

# City of Bozeman Drought Management Plan May 2022

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# 1 INTRODUCTION

The Drought Management Plan is designed to maximize available water supplies and reduce water use during times of shortage and provide guidelines the City of Bozeman will use to manage water supply and water use during drought. The guidelines are designed to maintain the health, safety and economic vitality of the community; to avoid adverse impacts to public activity and quality of life for the community; and to consider individual customer needs as much as possible to the greatest extent possible in the face of water shortages.

Because each drought is different, it is not practical to develop a set of hard-and-fast rules to apply to all droughts. Rather, these guidelines are intended to provide a framework for timely drought response while maintaining flexibility to respond to unique drought conditions. These guidelines are intended to assist the City Manager in making decisions throughout the course of a drought. The City Manager may adjust or refine the response based on actual drought conditions.

Drought is a natural occurring phenomenon that may affect any climate zone in any part of the world at a given time. Depending on drought severity and characteristics of the area, the repercussions of drought can be significant - impacting local economies, disrupting quality of life, and disturbing the health and welfare of a population and its environment.<sup>1</sup>

Chronic drought is a part of the Gallatin Valley’s history and is of particular concern to the City of Bozeman as the City has experienced rapid growth in recent decades. The impact of drought on Bozeman is further compounded by its location in the headwaters of the Gallatin River watershed, the susceptibility of the City’s source waters to drought conditions and limited water storage.

This Plan was designed with input from the 2017 City of Bozeman Drought Management Team and community stakeholders. The Drought Management Team was revised in 2022 to include additional members of City staff and other organizations in the Gallatin Valley in order to increase the effectiveness of drought communications. Drought Team members comprise a diverse group of water supply and communications experts to aid in data driven decision making and ensure adequate and consistent drought messaging and communications throughout organizations across the Gallatin Valley. Team members are identified in **Appendix A**. Select City staff included in the City of Bozeman Drought Management Team represent key decision makers who, together, will make recommendations to the City Manager regarding drought declaration and pursuant response measures.

The Plan is based on an analysis of Bozeman’s climate and available water supplies, a review of other drought plans from across the United States and lessons learned from past drought events in communities throughout the Western United States. This Drought Management Plan should be updated regularly to ensure that it addresses current conditions and will be administered by the City of Bozeman’s Utility Department staff.

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<sup>1</sup> <https://www.ncdc.noaa.gov/news/drought-monitoring-economic-environmental-and-social-impacts>

## 1.1 Drought Management Plan Objectives

- Preserve essential public services during any level of drought severity.
- Reduce adverse impacts on public health, safety, economic activity, environmental resources, and quality of life during a drought event.
- Ensure that drought management programming and outreach are accessible and targeted to reach renters, low-income residents, residents of multi-unit buildings, and other vulnerable or marginalized groups, while also ensuring that rate structures (including drought surcharges) do not disproportionately impact these groups.
- Provide a complete but flexible roadmap to guide implementation and enforcement of the Drought Management Plan.
- Develop an effective public communications strategy to raise the level of drought awareness throughout the community and to provide sufficient information about the importance of drought preparedness and response and the public's role in the effective implementation of the response measures set forth in the Plan.
- Coordinate drought management with the City of Bozeman's water supply planning and demand management efforts and regional policies and planning initiatives. This includes City, County, and State laws and regulations, the City of Bozeman's water conservation program and Gallatin County's Hazard Mitigation and Emergency Response Plans.

## 1.2 Drought Management Plan Components

Drought Severity Indicators (Vulnerability Assessment and Drought Monitoring) – Factors that should be considered in choosing appropriate drought response.

Drought Mitigation and Response Actions – Guidelines for generating additional water supplies and reducing water use during times of drought.

Drought Response Program – Strategies for reducing water use during each stage of drought and enforcement actions for violations. The authority to enforce response measures and water reduction targets provided in the Plan is provided for in the Bozeman Municipal Code and can result in fines or, in some cases, the potential for water shut offs.

## 1.3 Defining Drought

While drought is a widely-used term, there is no single universally-accepted definition of drought. From a meteorological perspective, drought is defined as an extended period of below average precipitation for a given region. Hydrologic drought refers to reduced stream flows, reservoirs, lakes and groundwater to below-normal levels and tends to lag behind the onset of low precipitation due to the buffering effects of soil moisture, groundwater and snowpack. Droughts are most often discussed from this perspective when water shortages begin to impact people in terms of water supply, loss of hydropower production, loss of

fisheries, agricultural production losses and food shortages. Thus, drought is most commonly thought of as an interplay between climate and water-dependent processes. Often, drought is defined by its effects rather than its causes.

For the City of Bozeman, a drought is a condition of insufficient water supplies caused by deficits in precipitation and hydrologic conditions. When the amount of water flowing in streams and into reservoirs is less than average, the City of Bozeman should more closely monitor its water supply outlook. If continued low stream flows stress water supplies, City staff will seek City Manager approval to implement the Drought Management Plan. The extent and duration of implementation will depend on actual drought conditions. Unfortunately, no one can predict how long drought conditions will last once they begin.

### 1.4 Water Supplies

Drought indicators are based on quantification of available water supplies which are set forth in the City of Bozeman’s Integrated Water Resources Plan (IWRP) and the estimated amount of water available from its collection system to meet customer demand.<sup>2</sup> Figure 1-1 depicts Bozeman’s existing water supply sources.

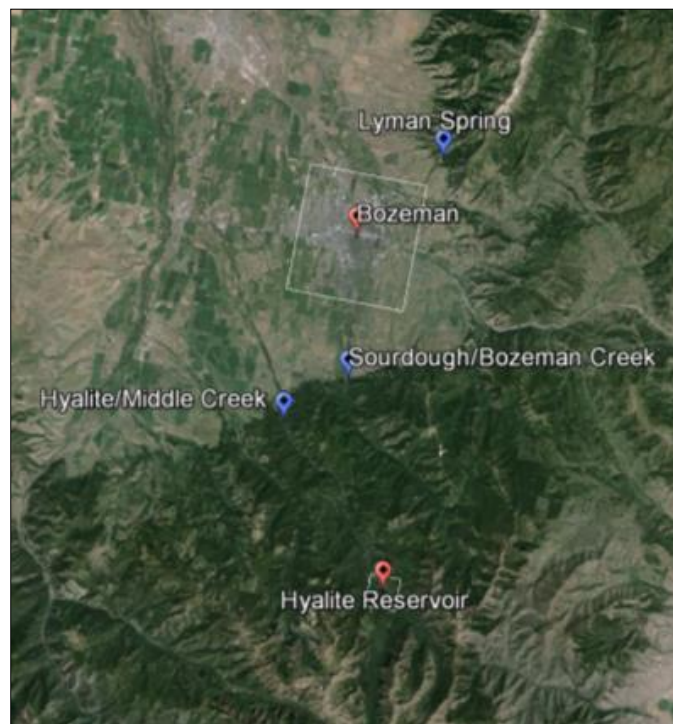


Figure 1-1: Regional Map of the City of Bozeman's Water Supply Sources

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<sup>2</sup> City of Bozeman Integrated Water Resources Plan, EX-2 (2013).



The water supply data set forth in the IWRP is incorporated into monitoring near and long-term water availability, with the goal of providing a framework for predicting future drought probability, or confirming the intensity of an existing drought. A robust monitoring plan is critical to recognize and respond as soon as possible to the onset of a drought event. This is of particular importance in light of the fact that currently, year over year storage is not part of reservoir management practice, which can rapidly change the severity of impacts from drought events.

As a part of this Drought Management Plan, it is recommended that upon approval by the Commission, the City develop a strategic water reserve from Bozeman’s water supplies to provide protection against circumstances such as climate change or drought conditions of greater severity than have been projected to occur within the thirty year planning horizon.<sup>3</sup> Implementation and operation of the strategic water reserve will be determined by the Commission, subsequent to the adoption of this Plan.

**1.5 Strategic Water Reserve**

Strategic water reserves are volumes of water set aside by a utility or water purveyor for use in a drought or other water shortage emergency. In recent years, several utilities have established water reserves to provide water resiliency in the event of a prolonged or severe drought event.<sup>4</sup> The development of a strategic water reserve necessitates that water is set aside and removed from the accounting used to determine the water supply available for additional population growth.

Consideration of a strategic water reserve is recommended for the City of Bozeman to reduce future drought vulnerability. This reserve could comprise existing water rights stored from Hyalite Reservoir or from aquifer storage, from water saved as a result of water conservation measures or established via private agreement with interested parties. If a drought was especially severe and persistent, having a drought reserve that could ensure enough water to provide minimum water usage to the next wet weather period would be prudent. The volume of a reserve will be determined by the City Commission after review of additional information specific to the City of Bozeman’s water supplies in order to facilitate the development of a strategic water reserve.

The City is currently underway with the development of a water supply optimization study that includes the examination of developing a strategic water reserve. The implementation of a strategic water reserve will be determined by the City Commission after review of recommendations that result from the water supply optimization study.

**1.6 Long Term Drought Mitigation Efforts**

The drought response actions set forth in this Plan should not be confused with long term drought mitigation. The City of Bozeman engages in long term drought mitigation through on-going water

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<sup>3</sup> *Id.* At Appendix A: Climate Change Adjustments to Firm Yield and Demand for Bozeman, MT, Technical Memorandum.  
<sup>4</sup> Examples include Albuquerque, Bernalillo County Water Utility Authority, Santa Fe, Denver Water, Truckee Meadows Water Authority.



conservation efforts and supply projects outlined in Bozeman’s Integrated Water Resources Plan.

The City of Bozeman’s semi-arid climate requires water efficiency become a way of life. The City of Bozeman’s Water Conservation Division has been effective in reducing water consumption and is committed to water efficiency and customer outreach. While the City of Bozeman has a separate Water Conservation Division and water conservation savings goal, water conservation program development is directly linked to drought mitigation. For more information about how water conservation is an integral component of long-term drought management, and what the City is doing to increase water resiliency, please visit [www.bozemanwater.com](http://www.bozemanwater.com).

Despite these long term water planning efforts, because of drought, there will be times when further water use reductions are needed in addition to standard water conservation efforts. Drought restrictions that are part of a response plan indicate urgency and are not intended for long-term application.

Because it is unknown how customers will respond during declared drought events, the reduction targets presented in this Plan have been established based on documented achievable reductions in other drought-prone communities in the Western United States, best practice and what is achievable and necessary to mitigate economic impacts from drought and to preserve public health and safety.

**1.7 Drought Communications**

Drought communications are an integral component of this Plan and will be closely coordinated with the Water Conservation Division to provide information regarding water resiliency and conservation. Messaging should promote the importance of conserving water and achieving water savings in both normal and drought years.

During non-drought years, drought communications should consist of resources and information regarding customer-driven long-term drought mitigation efforts, general drought information and drought preparedness tools to the community.

During a drought, the messages should increase in frequency and include information on the stages of drought declared by the City Manager and the various response actions requested or required from Bozeman residents in order to reduce impacts from drought.

Drought messaging should provide clear and effective drought information to water customers and the media, adjust the scope of public education and outreach efforts pursuant to the drought stage, and coordinate public communication efforts with county planning and hazard mitigation personnel, nearby municipal entities, state agencies, and other conservation-focused organizations to convey, where appropriate, a consistent drought message.

## 2 DROUGHT SEVERITY INDICATORS

Drought severity indicators identify risks to critical resources during drought and the factors that contribute to those risks. This Plan divides these indicators into two categories: (1) vulnerability assessment and (2) drought monitoring. During a drought, the City Manager should consider drought severity indicators in choosing the appropriate drought response actions. The Drought Response Actions section below demonstrates how the drought severity indicators align with the suggested drought response framework.

### 2.1 Vulnerability Assessment

Risks to critical water resources in the Bozeman area combine the frequency of occurrence, magnitude and severity, and consequences of drought. The vulnerability assessment drives the development of potential drought mitigation and response actions. Assessing the level of risk requires a review of past drought impacts, and an analysis of historical water supply and water use trends which demonstrate how trends may change over time.

The City of Bozeman is extremely vulnerable to drought due to a long history of drought in the region, increased potential for impacts from climate change, increased risks for wildfire, rapid population growth, dramatic increases in water use during the summer months, and the needs of other water users in the watershed.

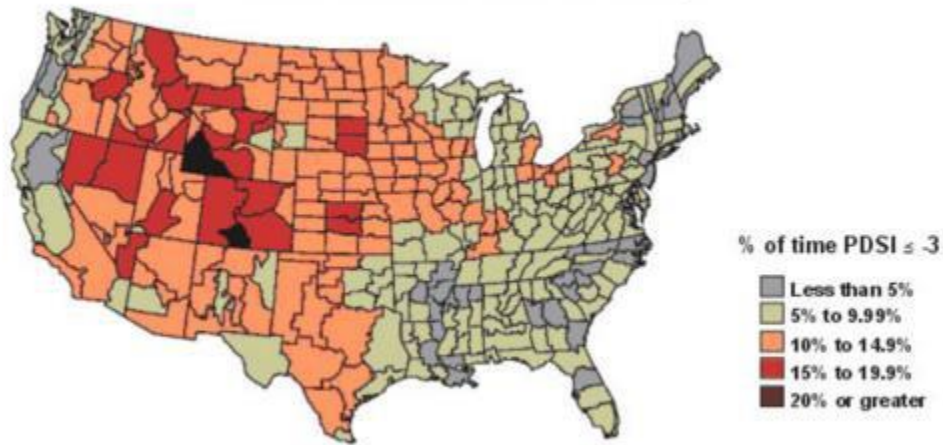
#### 2.1.1 Drought History

Southwestern Montana has experienced severe drought in its recorded history and is located in a region that is relatively prone to drought conditions according to historical Palmer Drought Severity Index data. Figure 2-1 represents the historical Palmer Drought Severity Index. Based on the figure, southwestern Montana has been in severe or extreme drought 15% to 19.9% of the time between 1895 and 1995, which is significant given only two other areas of the continental U.S. in southwest Wyoming and south central Colorado appear to be more susceptible to drought conditions.

# Palmer Drought Severity Index

1895–1995

Percent of time in severe and extreme drought



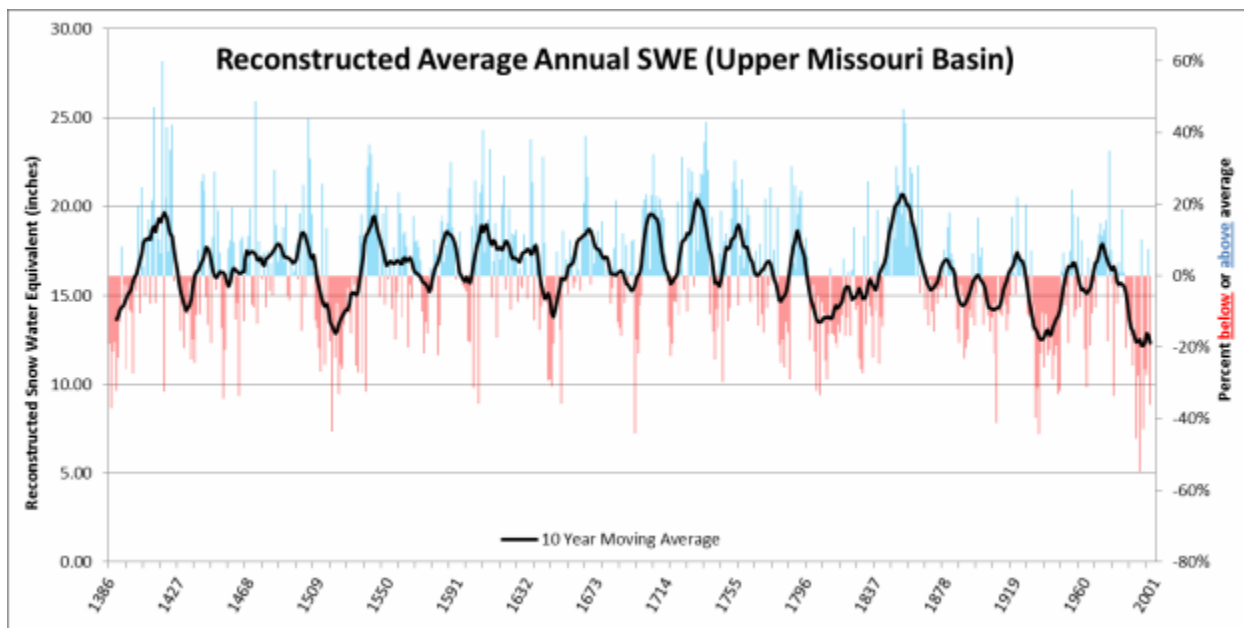
SOURCE: McKee et al. (1993); NOAA (1990); High Plains Regional Climate Center (1996)  
Albers Equal Area Projection; Map prepared at the National Drought Mitigation Center

Figure 2- 1: Palmer Drought Severity Index for the United States (1895-1995)

In addition, recent improvements in paleoclimate data examination using tree-ring analysis indicate that more severe and prolonged droughts have occurred in the region than are reflected by recorded history.<sup>5</sup> Figure 2-2 shows the historical snow water equivalent from tree ring data in the Upper Missouri Basin for the last six hundred years. The historical data indicate that prolonged and severe drought in the area is chronic, and the importance of adequately preparing for such periods via the adoption of this Drought Management Plan is a necessary step to increasing water security for the City of Bozeman.

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<sup>5</sup> Ault, T. R., Cole, J. E., Overpeck, J. T., Pederson, G. T., & Meko, D. M. (2014). Assessing the risk of persistent drought using climate model simulations and paleoclimate data. *Journal of Climate*, 27(20), 7529-7549; See also, City of Bozeman Integrated Water Resources Plan (2013).



**Figure 2- 2: Historical Streamflow and Snow Water Equivalent Trends from the Tree Ring Data for the Upper Missouri Basin**

In the more recent past, the Bozeman area experienced moderate to extreme drought in several months between 2000 and 2022. Figure 2-3 illustrates rainfall and temperature in the Bozeman region from 2000-2022, and while it does not evaluate snowpack, it is still a very relevant illustration of water impacts in Bozeman as late spring and early summer precipitation and evapotranspiration rates are strongly correlated to the City’s water demand.<sup>6</sup>

### 2.1.2 Potential Climate Change Impacts

Climate change models predict warming in the region and longer dry spells which could reduce snowfall and result in earlier melting of the snowpack and increased evapotranspiration in the area.<sup>7</sup> Even without any changes in precipitation intensity, this could lead to a shift in peak stream runoff to early spring or even late winter, away from the mid to late summer when water demand is greatest. Warming temperatures could also cause more precipitation to occur in the form of rain instead of snow.

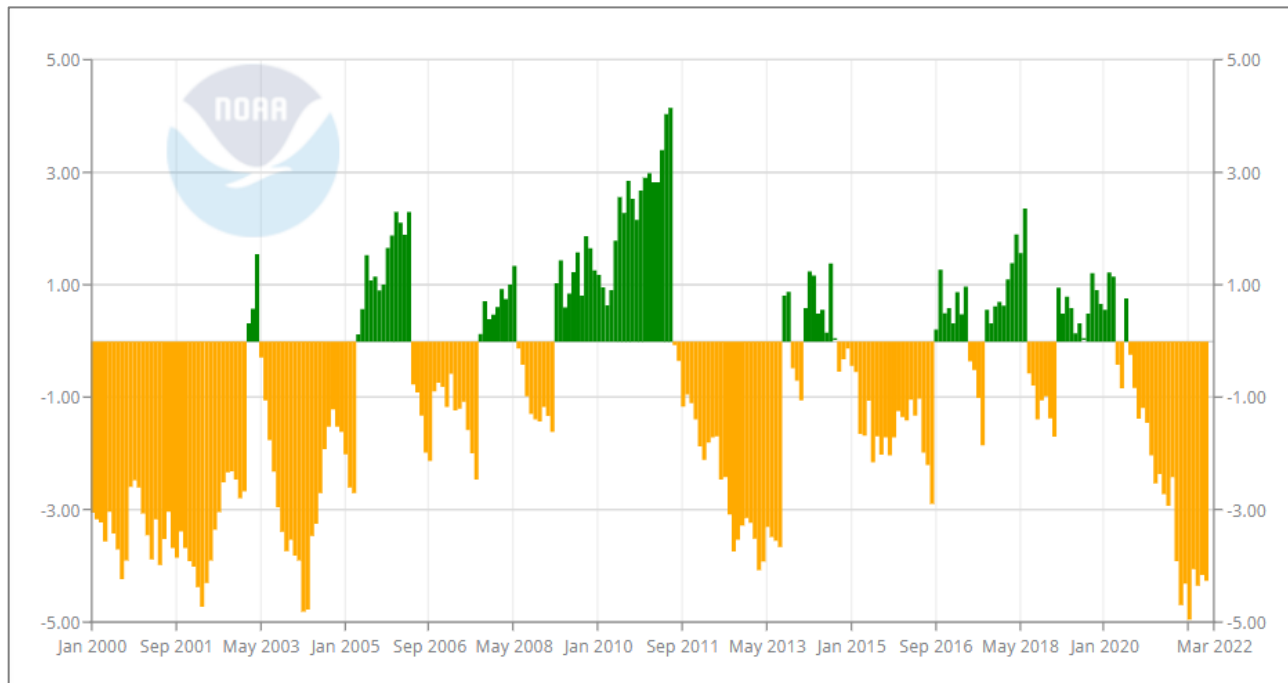
All of the City’s water supply sources are heavily reliant on snowpack, which has generally decreased in the region since approximately 1980.<sup>8</sup> Climate change models predict snowpack will decrease substantially in

<sup>6</sup> National Drought Mitigation Center Drought Risk Atlas: <http://droughtatlas.unl.edu/>

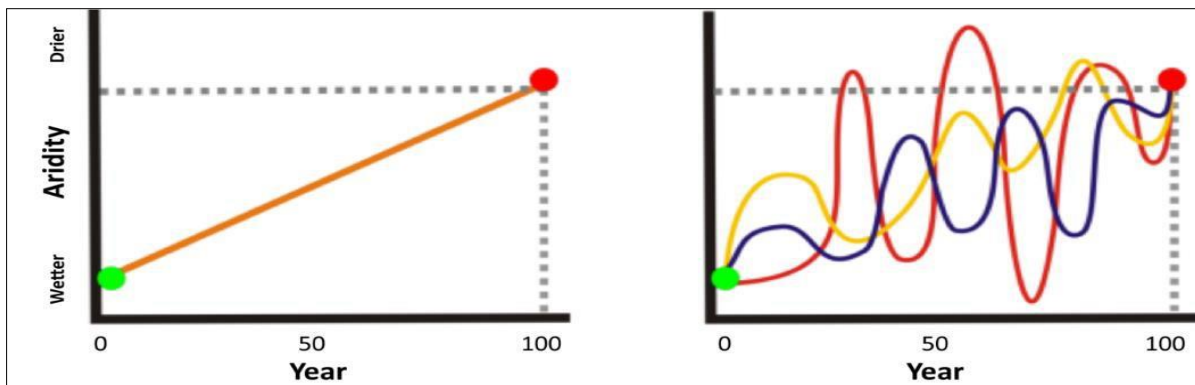
<sup>7</sup> Barnett, T. P., Adam, J. C., & Lettenmaier, D. P. (2005). Potential impacts of a warming climate on water availability in snow-dominated regions. *Nature*, 438(7066), 303-309.

<sup>8</sup> Pederson, G. T., S. T. Gray, C. A. Woodhouse, J. L. Betancourt, D. B. Fagre, J. S. Littell, E. Watson, B. H. Luckman, and L. J. Graumlich (2011), The unusual nature of recent snowpack declines in the North American Cordillera, *Science*, 333(6040), 332–335, doi:10.1126/science.

coming years due to early spring warming.<sup>9</sup> Additionally, climate models demonstrate increased climate variability rather than a linear trend due to a combination of climate change and natural variability as shown in Figure 2-4.<sup>10</sup>



**Figure 2- 3: Monthly Palmer Drought Severity Index (PDSI) for Bozeman Region (Jan 2000-Feb 2022)**



**Figure 2- 4: Future Climate Trend Consisting of Natural Variability and Climate Change**

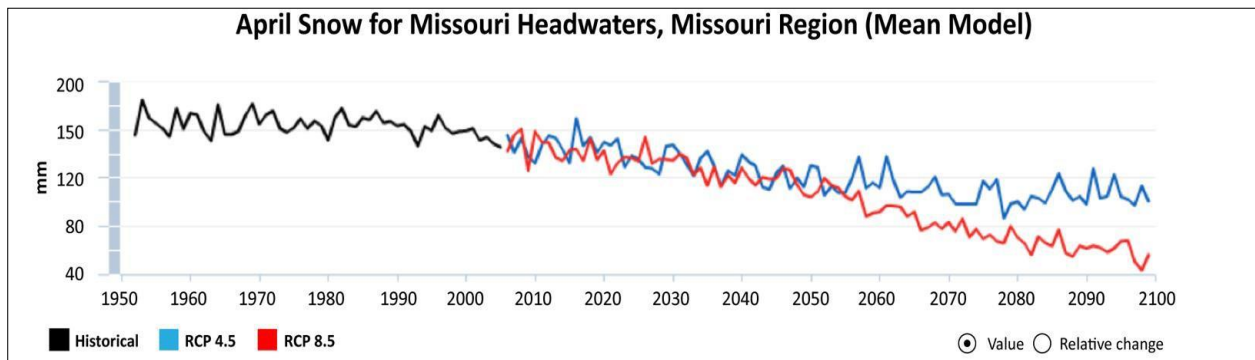
Climate variability must be taken into account with future consideration of drought management and

<sup>9</sup> UW Climate Impacts Group – <http://cses.washington.edu/cig/>

<sup>10</sup> Gray, S. T., Betancourt, J. L., Jackson, S. T., & Eddy, R. G. (2006). Role of multi-decadal climate variability in a range extension of pinyon pine. *Ecology*, 87(5), 1124-1130.

response due to the increased probability of long-term drought, and an increase in the magnitude and related impacts of short-term drought. Due to current limitations on accounting for storage of water from a previous water year and the reliance on snowpack, a severe short-term drought could have significant impacts.

Figure 2-5 shows the historical April snowpack for the Missouri River Headwaters Region, as well as the United States Geological Survey’s projection of future snowpack based on two levels of solar radiation. Regardless of solar radiation levels, the overall estimates predict substantial reductions in April snowpack.



**Figure 2- 5: Historical and Projected April Snow for Missouri River Headwaters Region (Mean Mode)**

Figure 2-6 is a compilation of Hyalite snowpack snow water equivalent data (Shower Falls and Lick Creek SNOTEL sites) and Bridger Mountain snowpack snow water equivalent data (Sacajawea and Brackett Creek SNOTEL sites), with non-exceedance projections based on historical values depicted on the graph. The term non-exceedance is used to describe a method of cumulative frequency analysis and refers to how likely various changes in the current snowpack are to occur based on historical data. The graph in Figure 2-6 displays non-exceedance projections which correspond to the amount of time that the snowpack has historically held more water on the same date as the current measurement.

The graph projects that over time the snowpack snow water equivalence will decrease as less snow water is present in the snowpack, and what is present will melt earlier in the spring.

Regionally, early snowpack melt has been occurring with what appears to be increasing frequency.<sup>11</sup> The early occurrence of winter and spring snowmelt is anticipated to place increased strain on the adequacy of the City of Bozeman’s water supplies in the late summer and fall months. The arrow in Figure 2-6 illustrates the predicted trend for future snowpack and timing of snowmelt.

<sup>11</sup> Gregory T. Pederson, et al, (2011). Climatic Controls on the Snowmelt Hydrology of the Northern Rocky Mountains. *J. Climate*, 24, 1666–1687.

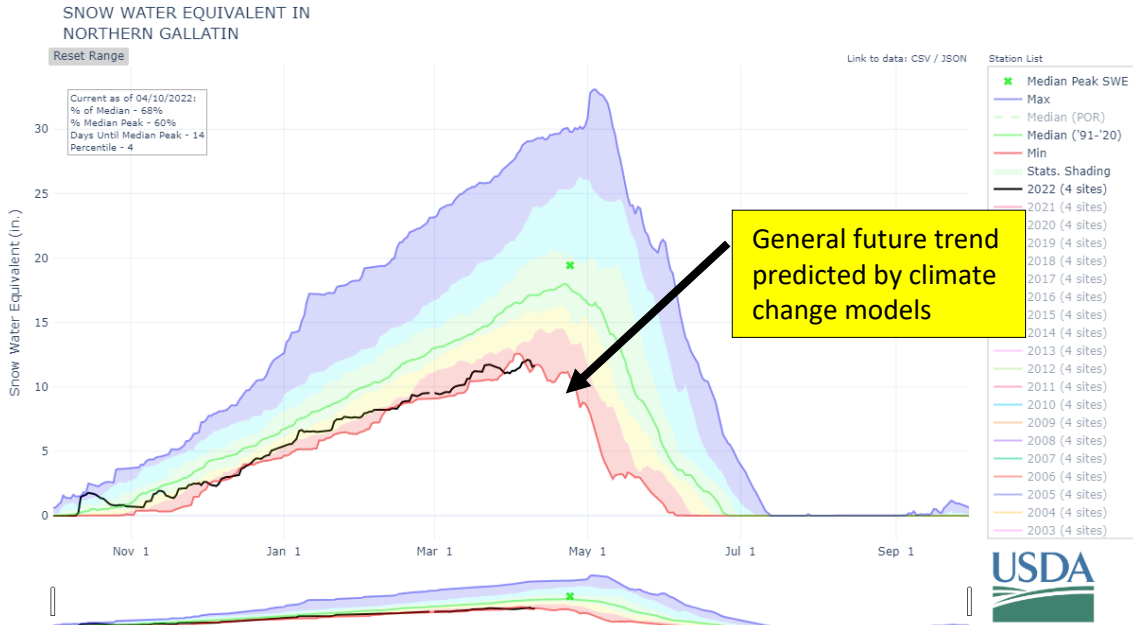


Figure 2- 6: Northern Gallatin Snowpack Snow Water Equivalent

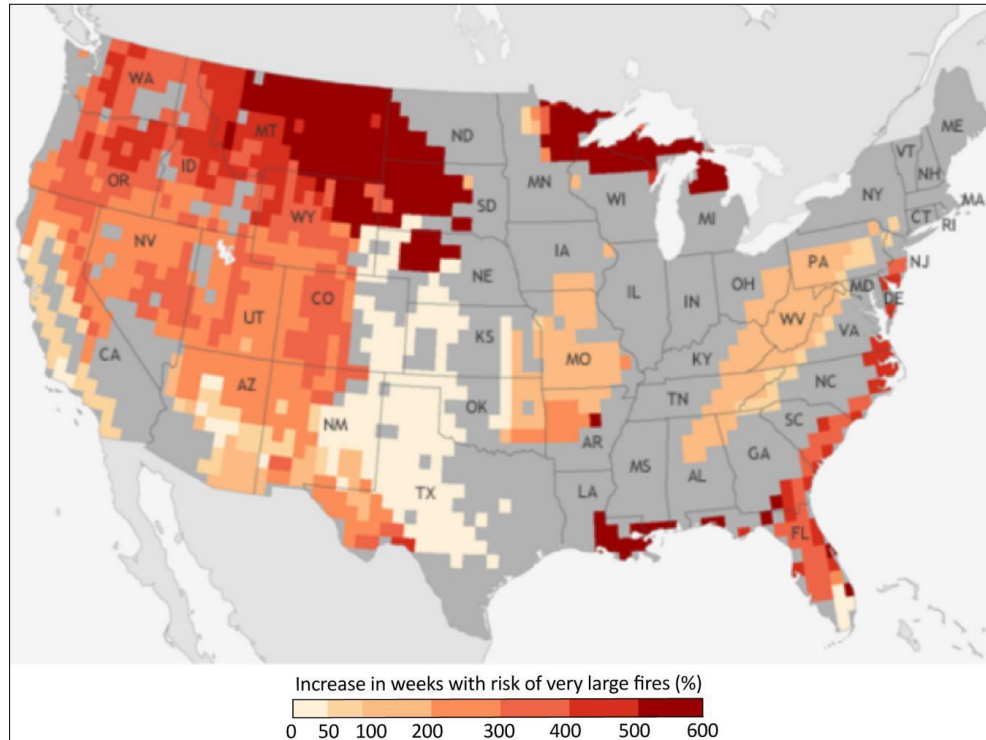
### 2.1.3 Wildfire Risks and Impacts

Climate change models also predict increased wildfire frequency and duration, as well as longer wildfire seasons.<sup>12</sup> Wildfire risk has a tendency to follow drought conditions. All of the City’s watersheds (Sourdough, Hyalite and Lyman) are forested and therefore susceptible to wildfire, which would likely reduce the amount and quality of water available from the municipal watersheds for an extended period of time. Nationally, wildfire already occurs with more frequency. A warming climate leads to increased rates of evapotranspiration resulting in drier forests in the late summer and fall months. Figure 2-7 depicts increased risks of very large wildfires in the contiguous United States.<sup>13</sup>

<sup>12</sup> <https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires> An, H., Gan, J., & Cho, S. J. (2015). Assessing climate change impacts on wildfire risk in the United States. *Forests*, 6(9), 3197-3211.

<sup>13</sup> Barbero, R.; Abatzoglou, J.T.; Larkin, N.K.; Kolden, C.A.; Stocks, B. (2015). Climate change presents increased potential for very large fires in the contiguous United States. *International Journal of Wildland Fire*.





**Figure 2- 7: Relative Increased Risk of Very Large Wildfires in Contiguous United States**

Wildfires negatively impact water sources by increasing ash and sediment mobilization, thus reducing water quality as a result of ash and sediment-laden reservoirs and streams. A fire in the Hyalite watershed could result in substantial increases in sediment deposition, reducing the capacity of Hyalite Reservoir.

Water utilities impacted by wildfire have reported that intense rains subsequent to a wildfire event caused massive sediment accumulations that damaged infrastructure and resulted in power outages, long-term reduction in source water quality, short-term contamination of drinking water sources, loss of source water, and water demand in excess of water production.<sup>14</sup> Due to the fact that Bozeman Creek and Hyalite Creek watersheds are at risk of high severity fire, the City of Bozeman’s new water treatment plant was specifically designed to function even with some sediment loading from a wildfire event. However, it is not equipped to handle the aftermath of large and prolonged fires. As a result, fuel reduction measures in these source watersheds are necessary to reduce wildfire impact severity.<sup>15</sup>

The City is currently underway with the Bozeman Municipal Watershed Fuels Reduction Project, a joint effort between the City of Bozeman and Custer Gallatin National Forest, which aims to reduce forest fuel

<sup>14</sup> Sham, C.H., Tuccillo, M.E., and Rooke, J. (2013). Effects of Wildfire on Drinking Water Utilities and Best Practices for Wildlife Risk Reduction and Mitigation. Water Research Foundation, Web Report #4482.

<sup>15</sup> City of Bozeman Source Water Protection Plan, Western Groundwater Services, Bozeman, 2004; USFS, Bozeman Municipal Watershed Risk Assessment. Bozeman, MT, 2003.

loads. The project will help protect Bozeman’s drinking water supply and will increase public and firefighter safety.

### 2.1.4 Population Growth

A rapidly growing population (3% to 6% growth rate in recent years) increases vulnerability to drought. The City of Bozeman’s Integrated Water Resources Plan (IWRP) determined that without substantial conservation Bozeman will likely experience a water supply and demand gap within the next 25 years.<sup>16</sup>

However, current growth trends and water use trends indicate that Bozeman may experience a water supply and demand gap within the next 15 years. Figure 2-8 shows the population growth of Bozeman from 1950 to 2021. Rapid population growth in an area without a large, stable raw water source (large river, groundwater aquifer, or very large raw water reservoir) increases vulnerability to drought, unless new sources are developed to accommodate growth.

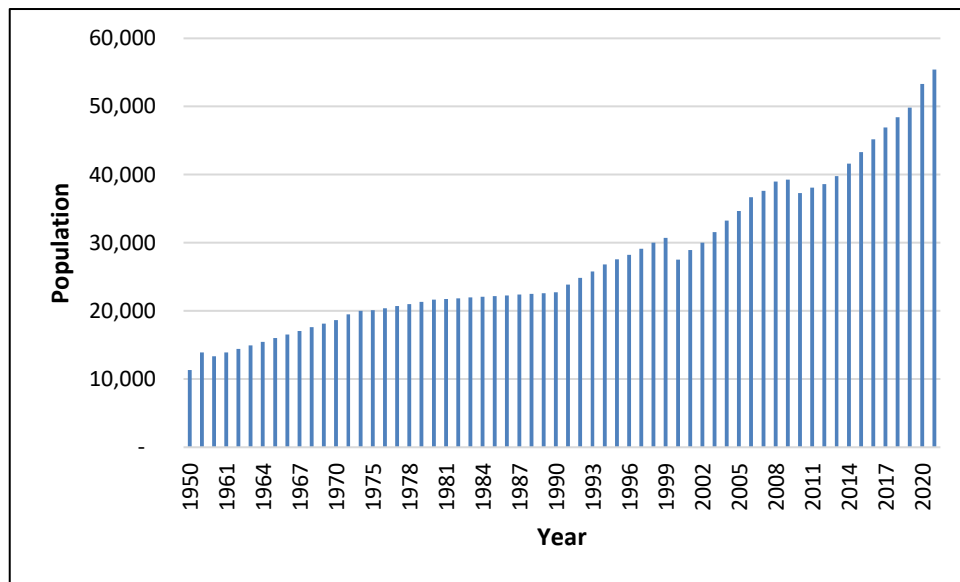


Figure 2- 8: City of Bozeman Population Growth from 1950 to 2021

### 2.1.5 Increased Summer Water Usage

Water usage significantly increases during the months of June, July, and August as a result of outdoor watering. The peak summer demands for lawn watering are roughly 250% of the average winter demand. During drought, lawns become drier, prompting homeowners to irrigate more, rather than less.

Figure 2-9 shows the average monthly water demand by water customer class from 2016 – 2020. When evaluating water usage across all customer classes, summer demands are approximately 2.5 times higher than winter demands. If the data represented in Figure 2-9 are disaggregated by year, a correlation

<sup>16</sup> City of Bozeman Integrated Water Resources Plan (IWRP), Advanced Engineering and Environmental Services, 2013

between monthly water demand and evapotranspiration becomes very apparent. Single family residents use a high proportion of water for irrigation compared to other customer classes, and residents who irrigate their lawn use more water during dry years than normal years. This practice will be reduced or curtailed as a component of drought response set forth in this Plan.

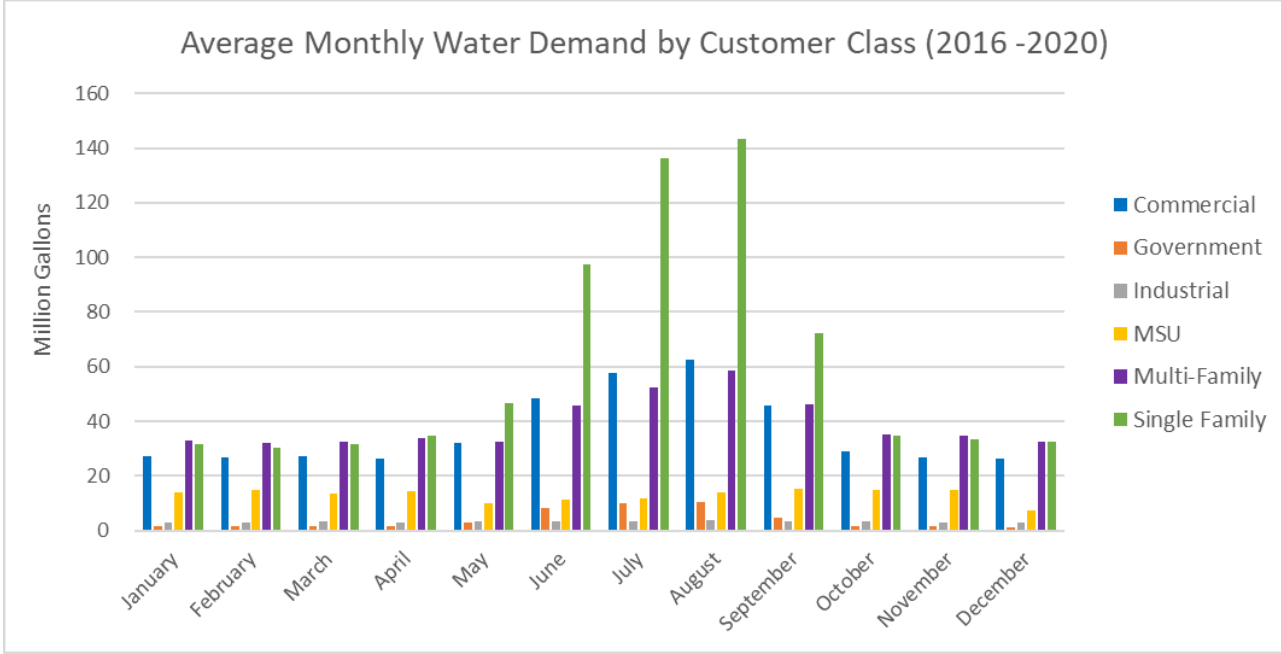


Figure 2- 9: City of Bozeman Average Monthly Water Demand by Customer Class (2016-2020).

**2.1.6 Requirements of Neighboring Water Users**

Bozeman’s vulnerability to drought is further subject to the water needs of neighboring communities and user groups. Agricultural interests, adjacent cities, towns and residential communities, and recreational and environmental interests have rightful claims to water supplies in the Gallatin Valley and are significantly impacted during drought.

Additional complications arise when drought is incorporated into the legal framework allocating water in Montana. This structure is based on the doctrine of prior appropriation in which the date the water is appropriated and placed to beneficial use determines the priority of the water right. The oldest or most senior dates of appropriation are administered first. As a result, during times of shortage, priority determines who is entitled to divert and use water. As increasing demands are placed on the finite amount of water available, the risks for conflicts between water users increase. An effective Drought Management Plan can reduce the likelihood for such conflicts.

**2.2 Drought Monitoring**

A Drought Management Plan must include a means of monitoring current drought conditions and applying the conditions to the development of an overall drought stage framework. The primary goal of drought monitoring is to recognize a drought in its early stages and accurately assess its severity over time so that appropriate responses are successfully implemented.

A transparent, quantifiable, and scientific basis for drought declaration is critical for timely decision-making, effective communication, and managing expectations of the public. Drought monitoring allows for the use of local and national data in decision-making, implementation of appropriate restrictions at the appropriate times, and allowances for different types of uses and the needs of different water users.

For purposes of this Plan, a drought monitoring protocol was developed that incorporates local data such as reservoir storage, area streamflow, snowpack, precipitation, temperature, evapotranspiration and weather forecasts, as well as national drought indices. City staff will monitor these data, including the use of a customized monitoring tool comprising local and national indicators described in this Section. These data should be monitored all year, and during summer months data should be monitored alongside water demand order to understand how water supply availability and weather patterns are impacting demand trends. Select outputs from the drought monitoring tool are set forth in **Appendix B**. Calibration of the City’s drought monitoring tool ensures the accuracy and reliability of the data generated by the drought monitoring tool. A snapshot of the calibration of the tool is provided in **Appendix C**.

### **2.2.1 Local Indicators**

Droughts are highly variable, complex, and specific to a region’s local climatic conditions. Due to the fact that 80% to 85% of Bozeman’s water supply is surface water, monitoring will primarily rely on levels in Hyalite Reservoir, area streamflow and snow water equivalence.

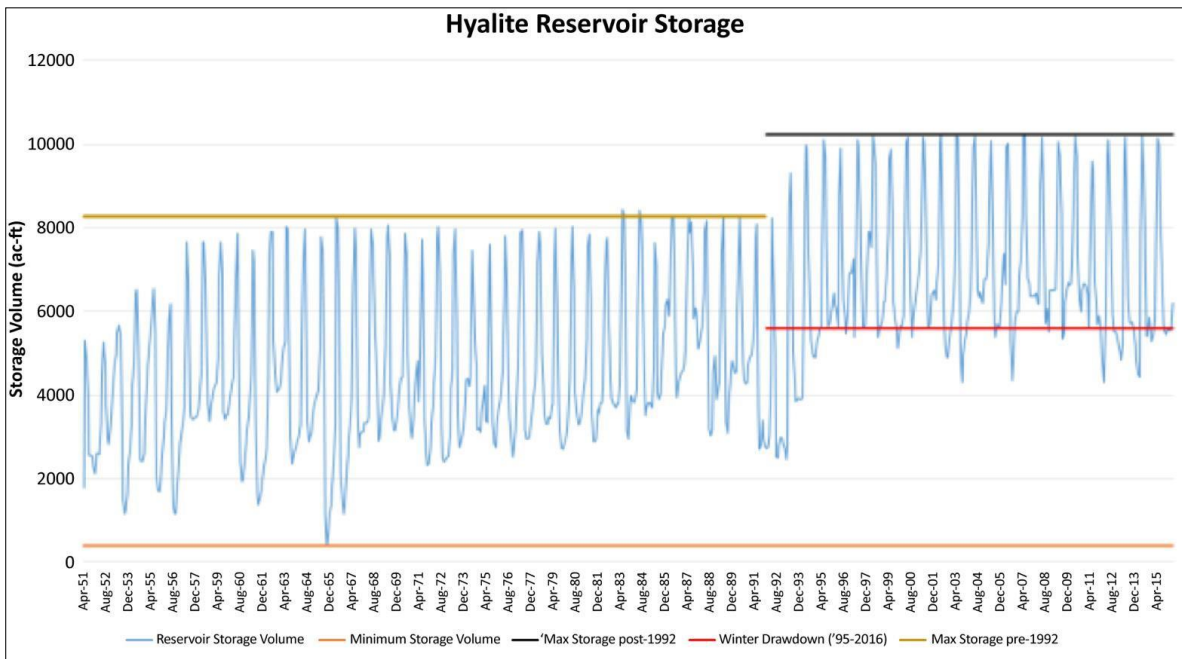
#### **2.2.1.1 Reservoir Storage**

Because much of the water supply during summer drought events comes from storage reservoirs, reservoir contents are an accurate indicator of a drought’s impact on available supplies when conditions are hot and dry and water use increases due to irrigation. Reservoir contents are the bottom line result of the factors affecting supply, including weather, snowpack, soil moisture, runoff, water rights, collection system limitations and water use.

Although the City of Bozeman currently has limited storage capacity, seasonal water elevation in Hyalite Reservoir, and the corresponding volume in storage, is an immediate and direct assessment of the area’s water supply status, particularly during summer months. Reservoir levels are regularly monitored by the Department of Natural Resources and Conservation (DNRC), and the data are easily accessible. The volume of water in Hyalite Reservoir alone is not indicative of what is available to the City at any given time, but due to the City’s reliance on Hyalite Reservoir as a source of water to support irrigation demands during summer months, the reservoir level serves as a key general indicator of drought conditions in a given year. As a result, Hyalite Reservoir volume is given a relatively significant weighting factor in the City’s drought monitoring tool during summer months.

The historical storage volume in Hyalite Reservoir from 1951-2015 is shown in Figure 2-10 and cycles through the year, typically reaching maximum volume in late May or June. The reservoir is drawn down to its winter pool level in mid to late fall. In order to accurately assess a drought condition at any given time, the storage volume in Hyalite Reservoir must be normalized to the time of year. This is accomplished using a cumulative frequency analysis method referred to as “frequency of exceedance,” or the amount of time expressed as a percentage that the reservoir has historically held more water on the same date as the current measurement. This is the method that will be used to evaluate how likely low reservoir levels will be in the future based on how often low reservoir levels occurred in the past. For example, an exceedance value of 90% for Hyalite storage volume indicates that 90% of historical storage volumes on that same date have been greater than the current measurement and the current measurement has been exceeded by 10% of the historical data.

Aggregate reservoir contents in Hyalite usually peak in June following spring snowmelt. Since the dam was raised in 1991-92, this metric was divided into pre- and post-1992 periods to reflect the increased storage subsequent to the dam raise.



**Figure 2- 10: Hyalite/Middle Creek Reservoir Historic Minimum and Maximum Storage Volumes (1951 – 2015)**

**2.2.1.2 Area Streamflow**

Bozeman is located near multiple streams and creeks including Lyman Creek, Sourdough Creek, Hyalite Creek, the East Gallatin River and Gallatin River, situated at the headwaters of the Gallatin River Watershed shown in Figure 2-11. These streams are also indicators of local drought conditions. However,

due to the lack of data on key streams, overall streamflow is not weighted as heavily as reservoir storage data in the City’s drought monitoring tool during summer months. As the period of record increases, these parameters should be incorporated into the Plan.

More specifically, Sourdough (Bozeman) Creek flow would likely offer the most direct assessment of the status of water availability for the City. Unfortunately, streamflow on Sourdough has not historically been monitored. A new gage has been installed on Sourdough, but without a robust historical record, it is not possible to evaluate and compare current water status accurately with historical flows. As future data are collected, the information will become increasingly valuable.

The same is true of the East Gallatin River, which drains the portion of the Gallatin watershed that includes Lyman Creek. The Gallatin River streamflow monitored at a USGS gaging station at Logan is used as it offers a robust historical data set which provides valuable information on drought conditions throughout the watershed and is well suited to long-term drought monitoring. However, the usefulness of the Logan gage data is somewhat minimized as the City of Bozeman’s source watersheds comprise only approximately one quarter of the total Gallatin watershed flows that are measured at the Logan gage and there are numerous agricultural diversions upstream of Logan, impacting flows measured at the Logan gage.

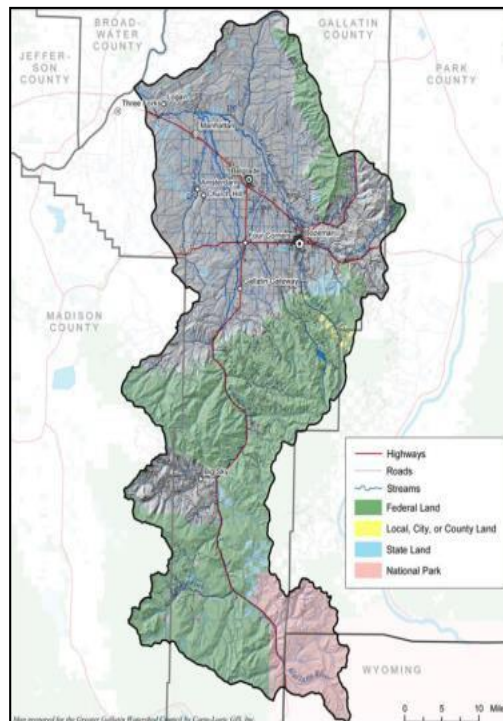


Figure 2- 11: Gallatin River Watershed

Hyalite Creek itself is also a water source for the City. Flow in the creek is monitored at a USGS gaging station with a reliable historical data set downstream of the dam. However, due to the influence of dam

releases to the flows in Hyalite Creek downstream of the dam, Hyalite Creek flow is not included in the monitoring plan. The East and West Forks of Hyalite Creek, which flow directly into Hyalite Reservoir, are monitored by the USGS and also have a reliable historical data set. These data have a direct impact on the volume of water in Hyalite Reservoir throughout the year and are therefore important indices included in the drought monitoring tool.

**2.2.1.3 Snow Water Equivalents (SNOTEL)**

The City’s water supply is directly influenced by snowpack; therefore, the inclusion of snowpack data is also critical to include in the drought monitoring tool. Snow-water equivalence (SWE) provides the most accurate indication of water availability in snowpack. A map showing the general locations of the SNOTEL sites is provided in Figure 2-12. One SNOTEL site in the Bridger Range and one site from the Gallatin Range in the Hyalite watershed were selected for inclusion in the monitoring tool.

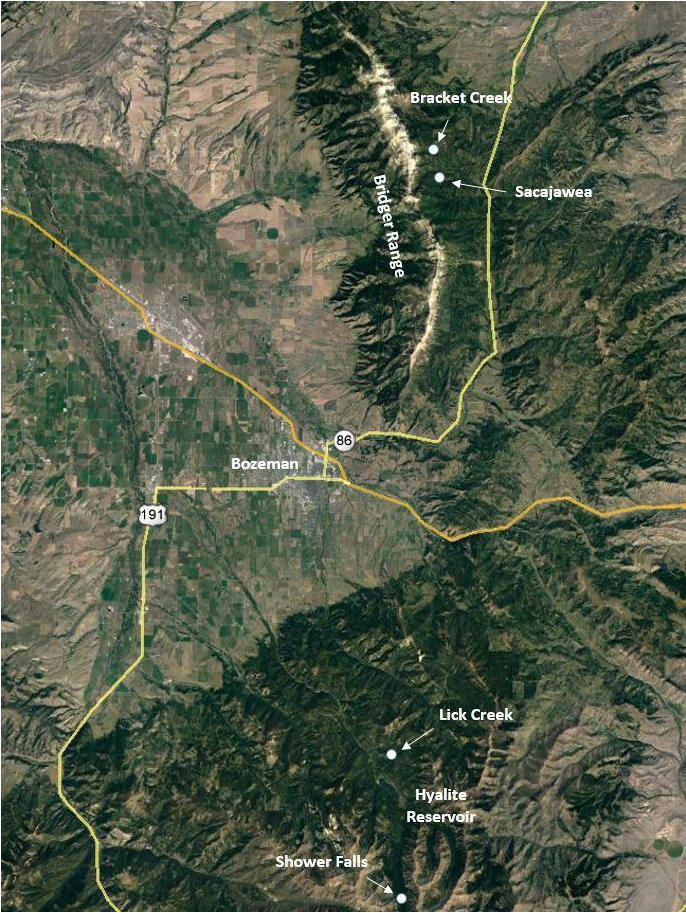


Figure 2- 12: Location of Bozeman Area SNOTELs

Snow Water Equivalence data from the Sacajawea SNOTEL shows a very strong correlation with flows from Lyman Spring and as a result is included in the monitoring tool.<sup>17</sup>

Snow Water Equivalence data in the Hyalite watershed is monitored using the Shower Falls SNOTEL site, as this SNOTEL lies above the Hyalite Reservoir and is more indicative of the water that contributes to reservoir storage.

**2.2.1.3 Recommended Future Local Indicators**

Due to the limited number of local indicators for monitoring purposes, valuable drought information that is not currently available could be acquired from additional monitoring devices, including stream gages in Sourdough Creek and snow-water equivalence sites in the Sourdough Creek and Lyman Watershed. Table 2-1 summarizes recommended additional monitoring parameters that should be considered.

Location / Source	Monitoring Situation
Sourdough Watershed	<ul style="list-style-type: none"> <li>• SNOTEL site in the Sourdough Watershed</li> <li>• Additional real time stream gages at multiple locations</li> </ul>
Lyman Spring	<ul style="list-style-type: none"> <li>• SNOTEL site in Lyman Canyon</li> </ul>

**Table 2- 1: Recommended Additional/Future Local Monitoring Locations**

**2.2.2 U.S. Drought Monitor**

The U.S. Drought Monitor (USDM) is a composite index based on measurements of hydrologic, climatic, and soil conditions and accounts for the importance of snow in the hydrologic cycle of the Bozeman area via the use of snow water content information, river basin precipitation levels, and the Surface Water Supply Index.<sup>18</sup> The USDM identifies areas of drought and labels them by intensity. D1 is the least intense level and D4 the most intense. D0 areas are not in drought, but are experiencing abnormally dry conditions that could turn into drought or are recovering from drought but are not yet back to normal.

The USDM indicates whether primary physical effects are for short- or long-term drought:

- **S** = Short-term, typically less than 6 months (agriculture, grasslands)
- **L** = Long-term, typically more than 6 months (hydrology, ecology)
- **SL** = Area contains both short- and long-term impacts

Due to the combination of various national drought indicators and streamflow data included in the USDM, the USDM is the only national drought index included in the City’s drought monitoring tool. A summary of the U.S. Drought Monitor and drought severity categories is included in Table 2-2.

<sup>17</sup> SNOTEL site correlation data 2009-2015 on file with City of Bozeman (2016).

<sup>18</sup> Additional information about the U.S. Drought Monitor is available at: <https://droughtmonitor.unl.edu/> Last visited April 12, 2022.



Category	Description	Possible Impacts	Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (Percentile)	USGS Weekly Streamflow (Percentile)	Standardized Precipitation Index (SPI)	Objective Drought Indicator Blends (Percentile)
D0	Abnormally Dry	<p><b>Going into drought:</b></p> <ul style="list-style-type: none"> <li>• short-term dryness slowing planting, growth of crops or pastures</li> </ul> <p><b>Coming out of drought:</b></p> <ul style="list-style-type: none"> <li>• some lingering water deficits</li> <li>• pastures or crops not fully recovered</li> </ul>	-1.0 to -1.9	21 to 30	21 to 30	-0.5 to -0.7	21 to 30
D1	Moderate Drought	<ul style="list-style-type: none"> <li>• Some damage to crops, pastures</li> <li>• Streams, reservoirs, or wells low, some water shortages developing or imminent</li> <li>• Voluntary water-use restrictions requested</li> </ul>	-2.0 to -2.9	11 to 20	11 to 20	-0.8 to -1.2	11 to 20
D2	Severe Drought	<ul style="list-style-type: none"> <li>• Crop or pasture losses likely</li> <li>• Water shortages common</li> <li>• Water restrictions imposed</li> </ul>	-3.0 to -3.9	6 to 10	6 to 10	-1.3 to -1.5	6 to 10
D3	Extreme Drought	<ul style="list-style-type: none"> <li>• Major crop/pasture losses</li> <li>• Widespread water shortages or restrictions</li> </ul>	-4.0 to -4.9	3 to 5	3 to 5	-1.6 to -1.9	3 to 5
D4	Exceptional Drought	<ul style="list-style-type: none"> <li>• Exceptional and widespread crop/pasture losses</li> <li>• Shortages of water in reservoirs, streams, and wells creating water emergencies</li> </ul>	5.0 or less	0 to 2	0 to 2	2.0 or less	0 to 2

Table 2- 2: Drought Severity Categories and Inputs for the U.S. Drought Monitor

As drought events and impacts of climate change continue to threaten water supply availability across the West, additional drought indices have become available to better monitor national and regional drought events and their local impacts. The City is currently underway with making improvements to its drought monitoring protocol through incorporation of additional data into the drought monitoring tool. This includes:

- Local Hydrologic Indicators
  - Lick Creek SNOTEL to capture mid-elevation snow water equivalence in the Hyalite watershed,
  - USGS Stream Gage 06043500 (Gallatin River near Gallatin Gateway) to capture Gallatin River flows upstream of agricultural diversions in the Gallatin Valley,
  - AgriMet station “BOZM” modified Penman ET data to capture evapotranspiration trends which directly correlate to water demands in Bozeman during summer months,
- National and Regional Drought Indices
  - Evaporative Demand Drought Index (EDDI), which can offer early warning of hydrologic drought and fire-weather risk by providing near-real-time information on the emergence or persistence of anomalous evaporative demand in a region,
  - Standardized Precipitation Evaporative Index (SPEI), an extension of the Standardized Precipitation Index (SPI), which is designed to take into account both precipitation and potential evapotranspiration in determining drought; and
  - Standardized Snow Water Equivalent (SWE), for the Gallatin and Bridger Mountain areas.

### 2.3 Drought Monitoring and Response

Tables 2-3 and 2-4 illustrate the relationship between the local and national drought severity monitoring indicators currently represented in the drought monitoring tool and the corresponding drought response stage. The response stages in the table are illustrative only as there are no hard-and-fast relationship between the indicators and the appropriate drought response stages. These tables are guidelines only, as the City Manager may evaluate many factors in addition to those represented in the drought monitoring tool when making decisions regarding drought response decisions. This may include but is not limited to area snowpack, soil moisture, streamflow, precipitation, evapotranspiration, water rights, reservoir levels, weather forecasts, and water demand compared to normal use and weather-adjusted expected use. Actual summer and winter weighting factors and percent exceedance values for data included in the drought monitoring tool are shown in Tables 2-3 and 2-4 and are subject to change.

Indicators	October - June Weighting Factor	Response Stages Percent Exceedance			
		Stage 1 Drought Watch	Stage 2 Drought Advisory	Stage 3 Drought Warning	Stage 4 Drought Emergency
Hyalite Reservoir Storage	10%	70%	85%	90%	95%
Stream Flow	25%				
Hyalite Creek East Fork	25%	80%	92%	95%	98%
Hyalite Creek West Fork	25%	80%	92%	95%	98%
Gallatin River At Logan	50%	88%	92%	95%	97%
Snow Water Equivalence	50%				
Shower Falls SNOTEL	80%	70%	80%	90%	95%
Sacajawea SNOTEL	20%	70%	80%	90%	95%
U.S. Drought Monitor	15%	D1	D2	D3	D4

**Table 2- 3: October-June Indicators for Monitoring in Relation to Response Stages**

Indicators	July – September Weighting Factor	Response Stages Percent Exceedance			
		Stage 1 Drought Watch	Stage 2 Drought Advisory	Stage 3 Drought Warning	Stage 4 Drought Emergency
Hyalite Reservoir Storage	40%	70%	85%	90%	95%
Stream Flow	35%				
Hyalite Creek East Fork	25%	80%	92%	95%	98%
Hyalite Creek West Fork	25%	80%	92%	95%	98%
Gallatin River At Logan	50%	88%	92%	95%	97%
Snow Water Equivalence	0%				
Shower Falls SNOTEL	0%	0%	0%	0%	0%
Sacajawea SNOTEL	0%	0%	0%	0%	0%
U.S. Drought Monitor	25%	D1	D2	D3	D4

**Table 2- 4: July- September Drought Indicators for Monitoring in Relation to Response Stages**

## 2.4 Uncertainty Associated with Forecasts

Just like other weather phenomena, forecasting a drought and knowing with certainty if one exists can be difficult. When a dry year occurs, for example, it is unknown whether it is the first year of a three-, five- or 10-year drought, or if it is merely a dry year somewhere in a series of average-to-wet years. Even though droughts cannot always be predicted, the City of Bozeman should continue to advise customers of the latest water supply information so they can consider it in their own planning.

## 3 DROUGHT RESPONSE ACTIONS

As reservoir levels, stream flows and snowpack decrease, efforts to add water supplies and reduce water demand should increase. The City of Bozeman's response actions should consist of the following components:

- Utilization of the drought monitoring tool to help facilitate data driven decision making regarding drought stage declaration;
- Drought declaration, including the implementation of pursuant:
  - Response measures that residents will be required to adhere to,
  - Drought surcharges; and
- Implementation of a robust communications campaign which should increase in scope and frequency pursuant to drought stage.

This Plan delineates four stages of drought severity. Each stage is based on local and national indicators included in the drought monitoring tool described in Section 2, as well as area snowpack, soil moisture, streamflow, precipitation, evapotranspiration, water rights, reservoir levels, weather forecasts, and water demand compared to normal use and weather-adjusted expected use.

Progressively more stringent response measures are recommended when moving from one drought stage to the next. Some drought response measures, particularly those designated for mild episodes of drought, require minimal customer effort. However, as drought intensifies, measures can become increasingly restrictive, are associated with increasing costs due to the implementation of drought surcharges, and are sometimes intrusive.

The recommended response measures associated with each stage of drought are meant to ensure adequate water supplies for essential uses and are summarized as follows:

- Stage 1 – Drought Watch asks for increased communication on dry conditions;
- Stage 2 – Drought Advisory implements mandatory watering restrictions;
- Stage 3 – Drought Warning prohibits lawn watering; and
- Stage 4 – Drought Emergency rations water supplies for essential uses.

At the onset of drought, an interdivisional team of select City staff from the Drought Management Team will increase drought monitoring procedures in order to advise the City Manager on drought declaration

and response. To activate the response component of this Plan, the City Manager declares a drought stage and corresponding response measures, including the implementation of pursuant drought surcharge rates. Select staff from the Drought Management Team should monitor drought conditions and evaluate the effectiveness of the drought response measures implemented during each stage. Because every drought is different, the City Manager may refine drought response actions based on actual conditions.

Stage 2, Stage 3 and Stage 4 droughts involve mandatory water use restrictions which are authorized by the Bozeman Municipal Code (BMC), described further in Section 5 below. The declaration process is outlined in detail in Section 3.3.

The declaration of a drought should be followed by a robust communications campaign which may increase in scope and frequency pursuant to drought stage.

### **3.1 Increasing Water Supply**

In addition to managing water use during a drought, the City may try to increase its supplies by gaining access to other temporary water sources.<sup>19</sup> Each supply alternative presents unique intergovernmental, legal and technical issues, and each will depend on the current conditions.<sup>20</sup>

### **3.2 Reducing Water Use**

The City's primary response to drought is to reduce customer water demand so that existing supplies will be available for the most essential uses for the duration of the drought. A variety of actions, rather than one single approach, is generally more effective at creating an overall atmosphere that promotes water use reductions.

The actions discussed in the sections that follow are based on drought severity indicators and include monitoring and evaluation, restrictions, water use education and enforcement, and drought rates. Generally speaking, restricting the number of days and times allowed for watering landscapes or providing a maximum water allowance can be effective methods for reducing water use. Other methods, such as implementing drought rates and public information efforts, complement those watering restrictions. Other restrictions may not substantially reduce water use but may eliminate discretionary uses of water or heighten public awareness of drought severity.

### **3.3 Monitoring, Evaluation and Declaration**

When drought conditions emerge, monitoring and evaluation activities should be intensified. The

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<sup>19</sup> Detailed information about current and future plans to increase water supplies is set forth in the Integrated Water Resources Plan available at: <https://weblink.bozeman.net/WebLink/DocView.aspx?id=95444&dbid=0&repo=BOZEMAN&searchid=f0a91343-923b-4846-b47d-dbf547c5a123>, last visited: March 21, 2022; See also <https://www.bozeman.net/departments/utilities/water-conservation>, last visited: April 12, 2022.

<sup>20</sup> *Id.*

monitoring and evaluation program will track information described in Section 2, which includes but is not limited to snowpack, soil moisture, streamflow, precipitation, water rights, reservoir levels, weather forecasts, and water demand compared to normal use and weather-adjusted expected use. Together, this information will facilitate data-driven decision making. The water reduction goals associated with each drought stage are based upon what is needed in order to preserve economic vitality of the community while also preserving public health and safety. If water reduction goals are not being met, the City may increase public outreach and/or implement additional drought response measures.

The four stages of drought outlined in this Section will be utilized for the purposes of assessing, communicating, and responding to drought conditions. The drought stages will increase with worsening drought conditions and reduce progressively as conditions improve.

Drought events are eminent, unpredictable, and can be severe in nature. Declaring a drought immediately upon recognition of drought conditions is necessary in order to ensure adequate water supplies for essential uses and responsible management of the water utility as a whole. The procedure for utilization of the drought monitoring tool and drought declaration process is included below, and is intended to facilitate immediate action during times of shortage.

1. The drought monitoring tool should be updated no less than monthly during non-drought or Drought Watch stages, and no less than weekly during Drought Advisory, Warning, and Emergency stages. City staff will update the City Manager as to current drought conditions as needed.
2. The City Manager will decide whether or not to enact a drought declaration based on staff recommendations, the drought monitoring tool, and other information tracked as part of the monitoring and evaluation program. This declaration will include the drought stage and corresponding response measures, which will generally be pursuant to response measures outlined in this Plan.
3. Upon enacting a drought declaration, the City Manager will notify the City Commission of the declared drought stage and corresponding response measures.
4. City staff will present an update on drought conditions to the City Commission during a public meeting as soon as possible after the declaration.
5. The City Manager will also enact changes in drought stages (increasing or rescinding stage declarations), as well as declaring an end to the drought, based on staff recommendations, the drought monitoring tool, and other information tracked as part of the monitoring and evaluation program.
6. The City Manager will notify the City Commission upon increasing, decreasing, or rescinding a drought stage declaration.
7. The City Commission may request a presentation on changing drought conditions from City staff, which should be held at a public meeting as soon as possible after the new drought stage declaration has been enacted, or at the end of the drought.
8. A drought communications campaign may follow any drought declaration, stage increase, the

rescinding of a declared drought stage, or the end of the declared drought. The communication campaign should increase in scope and frequency pursuant to drought stage severity.

### **3.4 Water Use Restrictions**

Once a drought stage and corresponding response measures have been declared, residents may be required to reduce water use. The goal of these drought response measures is to maintain the health, safety and economic vitality of the community to the greatest extent possible in the face of water shortage.

The following principles guide the implementation of water use restrictions during a drought:

Implement extensive public information and media relations programs.

- Inform customers about conditions and actions they can take to reduce water use.
- Have open, clear and consistent messaging and communication.
- Maintain the trust of customers and stakeholders.

Minimize adverse financial effects.

- Be respectful of water-based businesses that will be financially affected by restrictions.
- Engage in ongoing dialogue with the landscaping industry to obtain input and to allow these businesses to plan for future months.

Avoid irretrievable loss of natural resources.

- Allow for watering of trees if possible.
- Avoid damaging perennial landscaping if possible.
- Tailor watering restrictions to known landscape needs as much as possible.

Restrict less essential uses before essential uses.

- Curtail outdoor water use (except for trees and shrubs and potentially urban gardens) before restricting domestic indoor use.
- Eliminate water waste.

Affect individuals or small groups before affecting large groups or the community as a whole, allowing as much public activity as possible to be unaffected.

- Consider a maximum allowable water allowance program for playing fields or other high-traffic landscapes in order to prevent permanent damage to these areas, when appropriate.
- Preserve community pools before residential pools.

### **3.5 Water Use Education**

The City should develop a water use education and enforcement program based on the elements of the Plan to educate customers about efficient water use, to enforce water waste rules and drought

restrictions, and to save water. During a drought, the Water Conservation Division may coordinate with the Water and Sewer Operations Division and the Bozeman Police Department to monitor Bozeman’s water service area for customers who are not complying with drought response measures.

The goal of the program is to educate and inform customers, not to merely penalize violators. City staff should distribute educational materials, and initiate targeted outreach to help customers reduce their water use and answer questions about the drought. Customers will be able to report water waste through the Water Conservation Division’s phone number and website.

### **3.5.1 Communications Campaign**

An on-going communications campaign should be a significant component of the City of Bozeman’s Drought Management Plan and closely coordinated with the Water Conservation Division’s education and outreach initiatives. When appropriate, these programs may be integrated into a single program by the Water Conservation Division. These initiatives promote the value of water, the need to conserve and ways in which to achieve water savings under normal climatic conditions and during drought events.

During non-drought years, the communication campaign should provide general information on drought and drought preparedness. During a drought event, the campaign should increase the scope and specificity of messaging to the public and include information pertaining to drought stages and associated responses.

The objectives of the communication campaign are to:

- Provide clear and consistent drought information to City of Bozeman water customers;
- Adjust the scope and frequency of messaging in accordance with drought stage and restrictions; and
- Coordinate implementation of the campaign with Gallatin County, nearby municipalities and other affected communities to provide consistent drought messaging.

The Water Conservation Division will be responsible for developing communications campaigns identifying specific drought messaging delivered to targeted audiences before, during and after a drought event. Specific communications plans may depend upon the current and forecasted water supply and weather conditions present at the time. Outreach will primarily consist of website communications, social media, newspapers, bill inserts, and mailers. During a drought, communications may be expanded to television, radio, newspapers, emails, public meetings, presentations at community events and school programs.

### **3.6 Drought Management for Master Meter Customers**

The City of Bozeman’s master meter customers (e.g. MSU) are governed by the City’s drought management guidelines. Master meter customers can make and enforce their own plans as long as they are consistent with drought management guidelines set forth in this Plan. Master meter customers should also assist the City in enforcing the Drought Management Plan.

It is recommended that master meter customers have a water use education and enforcement program



during drought response to ensure customers comply with operating rules. Master meter customers can choose to opt in to the City of Bozeman’s water use education and enforcement program or create their own program. If opting in to the City’s program, City staff should work closely with the customer to facilitate proper communication with customers.

If a master meter customer chooses to create its own water use education and enforcement program, the following program elements are recommended to be considered for inclusion:

- Creating a mechanism to educate customers about drought restrictions, such as online or printed materials and direct customer interaction.
- Creating a reporting tool, such as a phone number or email, that allows customers to report violations of water waste rules.
- Monitoring for violations of water waste rules.
- Tracking customer violations.

### **3.7 Drought Surcharge Rates**

Drought surcharge rates were adopted by City Commission and went into effect in September of 2019 and were updated September 2021. Drought surcharges are implemented during a declared drought event and vary based on water customer class. Drought surcharges are designed to encourage conservation and supplement lost revenue from watering restrictions through increased rates in the event of a drought. Drought rates are different from regular water-use rate structures in that they are temporary in nature (effective only during a declared drought) and are required across all customer classes during a declared drought.

Drought surcharge rate percentages are tied directly to the severity of the declared drought stage. The following guiding principles were key considerations in the development and implementation of drought surcharge rates:

- Drought surcharges are aligned with water availability – when water supplies are scarce, the true cost of water for non-essential usage, such as outdoor watering, increases.
- Customer class-based volumetric drought surcharges are tied to the varying water reduction abilities of each user class.
- Drought surcharge rates were developed to ensure that the City has enough water to meet the needs of essential uses.
- Drought surcharges in a stage 1 and 2 declared drought are intended to provide revenue neutrality for the utility service as well as water customers.
- Drought surcharges are higher during drought stages 3 and 4 to discourage outdoor watering when lawn watering bans are in place, as well as provide adequate revenue for the water utility.

Effective drought surcharge rates as of April 2022 are included in Table 3-1.

Drought Rate Customer Class Category	Stage 1	Stage 2	Stage 3	Stage 4
Single Family and Low Income Residential	<i>Drought surcharges are subject to change based on ongoing evaluations of water use patterns in Bozeman. Changes may be adopted by Commission Resolution.</i>			
Tier 1 (0-6 HCF*)	0.0%	10.0%	20.0%	25.0%
Tier 2 (6-25 HCF*)	21.9%	39.6%	100%	200%
Tier 3 (25-55 HCF*)	21.9%	39.4%	100%	200%
Tier 4 (55+ HCF*)	21.8%	39.4%	100%	200%
Multi-Family Residential	15.6%	23.8%	23.8%	25.0%
Government	15.6%	25.0%	25.0%	25.0%
MSU	15.6%	20.9%	20.9%	25.0%
Commercial	15.6%	25.0%	25.0%	25.0%
Industrial	11.1%	11.1%	11.1%	11.1%

\*1 HCF = 748 gallons

**Table 3- 1: Drought Surcharge Rates by Customer Class**

### 3.7.1 Drought Reserve Rate

After adoption by the City Commission, drought reserve rates went into effect in September 2019. The drought reserve is separate from, but used in conjunction with, drought surcharge rates to continue to provide quality service when revenues decrease during a drought. A monthly charge of \$0.08/HCF<sup>21</sup> is applied to every customer’s water bill regardless of customer class or drought declaration status. The drought reserve was established with the following intentions:

- Minimize financial impacts of drought surcharge severity during a drought event;
- Work alongside the drought surcharge rates to continue to provide quality service when revenues decrease during a declared drought event; and
- Create a revenue reserve to help the City avoid extreme rate increases during drought events.

### 3.8 Drought Stages

Drought stages are determined, in part, by the outputs from the drought monitoring tool. The most important indicator during summer months is storage levels in Hyalite Reservoir, and during winter months is snow water equivalence. Stages are determined using the exceedance method. The exceedance value corresponds to the amount of time (expressed as a percentage) that the identified water supply source (reservoir, stream, snowpack) held more water on the same date as the current measurement.

<sup>21</sup> Effective drought reserve rate as of April 2022.

If the reduction targets for each stage are met, drought declarations of increasing severity may be delayed or avoided.

The water reduction targets model industry best practices and reflect reductions achieved in similarly situated municipalities during drought events. If water-reduction goals are not being met, the City Manager may increase public outreach and/or the level of drought response.

Drought Stage	Stage 1: Drought Watch	Stage 2: Drought Advisory	Stage 3: Drought Warning	Stage 4: Drought Emergency
<b>System-wide Water Reduction Targets</b>	<b>10%</b>	<b>20%</b>	<b>30%</b>	<b>40%</b>

**Table 3- 2: Distribution System-wide Water Reduction Targets During Declared Drought Stages**

### 3.8.1 Stage 1 - Drought Watch: Customer Outreach

Description:

A Drought Watch declaration should increase communication to customers to alert them that water supplies are below average and Stage 1 drought surcharges are in effect. Messaging about current drought conditions should increase to inform customers that continued dry weather could lead to mandatory watering restrictions. A Drought Watch will require a formal declaration from the City Manager. Table 3-3 outlines Stage 1 drought indicator weighting factors and exceedance percentages. The exceedance method looks at the amount of time (expressed as a percentage) that the identified source held more water, had higher flows or snow water equivalent on the same date as the current measurement.

Indicator	Indicator Detail	Weighting Factor: Winter (Oct June)	Weighting Factor: Summer (July Sept)	Percent Exceedance for a Stage 1 Drought
Hyalite Reservoir Volume	N/A	10%	40%	70%
Streamflow	East and West Fork Hyalite Creek	25%	35%	80%
	Gallatin River at Logan			88%
Snow Water Equivalence	Showers Falls SNOTEL	50%	0%	70%
	Sacajawea SNOTEL			
U.S. Drought Monitor	N/A	15%	25%	N/A

**Table 3- 3: Drought Tool Indicators, Seasonal Weighting Factors, and Percent Exceedance for a Stage 1 Drought**

Use Reduction Target: 10 % reduction of current use. This is a system-wide target, and individual or customer group-specific response measures should be implemented.

Response Measures:

Increase communication and outreach to customers and stakeholders to explain the City is beginning to see indicators of drought.

- Encourage customers to use water efficiently and provide suggestions for reducing water use in order to reduce the risk of progression to mandatory restrictions.
- Notify customers and prepare for the possibility of mandatory watering restrictions.
- Enhance the water use education program.
- Notify customers of the implementation of Stage 1 drought surcharges.

**3.8.2 Stage 2 - Drought Advisory: Mandatory Watering Restrictions**

Description:

A Stage 2 drought declaration imposes mandatory watering restrictions, Stage 2 drought surcharge rates, and requires effort on the part of customers. Circumstances warrant possible adverse impacts on water-dependent businesses involved in outdoor water use. Table 3-4 outlines Stage 2 drought indicator weighting factors and exceedance percentages. The exceedance method looks at the amount of time (expressed as a percentage) that the identified source held more water, had higher flows or snow water equivalent on the same date as the current measurement.

Indicator	Indicator Detail	Weighting Factor: Winter (Oct June)	Weighting Factor: Summer (July Sept)	Percent Exceedance for a Stage 2 Drought
Hyalite Reservoir Volume	N/A	10%	40%	85%
Streamflow	East and West Fork Hyalite Creek	25%	35%	92%
	Gallatin River at Logan			
Snow Water Equivalence	Showers Falls SNOTEL	50%	0%	80%
	Sacajawea SNOTEL			
U.S. Drought Monitor	N/A	15%	25%	N/A

**Table 3- 4: Drought Tool Indicators, Seasonal Weighting Factors, and Percent Exceedance for a Stage 2 Drought**

Use Reduction Target: 20% reduction of current use. This is a system-wide target, and individual or customer group-specific response measures should be implemented.

Response Measures: Spray Irrigation Watering Restrictions recommend for Stage 2 response

- A. Outdoor watering should be limited to two days per week in accordance with the following schedule:
  - Single residential properties with odd-numbered addresses: Saturday, Wednesday
  - Single residential properties with even-numbered addresses: Sunday, Thursday
  - All others (multi-unit, HOAs, commercial, industrial, government): Tuesday, Friday.
- B. The City Manager may by formal action establish a limit on the number of minutes of irrigation that each area of turf may receive or a maximum total amount of time during which irrigation at a premises may occur.
- C. This subsection may not apply to athletic or playing fields, and tees and greens at golf courses, heavily used by the community so long as irrigation of such landscapes is accomplished without waste of water.
- D. Watering prohibited between the hours of 10:00 a.m. and 8:00 p.m., except when limited watering is essential to preserve turf subject to heavy public use.
- E. Watering prohibited on Mondays, except for irrigators operating under special exemptions as approved by the City Manager.
- F. Restaurants permitted to serve water only upon request.
- G. Hotels/motels and other lodging establishments must comply with the City of Bozeman’s signage program, providing guests with the option to forgo having towels and linens laundered daily.
- H. Permissible watering should be conducted without any water waste, pursuant to B.M.C. Section 40.02.1310.

Strategic Water Reserve:

Pursuant to the future adoption of a strategic water reserve by the Commission, the Commission may make water from the strategic water reserve available for use during a Stage 2 drought. Such action could reduce the severity of Stage 2 restrictions, or be used to delay or eliminate a Stage 3 drought response.

**3.8.3 Stage 3 - Drought Warning: Ban on Targeted Water Uses**

Description:

A Stage 3 drought imposes mandatory watering restrictions and Stage 3 drought surcharge rates on City of Bozeman water customers. Stage 3 drought restrictions are severe and will likely result in damage to or loss of landscapes. Circumstances warrant possible adverse impacts on water-dependent businesses involved in outdoor water use. Table 3-5 outlines Stage 3 drought indicator weighting factors and exceedance percentages. The exceedance method looks at the amount of time (expressed as a percentage) that the identified source held more water, had higher flows or snow water equivalent on the same date as the current measurement.

Indicator	Indicator Detail	Weighting Factor: Winter (Oct June)	Weighting Factor: Summer (July Sept)	Percent Exceedance for a Stage 3 Drought
Hyalite Reservoir Volume	N/A	10%	40%	90%
Streamflow	East and West Fork Hyalite Creek	25%	35%	95%
	Gallatin River at Logan			
Snow Water Equivalence	Shower Falls SNOTEL	50%	0%	90%
	Sacajawea SNOTEL			
U.S. Drought Monitor	N/A	15%	25%	N/A

**Table 3- 5: Drought Tool Indicators, Seasonal Weighting Factors, and Percent Exceedance for a Stage 3 Drought**

Use Reduction Target:

30% reduction of current use. This is a system-wide target, and individual or customer group-specific response measures should be implemented.

Response Measures:

- A. Recommended watering restrictions for a Stage 3 drought response:
  - Ban on all lawn watering.
  - Existing trees and shrubs and flower and vegetable gardens may be watered with hand held hose or low-volume, non-spray devices.
  - Community gardens may be watered on assigned watering days.
  - Athletic and playing fields may irrigate pursuant to a water schedule.
  - Golf courses may irrigate tees and greens only.
  - Ban on water fountains and filling private swimming pools.
- B. The City Manager may by formal action establish a limit on the number of minutes of irrigation that each area of turf may receive or a maximum total amount of time during which irrigation at a premises may occur.
- C. This subsection may not apply to athletic or playing fields, and tees and greens at golf courses, heavily used by the community, however these landscapes may be subject to a mandatory schedule or water budget to be developed in coordination with the Water Conservation Division and based on current conditions at the time of the declaration.
- D. Watering prohibited between the hours of 10:00 a.m. and 8:00 p.m., except when limited watering is essential to preserve turf subject to heavy public use.
- E. Watering prohibited on Mondays, except for irrigators operating under special exemptions as approved by the City Manager.

- F. Restaurants permitted to serve water only upon request.
- G. Hotels/motels and other lodging establishments must comply with the City of Bozeman’s signage program, providing guests with the option to forgo having towels and linens laundered daily.
- H. Permissible watering shall be conducted without any water waste, pursuant to B.M.C. Section 40.02.1310.

Strategic Water Reserve:

Pursuant to the future adoption of a strategic water reserve by the Commission, the Commission may make water from the strategic water reserve available for use during a Stage 3 drought. Such action could reduce the severity of Stage 3 restrictions, or it could be used to delay or eliminate a Stage 4 drought response.

**3.8.4 Stage 4 - Drought Emergency: Rationing**

Description:

A Stage 4 drought may activate a rationing program for City of Bozeman water customers. Conditions that would lead to a Stage 4 drought are highly unlikely. However, if conditions warrant, the City may implement a rationing program for an indefinite period of time to ensure, to the extent possible, that there is adequate water for essential uses. Stage 4 drought surcharge rates will be in effect. No outdoor watering will be allowed. Stage 4 drought restrictions will damage the quality of life in the City of Bozeman’s service area, including the long-term loss of landscapes. Table 3-6 outlines Stage 4 drought indicator weighting factors and exceedance percentages. The exceedance method looks at the amount of time (expressed as a percentage) that the identified source held more water, had higher flows or snow water equivalent on the same date as the current measurement.

Indicator	Indicator Detail	Weighting Factor: Winter (Oct June)	Weighting Factor: Summer (July Sept)	Percent Exceedance for a Stage 4 Drought
Hyalite Reservoir Volume	N/A	10%	40%	95%
Streamflow	East and West Fork Hyalite Creek	25%	35%	98%
	Gallatin River at Logan			97%
Snow Water Equivalence	Shower Falls SNOTEL	50%	0%	95%
	Sacajawea SNOTEL			
U.S. Drought Monitor	N/A	15%	25%	N/A

**Table 3- 6: Drought Tool Indicators, Seasonal Weighting Factors, and Percent Exceedance for a Stage 4 Drought**

Use Reduction Target: 40% reduction of current use. This is a system-wide target, and individual or customer group-specific response measures should be implemented.

Response Measures:

Stage 4 response measures will aim to ensure water is available for essential uses and may include a water rationing program for City water customers.

Strategic Water Reserve:

Pursuant to the future adoption of a strategic water reserve by the Commission, due to the severity of the situation, the Commission will likely make any water remaining in the strategic water reserve available for essential uses during a Stage 4 drought.

## **4 DROUGHT RESPONSE PROGRAM MEASURES**

The drought response program measure Tables 4-1 – 4-4 below are meant to serve as a guide to water uses under various levels of drought severity. Actual water use limitations associated with a drought declaration will be adopted by administrative order of the City Manager. The City reserves the right to modify these program measures as needed to meet changing water supply conditions.



		Outdoor Watering and New Vegetation Installation Recommended Response Measures						
	Water Use Element	Turf grass watering	New installation of seed and/or sod	Watering trees, shrubs, perennials	New installations of trees, shrubs, perennials	Watering vegetables and community gardens	Watering athletic and playing fields	Watering golf courses
<b>Drought Stage Declared</b>	<b>Stage 1</b> Customer Outreach	No restrictions.	Permitted.	Water efficiently with no water waste.	Permitted.	No restrictions.	Water efficiently with no water waste.	Water efficiently with no water waste.
	<b>Stage 2</b> Mandatory Restrictions	2 days/week mandatory watering schedule based on customer class and/or address.	Permitted with exemption.	May be watered by hand-held hose or low-volume non-spray irrigation on any day not between 10a.m. - 8p.m.	Not permitted/limited installations from June-August.	May be watered by hand-held hose or low-volume non-spray irrigation on any day not between 10a.m. - 8p.m.	Irrigated per mandatory scheduling or water budget restrictions.	Irrigated per mandatory scheduling or water budget restrictions.
	<b>Stage 3</b> Ban on Lawn Watering	No watering permitted.	Not permitted.	May be watered by hand-held hose or low-volume non-spray irrigation no more than once/week on scheduled day and not between 10a.m. - 8p.m.	Not permitted.	May be watered by hand-held hose or low-volume non-spray irrigation on assigned watering day and not between 10a.m. - 8p.m.		Trees and greens only.
	<b>Stage 4</b> Rationing			No watering permitted/may be limited to 1 assigned day/month.		No watering permitted.	No watering permitted.	No watering permitted.

**Table 4- 1: Outdoor Watering and New Vegetation Installation Recommended Response Measures**

Water Feature Recommended Response Measures			
	Water Use Element	Swimming pools	Other water features (fountains, splash pads, ponds and waterfalls)
Drought Stage Declared	<b>Stage 1</b> Customer Outreach	No restrictions.	No restrictions.
	<b>Stage 2</b> Mandatory Restrictions		All ornamental fountains on City-owned property and in City owned buildings and splash parks are turned off.
	<b>Stage 3</b> Ban on Lawn Watering	Single-family residential pools and spas shall not be filled or refilled. Operation of other pools and spas will be permitted.	All ornamental fountains and splash parks are turned off.
	<b>Stage 4</b> Rationing	No filling of any pools or spas.	All ornamental fountains, outdoor drinking fountains, and splash parks are to be turned off.

**Table 4- 2: Water Feature Recommended Response Measures**

Washing Events Recommended Response Measures						
	Water Use Element	Car-washing at home	Commercial car washes	Fleet vehicle washing	Street cleaning	Driveway and sidewalk washing
Drought Stage Declared	<b>Stage 1</b> Customer Outreach	Permitted with bucket or hand-held hose with shutoff nozzle.	No restrictions.	No restrictions.	No restrictions.	Use dry clean-up methods prior to washing.
	<b>Stage 2</b> Mandatory Restrictions			Washing is limited to once every 2 weeks.		Use dry clean-up methods prior to washing. High efficiency equipment required.
	<b>Stage 3</b> Ban on Lawn Watering	Not permitted. Must use commercial car wash.		Limited to 1 time per month only for health and safety.		Permitted for extreme health and safety issues only.
	<b>Stage 4</b> Rationing			Not permitted unless for public health and safety reasons.		

**Table 4- 3: Washing Events Recommended Response Measures**

Commercial-Institutional Processes Recommended Response Measures					
	Water Use Element	Restaurants	Lodging	Construction water	Hydrants
Drought Stage Declared	<b>Stage 1</b> Customer Outreach	No restrictions.	No restrictions.	No restrictions.	No restrictions.
	<b>Stage 2</b> Mandatory Restrictions	Water served only on request.	Laundry restrictions. Must comply with City's signage program.	Conserve and prevent wasting of construction water.	Hydrant flushing is prohibited unless necessary for public safety reasons.
	<b>Stage 3</b> Ban on Lawn Watering			Use of all construction water is prohibited unless necessary for air quality, public health and safety reasons.	Hydrant flushing is prohibited unless necessary for public safety reasons. Use of all water for fire training and use of water from hydrants is not permitted unless necessary for public safety.
	<b>Stage 4</b> Rationing				

**Table 4- 4: Commercial-Institutional Recommended Response Measures**

## 5 DROUGHT RESPONSE PROGRAM ENFORCEMENT

The authority to enforce the water reduction targets provided in the Plan and City of Bozeman customers' violations of the response measures is provided for in the Bozeman Municipal Code (BMC). Relevant code provisions are set forth in their entirety in **Appendix D** and summarized below.

- BMC Section 40.02.1280 states that all provisions addressing outdoor water use restrictions are applicable to all persons both in and out of the City and regardless of whether any person using water has a contract for water service with the City.
- BMC Section 40.02.1300 establishes that the City Manager is authorized to enact a drought declaration including the implementation of pursuant response measures and drought surcharges. This includes the authority to restrict or wholly prohibit the outdoor use of the water supply.
- BMC Section 40.02.1300.H states that whenever drought restrictions are in effect, certain indoor uses are also not permitted. This includes requiring business establishments which serve beverages for human consumption to only serve water upon request and that hotels, motels, and other commercial lodging establishments provide guests with the option to forgo having used towels and linens laundered daily.
- BMC Section 40.02.1310 prohibits the waste of water including but not be limited to permitting water to escape or run to waste, excessive use, and escape of water through breaks, leaks, or malfunctions in the plumbing or irrigation system.
- Additional drought contingency provisions pertaining to the timing of outdoor watering, installation of new landscape vegetation, other outdoor water uses, as well as the implementation of drought surcharge rates are set forth in BMC Section 40.02.1300.

Enforcement provisions for violations of drought response measures are set forth in BMC Sections 40.02.1340 and 40.02.1350. Enforcement provisions include fines and discontinuation of water service. Violation of the watering restrictions and mandatory drought response measures constitutes a misdemeanor pursuant to BMC Section 40.02.1350. Upon conviction thereof, the violator shall be fined an amount not less than \$100 and not more than \$500.

Violators will be located based on citizen complaints received at 406.582.3220 from 8am to 5pm or via the City of Bozeman's ([www.bozemanwater.com](http://www.bozemanwater.com)) Drought Management Webpage. The City should issue a warning to the customer notifying the water user that there has been a complaint. Individuals with numerous complaints may receive special attention by the City of Bozeman's enforcement team.

## 5.1 Drought Management Plan Updates

The Drought Management Plan should be updated regularly for the following reasons:

1. The local and national drought monitoring parameters should be refined over time as new and improved data become available.
2. The City has recently added monitoring on Sourdough Creek and the East Gallatin River. As these data sources become more robust, they can be utilized by the City for drought monitoring purposes.
3. Demand volumes and patterns may change over time.
4. The City's infrastructure, specifically its raw water supply portfolio and distribution system, may grow and change over time.
5. Drought surcharge and reserve rates may change over time.
6. Response actions identified in this Plan may be improved upon, or new response actions may be identified.

It is recommended that the City update the Drought Management Plan at a minimum of every 5 years. However, if a moderate to severe drought is encountered, and in the process of monitoring and responding to that drought the City encounters weaknesses or gaps in the Drought Management Plan, then the Plan should be updated at that time.

Updates to the Plan may necessitate the re-establishment of the Drought Management Team and other vested stakeholders to provide subject matter expertise.

## APPENDIX A – Drought Management Team

Organization	Title/Role	Drought Team Function	Responsibilities
City of Bozeman	Water Conservation Program Manager	Drought Plan coordinator	Manage the Drought Team and Drought Plan
City of Bozeman	Utilities Director	Utilities coordination	Direct oversight of Utilities
City of Bozeman	Water/Sewer Superintendent	Water distribution impacts and response, lead of City water crews	Coordinate water distribution activities and utilize crews for monitoring water use during drought
City of Bozeman	Senior Water Resources Engineer	Water/wastewater infrastructure and water supply contact	Support coordination of Drought Plan
City of Bozeman	Parks and Cemetery Superintendent	Parks and cemetery irrigation coordination	Manage parks and recreation water usage and responses to drought stages
City of Bozeman	Chief of Police	Law enforcement	Enforcement of violations to enacted response measures
City of Bozeman	Fire Chief	Fire hazard authority	Enactment of burn ban during severe drought
City of Bozeman	Water Treatment Plant Superintendent	Water treatment plant operations and water supply contact	Monitor and report water supply and demand information
City of Bozeman	Finance Director	Drought surcharge coordinator	Ensure timely implementation of drought surcharges as needed
City of Bozeman	Associate Planner	Planning coordinator	Coordinate solutions for restrictions that impact the development review and approval process
City of Bozeman	Communications and Engagement Manager	Communications coordinator	Coordinate City communications, ensure consistent messaging
City of Bozeman	Sustainability Program Manager	Climate Plan coordination	Coordinate with Climate Plan efforts

Gallatin County	Disaster and Emergency Coordinator	Disaster and Emergency Services Contact and Coordination	Disaster and emergency coordination and drought communications coordination.
Gallatin County	Communications Coordinator	Gallatin County drought education coordination	Drought communication and education coordination.
Gallatin County	Planning Director	Gallatin County Drought Plan communications coordinator	Coordinate/assist with county-wide drought planning and response
Gallatin County Local Water Quality District	District Manager	Gallatin County water supply monitoring	Provide county water supply monitoring data and support
Montana State University	Director of Facility Services	MSU drought coordinator	Coordinate MSU water use and assist with drought communication to MSU community
Montana State University	Grounds Manager	MSU irrigation coordinator	Coordinate MSU irrigation use
Bozeman Public Schools	Director of Facilities	BPS drought coordinator	Coordinate BPS water use and assist with drought communication to BPS community
US Forest Service	Fire Management Officer	Fire management coordinator	Fire condition monitoring, planning fire communications
Dept. of Natural Resources and Conservation	Bozeman Regional Manager	DNRC coordinator	Assist with drought communications and response and regional water supply coordination
AE2S	Project Manager	Drought Management Plan point of contact	Provide short-term, as-needed support and modifications to the drought monitoring tool

# APPENDIX B - Drought Monitoring Tool and Dashboard Snapshot

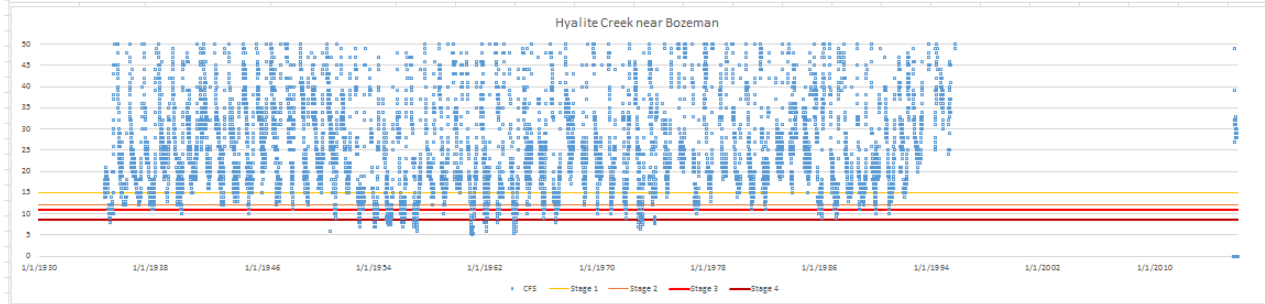
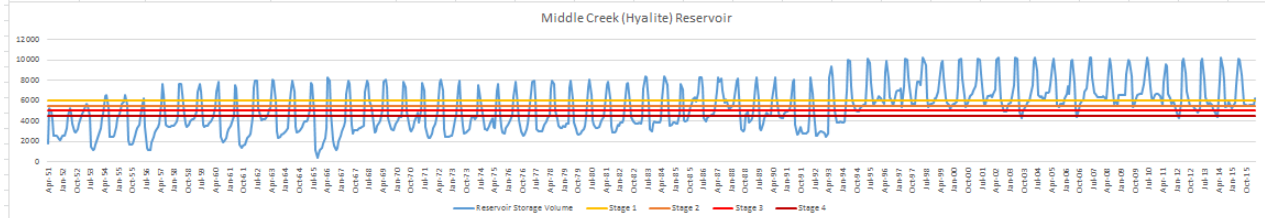
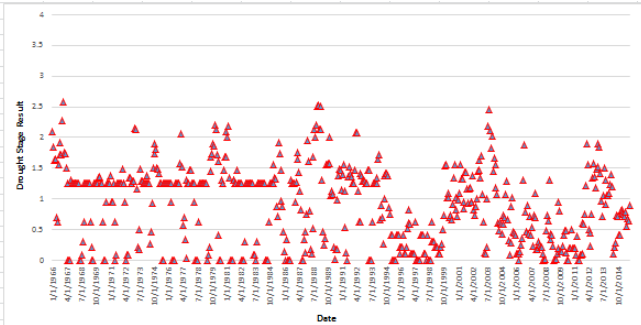
Latest Data													
	Shower Falls	Sacajawea	Gallatin River	Hyalite Canyon	Middle Creek Reservoir	Bozeman Well	SW Montana	SW Montana	SW Montana	SW Montana	SW Montana	SW Montana	SW Montana
	Snow-Water (in)	Snow-Water (in)	Flowrate (cfs)	Flowrate (cfs)	Volume (ac-ft)	Depth (ft)	PDSI	Standard Precip 6 mo	Standard Precip 12 mo	None % (No Drought)	D0 % (Abnormally Dry)	D1 % (Moderate Drought)	D2 % (Severe Drought)
Value	16.8	0.4	237	55	9164.000		-2.14	-0.83	-0.46	0	87.67	12.33	0
Date	2016-05-24	2016-05-24	2016-08-16	2016-08-16	2016-04-15		2016-07-15	2016-07-15	2016-07-15	2016-08-09	2016-08-09	2016-08-09	2016-08-09

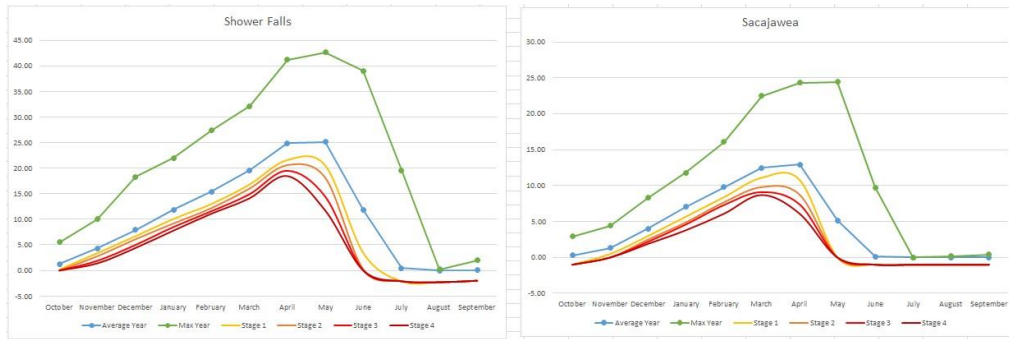
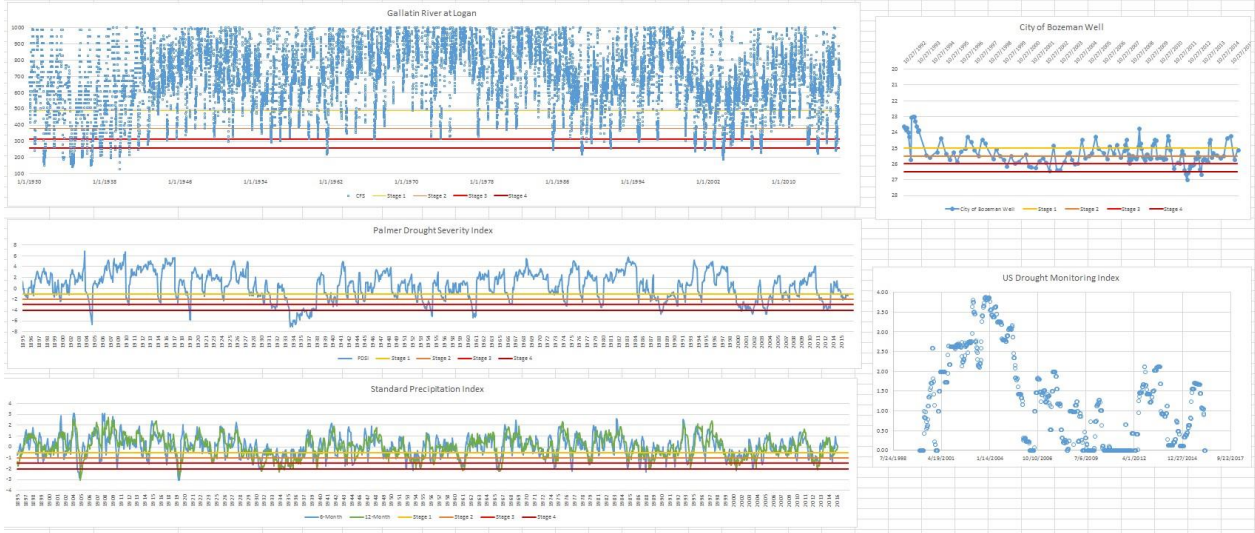
CITY OF BOZEMAN		BOZEMAN MT												Drought Monitoring												4/19/2022				
2021 Tracking		2021 Tracking												2021 Tracking												2021 Tracking				
Month	Use ?	SNOTEL Data		Streamflow Data						Reservoir Data		Well Data		Regional Drought Indicators - Southwest Montana												Composite Drought Stage				
		Shower Falls Snow-Water (in)	Sacajawea Snow-Water (in)	Gallatin River Flowrate (cfs)	Hyalite Creek Flowrate (cfs)	Hyalite - East Fork Flowrate (cfs)	Hyalite - West Fork Flowrate (cfs)	Middle Creek Storage (ac-ft)	Bozeman Well Depth (ft)	Palmer Drought Severity Index	Standard Precipitation Index 6-Month	Standard Precipitation Index 12-Month	US Drought Monitor - Categorical Percent Area																	
														None												D0	D1	D2	D3	D4
January	% Exc / Stage	54%	79%	80%	100%	80%	80%	60%	70%	0.00	0.00	0.00													1.41					
	Value	11.1	5.4	715	2.79	3.71	6.39	5475	705	0	0	0													0					
	Date	1/28/2021	1/28/2021	1/28/2021	1/28/2021	1/28/2021	1/28/2021	1/28/2021	1/28/2021	1/26/2021	1/26/2021	1/26/2021													1/26/2021					
February	% Exc / Stage	37%	80%	80%	80%	80%	96%	70%	100%	1.00	3.00	2.00													1.23					
	Value	11.2	5.2	613	20.6	4.28	7.38	5505	705	1.98	1.63	1.04													0					
	Date	1/21/2021	1/21/2021	1/21/2021	1/21/2021	1/21/2021	10/25/2020	1/22/2021	705	12/31/2020	12/31/2020	12/31/2020													1/19/2021					
March	% Exc / Stage	52%	60%	80%	80%	80%	96%	70%	100%	2.00	3.00	2.00													1.33					
	Value	19.3	12	855	20.2	3.53	7.38	5340	705	-2.5	-1.65	-1.11													0					
	Date	3/7/2021	3/7/2021	3/7/2021	3/7/2021	3/7/2021	10/25/2020	3/8/2021	705	1/31/2021	1/31/2021	1/31/2021													3/2/2021					
April	% Exc / Stage	42%	76%	86%	83%	80%	96%	70%	100%	2.00	1.00	2.00													1.25					
	Value	25.2	10.6	713	21.1	3.78	7.38	5415	705	-2.65	-0.34	-1.33													0.66					
	Date	4/21/2021	4/21/2021	4/21/2021	4/21/2021	3/28/2021	10/25/2020	3/28/2021	705	3/31/2021	3/31/2021	3/31/2021													4/20/2021					
May	% Exc / Stage	48%	45%	80%	93%	80%	96%	72%	100%	2.00	2.00	2.00													1.32					
	Value	26.1	3.6	1470	30.7	3.78	7.38	6677	705	-2.8	-1.35	-1.32													1.28					
	Date	5/10/2021	5/10/2021	5/10/2021	5/10/2021	3/28/2021	10/25/2020	5/11/2021	705	4/30/2021	4/30/2021	4/30/2021													5/4/2021					
June	% Exc / Stage	82%	72	91%	80%	80%	84%	70%	100%	2.00	2.00	2.00													1.50					
	Value	0	0	1010	147	4.14	50.14	10212	705	-2.27	-1.05	-1.06													0					
	Date	6/20/2021	6/20/2021	6/20/2021	6/20/2021	6/21/2021	6/21/2021	6/21/2021	705	5/31/2021	5/31/2021	5/31/2021													6/15/2021					
July	% Exc / Stage	12%	0%	33%	87%	100%	96%	86%	100%	3.00	2.00	4.00													3.16					
	Value	0	0	224	57.9	5.25	12.12	1789	705	-3	-1	-2													0					
	Date	7/31/2021	7/31/2021	7/31/2021	7/31/2021	7/31/2021	7/31/2021	7/31/2021	705	6/30/2021	6/30/2021	6/30/2021													7/27/2021					
August	% Exc / Stage	2%	1%	35%	80%	100%	81%	70%	100%	4.00	3.00	4.00													3.51					
	Value	0	0	269	50.7	2.31	10.62	6700	705	-4.55	-1.74	-2.12													0					
	Date	8/12/2021	8/12/2021	8/12/2021	8/12/2021	8/12/2021	8/12/2021	8/12/2021	705	7/31/2021	7/31/2021	7/31/2021													8/3/2021					
September	% Exc / Stage	10%	4%	100%	80%	100%	89%	74%	100%	4.00	3.00	4.00													3.72					
	Value	0.1	0	236	54.6	1.46	8.93	5703	705	-4.55	-1.74	-2.12													0					
	Date	9/27/2021	9/27/2021	9/28/2021	9/27/2021	9/30/2021	9/30/2021	9/30/2021	705	7/31/2021	7/31/2021	7/31/2021													9/28/2021					
October	% Exc / Stage	33%	13%	82%	80%	100%	80%	85%	100%	4.00	3.00	3.00													3.66					
	Value	17	1	571	32.2	1.77	10.18	5370	705	-4.22	-1.67	-1.62													0					
	Date	10/20/2021	10/20/2021	10/20/2021	10/21/2021	10/21/2021	10/21/2021	10/19/2021	705	8/31/2021	8/31/2021	8/31/2021													10/19/2021					
November	% Exc / Stage	36%	61%	80%	80%	87%	80%	70%	100%	4.00	2.00	3.00													3.26					
	Value	5	0.3	615	26.3	3.43	8.53	5635	705	-4.07	-1.05	-1.72													0					
	Date	11/28/2021	11/28/2021	11/28/2021	11/28/2021	11/28/2021	11/28/2021	11/4/2021	705	10/31/2021	10/31/2021	10/31/2021													11/23/2021					
December	% Exc / Stage	44%	88%	80%	80%	83%	80%	100%	100%	4.00	2.00	3.00													2.37					
	Value	8.2	2.3	633	30.3	3.245	9.865	5355	705	-4.33	-1.38	-1.77													0					
	Date	12/28/2021	12/26/2021	12/28/2021	12/5/2021	12/27/2021	11/7/2021	12/7/2021	705	11/30/2021	11/30/2021	11/30/2021													12/21/2021					



# APPENDIX C - Drought Monitoring Tool Calibration Snapshots

Weighting	SubWeigh	Category/Resource	Units	Stage 1	Stage 2	Stage 3	Stage 4
15%	70%	Stream Flow					
	30%	Hyalite	PCT Exceedance	90%	95%	97%	99%
		Gallatin	PCT Exceedance	85%	92%	96%	98%
30%		Reservoir - Middle Creek	Acre-Ft of Storage	6,000	5,500	5,000	4,500
20%	75%	Snotels					
	25%	Showers Falls	PCT Exceedance	70%	80%	90%	95%
		Sacajawea	PCT Exceedance	75%	85%	90%	95%
10%		Palmer		-1	-2	-3	-4
10%	80%	SPI					
	20%	6-Month		-0.5	-1	-1.5	-2
		12-Month		-0.5	-1	-1.5	-2
10%		City Well off South 3rd	Depth to Water (Feet)	25	25.5	26	26.5
5%		US Drought Monitor	Stage				
		None	0				
		D0	1				
		D1	1.5				
		D2	2				
		D3	3				
		D4	4				





## **APPENDIX D – Bozeman Municipal Code Outdoor Water Use Restrictions and Drought Contingency Response**

### **DIVISION 4. - OUTDOOR WATER USE RESTRICTIONS AND DROUGHT CONTINGENCY RESPONSE**

#### **Sec. 40.02.1250. - Findings.**

- A. A reliable minimum supply of water is essential to the public health, safety and welfare of the people and the economy of the City of Bozeman.
- B. Bozeman is a semi-arid, headwaters community dependent on limited water supplies that are driven by snowpack and subject to impacts from drought. Drought events, population growth, and impacts of climate change on water supply yields, make Bozeman highly-susceptible to water supply reliability challenges.
- C. Responsible water management requires active conservation measures not only in times of drought but at all times.
- D. A reliable minimum supply of water is essential to meet current and future water supply needs.

#### **Sec. 40.02.1260. – Purpose and intent**

To minimize or avoid the effect and hardship of potential water supply shortages to the greatest extent possible, this division establishes the means and authority to:

- 1. Implement the City of Bozeman’s Drought Management Plan;
- 2. Reduce water consumption long-term through permanent, outdoor water use restrictions, and short-term through additional water demand mitigation actions;
- 3. Enable effective water supply reliability planning;
- 4. Assure reasonable and beneficial use of water;
- 5. Ensure adequate supplies of water are available for essential uses during times of water shortage; and
- 6. Prevent waste of water and ensure water use efficiency.

#### **Sec. 40.02.1270. – Definitions.**

- A. For the purposes of this division only, the following terms, phrases, words, and their derivations shall have the meaning given herein.
  - 1. “Drought restriction” means a required curtailment of specific water uses enacted due to a drought declaration.
  - 2. “Essential use” means the use of water necessary for firefighting, health, welfare and safety; water needed to sustain basic human, aquatic and animal life; and water necessary to satisfy federal, State, and local laws for the protection of public health, sanitation and safety.
  - 3. “Excessive water use” means use that is not considered reasonable, prudent, or a wise use of water

for an authorized purpose.

4. "Landscape" means an area with vegetative groundcover or other natural living plant materials including but not limited to: grass, turf, trees, ornamental perennials, shrubs, perennial flowers, annual flowers, food gardens, and surrounding landscape design elements such as rock mulch and wood mulch.
5. "Low volume drip irrigation" means the application of irrigation water at low pressure through a system of tubing or lateral lines and low volume emitters such as drip, drip lines, and bubblers.
6. "Non-essential use" means the use of water not for essential use, which may be curtailed during times of shortage without compromising public health, sanitation, welfare and safety.
7. "Outdoor water use" means the use of water, excluding water which has been used indoors and is being recycled for outdoor use, for:
  - a. Sprinkling or irrigating gardens, lawns or other outdoor vegetation;
  - b. Washing motorized and non-motorized vehicles, including but not limited to automobiles, trucks, vans, buses, motorcycles, boats, bikes and trailers;
  - c. Washing sidewalks, walkways, driveways, parking areas, outside building walls, patios, alleys or other outdoor surfaces;
  - d. Washing any business or industrial equipment machinery;
  - e. Operating any ornamental fountain or other similar structure not employing a recirculating system; and
  - f. Filling swimming pools, wading pools, hot tubs and spas not employing a filter and recirculating system.
8. "Spray irrigation" means the act of applying water to landscape by sprinklers or spray nozzles that deliver water to the landscape through the air.
9. "Turf" means grass and the surface layer of earth held together by its roots, including but not limited to cool season lawn grasses.
10. "Water" means water from the city's water service utility.
11. "Water waste" means the intentional or unintentional excessive use of water; allowing water to be applied in any manner, rate or quantity such that the runoff from the landscaped area being watered is allowed to pool or flow across the ground, into any drainage way, or onto any impervious surface; water that has escaped or run to waste; and the escape of water through defective plumbing, breaks, leaks, or malfunctions in the plumbing or irrigation system.
12. "Watering window" means the period, timeframe, or continuous hours of the day(s) in which outdoor watering is permitted.

Sec. 40.02.1280. – Application of division.

- A. The provisions of this division or any restriction or prohibition in force shall apply as follows:
  1. To all persons using water both in and outside the city, and regardless of whether any person using water shall have a contract for water service with the city; or
  2. To persons contracting for water service at a location who shall be responsible and strictly liable for all water use at that location.

B. This division is intended to ensure an adequate and reliable water supply for essential uses, ensure the public's health safety during times of water shortage, and to further the beneficial use and conservation of water.

Sec. 40.02.1290. – Outdoor water use restrictions.

A. Authority to restrict outdoor use of water. The city manager is authorized and empowered, whenever the situation demands, to restrict or wholly prohibit outdoor water use of the city's water service utility. This includes the power to approve exemptions and relaxations to outdoor water use restrictions. Except for the restrictions in 40.02.1290.B, any restriction imposed by order of the city manager shall become effective at midnight immediately following notice posted and available on the city's website.

B. Outdoor water use restrictions. Notwithstanding the city manager's authority in 40.02.1290.A, the following restrictions apply to all property using water from the city's water utility:

1. Permanent time of day and day of week watering restrictions. Outdoor watering of landscapes with the use of spray irrigation shall be limited to an assigned three (3) days per week watering schedule as follows:

- a. Properties with even numbered physical addresses: Tuesday, Thursday, and Saturday;
- b. Properties with odd numbered physical addresses: Wednesday, Friday, and Sunday; and
- c. Public parks, private open spaces, street right-of-ways: Monday, Wednesday, and Friday.

2. Time of day watering prohibition. The outdoor watering of landscapes with the use of spray irrigation is prohibited seven (7) days a week between the hours of 10:00am and 8:00pm.

3. Watering window. For the purposes of identifying the allowable watering windows associated with the allowable watering day and times of day, the watering window begins at 12am and ends at 10am, and the second watering window begins at 8pm and ends at 11:59pm on the allowable watering day. The allowable watering day refers to a calendar day (12:00am – 11:59pm).

4. Water waste prohibited. Outdoor water use that results in water escaping or running to waste, excessive use, and the escape of water through breaks, leaks, or malfunctions in the plumbing or irrigation system is prohibited.

C. Exemptions to outdoor water use restrictions. The following activities are exempt from the requirements of 40.02.1290.B:

- 1. Outdoor watering of trees, drought tolerant ornamental perennials, shrubs, flowers and food gardens only when watered with the use of a hose equipped with positive shut-off nozzle or device, hand-held bucket or similar container, slow release watering bag, or landscape irrigation system that exclusively uses low-volume drip irrigation.
- 2. Turf establishment. Watering, for the sole purpose of turf establishment, is permitted for up to 45 days upon the installation of new turf from sod or seed.
- 3. Irrigation system maintenance. Water use associated with irrigation system operation for the purposes of installation, repair, adjustments, performance assessments, and other related

maintenance issues provided that the system is attended to throughout the period of operation.

D. Special circumstances. The city manager may establish standards for the exemption or relaxation of the restrictions in this division. When reasonable cause exists, the city manager may grant an exemption or relaxation for special circumstances not described in this division, including but not limited to the use of new irrigation technology, and preservation of turf subject to heavy public use. The city manager must maintain a list of approved exemptions and relaxations to requirements in this section.

Sec. 40.02.1300. – Drought contingency response.

A. Authority to enact a drought declaration. The city manager is, upon notification to the city commission, authorized to order a drought declaration and corresponding water use restrictions. This includes the power to approve exemptions and relaxations to enacted water use restrictions.

B. Drought restriction and response measure implementation.

1. Response measures must substantially protect the City's water supply as drought severity increases or water supply availability decreases, in order to preserve the City's available water supply for purposes essential to public health, sanitation, safety, welfare and essential services including but not limited to police and fire services.

2. A drought declaration may necessitate that the city manager implement additional water use restrictions not listed in 40.02.1290. These drought restrictions may vary based upon drought severity and other pertinent circumstances. Any additional water use restriction must consider the response measures outlined in the city's Drought Management Plan.

C. Drought surcharge rates.

1. Effective Date. Upon a drought declaration, drought surcharge rates provided for in the effective water utility rate structure adopted by the city commission shall go into effect pursuant to the drought stage, customer class, and water rate tier, as applicable.

2. Billing Cycle. Drought surcharge rates shall not go into effect prior to the effective date of the declared drought, and shall be reflected in utility customer billing statements representing water usage during the declared drought.

D. Water Superintendent Emergency Authority. Nothing in this division diminishes the authority given to the water superintendent in 40.02.840 to prohibit or restrict water use during an emergency.

E. Irrigation systems; timing. When drought restrictions are in effect, the city manager may set alternative watering time and/or duration restrictions for the use of automatic irrigation systems or those which are equipped with a timing device.

F. Landscaping; seeding; sodding; planting. When drought restrictions are in effect, the city manager may restrict or wholly prohibit the seeding, sodding or planting of live vegetation. Landscaping not installed for new development projects due to the implementation of this section may be allowed an extended time to complete landscaping improvements of an additional 12 months to the timing provisions outlined in 38.270.060 for the purpose of receiving issuance of a certificate of occupancy.

G. Restriction of certain outdoor uses when drought restrictions are in effect.

1. Hosing or washing down hard or paved surfaces.
  - a. When drought restrictions are in effect, hosing or washing down hard or paved surfaces including, but not limited to, sidewalks, walkways, driveways, parking areas, outside building walls, patios or alleys is prohibited.
  - b. When it is necessary to hose or wash down hard or paved surfaces for purposes essential to protect public health, sanitation, safety, and welfare, the following devices may be used: hand-held bucket or similar container; hand-held hose equipped with a positive shut-off nozzle or device; and low volume, high-pressure cleaning machine.
2. Hosing or washing down vehicles.
  - a. When drought restrictions are in effect, hosing or washing down motorized and non-motorized vehicles, including but not limited to automobiles, trucks, vans, buses, motorcycles, boats, bikes and trailers is prohibited.
  - b. The following devices are exempt from this restriction: use of hand-held bucket or similar container; use of hand-held hose equipped with a positive shut-off nozzle or device; and commercial car washing facility.
3. A drought declaration may warrant the implementation of drought restrictions that require additional curtailments of outdoor water uses beyond those identified in this division. All additional curtailments must consider the city's Drought Management Plan.

H. Restriction of particular indoor uses when drought restrictions are in effect.

1. Water served only upon request. When drought restrictions are in effect, business establishments are prohibited from serving complimentary water for human consumption unless requested by a customer.
2. Option not to have towels/linens laundered. Whenever drought restrictions are in effect, hotels, motels, and other commercial lodging establishments must provide guests the option to decline having used towels and linens laundered daily. Such establishments must prominently display notice of this option in each room using clear and easily understood language.

Sec. 40.02.1310. – Wasting water prohibited.

No person shall waste water which shall include but not be limited to permitting water to escape or run to waste, excessive use, and escape of water through breaks, leaks, or malfunctions in the plumbing or irrigation system.

Sec. 40.02.1330. - Exception to maintain sanitation.

The director of public works shall have the authority to permit a reasonable use of water in any case necessary to maintain adequate health and sanitation standards.

Sec. 40.02.1340. - Enforcement.

- A. *Police officers to enforce.* Every police officer of the city shall, in connection with the duties imposed by law, diligently enforce the provisions of this division.
- B. *Discontinuance of service.* The City Manager shall have the authority to enforce the provisions of this division by the discontinuance of water service in the event of violation hereof.

Sec. 40.02.1350. - Penalties.

Any person who violates this division or the restrictions issued hereunder shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined in an amount not less than \$100.00 or more than \$500.00.

Sec. 40.02.1360. - Legislative intent.

It is the intent of the City Commission that the criminal offense listed in this division shall be an offense involving absolute liability. Unless specifically provided otherwise, this offense shall not require proof of any one of the mental states described in MCA 45-2-101(33), (37), and (58).