Treasure Valley Water Supply Options to meet Projected Municipal Demand

Prepared for:

Veolia Water Idaho, Inc.
(formerly SUEZ Water Idaho, Inc.)
8248 W. Victory Road
Boise, ID

Prepared by:

HDR | SPF
300 East Mallard, Suite 350
Boise, ID 83706

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Christian Petrich, Ph.D., P.E., P.G.

HDR | SPF

Summary

The Treasure Valley benefits from a substantial local water supply—arguably a greater per capita supply of surface water and groundwater[1] than in many other arid western urban areas. Approximately 2 million acre feet[2] (AF) of water enter the Treasure Valley in an average year, mostly via the Boise River. Three large reservoirs store spring runoff in the upper Boise basin for release later in the year, mainly for irrigation of farms and (to a lesser extent) urban landscaping. About 1 million AF flows out of the Treasure Valley each year via the Boise River, with additional outflow to the Snake River from drains and groundwater discharge. Groundwater levels are stable in most parts of the valley, indicating that current groundwater use is in a relative equilibrium with aquifer recharge.

Nevertheless, the Treasure Valley faces the challenge of supplying municipal water to a growing population. In 2015, Treasure Valley water purveyors delivered about 110,000 AF for municipal uses (not including water delivered through separate non-potable systems). Municipal demand is projected to increase by another 110,000 AF to 190,000 AF in the coming decades.[3] Although Treasure Valley aquifers will support additional pumping, there are aquifer-capacity, water-quality, and administrative constraints that may limit additional groundwater withdrawals in some areas. Boise River water is abundant but is (for the most part) fully appropriated in Ada County for existing uses. Boise River diversions authorized by junior priority water rights are vulnerable to extended drought conditions.[4]

Fortunately, there are numerous options available for increasing municipal supplies. Potential water sources include additional groundwater development, new upstream storage, the Snake River, the Boise River downstream of Star, and treated municipal effluent. In combination, these sources likely will be sufficient to meet the projected domestic, commercial, municipal, and industrial (DCMI) demand in the Treasure Valley

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[1] *Surface water* is water present in reservoirs, rivers, canals, etc. *Groundwater* is water found in soil, sand, and rocks beneath the surface of the earth.

[2] An acre-foot of water is enough to flood one acre of land to a depth of one foot. An acre-foot of water contains approximately 325,850 gallons, or 43,560 cubic feet.

[3] This range of projected muncipal water-demand values reflects various assumptions about water-conservations levels, housing density (which influences irrigable area), landscape-irrigation patterns, and the current availability of surface water for urban irrigation.

[4] Some very junior-priority rights may be exercised only during times of high river flows or flood-release conditions.

over the coming decades. Developing these sources will likely entail overcoming various physical, institutional, and administrative constraints. Some of these sources (e.g., groundwater) lend themselves to incremental implementation; others will require coordinated, long-term planning. Some of these water-supply options will incur substantial expense. Climate change will influence municipal water demand and will impact the availability and timing of water sources. Meeting a growing municipal water demand will require an adaptive, cooperative strategy for developing some or all of the water-supply options described in this report.

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1 INTRODUCTION

1.1 Background

The Treasure Valley[5] (Figure 1) of southwestern Idaho has seen substantial population growth in recent years, leading to increased municipal water demand. Furthermore, the Treasure Valley, like other parts of the western United States, experienced a serious drought in 2021. Water supplies in many western states are constrained. This led Treasure Valley leaders to ask about the sufficiency of the current and future Treasure Valley water supply. Are Treasure Valley aquifers stable? How vulnerable are Treasure Valley municipal water sources to extended drought conditions? Are there sufficient options for meeting projected increases in municipal water demand over the coming decades?

This report addresses these questions. In preparing this report, we've (1) reviewed projections for increased municipal water demand, (2) reviewed the characteristics—and vulnerabilities—of the groundwater and surface water upon which we rely, (3) described water-supply options for meeting future water-demand increases, and (4) described ways in which climate change could impact these water-supply options.

This document does not present a specific water-supply plan or strategy. Instead, the report provides an outline and discussion of water-supply options to meet projected municipal demand. Ideally, this document will assist municipal water purveyors, municipalities, surface-water delivery entities, and other interested parties in developing a comprehensive water-supply strategy and plan.

This review of municipal water-supply options was requested by Veolia Water Idaho Inc. (Veolia).[6] However, the review was not limited to the Veolia service area. Instead, the review covers the entire Treasure Valley, reflecting the intertwined and interdependent nature of current and future water demand and water-supply options in the valley.

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[5] For the purposes of this review, the Treasure Valley is defined as the area between the Boise foothills and the Snake River, essentially consisting of Ada and Canyon counties. The Treasure Valley encompasses the lower Boise River basin, although some surface water and groundwater in the southern portion of the valley drains or discharges directly toward the Snake River. Excluded for purposes of this report is the Payette River basin in Gem and Payette counties.

[6] SUEZ Water Idaho, Inc. changed its name to Veolia Water Idaho, Inc. in March, 2022.

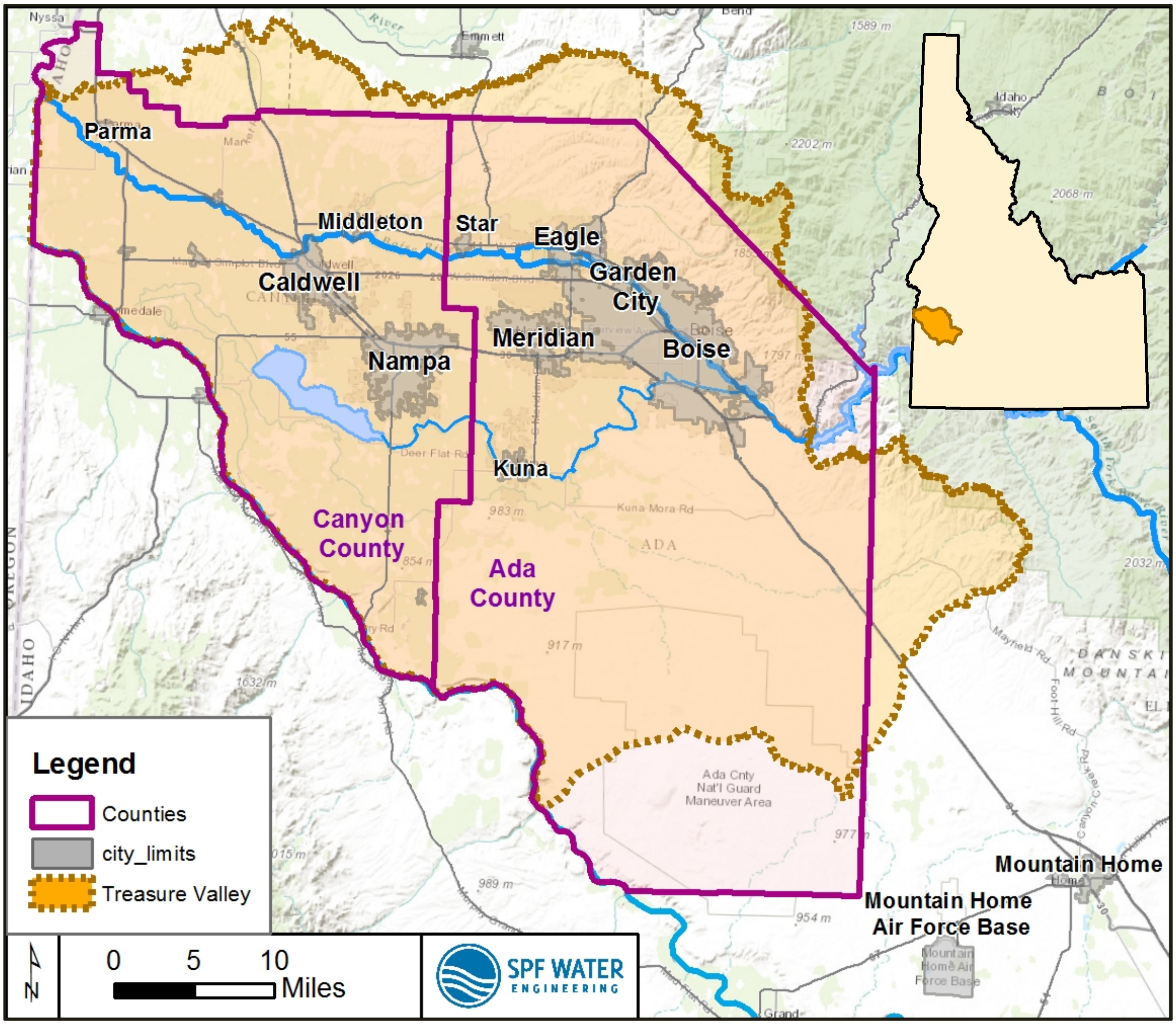

Figure 1. Treasure Valley.

1.2 Report Organization

This report begins with a review of municipal water-demand projections (Section 2), followed by a review of current municipal water sources (Section 3). Options for meeting increasing municipal water demand are summarized in Section 4 and described in greater detail in Sections 5 (groundwater), 6 (Snake River), 7 (Boise River), and 8 (wastewater reuse). Managed aquifer recharge, while not strictly a water-supply source, may be part of an overall water-supply strategy (Section 9). Potential climate-change impacts on municipal demand and supplies are considered in Section 10. A conceptual mix of water-supply sources is described in Section 11, followed by a list of conclusions and recommendations (Section 12).

1.3 Acknowledgements

This report was prepared for Veolia Water Idaho, Inc. The report builds on previous work (e.g., water-demand projections, initial identification of water-supply alternatives) prepared for the Idaho Water Resource Board (IWRB).

Christian Petrich[7] was the primary author of this report.[8] Terry Scanlan[9] assisted with sections pertaining to Boise River water rights, rental pool, water bank, and general water availability, and provided general review. Lori Graves provided GIS support.

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The opinions and conclusions in this report are solely those of the authors and are based on information available as of the date of publication.

[7] Christian Petrich, Ph.D., P.E., P.G., Consulting Hydrologist (formerly Principal Engineer/Hydrologist with SPF Water Engineering, LLC).

[8] Any questions regarding this report should be directed to Dr. Petrich at crpetrich@gmail.com.

[9] Terry Scanlan, P.E., P.G., Principal Engineer, HDR | SPF.

2 MUNICIPAL WATER DEMAND

SUMMARY: Municipal water demand in the Treasure Valley is projected to at least double by 2065, increasing by roughly 110,000 to 190,000 AF per year from the approximately 110,000 AF delivered in 2015.

2.1 Municipal Water

For purposes of this report, *municipal water* is the potable water used for domestic, commercial, municipal, and industrial (DCMI) purposes.[10] In this discussion, municipal water includes water for landscape irrigation only if the water was delivered by a municipal provider through its potable water-delivery system.[11] The term *municipal water* doesn't include non-potable water supplied by irrigation entities (e.g., irrigation districts, canal companies, ditch companies, etc.) or some cities (e.g., Nampa) within municipal-water service areas for landscape irrigation.[12]

Municipal water may be supplied by a variety of municipal providers, including cities, private companies (e.g., Veolia or Capitol Water Corporation), or quasi-public entities (e.g., subdivision systems). Municipal suppliers strive to satisfy *water demand*, which

[10] The definition of "municipal water" used here is similar, but not identical, to the legal definition of "municipal purposes" under Idaho water law. For example, the legal definition of municipal purposes may include treated effluent that is applied to farm land. The definition of municipal water used in this report includes treated effluent only to the extent it was used to meet municipal water demand, e.g., for landscape irrigation.

[11] Potable municipal water (from either groundwater or a combination of groundwater and surface-water sources) typically is used for urban irrigation when untreated surface water is not available. Untreated (i.e., non-potable) surface water may be available for urban irrigation if the land is within an irrigation delivery entity's authorized *place of use* and the land has physical access to surface water. Potable municipal water is used for urban irrigation when (1) land does not have an available surface-water irrigation supply, (2) land is included in an irrigation entity's place of use but does not have physical access to surface water, (3) some surface water is available, but not in a sufficient quantity to meet the full irrigation demand, or (4) when surface water becomes unavailable during the shoulder season or under drought condtions.

[12] In Idaho, untreated surface water delivered in pressurized-irrigation (PI) systems often is preferred by residents over potable municipal water. The cost of untreated surface water generally is less than that of municipal water (untreated surface water is usually unmetered). Because of lower cost, per-irrigable-acre water use can be greater when surface water is provided through pressurized non-potable systems than when potable water is provided via muncipal sytems.

is defined for the purposes of this report as the volume of water needed by municipal water users.[13]

The term *net DCMI water demand* describes the portion of DCMI demand that is not delivered by irrigation entities. Net DCMI water demand is met with water from municipal providers via potable municipal water systems. For the purposes of this report, the term *municipal water demand* is synonymous with *net DCMI water demand*.

2.2 Future Municipal Water Demand

Municipal water demand will increase in the coming decades with increasing population growth. In 2016, SPF Water Engineering, LLC (SPF) projected the 2065 municipal water demand for four different scenarios (SPF, 2016), distinguished by various assumptions regarding the amount of water conservation and the amount of urban irrigation. In these scenarios, SPF projected that the Treasure Valley municipal water demand will grow from 110,000 AF/year in 2015 to between 219,000 and 298,000 AF/year by the year 2065. This represents an increase of 109,000 AF/year to 188,000 AF/year by the year 2065. These values represent increases of 200% to 270% over 2015 usage. The projected municipal water-demand increases are concentrated between the Boise Foothills and the New York Canal in and around the urban areas of Boise, Meridian, Nampa, Caldwell, Eagle, and Kuna (Figure 2).

Veolia, the largest municipal water provider in the Treasure Valley, projected a 2065 demand of about 103,000 AF, which is up from about 50,000 AF/yr in 2015 (SUEZ, 2016). Veolia's (then SUEZ's) projection of 103,000 AF/yr is most consistent with SPF's "Scenario 2" 50-year projection of 106,000 AF/year, which was built on assumptions of moderate water conservation.

Annual valley-wide population growth rates since 2015 have ranged from 0.7% to 4.3% (Table 1). These growth rates are consistent with historical rates (Table 2) but are greater than the average annual growth rates of 1.5% to 2.6% projected by SPF (2016).[14] If the past is a guide, the valley will continue to see population growth-rate swings in future years.

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[13] This definition is consistent with Idaho Department of Environmental Quality (IDEQ) definitions and standard engineering terminology. The engineering definition for "water demand" may differ from the definition used by an economist, for whom the term "water demand" might be defined as the relationship between water use and price.

[14] The 2016 SPF population projections were prepared by John Church (Idaho Economics) based on Southwest Idaho Community Planning Association (COMPASS) population projections and semi-logarithmic extrapolation from 2040 to the year 2065. The spatial distribution of population, households, and employment projections was refined based on a review of various comprehensive plans and interviews with local planning officials, conducted by Bob Taunton (Taunton Group).

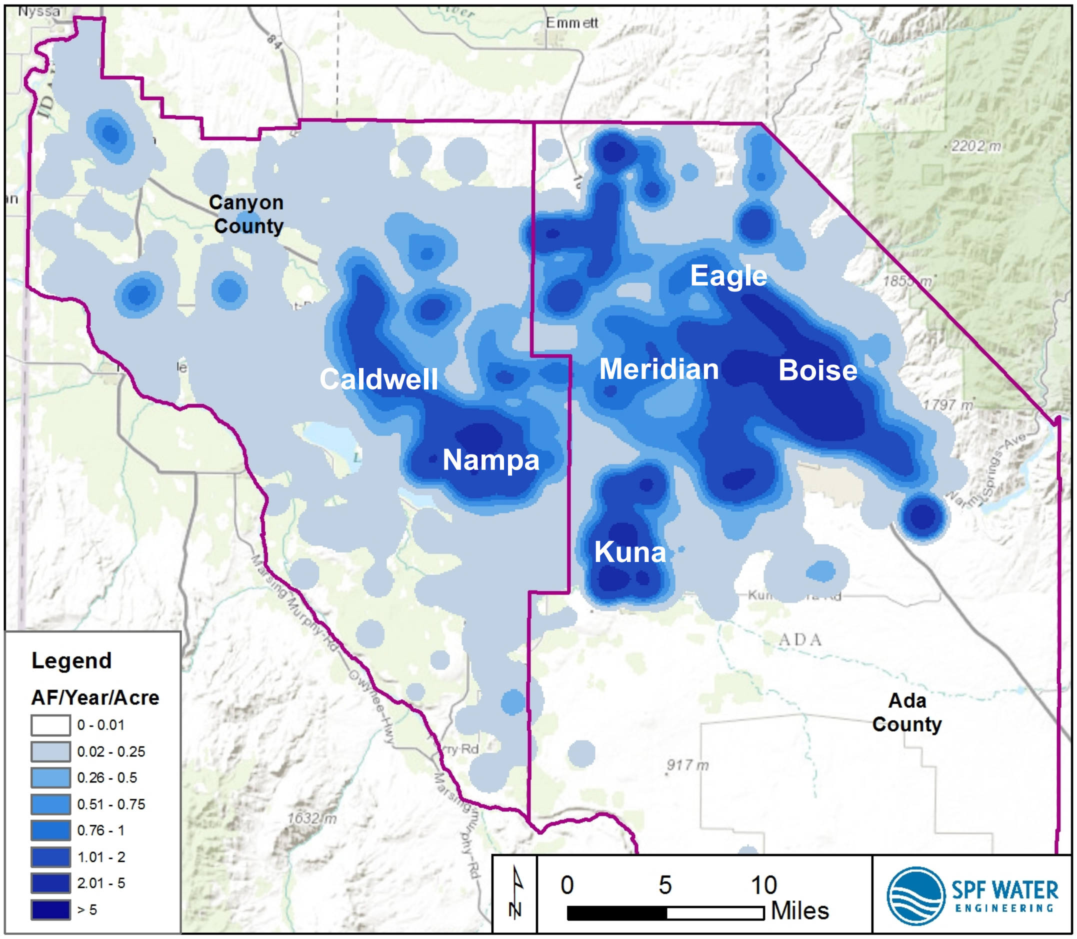

Figure 2. Spatial distribution of 2065 municipal water demand (SPF, 2016).

Increases in municipal water demand are somewhat—but not completely—proportional to population growth. The demand for indoor potable water may be relatively proportional to population, but municipal water demand for irrigation depends on location (i.e., some areas have greater surface water availability than others), housing density (which influences the amount of irrigable area), and other factors.

Neither COMPASS, local planning officials, or the SPF team anticipated the conditions contributing to the recent larger-than-anticipated Treasure Valley population growth.

Annual Treasure Valley Population Growth						
	Ada County		Canyon County		Treasure Valley	
Year	Population	Percent Growth	Population	Percent Growth	Population	Percent Growth
2021	518,300	3.0%	243,380	3.6%	761,680	3.2%
2020	502,970	3.1%	234,820	4.6%	737,790	3.6%
2019	487,660	3.6%	224,540	3.4%	712,200	3.5%
2018	470,930	3.6%	217,180	0.8%	688,110	2.7%
2017	454,400	2.6%	215,430	3.5%	669,830	2.9%
2016	442,850	1.0%	208,180	0.2%	651,030	0.7%
2015	438,660	4.0%	207,790	4.9%	646,450	4.3%
2014	421,920	3.7%	198,160	2.7%	620,080	3.4%
2013	406,870	1.8%	192,970	1.3%	599,840	1.7%
2012	399,670	0.9%	190,400	0.3%	590,070	0.7%
2011	395,960	0.9%	189,850	0.5%	585,810	0.8%
2010	392,365		188,923		581,288	

Table 1: Annual Treasure Valley population growth (2010-2021).

Historical Treasure Valley Population Growth, by Decade							
	Ada County		Canyon County		Treasure Valley		
Year	Population	Percent Growth	Population	Percent Growth	Population	Percent Growth	Average Annual Growth
2020	502,970	28%	234,820	24%	737,790	27%	2.7%
2010	392,365	30%	188,923	44%	581,288	34%	3.4%
2000	300,904	46%	131,441	46%	432,345	46%	4.6%
1990	205,775	19%	90,076	8%	295,851	15%	1.5%
1980	173,125	54%	83,756	35%	256,882	47%	4.7%
1970	112,230	20%	62,123	8%	174,353	15%	1.5%
1960	93,460	32%	57,662	8%	151,122	22%	2.2%
1950	70,649	40%	53,597	31%	124,246	36%	3.6%
1940	50,401		40,987		91,388		

Table 2: Treasure Valley population growth, by decade (1940-2010).

Long-term water-demand projections are based on historic and recent population growth rates, current and anticipated water-use patterns, observations of other growth patterns in similar western cities, and current economic national and local economic conditions. Water-demand projections do not capture the unanticipated, such as pandemics (and associated economic impacts), national changes in remote-work patterns, future policy changes influencing urban water demand, etc. Water-demand projections are based on a snapshot in time and will evolve as conditions change.

Recent jumps in Treasure Valley population do not negate the municipal water-demand projections made in 2016, even if the recent population growth exceeds the projected *average* growth rates. The actual demand in the coming decades may be greater or less than the 2016 projections suggest. However, the 2016 projections—representing an increase of roughly 110,000 to 190,000 AF/year in the next four or five decades—still frames the general magnitude of future increases in municipal water demand.

Another way to think about these demand projections is that the Treasure Valley will very likely need an *additional* 110,000 to 190,000 AF/year of water at some time in the coming decades to meet growing municipal demand. This water-demand increase may be realized within 40 years, or within 60 years or more, but the uncertainty in timing has little influence on the general demand-reduction and water-supply options available to Treasure Valley municipal suppliers.

3 TREASURE VALLEY WATER SUPPLY CHARACTERISTICS

3.1 Introduction

SUMMARY: Treasure Valley municipal water comes from groundwater and, to a lesser extent, the Boise River. Groundwater levels are mostly stable throughout much of the Treasure Valley, despite historic pumping increases.

Municipal suppliers in the Treasure Valley currently rely mostly on groundwater for potable municipal supplies. Veolia, the valley's largest municipal supplier, also diverts water from the Boise River,[15] which is treated at its Marden Lane and Columbia treatment facilities. A brief description of Treasure Valley aquifers and Boise River flows is warranted to better understand the reliability—and vulnerability—of these water-supply sources. This section summarizes Treasure Valley surface-water and groundwater hydrology and discusses the vulnerability of these sources during times of drought.

3.2 Surface Water

3.2.1 Surface Water Characteristics

About 2,000,000 AF of water flows into the Treasure Valley in a typical year from the upper Boise River basin;[16] about 1,000,000 AF flows out of the lower Boise River into the Snake River. Three reservoirs upstream of Boise (Anderson Ranch, Arrowrock, and Lucky Peak— see Figure 3), can store up to 949,700 AF.[17] Off-stream storage capacity in Lake Lowell is about 159,000 AF. Water stored in these reservoirs, combined with natural streamflow in the Boise River, is the primary source of Treasure Valley irrigation water.

= 1,108,700 AF Total

Surface-water availability is shaped by climate and precipitation. The Treasure Valley has a temperate and arid-to-semi-arid climate. Annual precipitation since 1990 has ranged from 6.9 inches in 2004 to 16.7 inches in 2019 (Figure 4). Portions of the upper Boise River drainage receive over 40 inches of precipitation in a typical year. Most of the precipitation falls during the fall, winter, and spring months (Figure 5).

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[15] About 30% of Veolia's supply comes directly or indirectly from the Boise River.

[16] Idaho Department of Water Resources data, circa 2004.

[17] https://www.usbr.gov/pn/hydromet/boipaytea.html.

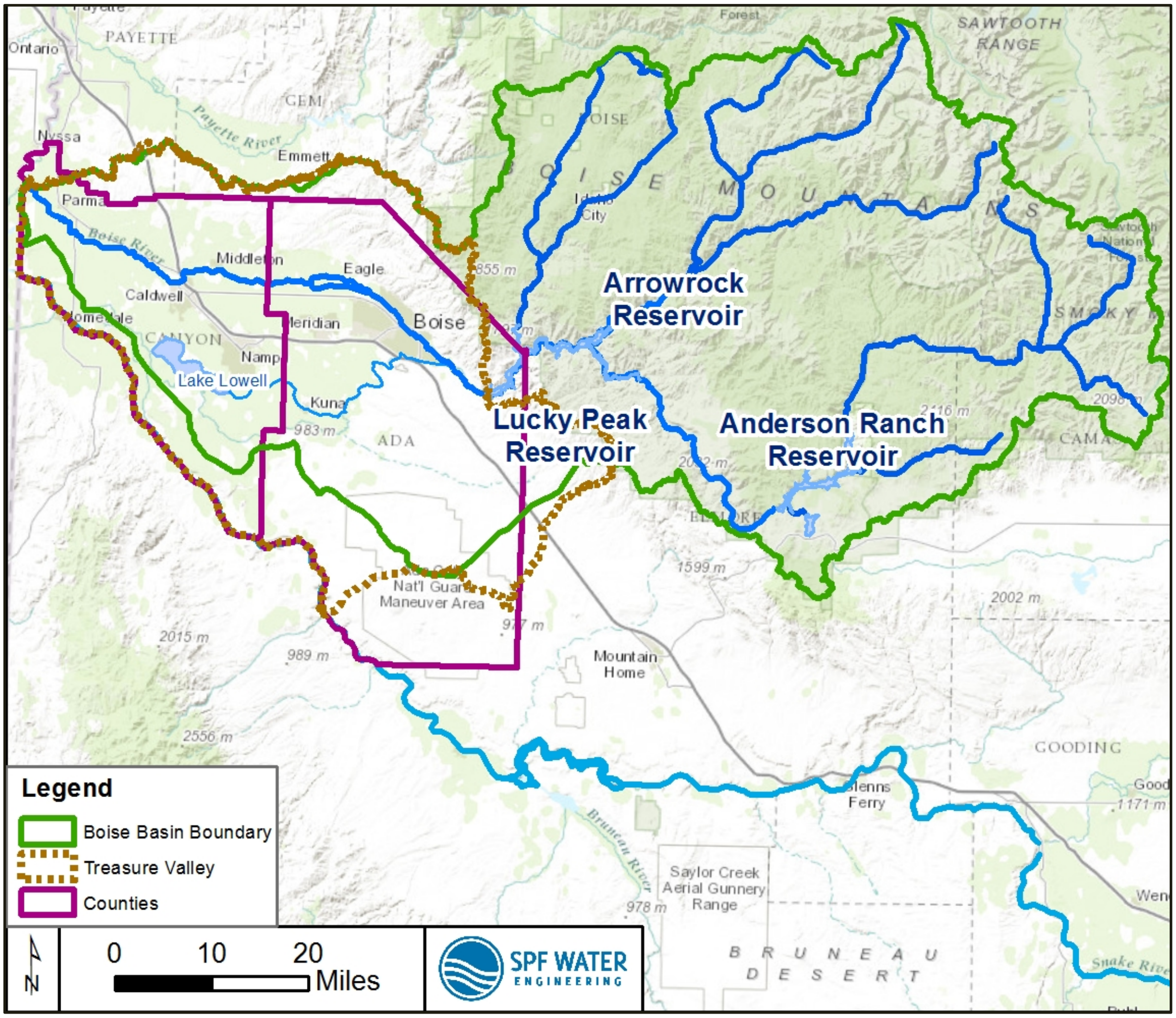


Figure 3. Boise River Watershed.

Large-scale irrigation using surface water from the Boise River began in the late 1800s, and by the 1930s a large portion of the valley was irrigated with surface water. Water for irrigation is delivered mostly by gravity flow through canals operated by a variety of large and small irrigation companies or districts.

Development of surface-water irrigation continued in the following decades with water from the Payette River. The Black Canyon Irrigation District, developed between the 1920s through 1950s, pumps water from the Payette River to lands in the Boise River drainage west of Star, Idaho. Some surface water is also pumped from the Snake River in southern portions of the Treasure Valley for irrigation.

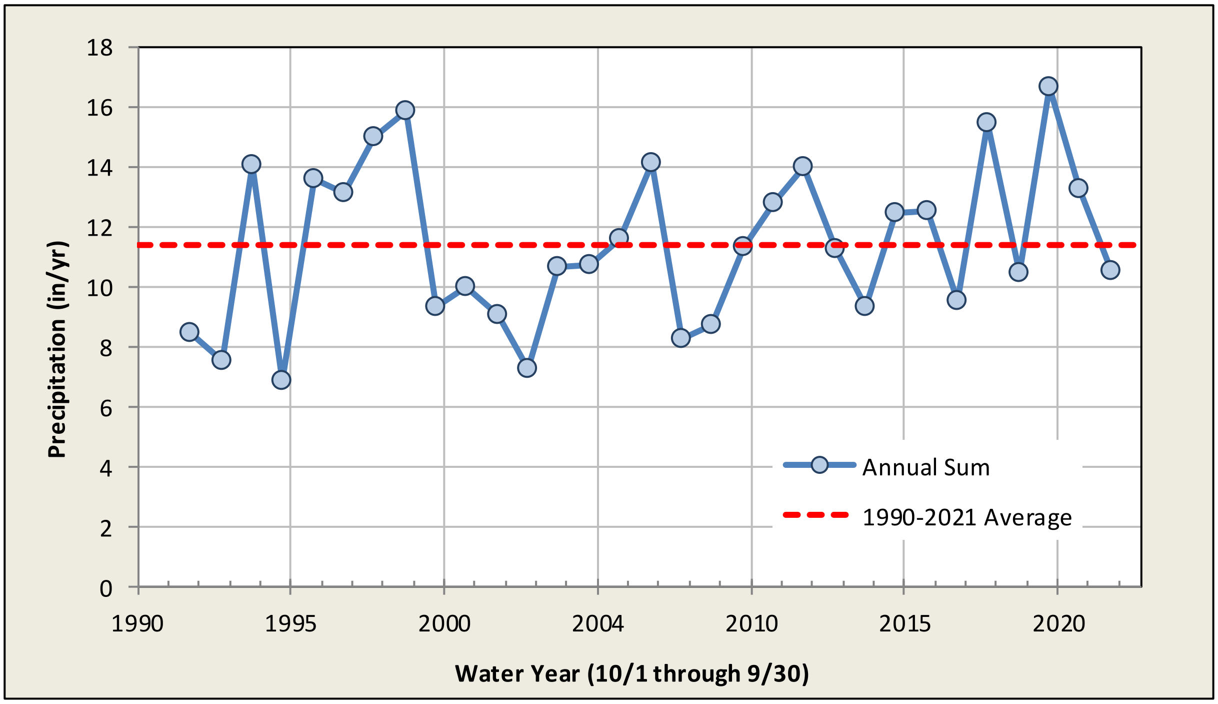


Figure 4. Annual precipitation, Boise Airport, water years 1990-2021.

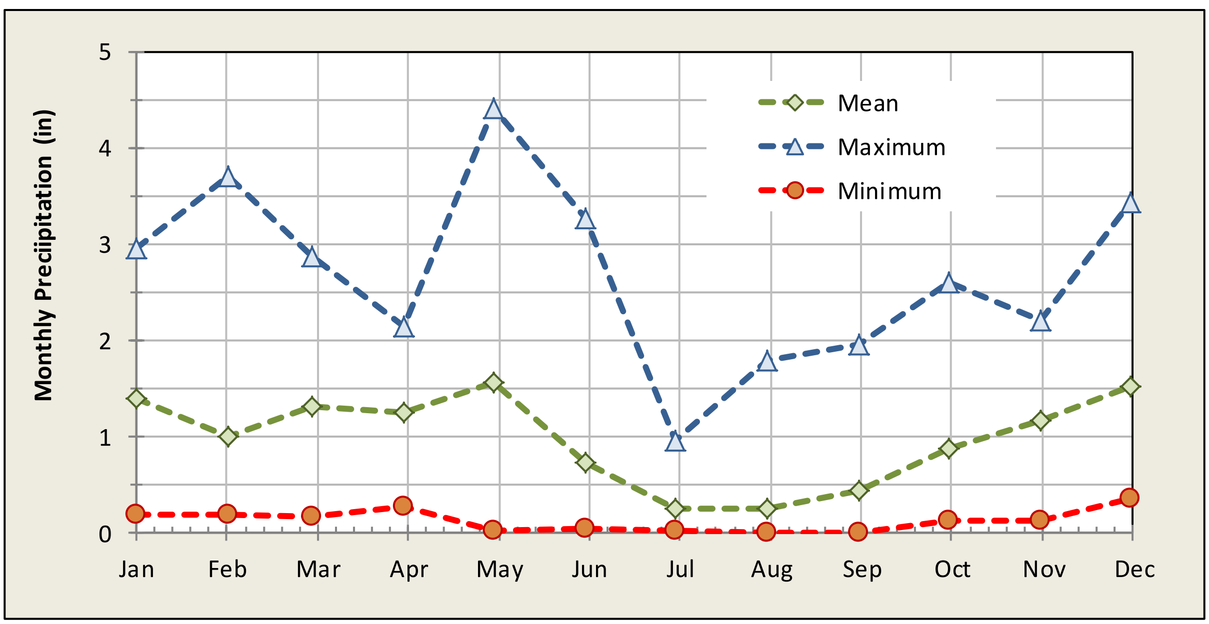


Figure 5. Monthly precipitation, Boise Airport, 1990-2014.

Irrigation districts, canal companies, and ditch companies[18] deliver water for irrigation via a complex system of canals, laterals, drains, diversions, and re-diversions. Non-potable pressurized irrigation (PI) systems operated by surface-water delivery entities, cities, and subdivisions are often used to deliver water for irrigation of residential and commercial areas. Some surface-water delivery entities provide water for municipal PI systems (such as one operated by the City of Nampa). Some irrigation entities also dedicate water (by virtue of non-diversion or by returning measured flows to a surface-water channel) for the mitigation of diversions under junior-priority groundwater rights.

Average Boise River flows at gage locations at Lucky Peak Dam, Glenwood Bridge, and Parma (Figure 6) reflect winter storage (i.e., low flows in winter while reservoirs are filling), flood releases (high flows in May and early June), and irrigation releases through September (Figure 7). Lower summer flows at Glenwood Bridge (compared to Lucky Peak Dam) are the result of Boise River diversions for irrigation between Lucky Peak Dam and Glenwood Bridge. Average Boise River flows are lowest in the vicinity of Star, Idaho (Figure 1). Boise River flows typically increase downstream of Star (reflected in the Parma gage) as a result of (1) groundwater discharge to surface channels, (2) irrigation return flows during the irrigation season, and (3) inflows from tributary streams.

3.2.2 Surface Water Vulnerability

The Boise River above Star Bridge is "fully appropriated," meaning that essentially all flow except during high runoff events is spoken for. Most diversions are curtailed to some extent every summer and fall as flows decrease, especially in low-water years.

Diversions are authorized by water rights. Water in Idaho is allocated on a first-in-time, first-in-right basis for recognized beneficial uses. This means that diversions of water are administered by the State of Idaho based on the date that water was first put to a particular beneficial use (e.g., irrigation). In general, diversions from the Boise River under water rights with priority dates senior to about 1870 are not fully curtailed during the irrigation season as natural flows decrease (although most rights upstream from Star are curtailed to 60% under the somewhat unique Stewart Decree sliding scale in which all rights are cut in priority order, first from 100% to 75%, then from 75% to 60%, and finally from 60% to 0%). In contrast, diversions under junior-priority rights (like those, for example, with priority dates more recent than about 1880) are fully curtailed each irrigation season. Diversions under rights authorizing springtime flood flows are not available at all in some low-water years.

[18] Referred to herein as *surface-water delivery entities* or *irrigation entities*.

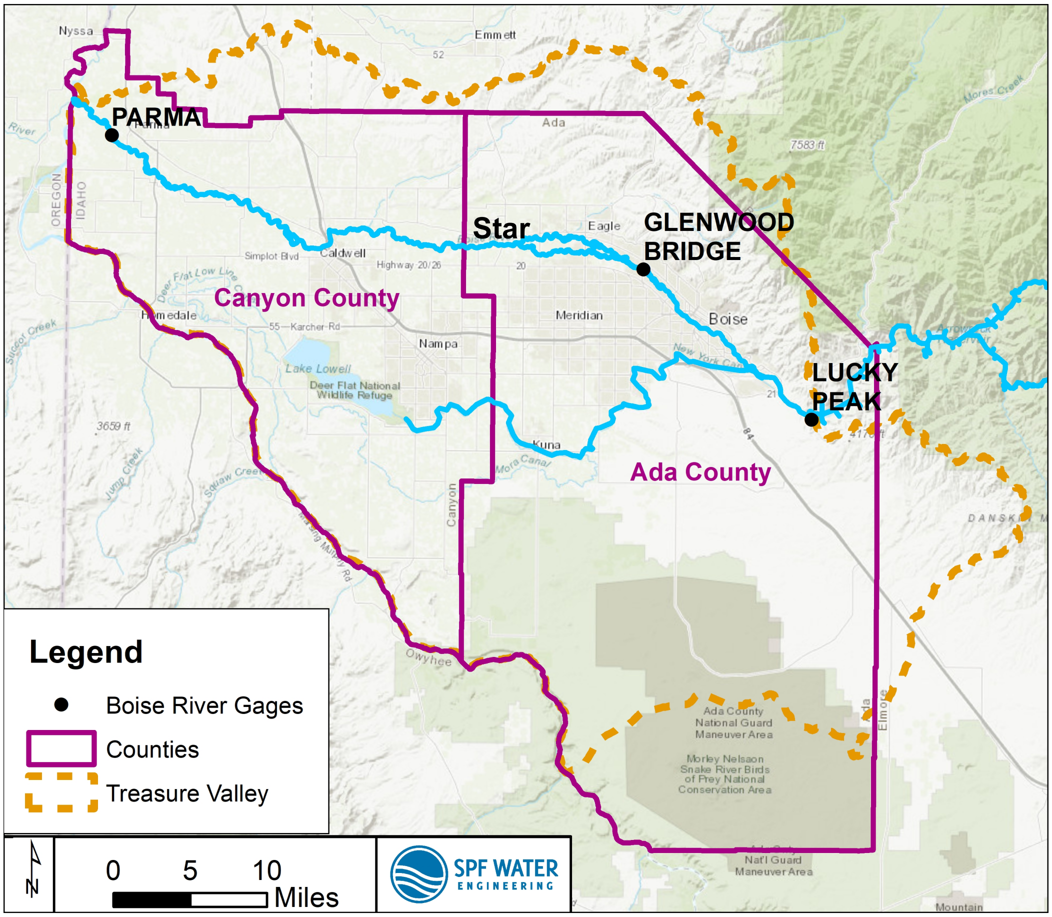


Figure 6. Boise River gaging locations.

Drought conditions reduce the Treasure Valley's water supply. Less precipitation can mean less early-season natural flow in the Boise River, and less reservoir storage. Less storage in the upper Boise River basin can lead to shorter periods of availability during irrigation seasons, especially for those with junior-priority water rights. For example, in 2021 natural flow water rights with priority dates as early as 1865 were fully curtailed for a few days in early September, which is almost unprecedented. Many irrigators relied on reservoir storage to meet demands in July and August and were forced to shut down major canals in early September when storage supplies were exhausted.[19]

[19] Ironically, as major canals shut down, diversions of natural flow decreased, and water rights with priority dates of 1911 and earlier were able to divert for the remainder of the 2021 season.

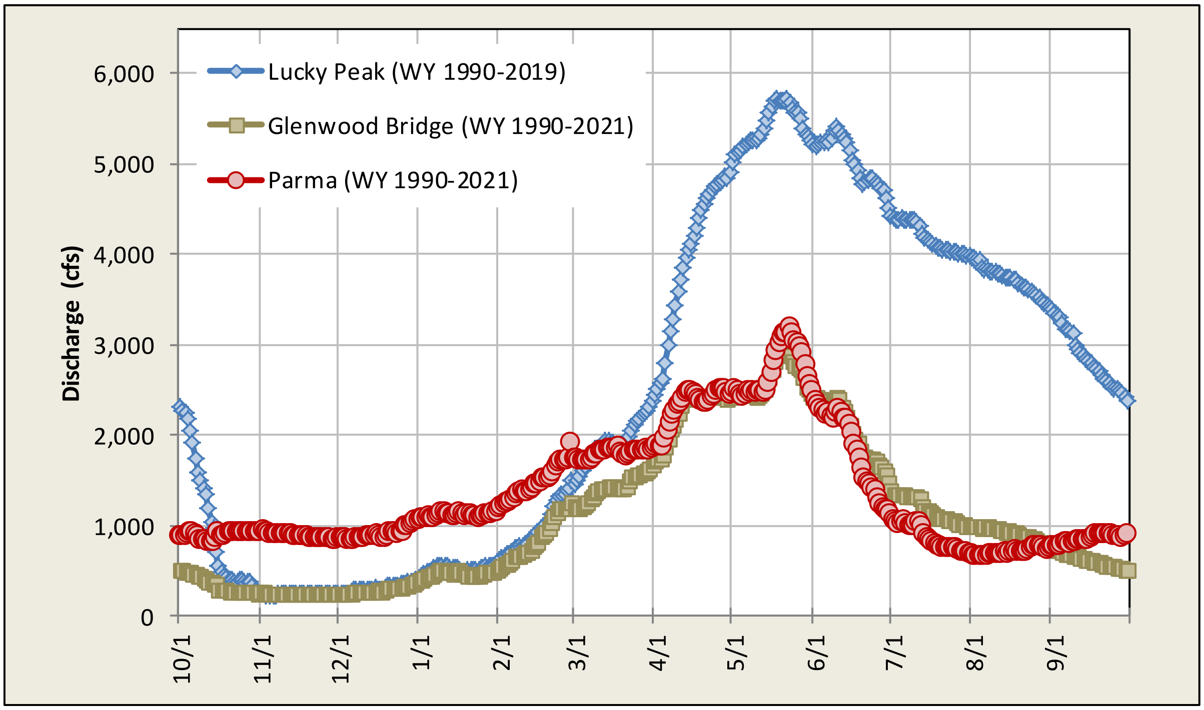


Figure 7. Boise River flows at selected gaging locations, 1980-2015.

In the foreseeable future, Boise River water rights with priority dates senior to 1870 will be available most of the time; water rights with priority dates junior to 1880 will be cut frequently. Rights authorizing the diversion of flood flows may be available for short durations in some years, but not available at all in other years. In the long run, availability of diversions under these surface-water rights will depend on climate-related hydrologic changes and the measures taken to mitigate these impacts (Section 10).

3.2.3 Drains

The primary source for Treasure Valley surface-water diversions is the Boise River, but drains are an important indirect source of water for users in central and western portions of the valley. Groundwater levels rose substantially following the development of irrigation in the valley; drains (Figure 8) were constructed beginning in the early 1900s to alleviate waterlogged soils resulting from elevated groundwater levels (Carter, 1926; Iakisch, 1931; Paul, 1916; Steward, 1919; Weymouth and Bliss, 1912). In addition to shallow groundwater discharge, drains collect return flows from irrigation activities, excess conveyance flows, water left undiverted in a delivery system when, for instance, on-farm deliveries are reduced because of wet weather or harvest), or other reasons.

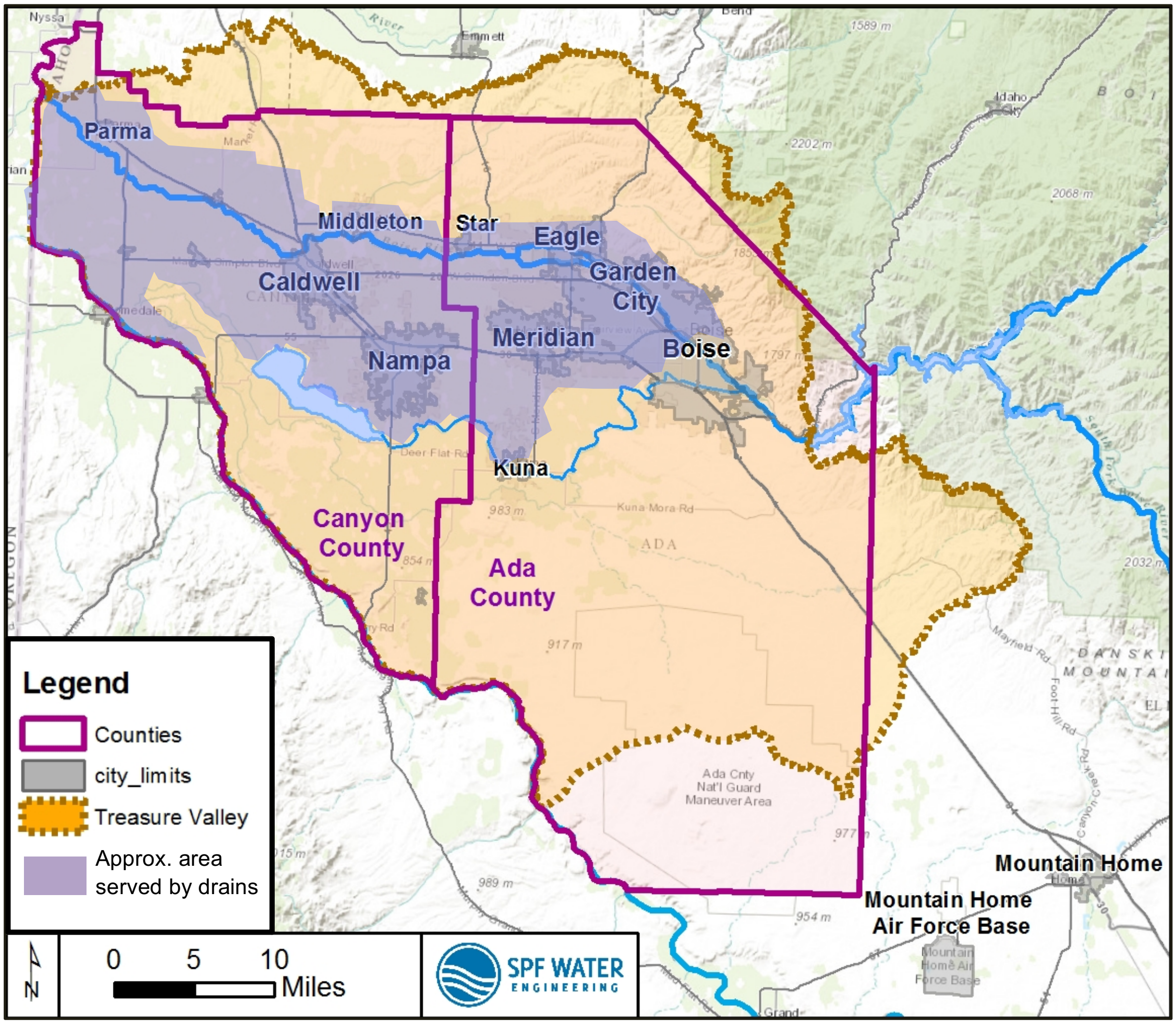


Figure 8. Approximate area served by agricultural drains.

A number of irrigation entities and water users rely on drain flows as a primary or secondary water supply. Water that is not diverted within the drain system returns as discharge to the Boise River. Some users rely, in part, on drain discharge for lower Boise River diversions.

Similar to Boise River diversions, diversions from drains are vulnerable to drought conditions. Boise River diversions constrained by drought logically leads to less return flows in drains. A shorter irrigation season (shorter because of constrained supply) results in less drain flow. Greater groundwater pumping—especially from shallow aquifers in direct hydraulic connection with drains—can impact drain flows.

Drains are also vulnerable to land-use changes in the watersheds they drain. More impermeable surfaces covering formerly-irrigated agricultural land can contribute to drain flows if irrigation continues on a "gross-acre" basis (see Section 7.7), or lead to reduced drain flows if deliveries of surface irrigation water to partially-impermeable, urban areas is reduced after development.

3.3 Groundwater

3.3.1 Aquifer Characteristics

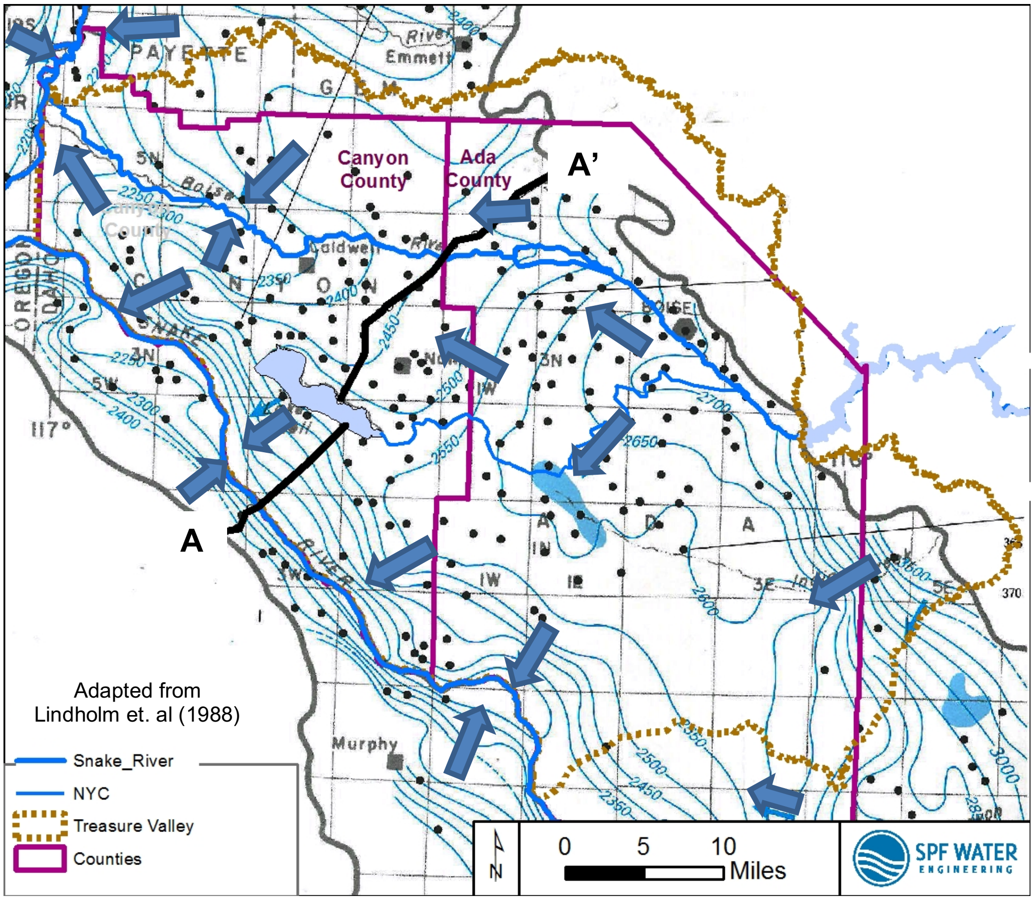
Groundwater is currently the primary source of potable municipal water.[20] Groundwater is pumped from a complex series of interbedded, tilted, faulted, and eroded sediments underlying the valley (Bartolino, 2019; Petrich and Urban, 2004). Although these sediments extend to depths of over 6,000 feet (Wood and Clemens, 2004), most groundwater in the Treasure Valley is pumped from depths of less than about 1,100 feet.

Groundwater generally flows in a westerly direction, depending on depth and location (Lindholm et al., 1988; Petrich and Urban, 2004). The New York Canal and Lake Lowell mark a general groundwater-flow divide (Figure 9). North of the New York Canal and Lake Lowell, shallow groundwater flows (depending on depth) in a westerly or northwesterly direction toward the Boise or Snake rivers. South of the New York Canal and Lake Lowell the predominant direction of shallow groundwater flow is in a southwesterly direction (Lindholm et al., 1988). The New York Canal and Lake Lowell groundwater flow divide evolved in response to seepage from the Boise Project facilities and incidental infiltration of water conveyed by these (and other) facilities for agricultural irrigation.

Downward hydraulic gradients[21] are present along the Boise Foothills and eastern parts of the Treasure Valley (Petrich and Urban, 2004), indicating the potential for downward groundwater movement. Upward hydraulic gradients are evident in the central and western portions of the valley and in the vicinity of the Boise River.

[20] All Treasure Valley municipal suppliers currently rely solely on groundwater except for Veolia, which obtains about 30% of its supply from the Boise River.

[21] *Hydraulic gradient* is the driving force that causes groundwater to move in a particular direction. Gradients are calculated based on *hydraulic head*. Hydraulic head consists of elevation head and pressure head. Just like water flowing downhill, groundwater (if unimpeded) moves from high hydraulic head to low hydraulic head.



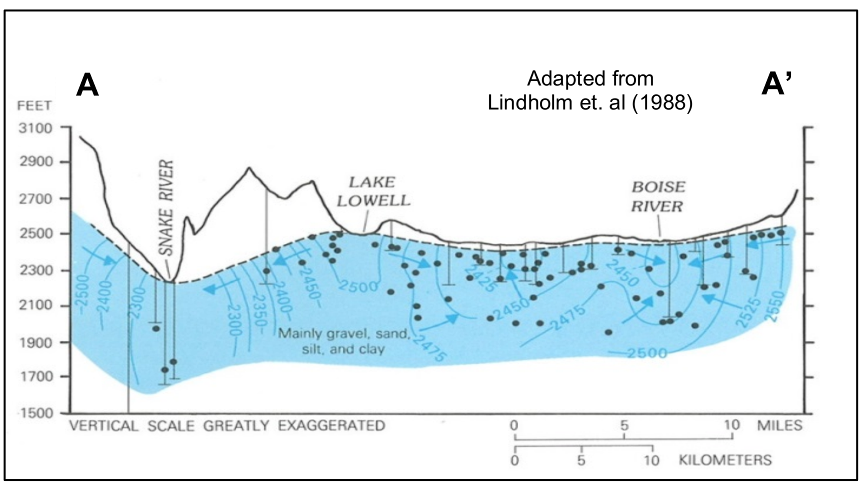


Figure 9. Treasure Valley groundwater flow directions.

Recharge to the Treasure Valley aquifer system stems from (1) seepage from canals and irrigated fields, (2) seepage from rivers and streams, (3) seepage from Lake Lowell,

(4) underflow from the Boise foothills, and (5) infiltration of precipitation (including snowmelt).

Discharge (outflow) from Treasure Valley aquifers includes (1) discharge to canals, drains, and rivers, (2) pumping for irrigation, municipal, domestic, industrial uses, and (3) evapotranspiration. Natural discharge from deeper aquifer zones, especially in the central and western portions of the valley, is limited by low-permeability confining sediments.

3.3.2 Groundwater Quality

Water quality in many Treasure Valley aquifer zones is good. However, some shallow- or intermediate-depth aquifer zones have elevated concentrations of nitrate (which are often associated with human activity). Also, naturally-occurring arsenic, uranium, and fluoride concentrations in excess of EPA-mandated maximum contaminant levels are found in some aquifer layers. Absent treatment, these constituents may prohibit use of this water for potable municipal purposes.[22] Similarly, aesthetically objectionable concentrations of iron, manganese, or hydrogen-sulfide can inhibit use of some aquifer zones for municipal purposes. Finally, some local areas within the Treasure Valley have known contaminant plumes resulting from spill or leaks of fuels, solvents, or other chemicals, rendering groundwater in these areas unusable.

3.3.3 Groundwater Residence Times

Groundwater residence times—the time between when surface water enters the aquifer system and the time that it is discharged—ranges from days to tens of years in shallower aquifer zones. Deep, regional flow systems have groundwater residence times ranging from hundreds to tens of thousands of years, especially in western portions of the valley (Hutchings and Petrich, 2002; Petrich and Urban, 2004). High residence times in deeper aquifers reflect, in part, low-permeability layers that limit upward movement of groundwater to the Snake River. Groundwater withdrawals from such zones likely induce (directly or indirectly) recharge that replaces the pumped water (Petrich and Urban, 2004), at least at current pumping rates.

3.3.4 Groundwater Withdrawals

Current valley-wide estimates of groundwater withdrawals are not available (groundwater withdrawals in the Treasure Valley are not uniformly measured as they are in some other parts of Idaho). The most recent valley-wide estimate of groundwater withdrawals (Urban, 2004) was approximately 177,000 AF for agricultural, municipal,

[22] However, groundwater with such constituents (depending on concentrations) may be acceptable—and is currently used—for agricultural and urban irrigation.

industrial, domestic, and stock water uses.[23] This is about 17% of a total estimated aquifer discharge in the year 2000 of 1,060,000 AF. At the time, annual municipal withdrawals were estimated to be about 77,000 AF, or about 7% of the total estimated aquifer discharge of 1,060,000 AF. For comparison, approximately 814,000 AF/year were estimated to discharge directly to drains, rivers, and other surface channels, much of which flows out of the Treasure Valley to the Snake River.

In the early 2000s, there were approximately 450 pending applications for new water rights in Administrative Basin 63 (which includes the Treasure Valley) being held for processing by the Idaho Department of Water Resources (IDWR), representing an aggregate volume of approximately 36,300 AF/year (Petrich, 2004b). Many, but not all, of these applications were processed by IDWR from approximately 2009 through 2016.[24] Additional applications have been processed—and withdrawals begun—since the processing hold was lifted. Thus, the current aggregate groundwater withdrawals are now almost certainly greater than 200,000 AF/year, perhaps somewhere between 200,000 and 250,000 AF/year.

3.3.5 Groundwater Levels

Groundwater levels typically fluctuate in response to seasonal recharge and pumping patterns. However, groundwater levels are relatively stable on a year-to-year basis in most portions of the Treasure Valley.

Historically, groundwater levels in central parts of the valley rose substantially—up to 140 feet—following the construction of irrigation systems south of the Boise River beginning in the early 1900s (Nace et al., 1957; Thomas and Dion, 1974). The broader effect of this incidental seepage is illustrated by the rise of groundwater levels in the vicinity of Lake Lowell in the early 1900s following the construction and use of the Boise Project facilities (Figure 10). Recorded water levels in some of the wells in this area rose more than 75 feet during this period.

Veolia monitors groundwater levels in more than 80 municipal supply wells within its service area. Veolia reports generally stable water levels,[25] although some wells have seen declines corresponding with recent production increases in those wells.

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[23] The USGS is estimating 2015 aggregate withdrawals as part of its current modeling effort, but preliminary data summarizing groundwater withdrawals are not yet available (Stephen Hundt, USGS, *personal communication*, November 19, 2021).

[24] Some applicants chose not to proceed once IDWR began processing applications.

[25] Kurt Newbry (Veolia, *personal communication*, November 18-19, 2021).

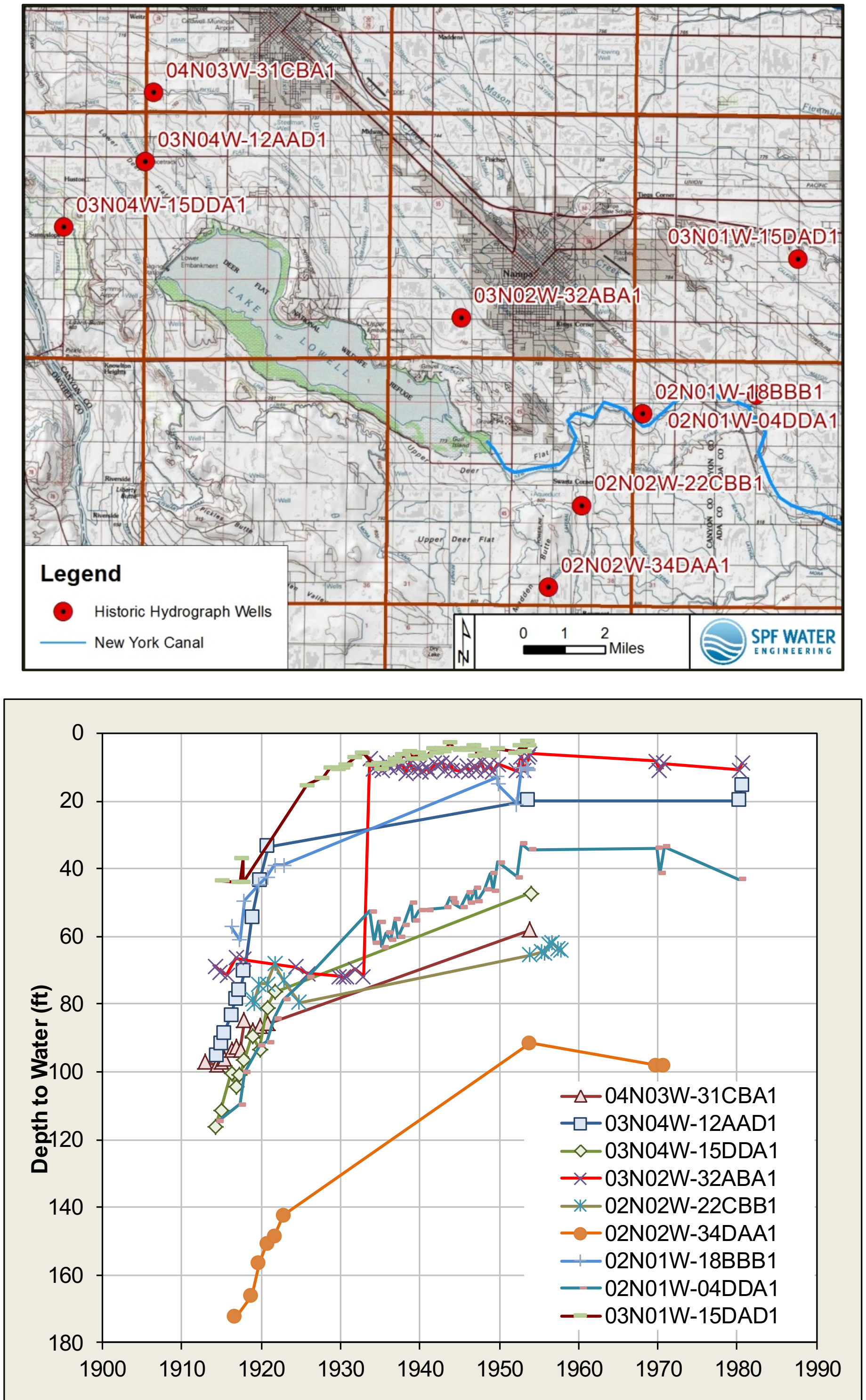

Figure 10. Historic groundwater-level increases in the vicinity of Lake Lowell.

Southeast Boise in the vicinity of Micron Technology, Inc. has experienced substantial groundwater-level declines in past decades. This area is now a Ground Water Management Area (GWMA). Groundwater levels have stabilized because of reduced groundwater production and managed aquifer recharge.

More recently, IDWR reports[26] that groundwater levels in most of the valley remain stable, although some local declines have been noted in shallow wells susceptible to drought conditions (such as in urbanizing areas with decreasing infiltration or local areas undergoing recent increases in groundwater withdrawals). Quarterly groundwater-level measurements that could capture responses to recent drought conditions are underway.[27]

There are two factors contributing to generally stable groundwater levels in the Treasure Valley. First, shallow groundwater levels in central parts of the valley irrigated with surface water are controlled by surface drains.[28] Because of these drains, groundwater levels are essentially controlled by surface topography. In these areas, increases in pumping (or decreases in incidental recharge) may result in decreased drain flows, but will not result in broadly lower groundwater levels.[29,30]

Second, deeper sand aquifers are generally interbedded with silt and clay layers that inhibit vertical groundwater movement. Relatively long residence times in regional aquifers (thousands of years in some areas) suggest that deeper regional aquifers are discharge-limited (Petrich and Urban, 2004); groundwater cannot freely discharge to the Boise or Snake River in the western parts of the valley. To the extent that aquifers are discharge-limited, pumping in these areas should not induce broad declines as long as upgradient recharge water (e.g., groundwater in shallow aquifers in eastern portions of

[26] Dennis Owsley, *personal communication*, August 26, 2021.

[27] *Ibid*.

[28] In the early 1900s, groundwater-level increases from a newly constructed irrigation system reached ground surface, causing waterlogging in soils and rendering them unfit for agriculture. In response, surface drains—essentially large ditches—were dug to drain excess groundwater. Between 2016 and 2020, these drains, which flow year-round, returned an annual average of about 332,000 AF/year to the Boise River (2016-2020 data courtesy of Jennifer Sukow, October 28, 2021).

[29] This would be the case until water levels in the uppermost aquifer drop below the elevation of the bottom of the drains. If groundwater levels are below the drain elevations, then groundwater levels can fluctuate freely based on pumping, recharge rates, etc.

[30] In March and April of 2021 natural flows were released from Lucky Peak Dam (flows that could otherwise have been stored) to help satisfy senior-priority Boise River diversions in the Middleton area; the need for these releases was attributed in part to decreased drain flows (Mike Meyers, Basin 63 Watermaster, personal communication, May 3, 2022).

the valley) remains available and pumping does not exceed the capacity of local aquifers to transmit water from recharge areas to deeper wells.

3.3.6 Groundwater Vulnerability

Despite generally stable groundwater levels, are Treasure Valley aquifers vulnerable to drought conditions or excessive pumping? Shallow aquifers in areas where groundwater levels are not controlled by drains may be vulnerable to seasonal fluctuations during times of drought (because of decreased incidental recharge from irrigation or increased pumping), although few if any of such areas currently exhibit broad, long-term, water-level declines. Large pumping increases from deeper aquifers could lead to groundwater-level declines, although so far groundwater levels in deeper aquifers—especially those used for municipal pumping[31]—have remained relatively stable. Seasonal groundwater-level fluctuations may exceed 100 feet in some aquifers, but water levels typically recover fully every year (i.e., there are no annual declines).

Some Treasure Valley groundwater pumping is theoretically vulnerable to a delivery call.[32] A delivery call is filed when a water user with a senior-priority water right requests the state "administer" junior-priority rights (often through curtailment) so that the senior-priority user receives sufficient water. A typical scenario is one where delivery calls are filed by one or more surface-water users seeking to reduce the impact from groundwater pumping on hydraulically-connected surface channels. Surface-water to groundwater delivery calls in the Eastern Snake River Plain, for example, have led to curtailments in groundwater pumping.

There have been rumors of a possible delivery call by senior-priority surface water rights on junior-priority groundwater rights in the Treasure Valley for at least two decades, but as of this writing, we are unaware of any that have been filed. Furthermore, it is not clear what impact (if any) such a call would have on deeper municipal wells. Most deeper wells have much less impact (if any) on the Boise River above Star Bridge[33] than shallow wells close to the river or individual drains. Even if a delivery call is successful,

[31] Through experience, some muncipal suppliers have identified pumping constraints in individual wells, but such constraints generally reflect local aquifer conditions—not widespread groundwater-level declines. These suppliers manage constraints such as these by shifting pumping among multiple wells.

[32] The basis and procedure for delivery calls involving groundwater are defined by IDAPA 37.03.11 – Rules for Conjunctive Management of Surface and Ground Water Resources. The rules describe how IDWR is to respond to delivery calls, administer water rights, determine material injury, and evaluate mitigation plans.

[33] The "Basin 63 Restricted Area" limits new groundwater appropriations from shallow aquifers tributary to the Boise River above Star Bridge.

there likely are viable options for mitigating groundwater-pumping impacts from individual deep wells. Thus, while a delivery call represents a potential vulnerability, it is not clear how much impact—if any—such a call would have on municipal suppliers relying on deeper wells.

Numerical modeling has been used in other parts of the state to define impacts of groundwater pumping on surface waters. The transient numerical model currently in development for the Treasure Valley[34] may be able to simulate such impacts.

[34] https://idwr.idaho.gov/water-data/projects/treasure-valley/

4 OPTIONS FOR EXPANDED MUNICIPAL SUPPLY

SUMMARY: Options for supplying projected increases in municipal water demand in the next 50 years include groundwater, water from the Snake River, water from the Boise River, and recycled water.

Municipal water demand is projected to increase by approximately 110,000 to 190,000 AF/yr in the coming decades. This increased demand could be realized in 30 or 40 years, or 60 years, or perhaps longer if population-growth rates moderate.

Fortunately, there are a number of options for supplying a growing municipal water demand. These options (in no particular order) include (1) groundwater from aquifers underlying the Treasure Valley, (2) water from the Snake River, (3) water from the Boise River (including water possibly made available through new upstream storage), and (4) reuse of treated municipal effluent.[35] These options—and approaches for developing them—are described in the following sections. In addition, aquifer storage and recovery (ASR), while not a water source in and of itself, could be included in a water-supply strategy, and is therefore included in the discussion below.

Some of the municipal water-supply options described below will be used to meet a portion of the anticipated increased municipal demand, while others could—at least theoretically—supply the entire amount needed. Some of the water-supply options lend themselves to incremental implementation by individual municipal suppliers, while others might be more appropriate for a coordinated, regional approach.

Three examples of potential water-supply mixes that could yield 110,000 to 190,000 AF for municipal uses are described in Section 11.1. Some of these water-supply options will be impacted by climate change (Section 10); demand- and supply-side water-planning considerations to address climate-change impacts are explored in Section 11.2.

[35] Water from the Payette River could also be a source of supply (water from the Payette River is currently pumped by Black Canyon Irrigation District to irrigate Treasure Valley land north of the Boise River). However, this report focuses on the Snake and Boise rivers as they lie within the Treasure Valley.

5 GROUNDWATER

SUMMARY: There is sufficient groundwater in Treasure Valley aquifers to supply at least a portion of the projected municipal water-demand increase. However, physical, administrative, and water-quality constraints likely will limit increased pumping in some portions of the Treasure Valley. As such, groundwater likely will not be the sole water source for meeting projected future municipal water demand.

5.1 Introduction

Groundwater is currently the primary municipal-water source in the valley. New wells and corresponding distribution infrastructure have met most of the historical growth in municipal water demand. Groundwater remains a viable source of additional municipal water supply in large parts of the Treasure Valley, based on simulations of increased withdrawals (Section 5.2) and stable groundwater-level trends (Section 5.3). However, groundwater supplies are limited in other parts of the valley (Section 5.4). Furthermore, various water-quality and administrative constraints may limit new groundwater development (Section 5.5), even in areas with sufficient physical supply. It is unlikely that groundwater alone can meet all of the projected annual 110,000 to 190,000 AF increase in municipal demand (Section 5.6). Later in this report we describe (1) potential infrastructure (Section 5.7) needed to meet a portion of the increased municipal demand and (2) an approach for developing additional groundwater (Section 5.8) for municipal uses.

5.2 Simulated Increased Withdrawals

A new computer model is being developed to simulate groundwater flow in Treasure Valley aquifers[36] but is not yet available for use. A previous model showed that valley aquifers would support broad increases in groundwater withdrawals (Petrich, 2004a; Petrich, 2004b).

Some (or much) of the previously-simulated increase in pumping[37] has been developed in the intervening years. It is instructive to review the impacts of the simulated pumping increases, to the extent that these simulated impacts apply to new, future withdrawals.

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[36] https://idwr.idaho.gov/water-data/projects/treasure-valley/

[37] One scenario described in Petrich (2004a, 2004b) was a 20% across-the-board increase over 1996 withdrawals, distributed spatially and depthwise to correspond with 1996 pumping (i.e., the scenario included, but was not specific to, the deeper aquifers from which most municipal pumping occurs).

The largest impact of the simulated 20% across-the-board production increase was borne directly or indirectly by the Boise River (Petrich, 2004a). The ultimate "sources" of water identified in the production-increase simulations included decreased discharge to drains (62%, almost all of which ultimately discharges to the Boise River below Star Bridge), increased leakage from the Boise River (23%, occurring both above and below Star Bridge),[38] decreased discharge to the Snake River (9%), increased leakage from Lake Lowell (3%), and decreased aquifer discharge to the Boise River (3%). In other words, increased groundwater pumping in the central part of the valley will mostly reduce discharge to drains, but a portion will increase seepage from, or reduce discharge to, the Boise River both upstream and downstream of Star Bridge. The timing of these impacts was not simulated, but most of these impacts, especially from deeper wells, will likely take months and years to propagate through the aquifer system.

The largest "source" of water for the simulated production increases, i.e., drains, continues to carry water to the Boise River. Some users have developed water rights based on the flow in these drains,[39] but steady flows from drains to the Boise River suggest that additional groundwater development is possible in areas with surface drains without broad impacts to regional groundwater levels.

5.3 Groundwater-Level Trends

Groundwater-level trends provide one indication of whether or not an aquifer has additional water available for appropriation (i.e., water available for additional withdrawals). Some groundwater-level decline is expected—and normal—in response to groundwater withdrawal from one or more wells.[40] However, it is also important that groundwater levels eventually stabilize.[41]

[38] The increased-pumping scenarios included increased withdrawals near the Boise River in areas that are now closed to new appropriations.

[39] Some of these rights are listed with a source of "wastewater," and as such, cannot be used to place a delivery call on upstream surface water or groundwater rights.

[40] Some amount of groundwater-level decline around a well (commonly referred to as "cone of depression") is needed to induce groundwater movement toward the well. Groundwater levels around a well (or a general pumping area) generally achieve a new equilibrium level after some period if groundwater diversions are matched by induced recharge or groundwater flow.

[41] "Stable" groundwater levels in this context refers to annual levels rather than seasonal fluctuations. Groundwater levels can fluctuate substantially (e.g., tens of feet, or even 100 feet in some areas) each year in response to seasonal or local pumping stresses, but are considered to be stable if the annual maximum level does not substnatially decline (or increase) over time.

Groundwater levels throughout much of the valley are relatively stable (Section 3.3.4), despite current withdrawals. Stable groundwater levels and known productive aquifers suggest that more groundwater can be extracted on a sustainable basis.

5.4 Groundwater-Limited Areas

Model simulations and steady groundwater-level trends notwithstanding, there are some areas of limited groundwater supply and areas in which IDWR will not process new water-right applications without some form of mitigation for impacts. These areas include the following:

1. Portions of the Boise Foothills consisting of granitic rocks (e.g., east of State Highway 16, which have limited groundwater supply.
2. The "Consolidated Cases" Study Area (Figure 11) of eastern Ada County and western Elmore County, withdrawals from which are limited by administrative order[42] to no more than 7,440 AF because of limited natural recharge.
3. The Southeast Boise Ground Water Management Area (GWMA); authorization for new groundwater diversions in this GWMA require full mitigation.
4. The "Basin 63 Restricted Area," which includes areas in which surface water and groundwater is tributary to the Boise River above Star Bridge, and in which mitigation is required for all new groundwater diversions from aquifers shallower than 200 feet below ground surface.[43,44]
5. The very southern portion of Ada County located within the Mountain Home GWMA and south of the "Consolidated Cases" study area; new appropriations in this area are unlikely without mitigation.

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[42] Final Order Regarding Water Sufficiency in the Matter of Application for Transfer No. 78356 (Shekinah Industries); Application for Transfer 78355 (Orchard Ranch; Application for Permit 63-32499 (Mayfield Townsite); Application for Permit 61-12095 (Nevid-Corder); Application for Permit 61-12096 (Nevid) Application for Permit 63-32703 (Orchard Ranch); Application for Permit 61-12256 (Intermountain Sewer and Water); Application for Permit 63-33344 (Ark Properties-Mayfield Townsite), November 4, 2013.

[43] Amended application processing memo No. 59, *Processing of Applications to Appropriate Water in the Lower Boise River Basin (Basin 63)* | *Application Processing Guidance Document #59* | *February 22, 2008 (idaho.gov)*.

[44] This "Basin 63 Restricted Area" could be expanded if drain discharge to the Boise River diminishes over time (see Section 3.2.3) and administration of diversions tributary to the Boise River below Star Bridge becomes more rigorous.

6. Deeper portions of the Treasure Valley aquifer system with groundwater having temperatures greater than 85°F.

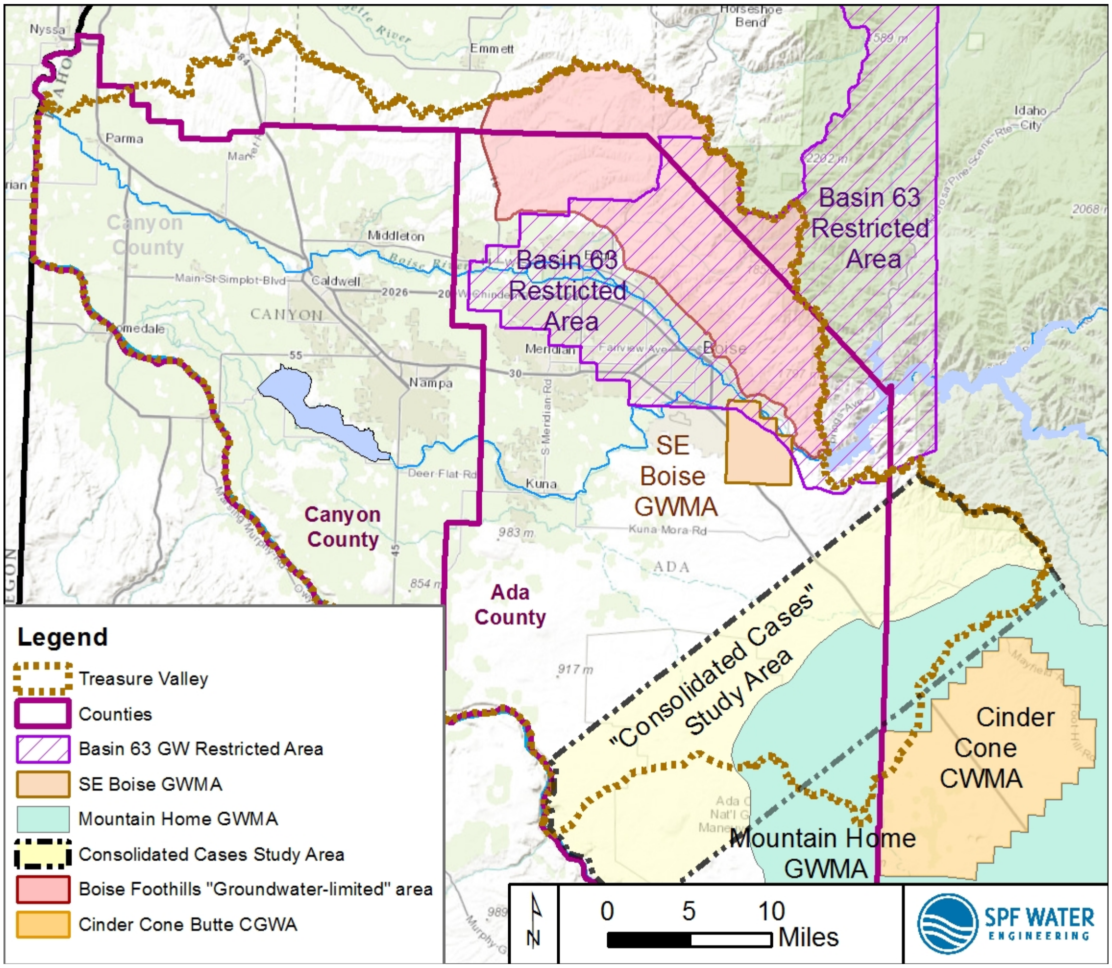

Figure 11. Water-limited areas.

5.5 Constraints to Groundwater Development

5.5.1 Water Quality

Water quality concerns may constrain groundwater development in some areas. Elevated concentrations of naturally occurring arsenic and uranium are present in some Treasure Valley groundwater. Similarly, elevated concentrations of nitrate have been documented in Treasure Valley aquifers, especially in shallow aquifer zones. The presence of these constituents is very site-dependent and typically depth-specific, but is not consistently associated with specific aquifer zones.

Sometimes, new municipal wells can be designed to avoid drawing water from aquifer zones with elevated arsenic, uranium, or nitrate (or other potential contaminants) concentrations. Treatment options are available for these constituents if they are unavoidable, but treatment can increase the cost of delivered water substantially.

5.5.2 Potential Impacts to Existing Users

Relatively stable groundwater levels in many areas and simulation results suggest potential for increased groundwater withdrawals. However, new withdrawals could impact existing groundwater or surface-water users, even if the physical supply is adequate. In the end, such new withdrawals could be found to not materially injure the senior user, or the impacts of new withdrawal could be mitigated, but the administrative process for resolving these concerns or the resulting mitigation requirements would add friction to the groundwater-development process.

Reduced flow in drains could lead to greater scrutiny of proposed (or existing) groundwater pumping, especially from shallow aquifers. Drain flows are arguably most sensitive to Boise River availability (more water in wet years, less in droughts) and upstream irrigation efficiency, but can also be influenced by groundwater pumping.

Aquifers discharging to flowing artesian wells, found primarily near the Boise River between Boise and Caldwell, have significant potential for additional groundwater development, but minor water-level declines can impact or eliminate artesian flows. Development of these groundwater sources may result in conflict with users relying on artesian flows. Similarly, areas with a large number of shallow domestic wells can be impacted by relatively modest water-level declines associated with groundwater development. In such cases, groundwater development might be constrained more by impacts to diversion systems of existing users than by the physical capacity of the aquifer to support additional development. However, such impacts to shallow wells—if they occur—could be mitigated by deepening shallow wells, by offering users relying on them access to a municipal water system, or by managed recharge.

5.5.3 Administrative Constraints

Administrative constraints may limit future groundwater development in areas where groundwater is currently available for appropriation. Such constraints could include prolonged protests or other administrative hurdles to obtaining new water rights.

For example, IDWR currently recognizes that surface water and groundwater in the Treasure Valley is hydraulically connected (directly or indirectly). However, at present and in general, Treasure Valley groundwater rights are not actively administered. Gaining approval for new appropriations could become more difficult (and more expensive) if IDWR were to begin broadly administering Treasure Valley groundwater rights.

Similarly, some Treasure Valley aquifer zones, especially at depth, may contain low-temperature geothermal water (defined as water in the bottom of a well having a temperature greater than 85°F, but less than 212°F).[45] Use of low-temperature geothermal water is limited to heating purposes (after which it can be put to another beneficial use).[46] Low-temperature geothermal water is thus not readily available for general municipal uses.

5.6 Possible Increased-Withdrawal Amounts

It is not possible to precisely (1) define the total volume of water held in Treasure Valley aquifers, (2) determine the amount of water that can be successfully appropriated,[47] or (3) project the volume of additional groundwater that can be sustainably pumped from Treasure Valley aquifers. Some parts of the valley clearly can support additional pumping; other areas can sustainably support more pumping but perhaps with lower (but stable) groundwater levels. The sustainable volume of increased pumping is partly a function of the physical aquifer capacity, but, at least in some areas, may also be a function of acceptable impacts to existing surface water and groundwater rights or other regulatory constraints.

Groundwater development in some areas may be constrained by water quality characteristics, such as elevated concentrations of (1) naturally-occurring arsenic, uranium, fluoride, iron, manganese, or hydrogen sulfide or (2) constituents associated with human activities (e.g., nitrate). There are treatment options for these constituents, but the treatment may or may not be cost-effective compared to alternative water-supply options (treatment is generally not required if the water is being used solely for irrigation).

There is very likely sufficient groundwater to support substantial additional groundwater withdrawals (depending on the distribution of new withdrawals in the valley, and in some areas, acceptable impacts). A reasonable expectation might be 20,000 AF or 40,000 AF, or perhaps even more. Assuming that about 200,000 AF or more of groundwater is currently pumped from Treasure Valley aquifers (see Section 3.3.4), a 20,000-AF or 40,000-AF withdrawal increase would represent a relatively modest valley-wide 10% to 20% pumping increase, respectively.

The ability of aquifers to support these additional withdrawals can be tested with the new USGS groundwater model currently in development. But ultimately the most

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[45] Idaho Code § 42-230(1).

[46] Idaho Code § 42-233 states that "Usage of a low-temperature geothermal resource primarily for reasons other than heat value is not a beneficial use of the resource, unless the director of the Department of Water Resources exempts the proposed use."

[47] Meaning the amount of water for which new water rights can successfully be obtained.

successful approach for new groundwater development likely will be the approach used in the past: (1) project local impacts of a proposed pumping based on hydrogeologic analysis, (2) begin withdrawals, and (3) monitor impacts of extended pumping on local groundwater levels.

Thus, the process of increasing municipal groundwater withdrawals is one of incremental development. Treasure Valley aquifers likely will support substantial increases in pumping (at least in some areas), but uncertainty about possible administrative constraints (and physical supply in some areas) limit long-term planning. It is therefore prudent to consider—and plan for—other sources of supply, which are described in subsequent sections.

5.7 Infrastructure/Conveyance Requirements

It could require between 55 and 110 new municipal wells to produce 20,000 AF and 40,000 AF per year (Table 3). This estimate is based on an assumed average uniform pumping rate of 450 gpm (1 cfs) per well (some wells will produce more than this amount, some will likely produce less) and an assumed average delivery season of 6 months (some of the new wells would likely supply water on a year-round basis, while other wells might be used solely for short-term peaking).

Number of Municipal Wells		
Parameter	**Volume**	
Target volume (AF/yr)	20,000	40,000
Assumed average delivery season	Apr 1 - Sept 30 (6 months)	
Assumed uniform pumping rate per well (gpm)	450	
Assumed uniform pumping rate per well (cfs)	1	
Number of wells required to produce volume at assumed uniform rate	55	110

Table 3. Hypothetical number of wells needed for increased groundwater withdrawals.

New Treasure Valley municipal wells likely will be located in areas of developing demand and available supply. These criteria would place many of the future new wells in the central and western portions of the Treasure Valley. In the area where groundwater flow has been deemed tributary to the Boise River below Lucky Peak Reservoir but above Star Bridge, wells supplying new consumptive uses would have to extend to depths of at least 200 feet below ground surface under current rules unless suitable mitigation was provided.

5.8 Groundwater Development Strategy

Groundwater will continue to supply a large portion of the municipal water demand. Groundwater provides flexibility: groundwater can be used to supply base demand over the course of the year, supply water for seasonal peaking requirements, and supply short-term peaking demand when other sources are unavailable.

The ultimate amount of additional groundwater that can be sustainably pumped from Treasure Valley aquifers is unknown. The approach for groundwater development that has been used in the past is one of incremental increases of groundwater withdrawals combined with monitoring of groundwater levels and drain flows. These monitoring data provide one of the best indications of whether there is additional water available for development on a local basis, whether groundwater pumping exceeds recharge rates, and whether groundwater pumping results in unacceptable decreases in aquifer discharge (i.e., drain flows) or groundwater levels.

6 SNAKE RIVER

SUMMARY: The Snake River has sufficient unappropriated water downstream of Swan Falls Dam and upstream of Weiser to satisfy the entire projected increase in municipal demand by 2065. Pumping water from the Snake River would involve substantial cost and time to plan and implement.

6.1 Introduction

The Snake River represents a reliable source of water for expanding Treasure Valley municipal needs. This section describes typical flows, a minimum streamflow constraint, and general infrastructure needed to divert and convey water from the Snake River to Treasure Valley core-use areas.

6.2 Snake River Flows

The Snake River forms the southern and western boundary of the Treasure Valley study area. The Snake River above Swan Falls Dam is administered to ensure sufficient flow for hydropower water rights at Swan Falls Dam and minimum stream flows[48] just downstream of Swan Falls Dam (Figure 12). Although water above Swan Falls Dam is available for appropriation at some times during the year, new diversions from the Snake River below Swan Falls Dam are much less constrained. Water below Swan Falls Dam is available for appropriation as long as the established minimum flow of 4,750 cfs at the Weiser gage[49] (Figure 12) is met.

The Snake River gains substantially between Swan Falls Dam[50] (Figure 13) and Weiser (Figure 14).[51] Typical streamflow at the Weiser gage has ranged from approximately

[48] Minimum streamflow rights 02-201 (which has a priority date of December 29, 1976), 02-223 and 02-224 (both of which have a July 1, 1985 priority date) are held by the Idaho Water Resource Board.

[49] Minimum streamflow water right 03-06, having a priority date of December 29, 1976, is held by the Idaho Water Resource Board.

[50] For purposes of water-rights administration, Snake River flows at Swan Falls Dam have been measured at the Murphy Gage, which is located approximately 4.2 miles downstream of Swan Falls Dam. A new gage has been installed between the Swan Falls Dam and the Murphy Gage, and will be used in the future for purposes of administration.

[51] The flows represented in these two figures and subsequent flow graphs represent the mean, minimum, or 20th percentile flows on a given day over the period of record (e.g., 1990-2021). They do not illustrate flows in any specific year.

9,300 cfs to 25,000 cfs since 1990. Since 1990, the average daily Snake River flow at Weiser, Idaho was below the minimum flow of 4,750 cfs only on 4 days in 1992.[52]

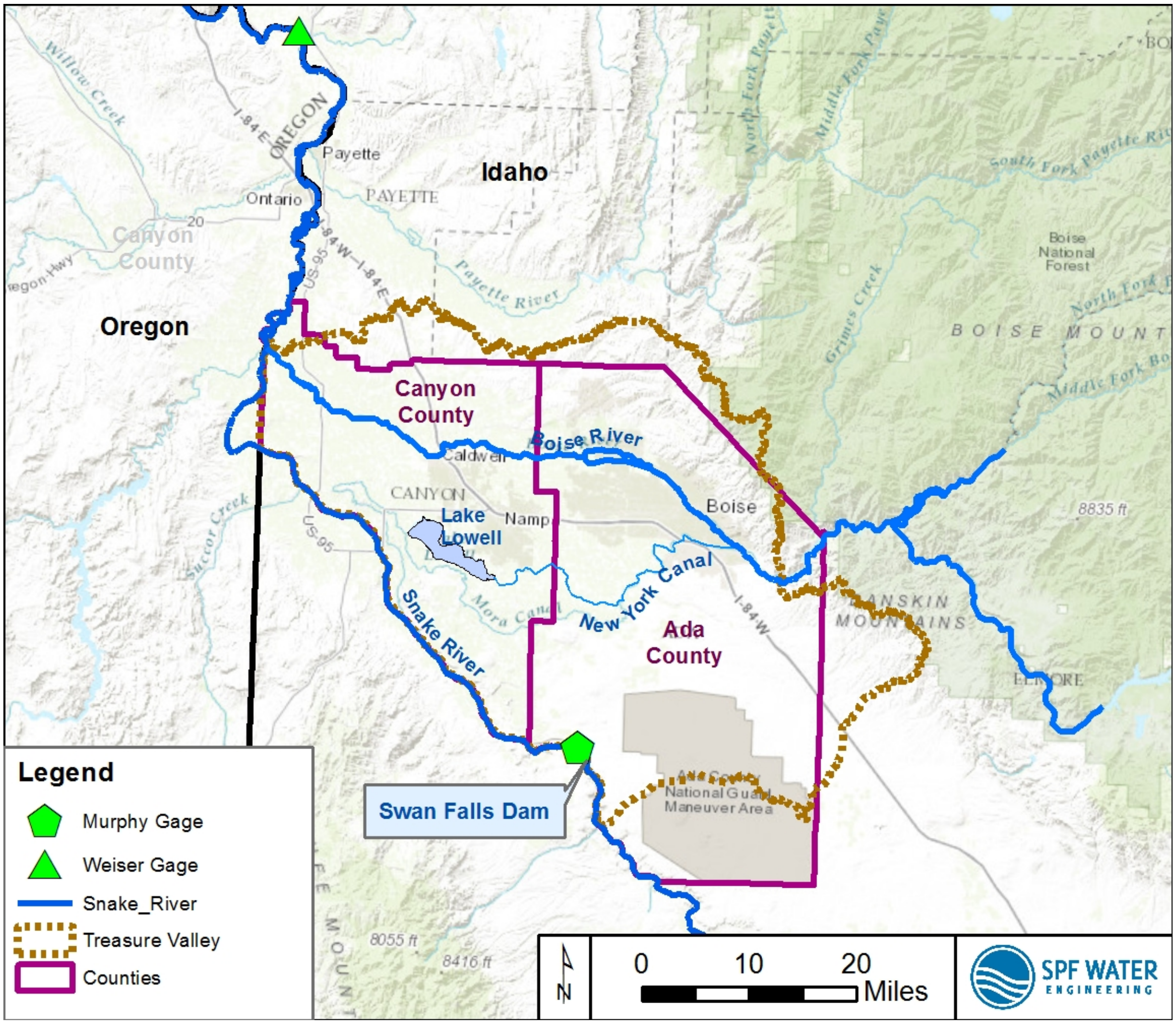

Figure 12. Snake River streamflow gages.

[52] Snake River flows at Weiser were recorded as less than 4,750 cfs on June 5, 6, 7, and 25, 1992.

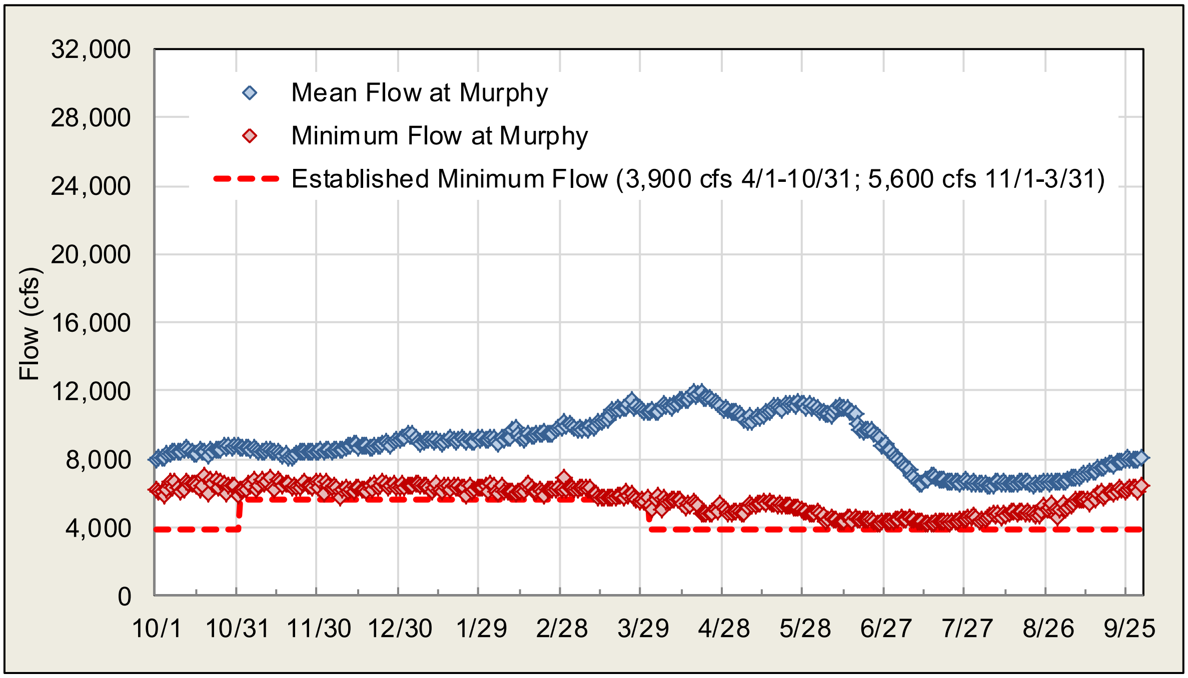

Figure 13. Snake River flows near Murphy, Idaho, water years (WY) 1990-2021 (USGS Gage Station 13172500).

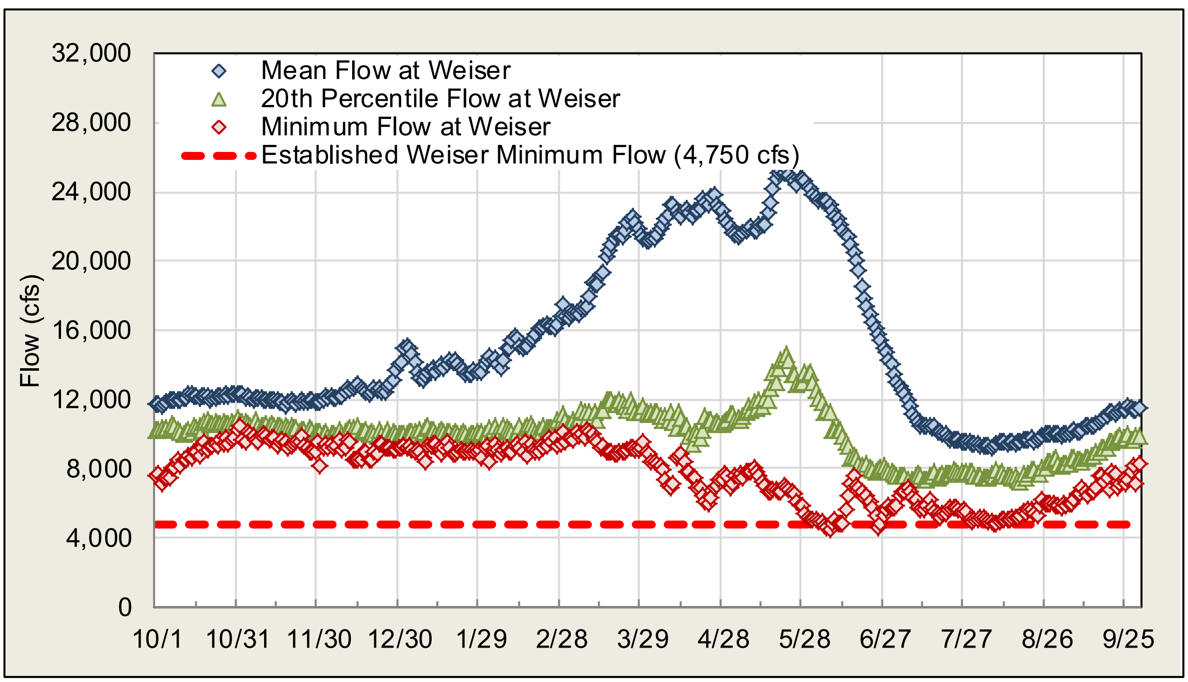

Figure 14. Snake River flows at Weiser, Idaho, WY 1990-2021 (USGS Gage Station 13269000).

Snake River diversions for Treasure Valley municipal purposes would be curtailed if the Snake River flow at Weiser drops below 4,750 cfs. Hypothetically, a continuous daily diversion of 210 cfs from the Snake River (which would yield 150,000 AF/year) would have been fully or partially curtailed on 16 days (all of which would have occurred between May 29 and August 23, 1992). A daily diversion of 84 cfs (which would yield 60,000 AF/year) would have been fully or partially curtailed on 9 days since 1990. In other words, if past flows are any indication of future flows, the Snake River below Swan Falls Dam likely represents a reliable municipal water supply.

6.3 Snake River Water-Supply Alternatives

Alternatives for diverting water from the Snake River for Treasure Valley DCMI uses include (1) diversions for direct use, (2) diversions to Lake Lowell or irrigation canals in exchange for Boise River water currently conveyed via the New York Canal to Lake Lowell, and (3) diversions for an ASR strategy.

First, diversions from the Snake River for direct use could be conveyed to Treasure Valley areas with DCMI demand. Examples might include conveying water to Kuna or South Boise (Figure 15). The water could be treated for potable purposes or used without treatment for DCMI irrigation purposes.

Another possible option (at least on a physical basis) would be to divert water from the Snake River and pump it to Lake Lowell (Figure 15) in exchange for water currently being delivered by the Boise Project to Lake Lowell from the Boise River via the New York Canal (diversions from the Boise River into the New York Canal occur at Diversion Dam east of Boise).[53] Such water could be used for urban irrigation[54] or potable uses (requiring treatment before entering a municipal water system). Similarly, it may be

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[53] The New York Canal is operated on a seasonal basis, and is used to convey water to irrigated lands during the irrigation season. The New York Canal may also convey water to Lake Lowell prior to or immediately following the primary irrigation season. Conceivably, water could be pumped from the Snake River to Lake Lowell on a year-round basis (as long as the minimum streamflow at the Weiser gage is met) in exchange for irrigation-season diversions from the New York Canal or Lake Lowell.

[54] For example, water currently diverted into the New York Canal (if exchanged for water pumped to Lake Lowell from the Snake River) could potentially be used for urban irrigation in non-potable systems throughout the Treasure Valley, including in areas that currently do not have appurtenant surface water (such as areas south of the New York Canal). This would require certain water-right actions, but would reduce the need to provide potable municipal water for irrigation in these areas.

possible to pump water from the Snake River to Lake Lowell in exchange for diversions from Lake Lowell for use in the growing cities of Nampa and Caldwell[55] (Figure 15).

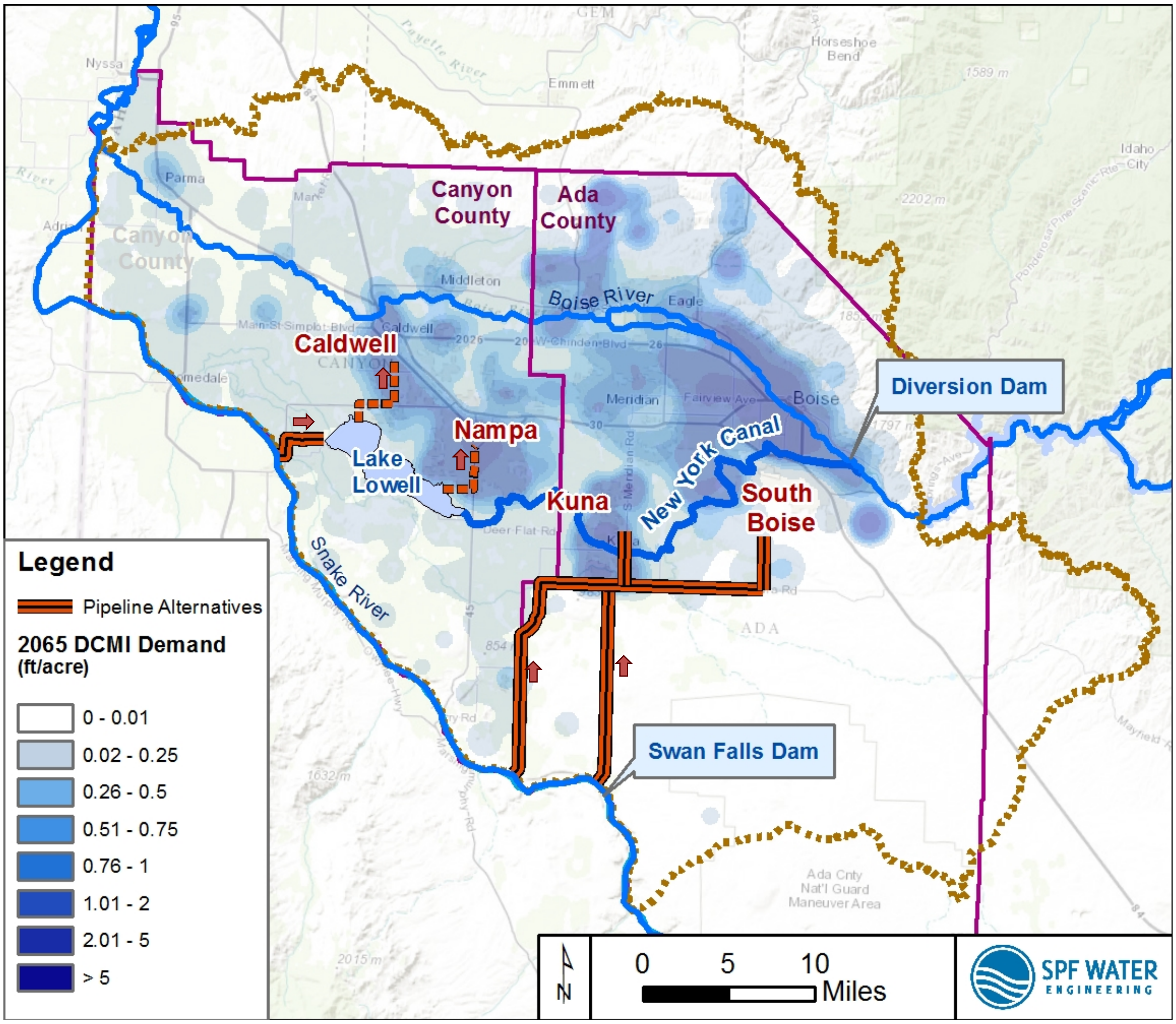


Figure 15. Conceptual Snake River conveyance alternatives.

Any such exchanges would require the cooperation of (1) the U.S. Bureau of Reclamation (USBR), which owns Diversion Dam, the New York Canal, and Lake

[55] However, such additional water supplies for the Caldwell and Nampa areas may be unnecessary because of abundant groundwater supplies and existing surface-water supplies.

Lowell, and (2) the Boise Project Board of Control (Boise Project), which operates these facilities, and (3) the irrigation districts that are supplied from these facilities.

Yet another potential option would be to use water diverted from the Snake River for ASR purposes. If, in the future, groundwater levels south of the Boise River experienced substantial declines in response to increased groundwater withdrawals, water could be pumped from the Snake River, treated, injected into selected aquifer zones, and stored for subsequent use (see also Section 9). Similarly, water could be pumped from the Snake River to lands currently irrigated with groundwater in exchange for groundwater that could then be pumped for municipal purposes.

6.4 Available Volume

Appropriations for new water rights authorizing diversions from the Snake River are available except during the occasional days during which the Snake River flows are less than established minimums at the Weiser gage. The Snake River could provide the entire 110,000 to 190,000 AF projected net DCMI demand increase, although doing so could be more expensive than other options, and likely is not necessary to fully supply the projected future demand. Groundwater will likely supply some of the increased demand, and the lower Boise River will be more accessible than the Snake River for some growing municipalities.

For example: a uniform diversion of 28 cfs would supply 20,000 AF over 12 months (Table 4); a uniform diversion of 56 cfs would provide the same volume over 6 months (i.e., irrigation season). For 60,000 AF/year, these rates would be 83 and 168 cfs, respectively. These rates could be sustained during all but the lowest of Snake River flows (i.e., when Snake River flows at Weiser fall below established minimums).

Snake River Diversion Rates					
Parameter	**Value**				
Target volume (AF/yr)	20,000	40,000	60,000	80,000	150,000
Uniform flow to deliver target volume over 365 days (cfs)	28	55	83	111	207
Uniform flow to deliver target volume over 180 days (cfs)	56	112	168	224	420

Table 4. Example Snake River diversion rates.

6.5 Infrastructure/Conveyance Requirements

Infrastructure requirements needed to develop a Snake River water supply for Treasure Valley municipal uses consist of diversion structures, conveyance pipelines, pumping stations, and treatment facilities. An intake pump station on the Snake River would require a forebay, screening, pumping facility, and power supply. Easements and rights-of-way would have to be acquired for much of the infrastructure. Any such project would involve significant costs and efforts to plan and implement.

Surface water used for potable DCMI purposes must be treated to drinking water standards established by the U.S. Environmental Protection Agency (EPA) and regulated by the Idaho Department of Environmental Quality (IDEQ). At a minimum, a water treatment facility would need to include filtration and disinfection processes. Water quality of the Snake River in this reach is generally amenable to treatment to drinking water standards and is currently used as a source of supply for the municipalities of Glenns Ferry and Weiser, Idaho, and Ontario, Oregon. For a scenario involving delivery of Snake River supply to Lake Lowell in exchange for water from the Boise River, the Snake River supply likely would not require treatment (although Boise River diversions for municipal uses mitigated by pumping Snake River water to Lake Lowell would also require treatment).

It may be possible to avoid treatment costs if water is pumped from the Snake River to replace irrigation currently done with groundwater. An equivalent amount of groundwater (which likely would require less treatment) could then be pumped to meet DCMI demands. This may be a more cost-effective approach that potentially avoids surface-water treatment requirements.

7 BOISE RIVER

SUMMARY: Water is available for appropriation from the Boise River below Star. Opportunities for new, large diversions from the Boise River upstream of Star are limited. Proposed increases in surface storage in the upper basin may provide opportunities for municipal use. Re-purposed water, potentially made available as irrigated farmland is developed, could contribute a substantial supply over the coming decades.

7.1 Introduction

The Boise River carries surface water through the area of greatest anticipated municipal-demand increase. Options for developing additional municipal water supplies from or via the Boise River include appropriation of flood releases (Section 7.2), new diversions downstream of Star (Section 7.3), increased surface storage (Section 0), short-term rentals from the Boise River Rental Pool (Section 7.5) or Idaho Water Supply Bank (Section 7.6), use of existing agricultural irrigation water (Section 7.7), or acquisition of existing rights (Section 7.8).

7.2 New Diversions Upstream of Star

The Boise River is closed to new appropriations above Star (Figure 1) except during times of high runoff, which typically occurs in the spring and early summer.[56] However, high-runoff conditions do not occur every year, and when they do, are typically of short duration. For example, flood control releases associated with flood flows occurred in 15 of the 27 years between 1989 and 2015 (Table 5 and Figure 16); no flood-control releases were made in 12 of those 27 years. The longest intervals with no flood-control releases were 3 years from 1990 through 1992 and 5 years from 2001 through 2005.[57]

[56] For the sake of this discussion, *high runoff* can consist of (1) *flood flows* or (2) *flood-control releases*. *Flood flows* can occur during periods of exceptionally high precipation or snow melt, and reflect runoff associated with natural conditions. *Flood-control releases* are the result of federal operation of upstream reservoirs: water is released to create space in upstream reservoirs for additional inflow. Idaho theoretically allows appropriation of both flood flows *and* flood-control releases, subject to availability and certain conditions to help ensure that upstream reservoir storage rights are protected.

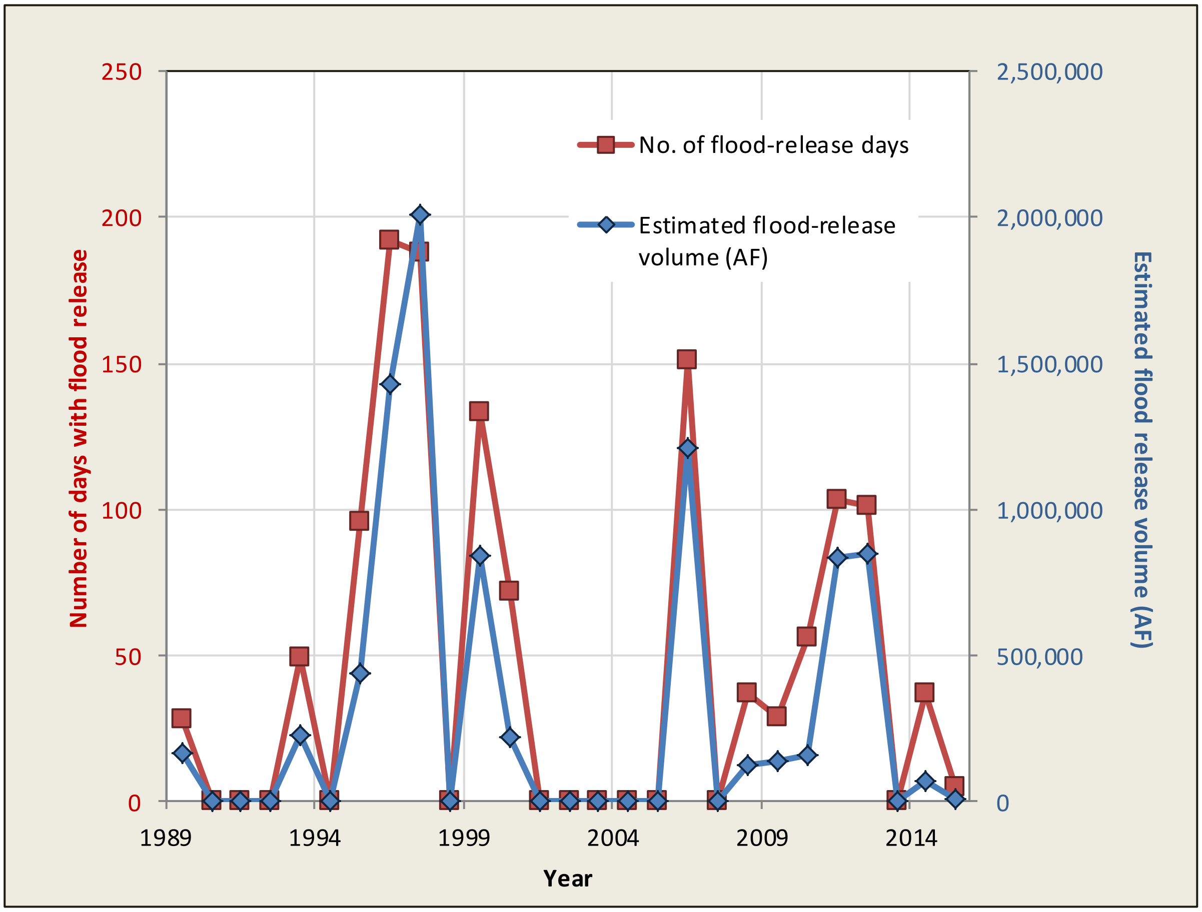
[57] While numerically based, analyses like this can be somewhat subjective in that the availability of unappropriated water depends on assumptions about the end of flood control, the time during which flood control releases occur, the degree to which “flood-control water” overlaps with water to be diverted under other rights or storage-release water (e.g., flow augmentation for the lower Snake River), etc. Nonetheless, the conclusions from analyses like this should be consistent: flood-water releases are available for limited periods of time and only in some years.

Boise River Flood Releases					
Year	No. of Flood Release Days	Estimated Flood Release Volume (AF)	Year	No. of Flood Release Days	Estimated Flood Release Volume (AF)
1989	28	162,776	2003	-	-
1990	-	-	2004	-	-
1991	-	-	2005	-	-
1992	-	-	2006	151	1,208,412
1993	49	226,651	2007	-	-
1994	-	-	2008	37	123,217
1995	96	435,033	2009	29	136,610
1996	192	1,428,408	2010	56	159,277
1997	188	2,009,143	2011	103	834,934
1998	-	-	2012	101	850,870
1999	133	840,457	2013	-	-
2000	72	218,732	2014	37	66,590
2001	-	-	2015	5	4,784
2002	-	-	Data prepared by Liz Cresto, IDWR		

Number of flood release days	
Average in years during which flood releases occurred:	85
Median in years during which flood releases occurred:	72
Estimated flood release volume (AF)	
Average in years during which flood releases occurred:	664,194
Median in years during which flood releases occurred:	435,033

Table 5. Boise River flood-control releases.[58]

[58] To calculate the "No. of flood release days" in Table 5, the start date of annual flood control releases were determined by IDWR staff by reviewing the Boise River flows at Middleton and historical IDWR water-rights accounting data. The end of the flood control releases was determined by USBR and IDWR staff. The "estimated flood-release volume (AF)" in Table 5 is based on the flow passing the Boise River Middleton gage during times of flood release less 250 cfs (because the Boise River is managed to maintain a flow of approximately 250 cfs at the Middleton gage for operational purposes and winter instream flow).



Based on data prepared by Liz Cresto, IDWR.

Figure 16. Boise River flood releases, 1989-2015.

As a result of the settlement of recent "refill" litigation, new appropriations of flood flows are limited, for all practical purposes, to the water released from the Boise River reservoirs for flood control.[59] Estimated minimum flood release volumes—when they did occur—ranged from 4,784 AF in 2015 (Table 5 and Figure 16) to over 2 million AF in 1997. The duration of flood releases (in years during which flood releases occurred) ranged from 5 days (in 2015) to 192 days (in 1996). The flood control season has begun as early as January, but most releases occur in March through May.

[59] Under the settlement, all existing rights (including those of municipal providers) are protected from "refill" by the Bureau of Reclamation. However, the Bureau received a new "refill" water right (subordinated to existing uses) that puts the Bureau ahead in priority of any post-settlement appropriations.

In 14 of the last 27 years, at least 66,590 AF could have been available over 28 days (Table 5). A diversion rate to deliver this volume over 28 days would be approximately 1,200 cfs. A diversion rate to deliver a lesser volume (e.g., 5,000 AF) during 28 days would be 90 cfs. Flood releases occurred for more than 49 days in 10 years and more than 100 days in 6 years between 1989 and 2015. A diversion of 90 cfs for 49 days and 100 days would yield 8,750 AF and 17,850 AF, respectively.

While Boise River flows may be available for appropriation during times of flood releases, such releases do not occur on an annual basis. Thus, diversion of Boise River water during times of flood releases might be most appropriate to serve existing infrastructure (using, for example, the Veolia Marden and Columbia treatment plants). Substantial new infrastructure used only during a small portion of a year, and not in every year, may not be cost-effective.

A modest portion of flood-release diversions might be used for early-season (i.e., pre-June) municipal irrigation, thus "saving" groundwater for later use. Diversions could be used for the irrigation of large open areas such as parks, school grounds, etc., but many open areas near the river are already irrigated by surface water or groundwater. The irrigation of new large open areas constructed away from the Boise River could require substantial conveyance infrastructure.

Another possible use for diversions during flood releases would be for a managed-recharge strategy. Such a strategy (see Section 9 below) would, essentially, enable storing flood-release water for use during other times of the year. However, such a strategy would also be constrained by infrastructure costs for conveyance, treatment, and injection (unless suitable recharge sites could be identified within the proximity of existing facilities, such as canal systems). Infrastructure to divert and deliver flood-release water for managed recharge likely would stand unused in years during which flood releases do not occur. Other water-supply options may be more cost-effective and operationally simple.

Finally, two additional upstream surface-water-storage facilities have been proposed in the upper Boise River basin (see Section 7.4). Filling new storage capacity in these (and perhaps additional) facilities will reduce the volume and frequency of future flood releases below Lucky Peak Dam, although the additional stored water may be available to supply future municipal demand.

7.3 New Boise River Diversions Downstream of Star

Flows in the Boise River are generally available for appropriation downstream of Star. September through April flows at the USGS Middleton Gage[60] (located downstream of,

[60] USGS Station #13210050 (for which data are not available after 2013).

but near, Star) are typically about 250 cfs[61] (see "mean flows," Figure 17). By comparison, average Boise River flows at the Parma gage[62] (located further downstream of Star, nearer to the mouth of the Boise River (Figure 1), are typically *at least* 700 cfs year-round, and generally well over 1,000 cfs from January through June each year. Even 20th percentile flows (flows which are exceeded 80% of the time) are typically above 400 cfs near Parma.

Greater Boise River flows at Parma than at Middleton reflect tributary inflows and discharge from agricultural drains. Typical gains during the winter months are often over 400 cfs. IDWR estimated an annual average of about 332,000 AF returning to the Boise River between 2016 and 2020.[63]

Thus, it appears that most if not all the 110,000- to 190,000-AF of projected additional municipal demand could be diverted, if necessary, from the Boise River downstream of Star, particularly near its mouth (a uniform diversion of 210 cfs would yield an annual volume of 100,000 AF). However, diversions could be constrained during times of very low flows (Figure 17) or when Snake River flows at Weiser fall below the 4,750 cfs minimum flow (see Section 6.2).

Availability of lower Boise River surface water could also be constrained if there are changes in the administrative framework. Currently, upper reaches of the Boise River (i.e., above Star Bridge) are administered differently than the reach below Star Bridge. Reduced drain flows above and below Star Bridge (or general low-water conditions) could lead to changes in the way the lower reach is administered—perhaps resulting in reduced ability to appropriate water or portions of the lower reach.

Infrastructure needed for new diversions downstream of Star, including intake structures, treatment facilities, pumping facilities, and conveyance pipelines, would be like that described for the Snake River (Section 6.5). For example, an intake structure could be located between Caldwell and Parma, and as need grows, an additional intake structure could theoretically be built downstream to capture more flow. The pipeline would be aligned to deliver water to areas of greatest projected need (Figure 18).

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[61] Median flows at the Middleton Gage are higher during spring runoff and portions of the irrigation season.

[62] USGS Station #13213000.

[63] Based on measurements in Indian Creek, Dixie Drain, Mason Creek, Middleton Drain (Mill Slough), Fifteenmile Creek (which also collects flow from Fivemile and Tenmile creeks), Hartley Gulch, Conway Gulch, and Eagle Drain. These drain-discharge estimates are conservative because there are additional drain flows in unmeasured drains.

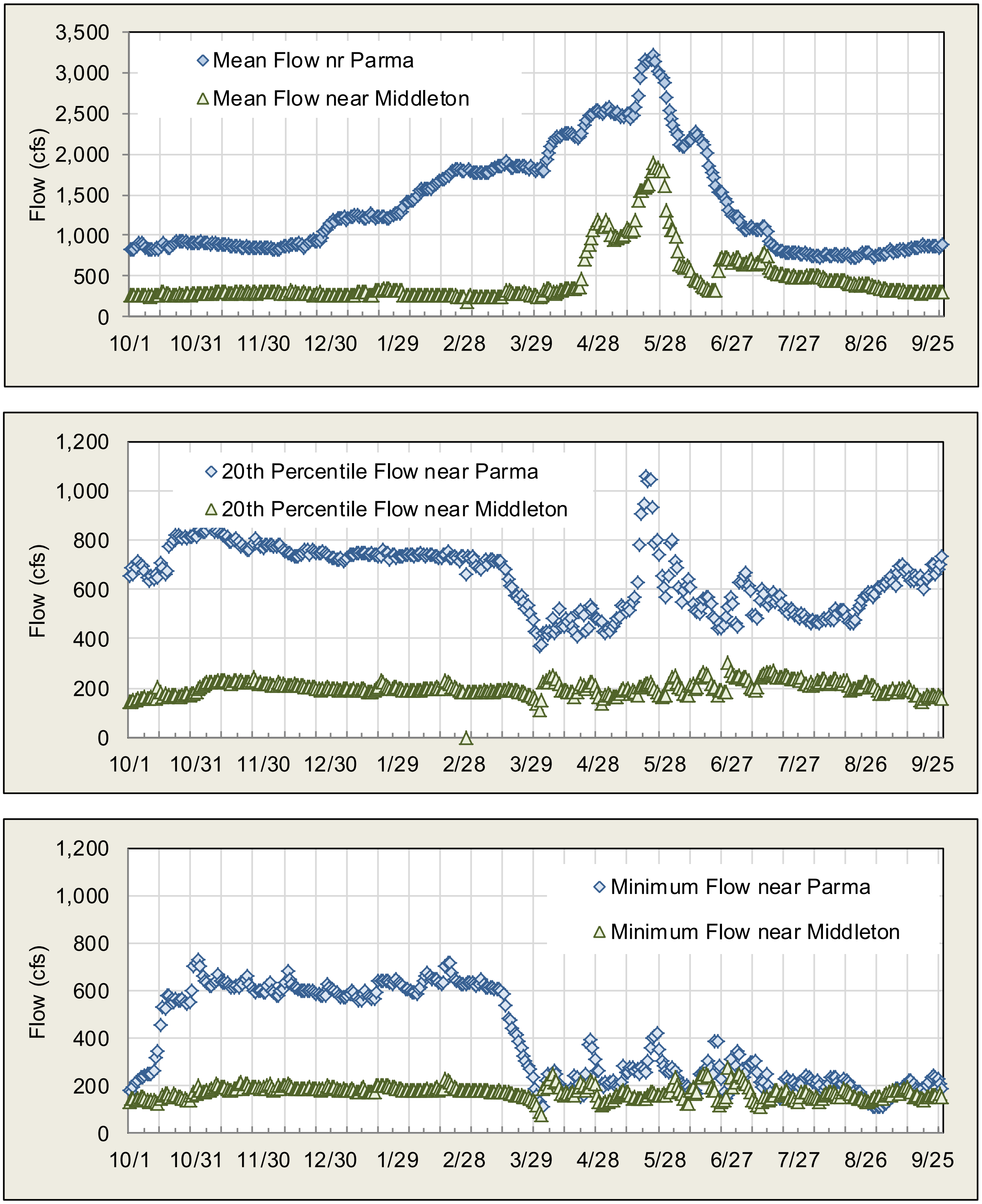

Figure 17. Mean, 20th percentile, and minimum Boise River flows near Middleton and Parma, water years 1991-2013.

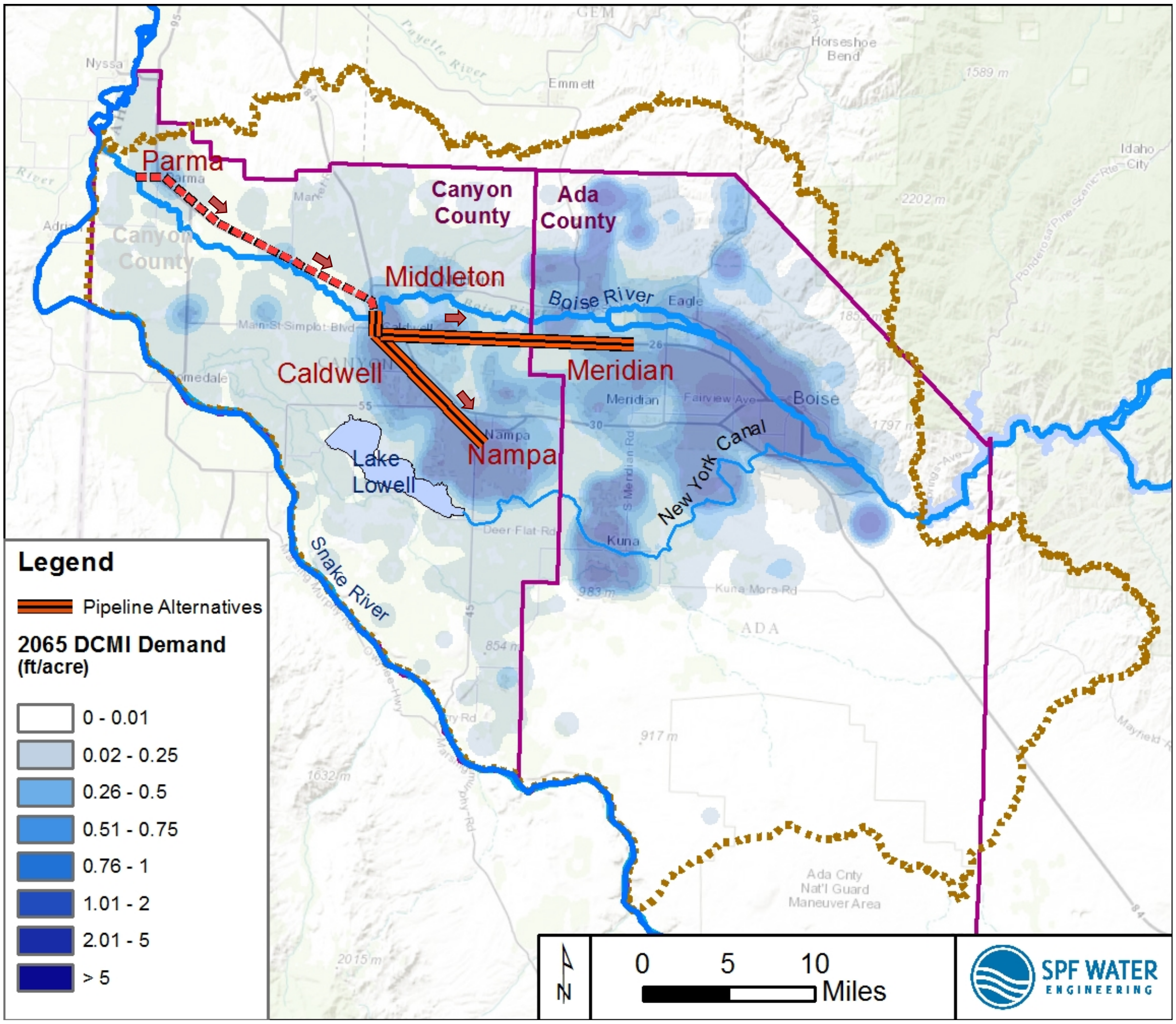

Figure 18. Conceptual Boise River conveyance alternatives.

Finally, because the Boise River flows into the Snake River upstream of Weiser, new diversions from the lower Boise River would be constrained if the Snake River flows at the Weiser gage fall below established minimum flows (see Section 6.2). Municipal providers would need to rely on groundwater (or other sources) during brief periods during which Snake River flows are less than established minimums at Weiser.

7.4 Surface Storage

Unappropriated Boise River flood flows could be captured in new above-ground storage facilities. Two new surface storage projects are proposed to capture Boise River flood flows: (1) a USBR proposal to raise Anderson Ranch Dam by 6 feet to create an additional 29,000 AF of storage[64] and (2) a roughly 100,000 AF pumped-storage hydropower project located in and above Anderson Ranch Reservoir (proposed by Cat Creek Energy). While the Cat Creek Energy proposal[65] is primarily intended as a pumped-storage hydropower project, the project developer has proposed to make some of its storage available for other uses, including municipal use.[66] As of this writing, water right permit applications for the Cat Creek Energy project are being processed by IDWR.[67]

A recent USBR feasibility study concluded that the benefits of raising Anderson Ranch Dam by 6 feet (increasing storage by 29,000 AF) are greater than the costs. The USBR study concluded that an average of 9,918 AF of the increased 29,000-AF storage volume would be available for DCMI uses every year (USBR, 2020).[68] However, the actual volume dedicated to municipal storage has not yet been determined. This will depend, in part, on the actual cost of the Anderson Ranch Dam raise. While IWRB has signed an agreement that binds the State for project completion (contingent on the USBR meeting certain conditions and IWRB's approval of final construction cost estimates), the cost of new storage will be borne by users. Thus, allocation of storage to municipal use will depend on the willingness of municipal providers to pay for portions of the increased storage.

Some storage may be available to Treasure Valley municipal suppliers in an Anderson Dam raise or Cat Creek Energy project. However, storage from these projects could contribute only a modest portion of the 110,000 to 190,000 AF/yr projected additional Treasure Valley municipal demand; other water-supply sources will be needed as well.

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[64] The "average annual delivery" or "average annual water availability" for the 29,000-AF storage increase was projected to be 11,020 AF (USBR, 2020). This is based on a 38% refill probability that was calculated taking into account basin hydrology and senior water rights, permits, and applications (including applications by Elmore County and Cat Creek Energy). In essence, the proposed 29,000-AF storage is projected to fill in some—but certainly not all—years.

[65] Idaho Department of Water Resources Applications for Permit 63-34403, 63-34652, 63-34897, and 63-34900.

[66] The primary goal for Cat Creek Energy's project is to create a pump-back storage reservoir. Water would be pumped from Anderson Ranch Reservoir to an upper reservoir as a form of energy storage. It is unclear from the applications how much of the proposed 100,000 AF storage ultimately would be available for municipal uses, and if so, how often and under what conditions it would be available.

[67] Numerous protests have been filed against this application that have not yet been resolved.

[68] According to IWRB member Al Barker (personal communication, April 26, 2022), this number should not be viewed as a cap; new municipal storage as a result of an Anderson Dam raise could be substantially higher than 9,918 AF.

7.5 Rental Pool

The Boise River Rental Pool provides a mechanism for renting storage allocations in Anderson Ranch, Arrowrock, Lucky Peak, and Lake Lowell reservoirs. The Rental Pool approves temporary leases to, and rentals of storage water from, these reservoirs for a period of up to 5 years. In 2021, the rental rate for storage water was $20/AF.[69]

Of the 1,109,065 AF stored in these four reservoirs, 68,606 AF (6.2% of the total storage) were leased into and rented from the rental pool in 2019.[70] Of this amount, 63,522 AF was storage water contracted by USBR for lower Snake River flow augmentation[71] (the remaining 5,096 AF were contracted for in-basin uses). Storage for "out of basin uses" (e.g., downstream flow augmentation for salmon and steelhead listed under the federal Endangered Species Act) is considered "last to fill," meaning this volume may not be available if the reservoirs are not fully filled at the start of the irrigation season.

The upper Boise River basin reservoirs are operated such that storage holders can carry over storage from one year to the next. Especially during dry cycles, most storage holders are conservative about placing water in the rental pool, opting to carry it over rather than be caught short in a subsequent dry year.[72]

Because of the current short-term nature of rental pool leases, availability uncertainty, allocation of storage water for fish-flow augmentation, and the relatively small amounts of water leased into the rental pool, the rental pool water currently is not a good source for meeting a large portion of the increasing, long-term municipal water demand. However, leasing water into the rental pool is partly a function of demand. A greater financial incentive (e.g., higher lease rate) might increase the amount of water made available through the rental pool. A water user (e.g., a municipal provider) might justify paying substantially more for rental-pool water if the cost of doing so is less than that of other water-supply options.

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[69] https://idwr.idaho.gov/iwrb/programs/water-supply-bank/pricing/

[70] Idaho Water Supply Bank 209 Rental Pools Report (https://idwr.idaho.gov/wp-content/uploads/sites/2/water-supply-bank/2019-rental-pool-report.pdf)

[71] Salmon flow augmentation is conducted pursuant to the 2004 Nez Perce Settlement and the 2008 Upper Snake Biological Opinion, and is enabled by IC § 42-1763B. The current term of this "Snake River Flow Component" of the Nez Perce Settlement is 30 years, or until 12/31/2034.

[72] *Report on Canal Deliveries from Boise River and Different Features Affecting These Deliveries for the Irrigation Season 2020*, prepared by Rex Barrie, Watermaster, Boise River (retired end of 2021).

7.6 Water Bank

The Idaho Water Supply Bank is a water exchange operated by the IWRB. Similar to the rental pool, the Water Supply Bank allows water-right holders to lease water rights to the bank (if not currently in use) and allows other water users to rent the water rights for authorized beneficial uses.

At the time of this writing, there are 151 Basin 63 water rights leased to the water supply bank, of which 8 authorize diversions for irrigation with water from the Boise River. A cursory review indicates that these rights authorize an aggregate diversion of approximately 23.84 cfs. This amount, if for primary (not supplemental) irrigation and if not seasonally curtailed, would be sufficient for the irrigation of 1,133.6 acres. At 4.5 feet per acre, these rights might authorize a maximum diversion volume of approximately 5,101 AF. However, the actual volume for municipal use would be less than this amount if IDWR allows only the consumptive use to be delivered to municipal systems. Furthermore, some of the water rights are curtailed in typical water years because of relatively junior priority dates, which further reduces the amount of water potentially available from these rights.

The water supply bank represents an option for short-term rentals, but does not represent a large-scale, long-term water-supply solution for growing municipal demand. However, leases into the water supply bank may yield clues about water rights possibly available for acquisition.

7.7 Currently Appropriated Agricultural Irrigation Water

In 2016, surface-water rights authorized diversions from the Boise River to irrigate approximately 325,000 acres in the Treasure Valley.[73] Assuming an average diversion of about 4.5 AF/acre and 4-AF/acre headgate delivery, Boise River diversions to irrigate the 325,000 acres ranged from about 1.3 to 1.5 million acre feet. Further assuming a consumptive use of about 2.5 feet of water per acre, the total consumptive use associated with this irrigation might have been about 800,000 AF/year (with rounding).[74]

Given past and current development trends, we can expect to see more Treasure Valley irrigated farmland covered by commercial buildings, houses, roads, sidewalks, and other impermeable surfaces in the coming years. About 40-60% of formerly-irrigated

[73] Rex Barrie, Boise River Watermaster, *personal communication*, August 29, 2016.

[74] Additional water is delivered to the Treasure Valley north of the Boise River from the Payette River via the Black Canyon Irrigation District.

farmland converted to a 4-5 unit per acre subdivision typically remain irrigable,[75] the balance of the land becoming an impermeable surface and therefore non-irrigable. A substantial portion of the irrigation water previously applied to land that becomes non-irrigable could be re-purposed for irrigation elsewhere or other uses.

The volume of water dedicated to land that becomes non-irrigable in the course of development could be substantial. If, for example, 25% of currently-irrigated agricultural land becomes impermeable (and therefore non-irrigable) as a result of development by 2065, the reduction in irrigated acres could theoretically yield up to about 200,000 AF[76] of water.

However, it unlikely that *all* of the 200,000 AF would become available for irrigation elsewhere or for other uses, for several reasons. First, urban turf on remaining irrigated ground may require more water than some of the previous agricultural crops, such as grains. Second, urban irrigation may be less efficient than some forms of agricultural irrigation. Third, the irrigation season for urban landscaping may start earlier and last longer than for some agricultural crops, with no time out for harvest. Thus, remaining irrigated urban acres may use more water on a per-acre basis than previous agricultural ground.

Historically in the Treasure Valley, the amount of water becoming available as a result of urbanization has been limited. In addition to the reasons listed above, water dedicated to now-impermeable land has been used to help meet urban irrigation-demand variability. Water for agricultural irrigation is typically delivered on a relatively uniform basis over a 24-hour period, and most of the water delivered through a canal, lateral, or ditch headgate is applied as irrigation. Urban residents, in contrast, often seek to irrigate mostly during night and early morning hours, effectively reducing urban irrigation to between 8 and 12 hours per day. This leads to greater irrigation-demand variability. Lacking storage facilities (e.g., regulating ponds), it can be challenging for irrigation entities to meet this variable residential-irrigation demand with canals, laterals, and ditches that operate most efficiently with uniform flow.

Some Treasure Valley irrigation entities satisfy residential irrigation-demand peaks by delivering a continuous stream of water based on pre-development irrigated acreage (i.e., "gross acres") rather than post-development irrigable acres (i.e., "net acres"). Water delivered in a surface channel to a pressurized urban irrigation system in excess of *actual* instantaneous demand (such as in late afternoon when residential irrigation

[75] The actual post-development irrigable area depends on multiple factors, including density, home sizes, street sizes, etc. The percentage of remaining irrigable land could be less than 40%, but probably not much more than 60%.

[76] 25% of an 800,000-AF/yr consumptive use would be about 200,000 AF.

demand is less than at other times) remains unused in a delivery channel, flowing from the delivery system as wastewater. Some of this wastewater may be diverted by downstream water users connected to the same canal, lateral, ditch, or drain system. Undiverted water returns to the Boise River, primarily below Star. Return flows in the Boise River not diverted by irrigators below Star leave the basin.

Delivering an appropriate quantity of water for net irrigable acres served by a residential non-potable pressurized irrigation system would require reductions in demand variability for urban irrigation water. Ways of doing this include (1) tighter residential-irrigation rotation schedules to reduce demand peaks, (2) local storage facilities (e.g., ponds, tanks) to help meet peak demands, (3) construction of supplemental wells to help meet demand peaks, and (4) delivery-system automation (to better tailor deliveries to demand). Implementing strategies to reduce water deliveries to residential pressurized irrigation systems[77]—while delivering the full amount of water needed to meet irrigation requirements on remaining irrigable ground—would free up water that could be re-purposed to irrigation elsewhere or other uses.

Re-purposed agricultural irrigation water made available through market-based solutions could represent a major—and perhaps one of the less expensive—sources of supply for a growing municipal demand. Re-purposed irrigation water could be used for new urban irrigation delivered via non-potable pressurized irrigation systems to residential or commercial areas within irrigation entities' current or modified permissible places of use,[78] or other areas served by private water-delivery associations (e.g., homeowner associations) or municipal providers.[79] Doing so would reduce the amount of potable water that a municipal provider would otherwise need to supply.

Irrigation entities could theoretically also make water available directly or indirectly to municipal suppliers for potable uses. Delivering re-purposed irrigation water for municipal uses would likely (1) require a water-right transfer to change the nature of use (from irrigation to municipal use and season of use) and (2) require changes to federal

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[77] Some have suggested that reducing surface-water deliveries in some areas commensurate with reductions in irrigated area could lead to less incidental infiltration and perhaps eventually lower groundwater levels. Although a valid concern, the alternative is to maintain an inefficient surface-water delivery system simply to maintain groundwater levels that are arguably high as a result of irrigation activities. A likely more efficient alternative would be to conduct targeted ASR in areas impacted by reduced surface infiltration, if and when needed.

[78] The terms *permissible place of use* and *place of use* are elements of a water right describing the area within which beneficial use (e.g., irrigation) is authorized.

[79] Delivering water outside of a delivery entity's current permissible place of use would require water right modifications (to change the permissible place of use).

contracts (not a trivial task) under which water is stored or delivered via federal facilities (e.g., reservoirs).

If only 25% of the valley's irrigated agricultural lands becomes impermeable by 2065 (as per the example suggested above), water from previously irrigated but now impermeable land could satisfy a substantial portion of the 110,000 to 190,000 AF of additional municipal demand projected for 2065. Doing so would cost money for delivery- and irrigation-system modifications (to reduce demand variability, for instance), but irrigation entities could generate additional revenues by delivering re-purposed water for other uses (including municipal uses), thereby defraying the cost of delivery-system improvements. It is conceivable that some stakeholders (such as cities or municipal providers) could help fund such improvements. It is also conceivable that over the next 50 years, some irrigation entities become direct or indirect municipal providers, supplying potable and non-potable water to customers for municipal uses.[80]

Re-purposing surface water associated with land that has become non-irrigable in newly-urbanizing areas is not easy, but arguably is easier than in already-urbanized areas. In existing subdivisions, irrigation infrastructure has been built, irrigation patterns have been established, and land may not be available for irrigation-storage ponds or supplemental wells. Modifying irrigation practices in existing urban areas would involve many players (irrigation entities, homeowners, homeowner associations, municipal providers, etc.) and would be highly incremental (perhaps only yielding water from one commercial area or neighborhood at a time).

In contrast, new subdivisions and commercial areas represent prime opportunities for re-purposing irrigation water (to be used for irrigation elsewhere in an irrigation entity's service area or other uses). Cities and counties (or developers) could begin by quantifying pre- and post-development irrigable acres as part of the planning and zoning approval process for new subdivisions and commercial areas. This information could help irrigation entities identify water that could (1) be moved to other areas within their permissible place of use or (2) possibly become available for other uses as re-purposed water. [81]

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[80] For example, the Salt River Project in Arizona delivers non-potable and potable water for agricultural and urban customers in the general Phoenix area.

[81] It may also be possible to convey all water from some new surface-water irrigated development lands to municipal suppliers via irrigation-entity assessments or shares. The municipal supplier would then deliver potable water for both irrigation and domestic purposes to those same new developments. Municipal systems, with peaking wells and storage reservoirs, can efficiently supply water to meet hourly variations in demand. And the higher cost of municipal water is an effective tool to promote conservation, driving down water use when compared to developments served by low-cost non-potable pressure irrigation.

Similarly, the land-use planning process could lend itself to encouraging (1) the use of drought-tolerant landscaping to reduce irrigation demand on remaining irrigable acres, (2) installation of delivery systems that reduce local demand peaks and reduce demand variability, (3) efficient irrigation systems and practices, and (4) irrigation rotation schedules to reduce subdivision-scale demand variability. Maintenance access and safety challenges faced by surface-water delivery entities in urbanizing areas could become part of this cooperative surface-water efficiency planning effort.

There is no guarantee that re-purposed irrigation water identified through the process described above would become available for municipal use—the water right holders may seek to use re-purposed irrigation water for new irrigation elsewhere within (or even outside of) their currently-authorized places of use. Also, there could be administrative hurdles to using re-purposed water in a municipal system, such as changing authorized place of use, points of diversion, and/or nature of use of the water rights.[82] However, *not* taking steps to identify impermeable surfaces on formerly irrigated ground, reducing irrigation demand with drought-tolerant landscaping, and reducing demand variability precludes—or at least makes much more challenging—tapping re-purposed water for municipal use in the future. This is important, given that the Treasure Valley population is projected to more than double in the next 50 years and, as we have seen, much of the residential, commercial, and industrial growth replaces formerly-irrigated agricultural ground.

The precise amount of agricultural irrigation water available for re-purposing is unclear. But this much *is* clear: there is a large amount of water diverted from the Boise River for irrigation purposes, and the irrigable area in urban settings (e.g., residential developments) is less than formerly-irrigated agricultural fields. The amount of agricultural irrigation water available for re-purposing will depend on the degree to which institutional, legal, and regulatory concerns can be addressed, but conceivably could provide a substantial portion of the projected municipal demand at a lower cost than some other options. Development of re-purposed surface water as a municipal source begins with tracking changes to irrigable ground and taking measures to improve urban irrigation efficiency and reduce neighborhood demand peaks.

[82] Other regulatory or adminstrative hurdles to re-purposing irrigation water for municipal uses include complying with federal storage contracts, meeting administrative criteria to prevent “water spreading,” making water right places-of-use consistent with municipal service areas, ensuring that an irrigation entity’s existing obligations to its patrons are met, addressing possible changes in existing delivery entity bylaws, etc.

7.8 Acquisition of Existing Rights

Municipal water providers may be able to purchase existing Treasure Valley groundwater or surface water rights on a willing buyer/willing seller basis. Acquiring existing water rights likely will require a transfer to change the place of use, point of diversion, and/or nature of use[83] (a change in the nature of use will be required to use an irrigation right for general DCMI purposes). A transfer may be constrained by the history of beneficial use, conditions listed in the water right being acquired, transfer protests, or new conditions placed on the right during the transfer process.

The availability of senior-priority surface water rights for acquisition have historically been—and likely will continue to be—quite limited. Sellers would likely be private owners (which represent a very small percentage of Boise River water rights) more than irrigation districts and canal companies. As such, it is difficult to predict what portion of the projected municipal demand increase (110,000 to 190,000 AF) will be met by the acquisition of existing rights, but it will likely not be a substantial amount.

[83] These administrative issues are similar to those associated with leasing, renting, or purchasing "re-purposed" agricultural irrigation water described above in Section 7.7.

8 REUSE

SUMMARY: Treated wastewater could supply a substantial amount of future municipal demand, likely for irrigation and industrial uses. Recycled water (with appropriate treatment) might also be used for managed aquifer recharge.

8.1 Introduction

Municipal providers delivered approximately 50,000 AF for potable indoor uses in 2015. This amount could increase to approximately 120,000 AF/year by 2065 (SPF, 2016). Most of this water (90-95% or more) becomes wastewater, and is collected and treated in municipal wastewater facilities, and ultimately discharged to the Boise River or its tributaries. A small portion of treated effluent is currently used for DCMI irrigation. As DCMI demands increase, a greater amount of treated effluent could be used for irrigation or other DCMI purposes in the future.

8.2 Water Reuse in the United States

Water reuse for DCMI purposes in the United States continues to increase, especially in the arid southwest. Historically, reclaimed water has been used for large-scale landscaping, agriculture, industrial processes (such as for cooling systems), and groundwater recharge. In the future, water reuse may increasingly be used for small-scale landscaping irrigation, vehicle washing, toilet flushing, and other commercial uses.

Reuse is most common where water demand is high and water supplies are scarce, such as parts of California, Arizona, Texas, Nevada, and portions of the southeastern United States, where less costly sources of water may not be available. In the Treasure Valley, reuse is sometimes driven not by the demand for municipal water but as a way of meeting Idaho Pollutant Discharge Elimination System (IPDES) requirements.

Currently the most prevalent type of reuse is land application of treated effluent for agricultural purposes. There are three general types of DCMI reuse (Table 6): (1) non-potable reuse (NPR), (2) indirect potable reuse (IPR), and (3) direct potable reuse (DPR).

NPR is by far the most common type of DCMI reuse and involves reclamation of wastewater for non-potable uses such as residential or municipal irrigation and industrial or commercial uses such as cooling water supply. NPR is frequently used for irrigation of larger municipal areas such as parks, golf courses, cemeteries, and roadside or median strip landscaping. NPR is the only type of DCMI reuse currently practiced in the State of Idaho.

IPR involves releasing treated wastewater into groundwater or surface water supplies, and then reclaiming it and treating it to drinking water standards for potable uses. IPR has been practiced in the United States for over 40 years. The Orange County Water District in California has used IPR for groundwater recharge since 1975. In Northern Virginia, the Upper Occoquan Sewer Authority discharges treated wastewater which during drought can constitute up to 90% of the source water for Fairfax Water's 120 million gallon per day (mgd) Griffith Water Treatment Plant. Chobani in Twin Falls currently is pursuing an IPR application for ASR and subsequent in-plant use.[84] To some extent, any municipal surface water treatment plant located downstream of a municipal wastewater treatment plant is practicing a form of IPR.

<table>
<tr><th colspan="3">Types of DCMI Water Reuse</th></tr>
<tr><th>Type of Reuse</th><th>Definition</th><th>Examples</th></tr>
<tr><td rowspan="2">Nonpotable Reuse (NPR)</td><td rowspan="2">Use of reclaimed water for non-potable uses such as municipal irrigation</td><td>City of Meridian Idaho Reclaimed Water Program – Nonpotable Use at Heroes Park</td></tr>
<tr><td>Avimor Water Reclamation Company – Irrigation of Common Areas</td></tr>
<tr><td rowspan="2">Indirect Potable Reuse (IPR)</td><td rowspan="2">Blending treated wastewater into a natural source (groundwater or surface water) and then reclaiming it and treating it for potable uses</td><td>Orange County Water District Ground Water Replenishment System (California)</td></tr>
<tr><td>Upper Occoquan Sewer Authority (Virginia)</td></tr>
<tr><td rowspan="2">Direct Potable Use (DPR)</td><td rowspan="2">Introduction of reclaimed water either directly into a public water system or into the raw water supply directly upstream of a water treatment plant</td><td>City of Big Spring, Texas</td></tr>
<tr><td>Cloudcroft, New Mexico</td></tr>
</table>

Table 6. Types of DCMI water reuse.

DPR is the planned introduction of reclaimed water either directly into a public water system or into a raw water supply directly upstream of a water treatment plant without

[84] Application for permit 47-17745

an environmental buffer of any kind. At least two municipal DPR systems have been proposed or are operating in Texas and New Mexico. In connection with the IPR/ASR project mentioned above, Chobani also is undertaking an advanced process-water effluent treatment program with the goal of DPR in its Twin Falls manufacturing facility.

8.3 Current Water Reuse in Treasure Valley

Reuse for DCMI purposes is a recent development in the Treasure Valley. However, with future Treasure Valley population growth, expanded municipal reuse is one option for meeting projected DCMI water-demand increases. Municipal reuse also may be a method for addressing increasingly stringent wastewater-discharge requirements.

Several DCMI water reuse systems are in operation in the Treasure Valley. The largest DCMI reuse system is operated by the City of Meridian. It was put into service in 2009 and delivers an average volume of approximately 100 AF to Heroes Park for use in bathrooms and irrigation of athletic fields. The system is the first Class A wastewater reuse facility in the State of Idaho, and the City plans to expand the system to deliver up to 13 mgd peak flow, with an annual volume of approximately 5,000 AF by 2040. The City of Nampa is initiating a new program to deliver its treated wastewater for use in the Pioneer Irrigation District delivery system. Similarly, the Avimor planned community operates a Class B reuse facility that supplies approximately 20 AF of reclaimed water annually for common area irrigation.

Other municipal or domestic water reuse systems have been constructed for Arrowrock Ranch, the City of Greenleaf, Hidden Springs planned community, the Idaho Department of Corrections, the City of Kuna, Bogus Basin, Danskin Ridge Subdivision, Ironhorse Estates, Meridian Heights Water and Sewer, Riverine Water and Sewer, Stonebriar Subdivision, and Trellis HOA. Also, a substantial amount of industrial wastewater effluent is reused through land application facilities by JR Simplot Company, CS Beef Packers, Sorrento Lactalis, The Amalgamated Sugar Company, CTI Food Services, and Darling Ingredients.

8.4 Reuse Cost Considerations

Typically, reuse systems supplying Class A or B recycled water for urban irrigation are more expensive than standard potable water systems because of the costs of wastewater treatment and the need to deliver recycled water in a separate non-potable water delivery system. Nonetheless, reuse systems have been found to be cost-effective in water-constrained areas and as an alternative to discharging wastewater into surface streams. It may be costly to construct new wastewater reuse systems for urban irrigation in urban/suburban areas that have already been built out. Wastewater reuse systems are more economical when they can be designed into, and built with, newly constructed urban/suburban areas.

While expensive, reuse is often driven by the goal of reducing treated municipal effluent. Municipal effluent may be land-applied by a municipality simply to avoid returning the effluent to the Boise River. Where the cost of treatment necessary to discharge wastewater into surface waters is high, the relative cost of using reuse water to offset municipal water used for irrigation could be very low.

Separate pressurized irrigation systems are less costly than dual plumbing systems that provide both potable and non-potable supply for indoor use. Because irrigation use comprises well over half the DCMI demand in the Treasure Valley, there are many opportunities to use recycled water for irrigation supply.

8.5 Potential for Reuse in the Treasure Valley

Often the most cost-effective reuse systems provide irrigation supply to large areas of turf at golf courses, parks, and cemeteries, especially when located near existing wastewater treatment facilities, thereby minimizing conveyance costs. As such, reuse is most practical and least expensive when used directly for irrigation during the irrigation season since storing treated effluent during the winter for the next irrigation season requires substantial and costly storage facilities. Recycled water (with appropriate treatment) might also be used for managed aquifer recharge (see next section).

Using recycled water for irrigation is also most practical in areas that have not yet been developed. The largest publicly-owned wastewater treatment facilities (WWTFs) are located in Boise (Lander Street and West Boise), Meridian, Nampa, Caldwell, and Kuna. Except for the Lander Street WWTF, these facilities are located fairly close to anticipated growth and could provide reuse water to large irrigation systems and new PI systems in the vicinity. In some instances, water might be discharged to existing canals in exchange for upstream surface water supplies.

The amount of water potentially available for reuse is uncertain. Assuming 50% of the total projected 2065 domestic water use of about 120,000 AF is generated during the mid-April through mid-October irrigation season, and further assuming 10% system loss, the 2065 Treasure Valley reuse potential might be—at most—about 54,000 AF. However, reusing this volume likely is not practical, especially in built-out urban areas with established irrigation infrastructure (such as in the vicinity of Boise's Lander Street WWTF). But recycling between 15,000 and 20,000 AF/yr (or perhaps more) might be a realistic goal over the coming decades.

Finally, treated wastewater discharge could be considered mitigation for streamflow depletions caused by municipal groundwater pumping. This could limit water reuse for irrigation or other purposes but could provide the benefit of "protecting" municipal groundwater pumping in areas tributary to the Boise River upstream of Star.

9 MANAGED AQUIFER RECHARGE, STORAGE, AND RECOVERY

SUMMARY: Managed aquifer recharge has been implemented in some local Treasure Valley areas (e.g., southeast Boise). However, shallow groundwater levels in large central portions of the valley currently preclude effective managed recharge. Areas with the greatest potential for managed recharge (e.g., south of the New York Canal) generally are not within the areas of greatest projected municipal demand. Managed recharge may become a more useful tool in the future if groundwater levels decline. Sources of water for managed aquifer recharge include wastewater, Boise River flood flows, or water pumped from the Snake River.

Managed aquifer recharge is the process of actively recharging an aquifer to raise groundwater levels or increase the groundwater supply. Managed recharge is being used in a variety of applications, including seasonal storage, long-term storage, emergency storage, restoration of declining groundwater levels, and water quality improvements (Pyne, 2005). There are three general forms of managed aquifer recharge in Idaho:

1. Aquifer Storage and Recovery (ASR), which is typically undertaken for the purpose of storing and diverting water for private benefit (an example of this is Micron Technology's water injection, storage, and recovery program in southeast Boise).
2. Public Benefit Aquifer Recharge (PBAR), which is typically undertaken at public expense by governmental entities to bolster groundwater levels.
3. Aquifer Recharge Mitigation (ARM), which is typically undertaken by private parties or groups of water users for mitigation purposes.

PBAR is extensively used in the Eastern Snake River Plain (ESPA) to raise groundwater levels. Micron Technology, Inc. has an active ASR program in the Southeast Boise Ground Water Management Area using treated Boise River water. Veolia and Capitol Water Corporation, both municipal water providers in the City of Boise, utilize ASR for winter recharge of wells in aquifers of poor water quality to provide additional capacity during peak summer months. The water source for these latter ASR programs is high-quality groundwater.

Possible Treasure Valley applications include one or more of the following:

1. Seasonal storage, consisting of storing flood flows in the Boise River (or water pumped on a more consistent basis from the Snake River) for use in meeting peak demand.
2. Long-term storage of flood flows in the Boise River for use during years in which flood flows do not occur. Proportional recovery may

decrease with multiple years of storage, but this disadvantage may be outweighed by the ability to divert water in high-runoff years for use in low-water years.

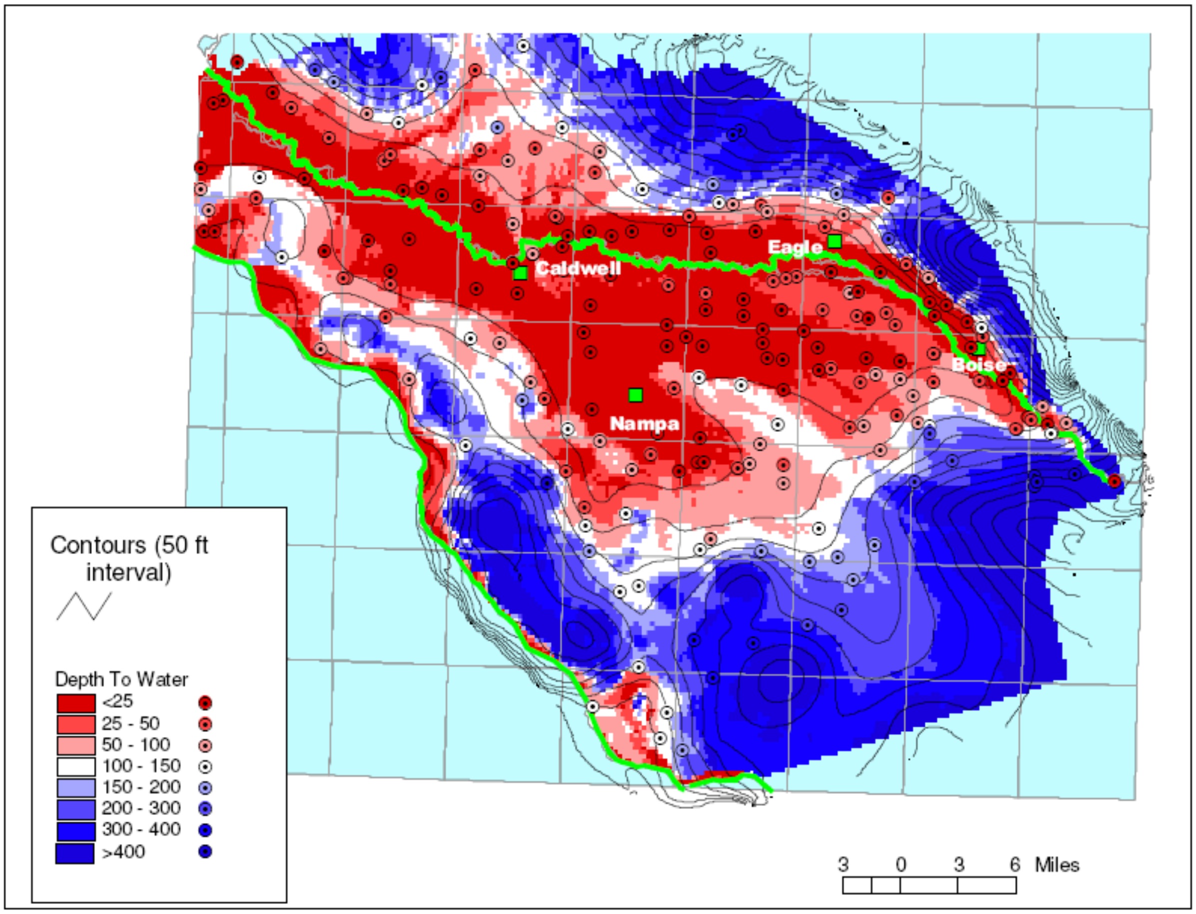
3. Emergency storage. ASR can be used to provide an emergency water supply to meet demands when a primary source of supply is temporarily unavailable (such as would be the case for Boise River or Snake River diversions if the Snake River flows fall below established minimums).
4. Storage of reclaimed water, which could increase the amount of treated-wastewater reuse over that contemplated in Section 8 above. Such injection would need to meet IDAPA 58.01.17 Recycled Water Rules.

A successful managed recharge program requires a high-quality water source (or water that can be treated), appropriate hydrogeologic conditions, measures to address potential water quality issues, and regulatory compliance. At a minimum, water would likely need to be treated to drinking water standards prior to direct injection, which would include removal of biological constituents and suspended solids. Treatment requirements may vary on a seasonal basis and be influenced by Snake River or Boise River flow rates (which influences the concentration of suspended solids), ambient water temperatures, and other factors.

Managed recharge requires the presence of saturated or unsaturated subsurface zones capable of transmitting and storing sufficient amounts of water (National Research Council, 2008). Storage zones can range in depth from about 200 feet to over 1,000 feet. Groundwater levels in storage zones (following injection) might range from about 30 feet to several hundred feet.

Some parts of the Treasure Valley area overlie aquifers with hydrogeologic conditions conducive to managed recharge (Brown and Caldwell, 2020). However, most of these are not in areas of greatest projected municipal water demand. The greatest projected municipal water demand lies between the Boise foothills on the north and the New York Canal and Lake Lowell on the south, but shallow groundwater levels in this part of the Treasure Valley (Figure 19) would currently preclude effective managed recharge.[85]

[85] The extensive drain system in this area was constructed to drain away excess shallow groundwater that was waterlogging productive ground. Additional groundwater recharge in this area would simply increase discharge to drains.



From IWRRI & IDWR (2011).

Figure 19. Depth to groundwater.

Managed recharge may be a useful tool east of Boise and south of the New York Canal and Lake Lowell. Regulatory considerations would consist of meeting (1) IDWR requirements for water injection, (2) IDEQ public drinking water regulations, and (3) water right requirements. From a regulatory standpoint, it is likely that 100 percent of water injected into the subsurface could be withdrawn–if needed–in the same calendar year. However, the State would likely limit the amount of water that can "banked" in the subsurface over a multi-year period (which would limit the practicality of multi-year water storage). For example, new permits may be conditioned similar to water right 63-31183 (used by Micron Technology at its southeast Boise facilities):

> "… the entire volume of water injected by the right holder into the SEBGWMA[86] aquifer for groundwater recharge pursuant to right 63-12420 or pursuant to diversions of storage water, up to the total amounts authorized by this right, can be diverted from the aquifer under this right during the calendar year it is injected. Water not diverted during the year it is injected can be carried over for future withdrawal and beneficial use associated with this right. The volume authorized for withdrawal will be reduced by 10% each calendar year following the first calendar year the water is injected."

One of the aspects of Micron Technology's ASR strategy is that treated Boise River water is being injected into a regional cone of depression (decreased groundwater levels in this area led to the formation of the Southeast Boise Ground Water Management Area). The presence of an established cone of depression helps ensure that the injected water is recovered. Similar cones of depression are not present in other parts of the Treasure Valley.

Broad reductions in infiltration associated with urbanization could contribute to declining water levels in shallow aquifers. In this case, managed recharge may be a viable option for replenishing shallow aquifers. This could be appropriate for areas where groundwater levels are a substantial distance from ground surface; managed recharge would not be feasible for areas where the aquifer profile is fully saturated and drains collect shallow aquifer discharge.

In summary, managed recharge has been used extensively in the Eastern Snake River Plain and other Idaho basins. However, broad-scale managed recharge in the Treasure Valley is more challenging—and potential benefits less clear—than in other parts of the state because of the Treasure Valley's complex, multi-level aquifer system, shallow groundwater levels in areas of highest projected municipal demand, and current lack of demand in areas that might lend themselves to managed recharge. Managed recharge nevertheless is a useful local tool in parts of the Treasure Valley (e.g., southeast Boise) and may become more useful in the future if groundwater levels decline as a result of decreased incidental recharge or increased groundwater pumping.

[86] Southeast Boise Ground Water Management Area.

10 CLIMATE CHANGE

SUMMARY: Projected climate-change impacts for the rest of the century include higher temperatures, greater evapotranspiration, less snowpack, earlier runoff, and greater weather extremes. These projected conditions will impact future water demand and supply.

Climate change will impact future water demand and the amount and timing of water availability, and therefore will impact municipal water-supply planning. Projected climate-change impacts for the rest of the century include higher temperatures, greater evapotranspiration, less snowpack, earlier runoff, and greater weather extremes.

Climate-change projections have inherent uncertainty, especially on a year-to-year basis. Climate-change projections made with computer simulations are limited by a large number of simplifications, assumptions, and parameter constraints. Global greenhouse-gas emissions may diminish in the future and some of the more extreme projections may not materialize. However, there is a growing recognition that we will see at least some of the projected climate-change impacts in the coming decades—in fact, we've already begun seeing them. Thus, municipal water-supply planners would be remiss to not at least consider some of the climate-change impacts that scientists predict, despite inherent uncertainty.

Human influence has warmed the climate at rates not seen in at least the last 2,000 years (IPCC, 2021). Each of the last four decades has been warmer than any decade that preceded it since 1850 (IPCC, 2021). Most of Idaho has warmed one to two degrees Fahrenheit in recent decades (U.S. EPA, 2016), and temperature is projected to continue increasing in the coming decades.[87] The frequency of days with a heat index[88] greater than 91°F is projected to increase from a historical baseline of about 16 days per summer to 66 days per summer by the mid-21st century (Abatzoglou and Kuechle, 2016). Similarly, days with a heat index greater than 103°F will become more common during the 21st century.

[87] https://cig.uw.edu/resources/analysis-tools/pacific-northwest-climate-projection-tool/

[88] The heat index, also known as the apparent temperature, is what the temperature feels like to the human body when relative humidity is combined with the air temperature. There is direct relationship between the air temperature and relative humidity and the heat index, meaning as the air temperature and relative humidity increase (decrease), the heat index increases (decreases)—see https://www.weather.gov/ama/heatindex.

Recent climate-model simulations suggest that western states could experience sequential years of low-to-no snow[89] within 35-60 years if greenhouse gas emissions continue unabated (Siirila et al., 2021). While a complete loss of snowpack is a worst-case scenario, the potential for persistent low-to-no snowpack is substantial. Increasing evapotranspiration resulting from higher temperatures can increase irrigation water demand and the severity of droughts.

Mountain snowpack in the Boise River basin serves, in essence, as a large water-storage reservoir. Projected temperature increases and decreasing snowpack will change streamflow dynamics that are core to the valley's water supply—peak runoff will occur earlier than it has in the past. More extreme or extended drought could decrease reservoir fill and carryover storage.

Projections show that as temperatures warm, snow accumulation will diminish, spring runoff flows will shift to earlier in the season, winter flows will increase (as more precipitation falls in the form of rain instead of snow), and late-summer flows will decrease (Dalton et al., 2013). Climate change will likely bring increases in the frequency and intensity of hot extremes, droughts, and precipitation events (Masson-Delmotte and Huang, 2021).

Higher summer temperatures will bring greater evapotranspiration; accordingly, per-acre irrigation requirements will increase. An increase of approximately 4 inches of irrigation water is projected by the mid-21st century (Abatzoglou and Kuechle, 2016). The irrigation demand for turf grass in the Treasure Valley currently is about 3.2 AF per acre per year.[90] An additional 2 to 4 inches of water for turf irrigation represents increases of 5% to 10%, respectively. Higher temperatures also mean greater losses from surface channels (rivers, lakes, ponds, canals, etc.) and greater riparian evapotranspiration (which draws water from shallow aquifers).

Climate simulations suggest an annual precipitation increase, but summer precipitation is expected to decrease in the northwest (Kunkel et al., 2013). Moderate drought, which historically has occurred in about one of every 4 years, is projected to occur in one of every 2 years, on average, by the mid-21st century (Abatzoglou and Kuechle, 2016). Similarly, extreme droughts that historically occurred in about one out of every 12 years are projected to occur in nearly one of every 3 to 4 years by the mid-21st century (Abatzoglou and Kuechle, 2016).

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[89] A "low-to-no snowpack" is defined by Sirrila-Woodburn et al. (2021) based on historical peak snow-water equivalent (SWE) percentiles, with "low snow" defined as ≤30th percentile of SWE and "no snow" defined as ≤10th percentile of peak historical SWE.

[90] http://data.kimberly.uidaho.edu/ETIdaho/stcvrstats.py?station=12&cover=17&stats=Deficit.

Extended drought could lead to greater groundwater withdrawals and decreased aquifer recharge as surface water deliveries are cut. Demand for municipal irrigation water could increase in areas that are currently irrigated with surface water if surface-water deliveries are cut earlier than usual because of reduced natural flow and storage. Water rights authorizing surface-water diversions under junior priority dates could be cut earlier in the season than in past years. Reservoirs may not completely fill during extended droughts.

While the average temperature rise associated with climate change may be relatively slow, seasonal variability could become greater. Historical temperature, evaporation, and streamflow data likely may not fully capture future conditions. The shift from individual wet years and dry years could be swift.

These factors create challenges and uncertainties for water planners, managers, and users. Conditions could change rapidly from relatively wet years with mild temperatures to years with extreme heat and drought-limited water supplies. Municipal suppliers will need to ensure sufficient supply and conveyance capacity to meet demand increases (and perhaps constrain irrigation demand) during extreme hot and dry years. Adaptation to climate changes will require resourcefulness by—and cooperation among—municipalities, irrigation entities, water providers, and residents.

11 Components of a Municipal Water-Supply Strategy

SUMMARY: A comprehensive Treasure Valley municipal water-supply strategy will include increased use of groundwater, surface water, and reuse of treated wastewater. A changing climate will require both demand-side and supply-side adaptations to ensure an adequate municipal supply.

11.1 Introduction

Treasure Valley municipal suppliers have multiple options for supplying a projected 110,000- to 190,000-AF water-demand increase in the coming decades. The long-term Treasure Valley municipal water-supply mix likely will include groundwater, surface water from the Boise and Snake rivers, and reuse of treated wastewater.

An optimal municipal water strategy will have components that address both demand and supply. Such a strategy will be (in our opinion) most successful if developed and implemented cooperatively between city and county governments (elected officials, planning and zoning departments), state and federal water managers, irrigation-water suppliers, valley residents, and municipal providers. It will be difficult—if not impossible—for individual public or private municipal-water purveyors to develop some of these water-supply components alone.

The following sections summarize municipal water supply components that lend themselves to incremental implementation (Section 11.2), options that involve larger-scale solutions (Section 11.3), an adaptive management approach to implementation (Section 11.4), some hypothetical supply-mix examples for meeting projected future demand (Section 11.4), and ways in which climate change could affect water demand and water-supply planning (Section 11.6).

11.2 Incremental Components

1. Develop groundwater resources where available, while monitoring groundwater-level impacts associated with increased groundwater production.[91] Construct additional groundwater treatment facilities where

[91] One possible impact of groundwater pumping is decreased drain flow. However, drain flows are influenced by numerous factors, including diversion rates (controlled in part by water availability), diversion season, irrigation efficiency, and watershed land use. Detailed analyses will be required to separate any groundwater-pumping impacts from other factors influencing drain flows. Intensive monitoring of flows in major drains began in about 2016, but parsing causes of changes in drain flows

needed or mix water from different aquifer zones to meet drinking water requirements. Use the USGS model currently in development (scheduled for completion in 2022) to evaluate the impacts of additional groundwater withdrawals.

2. Continue to develop pressurized systems for residential/urban irrigation on formerly-irrigated agricultural land using surface water currently diverted for agricultural irrigation purposes. Consider measures, such as drought-tolerant landscaping, that will temper future demand.[92]
3. Strive to make surface water irrigation as efficient as possible, and deliveries at the subdivision scale as uniform as possible. This will enhance the ability of surface water delivery entities to move irrigation water from previously irrigated agricultural land that has become non-irrigable through urbanization to other areas or uses.
4. Pursue potential rental pool or water bank rentals on an opportunistic basis, recognizing that neither of these sources represents a complete or long-term solution to meeting projected municipal water-demand increases (especially during times of drought).
5. Pursue potential water-right acquisitions on an opportunistic basis, recognizing that such acquisitions may provide incremental benefits but likely do not represent a complete solution for meeting projected municipal water-demand increases. Acquisitions of existing irrigation rights will require water-right changes to authorize municipal uses and changes in points of diversion or places of use.
6. Develop a regional plan for wastewater reuse (potential amounts by treatment facility, areas of potential application, and associated infrastructure requirements). Implement this plan on an incremental, opportunistic basis.
7. Develop a regional water-conservation plan to promote efficient water use. Consistency among Treasure Valley communities may help residents throughout the valley adopt appropriate conservation measures.
8. Develop a regional emergency drought plan that outlines measures to reduce water use—especially irrigation use—during times of extreme or

will require analysis of long-term trends. Unfortunately, the availability of reliable system-wide drain flow data from prior to 2016—which are needed to evaluate long-term trends—is limited.

[92] This is relevant to municipal suppliers, because even where the primary irrigation water source for some subdivisions is surface water, users may turn to potable municipal water for irrigation if surface deliveries are cut during times of drought.

extended drought. Adopt such a plan prior to severe drought conditions, which could help customers anticipate possible drought-induced constraints and plan accordingly.

9. Review pre- and post-urbanizing irrigable area under existing water rights during a city's or county's land-use planning and permitting process to help identify previous beneficial surface water uses that can be moved to other areas or uses. While authority for administering water rights rests with the state, and while irrigation-delivery entities have discretion over applying irrigation water within their permissible places of use, the identification of surface-water irrigated lands that are becoming non-irrigable (through the construction of rooftops, driveways, sidewalks, roadways, etc.) can assist in the overall efficient allocation of irrigation water.

10. "Lock in" water-use efficiency during the land-use planning and permitting process. These improvements can be much easier to implement in new subdivisions and commercial areas than in built-out urban areas. The land-use planning and permitting process for new subdivisions and commercial areas provides a one-time opportunity to help lock in water-use efficiency. Begin by initiating a discussion between surface water delivery entities, municipal providers, and municipalities to consider the following steps:

    a. Reduce irrigation water use in new subdivisions or commercial areas (with measures such as drought-tolerant landscaping, 24-hour irrigation-water storage, and irrigation-rotation schedules). Develop a strategy for ensuring that future water use, especially for irrigation and aesthetic water features, is as efficient as possible.

    b. Identify measures in which municipalities and municipal water purveyors can help surface-water delivery entities reduce subdivision-scale irrigation demand variability and increase delivery efficiency. Such measures might include (i) establishing irrigation rotations, (ii) constructing irrigation ponds, closed reservoirs, or supplemental wells in new subdivisions to help meet hourly peak-irrigation demands, and (iii) control systems to automate delivery-system components.

    c. Identify ways in which municipal land-use planning processes can be used to assist surface-water providers in maintaining access to surface-channel rights-of-way (for maintenance and enhancing safety).

    d. Adopt development and building requirements that promote efficient water use (by incorporating, for instance, water efficient appliances and fixtures, etc.).

11. Develop policies and strategies for re-purposing water associated with agricultural lands that become non-irrigable due to urbanization.

12. Implement managed recharge where aquifer conditions permit, where a water supply is available, and where there is need for additional groundwater pumping.

11.3 Large-Scale Long-Term Components

1. If cost-effective, take advantage of opportunities for increased surface-water storage, such as in Anderson Ranch Reservoir.
2. Develop an annual reporting system to tabulate valley-wide municipal water use. This could help water managers and utilities (a) monitor water use with respect to projections and plan accordingly for demand-reduction or supply-development measures and (b) perhaps (when compared to groundwater-level trends) help provide insight into groundwater-level changes.
3. Begin developing conceptual-level plans and associated cost opinions for large-scale water-supply options, including:
    a. Diversions from the Snake River below Swan Falls Dam with conveyance to South Boise, Kuna, or Lake Lowell areas for direct municipal use, exchange with irrigation water supplies currently diverted from the Boise River or groundwater, or ASR.
    b. Diversions from the lower Boise River with conveyance to up-valley municipal service areas.
    c. Diversions during times of Boise River flood releases for direct use, managed recharge, or ASR.
4. Use conceptual-level plans and cost opinions to identify preferred options. Identify potential points of diversion and pipeline alignments. Identify and acquire easements for infrastructure components (e.g., intakes, treatment facilities, conveyance facilities, etc.) of the preferred large-scale water-supply options. Identify active measures to help preserve future water-supply options.
5. Continue efforts to measure discharge from drains to the Boise River (which is currently done by IDWR). Use discharge measurements to (a) monitor impacts of increased groundwater pumping[93] and (b) help identify areas of potential surface-water delivery-system efficiency improvements.

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[93] Doing so will require parsing the impacts of groundwater pumping and other factors influencing drain flows.

6. Develop water rights and construct infrastructure for large-scale diversions from the Snake and Boise rivers if the above-listed incremental options appear to be insufficient.

11.4 An Adaptive-Management Approach

The water-supply components described above lend themselves to an adaptive approach to water-supply planning. While relying on valley aquifers has served the valley well over many decades, physical and administrative constraints already limit additional groundwater development in some areas and may limit future groundwater development in other areas. Having conceptual plans in place for larger-scale projects should incremental water-supply options prove insufficient would provide the foundation for an effective, adaptive supply strategy.

11.5 Hypothetical Water-Supply Mix

The ultimate source-of-supply mix for an additional 110,000- to 190,000-AF projected DCMI demand will depend on many factors, including the physical and administrative availability of groundwater, success in developing water reuse programs, the cost of potential long-term leases or acquisitions of deliveries under existing water rights, the cost of new surface-water diversion, treatment, and conveyance infrastructure, and the level of cooperation between municipal suppliers. For illustrative purposes, three hypothetical water-supply mixes to meet 110,000- and 190,000-AF municipal demand increases are outlined in Table 7 and Table 8. A more detailed target mix could be developed as part of a regional water-supply strategy.

It *might* be possible to supply an additional 110,000 AF/yr without tapping unappropriated surface water in the Snake or lower Boise rivers (Table 7). However, a strategy to accomplish this would rely on a substantial increase in groundwater pumping, wastewater reuse to offset municipal demand, availability of rental pool and water bank water, availability of flood flows, and additional storage availability. If increased supply from these sources is not available, or if some of these sources are constrained in drought years, then municipal water providers likely would need to look at developing unappropriated surface water from the Snake or lower Boise rivers.

In contrast, meeting an additional municipal demand of 190,000 AF/yr *likely* will require diverting water from the Snake or lower Boise rivers (Table 8). For example, even with additional 50,000 AF/yr of groundwater withdrawals, 20,000 AF/yr reuse, and 12,500 AF/yr Boise River diversions, there would still be a shortfall of 80,000 AF/yr that could be made up by pumping water from the Snake and lower Boise rivers. Diverting water from the Snake or lower Boise rivers could perhaps be avoided if a substantial amount of re-purposed Boise River water becomes available as a result of the urbanization of formerly-irrigated agricultural lands.

Conceptual Supply Mix Additional 110,000 AF/yr for municipal use					
Source	**Example -->**	**1**	**2**	**3**	**Comments**
Groundwater	Vol (AF/yr)	20,000	40,000	50,000	Incremental implementation, less certain supply in greater quantities
	Avg rate (cfs)(1)	42	84	315	
Re-Use of treated municipal wastewater	Vol (AF/yr)	5,000	15,000	20,000	
	Avg rate (cfs)(2)	21	63	84	
Boise River (rental pool, water bank, acquired rights)	Vol (AF/yr)	3,000	5,000	7,500	
	Avg rate (cfs)(1)	6	11	16	
Boise River (water delivered by surface-water irrigation entities)	Vol (AF/yr)	5,000	10,000	20,000	
	Avg rate (cfs)(1)	11	21	42	
Boise River (flood diversions, e.g., for ASR)(4)	Vol (AF/yr)	0	5,000	5,000	
	Avg rate (cfs)(3)	0	28	28	
New Boise River storage (e.g., Anderson Ranch raise)	Vol (AF/yr)	2,000	5,000	7,500	Long-range implementation; less certain annual fill
	Avg rate (cfs)(2)	8	21	32	
Snake River(5)	Vol (AF/yr)	60,000	20,000	0	Long-range implementation, more certain annual availability
	Avg rate (cfs)(6)	84	28	0	
Boise River (new diversions below Star)	Vol (AF/yr)	15,000	10,000	0	
	Avg rate (cfs)(1)	32	21	0	
Total	Vol (kAF)	110,000	110,000	110,000	

(1) Assume volume delivered over an 8-month period
(2) Assume volume delivered over a 4-month period
(3) Assume volume delivered over a 3-month period
(4) Conceptual amount listed as multi-year average
(5) The Snake River alone is theoretically capable of providing virtually all of the projected municipal increase over the next 50 years
(6) Assume uniform delivery over a 12-month period

Table 7. Hypothetical water-supply mix examples (110,000 AF/yr).

Conceptual Supply Mix Additional 190,000 AF/yr for municipal use					
Source	**Example -->**	**1**	**2**	**3**	**Comments**
Groundwater	Vol (AF/yr)	20,000	40,000	50,000	Incremental implementation, less certain supply in greater quantities
	Avg rate (cfs)(1)	42	84	315	
Re-Use of treated municipal wastewater	Vol (AF/yr)	5,000	15,000	20,000	
	Avg rate (cfs)(2)	21	63	84	
Boise River (rental pool, water bank, acquired rights)	Vol (AF/yr)	3,000	5,000	7,500	
	Avg rate (cfs)(1)	6	11	16	
Boise River (water delivered by surface-water irrigation entities)	Vol (AF/yr)	5,000	10,000	20,000	
	Avg rate (cfs)(1)	11	21	42	
Boise River (flood diversions, e.g., for ASR)(4)	Vol (AF/yr)	0	5,000	5,000	
	Avg rate (cfs)(3)	0	28	28	
New Boise River storage (e.g., Anderson Ranch raise)	Vol (AF/yr)	5,000	5,000	7,500	Long-range implementation; less certain annual fill
	Avg rate (cfs)(2)	21	21	32	
Snake River(5)	Vol (AF/yr)	112,000	80,000	60,000	Long-range implementation, more certain annual availability
	Avg rate (cfs)(6)	157	112	84	
Boise River (new diversions below Star)	Vol (AF/yr)	40,000	30,000	20,000	
	Avg rate (cfs)(1)	84	63	42	
Total	Vol (kAF)	190,000	190,000	190,000	

(1) Assume volume delivered over an 8-month period
(2) Assume volume delivered over a 4-month period
(3) Assume volume delivered over a 3-month period
(4) Conceptual amount listed as multi-year average
(5) The Snake River alone is theoretically capable of providing virtually all of the projected municipal increase over the next 50 years
(6) Assume uniform delivery over a 12-month period

Table 8. Hypothetical water-supply mix examples (190,000 AF/yr).

11.6 Climate-Change Considerations

Meeting projected municipal water demand over the next 50 years becomes more challenging in the context of climate change. Higher temperatures (leading to increased agricultural and urban irrigation demand), more severe and perhaps more extended droughts, more extreme precipitation events, diminishing snowpack, and changing runoff patterns (e.g., earlier runoff peaks) will influence Treasure Valley water management.

A changing climate likely will require both demand-side and supply-side adaptations such as:

1. Steps to reduce urban irrigation demand (the largest component of municipal water use), which will become increasingly important as summer temperatures rise, especially during drought conditions.

2. Measures to provide backup for diversions made possible through the water supply bank, rental pool, or junior-priority rights during particularly dry years. The availability of these diversions could become more variable (and therefore less reliable) during more frequent or more extended dry periods.

3. Increases in upper Boise River storage capacity to provide greater carryover storage. Such increased storage could become increasingly important during severe, extended drought conditions and earlier spring runoff.

4. New diversion and conveyance infrastructure to bring surface water from the Snake or lower Boise rivers. Such infrastructure is expensive, entails substantial energy use for pumping, and requires long planning horizons. Nonetheless, diverting water from the Snake or lower Boise rivers could provide greater municipal-supply certainty in a changing-climate world.

   Pumping water from the Snake River could effectively increase the size of the precipitation catchment basin from which Treasure Valley municipal providers draw water. This could provide a hedge against potential local drought conditions that constrain Boise River supplies. Snake River diversions would add water-supply diversity to municipal portfolios should Boise River basin precipitation be lower than in other parts of eastern Idaho and western Wyoming. Furthermore, the State of Idaho administers water rights to help ensure Swan Falls Dam minimum flows are met whenever possible. This could help ensure Snake River water availability below Swan Falls Dam.

5. Changes in municipal delivery infrastructure to respond to climate change. For example, the flexibility to move water within a municipal system may be needed to compensate for constrained supply in some portions of a

system, or to take advantage of greater capacity in other portions of the system. Infrastructure will be needed to take advantage of larger amounts of surface water when available, or groundwater when surface water is not available.

6. Actively managing municipal pumping by (for example) reducing pumping when surface water is available and by pumping more groundwater when surface-water supplies are constrained. Also, pursue managed recharge where warranted.

7. Infrastructure-capacity changes to address climate variability. Municipal water infrastructure is typically designed to provide adequate capacity for reasonably-anticipated conditions. By example, climate change may bring drought conditions outside of historical norms. Reduced surface-water supply and/or temporarily-increased demand may require infrastructure or supply capacity that has not been needed in the past. For instance, municipal suppliers could experience an increase in potable-water demand in areas where surface water that is normally used for residential irrigation has been cut because of drought conditions.

8. Emergency measures for periods of extreme or prolonged drought. A series of abnormally-dry years during which Boise River reservoirs do not fill completely would leave many water users scrambling for water. Opportunities for diverting flood flows, finding water bank rentals, or obtaining storage rentals for municipal use could be seriously constrained. At the same time, irrigation demand could increase as irrigators and residents attempt to compensate for greater evapotranspiration, leading to greater municipal water demand. An emergency drought plan developed jointly by cities, counties, and water providers in advance of extreme drought conditions could help residents prepare for possible delivery constraints during extreme drought.

12 Summary, Conclusions, and Recommendations

SUMMARY: There are sufficient viable options for meeting increased municipal water demand in the coming decades. But implementing some of these options will likely require a cooperative, regional approach.

The general conclusion from this review is that there are sufficient viable options for meeting increased municipal water demand in the coming decades. Specific conclusions include the following:

Projected DCMI Demand

1. Municipal water demand is projected to increase between 110,000 and 190,000 AF by 2065, which is 200% to 270% of 2015 usage.

General Water-Supply Options

2. General water-supply sources include groundwater from Treasure Valley aquifers, surface water from the Snake River, surface water from the Boise River, and reuse of treated municipal effluent.

Groundwater

3. Known well capacities and generally stable groundwater levels in large portions of the Treasure Valley suggest that aquifers can sustain additional groundwater withdrawals.
4. The availability of groundwater throughout the Treasure Valley is not uniform. Areas of limited groundwater supply include the Boise foothills, portions of south and east Ada County, and the Southeast Boise Ground Water Management Area. Shallow portions of the Treasure Valley aquifer deemed tributary to the Boise River above Star are not available for new appropriations without some form of mitigation. Deeper aquifer zones with groundwater temperatures in excess of 85°F may be available for heating purposes but are restricted for general municipal use.
5. Groundwater development may be constrained by water quality (although treatment methods are available for most constituents of concern).
6. Groundwater development may be constrained by potential impacts to existing users (e.g., well interference or surface water depletions), and other administrative constraints (such as unresolvable protests to new water-right applications).

Snake River

7. Water is currently available for appropriation from the Snake River below Swan Falls as long as the established minimum flow at the Weiser, Idaho gage (4,750 cfs) is met. This minimum flow has been met on all but 4 days since 1980. The Snake River represents one of the Treasure Valley's largest potential (and arguably most certain) municipal water supply sources.
8. Typical Snake River flows would be sufficient to supply the entire 110,000- to 190,000-AF municipal demand increase projected for the year 2065.
9. General options for using Snake River water for Treasure Valley municipal purposes include the following:
    a. Divert, pump, and convey water from the Snake River to areas of increasing municipal demand (such as Kuna or Boise). Direct use for municipal purposes would require treatment.
    b. Pump water from the Snake River to Lake Lowell in exchange for Boise River water that is currently diverted from the Boise River and is conveyed to Lake Lowell via the New York Canal. Alternatively, diversions from the Snake River to Lake Lowell might facilitate municipal diversions from Lake Lowell for use in the Nampa or Caldwell areas.[94]
    c. Divert Snake River water to replace groundwater currently used for agricultural irrigation, in exchange for pumping groundwater for direct municipal use.
    d. Divert water from the Snake River as part of a comprehensive managed recharge or ASR strategy (direct injection would require treatment). Such diversion and injection could occur at a nominal rate over a 12-month period, with recovery at higher rates during the summer peak-irrigation season.
10. Development of Snake River water supplies for options that would entail the use of Lake Lowell or the New York Canal would require the cooperation of the USBR, the Boise Project Board of Control, and irrigation districts served by Boise Project Board of Control.
11. Snake River water is arguably one of the most certain municipal water-supply sources, but also one of the more expensive options.

[94] Although water from Lake Lowell might be an appealing source for urban irrigation in the Caldwell and Nampa areas, these areas have substantial groundwater supplies that have not yet been fully developed. Also, diversions from the Boise River below Star, or from drains contributing to the Boise River below Star, might be more cost-effective options.

Boise River Above Star

12. Additional surface water storage in upper Boise River basin reservoirs (such as proposed with the Anderson Ranch Reservoir raise or the Cat Creek Energy project) could provide additional water for municipal use. Storage water could be used on an annual basis or maintained as carry-over storage for times of drought.
13. The Boise River above Star is considered fully appropriated most of the year. However, new appropriations may be possible during times of high runoff. Flood releases of over 66,000 AF occurred over a period of at least 28 days in 14 years between 1989 and 2015. Flood releases will likely decrease if additional upstream storage is built.
14. New flood-flow appropriations may be most appropriate for existing facilities, as the development of new infrastructure to divert water that is only available for relatively short periods of time, and only in some years, may not be cost-effective.
15. The Boise River Rental Pool provides a mechanism for renting storage allocations in upper Boise River basin reservoirs. However, the amount of water available (based on recent data) has been minimal. The rental pool does not appear to be a substantial long-term water-supply source (especially while rental rates are low).
16. Similarly, the Idaho Water Supply Bank provides a mechanism for renting existing natural flow water rights. However, based on the amount of water currently in the Water Supply Bank, this too does not appear to be a promising long-term or large-scale municipal water-supply source.

Re-Purposed Irrigation Water

17. There is a large amount of water diverted from the Boise River for agricultural irrigation. Some (perhaps 40% to 60%) of the currently-irrigated farmland will, when developed in the future, be made impermeable with roads, rooftops, sidewalks, parking areas, etc.
18. Irrigation water associated with a reduction in irrigable area (resulting from an agricultural-to-urban land-use transition) could be re-purposed for urban irrigation (including on land beyond that which currently is served with surface water) or other uses (including potable municipal uses).
19. Re-purposed irrigation water conceivably could provide a substantial portion of the projected municipal demand, and do so at a cost lower than some other options.
20. Use of re-purposed irrigation water for municipal purposes would require the cooperation of a number of parties (including irrigators, irrigation entities, developers, IDWR, USBR, and municipal providers).

21. Optimizing surface-water use in pressurized urban irrigation systems (to make water available for other irrigation or municipal uses) likely will be easier to accomplish in new subdivisions than in existing ones.

Boise River Below Star

22. Water in the Boise River downstream of Star is generally available for appropriation. There are sufficient flows (including river gains from drain discharge, shallow aquifer discharge, and tributary inflows) downstream of Star to supply the entire projected 2065 DCMI demand during all but the lowest of flow conditions.
23. As with diversions from the Snake River, diversions from the lower Boise River would need to cease if Snake River flow at the Weiser gage drops below 4,750 cfs.
24. Diversion, pumping, treatment, and conveyance facilities such as those needed for use of Snake River water would be required for the use of Boise River water for potable municipal uses.
25. The urban areas nearest the lower Boise River with projected municipal demand increases (e.g., the Caldwell and Nampa areas) also have substantial groundwater supplies that have not yet been fully developed.

Water Reuse

26. Reuse of treated municipal wastewater likely will provide a source of incremental new supply to help meet a portion of municipal water-demand growth.

Aquifer Storage and Recovery

27. Managed aquifer recharge or ASR may be a useful tool, but is not as easy to implement in the Treasure Valley as it is in some other Idaho basins, because of the complex, interbedded, three-dimensional nature of Treasure Valley aquifers, hydrology (e.g., shallow groundwater levels), and topography.

General Water Supply Strategy

28. Water-supply options for meeting the projected 110,000- to 190,000-AF DCMI demand increase can be characterized as (a) incremental options and (b) large-scale water-supply options. Incremental options include (1) increased use of groundwater, (2) acquisition of existing Boise River water entitlements through water right purchases, rental pool leases, or water bank leases, (3) re-purposed irrigation water, and (4) reuse of treated municipal effluent. Larger-scale options include diversions from the Snake River and diversions from the Boise River (for direct use, exchange, or aquifer storage and recovery).

29. It *might* be possible to supply an additional 110,000 AF/yr without tapping the Snake or lower Boise rivers, but a strategy to accomplish this would rely on a substantial increase in groundwater pumping, re-purposing at least some existing Boise River irrigation water for potable uses, wastewater reuse to offset municipal demand, use of rental pool and water bank water, use of flood-water diversions, and additional surface storage. If increased supply from these sources is not available in the amounts needed, then municipal water providers likely would need to look at the Snake or lower Boise rivers as sources.

30. Developing an additional 190,000 AF/yr for municipal uses will almost certainly require pumping water from the Snake and/or lower Boise rivers unless a substantial amount of Boise River water historically associated with agricultural irrigation becomes available for municipal use.

31. A water-supply strategy for meeting projected municipal demand might include the following:

    a. Continue developing groundwater supplies wherever possible to meet growing DCMI demands, especially in central and western portions of the Treasure Valley. Construct groundwater treatment facilities where needed.

    b. Monitor groundwater levels throughout the valley in response to groundwater pumping increases. Continue to monitor drain discharge to the Boise River. Analyze the causes of changes in groundwater levels and/or drain flows.

    c. Pursue rental pool or Water Supply Bank rentals on an opportunistic basis.

    d. Pursue natural flow and storage water right acquisitions on an opportunistic basis.

    e. Expand wastewater reuse.

    f. Develop a regional water conservation plan to support efforts in reducing future water demand.

    g. Initiate discussions on the possible re-purposing for municipal use of existing Boise River water historically dedicated to agricultural irrigation.

    h. Develop conceptual-level plans and associated cost opinions for large-scale water-supply options (e.g., pumping water from the Snake or lower Boise rivers). Identify the most cost-effective options. Identify potential points of diversion and pipeline alignments for the most cost-effective alternatives. Develop a plan for creating and maintaining easements to preserve components of the preferred large-scale water-supply options. (The projected cost of large-scale water-supply options may encourage the pursuit of less expensive incremental options such re-purposing of irrigation water.)

i. Implement large-scale water-supply projects to divert water from the lower Boise River or Snake River if incremental options are (or are anticipated to be) insufficient to meet future DCMI demand.

Water Conservation

32. Water conservation is not in and of itself an alternative water supply. However, effective water conservation will reduce the water supply needed to satisfy future DCMI water demand. Water conservation should be an integral part of regional DCMI water strategy.
33. Consider developing a comprehensive, regional municipal water-conservation plan, consisting of conservation measures, education plans, utility coordination plans, etc.
34. Such a water-conservation plan might also describe emergency water-conservation measures, such as measures that might be needed during an extreme drought to reduce peak water demand.

Climate Change

35. Higher temperatures associated with climate change likely will lead to increased per-acre irrigation demand, more severe and perhaps more extended droughts, more extreme precipitation events, diminishing snowpack, and changing runoff patterns (e.g., earlier runoff). These impacts could have a profound influence on Treasure Valley water management.
36. Managing future water demand, especially summertime irrigation demand, becomes more important in the context of climate change.
37. An emergency plan to help reduce municipal irrigation demand may be especially important during an extreme and/or extended drought.
38. The availability of upper Boise River water (from the water bank, rental pool, or junior-priority rights) will be more constrained during times of drought.
39. Increasing surface-water storage space (such as the Anderson Dam raise) could provide additional carry-over storage for use during times of drought if managed properly. Additional surface storage will also be useful for capturing winter flood flows.
40. Diversions from the Snake River, which draws from a larger catchment basin than the Boise River, could bring diversity to the Treasure Valley's water supply during times of drought.
41. Enhanced flexibility in water-supply infrastructure may be needed to supply water when and where it is needed during times of drought or aquifer stress.
42. Climate change may alter how municipal providers manage groundwater pumping to help ensure capacity during times of drought.
43. Changing hydrologic conditions and uncertainty brought on by climate change will require an active, cooperative effort between state and federal water agencies, county and city governments, municipal water providers,

irrigation entities, and valley residents to help manage demand and ensure an adequate future municipal water supply.

Competing Demands

44. This report focuses on supplying projected increases in municipal water demand. At the same time, water demand for non-municipal agricultural, commercial, industrial, irrigation, and domestic uses likely will also increase (because of increased population and economic growth and increased summer temperatures). The availability of some of the municipal water-supply options described in this report may be constrained not only by physical supply but by competing demands from non-municipal users.

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