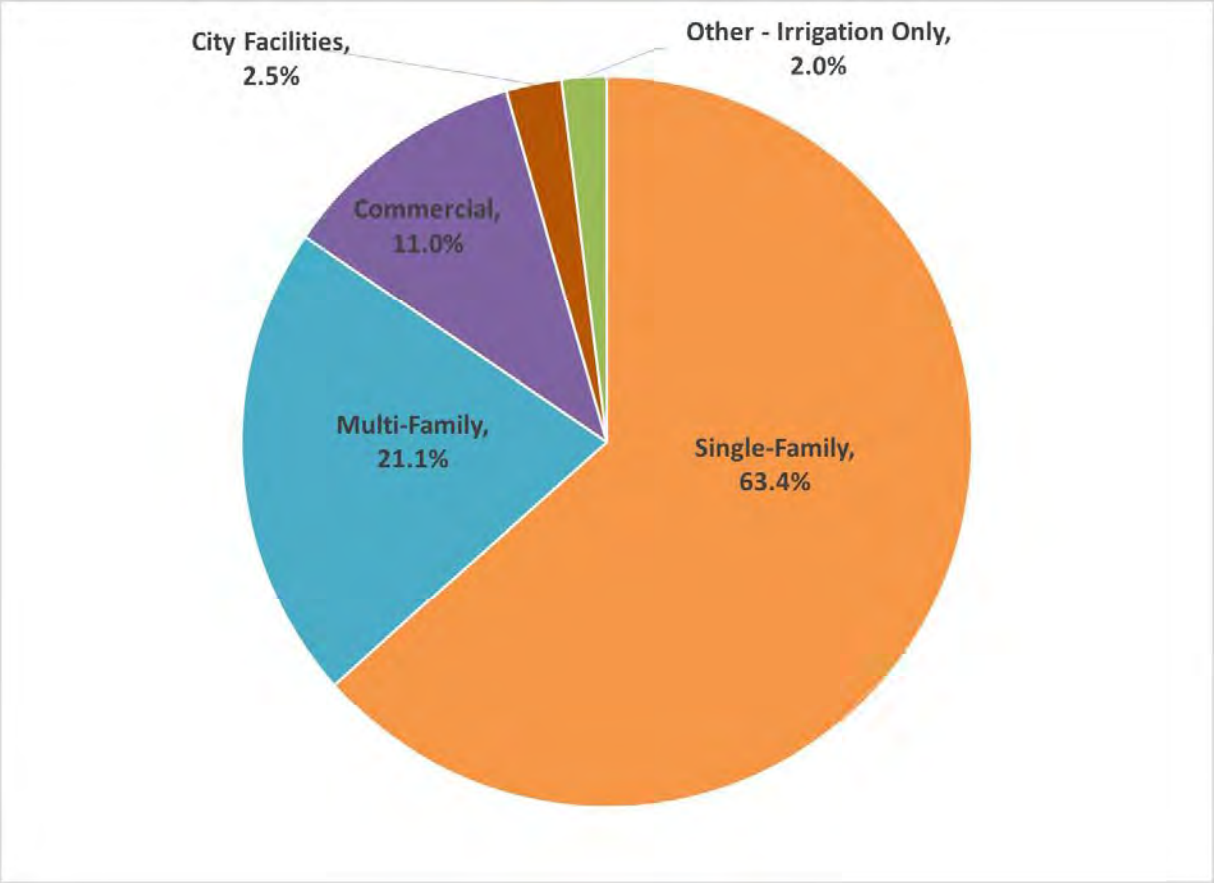


Figure 8. Distribution of Aspen City Customer Connections in 2013.

It is important to note that the values presented in this section reflect only treated water deliveries. The treated water deliveries for snowmaking operations, wholesale deliveries to West Buttermilk, bulk and flat rate water sales were included in the forecasting completed as part of this Water Efficiency Plan, but are not part of the efficiency measures or water savings estimates. Raw water deliveries for irrigation and snowmaking purposes were not included in the forecasting or as part of the efficiency measures and water savings estimates.

2.3 Seasonal and Peak Day Demands

A summary of the City of Aspen's annual and peak water production values from 2008 to 2013 is presented in **Table 4**. The data indicate the average daily production from 2009 to 2013 is 2.68 MGD, with an average maximum daily flow of 6.19 MGD. This indicates that a peaking factor of approximately 2.3 is reasonable for Aspen. The City has determined that firm yield production capacity, which is driven by water supply limitations in the late summer, is approximately 7.8 MGD after considering instream flow restrictions and continuation of historical raw water deliveries. The system capacity is constrained by the availability of streamflow and water quality issues associated with well production, not the capacity of the WTPs or the supply pipelines that convey water from Castle and Maroon Creeks to the WTPs.

The peak daily flows in 2012 and 2013 were 7.6 MGD and 6.97 MGD respectively. Although this indicates that demands were approaching the City's reported firm yield capacity, the peak demands occurred earlier in the season, so the City likely has sufficient supply to meet these demands even under drier streamflow conditions during the study period of current year through 2035, assuming the supply and demand curve do not shift significantly as a result of climate change. However, without storage to regulate supplies to match timing of demands, it is important for the City to monitor changes in precipitation from snow to rain and trends in the streamflow hydrology and demands. Managing landscape irrigation demands can help mitigate the City's vulnerability to streamflow conditions.

Table 4. Annual and Daily Flow and Treated Water Production Characteristics from 2008 through 2013.

Year	Annual Production (AF/yr)	Annual Production (MG)	Average Daily Flow (MGD)	Maximum Daily Flow (MGD)	Peaking Factor	Peak Day
2009	2,618	853	2.34	4.61	1.97	July 24, 2009
2010	2,817	918	2.51	6.13	2.44	June 25, 2010
2011	2,832	923	2.53	5.81	2.30	July 30, 2011
2012	3,484	1,135	3.11	7.60	2.44	June 21, 2012
2013	3,203	1,044	2.86	6.97	2.44	July 3, 2013
Averages	**3,007**	**980**	**2.68**	**6.19**	**2.30**	-

2.4 System Water Losses

The City's water mains are in good shape and system leakage is well below the 10% threshold that is often estimated as the national average. Aspen tracks water losses by regularly comparing production and metered usage values. Water loss audits over the last 8 years have shown loss values ranging from 0.6% to 8.4%, with an average of 3.9%. The City also annually conducts a leak detection program that utilizes sophisticated listening equipment to locate leaks, and repairs are then made based on this analysis.

On the customer side, approximately 800 of the customer connections have automated metering infrastructure (AMI) using the Aclara system, and the City uses this technology to identify potential leaks on a weekly basis.

The City could improve overall water loss control and accountability by implementing an annual water audit using the AWWA M36 methodology as discussed later in this document.

2.5 Past and Current Demand Management Activities

The City of Aspen's conservation program dates back to the early 1970s when water service began to be based on metered usage and the City completed an inventory of ECUs connected to the system. Aspen's water efficiency program has evolved over time, including the initiation

of the water audit and leak detection programs in 1995 and the implementation of a tiered water rate structure in 2006. The City of Aspen created its Efficiency Division in 2006. Dedicated Water Department staff are responsible for overseeing the water conservation program with assistance from other staff members. The City has demonstrated an exceptional commitment to water use efficiency, and has already implemented many of the most essential water conservation program measures.

In 1996, Aspen approved its first water conservation plan, which was included as an element of the larger Water Management Plan. While the 1996 plan did not contain all of the necessary elements to meet approval by the CWCB under the current statute, it was quite progressive for the period. Aspen's water conservation and efficiency plan is being updated as part of the City's participation in the Roaring Fork Watershed Regional Plan.

2.5.1 Analysis of Water Savings from Past Demand Management Efforts

In 1990, the City of Aspen's annual water demand was 4,368 AF and the population of combined permanent and seasonal residents was 23,435 people. This equates to an average gallons per capita per day in 1990 of 156.4 gpcd. In 2013, the gallons per capita per day as calculated using identical methods was just 62.8 gpcd.

To estimate the water savings achieved by the City of Aspen during the time period between 1990 and 2013 (23 years), a hypothetical demand forecast was developed using the gpcd from 1990 and the population from 2013 (36,540 permanent and seasonal residents). This analysis revealed that if 1990 demand patterns had continued in Aspen without any reduction from various demand management efforts, the 2013 hypothetical annual water demand in Aspen would have been 6,810 AF.

In reality, the 2013 annual water demand in the City of Aspen was 2,661 AF. This is 1,707 AF (39%) lower than Aspen's water demand in 1990, even though the population has increased by 13,105 people (56%). **This analysis suggests that since 1990, demand management efforts have successfully conserved 4,238 AF/yr of water, a savings of 63.5% compared to the hypothetical forecast using 1990's gpcd.** This is a significant achievement in water savings that has certainly reduced the amount of money that might have been spent obtaining new water supplies and expanding infrastructure. **Figure 9** shows the actual demand in Aspen from 1990-2013 compared with a hypothetical forecast based on the average gpcd in 1990. The erratic changes in demand are due to actual fluctuations in Aspen's population over the time period.

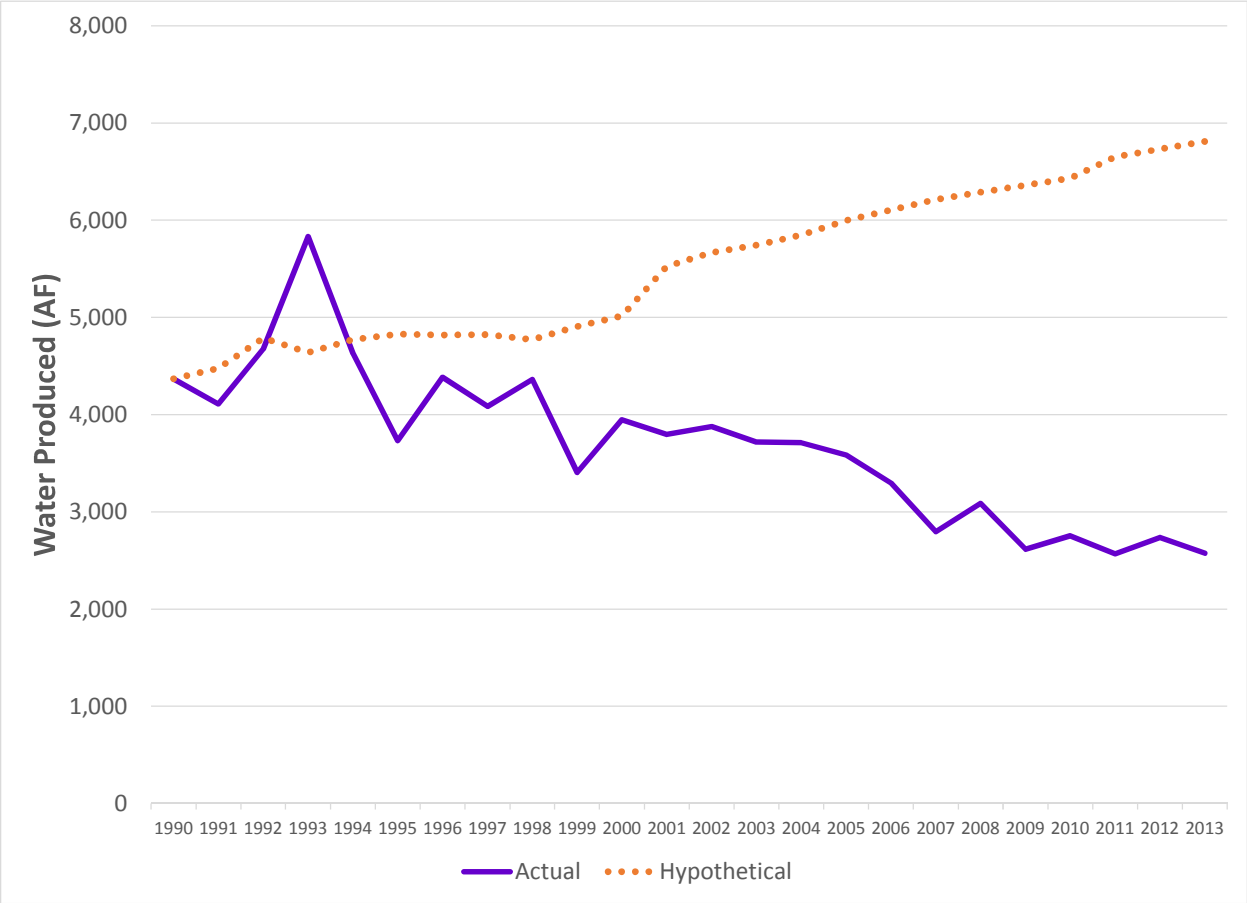


Figure 9. Actual and hypothetical consumption in Aspen from 1990 through 2013.

2.6 DEMAND FORECAST

As part of the preparation of the water efficiency plan, three separate treated demand forecasts were prepared:

1. Baseline Forecast (without conservation)
2. Passive Savings Forecast
3. Passive and Active Savings Forecast

The baseline forecasting method used historical treated demand patterns to establish baseline per capita demand and then to increase these demands with population out to 2035 as if the 2014 per capita water use patterns continue without change to 2035. This is a standard approach to demand forecasting, but it does not take into account conservation and the expected impacts of water efficiency.

The second two forecasts were developed using a more robust approach, where treated demands were separated out by sector (e.g. residential, commercial, irrigation, schools, etc.), with seasonal and non-seasonal demands (outdoor and indoor) disaggregated for each

category. Then a separate treated demand forecast out to 2035 was prepared for indoor and outdoor demand in each of Aspen's customer sectors. This allowed the impacts of specific water efficiency measures like high-efficiency toilets and clothes washers to be considered.

2.6.1 Population Planning Projections

Aspen is one of the most popular destination ski areas in the United States and also attracts many visitors in the summer months as well. Because of this, two separate service area population forecasts were developed for Aspen – one for the permanent, full-time population and one for the seasonal, part-time population. These forecasts are both presented in **Table 5** and **Figure 10**.

Table 5. Population Growth Projections from 2015 through 2035.

Year	Permanent Population	Seasonal Population
2015	10,632	26,791
2016	10,759	27,112
2017	10,888	27,437
2018	11,019	27,767
2019	11,151	28,100
2020	11,285	28,437
2025	11,979	30,185
2030	12,715	32,040
2035	13,496	34,009

2.6.1.1 Permanent Population

According to the 2010 Census, the full-time population within the municipal boundary of Aspen was 6,658 people, up from 5,914 full-time residents as reported in the 2000 Census. The City also has contracts to provide water service to areas outside of the municipal boundary, and after adding these additional full-time residents, the total number of residents served increases to approximately 8,895 in 2000 and 10,016 in 2010. The City uses a preferred long-term growth rate for planning purposes of 1.2% per year, which means that the year-round, full-time service area population is projected to increase to approximately 11,285 people in 2020 and 13,496 people in 2035 (Table 5 and Figure 10).

2.6.1.2 Seasonal Population

According to data provided by the City, the seasonal/part-time population of Aspen was 18,015 people in 2000. Using the City's preferred long-term growth rate for planning purposes of 1.2% the seasonal/part-time is projected to increase to approximately 28,437 people in 2020 and 34,009 people in 2035 (Figure 10).

The population projections for this water efficiency plan assume the seasonal population grows at the same rate as the permanent population. However, climate change and other factors could lead to a higher seasonal population growth rate and/or a larger portion of the seasonal population extending their duration in Aspen. As other cities plan for more extreme heat events and more frequent drought, Aspen is faced with the potential for 'climate refugees' to seek more time in Aspen. Aspen will continue to monitor its permanent and seasonal population and related impacts on water demands.

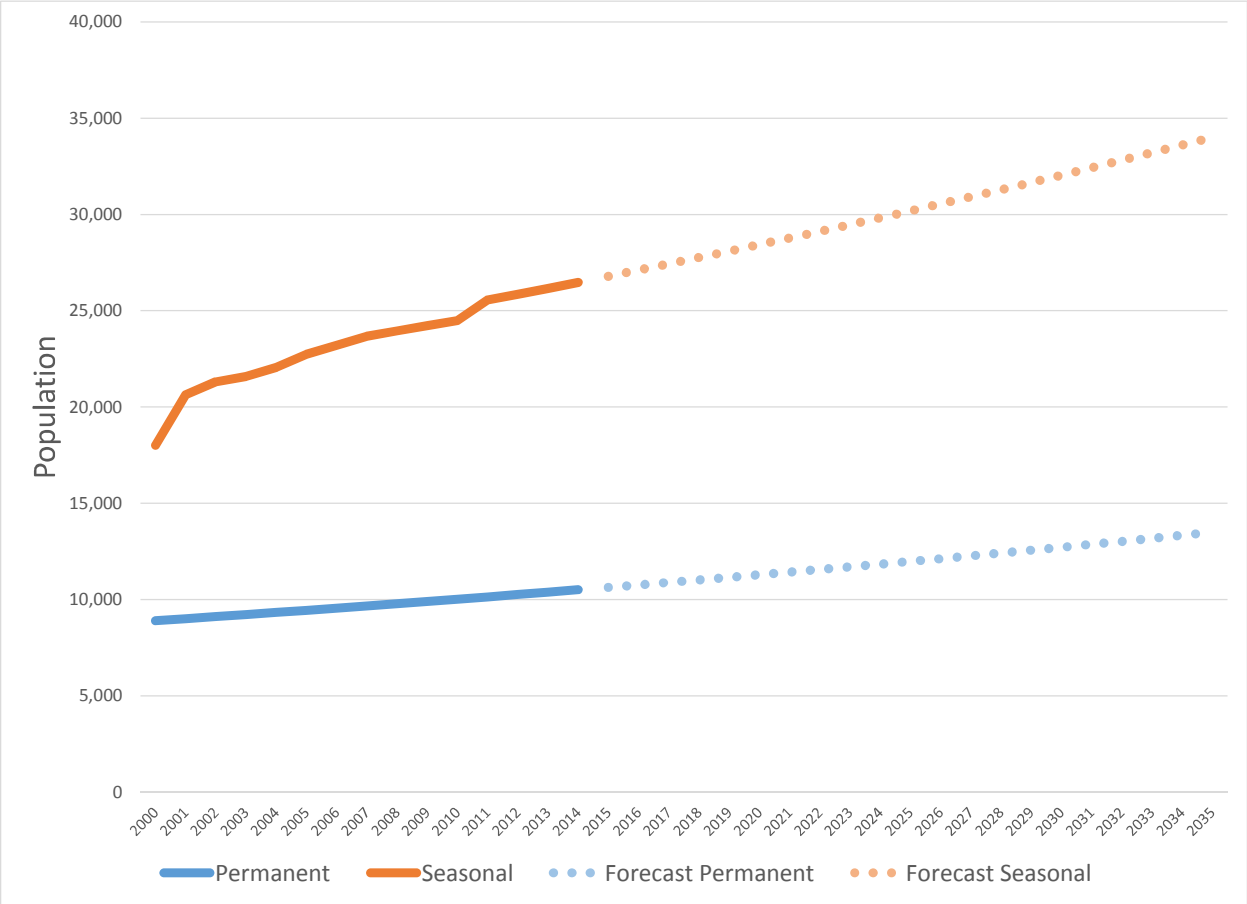


Figure 10. Actual and Forecast Permanent and Seasonal Population from 2000 through 2035.

The City of Aspen has adopted a Growth Management Quota System to limit future growth, as outlined in Chapter 26.470 of the City Code. The code limits the annual allotment of potential growth within the City, by land use type, as follows: 18 residential units (free market), 33,300 square feet of leasable commercial space, and 112 lodging pillows. No limits are in place for affordable housing or essential public facilities.

2.6.2 Demand Forecasts

As part of the water efficiency planning process, three distinct treated water demand forecasts were prepared. A description of each scenario and the forecasting methodology is presented below. The costs and benefits associated with these scenarios are considered in the next section of this plan document.

2.6.2.1 Forecast Methodology

First, a baseline treated demand forecast starting from 2015 and going out to 2035 was prepared. This baseline forecast did not include the impact of water conservation of any kind, even future passive water savings; it was developed only to assess the adequacy of future supplies if population increases and the unit rate of water use remains the same as current conditions (without considering climate change), and to demonstrate the impact of anticipated efficiency improvements. The baseline forecast is based on a combination of anticipated demographic and land use changes in Aspen. In the baseline forecast, all treated water demands (indoor and outdoor) increase proportionally with the population at the current rate of usage. Treated water demands for snowmaking, West Buttermilk, unmetered customers, and bulk sales were held constant in all forecasts at 525 AF/yr.

A second treated water demand forecast to 2035 was developed that includes the impact of passive efficiencies from Colorado legislation, and federal plumbing codes and standards. A third forecast was prepared that includes the anticipated impact the City's planned water efficiency program measures described in this plan.

The second and third forecasts include the impacts of water efficiency and were developed using a more robust approach that considers anticipated changes in each customer sector in Aspen. To develop these forecasts, treated demands were separated out by water use sector (e.g. residential, commercial, irrigation, and city facilities), with seasonal and non-seasonal demands (outdoor and indoor) disaggregated for each category as shown in Table 3. Then a separate demand forecast out to 2035 was prepared for indoor and outdoor demand in each customer sector. This allowed the impacts of specific water efficiency measures like high-efficiency toilets and clothes washers to be considered.

These three forecasts form the core of the water efficiency plan and are the forecasts upon which estimated conservation savings are based. Each forecast shows demand starting in 2015 and going through the planning horizon of 2035 (20 years). The results are provided in **Figure 11** and further described in the sections below.

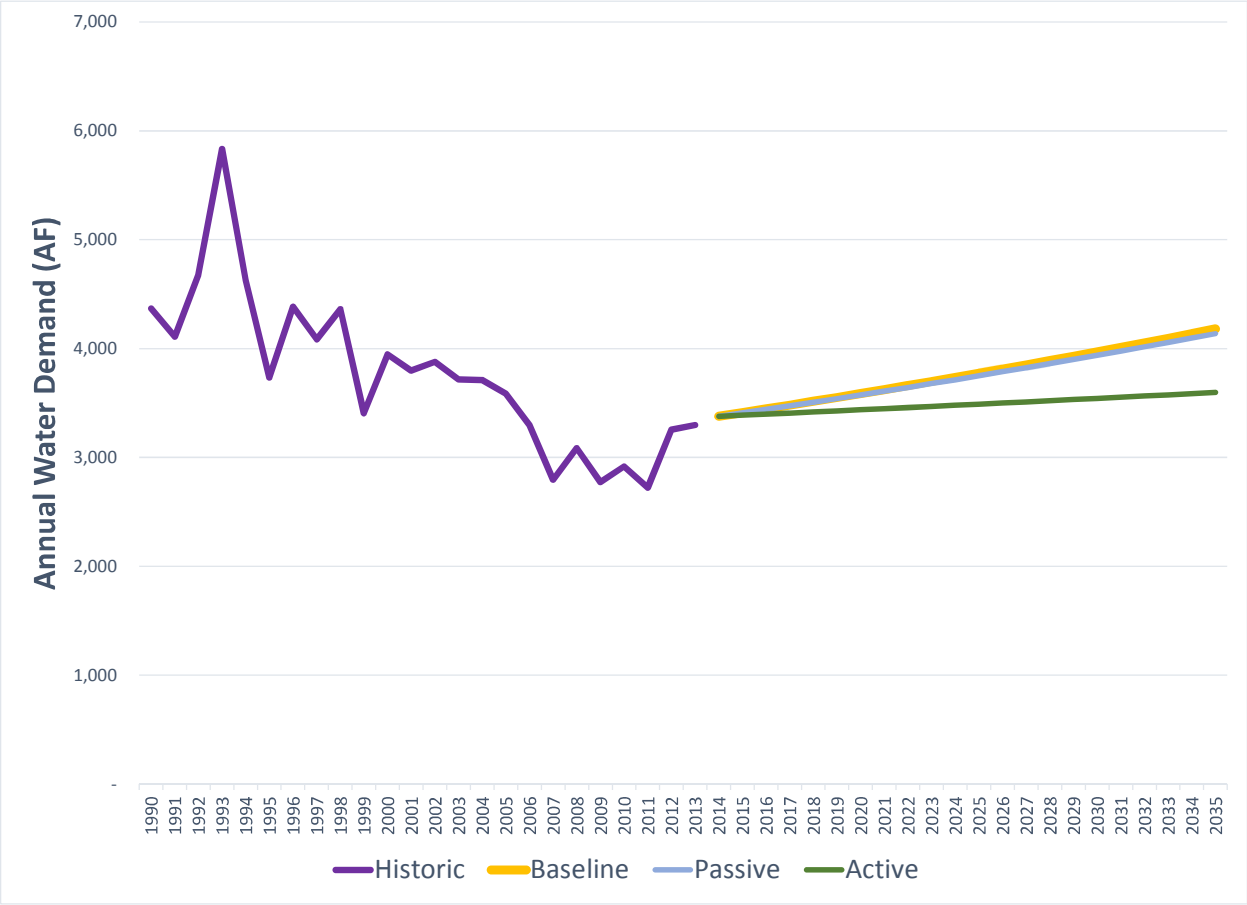


Figure 11. Baseline, Passive, and Active Treated Water Demand Forecasts through 2035.

Baseline Forecast

The concept of the baseline forecast is to exclude conservation of any kind and to simply assume that typical baseline treated water demand patterns (i.e. the water use patterns of 2009 through 2013) are continued into the future without change. It is also assumed that typical water demands for the City will change proportionally with increases in population. This assumes new customers joining the system use water identically to the current customer base. The fundamental purposes of the baseline forecast are to assess the adequacy of future supplies under reasonable "worst-case" conditions (i.e. no water efficiency gains) without considering impacts for additional future climate change, and to demonstrate the anticipated impact of water efficiency in Aspen from both passive and active conservation programs. The baseline forecast is presented in Figure 11. The impact of growth in both the permanent/full-time and seasonal/part-time population is included in all treated demand forecasts. The forecasting methodology uses the changes in both population forecasts as a key driver for future demands.

Key assumptions in the baseline forecast include:

- Baseline treated water use patterns for Aspen (Table 1).
- Population forecast for Aspen (Figure 10).
- Treated water use in all sectors both seasonal and non-seasonal changes proportionally with the population.
- Outdoor water use impacts from temperature and precipitation in 2035 are similar to 2015.
- Fixed annual demands of 525 AF/yr for snowmaking, West Buttermilk, unmetered customers, and bulk sales.

Baseline treated water demands in 2014, including water loss, totaled 3,377 AF (2,661 AF for City customers and 525 AF for snowmaking, West Buttermilk, etc., and 191 AF water loss). With this baseline forecast, demand is expected to increase by 803 AF to 4,180 AF in 2035.

Passive Conservation Forecast

A second treated water demand forecast was prepared to 2035 that includes the impact of anticipated passive efficiencies from Colorado legislation, and federal plumbing codes and standards on a sector-by-sector basis for both indoor and outdoor use. Colorado Senate Bill 2014-103, which was passed in 2014 and phases out the sale of low-efficiency lavatory faucets, showerheads, flushing urinals, and tank-type toilets, is an example of local legislation that is accounted for in the forecast of passive conservation between 2015 and 2035. However, a large component of these water savings have already been achieved in Aspen. Because Aspen has had water efficient building codes in place and many older properties have been renovated over the past 20 years, the impact of passive conservation is not anticipated to be great. This forecast found that treated water demands will increase to 4,137 AF in 2035. The passive forecast is presented in Figure 11.

Key assumptions in the passive conservation forecast include:

- Baseline treated water use patterns for Aspen (Table 1).
- Population forecast for Aspen (Figure 10).
- Outdoor water use in all sectors increases proportionally with the population.
- Outdoor water use impacts from temperature and precipitation in 2035 are similar to 2015.
- 0.6% per year decrease in combined SF and MF residential indoor per capita water use (from 56.7 gallons per capita per day (gpcd) in 2014 to 50.5 gpcd in 2035) continuing trends of the past 15 years[7] and recent Colorado legislation under Senate Bill 14-103

[7] Based on results from the Water Research Foundation *Residential End Uses of Water Update* (to be published in 2014).

that phases in the sale of only high-efficiency WaterSense labeled fixtures starting in 2016.
- 0.75% per year decrease in per capita commercial indoor use from ongoing replacement of fixtures, appliances and equipment and new Colorado legislation assuring high-efficiency plumbing in new construction.
- 0.75% per year decrease in per capita city facility indoor use from ongoing replacement of fixtures, appliances, and equipment and new Colorado legislation assuring high-efficiency plumbing in new construction.
- 0.75% per year decrease in per capita school indoor use from ongoing replacement of fixtures and appliances and new Colorado legislation assuring high-efficiency plumbing in new construction.
- Fixed annual demands of 525 AF/yr for snowmaking, West Buttermilk, unmetered customers, and bulk sales.

The passive conservation forecast hypothesizes a 22.5% increase in treated water demand over the next 20 years and suggests that more efficient fixtures and appliances could help reduce future demands in 2035 by 43 AF compared with the baseline.

Active Conservation Forecast

A third forecast was prepared that includes the anticipated impact the City's planned water efficiency program measures described in this plan. Under this forecast, treated water demand increases to just 3,597 AF in 2035. Compared with the original baseline forecast, if the elements of this plan are fully realized, then it is estimated that water demand at 2035 will be reduced by 583 AF as a result of passive and active water conservation measures in Aspen. The active conservation forecast is presented in Figure 11.

Key assumptions in the active conservation forecast include:

- Baseline treated water use patterns for Aspen (Table 1).
- Population forecast for Aspen (Figure 10).
- Outdoor water use in all sectors increases proportionally with the population, but is reduced by 0.25% per year due to a combination of factors including: Aspen's conservation-oriented rate structure which charges higher rates for outdoor use, densification as the City grows, anticipated smaller lot sizes in future developments, proposed landscape code for new development, irrigation efficiency improvements and irrigation audits, ongoing landscape transformation from traditional turf to water-wise plants, and the City's ongoing education and information efforts including Xeriscape seminars.
- Outdoor water use impacts from temperature and precipitation in 2035 are similar to 2015.
- 1.0% per year decrease in combined SF and MF residential indoor per capita water use (from 56.7 gpcd in 2014 to 47.0 gpcd in 2035), considering Aspen's active conservation

program and recent Colorado legislation under Senate Bill 14-103 that phases in the sale of only high-efficiency WaterSense labeled fixtures starting in 2016.
- 0.75% per year decrease in per capita commercial indoor use from ongoing replacement of fixtures, appliances and equipment and new Colorado legislation assuring high-efficiency plumbing in new construction.
- Fixed annual demands of 525 AF/yr for snowmaking, West Buttermilk, unmetered customers, and bulk sales.

The active conservation forecast hypothesizes a 6.5% increase in water demand over the next 20 years and suggest that more efficient fixtures and appliances could help reduce future demands in 2035 by 583 AF compared with the baseline.

The analysis completed for this water efficiency plan indicates that the likely yield of the City's direct flow water rights is around 26,850 AF in a dry year. The maximum annual treated water produced by Aspen over the past 5 years was 3,220 AF in 2012 and the range of forecast future demands in the year 2035 are from 3,597 AF to a maximum of 4,180 AF. On an annual basis, the dry year yield of the City's water rights appears to be more than sufficient to meet current and forecast future demands.[8] However, the City does not have storage to regulate the timing of supply to match demands, and therefore is vulnerable to peak demand shortfalls in dry years when physical streamflow conditions are limited, or in emergencies such as a fire or landslides when one or more particular water supply sources may become unavailable. Accordingly, the City has elected to focus on water efficiency measures that could reduce peak demands, primarily related to outdoor water use, which are financially viable and could potentially eliminate or delay infrastructure projects.

2.6.2.2 Climate Change Impact on Water Use

Recent climate change forecasts indicate a warming trend in irrigation season temperatures in the Roaring Fork region. A 2014 report from CIRES, warns that temperatures for the 2035 to 2064 time period are likely to increase by an average of approximately *4 degrees F* as compared to the period from 1971 to 2000 (CIRES 2014). More frequent and severe heat waves, droughts, and wildfires are projected. Such changes will impact both water supply and demand and the City is conducting additional research regarding these potential impacts. A hotter irrigation season means higher water requirements for landscapes. While this may increase the uncertainty in outdoor water demand projections, the net effect depends on numerous factors such as the amount and type of landscaping material, irrigation management practices, etc. Climate change also has the potential to impact the ski industry and increase demands for snowmaking. Water demands in Aspen could also increase if 'climate refugees', seeking to escape the heat from other cities, start spending more time in Aspen in houses that are currently vacant part of the year.

[8] The City uses the historical dry year of 1977 for planning purposes, and in its planning, accounts for changing its diversion patterns as needed to protect decreed instream flows.

Aspen's long-term commitment to water conservation is helping prepare the City for these changes. Increased indoor and outdoor efficiencies achieved over many years enable flexibility in meeting season needs.

Changing temperature and precipitation patterns are ongoing and are impacting Aspen's customers already. Climate change impacts are included to some degree in the water demand forecasts provided in this plan to the extent that current demands and climate patterns (which have already been affected by climate change) are utilized as the starting point to project future water demand patterns. It is important to consider both demand-side, as well as supply-side impacts of future climate change on overall water supply conditions. The forecast methodology provided in this plan, along with regular updates to the demand projections, can assist in this process.

2.6.2.3 Estimated Cost of New Supply Options

The City's water demands have continuously decreased over the past several decades (as shown above in Figure 9 and Figure 11), to the credit of its water users, staff, and progressive water conservation program. In 2014, Aspen has an ample water supply to meet present needs and most projected future needs, with the caveat that emergencies such as fires or landslides can prevent use of one or more supply sources, thereby creating a shortfall in supply, which may be temporary or long-term, depending on the impact of the emergency.

Based on the historical use patterns, it is reasonable to conclude that the City's water conservation efforts have at least delayed the need for storage. Today the City's water rights yield more than ample supply on an annual basis, but the City experiences late summer usage that approaches its available firm yield water supply during the period of mid-July through the end of the irrigation season. Absent additional storage or some treatment method to address water quality issues associated with well pumping, the City is obligated to manage the late summer demands based on local streamflow hydrology. Additional water treatment and/or additional water storage along with customer-side demand management of irrigation could provide Aspen increased system stability under a variety of hydrologic conditions, and in emergencies. Any option must be carefully evaluated in terms of financial, environmental, and other potential impacts.

The City has a $100,000 annual unallocated budget to fund water conservation programs and incentives, in addition to staff salaries and efforts related to metering. Under the City's planned conservation program, it is estimated that approximately 28 AF of water per year will be saved. Given the City's conservation program budget, it is estimated the City is spending just $3,500 - $5,200 per AF conserved.

The City plans to continue focusing on demand management as an alternative to near-term construction of expensive storage, and will monitor and evaluate the situation through its integrated planning process.

3. INTEGRATED PLANNING AND WATER EFFICIENCY BENEFITS AND GOALS

The City of Aspen utilizes a Comprehensive Water Management Plan to direct the use of its water rights and other resources to meet changing water demands while meeting the environmental goals of maintaining decreed instream flow levels to promote a healthy aquatic environment. Aspen has periodically updated studies on Raw Water Availability in order to track commitments for water service and to establish the adequacy of raw water to meet the changing levels of water demand over time. A complementary program is the Asset Management Plan which directs financial resources to specific construction projects and facilities required to develop added water supplies in a timely fashion considering the changing needs. Projects that will address any identified gaps between expected water demands and available supplies are scheduled and implemented through this program. These related documents have provided the basis to complete many projects and activities that have maintained a balance between water supply and demand while respecting the environmental goals of protection of decreed instream flows. For instance, the upgrade and expansion of the City's water treatment plant, improvements to raw water conveyance systems, the development of the City's well program (which is essentially development of groundwater storage) and the water conservation program (particularly leak detection and correction) have all resulted from direction provided by the Comprehensive Water Management Program. More recently the activities undertaken to obtain water rights and construct a reclaimed water project have followed from the Comprehensive Water Management Plan and will further increase the availability of raw water supplies to the City's water customers during critically dry periods.

4. SELECTION OF WATER EFFICIENCY ACTIVITIES

The City of Aspen considered a wide variety of water efficiency programs and measures before selecting the final components for inclusion in this plan. Efficiency measures were screened using a variety of criteria including:

- Feasibility and practicality.
- Water savings and estimated cost per AF.
- Potential to reduce peak water demands in the late summer irrigation season.

The City utilized the CWCB's *Municipal Water Efficiency Plan Guidance Document* (CWCB 2012) to inform and guide the development of this conservation plan, including the activity selection worksheets to assist in the screening process.

4.1 Summary of the Selection Process

The City implemented a tiered screening and selection process for evaluating potential water efficiency activities. Existing activities were included in the list of measures and unless duplicative, existing activities are expected to continue as part of the ongoing water efficiency program.

Initial Screening. An initial screening was conducted by the consultant team, using the CWCB screening and evaluation worksheets (CWCB, 2012) and the *Guidebook of Best Practices Guidebook for Municipal Water Conservation in Colorado* (CWW, 2010) as the key technical resources, along with professional experience. Activities that made it through the initial screening were assembled and passed along to the staff for screening.

Final Screening. The final level of screening and selection of water efficiency activities was made by the Utilities Finance and Administrative Services Manager. During the final screening, care was taken to select a suite of activities capable of achieving the level of water savings needed by Aspen to achieve the stated water efficiency goals.

This plan was carefully prepared to comply with State of Colorado planning requirements and legislation, which does not currently include water quality as part of the legal planning requirement. Thus, water quality was not included in the water efficiency activities selection criteria. However, the City understands that improving outdoor use efficiency to reduce irrigation runoff has the potential to reduce nutrient flows into local streams and rivers, providing an additional benefit from this water efficiency plan.

4.2 Water Efficiency Activities

Table 6 presents the new and updated water efficiency activities selected for inclusion in this plan, many of which have been ongoing since at least 1992. Each measure is described in more detail in the sections below.

Table 6. New and Updated Water Efficiency Activities and Water Savings Estimates.

Water Efficiency Activities	Sectors Impacted	Ongoing Activity?	Implementation Period of New Activities	Projected Water Savings 2015 2035 (AF/yr)
FOUNDATIONAL ACTIVITIES				
Automatic Meter Reading Installation and Operation	All	YES	2014-2018 for existing & ongoing for new customers	50
Enhanced Water Loss Control	All		annual	38
Conservation-Oriented Rates	All	YES	2015 – rate structure update	145
TARGETED TECHNICAL ASSISTANCE AND INCENTIVES, AND NATURAL REPLACEMENT OF FIXTURES AND APPLIANCES				
Fixtures, Appliances, and Incentives	All, indoor	YES	Ongoing	100
Outdoor Water Efficiency	All, outdoor	YES	Ongoing	20
Slow the Flow	All	YES	Ongoing	30
Info and education, Farmer's Market, xeriscape seminars, Efficient Parks, etc.	All	YES	Ongoing	40
Commercial, Institutional, and Industrial Water Efficiency	CII	YES	2015	70
ORDINANCES AND REGULATIONS				
Regulatory Measures	All	YES	Ongoing	
Water Reclaim and Recycling, Raw Water Irrigation	Irrigation	YES	Ongoing	
Waste of Water Ordinance Update	All	YES	2015	
Update landscape development regulations for new construction to place emphasis on water efficiency in residential development	SF & MF residential		2018	50
EDUCATIONAL ACTIVITIES				
Public information, customer outreach and education	All	YES	1992 - present	40
Community outreach event participation	All	YES	Before 2006 - present	
Utility billing inserts	All	YES	2008 - present	
TOTAL SAVINGS THROUGH 2035 (AF/YEAR)				**583**

4.2.2 Foundational Activities

4.2.2.1 Metering

A robust metering program is fundamental to the success of water conservation efforts. Colorado statute requires all water providers to meter the water use of their customers and to bill based on metered consumption. In Aspen, approximately 98% of the customers (including most municipal facilities) are metered and billed based on metered consumption.[9]

Aspen uses the Aclara STAR Network Advanced Metering Infrastructure (AMI) system for metering and billing purposes for approximately 800 of the 4,000 customer connections and is in the process of implementing the system for all customers. Data are remotely transmitted, and Aspen uses the AMI technology to complete weekly assessments of user accounts to identify outlier data points that are then flagged for further investigation. City staff report that the technology has been instrumental in identifying customer-side leaks and for general water management and system improvements.

4.2.2.2 Enhanced Water Loss Control

Leak detection and water loss control are also fundamental water efficiency practices for all water utilities. As discussed above in Section 2.4, system leakage in Aspen is currently estimated to average approximately 4%, which is well below the 10% threshold that is often estimated as the national average. This low rate of system leakage is not an accident, but rather the product of a progressive water main replacement and repair program in Aspen.

Conducting an annual system water audit, using the AWWA M36 Water Audits and Loss Control Programs methodology and the free AWWA water loss control Excel spreadsheet software, will further assist the City in managing its water by categorizing all water uses and identifying real losses that directly impact revenue, as shown in **Table 7** below.

The process of implementing the AWWA water audit takes just a few hours each year, but the results clearly show if water loss is a problem and evaluate the cost of real and apparent losses to the utility. This information is essential for informing water loss control programs and understanding where best to apply water loss control resources.

[9] It is common in Colorado for utilities to provide unlimited, free water to selected municipal connections based on historical practice, and all usage is metered.

Table 7. AWWA Water Audits and Loss Control Categories.

Billed Authorized Consumption	Billed Water Exported	Revenue Water
	Billed Metered Consumption (including water exported)	
	Billed Unmetered Consumption	
Unbilled Authorized Consumption	Unbilled Metered Consumption	Non-Revenue Water
	Unbilled Unmetered Consumption	
Real Losses	Unauthorized Consumption	
	Systematic Data Handling Errors	
	Leakage and Overflows at Utility's Storage Tanks	
	Leakage on Service Connections	

4.2.2.3 Conservation-Oriented Water Rate Structure

Aspen currently bills its customers on a monthly basis using a four-tier inclining block rate structure. This conservation-oriented rate structure has been in place since January 2006. The City's rate structure provides for 5,000 gallons per ECU per month in tier 1, an additional 10,000 gallons of water per ECU per month in tier 2, and additional 5,000 gallons per ECU per month in tier 3, and all monthly usage greater than 20,000 gallons per ECU per month is billed at the tier 4 rate. The 5,000 gallon/ECU for block 1 is intended to represent a reasonable estimate of indoor water use for the residential unit that can be approximated by a one bedroom, one bathroom home with a fully equipped kitchen, and exterior hose bib; a typical residential unit is equivalent to approximately 2.6 ECU. Given that the number of ECUs and the resultant billing is based on the number of fixtures, it is possible that the current structure may be providing a tier 1 budget that is too large for larger homes. The City is considering changes that would take a step toward addressing this issue. Separate rate structures apply to bulk water purchases and raw water customers.

4.2.2.4 Billing System and Water Rates

Aspen utilizes a computerized billing system that includes approximately 800 AMI meters. The AMI system enables frequent remote interrogation of water meters. The City is makes use of the advanced technology to help identify leaks and abnormal usage.

The standard 2014 schedule of rates and charges for water customers in Aspen is shown in **Table 8.** Water Rates and Rate Structure for 2014. **(Rates are $/1,000 gallons. Tier gallons are per ECU)** In this rate structure, tier 2 represents a 29% increase over tier 1, tier 3 represents a 42% increase over tier 2, and tier 4 represents a 41% increase over tier 3. The rates themselves are set based on Aspen's cost of service requirements. The rates vary by billing area to more

accurately reflect the changes in the cost of service. Aspen provides a 10% discount on demand and fire protection charges for qualified senior citizens. As of the date of this report, the City is in the process of tightening the tiers by reducing the volume (in gallons) for each tier by 20%. If approved by City Council, this rate change is targeted to become effective in January 2015. In future updates, the City may consider creating separate tiers for indoor versus outdoor water, and developing water budgets for irrigation that are based on irrigated area, planting materials, and local evapotranspiration rates (which define plant demands).

Table 8. Water Rates and Rate Structure for 2014. (Rates are $/1,000 gallons. Tier gallons are per ECU).

Rate Tier	Water Rate
Tier 1 - Up to 5,000 gallons	$1.90
Tier 2 - 5,001 to 15,000 gallons	$2.46
Tier 3 - 15,001 to 20,000 gallons	$3.51
Tier 4 - Greater than 20,000 gallons	$4.96
Demand Charge ($/ECU/month)[1]	$4.57 to $9.15
Pumping Charge ($/1,000 gallons/month)[2]	$1.37 to $4.11
Fire Protection Charge ($/ECU/month)[3]	$1.54 to $3.08

[1]Demand charge varies with billing area.
[2]Pumping charge varies with the number of pump stations used.
[3]Fire protection charge varies with billing area.

The schedule of rates and charges for bulk water customers is shown in **Table 9**. Aspen currently provides treated water at a wholesale rate under three scenarios: 1) treated water to Aspen Ski Company for Aspen Mountain snowmaking; 2) treated water to 80 customers located in West Buttermilk; and 3) treated water for filler hydrant draw permits. Most bulk water charges are equal to the tier 4 rate. Bulk deliveries to West Buttermilk are subject to contractual rates and charges.

Table 9. Bulk Water Rates and Rate Structure for 2014.

Rate Tier	Water Rate
Rate per 1,000 gallons[1]	$4.96
Demand Charge ($/use)[2]	$15.00

[1]Equivalent to Tier 4 for metered treated water use.
[2]Flat fee per use (e.g. each time a truck is filled).

The schedule of rates and charges for general raw water customers is shown in **Table 10**. There are approximately 68 raw water accounts that are used for irrigation and snowmaking purposes. Charges for pressurized raw water are the same as for bulk water, which are based

on tier 4 rates. Non-pressurized raw water deliveries for irrigation purposes are charged according to the number of square feet of irrigated area.

Table 10. Raw Water Rates for 2014.

Rate Tier	Water Rate
Rate per 1,000 gallons - hydrant[1]	$4.96
Rate - non-pressurized irrigation ($/1,000 sq. ft. of irrigation/year)	$10.45
Demand Charge ($/use)	$15.00

[1]Equivalent to Tier 4 for treated water use.

Aspen provides raw water from its municipal and irrigation water rights. This water can be delivered from the Leonard Thomas Reservoir as well as other non-potable raw water supplies according to the rates shown in **Table 11**. Raw water delivered from Thomas Reservoir is used as a supply for irrigation in the Meadowood common area, the hospital, and medium-density housing developments in the area, and can be used at other locations as well. Raw water delivered from Thomas Reservoir is also used as the source of supply for snowmaking operations at the Highlands Ski Resort. All customers are required to have a metered connection; however, the rate structure provides for a backup billing mechanism based on irrigated area under special circumstances.

Table 11. Thomas Raw Water Rates and Other Pressurized Non-Potable Water for 2014.

Rate Tier	Water Rate
Rate per 1,000 gallons ($/year)	$1.20
Rate per 1,000 square feet of irrigation ($/year)[1]	$47.91
Demand Charge ($/use)	$15.00

[1]Bulk rate only allowable in exigent circumstances.

Aspen also has a schedule of punitive rates for unmetered water service as shown in **Table 12**.

Table 12. Water Rates and Rate Structure for 2014 Unmetered Service.

Rate Tier	Water Rate
Demand Charge ($/ECU/month)[1]	$79.96 to $159.92
Fire Protection Charge ($/ECU/month)[2]	$1.54 to $3.08

[1]Demand charge varies with billing area.
[2]Fire protection charge varies with billing area.

Advanced Metering Infrastructure (AMI)

In recent years the City has equipped approximately 800 of the customer connections have AMI using the Aclara system, and the City uses this technology to identify potential leaks on a

weekly basis. In fact, staff check for abnormal usage three times a week, and contact customers regarding potential leaks. This is a significant customer service benefit that has the potential to reduce customer-side leakage.

This Aclara system has the capability of interrogating water meters hourly (or even more frequently) and this allows for sophisticated analysis of flow patterns that can quickly identify abnormal usage and leakage. As the City expands the use of this system, it may be possible to dramatically reduce customer-side leakage through data analysis and rapid-alerts that identify potentially wasteful water loss.

AMI metering is not without problems and the City's pilot testing approach makes sense before selecting a vendor and metering all customers. Regardless of the technology or system chosen, the potential benefits of AMI for increased customer service and improved demand management are significant and will be pursued.

4.2.3 Targeted Technical Assistance and Incentives

4.2.3.1 Fixtures, Appliances, and Incentives

As demands increase, Aspen will continue to face the combination of water supply limitations that occur during periods of peak demand. This means that for Aspen there is value in reducing its non-seasonal, or indoor, water uses. The gradual replacement of inefficient fixtures and appliances and other water using devices is an excellent way to accomplish this objective.

Even though Aspen has an unusually low percentage of homes with older fixtures due to the high penetration of remodels, Aspen still promotes the replacement of old and inefficient toilets, showerheads, faucets, clothes washers, and dishwashers through its regular education efforts. Aspen also has a series of monetary water efficiency incentives. In response to the 2002 drought, Aspen developed an innovative rebate program to incentivize customers to reduce water use. Over the last decade, the City has offered rebates for water efficient clothes washers, dishwashers, and toilets, and has provided free low-flow showerheads, hose spray nozzles, hose irrigation timers, and soil moisture meters. The City currently provides a rebate of $75 per low-flow toilet, and a maximum of 5 fixtures per residence are currently eligible for the rebate. Senate Bill 14-103, that phases in the sale of only high-efficiency WaterSense labeled fixtures in Colorado starting in 2016, may result in further indoor demand reductions for Aspen in the future.

In the future, Aspen may consider targeted programs to non-residential customers, such as the EPA H2Otel program.

4.2.3.2 Outdoor Water Efficiency

Aspen experiences high summer and late summer peak water demands due in part to the tourism industry, but more significantly due to irrigation demands from customers. The City

implements a variety of programs and pricing mechanisms (described above) to improve irrigation efficiency and reduce outdoor demands, and is considering additional programs to help reduce late summer peaking effects. These measures are intended to complement the City's energy audit and rebate program.

Irrigation Information and Education. The City has taken a number of steps to help reduce irrigation demands starting with customer education and extending through the conservation-oriented water rate structure. The City actively promotes efficient irrigation practices and seeks to reduce excessive use and waste. The City uses the water bill as an avenue for customer communication. In the spring, the City sends a utility bill insert that focuses on water efficiency programs, tips, and special offerings all designed around saving water. The City also has a very robust landing page for utilities on its website that has various water conservation related links and informational topics as well as a water use calculator.

Farmers Market. For many years the City has hosted an educational booth at the popular Saturday Farmers Market. This has proven to be an effective and popular outreach program that provides the opportunity to speak one on one with residents. These programs are expected to continue into the future.

Xeriscape Gardening. The City offers annual xeriscape seminars for Aspen residents.

Slow the Flow. Aspen is an ongoing participant of the week-long "Slow the Flow Colorado" program coordinated by the Center for Resource Conservation that provides free third-party sprinkler irrigation audits. A total of 50 free audits were completed in 2013, and an additional 48 were completed in 2014. The City expanded the 2014 program to include the "garden in a box" program, which is intended to simplify water-wise gardening by providing professional "plant-by-number" designs, a selection of xeriscape plants, and planting and care instructions all below retail costs.

Efficient Parks. Aspen leads by example through the efficient irrigation of parks and other municipal facilities. All City parks, medians, and other irrigated areas that use pressurized water are metered and billed based on their actual consumption. In 2008, the irrigation system at the Municipal Golf Course was completely upgraded with new piping, irrigation heads, and controllers.

Future Efficiency Upgrades to City Facilities. The City will research and evaluate opportunities to continue leading by example by incorporating the use of advanced irrigation system technologies at municipal properties, such as rain shutoff devices, efficient sprinkler heads, and weather-based controllers.

Conservation Oriented Water Rates. The City's rate structure encourages outdoor water efficiency by setting the tier 2 break point at 5,000 gallons/ECU/month, which attempts to distinguish indoor use (tier 1) and outdoor use (tier 2 to tier 4). As noted above, modifications

to the tier thresholds may be needed to limit the tier 1 budget being provided to larger homes with more fixtures.

Land Use Regulations for New Development. Described further below, the City may consider land use restrictions for irrigated landscaping associated with new developments.

Drought Response. While not a long-term outdoor water conservation measure, in the event of a climatological drought that affects the City's supply, Aspen's drought response regulations outline the process for implementing outdoor watering restrictions to reduce demands as required.

4.2.3.3 Commercial, Institutional, and Industrial Water Efficiency

Aspen's water conservation program for commercial, institutional, and industrial (CII) users focuses on education and pricing mechanisms. Pricing water and wastewater services appropriately has been shown to be an effective method for reducing water demands (Mayer et. al. 2008), (Mayer et. al. 2004), (Howe, 1982). In Aspen, CII customers are billed for water using the same rate structure as residential customers, which means that large users pay for most of their water at the higher tier rates.

The hospitality industry in Aspen, the largest block of non-residential water customers, has adopted a number of the best management practices. Guests at many Aspen lodging establishments are encouraged not to change their sheets and towels every day unless necessary. This has become an effective and successful industry-wide best-practice for hotels and motels across the U.S. The City also encourages the replacement of old and inefficient toilet fixtures in CII properties through the use of a rebate program. In 2011, the toilet rebate program was modified to double the compensation for commercial and lodging facilities as compared to residential ($150 vs $75), and allowed for an unlimited number of fixtures when previously capped at 3.

Aspen started conducting internal water use assessments in 2007 to evaluate the consumption in the City's buildings and the water treatment plant. The findings of this investigation prompted the replacement or upgrading of pumps and piping. In 2009, the City began working with a private consultant to implement $1.2 million worth of energy and water efficiency upgrades in 13 government-owned buildings. This provides Aspen an excellent opportunity to expand into CII water efficiency upgrades through similar programs or through the Center for Resource Conservation which is already implementing several programs for the City.

4.2.4 Ordinances and Regulations

4.2.4.1 Aspen Municipal Code

Aspen Municipal Code includes a number of important provisions related to water Conservation. Section 25.20.020 prohibits the waste of water including indoor leakage and

leaking irrigation system. Sec. 25.20.080 requires consumer education about water conservation. Text from these codes are provided below:

> ***Sec. 25.20.020. Wasting of water prohibited.*** *It shall be unlawful for any person using water from the City water system or any system connected thereto, to waste water. For purposes of this Section, to waste water shall mean any of the following:*
> *(a) The unnecessary running of water, which is not applied to any beneficial use, through or out of any water closet, lavatory, urinal, bathtub, hose, hydrant, faucet or other fixture, appliance or apparatus whatsoever, through the neglect or by reason of faulty or imperfect plumbing or fixture; or*
> *(b) The continuous application of water to lawns, sod, landscaping or amenity resulting in ponding or the flowing of water into drainage or storm drainage facilities; or*
> *(c) Failure to repair an irrigation system unit which is known to be leaking.*
> *(Code 1971, §23-151; Ord. No. 27-1985, §1; Ord. No. 37-1991, §5)*
>
> ***Sec. 25.20.080. Consumer education.*** *The Director of water shall develop a consumer education program to provide water consumers with information relating to water conservation. The consumer education program shall include, at a minimum, periodic distribution to water consumers of brochures on various water conservation topics. In addition, the Director of water may conduct seminars on water management techniques for both residential and commercial irrigation systems.*
> *(Code 1971, § 23-157; Ord. No. 37-1991, § 6)*

4.2.4.2 Regulatory Measures

On June 10, 2014 Governor Hickenlooper signed Senate Bill 14-103 into law, which will phase out the sale of old, inefficient toilets, showerheads, and faucets, and substitute high-efficiency, third party tested products in their place by 2016. This is a significant indoor water conservation provision that has the potential to reduce indoor demands over time in Aspen and across Colorado.

Given the challenge of addressing the late summer peaking issue, the City may consider including limitations on landscaping materials and the amount of irrigated area allowed under future water service agreements. Managing outdoor landscaping demands through land use regulations for new development is being considered throughout Colorado and provides an opportunity to reduce the impact from future demands.

The City has a water conservation and plumbing advisory code component of its Building and Building Regulations, Title 8, of Aspen Municipal Code. Included in this chapter are codes mandating the installation of high-efficiency plumbing fixtures, specific landscape and irrigation system requirements, and soil amendment requirements. This code contains strong water conservation provisions. The soil amendment provision is particularly good. Some of the plumbing fixture components of this code will likely be exceeded by the State-level WaterSense legislation passed in 2014.

Relevant sections of Aspen's municipal code are provided below.

Chapter 8.40
WATER CONSERVATION AND PLUMBING ADVISORY CODE

Sec. 8.40.010. Applicability.
The provisions of this Chapter shall govern the construction and the landscaping of new residential, commercial and industrial structures and the remodeling of existing residential, commercial and industrial structures within the City. (Code 1971, § 7-231; Ord. No. 43-1981, § 1)

Sec. 8.40.020. Installation of high-efficiency fixtures*.*
No building permit shall be issued for the construction of a new residential, commercial or industrial structure or for the indoor or outdoor remodeling of an existing commercial, residential or industrial structure unless the design, construction or remodeling incorporates high-efficiency plumbing fixtures. In the instance of indoor or outdoor remodeling, compliance with this Section shall be limited to that portion of the structure for which a building permit is issued.

High-efficiency plumbing fixtures shall be defined as those fixtures which comply with the following standards for water use:

> *(a) All water closets designed not to exceed a flow rate of one point 6 (1.6) gallons per flush.*
> *(b) Urinals designed not to exceed one point zero (1.0) gallons per flush. The use of automatic time flush devices for urinals shall not be permitted.*
> *(c) Shower heads designed not to exceed a flow rate of (two point five (2.5) gallons per minute.*
> *(d) Lavatory, kitchen and service faucets designed not to exceed a flow rate of two point 2 (2.2) gallons per minute.*
> *(e) All commercial lavatories equipped with spring-loaded faucets that close when not in use or faucets that are equipped with metering valves that close automatically after delivering a maximum of twenty-five (25) gallons, except for required handicapped facilities which may be equipped with faucets designed for the handicapped.*
> *(f) Exceptions. Restaurant kitchen faucets and safety showers shall be exempted from the above flow restrictions.*

Other types of high-efficiency fixtures may be permitted provided that those fixtures are proven to use no more water than those fixtures defined as high-efficiency fixtures. Such proof shall be made to the satisfaction of the Building Department Official reviewing the application for a building permit. (Code 1971, § 7-232; Ord. No. 43-1981, § 1; Ord. No. 37-1991, § 1)

Sec. 8.40.030. Landscaping criteria; grass species, irrigation.
(a) To the extent practicable and consistent with the proposed design and use of the property, landscaping shall utilize, for grassy areas, grasses which have the effect of minimizing the consumptive use of water applied to such grass for irrigation. The Director of Parks shall promulgate an advisory list of drought tolerant grass species and acceptable mixtures of such species. This list shall be updated as research and experience dictate.

(b) For all outside irrigation, the development proposal shall include, to the extent practicable, an irrigation system which would incorporate only equipment of the most water-conserving type commercially available at the time the proposal is submitted for approval. Additionally, all irrigation shall be undertaken with raw water if possible. At a minimum, irrigation systems shall:

(1) Be equipped with time-activated automatic control clocks and shutoff valves.
(2) Be equipped with sprinkler heads of a type which provide the most uniform coverage feasible and maximum feasible droplets sized to reduce evaporation and wind disturbance of the coverage (pulsating type).
(3) Where the slope gradient of the proposed development so requires, be designed to control flow for the purpose of reducing runoff. (Code 1971, § 7-233; Ord. No. 43-1981, § 1; Ord. No. 37-1991, § 2)

Sec. 8.40.050. Soil preparation.
No building permit shall be granted for the construction of a new residential, commercial or industrial structure unless the design of all landscaping areas primarily devoted to the cultivation of any species of grass for aesthetic purposes and not for agricultural food production, includes proper soil preparation as hereinafter defined.

Soil preparation shall be defined as the addition to existing soils of a minimum of three (3) cubic yards per one thousand (1,000) square feet of organic matter introduced by tilling, discing or other suitable method to a minimum depth of four (4) inches. Acceptable organic matter shall include compost, peat moss, aged manures, aged sawdust or any combination of the above. (Code 1971, § 7-235; Ord. No. 37-1991, § 3)

4.2.4.3 Reclaimed Water and Recycling

Aspen is in the process of implementing a reclaimed water system that will increase the availability of water in Castle Creek by shifting a portion of the diversions for the Aspen Golf Course and other irrigation demands to utilize treated wastewater effluent as a source of supply rather than to rely on delivery of water from Castle Creek. Since the treated water system relies on this same source of supply and because the City wishes to maintain a 13.3 cfs instream flow for aquatic habitat even during critically dry periods, this shift will free up an additional 1.0 million gallons per day of new supply. The Reclaimed Water System will be completed in 2015.

4.2.5 Public Education and Information

A key component of Aspen's water efficiency plan focuses on end-user education and information. Aspen has provided ongoing water use awareness education and conducted customer outreach since as early as 1992 and it is a requirement of Aspen Municipal Code as described above.

Public education and information efforts are ongoing, and Water Department staff regularly attend community events for outreach purposes. The City regularly provides information to customers about ways to conserve water and avoid water waste through flyers and bill inserts and the utility maintains conservation materials and information that are available upon request. Aspen's website includes a webpage with water conservation tips and drought management resources. Aspen's website also features a water calculator where customers can develop an estimate of their water use.

Aspen intends to explore opportunities to expand its education and outreach to target specific customer classes such as peak users and visitors. For example, there may be opportunities to educate visitors by expanding energy efficiency programs that have been implemented in the past with the hotel and hospitality industries, or by exploring other programs such as the EPA WaterSense H2Otel Challenge, which encourages hotels to assess water use and savings opportunities, change products or processes to incorporate best management practices, and track their water-saving progress and achievements.

5. IMPLEMENTATION AND MONITORING PLAN

The City's Water Department staff are primarily responsible for implementation of this plan, and has been successfully implementing the City's water and energy efficiency programs since 2006. The City will continue to budget money and may pursue CWCB water efficiency grants to further achieve its water efficiency goals.

5.1 MONITORING AND EVALUATION

Aspen will review and update this Water Efficiency Plan at least every seven years, or as needed. The City monitors water use on a regular basis and will maintain consumption records. Progress towards meeting the conservation goal can be evaluated when the conservation plan is next updated and into the future using empirical data. This tracking analysis will help determine what (if any) additional conservation program measures are necessary to help Aspen meet its stated goal by 2035.

Beyond tracking water efficiency progress every seven years, water efficiency program impacts are evaluated annually. The annual accounting summarizes total treated water production, the number of accounts in the system, metered deliveries, and estimates of both production and customer meter adjustments. This allows an estimate of annual losses to be made. For its AMI

customers, the City also monitors water use on a weekly basis. Staff prepare reports and personally contact customers with unexpected or abnormal water use, sometimes identifying leaks before the customers are aware of them.

When the conservation plan is updated, new forecasts will be developed and the adequacy of the City's water supplies will be compared to future demand forecasts. If necessary, the City will adopt additional demand management measures. The evaluation completed for this plan indicates that provided the elements of this plan are successfully implemented, Aspen will have sufficient raw water supply to meet forecast future treated water demands within the 20 year planning period (without factoring in additional climate change impact). However, the supply is vulnerable to streamflow hydrology, particularly in late summer months, and emergencies that prevent access to or use of one or more supply sources. A further provision regarding the adequacy of supply is that existing water supply projects including the reclaimed water project and efforts to increase available supplies from the City's wellfield must be successfully implemented. The City is monitoring hydrology trends and emphasizing demand management to mitigate this vulnerability.

5.2 REVENUE STABILITY

Revenue stability is a critical concern for the City of Aspen as it moves forward with the water efficiency program. The City's focus on water efficiency since the 1990's has resulted in decreased water use; and lower water sales mean reduced revenue. Water rates inevitably must rise to collect sufficient funds to cover fixed costs, which continue rising as aging infrastructure is repaired and replaced, and with inflation, the need to protect water rights and supplies, etc. Nationally, water costs are rising faster than costs for other utilities like energy, telephone, and cable; so water rates are rising (AWE 2013). While conservation is often perceived as the cause of increased water rates, it can actually help reduce the need for expansion of infrastructure and treatment costs.

The City of Aspen's water rate structure is designed to promote revenue stability and efficiency of water use. It includes a variable demand charge component based on the number of ECUs to provide for revenue stability and increasing rate tiers designed to promote efficiency. The City does anticipate a growth in water demand over time as the population grows. Water efficiency as practiced by the City of Aspen and its water customers helps ensure water rates remain as low as reasonably possible for customers, because efficiency is being achieved at a lower cost than procuring new supplies or constructing new infrastructure.

Long-term planning is critically important for revenue stability and anticipating changes in water use. Demand forecasting and quantifying responses to water efficiency programs (including rate changes) provide valuable information for forecasting future revenue and making necessary adjustments in advance of realizing a shortfall. Although such efforts are time intensive and require customer education, experts recommend adjusting revenue collection annually to allow for more immediate response to changes in costs and demand.

6. PUBLIC REVIEW, ADOPTION, AND APPROVAL OF WATER EFFICIENCY PLAN

6.1 PUBLIC REVIEW

The public review process is described in Appendix A. A total of one set of comments were received during the 60 day comment period. To the extent possible, comments were addressed in this updated plan.

6.2 WATER EFFICIENCY PLAN ADOPTION

City of Aspen Utilities staff reviewed this Water Efficiency Plan and made comments, after which the public review period began. The plan was updated to address public comments, and then presented to the City Council during a work session on June 15, 2015. The Water Efficiency Plan was subsequently updated to address comments from the City Council. On September 28, 2015, the City Council adopted the plan with the updates included in this final version. A copy of the City Council Resolution adopting the Water Efficiency Plan is included in Appendix A.

6.3 WATER EFFICIENCY PLAN APPROVAL

The draft Water Efficiency Plan was submitted to the CWCB Office of Water Conservation and Drought Planning on January 5, 2015, during the public review period. CWCB comments were addressed in this updated final version. On October 21, 2015, the City received official notification that the plan was approved by the CWCB.

7. COMPLIANCE WITH STATE PLANNING REQUIREMENTS

Colorado Revised Statute § 37-60-126 requires a covered entity to develop, adopt, make publicly available, and implement a water conservation (efficiency) plan that will encourage its domestic, commercial, industrial, and public facility customers to use water more efficiently. According to the statute, a "covered entity" means a municipality, agency, utility, or other publicly owned entity with a legal obligation to supply, distribute, or otherwise provide water at retail to domestic, commercial, industrial, or public facility customers, and that has a total annual demand for such customers of two thousand acre-feet or more.

Key elements that must be fully evaluated in development of the plan are listed as follows:

A. Water-saving measures and programs including:
   I. water-efficient fixtures and appliances;
   II. low water use landscapes, drought-resistant vegetation, removal of phreatophytes, and efficient irrigation;
   III. water-efficient industrial and commercial water-using processes;
   IV. water reuse systems;

V. distribution system leak identification and repair;
VI. information and education;
VII. conservation-oriented rate structures and billing systems;
VIII. regulatory measures designed to encourage water conservation;
IX. incentives to implement water conservation techniques including rebates.

B. Role of conservation in the entity's supply planning.
C. Plan implementation, monitoring, review, and revision.
D. Future review of plan within seven years.
E. Estimated savings from previous conservation efforts as well as estimates from implementation of current plan and new plan.
F. A 60-day minimum public comment period (or other time period based on local ordinance).

The following section of the plan details Aspen's compliance with this statute.

7.1 Aspen Water Efficiency Plan Compliance

The City of Aspen developed this conservation plan in order to comply with C.R.S. § 37-60-126. Each element of compliance is documented below.

A. Consideration of specific conservation measures.

(I) *Fixture and appliances* – The City actively promotes the installation of water efficient fixtures and appliances through its Water Conservation and Plumbing Advisory code which places specific requirements on new construction. The City has carefully considered and evaluated the costs and benefits associated with give-aways, rebates, and incentives to encourage more rapid adoption of efficient technology, and has offered incentives in the past. Additional expenditures for incentives are economically justified in order to help reduce demand, and because of State regulations mandating WaterSense labeled fixtures in the future, and the resulting benefit-cost analysis.

(II) *Water wise landscape* –The City implements a variety of programs and pricing mechanisms to improve irrigation efficiency and reduce outdoor demands, and is considering additional programs to help reduce late summer peaking effects. These measures are intended to complement the City's energy audit and rebate program. Specifically, the City implements an irrigation information and education program, periodically provides in-person efficiency information all summer long at the Aspen Farmer's Market, offers xeriscape seminars, provides free irrigation audits via Slow the Flow, requires efficient irrigation at City parks, and has specific irrigation and soil preparation requirements for new development.

(III) *Commercial, Industrial and Institutional (CII) measures* – Aspen's water conservation program for commercial, institutional, and industrial (CII) users focuses on education and pricing mechanisms. Guests at many Aspen lodging establishments are encouraged

not to change their sheets and towels every day unless necessary. In 2011, the toilet rebate program was modified to double the compensation for commercial and lodging facilities as compared to residential ($150 vs $75), and allowed for an unlimited number of fixtures when previously capped at 3.

Aspen started conducting internal water use assessments in 2007 to evaluate the consumption in the City's buildings and the water treatment plant. The findings of this investigation prompted the replacement or upgrading of pumps and piping. In 2009, the City began working with a private consultant to implement $1.2 million worth of energy and water efficiency upgrades in 13 government-owned buildings. This provides Aspen an excellent opportunity to expand into CII water efficiency upgrades through similar programs or through the Center for Resource Conservation which is already implementing several programs for the City.

(IV) *Water reuse systems* – Treated wastewater effluent from the wastewater plant will be reused for irrigation and possibly snowmaking. The City also provides raw water for irrigation.

(V) *Water loss and system leakage reduction* – System leakage in Aspen is currently estimated to average approximately 4%, which is well below the 10% threshold that is often estimated as the national average. This low rate of system leakage is not an accident, but rather the product of a progressive and ongoing water main replacement and repair program in Aspen. In the future, Aspen plans to implement the AWWA M36 Water Audit annually.

(VI) *Information and public education* – A key component of Aspen's water efficiency efforts is public education and information. The City regularly provides information to customers about ways to conserve water and avoid water waste through participation at community forums, flyers and bill stuffers, and the utility maintains conservation materials and information that are available upon request. The City hosts a booth at the Aspen Farmers Market where citizens can get in-person advice on energy and water efficiency.

(VII) *Water rate structure* – Aspen currently bills most of its customers on a monthly basis using a four-tier inclining block rate structure. Updates strengthening the price signal for high water users in this conservation-oriented rate structure take effect in January 2015.

(VIII) *Technical assistance* – none was requested for development of this plan.

(IX) *Regulatory measures* – Aspen has a number of significant water efficiency regulatory measures include:

- Water waste ordinance

- Consumer conservation education requirement
- Water conservation building code
    - High-efficiency fixtures
    - Landscaping and irrigation criteria
    - Soil preparation

(X) *Incentives* – Due to considerable remodeling and upgrading in Aspen, incentives are not a particularly cost-effective inducement to conservation, given the requirements currently in place for efficient fixtures. Regardless, Aspen has provided a wide variety of incentives for water conservation over the past 15 years and will continue to do so on an "as needed" basis.

B. Role of conservation in Aspen supply planning. This Water Efficiency Plan represents Aspen's most comprehensive effort to integrate water conservation into water supply planning. Through this plan, the City has established that its raw water supply is adequate to meet anticipated future growth, although lack of existing storage means that Aspen remains at risk of shortages when streamflows are low, or when emergency conditions prevent or limit use of one or more sources of supply. Moreover, the demand projections in this plan do not factor in impacts of additional future climate changes.

C. Plan implementation, monitoring, review, and revision. The City monitors water use on a regular basis and will continue to do so. The City produces monthly and annual demand reports for each customer sector and the system as a whole and keeps close track of demand. Aspen will review and update this water conservation plan every seven years or as needed. During this review, progress towards achieving the stated conservation goal will be evaluated.

D. Future review of plan within seven years. Aspen will review and update this water conservation plan every seven years or as needed.

E. Estimated savings from previous conservation efforts and current plan. Over the twenty-year forecasting period under the City's conservation program, annual demand rises from 3,377 acre-feet to 3,597 acre-feet and results in a savings of 583 AF/yr. The impact of past water conservation efforts since 1990 is estimated at 4,238 AF of water savings annually.

F. Public comment period. A 60-day public review process was held from December 24, 2014 through February 27, 2015. During this period, one person submitted written comments. The comments and responses from the City of Aspen are provided in Appendix A. To the extent possible, comments were addressed in this updated plan but did not result in any major changes.

8. ROARING FORK REGIONAL WATER EFFICIENCY PLAN

The development of the City of Aspen Water Efficiency Plan was a collaborative effort funded by a Colorado Water Conservation Board grant as part of the Roaring Fork Watershed Regional Water Efficiency Plan. The Regional Water Efficiency Plan is published under separate cover and focuses on regional opportunities to increase municipal water efficiency. The City's Water Efficiency Plan has potential to directly impact flows in the Roaring Fork River, although Aspen cannot guarantee that water it saves through conservation efforts will benefit the entire reach of the Roaring Fork to the extent that other downstream water users may divert that water out of the river.

The City is interested in regional partnership to improve water efficiency and is committed to assisting with the implementation of the Regional Water Efficiency Plan. Examples of Aspen's previous participation in regional activities include:

- Helped fund the Ruedi Water and Power Authority for its first 20 years;
- Partnered with Roaring Fork Conservancy on educational programs and tours;
- Has a board member on the Roaring Fork Watershed Collaborative;
- Partnership with Aspen Consolidated Sanitation District on reuse/reclamation project;
- Agreement with Colorado Water Conservation Board for use of Aspen's senior water right to protect decreed flow on Hunter Creek and agreement with Colorado Water Conservation Board for protection of decreed instream flow on Castle Creek;
- Colorado Water Trust pilot program involving a forbearance agreement that enhances streamflows in the Aspen reach of Roaring Fork River; and
- Cooperative agreements and projects with Colorado River Water Conservation District, Twin Lakes Reservoir & Canal Company and others to provide streamflow protection for the Roaring Fork River in connection with operation of transmountain diversion projects.

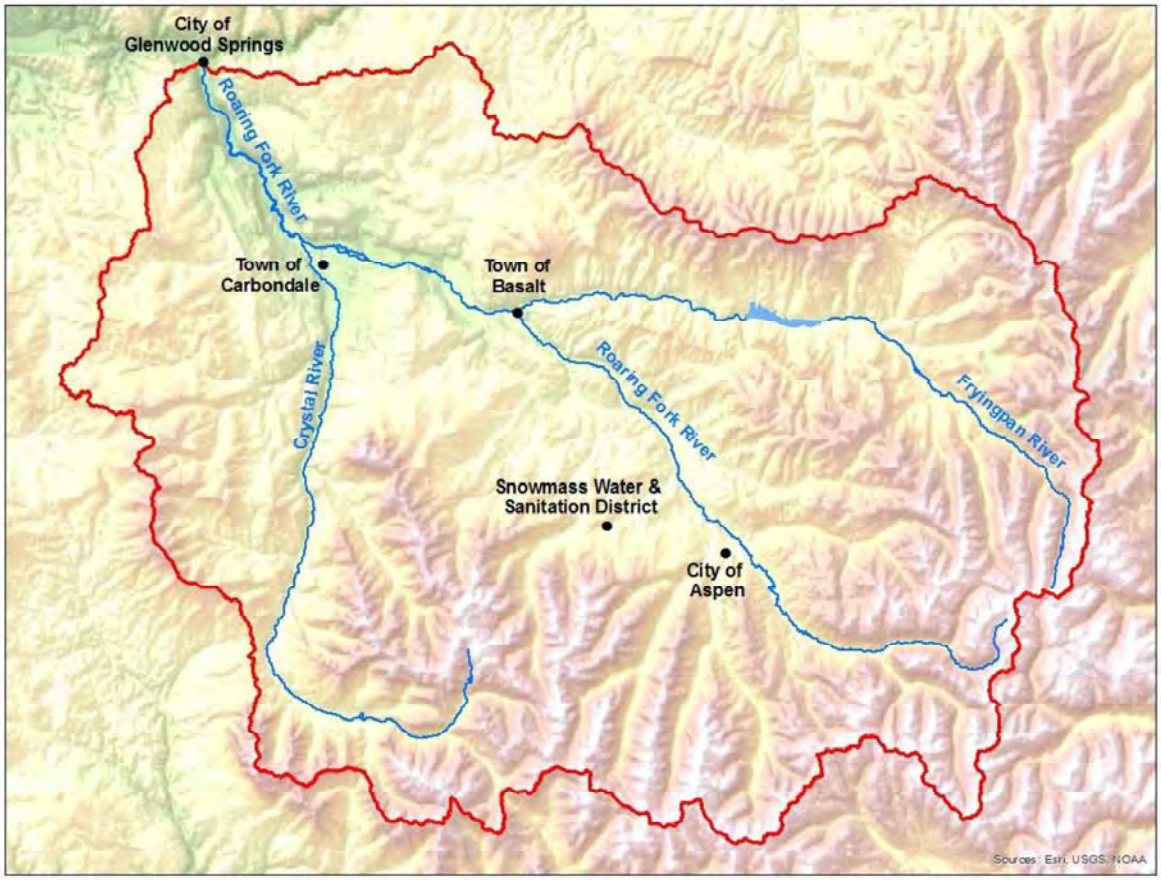


Figure 12. Water Providers Participating in the Roaring Fork Regional Water Efficiency Plan.

9. REFERENCES

Alliance for Water Efficiency (2013, June). Our Current Revenue Loss Dilemma: Is Customer Conservation Really the Culprit? Introductory Webinar.

Aspen (2014). Information downloaded from Frequently Asked Questions page of the City of Aspen website.
http://www.aspenpitkin.com/Portals/0/docs/City/CommRelations/FAQHYDRO.pdf

CIRES Western Water Assessment (2014, March). Climate Change in Colorado: A Synthesis to Support Management and Adaptation, Draft (Version 3).

Colorado Water Conservation Board (2012, July). Municipal Water Efficiency Plan Guidance Document.

Colorado WaterWise (2010). Guidebook of Best Practices Guidebook for Municipal Water Conservation in Colorado.

Howe, C. W. (1982). The Impact of Price on Residential Water Demand: Some New Insights. Water Resources Research 18(4):713-16.

Lukas et al. (2014). Climate Change in Colorado. Western Water Assessment.

Mayer, P.W. et. al. (2008, May). *Water Budgets and Rate Structures: Innovative Management Tools*. Journal of the American Water Works Association. Vol. 100, No. 5.

Mayer, P.W, et. al. (2004). National Submetering and Allocation Billing Program Study – Project Overview and Preliminary Results. Proceedings of the Water Sources Conference 2004, Austin, TX. Proceedings of the AWWA Annual Conference, Orlando, FL.

SWSI (2010). Statewide Water Supply Initiative 2010 Final Report, Colorado Water Conservation Board.

USGS (2013). Water-Data Report 2013, 09085000 Roaring Fork at Glenwood Springs, CO. http://wdr.water.usgs.gov/wy2013/pdfs/09085000.2013.pdf

Western Regional Climate Center (2014, WRCC). Aspen 1 SW, Colorado Period of Record Climate Summary from `980 to 2012, Station No. 050372.

Wilson Water Group, previously Grand River Consulting (2014, September). Personal communication with Tyler Benton.

APPENDICES

APPENDIX A

CITY OF ASPEN MUNICIPAL WATER EFFICIENCY PLAN PUBLIC NOTICE ANNOUNCEMENT, PUBLIC COMMENTS, AND OFFICIAL PLAN ADOPTION RESOLUTION

A1. PUBLIC NOTICE ANNOUNCEMENT

A Public Notice (reprinted below) was published on December 24, 2014, through the City of Aspen website: http://www.aspenpitkin.com/Departments/Utilities/Water. Public comments on the Municipal Water Efficiency Plan for City of Aspen were requested via email by February 27, 2015 to: WaterAdmin@cityofaspen.com.

Press Release

Public Input Requested for Aspen's Draft Water Efficiency Plan

PUBLIC SERVICE ANNOUNCEMENT

Public Input Requested for Aspen's Draft Water Efficiency Plan

Contact: Lee Ledesma, Finance and Administrative Services Manager, Utilities Department, City of Aspen, 429-1975 or lee.ledesma@cityofaspen.com.

Aspen, Colorado – December 24, 2014 – The City of Aspen has completed a draft of an updated water efficiency plan and is requesting public input. The plan is being updated as part of the City's participation in a Roaring Fork Watershed Regional Plan, which is a partnership between Aspen, Snowmass Village, Basalt, Carbondale and Glenwood Springs. The report is designed to look at future demand and efficiency measures with the goal of benefiting and enhancing the stream flow in the upper Roaring Fork River basin. To read the report and get information on how to comment go to www.aspenpitkin.com and click on Water Department. The deadline for comments is February 27, 2015.

###

Posted on Wednesday, December 24, 2014

A2. PUBLIC COMMENTS

The 60-day public review process was held from December 24, 2014 through February 27, 2015. During this period, one person submitted written comments. The comments and responses from the City of Aspen are presented below.

A2.1 COMMENTS RECEIVED

The comments received are reprinted below, as received.

> Thank you for accepting my feedback in response to the **City of Aspen's Municipal Water Efficiency (WE) Plan**. I welcome the opportunity to discuss my notes with your team in-person should that help inform Plan refinements. While it appears the report is focused primarily on **Water Quantity**; there is excellent opportunity to illustrate the parallel benefits of improved **Water Quality**. Too, the topics listed below are primarily focused on **outdoor water conservation** as informed by my professional practice—registered Landscape Architect.
>
> **Opportunities for additional WE activities/education** (page 40):
> Climate—reduce contributors to increasing temperatures
> Reduce risk of catastrophic events—slides, fires, etc
> Temperatures (reduce heat island effect)
> Restore/protect aquatic systems
> Require or incentivize for preservation/protection of native, undisturbed areas of soil/plants
> Soil/vegetation work together, protect together—reduce disturbance + protect
> Existing Veg/Soil/Water—protect
> Proposed Veg/Soil/Water—xeric, organic
> Consider solar exposure and effect on irrigation/water needs
> Manage precipitation on site—reduce hardscape, mimic nature/treatment train, direct roof and other runoff into planting beds, future possibility to manage/collect/store runoff
> Functional stormwater features as amenities—integrate functional stormwater features (review as Plan may complement and/or conflict with *City Engineering* regulations)
> Reduce water use in landscape/reduce irrigation/xeric/drip—mandate limitations
> Require irrigation be non-potable if available to property
> Reduce outdoor water use—pools, spas, water features, snowmelt (evapo loss), etc
> Provide detailed xeric plant list as informed by appropriate elevation/aspect/precipitation/etc
> Consider wind exposure (impact to water needs, irrigation inefficiencies)
> Landscape maintenance standards

Detailed inventory of City of Aspen parks, open space and similar public lands, inventory to consider:
Use of treated water for irrigation
Use Kentucky Bluegrass (define acreage)
Maintenance plan
Planting plan (xeric versus non)
Irrigation plan (drip versus spray)

Detailed inventory of Districts/School, as relevant
Same as above

Consider acknowledgment:
City Engineering standards—high quality guidelines and regulations
City code—aquatic systems currently protected (riparian buffers, wetlands, streams)

Despite **Colorado Water Law**, integrate a wish-list for future implementation opportunities such as
Rainwater harvesting, graywater reuse, etc.

Education/awareness—opportunities for field-demonstrations of vision implemented by City at City owned parks and open/space, such as:

Zoned irrigation, drip, temporary for establishment versus permanent
Turfgrass species location appropriate
Consider 'natural' swimming pools
Low-impact, aesthetically awesome stormwater design
Green roofs
Detention/retention

Consider pilot projects:
http://water.state.co.us/SurfaceWater/SWRights/Pages/RainwaterGraywater.aspx

A2.2 Responses from City of Aspen

Thank for you for taking the time and effort to prepare these useful comments. Below is a summary of how these comments were addressed in the Water Efficiency Plan. Please understand that it is not possible to incorporate all of the recommendations submitted.

A2.2.1 Treated Water Supply

The City understands that reducing irrigation runoff has the potential to reduce nutrient flows into local streams and rivers and is an additional benefit of this water efficiency plan, with its focus on outdoor

watering and irrigation efficiency. As noted in the comments, the City of Aspen Water Efficiency Plan is focused entirely on water quantity and does not touch on water quality. Aspen's plan was carefully prepared to comply with State of Colorado planning requirements and legislation, which does not currently include water quality as part of the legal planning requirement.

The City hopes to incorporate ideas for reducing runoff and improving water quality in the coming years through the consideration of a model landscape ordinance, which is further described in the Regional Water Efficiency Plan for the Roaring Fork Watershed.

A2.2.2 Water Efficiency Activities and Education

The City of Aspen actively promotes water efficiency through a variety of informational and educational efforts described in this plan. In addition, the City plans to research and develop a local landscape ordinance that will help ensure new and remodeled landscapes and irrigation systems incorporate best practices for water efficiency. This will provide an opportunity to incorporate some of the recommendations from the comments on solar exposure and landscape maintenance standards.

Some of the items listed in the comments such as "reduce risk of catastrophic events – slides, fires, etc." are not directly linked to existing or proposed water efficiency activities and may be considered for inclusion in a future plan update, or in a different context such as a regional plan or climate resiliency plan.

Aspen has provided ongoing water use awareness education and has conducted customer outreach since as early as 1992, and it is a requirement of Aspen Municipal Code as described above. Public education and information efforts are ongoing, and Water Department staff regularly attend community events for outreach purposes. The City regularly provides information to customers about ways to conserve water and avoid water waste through flyers and bill stuffers and the utility maintains conservation materials and information that are available upon request. Aspen's website includes a webpage with water conservation tips and drought management resources. Aspen's website also features a water calculator where visitors can develop an estimate of their water use.

A2.2.3 Inventory of City of Aspen Parks and School Properties

All City parks, medians, and other irrigated areas that use pressurized water are metered and billed based on their actual consumption. In 2008, the irrigation system at the Municipal Golf Course was completely upgraded with new piping, irrigation heads, and controllers. Irrigation systems on selected parks and open spaces have been converted to the alluvial groundwater supply system, which frees up treated water for other municipal purposes.

The City of Aspen Parks Department manages the City's parks. This management includes landscaping, irrigation and water management. School landscapes are designed and maintained by the local school district. Maintaining landscape inventories and irrigation system information are tasks that are accomplished by other departments and staff. Working with the Parks Department and school district to identify potential for additional water demand management may be considered in future plan updates.

A2.2.4 Acknowledgement of City Codes and Standards

The City does have regulations on riparian buffers and wetlands related to stormwater runoff. As stormwater runoff is outside the purview of this plan, these regulations are not explicitly discussed. Aspen does, however, provide stormwater quality treatment.

A2.2.5 Wish List "Despite Colorado Water Law"

While the City did not incorporate a "wish list" related to Colorado water law as part of its plan, this topic is addressed and included in the Roaring Fork Regional Water Efficiency Plan. The Regional Plan was made available for public review on March 10, 2015.

A3. OFFICIAL PLAN ADOPTION RESOLUTION

City of Aspen Utilities staff reviewed this Water Efficiency Plan and made comments, after which the public review period began. The plan was updated to address public comments, and then presented to the City Council during a work session on June 15, 2015. The Water Efficiency Plan was subsequently updated to address comments from the City Council. On September 28, 2015, the City Council adopted the plan with the updates included in this final version. A copy of City Council Resolution 081-15 adopting the Water Efficiency Plan is attached.

RESOLUTION NO. 81
Series of 2015

A RESOLUTION OF THE CITY OF ASPEN, COLORADO, ADOPTING THE CITY OF ASPEN MUNICIPAL WATER EFFICIENCY PLAN.

WHEREAS, the City of Aspen has demonstrated a long-term commitment to wise water stewardship and responsible and efficient use of its water resources; and

WHEREAS, the City of Aspen carefully developed a City of Aspen Municipal Water Efficiency Plan, attached hereto as Exhibit A and incorporated by this reference (the "Aspen Water Efficiency Plan"), in accordance with the Colorado Water Conservation Act of 2004 so that it meets or exceeds all statutory requirements according to Colorado Revised Statute § 37-60-126; and

WHEREAS, the Aspen Water Efficiency Plan was created to identify opportunities for further efficiencies in the Aspen water system; and

WHEREAS, the City of Aspen has been successful in implementing a number of indoor water conservation measures and has now identified future measures that focus on outdoor water efficiency to reduce water demands and provide reasonable cost savings for water utility customers.

NOW, WHEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF ASPEN, COLORADO, THAT:

Section One

The City Council of the City of Aspen hereby adopts the City of Aspen Municipal Water Efficiency Plan.

INTRODUCED, READ AND ADOPTED by the City Council of the City of Aspen on the 23rd day of Sept, 2015.

Steven Skadron, Mayor

I, Linda Manning, duly appointed and acting City Clerk do certify that the foregoing is a true and accurate copy of that resolution adopted by the City Council of the City of Aspen, Colorado, at a meeting held on the day hereinabove stated.

Linda Manning, City Clerk

CITY OF ASPEN

Drought Mitigation and Response Plan

City of Aspen, Colorado

ELEMENT Water Consulting

JULY 2020

130 SOUTH GALENA ST
ASPEN, CO 81611
(970) 920-5000

CITY OF ASPEN DROUGHT MITIGATION AND RESPONSE PLAN

PREPARED BY

ELEMENT
Water Consulting

www.elementwaterinc.com
(303) 481-2365

July 28, 2020

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AF	acre-feet
AFY	acre-feet per year
cfs	cubic feet per second
CWCB	Colorado Water Conservation Board
DMRP	Drought Mitigation and Response Plan
DRC	Drought Response Committee
gpm	gallons per minute
IRP	Integrated Resources Plan
NRCS	Natural Resources Conservation Service
SNOTEL	Snow Telemetry
SWE	snow water equivalent
USGS	United States Geological Survey
WATF	Water Availability Task Force
WEP	Water Efficiency Plan

INTRODUCTION

The City of Aspen (City or Aspen) owns and operates its water supply system, providing treated, i.e. potable, water to all customers in its service area and raw, i.e. non-potable, water for irrigation purposes to a small subset of customers. Aspen provides water for snowmaking from both treated and raw water supplies. The City is committed to sustainability and providing a quality potable water supply to the community. This Drought Mitigation and Response Plan (DMRP) provides a framework for Aspen to use water sustainably, particularly during drought and other conditions that create a water shortage. Water shortage occurs when water demands exceed available water supplies and is often driven by a combination of snowpack and precipitation conditions, temperature, and water use[1]. Implementation of the DMRP will support the wise use of water under all conditions, help preserve essential public services, and minimize the adverse effects of a water supply emergency on public health and safety, environmental resources, economic activity, and individual lifestyles. The DMRP works in concert with the City of Aspen Water Efficiency Plan (WEP) and programs implemented through the WEP, such as the Water Efficient Landscape Ordinance. These plans and programs encourage the efficient use of water at all times by establishing "normal" condition guidelines that are in place unless restrictions are imposed through action by City Council. Aspen staff rely upon national drought monitoring tools and indices as well as state and local hydrologic and climatic information to monitor for drought conditions. Through this monitoring, coupled with analyses and professional judgment, Aspen staff will recommend appropriate drought stage declarations for Council's approval under the DMRP. Section 6 of this plan provides an overview of the staged response program and Section 7 provides additional information about the implementation process.

PLAN FOCUS

Aspen obtains its water supply primarily from the surface water sources of Castle Creek and Maroon Creek which are tributaries to the Roaring Fork River. Aspen's water supply is highly dependent upon snowpack and the snowmelt runoff pattern. The City's water system does not currently include a significant water storage component that would allow it to store water supplies when they are available and release stored water when it is needed, retiming deliveries of water supplies to match timing of water demands. Without storage, the City is largely dependent upon streamflow availability at its river diversion points.

This DMRP focuses on managing the supplies that are available under the City's current surface water system operations. Potential future supply components, such as storage and use of ground water, are identified as longer-term water shortage mitigation strategies. Streamflow is susceptible to variation and changing conditions, including diurnal streamflow fluctuations, as well as catastrophic events such as landslides, fires, and other events that can prevent river diversions for some period of time. For Aspen, its surface water supply is vulnerable in the late summer, after the main snowmelt runoff period, when landscape irrigation demands are still high. Furthermore, Aspen is committed to protecting decreed instream flows and has adopted a policy to maintain streamflow in the creeks downstream of its diversion structures at flow rates that are at or above the Colorado Water Conservation Board's (CWCB) decreed

[1] This plan focuses specifically on mitigation and monitoring for drought indicators; however, many aspects of the response program are applicable for other types of water shortages. For purposes of this plan, the terms "drought" and "water shortage" are used somewhat interchangeably.

instream flow rights for the protection of the fishery and the associated aquatic habitats in those streams. At times, Aspen limits its river diversions to prioritize protection of the environmental flows.

Demand-side response strategies provide ways the City and its customers can reduce water use during a shortage. These strategies are the cornerstone of the City's DMRP. During drought conditions, water supply shortages are typically most pronounced during summer months, when demands are high due to irrigation. Therefore, the response measures in this DMRP generally target outdoor water uses. Additional detail regarding Aspen's water demands is available in the WEP.

This DMRP specifically applies to uses of the City's treated water supply. It also applies to use of the City's pressurized and non-pressurized raw water supply that is made available pursuant to agreements that provide for curtailment of water use or suspension of water delivery during water shortages or emergencies, as defined under Section 25.28 of the City Municipal Code. Some of the City's raw water supply is provided pursuant to longstanding agreements that do not contain curtailment provisions.

1. STAKEHOLDERS, OBJECTIVES AND PRINCIPLES

1.1 DROUGHT RESPONSE COMMITTEE

Historically, the Aspen Utilities Department has coordinated with other staff throughout the City as water supply monitoring began to indicate the potential for drought conditions. Staff have come together to make recommendations to City Council regarding water shortage declarations related to drought conditions. In 2019, a formal Drought Response Committee (DRC) was formed to support the planning for ongoing drought response efforts. Starting in 2018 and ending in summer of 2019 (the "2018" drought), Aspen was under a water shortage declaration. During this period, the Utilities Department staff realized that the success of an ongoing water shortage monitoring and response program would depend upon having an interactive, collaborative process with staff from other departments throughout the City. The DRC includes staff representing departments that need to be involved to monitor drought conditions, make recommendations for declaring a water shortage related to drought, communicate with elected officials and the public both before and during drought, evaluate the effectiveness of drought response, enforce drought restrictions, and provide recommendations for necessary actions. A list of the current DRC members and committee roles is provided in Table 1 below.

Table 1: Drought Response Committee Members and Roles.

Current Staff	Position	Committee Role	Committee Role Responsibilities
Scott Miller	Public Works Director	Final Decision Maker	Make final decisions in consideration of DRC input. Support Utilities Director and staff in development, promulgation, and implementation of Rules and Regulations.
Tyler Christoff	Utilities Director	Resource Authorization Lead	Assist in clarifying roles and providing staff support. Develop and promulgate Rules and Regulations to implement response plan under water shortage declaration. Ensure Rules and Regulations are carried out and provide coordination between departments.
Steve Hunter	Utility Resource Manager	Drought Response Team Leader	Lead the coordination, gathering, and dissemination of information and prepare recommendations for department heads and City Council.
Lee Ledesma	Utilities Finance Manager	Financial Advisor	Provide cost estimates to implement demand reduction programs, evaluate expected lost revenue estimates, and recommend drought pricing changes.
Austin Weiss	Parks Managers	Parks Advisors	Provide information and guidance on irrigation management of parks, golf course, and open spaces.
Rob Covington	Raw Water Supervisor	Watershed Conditions Advisors	Provide information and guidance on water supply availability, water rights, and operations.
Charlie Bailey	Water Treatment Supervisor	Water Treatment Advisor	Provide information and guidance on water treatment operations and water quality issues.
Ashley Perl	Climate Action Manager	Environmental Policy Advisor	Provide information and guidance on best science for monitoring climate and ensure that the drought response is coordinated with the City's environmental policy.
Mitzi Rapkin	Community Relations Specialist	Messaging Advisor	Lead the public outreach, messaging to customers, media relations, and messaging to staff.
Melissa Asay	Utility Billing Supervisor	Billing Advisor	Lead the implementation of database improvements and bill format changes to implement rate and fee changes and provide messaging information.
Chris Menges	E.H. Data and Research Project Planner	Efficiency Policy Advisor	Provide information and guidance on water demand reduction measures and associated cost estimates. Evaluate response effectiveness. Serve as the liaison between the WEP and DMRP.
Raquel Flinker	Project Manager II	Utilities Analyst	Serve as the liaison for internal planning and implementation efforts such as the City's exploration of Alternative Transfer Methods and the development of the Integrated Resources Plan.
April Long	Clean River Program Manager	River and Stormwater System Advisor	Provide information and guidance on impacts of drought to the health of the river and stormwater system.
Jim True	City Attorney	Legal Advisor	Provide legal advice on the drought response program, drought pricing changes, and need for City Council approval.

During the 2018 drought, four meetings were held with the DRC focusing on the drought conditions and response measures. The DRC meetings were designed to monitor drought conditions to inform ongoing drought stage recommendations while discussing long-term goals, objectives, and strategies for drought response planning and implementation. A significant amount of the DRC meeting time was spent discussing Aspen's unique customer base and how to engage and encourage customer and community support for efficient water use at all times. The DRC insight provided a broad perspective in developing this DMRP. When a drought occurs, the DRC will work together to move through water shortage declarations and implement a staged response plan.

1.2 OBJECTIVES AND OPERATING PRINCIPLES

Aspen's DMRP objectives and operating principles were established to guide the development of this plan while also supporting the City's water use priorities. The DMRP objectives are as follows:

- Maintain essential public services to preserve public health and safety, environmental resources, and economic activity during all drought stages.
- Provide guidance to prepare for and respond to drought conditions through a staged drought response program. This includes the framework for how to transition through varying drought stages depending on drought severity, as indicated through monitoring of available hydrologic, climatic, and water use information.
- Effective communication of drought awareness and response information to water customers.

When water shortages occur, water use restrictions are imposed in order to meet the most critical community needs. The general prioritization of water use under a water shortage condition is provided in Table 2. The City's first priority is to preserve the health and safety of the community, followed by the City's commitment to protect the natural environment through the preservation of decreed instream flows. Depending on the severity and duration of the water shortage, water uses described under Priorities 4, 5, 6, and 7 may need to be reduced or prohibited, starting with hydroelectric power generation as the lowest priority use. Restrictions under Priority 3 reflect 'nonessential' potable indoor uses; however, these restrictions could impact the business and commercial/recreational sector and would likely not be implemented except under severe, long-term shortages. While this sequence of priorities reflects the City's general philosophy for community water use during water shortage conditions, each water shortage circumstance is unique and will be evaluated by the City to determine the appropriate set of response measures. The DMRP provides a comprehensive yet flexible framework to guide the City through drought mitigation and response efforts, as well as the procedures to follow for declaring a drought and implementing drought response measures.

Table 2: General Water Use Priorities During Water Shortage Conditions.

Priority	Representative End Uses	Description
1	Health and Safety	Indoor sanitary uses for residential, commercial, schools, health services, etc.; firefighting and hydrant flushing.
2	Protection of Natural Environment	Protection and maintenance of decreed instream flows.
3	Discretional Commercial and Industrial Use	Non-sanitary indoor uses; outdoor commercial uses to support stability.
4	Public Parks and Recreation	Outdoor potable or raw water irrigation of public areas, including lawngrass in active recreation areas.
5	Residential Landscaping Features	Outdoor potable or raw water irrigation of trees and shrubs in residential areas.
6	Lawngrass Irrigation	Outdoor potable or raw water irrigation of residential lawngrass and public areas with low foot-traffic throughout the City.
7	Hydroelectric Power Generation	Generation of hydroelectric power from Maroon Creek diversions.

The following operating principles supported the development of this DMRP and provide a set of guidance criteria that will support the DRC while making decisions during times of a drought.

- Input from the DRC and other City representatives will be considered in the development and implementation of the DMRP.
- Response measures that limit and/or restrict water use of certain end-users will be implemented in a manner to reflect the priorities listed above, with the highest priority being the preservation of water for public health and safety purposes during periods of drought.
- Except when public health or safety is at risk, all reasonable efforts will be taken to preserve the environmental and recreational value of the surrounding lands which are important to the values and livelihood of City residents. This is the City's highest priority second only to public health and safety.
- Effective coordination and collaboration among City staff is crucial to the success of the DMRP. This plan provides a comprehensive framework for implementation of the staged drought response program based on available information. Exceptions/adjustments to this framework may be necessary during a drought or under other water shortage conditions. Any changes will be clearly communicated and coordinated among the appropriate City staff.
- The City will strive to minimize the severity of potential impacts through diligent planning and mitigation.
- Targeted communication and outreach with the community is critical to the implementation and success of any program requiring a reduction in demands. Developing an engaged and educated public will better support an effective drought response.

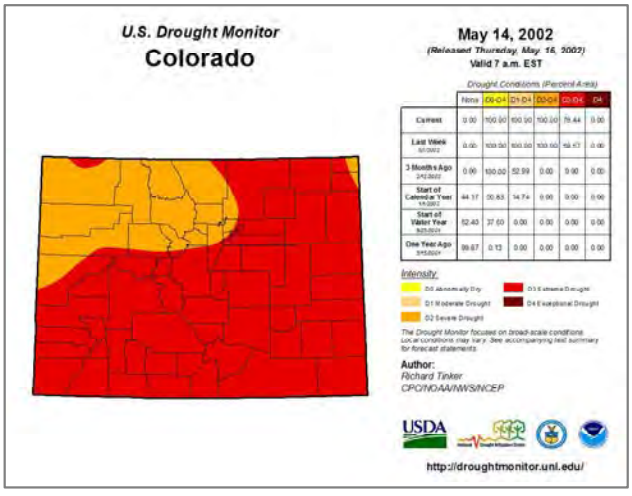
2. HISTORICAL DROUGHT AND IMPACT ASSESSMENT

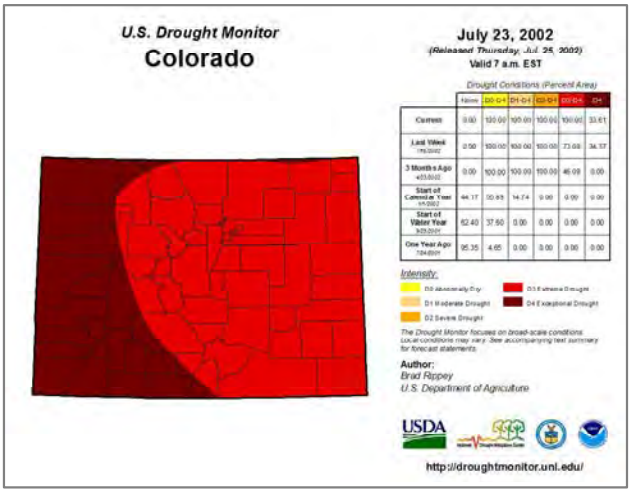
2.1 HISTORICAL ASSESSMENT OF DROUGHT, AVAILABLE SUPPLIES, AND DEMANDS

Droughts are cyclical and unavoidable, especially in Colorado's semi-arid climate. Our water history is reflected in terms of these historical droughts and how significantly streamflow was impacted. Historical periods of drought are often referenced in long-range water planning efforts to provide a "worst-case" planning scenario. The Aspen Utilities Department, for example, frequently references the 1977 drought to represent historically low streamflow. In fact, 1977 is known locally as the year that the Roaring Fork went dry through Aspen. In more recent history, 2002, 2012, and 2018 conditions influenced water shortage declarations in Aspen and across the state. In particular, 2002 was considered the worst drought year on record statewide in terms of streamflow. Without meaningful storage, Aspen relies completely on live stream conditions. Aspen considers these historical droughts in its water supply planning, as well as the potential for more severe or prolonged droughts to occur in the future. Following each of the recent droughts, Aspen has reevaluated its drought response and made changes to its drought response program and/or Municipal Code to reflect lessons learned and to more clearly define demand reduction goals, stages, and response mechanisms, as appropriate.

2002 Drought

At the end of April, 2002, the year-to-date precipitation at the Independence Pass SNOTEL site was at 64% of the long-term average. These conditions triggered the City to begin planning for a potential drought over the coming months. Streamflow projections were showing that runoff could peak as early as mid-May, which is about four weeks ahead of normal. There was another complicating factor due to atypical early administrative water rights calls on the river in the lower Gunnison and Colorado Rivers that impacted legally available supplies in the Roaring Fork Basin. Statewide, the Governor had declared a drought emergency by May of 2002, calling on local governments and others to do their part in conserving the State's water resources.





In early May, 2002, Aspen initiated a Stage 1 water shortage declaration, beginning with voluntary restrictions and an adjustment to its tiered rate structure in the highest tier. The City terminated the water shortage declaration and the associated temporary surcharges in October of 2002, never having advanced

beyond the Stage 1 declaration.[2] There has been a steady decrease in Aspen's potable demands, largely in response to the significant drought impacts and enhanced water efficiency focus following the 2002 drought. Aspen's ongoing conservation and efficiency activities have influenced a consistent decrease in water use over time and helped to mitigate drought impacts experienced in Aspen over the 2012 and 2018 droughts.

2012 Drought

By June, 2012, much of Colorado was experiencing some level of drought condition. The City was experiencing a reduction in supply from water that could not be produced from its wells due to water quality issues. Additionally, extremely low snowpack leading into the runoff season threatened late-summer streamflow levels. In June, 2012, Aspen initiated a water shortage declaration, beginning with voluntary restrictions and an adjustment to the highest tier of its rate structure. Aspen decided to keep the Stage 1 declaration through the 2012 – 2013 winter. Having the Stage 1 declaration in place at the beginning of the irrigation season was considered essential to early actions and educational outreach to City customers, allowing them an opportunity to initiate changes in irrigation and other uses that would conserve water throughout the 2013 irrigation season.

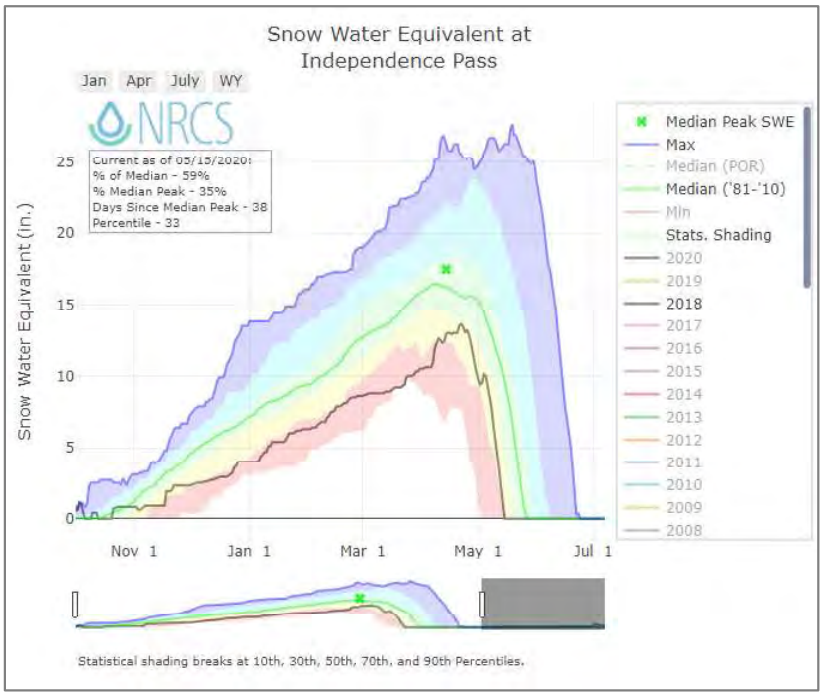
Aspen and the surrounding areas experienced strong monsoon weather patterns in late July through August of 2013, leading to improved instream flows in Castle and Maroon Creeks. In September, 2013, the City ended the Stage 1 declaration and all associated surcharges. The City experienced higher demands in 2012 with demands reducing in 2013 in response to ongoing Stage 1 declaration and voluntary reductions.[3] Following this drought, the City added water use reduction goals for pressurized and non-pressurized raw water systems.

2018 Drought

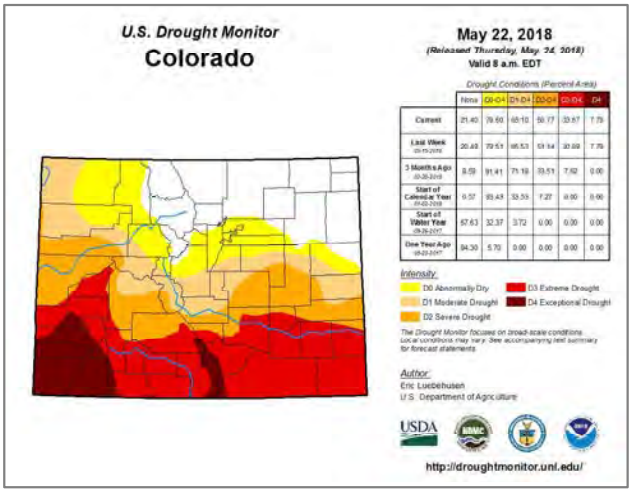
As of May 7, 2018, the year-to-date precipitation at the Independence Pass SNOTEL site was at about 60% of the long-term average. These drier than normal conditions were expected to impact the runoff season, both in terms of the time to return to baseflows and the volume of runoff available. Forecasts indicated the volume of runoff was expected to be 50% to 70% of normal for the Roaring Fork Basin.

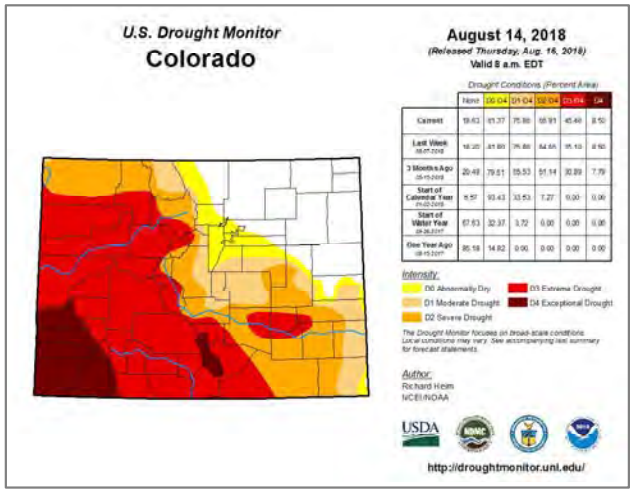
[2] Note that Stage 1 requirements in 2002 were different from the stages described herein.

[3] Note that Stage 1 requirements in 2012-13 were different from the stages described herein.



In mid-May, 2018, Aspen declared Stage 1 water shortage conditions. Under Stage 1, public facilities including parks and golf courses, were directed to lead by example and implement water use restrictions, public education materials were provided to the community to encourage voluntary efficient use, and temporary water surcharges were added to the upper tiers of the billing rate structure to encourage a reduction in water use. The City continued to monitor supply conditions and customer demands throughout the summer.





In mid-August, 2018, the City moved from a Stage 1 to a Stage 2 water shortage declaration. The goal under Stage 2 was to protect the health of Castle and Maroon Creeks while maintaining Aspen's municipal

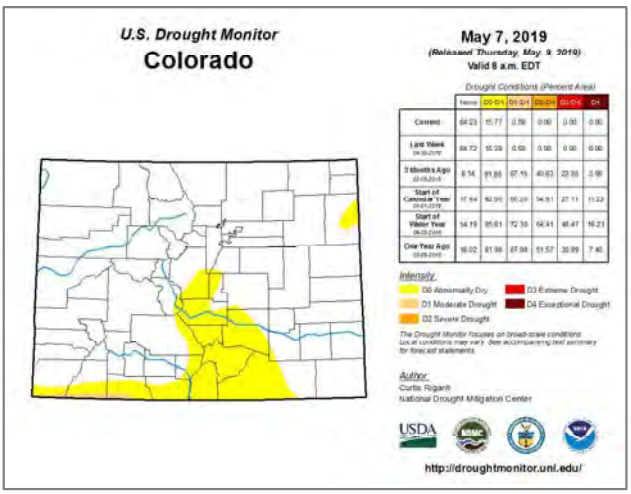
water supplies at levels that could meet customer demands and maintain healthy landscapes. Stage 2 included mandatory restrictions for all Aspen treated water customers, including:

- No watering of lawns between 10 a.m. and 6 p.m. or more than three days a week and no more than 30 minutes per sprinkler zone per day.
- No watering native areas more than two days a week or during rain events.
- No watering resulting in ponding or the flowing of water onto paved surfaces.
- No washing of sidewalks, driveways, patios, tennis courts and parking areas.

A City email address was provided to customers to report any observed violations and the City could issue fines for violations and disconnect water service for repeat violations. Temporary surcharges were increased for the upper tiers of the billing rate structure to support further reduction in water use. While revenue projections from water use in Tier 1 and Tier 2 were expected to decline once customers responded to the water shortage declaration, the City anticipated the decline to be offset to some extent by the increased rates for Tier 3 and Tier 4.

The City entered the 2018 – 2019 winter season under the Stage 2 water shortage declaration. Staff considered the pros and cons of remaining under the declaration through the winter versus relaxing or coming out from the declaration for the winter and then potentially having to re-establish the declaration in the spring or summer. Various climate projections were monitored and ultimately Aspen chose to maintain the Stage 2 declaration through the duration of the winter season. The primary justification was that if the 2018 – 2019 winter had another low snowpack with higher temperatures, Aspen was likely to advance the water shortage staged response program through the 2019 summer months. If the City came out of water shortage declaration during the winter, it would take time to re-engage the drought declaration should conditions not improve. Additionally, community outreach was already underway to support reductions in water use. City staff were concerned that interrupting the declaration would disengage the public. During the 2018 declaration process, staff had observed a large lag time between the stage being declared and the customer responses occurring. During fall of 2018, the DRC was engaged to support the planning for ongoing drought response efforts.

In early spring of 2019, the DRC was closely monitoring snowpack and weather conditions, meeting regularly to review conditions and prepare response strategies. Winter snowpack levels were below average until a large snow event in March brought snowpack levels up above average. The snowpack fluctuated but continued in an upward trend. By mid-April, the streamflow forecast through the summer was projected to be higher than 2018 conditions, indicating that the 2019 irrigation season would be significantly improved compared to the prior year. In May of 2019, Aspen lifted the Stage 2 restrictions and removed the water shortage declaration.



Enforcement was one of the largest challenges experienced during the 2018 – 2019 water shortage declarations. While customer complaint and reporting were the historical mechanism for enforcement, the DRC concluded that a more formal process for enforcing restrictions would increase the success of the drought response program. The City modified the "wasting of water" section of the Municipal Code to reflect more strict requirements for water use under normal conditions. The DRC also recommended transitioning Stage 1 restrictions from voluntary to mandatory and adding an "Emergency Response" stage to its water shortage categories, as reflected in this DMRP. Some additional changes to the Municipal Code Section 25.28 were made in conjunction with this DMRP.

3. DROUGHT IMPACT ASSESSMENT

Impacts to the City during future droughts may be similar to those experienced in past droughts, although depending upon how climate change impacts local conditions, future droughts may be more frequent, intense, and/or prolonged relative to historical droughts. The level of severity for the anticipated impacts varies from minor to significant and is influenced by the magnitude and duration of the drought. One operating principle identified through this plan is to minimize the severity of potential impacts through planning and mitigation. Table 3 below shows potential future drought impacts and the anticipated level of severity based on historical impacts and the anticipated effects of mitigation and planning.

Table 3: Potential Future Drought Impacts.

Potential Future Impact	Potential Severity
Increased costs and staff time to implement drought plan	Minor
Reduced firefighting capability	Minor
Changes in water use behavior to conserve water	Moderate
Costs to increase water use efficiency	Moderate
Impacts to fish and wildlife habitat	Moderate
Loss of revenue from reduction in water sales	Moderate
Loss to recreation and tourist industry	Moderate
Restrictions/limitations on landscaping companies	Moderate
Disruption of water supplies	Moderate to Significant
Domestic landscaping stressed or lost	Significant
Increased risk of frequency and severity of wildfires/flood hazards	Significant
Loss of hydroelectric power generation	Significant
Public landscaping stressed or lost	Significant
Visual and landscape quality	Significant

4. DROUGHT MITIGATION AND RESPONSE

Drought mitigation measures are implemented prior to a drought to avoid, delay, or reduce potential drought impacts. Aspen actively manages its water resources through ongoing and diverse planning efforts, which supports long-term sustainability goals and the mitigation of drought impacts. To date, Aspen's primary drought mitigation measure has been the implementation of the City's 2015 WEP. The 2015 WEP works along with the Roaring Fork Regional WEP to support the City's conservation efforts. Programs implemented through these plans, including a professional landscape certification program, have advanced the City's outdoor water efficiency program. The City is in the initial phases of developing

an Integrated Resources Plan (IRP), which will evaluate the City's water supply portfolio and demand projections under future conditions, including climate change, ultimately leading to a future supply strategy.

Because Aspen relies predominantly on streamflow for its supplies, management of demands is of high importance. Even during average years, Aspen's water supply system reaches a stress-point in early spring and again in late summer when streamflow are relatively low, demands are relatively high due to irrigation, and Aspen is operating to protect decreed instream flows (see Figure 1). This figure is an illustrative example showing a dry-year water supply compared to a projected demand. Periods where the demand exceeds the supply reflect a water shortage. This illustrates the importance of ongoing conservation as well as drought response strategies.

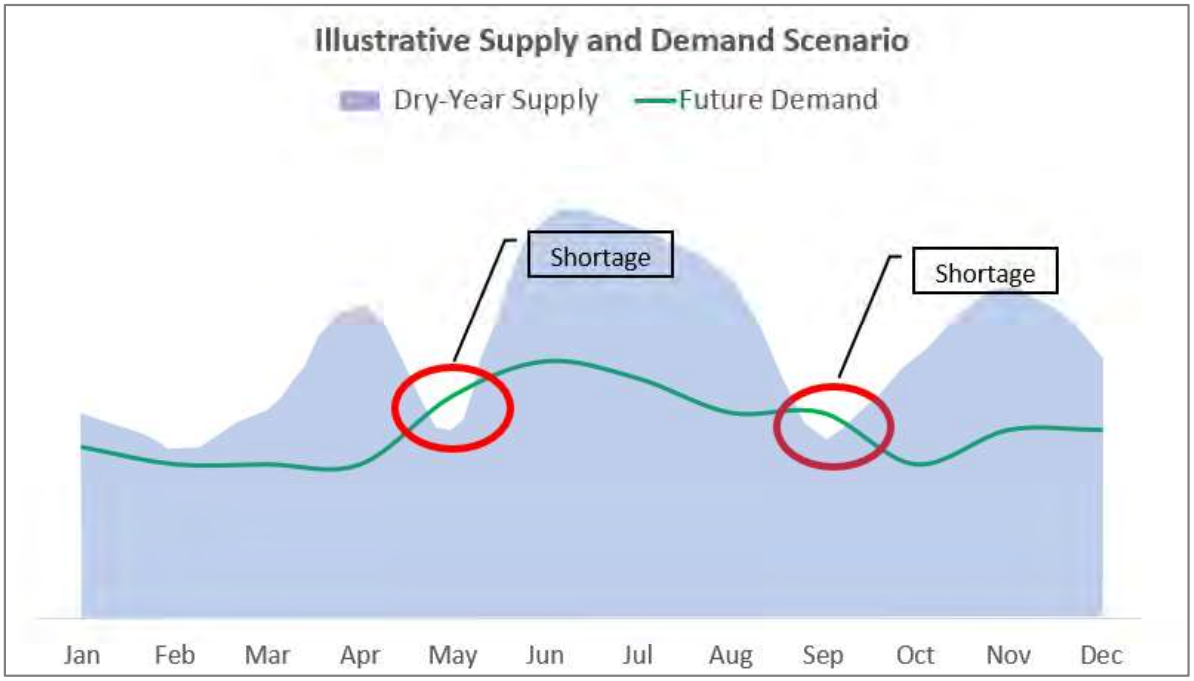


Figure 1: Illustrative Municipal Supply and Demand Scenario.

The following is a list of the City's historical and ongoing water shortage mitigation measures:

- Municipal Water Efficiency Planning
- Roaring Fork Regional Water Efficiency Planning
- Integrated Resources Planning
- Water Efficient Landscaping Standards
- Qualified Water Efficient Landscape Certification Program
- Leak Detection and Water Loss Audit Program
- Pursuit of an "Engaged Efficiency" Culture
- Ongoing Monitoring of Drought Indicators

4.1 SUPPLY-SIDE MITIGATION AND RESPONSE STRATEGIES

The City is in the process of expanding its existing water supply system to improve reliability, to firm its supplies for long-term drought mitigation and to further respond to an extreme or prolonged drought. The City recognizes that individual water supply sources may be impacted differently by drought conditions and will consider the availability of each supply and supply-side management strategies under each water shortage declaration. Potential supply-side strategies include the following:

- Storage would help the City to delay the initiation of a water supply shortage declaration under many conditions, particularly drought, and would provide a quantitative index for guiding drought stage selection. The City has conditional storage water rights and, at the time of preparing this plan, is in the process of studying storage site locations. Storage is an important part of Aspen's long-term drought mitigation strategy (although it will not fully eliminate the City's drought vulnerability). Until storage is available, Aspen's decisions regarding water shortage declaration under drought conditions are particularly complicated because water saved through early season demand reductions cannot be held over to meet demands during the latter part of the irrigation season. This requires a faster customer-side response to reduce irrigation demands once streamflow is low, and likely a more immediate implementation and enforcement of water use restrictions.
- The City owns alluvial groundwater rights that may be exercised in the future as a supplemental supply. At the time of this plan, the existing wells require additional costly treatment in order to be used. The City may retrofit piping from its decreed wells to deliver pumped water either into the City's water treatment plant or may provide further treatment at the wellhead to provide an additional potable supply into the distribution system. If implemented, this would mitigate and likely delay water shortage declarations due to drought by providing a supplementary, interim potable supply.
- The City may temporarily suspend some diversions of its irrigation water rights and associated deliveries in order to make more physical water available in the stream for diversion and treatment under its municipal water rights.
- During times that public health and safety is at risk, the City may divert and treat water that it would otherwise not divert because of its commitment to protect the CWCB decreed instream flow rights.
- The City has the right to reuse a portion of its water supply and is in the process of building a reclaimed water system to exercise this right. Reuse/reclaimed water is not subject to curtailment under this plan but may help mitigate future drought impacts by reducing irrigation by other water rights. Upon operational availability, the City may utilize reclaimed water supplies to irrigate higher priority outdoor water uses as identified in Section 1.2.
- The City's water supply depends upon diversions from Castle and Maroon Creeks and therefore data-informed monitoring of these watershed conditions is of critical importance. Monitoring of drought indicators is complicated by the fact that there are no automated snow depth and snow water equivalent (SWE) monitoring sites within the Castle and Maroon Creek watersheds and there is not an active streamflow gage located on Castle Creek. This makes it challenging to monitor the local snowpack and project the snowmelt runoff amount and timing. The installation and maintenance of a snow telemetry site (SNOTEL) and a Castle Creek streamflow gage would help improve the City's ability to monitor and make drought declaration decisions.

4.2 Demand-Side Mitigation and Response Strategies

The City's primary demand-side mitigation measure, as identified above, is the implementation of the 2015 WEP. In particular, the City has developed outdoor landscape and irrigation efficiency standards to support the efficient outdoor use of water. The City's efficiency programs support a lower baseline demand through efficient water use practices, which delays and minimizes impacts caused by drought. Demand-side response strategies focus on further reducing water use during times of drought. Because most of the City's water demand is for outdoor use, particularly during summer when supplies are more vulnerable to drought impacts, these strategies target outdoor use. Generally, demand-side response strategies can be categorized as follows:

- Water restrictions on irrigation.
- Water restrictions on private outdoor swimming pools and hot tubs.
- Water restrictions on outdoor commercial or construction uses.
- Billed water use surcharges.

These demand-side strategies are important but may not be enough to successfully navigate all droughts into the future, which is why the City continues to evaluate and expand its water supply system and planning efforts.

5. Drought Stages, Response Targets, and Monitoring

5.1 Drought Stages and Response Targets

The City's drought response strategy is based on five stages representing increasingly severe drought conditions as shown in Table 4 below. These stages and response strategies were developed for water shortage declarations related to drought conditions; however, they may also apply to water shortages related to other circumstances. Each water shortage should be evaluated independently with Rules and Regulations created to specifically address those conditions. For each stage, the City has identified demand reduction targets on systemwide demands served by treated water and outdoor demands served by a combination of treated water, pressurized raw water, and non-pressurized raw water. These reduction targets connect with response strategies developed for each stage, as described in Section 6 of this plan. Municipal drought response strategies tend to focus on outdoor water use reduction programs, targeting irrigation uses to achieve the bulk of the demand reduction goals for a staged drought response; outdoor uses consume significantly more water than indoor uses, and are typically considered more discretionary than indoor uses. Therefore, reductions are typically focused first on outdoor uses. Planning for this type of staged drought response program makes sense for Aspen because the City's water supply system is currently dependent upon streamflow and is most likely to be limited during the later summer period when landscape irrigation demands are high. Future modeling, monitoring, and the future addition of storage may warrant a review and potential modification of these response targets.

Table 4: Staged Drought Response Categories and Water Use Reduction Goals.

Category	WATCH Normal	MODERATE Stage 1	SEVERE Stage 2	EXTREME Stage 3	EXCEPTIONAL Emergency Response
WATER USE REDUCTION GOALS					
Systemwide	Voluntary	5% - 10% Reduction	10% - 15% Reduction	15% - 25% Reduction	25% - 40% Reduction
Outdoor	Voluntary	10% - 15% Reduction	15% - 25% Reduction	25% - 60% Reduction	60%+ Reduction

5.2 MONITORING OF DROUGHT INDICATORS

The amount of water available for the City's municipal supply is currently dependent upon the physically available streamflow in Castle and Maroon Creeks. Both Castle and Maroon Creeks are snowmelt dominated streams, and the amount of summer streamflow is closely related to snowpack conditions that occurred the prior winter. Timing of peak snowmelt runoff is another significant factor in summer streamflow availability. To interpret local conditions, Aspen staff rely upon several hydrologic and climatic indices including snowpack, precipitation, temperature, wind, evaporation, streamflow, soil moisture, and weather forecasts to support professional judgment in making recommendations for declaring water shortages and moving through drought stages. The combination of conditions makes each year unique and requires ongoing monitoring. The time of year corresponding with each indicator is also important to consider, e.g. snowpack is used as a primary indicator during winter and early spring months while streamflow is used as a primary indicator during runoff and summer months. Table 5 shows typical monitoring data relied upon by Aspen to predict drought conditions and the associated time of year.

Table 5: Drought Indicator and Corresponding Time of Year

Indicator	Applicable Time of Year
Snowpack	November through May
Snowmelt	April/May Projections
Precipitation	
Snowfall	October/November through April
Rainfall	May through September/October
Streamflow	April through October
Treated Water Demands	Year-Round
Temperature	Year-Round
Soil Moisture	Year-Round

Monitoring and data assessment are most intensive starting in February when snowpack levels start to show trends that can be compared to historical averages, continuing through August when Castle Creek and Maroon Creek flows are declining and outdoor uses are still high. The monitoring efforts challenging because there are no SNOTEL monitoring sites located within these watersheds and there is not an active streamflow gage located on Castle Creek. Because Aspen's supplies are driven by snowpack conditions and subsequent runoff patterns, it is difficult to accurately predict conditions far in advance. One large snow event can shift snowpack levels from far below average to above average. Similarly, early peak

runoff and abnormally high temperatures can result in reduced late-summer streamflow levels even if end-of-season snowpack data had indicated above-average levels. As such, monitoring is an ongoing process. Water shortage declaration is a near real-time decision made by analyzing and interpreting monitoring data, cross checking with other regional and local water resources experts, and applying historical experience coupled with professional judgment. Some events that may indicate drought include, but certainly are not limited to, include the following:

- Significantly lower than average peak snow water equivalent (SWE), or if the SWE level peaks early relative to historical average years, resulting in earlier than typical runoff.
- Above average temperatures.
- Dust on snow.
- Precipitation that falls in the form of rain rather than snow prior to April 1.
- Streamflow below 12 cubic feet per second (cfs) in Castle Creek and 14 cfs in Maroon Creek to support instream flows.
- Below average or no precipitation.

5.3 MONITORING REFERENCES AND RESOURCES

The City relies upon monitoring data and field observations to review local conditions. A combination of the drought indicators described above are used to evaluate conditions and make drought declaration decisions. Aspen also considers regional hydrologic and climatic data, drought indices such as the Palmer Drought Severity Index and the Surface Water Supply Index, information from other nearby water utilities, long-term weather forecasts, etc. The DRC provides a forum for soliciting monitoring information from multiple staff and further establishing key parameters and dates that are used to support monitoring through staff experience. Additionally, the City has a daily operational model of its municipal raw water system that can be used to predict available streamflow entering the City's system based on operational demand scenarios and streamflow projections. Because this is a predictive model, it can be utilized as an indicator but cannot be solely relied upon in making drought declarations.

Drought conditions change frequently and vary in extent and duration – no two droughts are exactly alike. Through ongoing tracking of water supply and demand conditions, before and during drought, the City can adapt its drought response strategy to meet changing conditions. This section of the DMRP documents information that has historically been used to monitor for drought conditions, which informs the City in its consideration of declaring water shortages and moving between stages of the drought response program. However, this is not a comprehensive list of resources reviewed and relied upon to support drought monitoring and declaration. Aspen will update its monitoring procedures as new resources and tools become available.

- The **US Drought Monitor**[4] provides broad-scale perspective on drought conditions nationally, regionally, and by state. The US Drought Monitor maps are updated weekly and released each Thursday. The author of the maps, who may be a different person each week, interprets quantitative data and qualitative information to update the drought intensity patterns. The maps show drought classifications based on geographic locations and range from "None" to D4 Exceptional Drought. This is an important tool for communicating with customers and can be

[4] https://droughtmonitor.unl.edu/CurrentMap.aspx

useful in evaluating current conditions relative to a prior period and over an expanded region. However, the drought designations shown in the US Drought Monitor do not reflect local drought declarations but rather provide a general reference for Aspen staff to consider. For example, the US Drought Monitor may show a D3 Extreme Drought condition for the Aspen area, but the City of Aspen may be in a Stage 1 drought declaration.

- The **Governor's Water Availability Task Force (WATF)**[5] monitors conditions that affect Colorado's supply, including snowpack, precipitation, reservoir storage, streamflow and weather forecasts. The WATF holds regular monthly meetings to present status reports from the State Climatologist and Natural Resources Conservation Service (NRCS), review outlooks on climate and streamflow conditions, and discuss potential water supply impacts. Drought monitoring and long-term mitigation are ongoing activities and the responsibility of the WATF. The **Colorado Drought Mitigation and Response Plan (Colorado Drought Plan)**[6], updated in 2018, outlines a mechanism for coordinated drought monitoring, impact assessment, emergency drought response, and mitigation of long-term drought impacts in Colorado. Drought monitoring is ongoing and facilitated through the WATF regular meetings. The WATF notifies the Governor when drought conditions reach significant levels and recommends activation of the Plan. The Governor activates relevant Impact Task Forces, which convene to determine the existing or potential impacts within sectors (municipal water, agricultural industry, wildlife, and energy). Implementation and the subsequent supporting actions are driven by the specifics of each emergency or disaster situation. The Colorado Drought Plan can be partially or fully implemented for any number of counties and classifications, allowing flexibility based on recommendations from the Impact Task Forces. Activation of the Colorado Drought Plan does not require any local drought response, although the it is a strong consideration for the City.
- The **Colorado Drought Plan Visualization Story Map**[7] was developed in association with the Colorado Drought Plan. The Story Map provides an interactive Drought Vulnerability Assessment summary (vulnerability scores and potential impacts) that are summarized by county for each of the following sectors: agriculture, energy, environment, recreation, socioeconomic, and state assets. The municipal sector is not explicitly referenced because of the uniqueness of each municipal water supply system. The Story Map provides a visual representation of counties that are currently triggered, allowing the user to select a county to view associated data for each of the defined sectors. The scoring for these sectors provides another indicator of drought conditions.
- Local snowpack conditions are a key water supply indicator that influences how snowmelt runoff will contribute to streamflow during the City's high outdoor water demand period of June through September. **NRCS Snow Telemetry (SNOTEL) Watershed Time Series Snowpack Graphs**[8] are published and updated frequently to show daily snowpack data by state or by river basin for the current year to date, the prior 3 years, median snowpack, and average snowpack. General statistics for current snowpack levels are updated with each published chart. This source is frequently used to monitor regional snowpack conditions that indicate the snow status and general seasonal trajectory.

[5] https://cwcb.colorado.gov/water-availability-flood-task-forces
[6] https://drought.unl.edu/archive/plans/Drought/state/CO_2018.pdf
[7] https://lynker.maps.arcgis.com/apps/MapSeries/index.html?appid=8b8a995c2574439cbef10088a08d12ae
[8] https://www.nrcs.usda.gov/wps/portal/nrcs/detail/co/snow/products/?cid=nrcs144p2_063323

- The **NRCS Colorado Basin-Wide Interactive SNOTEL Charts**[9] allow users to select and create SWE charts summarized by major river basin and by sub-basin, tracking average SWE levels from all SNOTEL sites within and adjacent to the selected watershed for any combination of years. The user can also develop interactive charts for precipitation. Both historical data and projection charts are available. While these may not provide a direct reflection of Aspen's local water supply conditions, these charts can be used to gain perspective of the overall basin conditions.
- **NRCS Colorado Site Interactive SNOTEL Charts**[10] allow the user to select a specific SNOTEL Site and open interactive charts for SWE or precipitation. Both historical data and projection charts are available. Unfortunately, there are no SNOTEL sites located within Aspen's water supply watersheds; however, the Independence Pass site is relatively close. Data from the Independence Pass SNOTEL site (Station ID 542) is monitored and used along with staff field observations to relate this information to snowpack within the Castle, Maroon, and Hunter Creek drainage areas , where Aspen's water supply is located, as well as the Roaring Fork.
- **Precipitation and temperature**[11] are compared to prior years and evaluated together with snowpack and streamflow. Early warming and rainfall enhance snowmelt and reduce snowpack. Temperature data from the Aspen 1 SW NOAA station or the Aspen Pitkin Co Airport Sardy Field NOAA station are used to observe the following:
    - The timing of when minimum daily (i.e. nighttime) temperatures start exceeding 35 degrees Fahrenheit.
    - Whether precipitation occurs as snow or rain below 10,000 feet elevation.
- **Streamflow** is monitored during the winter-to-spring transition period to observe the rate of snowpack dissipation (through inspection of the magnitude and shape of the streamflow curve) and streamflow response to snowmelt (runoff) through the change of season.
- The **NOAA Colorado Basin River Forecast Center**[12] develops geographic water supply forecasts for the Upper Colorado River Basin, Lower Colorado River Basin, and Eastern Great Basin. Through an interactive map of the basins, the user can select a station and view a hydrograph with observed streamflow, short-term forecast, and longer-term outlook. This website also shows snow conditions, reservoir conditions, precipitation, and soil moisture.
- Other national drought-specific resources including the **National Integrated Drought Information System (NIDIS)**[13], the **Advanced Hydrologic Prediction Center**[14]**,** the **Intermountain West Climate Dashboard**[15], the **Evaporative Demand Drought Index (EDDI)**[16], and the **USDA Topsoil Moisture Monitoring Maps**[17] are also relied upon.

Aspen also monitors its measured potable water use as follows:

- **Treated water production**[18] data provides an indication of how water demands are trending and is considered along with the water supply indicators to anticipate potential shortages.

[9] https://www.nrcs.usda.gov/wps/portal/nrcs/detail/co/snow/products/?cid=nrcseprd1432263
[10] https://www.nrcs.usda.gov/wps/portal/nrcs/detail/co/snow/products/?cid=nrcseprd1433035
[11] https://www.colorado.gov/cdss/climate-data
[12] https://www.cbrfc.noaa.gov/
[13] https://www.drought.gov/drought/states/colorado
[14] https://water.weather.gov/ahps/rfc/rfc.php
[15] https://wwa.colorado.edu/climate/dashboard.html
[16] https://psl.noaa.gov/eddi/
[17] https://www.drought.gov/drought/data-gallery/topsoil-moisture-monitoring
[18] https://www.cityofaspen.com/1165/Drought-Dashboard

- **Treated water demand** data are reported through Aspen's monthly billing software and tracked through an internal water use tool. Billed water use provides an indication of how water demands are trending by customer category. Billed demands are considered along with the production and water supply indicators to anticipate potential shortages.
    - Beginning in April, monthly water demand data are monitored by customer class relative to the prior 5-year period. Demand data are utilized to help focus recommendations for drought response measures and enhance customer outreach and communications.
    - During any declared water shortage, demand data summarized by customer category are evaluated for the effectiveness of response actions, including restrictions, water pricing, education, and enforcement, toward reducing demands and supporting recommendations for adjusting the drought response measures.

6. STAGED DROUGHT RESPONSE PROGRAM

The City's staged drought response program identifies appropriate response measures for each drought stage. This section outlines typical drought indicators and response measures, intended to provide a comprehensive set of activities to support the City's selection of staged response targets and guidance for developing Rules and Regulations when a water shortage is declared due to drought conditions. While many indicators are considered, all of the conditions listed below do not have to exist before declaring a drought. Similarly, the lists of shortage response measures provide a guide to water use modifications that will be considered during each shortage condition. This part of the DMRP will be used as a framework for developing the Rules and Regulations during a shortage declaration, which will provide details about the specific set of response measures to be implemented and enforced under the particular water shortage circumstances, as further described in Section 7.1 below. The City will modify the program elements as needed to meet demands under changing water supply conditions.

While some of the response measures rely on changes to City water uses and activities, the majority of response measures rely heavily on customer behaviors. The City will model effective drought response in its own water use and will provide the necessary information and tools to motivate a public response. However, it is ultimately in the hands of the City's customers to execute. As appropriate, modifications and adjustments may be made to the measures described here to best address the circumstances and conditions of a given water shortage. Any restrictions defined under a specific drought stage will continue through higher stages unless more strict restrictions are identified.

Under normal conditions, the City will implement normal monitoring activities. The City will actively implement the WEP programs and measures to manage the use of its finite water resource, minimize water waste, and encourage best practices. This is considered normal operation and does not require any formal action from City Council.

Common Indicators:

- Local watershed characteristics including snowpack, precipitation, streamflow, temperature, and soil moisture indicate normal conditions.
- Normal to above-average snowpack conditions during winter months.
- Normal to above-average measured and projected streamflow starting late-spring through fall.

- Average to below-average temperatures during all months.
- No indication that local conditions will deteriorate in coming months.

Common Response Measures:

- The City will work with the Colorado Division of Water Resources as needed to place administrative calls for water under the Colorado water rights priority system to protect supplies.
- All terms defined under Municipal Code Section 25.28 "Wasting of water prohibited" are mandatory at all times.

Under Stage 1 conditions, the City will increase emphasis on basic water use reduction measures and wise water use practices implemented through public education and outreach. The City will promote rebates and support programs for low-flow water use fixtures, irrigation technology, irrigation assessments, etc. and will begin targeting high volume water users and lower-priority water uses. Mandatory restrictions and water bill surcharges will begin.

Common Indicators:

- Local watershed characteristics including snowpack, precipitation, streamflow, temperature, and soil moisture indicate moderately dry conditions.
- Below-average snowpack conditions during winter months.
- Below-average measured and projected streamflow starting late-spring through fall.
- Above-average temperatures during all months.
- Other water providers in the Roaring Fork Basin are preparing to respond to dry conditions.
- Indication that local conditions will likely deteriorate in coming months.
- Indication that the Governor may activate the Colorado Drought Plan or has activated it in neighboring counties.

Common Response Measures:

- Irrigation of existing lawns limited to 3 days/week. Customers may choose which days or the City may designate days, depending upon the shortage condition.
- Irrigation of existing flowers, vegetable gardens, shrubs and trees using overhead irrigation systems limited to 3 days/week; watering by hand, drip, or subsurface irrigation any day.
- Encourage HOAs and commercial customers to perform irrigation system audits on common areas and increase rebates to support audits.
- Encourage postponing new landscape installations unless converting to xeriscape. Any allowed new seed/sod should have signage posted regarding establishment.
- Encourage customers not to operate any existing outdoor fountain, waterfall, or pond that is not used directly for irrigation.
- Public facilities will be directed to implement water use restrictions by administrative order, including: limiting irrigation of public parks and golf courses to an extent greater than the target reduction in overall water use; reducing street washing to minimum level necessary to comply with air quality standards and suspending fire hydrant flushing and testing except when required for completion and acceptance of a newly constructed water systems or to support public health and safety.

- Provide public education materials to increase awareness about water supply conditions, mandatory restrictions under Stage 1, and inform the public that worsening conditions may lead to more restrictive stages. Recommend hospitality and recreation-based establishments help communicate about water smart uses.
- Increases in water rates for tiers three (3) and four (4), shall be imposed as mandated by the City of Aspen City Manager up to the maximum rates defined in Municipal Code Section 25.28.

Under Stage 2 conditions, Aspen will work to keep trees, shrubs, vegetable and flower gardens, and lawns alive but will limit outdoor water use and nonessential uses. Aspen will emphasize wise water use practices through public education and outreach and eliminate wasteful water use and target reduction of excessive water use. Surcharges and rate increases will be implemented to further support conservation and to provide revenue stabilization. The City will advance demand reductions in lower-priority water uses. The response measures listed in this section assume that any restrictions required under Stage 1 will continue unless more strict response measures are specified under Stage 2.

Common Indicators:

- Local watershed characteristics including snowpack, precipitation, streamflow, temperature, and soil moisture indicate severely dry conditions.
- Below-average snowpack conditions during winter months with projections indicating conditions will not improve.
- Below-average streamflow starting late-spring through fall with projections indicating conditions will not improve.
- Above-average temperatures during all months with projections indicating conditions will not improve.
- Other water providers in the Roaring Fork Basin are actively responding to water shortage conditions.
- Strong indication that local conditions will continue to deteriorate in coming months.
- Colorado Drought Plan activated for Pitkin County.
- Aspen treated demands projected to exceed available supplies without further demand reduction, unless decreed instream flows are depleted, especially in mid to late summer.

Common Response Measures:

- Irrigation of existing lawns limited to 2 days/week based on customer address. The City may specify days of the week to certain customer classes (e.g. single family versus others) to help focus field monitoring and identify larger water uses.
- Irrigation of existing flowers, vegetable gardens, shrubs and trees using overhead irrigation systems limited to 2 days/week; watering by hand, drip, or subsurface irrigation any day.
- There shall be no new public or private landscaping installations allowed with the exception of that required as a minimum for erosion control of disturbed surfaces as determined by the City.
- Watering of golf courses and parks shall be managed to achieve the target reduction in water use based on type of specified water and delivery mechanism.
- There shall be no filling or refilling of single-family residential swimming pools with water provided by the City. Operation of other swimming pools is permitted.

- There shall be no operation of existing outdoor fountains, waterfalls, or refilling of ponds. No new water features allowed.
- There shall be no noncommercial washing of privately-owned cars, other motor vehicles, trailers or boats, except from a bucket and except that a hose equipped with a positive shut-off nozzle may be used for a quick rinse.
- No new or expanded water connections shall be authorized; however, existing authorizations shall be honored, provided, however, that this shall not apply to emergency situations in which a well user's indoor-use well has run dry.
- Dust control and construction water allowed on a case-by-case basis.
- Except for fighting fire, there shall be no use of water from a fire hydrant or specially designated loading hydrant for human consumption or for use in connection with animals, street washing or construction water supply. Hydrant draft permits for any of the foregoing uses shall be suspended for the duration of the Stage 2 designation.
- Aspen will take the following actions: increase media briefings and coverage with specific messages; increase monitoring and send reminders to top 10% water users; establish a water waste hotline/web address; create a pledge program for community leaders (businesses) to take steps toward smart water usage and conservation within their organizations; ask to display drought messaging signs.
- Surcharges may be imposed.

Under Stage 3 conditions, Aspen will work to sustain mature trees to the extent possible but recognizes that there may be a major loss of lawns, gardens, some trees, and some shrubs. Most low-priority water use, including many of the outdoor water use and non-essential uses listed in Table 2 under Priority Numbers 4 through 7, will be eliminated. The City will operate an aggressive public education and outreach program and will eliminate wasteful water use and excessive water use. Surcharges and rate increases will be implemented to further encourage conservation and to support revenue stabilization. Under an extreme condition, the City may pursue supply-side response measures including operating its physically available senior water rights to divert water even though they deplete the decreed instream flow. This will occur only when public health and safety is at risk. These response measures are considered to be subsidiary and may have legal or water quality implications that will be further investigated. The response measures listed in this section assume that any restrictions required under Stage 1 and 2 will continue unless more strict response measures are specified under Stage 3.

Common Indicators:

- Local watershed characteristics including snowpack, precipitation, streamflow, temperature, and soil moisture indicate prolonged, extremely dry conditions.
- Well below-average snowpack conditions during winter months with projections indicating conditions will deteriorate.
- Well below-average streamflow starting late-spring through fall with projections indicating conditions will deteriorate.
- Above-average temperatures during all months with projections indicating conditions will deteriorate.
- Other water providers in the Roaring Fork Basin and Colorado River Basin are actively responding to extreme water shortage conditions.

- Strong indication that local conditions will continue to deteriorate in coming months.
- Colorado Drought Plan activated for Pitkin County.
- Aspen treated demands projected to require diversion of senior rights that will reduce decreed instream flows, or, in a worst-case scenario, exceed available supplies under decreed municipal rights, especially in mid to late summer.

Common Response Measures:

- Irrigation of existing lawns limited to 1 day/week based on customer address.
- Irrigation of existing flowers, vegetable gardens, shrubs and trees limited to 1 days/week and watering only allowed by hand, drip, or subsurface irrigation.
- There shall be no new landscaping installation allowed.
- Athletic fields, trees, and golf course greens irrigated by mandatory schedule or water budget only. There shall be no daytime irrigation. This will influence both potable and raw supply reductions.
- There shall be no filling or refilling of swimming pools.
- There shall be no filling or refilling of water features.
- There shall be no car washing.
- There shall be no new or expanded water connections authorized; however, existing authorizations shall be honored provided, however, that this shall not apply to emergency situations in which a well user's indoor-use well has run dry.
- There shall be no water used for dust control, except pursuant to authorization from the City or Pitkin County Environmental Health Department and only to the extent necessary to comply with air quality standards.
- Hydrants allowed for fighting fire only.
- Increase frequency of public outreach.
- Surcharges may be imposed.

Emergency conditions are highly unlikely but require prioritizing essential uses. Long-term loss of landscape should be expected and indoor uses may be restricted. The response measures listed in this section assume that any restrictions required under Stages 1 through 3 will continue unless more strict response measures are specified under the Emergency Response. Under an emergency response condition, the City may pursue supply-side response measures including operating its senior water rights to divert water, even though they deplete the decreed instream flow, and reducing diversion of the City's raw water irrigation rights. This will occur only when public health and safety is at risk.

Common Indicators:

- Local watershed characteristics including snowpack, precipitation, streamflow, temperature, and soil moisture indicate prolonged, exceptionally dry conditions.
- Significantly below-average snowpack conditions during winter months with projections indicating conditions will deteriorate.
- Significantly below-average streamflow starting late-spring through fall with projections indicating conditions will deteriorate.

- Significantly above-average temperatures during all months with projections indicating conditions will deteriorate.
- Other water providers in the Roaring Fork Basin and Colorado River Basin are actively responding to extreme water shortage conditions.
- Indication that prolonged, extremely poor local hydrologic and climatic conditions will continue.
- Drought indicators predicting exceptional drought levels statewide.
- Colorado Drought Plan activated for Pitkin County.

Common Response Measures:

- Irrigation of lawns or plant material not allowed, except trees and shrubs may be watered by hand no more than 1 day/week.
- Irrigation of golf courses and parks not allowed. This will influence both potable and raw supply reductions.
- There shall be no new or expanded water connections.
- There shall be no dust control or construction water.
- Hydrants allowed for fighting fire only.
- There shall be no irrigation of public facilities.
- Consider supply-side response measures including diversion of senior water rights that will deplete instream flows if necessary to protect public health and safety.
- Surcharges may be imposed.

7. IMPLEMENTATION

7.1 WATER SHORTAGE DECLARATIONS

The City's Municipal Code provides authority for implementing and enforcing staged responses during a water shortage and requires City Council approval to declare and advance drought stages. Likewise, City Council approval is required to de-escalate drought stages and to rescind restrictions with the lifting of any drought status. As described in Section 25.28 of the City's Municipal Code, when the City Council passes a resolution declaring water shortage and stage, it will direct the City Manager to promulgate and enforce Rules and Regulations that define response measures to be implemented under the particular water shortage circumstances. The City Manager and supporting staff will utilize the DMRP framework for selecting the specific set of response measures to include in the Rules and Regulations.

Aspen's Utilities Department is primarily responsible for ongoing monitoring of drought indicators and for providing recommendations to City Council on drought stage declaration. The DRC will typically meet each February or March to review water supply and demand conditions and projections that are prepared by Utilities staff based on monitoring data. Upon anticipation of a water shortage declaration related to drought conditions, the DRC will increase its drought monitoring efforts and determine the frequency of meetings needed. Monitoring data along with professional judgment and historical experience will support staff recommendations for stage declaration and adjustments to the response program, which are ultimately presented to City Council for discussion and approval. Because certain water sources may be more or less impacted than other sources during a drought, drought response measures will be developed based on a review of the specific conditions. The DRC Communications representative will lead

public drought communication efforts and will rely upon the DRC for recommended content and messaging strategies.

Timing of drought stage declaration is very important for Aspen to allow ample time for staff to implement and engage the public in the staged response program. If a water shortage declaration does not occur with enough lead time for implementation and response effects to be achieved, decreed instream flows may be depleted and demands may exceed supplies, resulting in emergency situations. Public response lead time is a crucial consideration, as many customers are not full-time residents and may not initially be engaged enough to quickly react to an early water shortage declaration. This also highlights the importance of fostering an ongoing and engaged efficiency culture. Conversely, declaring a water shortage or advancing a drought stage prematurely can result in unnecessary restrictions, impacting community confidence as well as City revenue.

7.2 DROUGHT PUBLIC INFORMATION CAMPAIGN

A primary discussion topic during the DRC meetings was the need for a more formal communications plan providing ongoing education, messaging, and customer support before, during, and after a drought. The City recognizes that providing public information and maintaining its working relationship with customers are critical to the success of any water shortage response program. In order to encourage a positive response from customers, the City needs to communicate with customers about water supply conditions and the reasons for potential implementation of mandatory restrictions. Public response is more successful when customers are educated about local water supplies. A primary communications challenge with the City's customer base is that while many of the full-time residents are engaged and informed on local conditions, the majority of customers served during peak periods are seasonal residents or visitors who are less informed about and engaged with local conditions. Examples of potential messaging challenges that were identified by the DRC and will be further addressed in its ongoing education campaign include:

- The Roaring Fork River flows provide a visual indicator of water supply conditions to the public. However, flows in the Roaring Fork River may or may not correlate to Aspen's water supply conditions in the Castle Creek and Maroon Creek watersheds. Therefore, it is important for the City to continuously educate the public about where their water comes from and the conditions that pertain to Aspen's water supply.
- Public/athletic fields and parks may be allowed watering exceptions during some water shortage conditions. This is fairly standard practice for municipal uses but necessitates communication with the public to message the policy.
- Some properties are supplied by raw water for irrigation. Colorado water law, the customers' raw water contracts, and City policies may influence different water management criteria for these supplies during certain water shortage conditions. Therefore, it is important for the City to educate the public about how different types of water supplies may be affected under water shortage conditions.

The DRC acknowledged that a consistent customer outreach and messaging program could help support future drought responses, an engaged efficiency culture, and other planning efforts. The public drought campaign will be closely coordinated and developed with the City's current conservation and efficiency

education programs as well as other planning efforts underway for the City's Integrated Resource Plan development. The drought campaign will be adapted in each of the following phases:

1. *Normal Conditions:* Aspen's outreach will focus on consistent messaging to support conservation and efficiency efforts and to communicate local conditions including "where our water comes from", typical Roaring Fork Basin hydrology, general climate conditions, and how efficient water use helps reduce municipal streamflow diversions thereby leaving more water in the streams. Outreach will occur at regular intervals and will maintain consistency with other local areas including messaging provided by the Roaring Fork Conservancy. Information on local projects or programs will be integrated as appropriate. This messaging will be ongoing and will occur at all times outside of drought or water shortage conditions.
2. *Active Drought Conditions*: During this phase, Aspen will increase messaging frequency to communicate anticipated drought conditions and associated response measures. This will begin prior to initiation of a water shortage declaration, when monitoring data indicate potential drought conditions. Messaging will be focused on hydrologic conditions and the implementation of the staged drought program. As drought stages are advanced, messaging will focus on mandatory water restrictions, the City's responses, and progressing conditions. This messaging will continue through the duration of the drought.
3. *Post-Drought Reflection*: This phase will occur after all drought restrictions and declarations have been lifted or restrictions have been reduced. Aspen will provide a look-back at the drought impacts and response measures. Aspen may request targeted feedback on impacts from residents and local businesses at this time to evaluate the effectiveness of program implementation and outreach strategies. This information will be used to prepare for and ideally mitigate impacts from future droughts and, as warranted, make updates to this plan and the Municipal Code.

7.3 ENFORCEMENT

The City's Municipal Code provides the Utilities Department, in concurrence with the City Manager, the authority to enforce the response measures described in the Rules and Regulations governing the water shortage declaration. Education and outreach are utilized to promote efficient water use and inform customers about expectations in all drought stages. Warnings, citations, fines, and, in the most extreme cases, installation of flow restrictors inhibiting water use or terminating service altogether are common drought response program enforcement mechanisms. Municipal Code Section 25.08.040 provides the City Manager, Superintendent, or other designated official authority to inspect any premises where water from the City is used to determine if water is being wasted. The City can issue fines for violations and disconnect water service for repeat violations. Upon first violation, the owner or occupant will be issued a written warning. Upon further violations within the water shortage declaration period at the same premises, the owner or occupant will be advised in writing and a penalty charge will be added to the water bill in accordance with Section 25.28 of the Municipal Code.

The Director of Utilities and Utilities staff will be responsible for administering the enforcement of the staged drought response program and ensuring that the messaging associated with the enforcement are appropriate and reflective of the drought program. Utilities will need to work with the Finance Department to issue fines through water billings and to record and manage citations and associated fines. The City may consider hiring seasonal monitors to patrol and report excess or wasteful water use during periods of drought. It is anticipated that the City will also utilize its advanced metering infrastructure in the future to evaluate customers' water use during water shortage declarations.

7.4 REVENUE IMPLICATIONS AND FINANCIAL BUDGETING PLAN

A reduction in water use due to drought restrictions will result in reduced water sales and revenue. The City's Municipal Code Section 25.28 defines billing surcharges through drought stages. Surcharges are intended to offset revenue reductions during a water shortage, at least in-part. The City Manager determines the necessary rate changes and Utilities staff will work with the Billing Department to monitor water use and revenue, making recommendations to City Council to adjust surcharges as needed to offset revenue loss impacts. Additional costs associated with the implementation of the staged drought response program including the public drought campaign and enforcement may also have revenue implications. At the onset of a water shortage declaration, Utilities and Finance staff will develop a cost estimate associated with the implementation and enforcement of the drought response program under the given circumstances. Internal funding will be identified, and any additional funding needs will be pursued through available drought-related loans, grants, etc.

7.5 MONITORING OF PLAN EFFECTIVENESS

The City plans to monitor the effectiveness of this plan through ongoing and post-drought evaluations. Ongoing monitoring will be conducted in conjunction with the City's active review of water efficiency activities. An annual DRC meeting will be held in February or March to reflect on prior year observations and activities, review current monitoring data, and discuss anticipated watershed conditions and characteristics for the coming irrigation season. Depending on anticipated conditions, the DRC will either plan for increased monthly meetings in preparation for potential water shortage declaration or will focus discussions solely on ongoing planning efforts and review. The following monitoring data will be collected and presented at this DRC meeting by the appropriate committee members:

- Municipal water demands
- Drought indicator data
- Lessons learned or recommended modifications to the program
- Drought mitigation measures, specifically water efficiency efforts and programs
- Public outreach and information campaign status

This monitoring supports an assessment of the staged drought response program's effectiveness and allows the City to adjust mitigation and response programs as appropriate. It also facilitates recommendations for plan updates and improvements.

7.6 PLAN APPROVAL

Aspen's DMRP was approved and adopted by City Council on July 28, 2020 by Resolution #062.

7.7 FUTURE UPDATES

This plan may be updated to reflect modified operational conditions or as new water supplies and operational management components such as storage, potable-use wells, and non-potable reuse become available. The City is in the process of developing an IRP which will evaluate the City's supply status and future municipal demands. This plan will be reviewed and revised as necessary based on findings from the

IRP efforts. This plan may also be updated as needed based on plan monitoring and lessons learned as the City implements the staged drought response plan as described herein.

8. REFERENCES

Aspen Water Production: City of Aspen Drought Dashboard, Treated Water Production Website. https://www.cityofaspen.com/1165/Drought-Dashboard.

CDSS Precipitation and Temperature: CWCB/DWR Climate Data Website. https://www.colorado.gov/cdss/climate-data.

Colorado Drought Story Map: Colorado Drought Plan – Visualization Story Map Website. Prepared for the Colorado Water Conservation Board by Lynker Technologies. https://lynker.maps.arcgis.com/apps/MapSeries/index.html?appid=8b8a995c2574439cbef10088a08d12ae.

Conditions Map: NOAA Colorado Basin River Forecast Center Website. https://www.cbrfc.noaa.gov/

CWCB 2018: Colorado Drought Mitigation and Response Plan. Prepared for Colorado Water Conservation Board by Wood Environment & Infrastructure Solutions Inc in Coordination with the Drought Mitigation and Response Planning Committee and the National Drought Mitigation Center. August 2018.

CWCB Drought Guidance Document: Municipal Drought Management Plan Guidance Document. Prepared for Colorado Water Conservation Board by AMEC Earth & Environmental. August 2010.

CWCB Drought Sample Plan: Sample of a Municipal Drought Management Plan. Prepared for Colorado Water Conservation Board by AMEC Earth & Environmental. June 2011.

CWCB WATF: DNR CWCB Water Availability & Flood Task Forces Website. https://cwcb.colorado.gov/water-availability-flood-task-forces.

NRCS Interactive SNOTEL: NRCS Colorado Site Interactive SNOTEL Charts Website. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/co/snow/products/?cid=nrcseprd1433035.

NRCS SNOTEL Watershed: NRCS SNOTEL Watershed Time Series Snowpack Graphs Website. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/co/snow/products/?cid=nrcs144p2_063323.

Title 25: City of Aspen Municipal Code, Title 25 – Utilities. Last updated in January 2020.

United States Drought Monitor: United States Drought Monitor Map Website. https://droughtmonitor.unl.edu/CurrentMap.aspx.

USGS Streamflow: USGS National Water Information System Site Inventory for Colorado Website. https://waterdata.usgs.gov/co/nwis/inventory.

WEP 2015: City of Aspen Municipal Water Efficiency Plan. Prepared for the City of Aspen by ELEMENT Water Consulting Inc. and WaterDM. October 2015.

ROARING FORK CONSERVANCY
Bringing People Together to Protect Our Rivers

September 10, 2020

Mr. Ryan Loebach
Senior Project Manager
Utilities Department
130 South Galena St.
Aspen, CO 81611

Subject: U.S. Bureau of Reclamation WaterSMART Water and Energy Efficiency Grant: City of Aspen Maroon Creek Penstock Lining Project

Dear Mr. Loebach,

On behalf of Roaring Fork Conservancy, I would like to submit a letter in support of the City of Aspen's U.S. Bureau of Reclamation WaterSMART Water and Energy Efficiency Grant for the City of Aspen Maroon Creek Penstock Lining Project.

The City of Aspen is committed to providing a safe and resilient water supply and is a leader in water efficiency and conservation through the implementation of its State approved municipal Water Efficiency Plan. One of the City's primary initiative is identifying and reducing water loss within its system. While the focus tends to be on the treated water side, the City is also evaluating its raw water system losses to support its potable water supply deliveries and to protect its raw water supply sources. Over time, the City has identified potentially significant loss within its Maroon Creek municipal diversion pipeline. The City of Aspen will be rehabilitating a section of critical pipeline infrastructure that provides raw water from Maroon Creek, a perennial stream located upgradient from the City, to the City's raw water storage reservoir and to a small 400 kW hydroelectric generation facility. This supply is ultimately delivered to its water treatment facility and used as a primary potable supply.

Aspen is committed to protecting decreed instream flows and has adopted a policy to maintain streamflow in the creeks downstream of its diversion structures at flow rates that are at or above the Colorado Water Conservation Board's (CWCB) decreed instream flow rights for the protection of the fishery and the associated aquatic habitats in those streams. The City operates its senior Maroon Creek water rights in a way that protects the decreed instream flows. Through the pipeline lining improvements, the City will significantly reduce pipeline loss. This will allow the City to divert less water through its headgate to meet all its Maroon Creek hydropower, potable supply, and raw water supply demands. Through this improvement, the City is exhibiting its commitment to instream flow protection and the efficient use of all water supplies.

For these reasons, we strongly support the City of Aspen's U.S. Bureau of Reclamation WaterSMART Drought Resiliency Projects Grant application for Instrumentation and Monitoring Project.

If you have any further questions, please feel free to contact me at rick@roaringfork.org or (970) 927-1290.

Sincerely,

Rick Lofaro
Executive Director

waternow alliance
water leaders. resilient solutions.

September 11, 2020

Hon. Brenda Burman, Commissioner
U.S. Bureau of Reclamation
1849 C Street NW
Washington, DC 20240-0001

Subject: WaterSMART Water and Energy Efficient Program: Recommendation for City of Aspen's Maroon Creek Penstock Lining Project

Dear Commissioner Burman:

On behalf of WaterNow Alliance, I am pleased to write in support of the City of Aspen's WaterSmart Water and Energy Efficiency Grant (WEEG) application for Maroon Creek Penstock Lining Project. WaterNow Alliance, a national network of local water leaders supporting sustainable water management measures, has been working with City for the past three years to support their water efficiency and system resiliency objectives.

Aspen is a leader among Colorado utilities in implementing sustainable, resilient water solutions to address water supply reliability and water storage constraints. The City has adopted a variety of innovative water efficiency measures, as outlined in their 2015 State approved Water Efficiency Plan (WEP), including ambitious Water Efficient Landscaping Standards in 2018. These standards are designed to significantly reduce outdoor water use by instituting water budget limitations and by requiring third party irrigation audits for new and retrofitted landscapes. WaterNow Alliance has worked with the City to educate the local landscape community on best practices for irrigation efficiency and audits. In our view, Aspen has both the internal expertise and capacity to implement and administer a WaterSmart Grant. This proposal would enable the City to accelerate implementation of its critical water sustainability goals.

One of the City's primary water efficiency initiatives is identifying and reducing water loss within its system, specifically raw water system losses to support its potable water supply deliveries and to protect its raw water supply sources. The City has identified potentially significant water loss within its Maroon Creek municipal diversion pipeline. Aspen will be rehabilitating a section of critical pipeline infrastructure that provides raw water from Maroon Creek, a perennial stream located upgradient from the City, to the City's raw water storage reservoir and to a small 400 kW hydroelectric generation facility. This supply is ultimately delivered to its water treatment facility and used as a primary potable supply.

Aspen is committed to protecting instream flows and has adopted a policy to maintain streamflow in the creeks downstream of its diversion structures at flow rates that are at or above the Colorado Water Conservation Board's (CWCB) decreed instream flow rights for the protection of the fishery and the associated aquatic habitats in those streams. The pipeline lining improvements will significantly reduce pipeline loss, enabling the City to protect instream flows and more efficiently ensure the reliability of local water supplies.

We believe that Aspen's proposal would advance the core purposes of the WaterSMART Water and Energy Efficiency program and urge your favorable consideration of Aspen's grant application for the Maroon Creek Penstock Lining Project. Thank you for your consideration of our views.

Sincerely,

Cynthia Koehler

Cynthia Koehler, Executive Director
WaterNow Alliance

COLORADO
Colorado Water Conservation Board
Department of Natural Resources
1313 Sherman Street, Room 718
Denver, CO 80203

9/1/20

Ryan Loebach
Senior Project Manager
Utilities Department
130 South Galena St.
Aspen, CO 81611

Subject: U.S. Bureau of Reclamation WaterSMART Water and Energy Efficiency Grant: City of Aspen Maroon Creek Penstock Lining Project

Dear Mr. Loebach,

On behalf of the Colorado Water Conservation Board (CWCB), I would like to submit a letter in support of the City of Aspen's U.S. Bureau of Reclamation WaterSMART Water and Energy Efficiency Grant for the City of Aspen Maroon Creek Penstock Lining Project. The CWCB is the state water policy and planning agency for Colorado and we assist water providers across the state to use water more efficiently and sustainably. One such area is the control and management of their water loss through statewide training and financial assistance. Whether on the supply or demand side, water loss control and management is a fundamental best practice that all water providers should be employing.

The City of Aspen is committed to providing a safe and resilient water supply and is a leader in water efficiency and conservation through the implementation of its State approved municipal Water Efficiency Plan. One of the City's primary initiative is identifying and reducing water loss within its system. While the focus tends to be on the treated water side, the City is also evaluating its raw water system losses to support its potable water supply deliveries and to protect its raw water supply sources. Over time, the City has identified potentially significant loss within its Maroon Creek municipal diversion pipeline. The City of Aspen will be rehabilitating a section of critical pipeline infrastructure that provides raw water from Maroon Creek, a perennial stream located upgradient from the City, to the City's raw water storage reservoir and to a small 400 kW hydroelectric generation facility. This supply is ultimately delivered to its water treatment facility and used as a primary potable supply.

Aspen is committed to protecting decreed instream flows and has adopted a policy to maintain streamflow in the creeks downstream of its diversion structures at flow rates that are at or above the Colorado Water Conservation Board's (CWCB) decreed instream flow rights for the protection of the fishery and the associated aquatic habitats in those streams. The City operates its senior Maroon Creek water rights in a way that protects the decreed instream flows. Through the pipeline lining improvements, the City will significantly reduce pipeline loss. This will allow the City to divert less water through its headgate to meet all its Maroon Creek hydropower, potable supply, and raw water supply demands. Through this improvement, the City is exhibiting its commitment to instream flow protection and the efficient use of all water supplies.

For these reasons, we strongly support the City of Aspen's U.S. Bureau of Reclamation WaterSMART Drought Resiliency Projects Grant application for Instrumentation and Monitoring Project.

If you have any further questions, please feel free to contact me at kevin.reidy@state.co.us .

Sincerely,

Kevin Reidy
State Water Conservation Specialist
Colorado Water Conservation Board

Ryan Loebach
Senior Project Manager, Utilities Department
130 South Galena St.
Aspen, CO 81611

Subject: U.S. Bureau of Reclamation WaterSMART Water and Energy Efficiency Grant: City of Aspen Maroon Creek Penstock Lining Project

Dear Mr. Loebach,

On behalf of Pitkin County, I would like to submit a letter in support of the City of Aspen's U.S. Bureau of Reclamation WaterSMART Water and Energy Efficiency Grant for the City of Aspen Maroon Creek Penstock Lining Project. Pitkin County is the owner of the road above part of the project being contemplated. This road carries hundreds of thousands of visitors to see the Maroon Bells each year and ensuring that projects are minimally impactful to these visitors is an important factor when we considering impacts.

The City of Aspen is committed to providing a safe and resilient water supply and is a leader in water efficiency and conservation through the implementation of its State approved municipal Water Efficiency Plan. One of the City's primary initiative is identifying and reducing water loss within its system. While the focus tends to be on the treated water side, the City is also evaluating its raw water system losses to support its potable water supply deliveries and to protect its raw water supply sources. Over time, the City has identified potentially significant loss within its Maroon Creek municipal diversion pipeline. The City of Aspen will be rehabilitating a section of critical pipeline infrastructure that provides raw water from Maroon Creek, a perennial stream located upgradient from the City, to the City's raw water storage reservoir and to a small 400 kW hydroelectric generation facility. This supply is ultimately delivered to its water treatment facility and used as a primary potable supply.

Aspen is committed to protecting decreed instream flows and has adopted a policy to maintain streamflow in the creeks downstream of its diversion structures at flow rates that are at or above the Colorado Water Conservation Board's (CWCB) decreed instream flow rights for the protection of the fishery and the associated aquatic habitats in those streams. The City operates its senior Maroon Creek water rights in a way that protects the decreed instream flows. Through the pipeline lining improvements, the City will significantly reduce pipeline loss. This will allow the City to divert less water through its headgate to meet all its Maroon Creek hydropower, potable supply, and raw water supply demands. Through this improvement, the City is exhibiting its commitment to instream flow protection and the efficient use of all water supplies. These protections align with Pitkin County's values of ensuring are maximized whenever possible.

For these reasons, we strongly support the City of Aspen's U.S. Bureau of Reclamation WaterSMART Drought Resiliency Projects Grant application for Instrumentation and Monitoring Project.

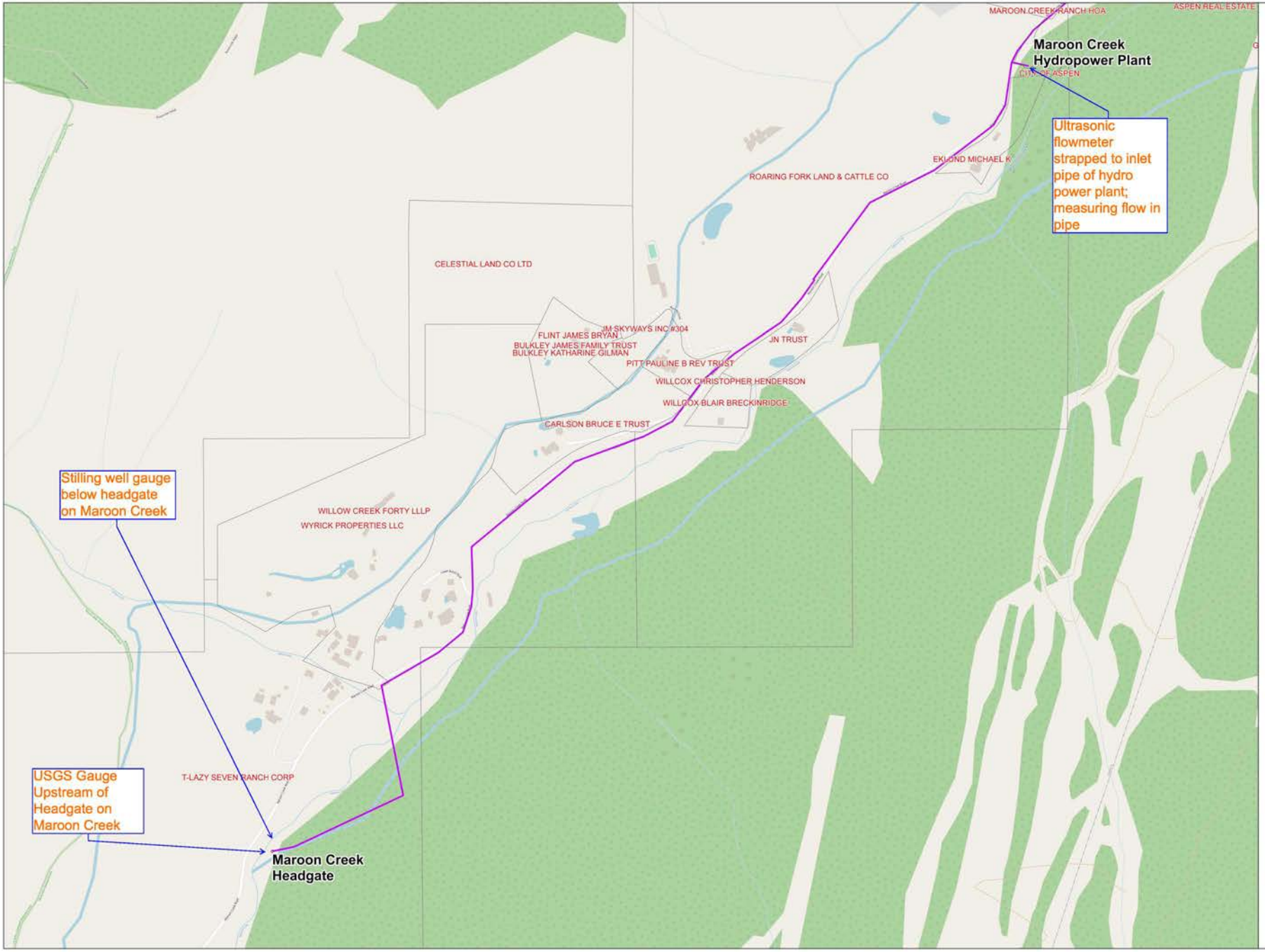
If you have any further questions, please feel free to contact me at Gerald.fielding@pitkincounty.com.

Sincerely,

GR Fielding

Digitally signed by GR Fielding
DN: C=US, E=gerald.fielding@pitkincounty.com, O=Pitkin County, OU=Engineering, CN=GR Fielding
Date: 2020.09.10 15:32:38-06'00'

G.R. Fielding, PE, County Engineer Pitkin County



Maroon Creek Pipeline: Headgate to Maroon Creek Hydropower Plant

UTILITIES
CITY OF ASPEN

6/23/2020

- Raw Water Pipeline
- Maroon Creek Headgate
- Maroon Creek Hydropower Plant
- Pitkin Parcels

N

0 500 Feet

1 inch equals 250 Feet

This map/drawing/image is a graphical representation of the features depicted and is not a legal representation. The accuracy may change depending on the enlargement or reduction.