# Technical Memorandum

# Modified Flows 2020, Upper Snake River Basin

**Columbia Pacific Northwest Region**

**U.S. Department of the Interior** October 2020

# Mission Statements

The Department of the Interior conserves and manages the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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# Acronyms and Abbreviations

| Acronym or Abbreviation | Definition |
|---|---|
| AF | Acre-feet |
| AMFI | Snake River at Neeley American Falls Inflow |
| ANDI | South Fork Boise River at Anderson Ranch |
| ANTI | Henrys Fork at St. Anthony, Idaho |
| ARKI | Boise River Arrowrock Inflow |
| BIGI | Boise River at Glenwood Bridge near Boise, Idaho |
| BFTI | Snake River near Blackfoot, Idaho |
| BLFI | Blackfoot River near Blackfoot, Idaho |
| BOI | Boise River Subbasin |
| BOMI | Boise River near Middleton, ID |
| BPA | Bonneville Power Administration |
| BRN | Snake River at Brownlee Dam Inflow |
| BSHI | Blackfoot River near Shelley, Idaho |
| BTSI | Boise River near Twin Springs, Idaho (TwSp) |
| Buhl | Snake River near Buhl, Idaho |
| cfs | Cubic feet per second |
| CHEI | Falls River near Chester, Idaho |
| Corps | U.S. Army Corps of Engineers |
| CSCI | North Fork Payette River Cascade Dam Inflow |
| DEDI | Deadwood River Deadwood Reservoir Inflow |
| DGGI | Teton River above South Leigh Creek |
| EMMI | Payette River Black Canyon Reservoir Inflow |
| FALI | Falls River near Squirrel, Idaho |
| GRS | Grassy Lake Inflow |
| HENI | Henrys Lake Inflow |
| HEII | Snake River near Heise, Idaho |
| HFAI | Henrys Fork near Ashton, Idaho |
| HRSI | Payette River near Horseshoe Bend, Idaho |
| IDWR | Idaho Department of Water Resources |
| ISLI | Henrys Fork near Island Park, Idaho Island Park Inflow |
| JCKY | Jackson Lake Inflow |

| Acronym or Abbreviation | Definition |
|---|---|
| JKSY | Snake River below Flat Creek near Jackson, Wyoming |
| KIMI | Snake River near Kimberly, Idaho |
| LUCI | Boise River Lucky Peak Inflow |
| MILI | Snake River at Milner, Idaho |
| MINI | Snake River near Minidoka, Idaho |
| OWYI | Lake Owyhee and Owyhee River near Nyssa, Oregon |
| PABI | North Fork Payette River near Banks, Idaho |
| PALI | Snake River near Irwin Palisades Inflow |
| PARI | Boise River near Parma, Idaho |
| PAY | Payette River Subbasin |
| PAYI | North Fork Payette River at McCall |
| PLEI | Payette River near Leatha, Idaho |
| PRLI | South Fork Payette River at Lowman, Idaho |
| PRPI | Payette River near Payette, Idaho |
| Reclamation | Bureau of Reclamation |
| REXI | Henrys Fork near Rexburg, Idaho |
| RIRI | Willow Creek below Ririe Dam Ririe Dam Inflow |
| SHYI | Snake River near Shelley, Idaho |
| SKHI | Snake River at King Hill, Idaho |
| SNK | Upper Snake River Subbasin |
| SnkblwSalmon | Snake River below Lower Salmon Falls near Hagerman, Idaho |
| SWAI | Snake River near Murphy, Idaho |
| TEAI | Teton River near St. Anthony, Idaho |
| TRXI | Teton River at mouth |
| VALO | Malheur River below Nevada Dam near Vale, Oregon (Malheur) |
| WEII | Snake River near Weiser, Idaho |
| WFWI | Willow Creek at mouth near Idaho Falls, Idaho |
| WRCC | Western Regional Climate Center |

# 1. Introduction

Modified Flows, as computed by the Bureau of Reclamation (Reclamation), are the historical unregulated streamflows from 1928 through 2018 adjusted to reflect what would have occurred with 2020 level reservoir regulation and 2020 level demands. Reclamation produces these flows for the Deschutes, Upper Snake, and Yakima river systems and provides the data to Bonneville Power Administration (BPA) for use in Columbia River System models.

The Modified Flows produced by Reclamation are different from the Modified Flows produced by the U.S. Army Corps of Engineers (Corps) and BPA for other parts of the Columbia System. For inputs other than from the Deschutes, Upper Snake, and Yakima, the Corps and BPA use streamflows that would have been observed if current irrigation depletions (as of year 2018) existed in the past and if the effects of river regulation were removed; for these locations, these flows are also termed Modified Flows. Stated another way, Modified Flows from the Corps and BPA differ from those produced by Reclamation in that the Corps/BPA Modified Flows are unregulated and Reclamation's are regulated; both sets are adjusted for the influence of irrigation.

Modified Flows quantified in the Pacific Northwest by the Corps, BPA and Reclamation are used together as baseline streamflows for analysis of future conditions, such as changes to the Federal Columbia River Power System due to operational or climatic changes.

This report describes the data, models, and processes that were used to develop the 2020 level Modified Streamflows for the Upper Snake River. Figure 1 shows a map of the basin and the included tributaries.

## 1.1. Reclamation Modified Flows Process

Modified Flows in the Deschutes, Upper Snake, and Yakima river basins are generated using the generalized process outlined below.

1. Unregulated reach gains/losses in the basin are developed using measured historical data. Unregulated flows at gaged locations are developed using these reach gains/losses.
2. A demand pattern for each diversion location is developed to represent current level conditions.
3. The regulation model is updated to include current level reservoir operations.
4. The unregulated reach gains/losses are input into the model along with the current level demand pattern. The output is the Modified Flows dataset.

The details of this process for the Upper Snake basin are described in this document.

## 1.2. Differences from Modified Flows 2010

The Modified Flows produced in 2020 used improved modeling tools and processes from the 2010 study (Modified Flows 2010) and therefore resulted in differences between the two datasets. Modified Flows 2010 were developed using a monthly timestep in the MODSIM platform. Between the publication of Modified Flows 2010 and this study, Reclamation developed a new daily timestep model for the Upper Snake River Basin using RiverWare. MODSIM and RiverWare are configured differently in the way that they solve for reservoir releases in the Upper Snake basin. MODSIM uses elevation targets that, depending on the time of year, can account for releases for flood risk management, irrigation, and other releases, whereas RiverWare uses rule curves with forecasted runoff and other logic to determine the release. These differences, combined with the change from a monthly to daily timestep, resulted in a change in timing of reservoir releases, particularly in the spring months where the RiverWare model more accurately represented releases for flood risk management.

Another difference between the two studies is the approach for calculating the influence of groundwater on unregulated and regulated streamflow. The 2010 study incorrectly assumed that all of the water diverted from the stream eventually returned to the river in the form of groundwater return flows, rather than having a portion be consumptively used. This resulted in too much water being removed from the river in the unregulated flows (as historical return flows are subtracted from unregulated flows) and too much being added in in the regulated flows (as current level return flows are added back to the regulated flows). Because these two calculations are the inverse of each other (the quantity is subtracted in the unregulated calculation and added back to the regulated flows), and because both had the incorrect assumption of zero consumptive use, the effect in the 2010 Modified Flows regulated dataset was minimized, particularly in later years where the historical effect would have been at the current conditions level. However, the unregulated flows were underestimated by as much as 10 percent annually.

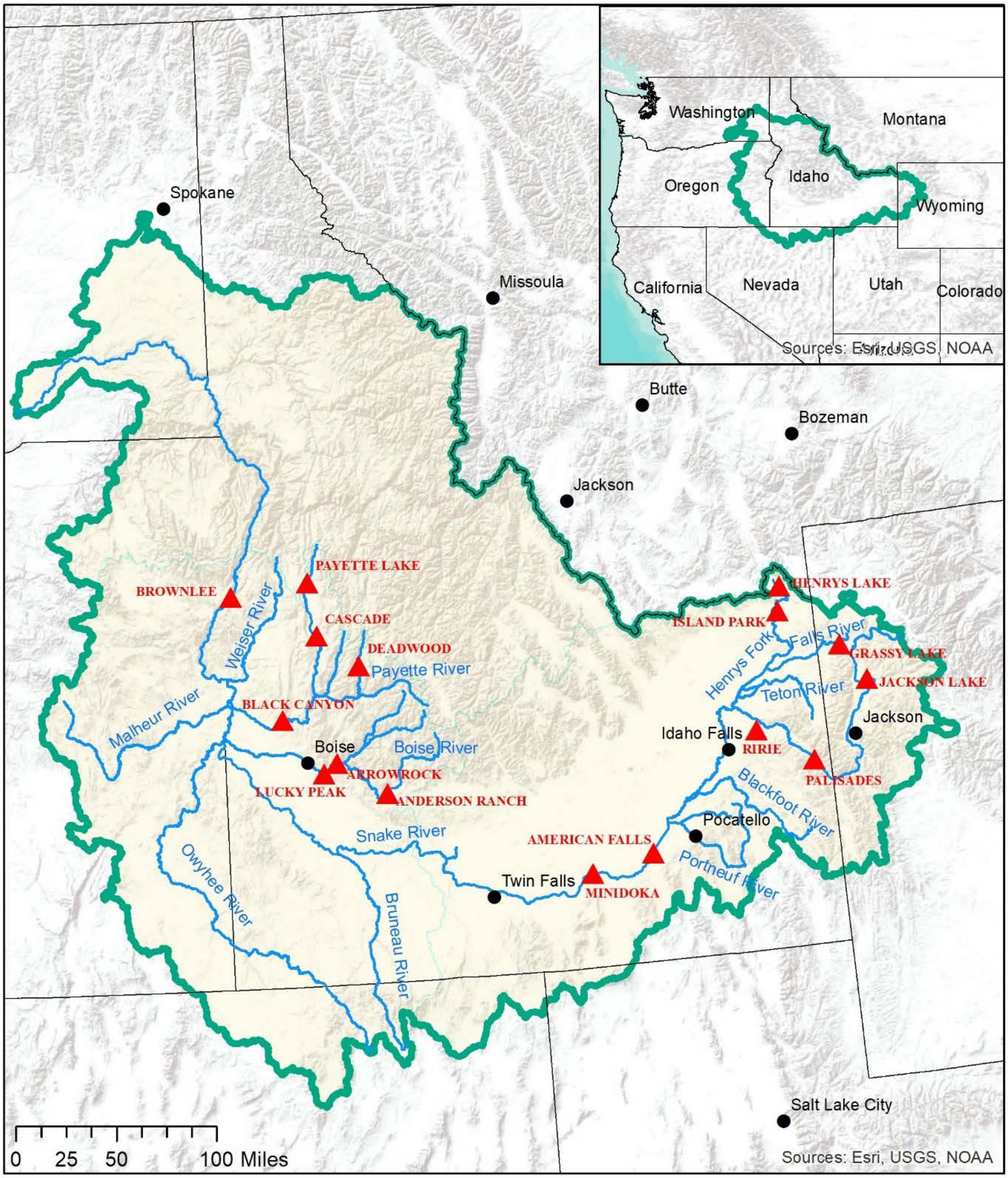


Figure 1. Upper Snake River, including the Boise and Payette River basins

# 2. Unregulated Flow Dataset Development

Unregulated flows are the basis for any water resources modeling study because they describe the flow in the system without any influence from regulation activities such as reservoir operation, diversion from the river, or return flow from irrigation activities. The intent of developing unregulated flows is to estimate the natural inflows to the system using measured data from the regulated system.

## 2.1. Unregulated Flows Methodology

Unregulated flows were calculated by first calculating reach gains and losses based on mass balance equations that assume that water can neither be created nor destroyed. Equation 1 is the generalized equation that is used to calculate gains/losses to a river reach that contains a reservoir, where $g/l$ is calculated gains and losses, $i$ is measured inflow, $o$ is measured outflow, $d$ is measured diversion, $r$ is calculated return flows, $e$ is reservoir evaporation, $s$ is reservoir seepage, $p$ is groundwater pumping and $\Delta s$ is the change in reservoir storage.

$$g/l = o - i + d - r + e + s + p + \Delta s \qquad \text{Equation 1}$$

Equation 2 is the generalized equation that is used to calculate gains/losses to a river reach without a reservoir.

$$g/l = o - i + d - r + p \qquad \text{Equation 2}$$

The reach gains and losses are then summed at gage locations to calculate the unregulated flows. A detailed methodology for determining unregulated reach gains and losses can be found in a separate Reclamation report[1] (Reclamation 2017). The equations used to calculate the unregulated gains and losses are presented in Appendix A and Appendix B of this document.

For the Upper Snake River, a daily MODSIM model was used to calculate the gains, losses, and unregulated flows. The MODSIM model uses the equations described above with measured regulated flow data.

This study included an additional step where reach gains and losses were quality controlled before being summed in to unregulated flows. This was done by examining the gains and losses for outliers caused by missing data or gage measurement errors; such errors could have been caused by many factors, including high flows, wind, and lack of accurate daily data before 1980. Negative outliers were often followed by positive outliers within days when the gage corrected itself and vice versa. These paired negative-positive outliers (greater than approximately 4,000 cubic feet per second (cfs)) were smoothed out while still conserving the amount of water flowing through each gage.

[1] The referenced document is focused on the Deschutes basin, but the Snake basin uses the same processes for calculating gains and losses.

## 2.2. Groundwater

When water is applied to irrigated lands, excess water can seep below the root zone and travel, via the aquifer, back to the river. The time it takes for that water to return to the river is described by a time-dependent function known as a groundwater response function. Response functions are also used to describe the lagged effect on the river due to pumping water from the aquifer. The response functions for the Upper Snake model were calculated using a groundwater model of the basin (IDWR 2013). In addition, the groundwater model describes where the water returns to the system and these locations are incorporated into the MODSIM unregulation model.

For the 2020 Modified Flows study, the historical effects of groundwater were removed from the gains and losses using historical diversion rates and the response functions. This is different than the approach taken for the 2010 Modified Flows study, where the historical influence of groundwater was left in the gains/losses; it was later removed when the regulated flows were calculated.

## 2.3. Unregulated Flows in the Upper Snake

Unregulated flows in the Upper Snake basin were calculated at a daily timestep for the period of October 1928 through September 2018. Figure 2 shows the time series of the daily unregulated flows for selected gage locations in the Upper Snake basin (blue dashed). Monthly average flows were calculated from the daily time series, and the plots show how much the variability was smoothed by the averaging process. The day-to-day variability is larger than the monthly average variability, which can be partly attributed to daily weather events. This can be especially true on reaches with reservoirs where wind and wave activity from boats on the reservoirs can cause changes to the daily measured forebay elevations; small changes in forebay elevation can translate into large variation in storage[2].

[2] Reservoir storage is computed from measured forebay elevations.

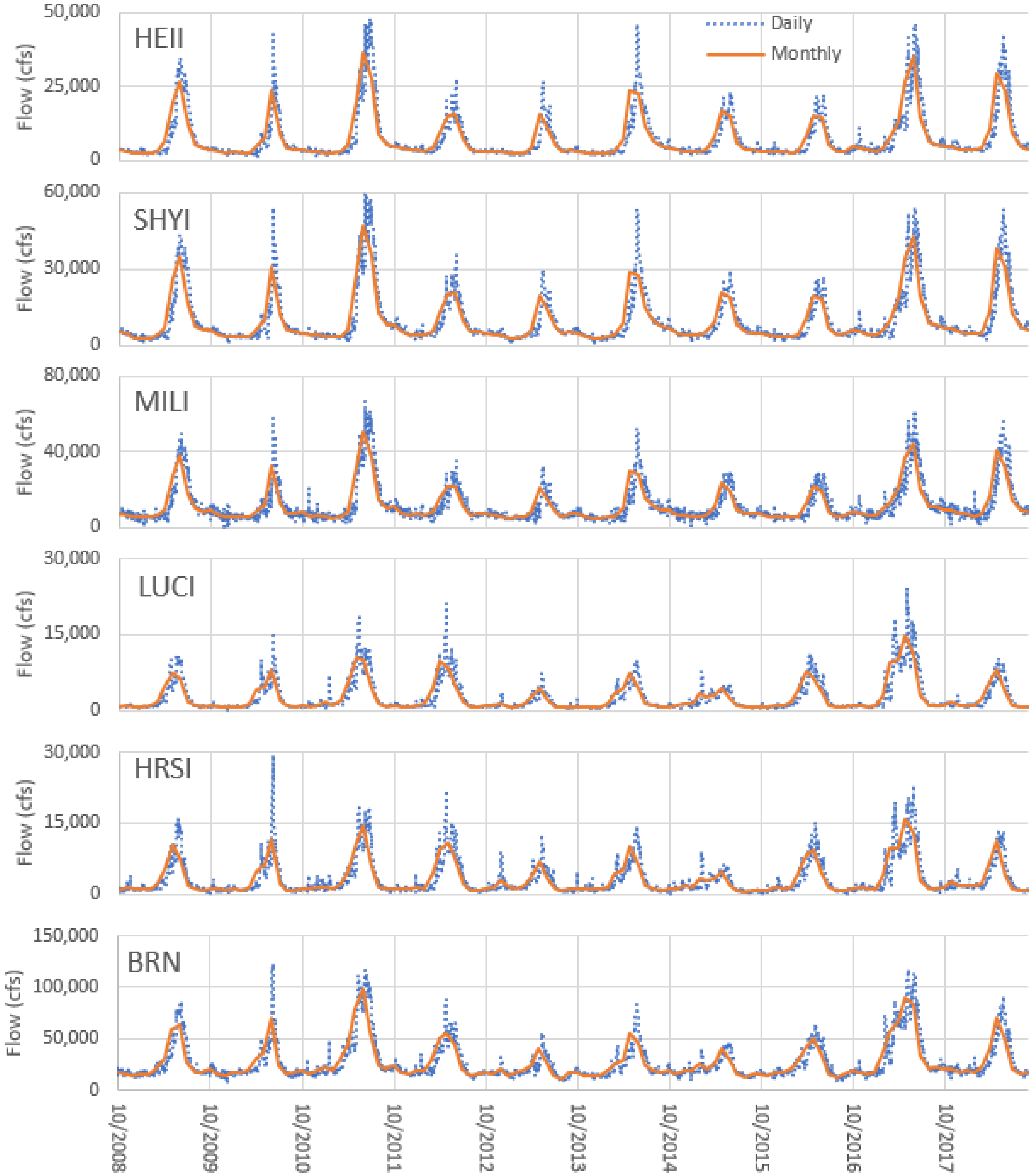


Figure 2. Selected unregulated flows for the different gages in the Upper Snake on a daily (blue) and monthly (orange) time step

Compared to unregulated flows at Brownlee from 2010 (Reclamation 2010; BPA 2011), the 2020 unregulated flows are higher. The differences in annual volume and peaks for 1999 through 2008 (the last ten years of overlap in the two datasets) are presented in Table 1. The annual volumes for the 2020 dataset are ten percent higher than the 2010 dataset on average, largely due to the groundwater calculation discussed in Section 2.2. The maximum monthly volumes for 2020 are 1 percent higher than the 2010 dataset average, since flood peaks are not notably influenced by groundwater. The minimum monthly volumes are 23 percent higher than the 2010 dataset, where the groundwater effects are most pronounced. As described in Section 1.2, this difference is largely due to too much water being removed from the river when subtracting the influence of groundwater return flows in the 2010 Modified Flows study.

Table 1. Comparison of the Brownlee 2020 Unregulated Flows dataset to the 2010 Unregulated Flows dataset for years 1999 to 2008 (the last 10 years of overlap). All volumes are in acre-feet.

| Year | Annual Volume | | Maximum Monthly Volume | | Minimum Monthly Volume | |
|---|---|---|---|---|---|---|
| | 2020 | 2010 | 2020 | 2010 | 2020 | 2010 |
| 1999 | 26,095,713 | 23,806,645 | 5,120,911 | 4,923,979 | 1,149,840 | 900,727 |
| 2000 | 19,432,475 | 17,551,353 | 3,351,271 | 3,212,959 | 964,230 | 806,483 |
| 2001 | 13,449,658 | 11,549,216 | 2,154,087 | 2,113,360 | 767,176 | 571,069 |
| 2002 | 16,001,081 | 13,938,439 | 2,697,309 | 2,528,530 | 807,295 | 638,497 |
| 2003 | 16,102,551 | 14,379,502 | 3,098,911 | 2,888,299 | 784,264 | 634,684 |
| 2004 | 16,066,845 | 14,118,924 | 2,517,232 | 2,424,676 | 824,421 | 626,647 |
| 2005 | 15,985,499 | 14,658,107 | 3,512,038 | 3,712,983 | 801,510 | 620,415 |
| 2006 | 25,026,981 | 22,972,314 | 5,481,723 | 5.601,418 | 946,861 | 637,144 |
| 2007 | 14,793,127 | 13,383,347 | 2,410,413 | 2,545,562 | 750,961 | 562,435 |
| 2008 | 19,015,332 | 16,902,094 | 3,867,369 | 3,766,908 | 938,304 | 716,385 |
| Averages | 18,196,926 | 16,325,994 | 3,421,126 | 3,371,867 | 873,486 | 716,385 |
| % Difference vs. 2010 | 10% | -- | 1% | -- | 23% | -- |

# 3. Modified Flow Dataset Development

Modified Flows are flows that represent 2020 level reservoir operations and irrigation demand levels throughout the period of record, 1928 through 2018. The Upper Snake RiverWare model was used to develop the Modified Flows dataset from 1928 through 2018.

## 3.1. Reference RiverWare Model

The water resources modeling for the 2020 Modified Flows study was conducted using a daily timestep RiverWare (Reclamation 2020) model of the Upper Snake River basin above Brownlee Reservoir. A short summary of the model is presented in this section. A complete description of the model development is provided in a separate document (Reclamation 2020).

The RiverWare model represents the Upper Snake River down to Brownlee Reservoir. It explicitly models operations in the Upper Snake above Milner, Boise River, and Payette River (Figure 1). Other tributaries, such as the Owyhee, are represented as inflow nodes.

RiverWare is a general rules-based modeling platform that requires full definition of the physical layout of a river system and logic to define operation of the system. The model is constructed using RiverWare objects that define reservoirs, diversions, river reaches, and river gages. Figure 3, Figure 4, and Figure 5 diagram the layout of the RiverWare model for the Upper Snake River, the Boise and Payette Rivers, and the Henrys Fork of the Snake River subbasins, respectively. The red circles indicate water users (representing diversions) and are labeled with the river reach or water user acronym that they serve. The orange boxes indicate stream gages and are named with their four-letter acronym from the Hydromet program (https://www.usbr.gov/pn/hydromet/), with the exception of a few USGS gages (Appendix B). The green triangles represent locations where gains and losses are input into the model. The model itself includes significantly more detail than these schematics, but the figures illustrate the most relevant features of the model.

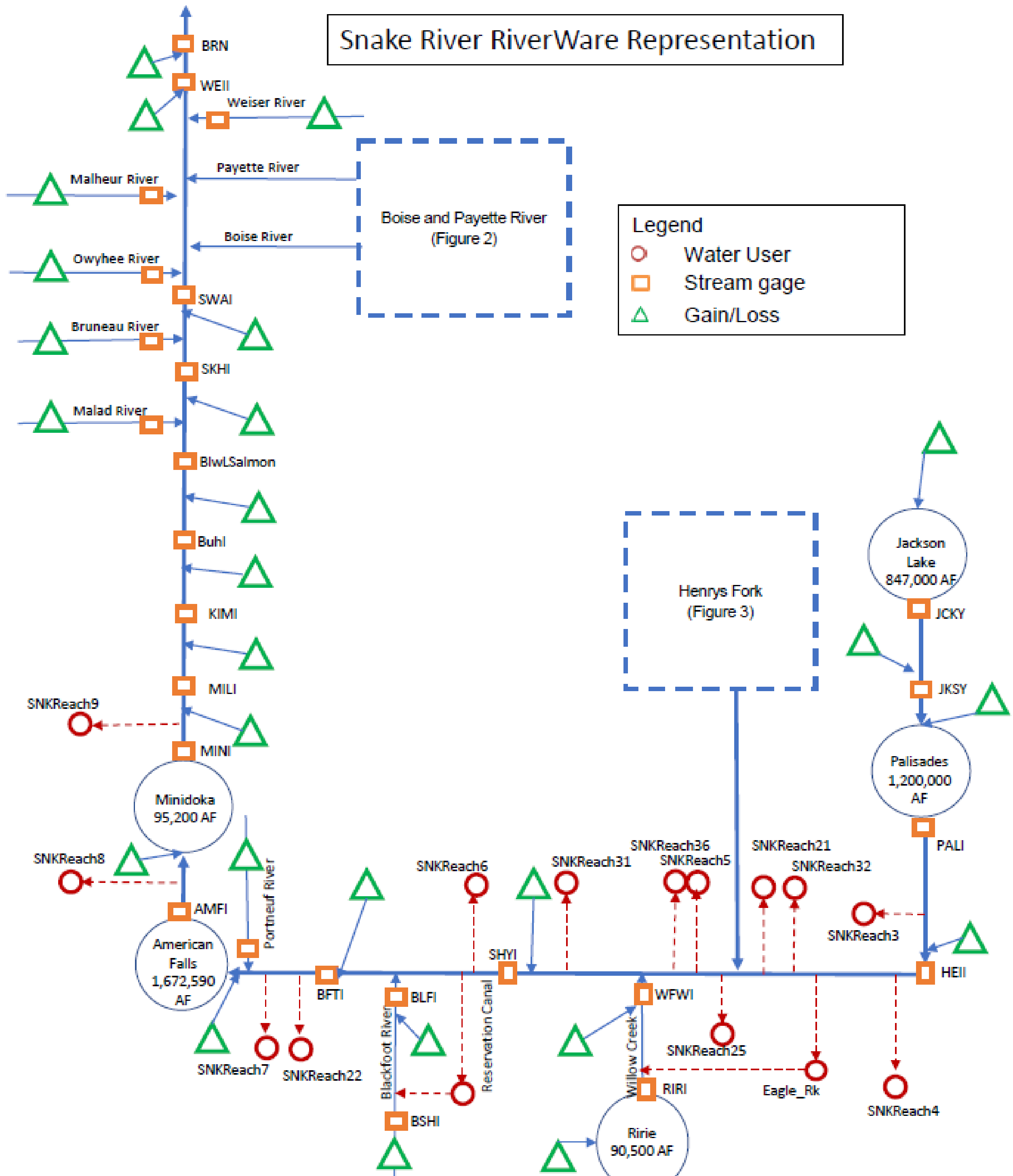


Figure 3. Schematic of RiverWare representation of the Upper Snake River

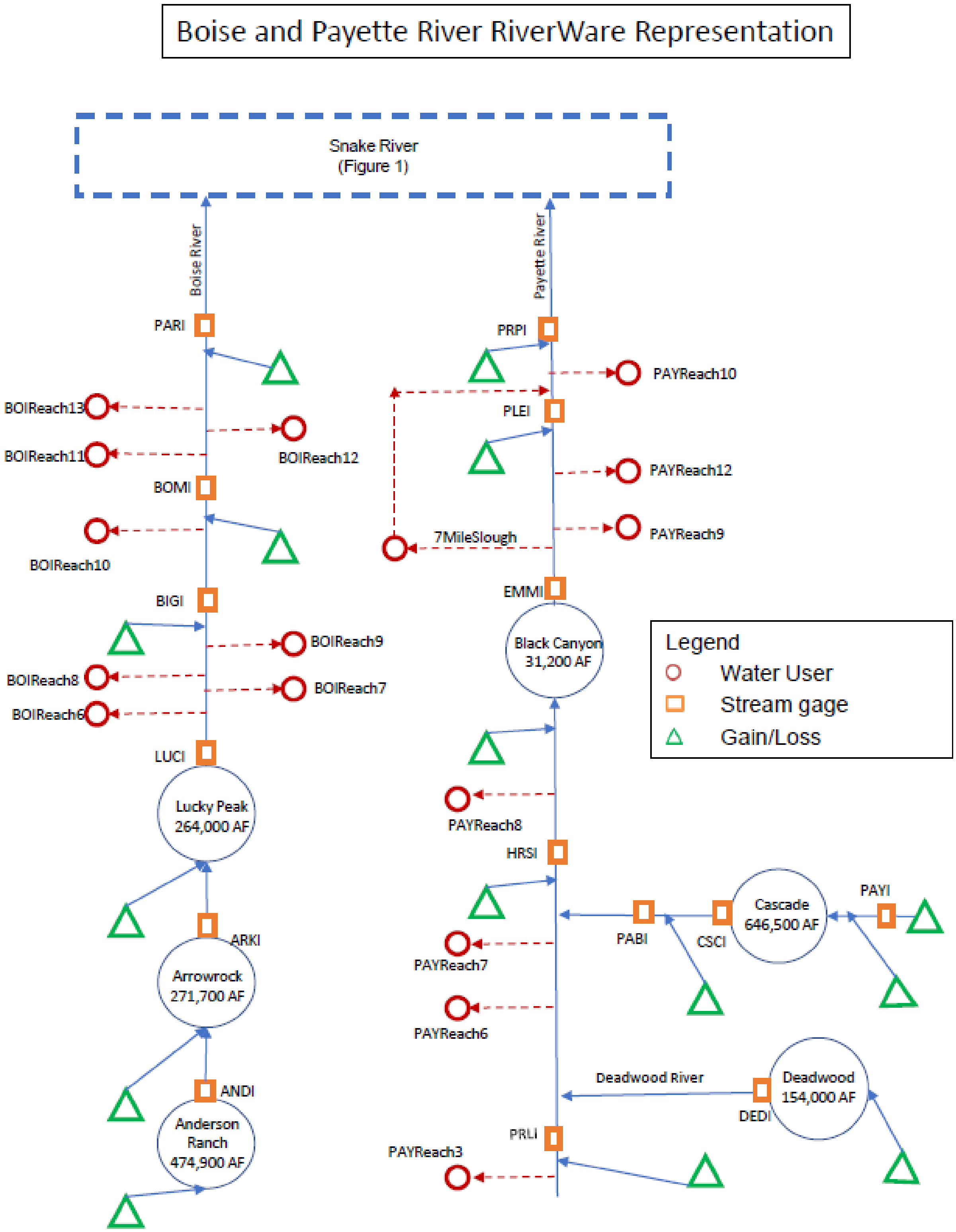


Figure 4. Schematic of RiverWare representation of the Boise and Payette Rivers

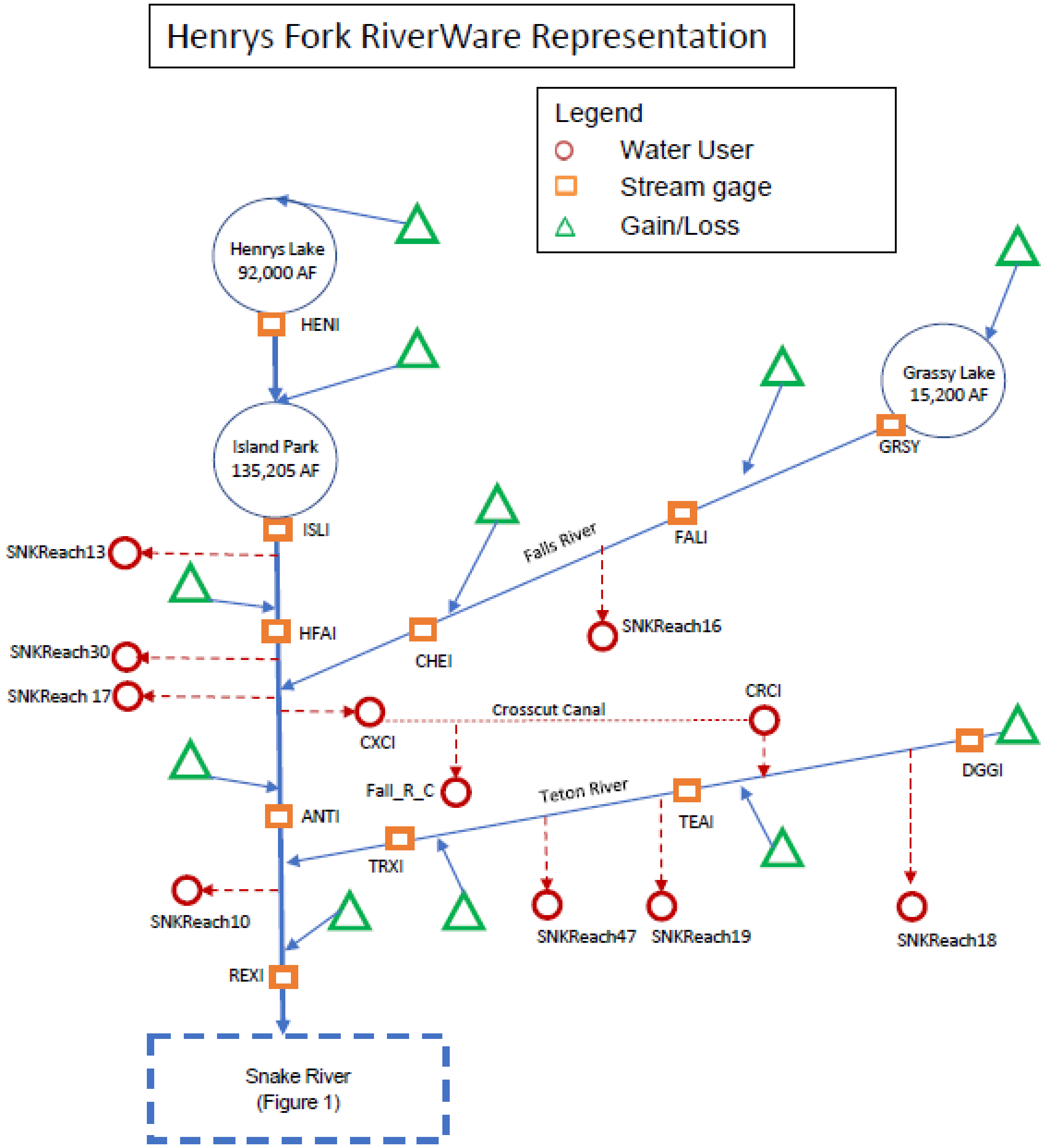


Figure 5. Schematic of RiverWare representation of Henrys Fork of the Upper Snake River

Operating rule logic was first developed to simulate historical operations from 1994 through 2006, the years in which measured data could be compared to model output to ensure proper operation. The model used water rights, diversion patterns, and inflow hydrology representative of the time period. Detailed information about the inputs and calibration quality is provided in a separate report describing model development (Reclamation 2020).

It is important to recognize that there are many assumptions and simplifications that are required when developing a model. The data and operating logic attempt to simulate realistic conditions and water management as closely as possible, but it is likely there will be some operations that are handled differently in real time.

## 3.2. Irrigation Demand Pattern

The Modified Flows study is designed to represent the response of a system using the current operational rules and demand levels. Demands were changed from the historical daily time series that varies from year to year to categorized dry, average, and wet year weekly patterns that represent average irrigation diversions calculated from measured data for recent years (2009 through 2018). Though the model is run at a daily timestep, demands change weekly to be more representative of real-world operations.

For the Upper Snake, Boise, and Payette, dry and wet years were categorized as the 25$^{th}$ and 75$^{th}$ percentile annual runoff for the entire record (1928 through 2018). Table 2 shows the years used to create the wet, average, and dry demand patterns using diversion data from recent years (2009 through 2018) as they were categorized using the entire runoff period (1928 through 2018). Table 3 shows the total average annual volume for each dry, average, and wet year pattern for reaches of the river and major canals. Figure 6 shows the sum of the weekly diversion patterns that is repeated every wet, average, and dry year for the model simulation period for the Boise, Payette, and Upper Snake subbasins. Diversions for other small tributary basins or below Milner were imbedded in the unregulated flows and not adjusted for current conditions. These diversions are small relative to the rest of the basin and therefore the effect is considered negligible.

Table 2. Years used to create wet, average, and dry patterns for the different basins

| Basin | Wet Years | Average Years | Dry Years |
|---|---|---|---|
| Upper Snake | 2009, 2011, 2017, 2018 | 2010, 2012, 2014, 2015, 2016 | 2013 |
| Boise River | 2017 | 2009, 2010, 2011, 2012, 2016, 2018 | 2013, 2014, 2015 |
| Payette River | 2011, 2017 | 2009, 2010, 2012, 2014, 2018 | 2013, 2015 |

Table 3. Total annual demand for the dry, average, and wet year patterns used in modeling

| River | Reach or Canal | Total Annual Demand (acre-feet) | | |
|---|---|---|---|---|
| | | Wet | Average | Dry |
| Snake River | Reach3Diversions_SNK | 12,016 | 9,836 | 9,242 |
| Snake River | Reach4Diversions_SNK | 1,184,432 | 1,169,773 | 1,076,131 |
| Snake River | Reach5Diversions_SNK | 434,014 | 486,374 | 481,608 |
| Snake River | Reach6Diversions_SNK | 742,232 | 823,956 | 749,180 |
| Snake River | Reach7Diversions_SNK | 50,668 | 67,828 | 68,747 |
| Snake River | Reach8Diversions_SNK | 589,018 | 614,628 | 647,466 |
| Snake River | Reach9Diversions_SNK | 2,766,151 | 2,744,869 | 2,744,733 |
| Snake River | Reach10Diversions_SNK | 222,359 | 233,087 | 213,201 |
| Snake River | Reach13Diversions_SNK | 935 | 1,510 | 1,818 |
| Snake River | Reach16Diversions_SNK | 132,970 | 131,938 | 118,886 |
| Snake River | Reach17Diversions_SNK | 253,732 | 243,364 | 228,863 |
| Snake River | Reach18Diversions_SNK | 17,441 | 27,238 | 28,449 |
| Snake River | Reach19Diversions_SNK | 192,445 | 197,738 | 177,851 |
| Snake River | Reach21Diversions_SNK | 9 | 15 | 29 |
| Snake River | Reach22Diversions_SNK | 45,756 | 47,650 | 43,921 |
| Snake River | Reach23Diversions_SNK | 73 | 195 | 265 |
| Snake River | Reach25Diversions_SNK | 201,419 | 210,212 | 189,042 |
| Snake River | Reach30Diversions_SNK | 7,108 | 6,845 | 4,677 |
| Snake River | Reach31Diversions_SNK | 150,631 | 162,595 | 152,722 |
| Snake River | Reach32Diversions_SNK | 188,511 | 192,377 | 181,422 |
| Snake River | Reach36Diversions_SNK | 76,598 | 76,925 | 73,773 |
| Snake River | Reach47Diversions_SNK | 14,187 | 11,922 | 11,524 |
| Snake River | Eagle_Rk | 187,165 | 206,683 | 208,196 |
| Snake River | CXCI | 68,973 | 77,969 | 86,088 |
| Snake River | Fall_R_C | 28,489 | 38,534 | 38,356 |
| Snake River | Reservation | 62,104 | 128,551 | 123,354 |
| Payette River | Reach8Diversions_PAY | 429,895 | 458,291 | 484,311 |
| Payette River | Reach9Diversions_PAY | 219,998 | 229,527 | 238,196 |
| Payette River | Reach10Diversions_PAY | 136,159 | 156,237 | 171,886 |
| Payette River | Reach12Diversions_PAY | 87,250 | 84,803 | 92,355 |

| River | Reach or Canal | Total Annual Demand (acre-feet) | | |
|---|---|---|---|---|
| | | Wet | Average | Dry |
| Payette River | Reach13Diversions_PAY | 3,449 | 4,028 | 4,179 |
| Payette River | SevenMileSloughAtHead | 113,633 | 113,134 | 115,568 |
| Boise River | Reach5Diversions_BOI | 181 | 131 | 145 |
| Boise River | Reach6LowerDiversions_BOI | 6 | 4 | 3 |
| Boise River | Reach6UpperDiversions_BOI | 133 | 117 | 26 |
| Boise River | Reach7Diversions_BOI | 790,538 | 782,178 | 661,916 |
| Boise River | Reach8Diversions_BOI | 158,118 | 171,913 | 150,849 |
| Boise River | Reach9Diversions_BOI | 123,723 | 126,977 | 109,550 |
| Boise River | Reach10Diversions_BOI | 230,449 | 235,655 | 219,184 |
| Boise River | Reach11Diversions_BOI | 177,189 | 197,771 | 168,747 |
| Boise River | Reach12Diversions_BOI | 56,785 | 62,285 | 58,619 |
| Boise River | Reach13Diversions_BOI | 39,722 | 62,991 | 52,065 |

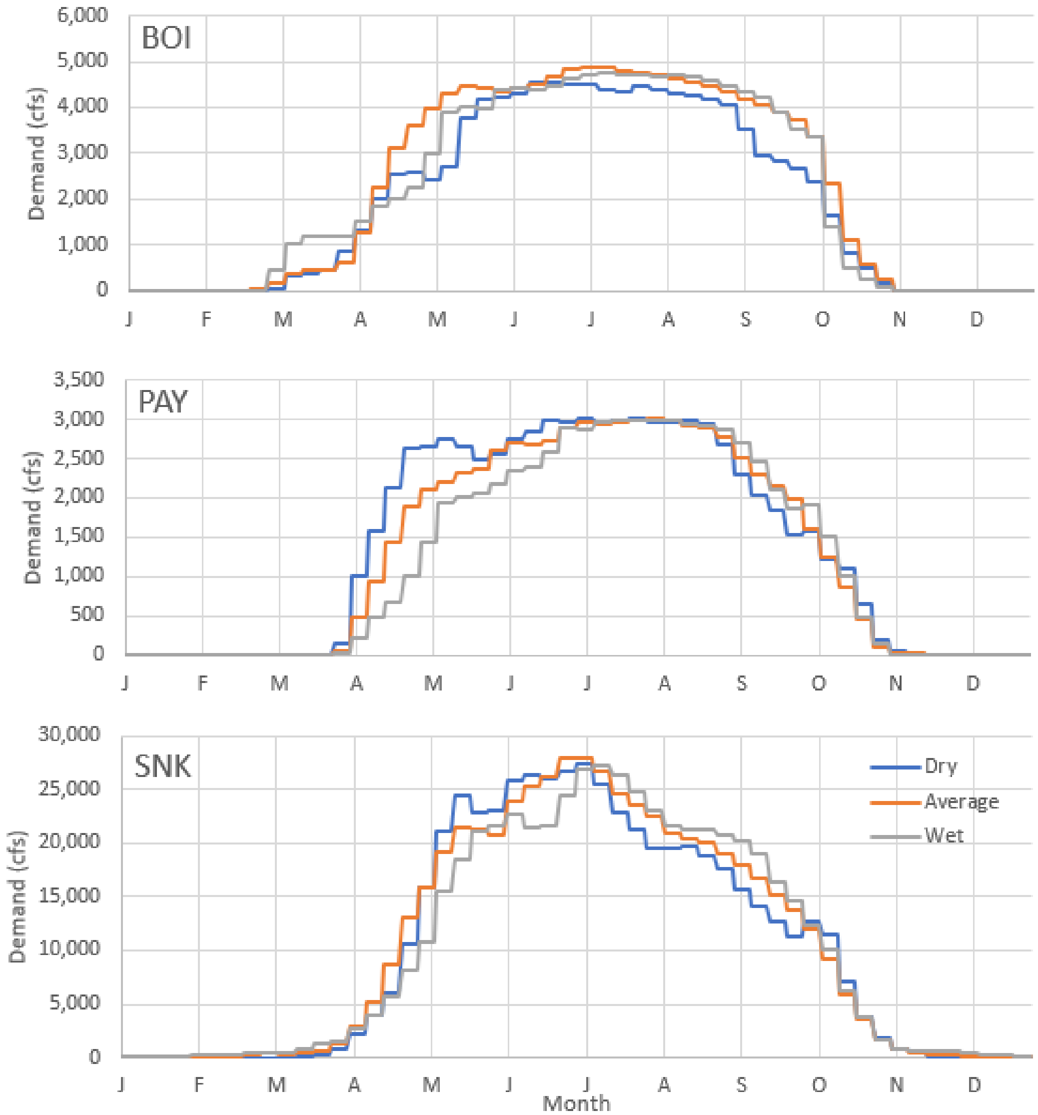


Figure 6. Annual irrigation demand diversion patterns for the sum of all the water users for each of the subbasins (Boise (BOI), Payette (PAY) and Upper Snake (SNK)) that are repeated for every dry, average, and wet year in the model simulations

## 3.3. Current Level of Groundwater Pumping and Return Flows

For the Modified Flows analysis, the model simulated groundwater responses based on 2020 level demands. In the Upper Snake basin (excluding Boise and Payette subbasins), it can take up to 50 years for the system to equilibrate with respect to groundwater responses based on simulated response functions.

Return flows are excess irrigation water from both surface and groundwater sources that seeps below the root zone and travel, via the aquifer, back to the river. Return flows can be estimated using the total surface water diversion (*div*), total pumped water applied to lands (*pump*), and evapotranspiration (*ET*) (Equation 3).

$$return\ flows = div + pump - ET \qquad \text{Equation 3}$$

Current level return flows are calculated using Equation 3 and estimates of the water budget components for the Upper Snake River as calculated by IDWR (IDWR 2013) for 1981 through 2008[3], where *div* average 7.4[4] million acre-feet per year, *pump* averages 2 million acre-feet per year, and *ET* averages 6 million acre-feet per year. The return flows for the Upper Snake River are approximately 3.4 million acre-feet of water.

Groundwater pumping for irrigation removes approximately 2 million acre-feet of water in the Upper Snake per year. Subtracting this from the current level return flows gives a net groundwater return flow of 1.4 million acre-feet per year. In other words, the impact of groundwater return flow and groundwater pumping on the Upper Snake River is 1.4 million acre-feet per year.

Both gains from return flows and losses from groundwater pumping are represented in the RiverWare model. In order to account for the gain of groundwater flowing into the river at certain locations, response functions representing returns from irrigation locations were input directly into the RiverWare model. The most recent 50-year pre-routed return flows which allowed for equilibrium conditions were input into the RiverWare model 50 years prior to the start date. This allows the response functions to accurately calculate return flows for the early period of the model.

In order to account for the loss of groundwater flowing into the river at certain locations, response functions representing locations where water is pumped were used to estimate a yearly pattern of removal of water outside of the RiverWare model. In the RiverWare model, this pattern of loss is input at each affected reach. Figure 7 shows the sum of the annual groundwater loss patterns for the entire Snake River.

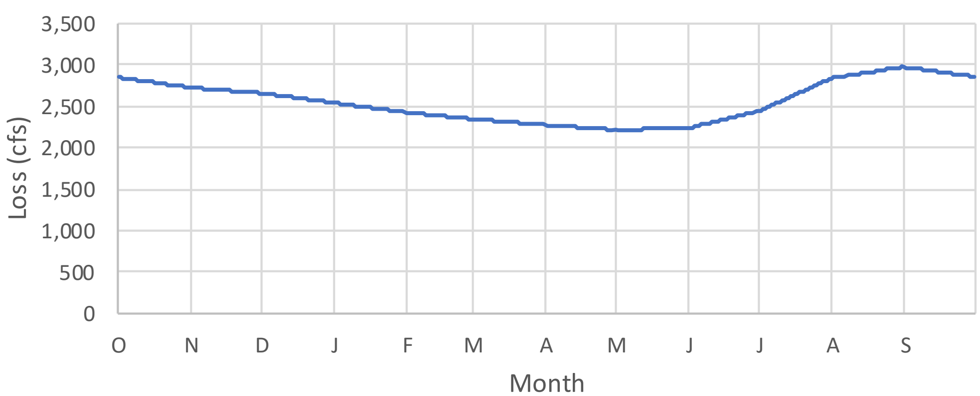


Figure 7. The total annual groundwater pumping pattern removed as reach losses throughout the Upper Snake

[3] It is assumed that groundwater influences have not changed substantially in the last 10 years.

[4] Diversion ranges from 6.3 to 8.5 million acre-feet per year (IDWR 2013).

This representation of groundwater response is considered to be more accurate that the representation used in the 2010 level Modified Flows, largely because it was identified that return flows were too large and did not remove the consumptive use portion of diversion in 2010 study.

## 3.4. Upper Snake River Operation

Baseline operating rules for the Upper Snake River reflect the operating criteria in the Upper Snake Documentation (Reclamation 2020). Generally, for each timestep, reservoir operations occur in order from upstream to downstream, with each reservoir following specific logic for flood risk management, irrigation, and minimum flow constraints.

## 3.5. 2020 Modified Flows in the Upper Snake

The 2020 Modified Flows in the Upper Snake Basin have been calculated using a daily timestep. Figure 8 shows the time series of the daily regulated flows into Brownlee Dam (blue dashed). Monthly average flows were calculated from the daily time series and are also shown on the figure (orange solid line). The plots show how much the variability was smoothed by the averaging process.

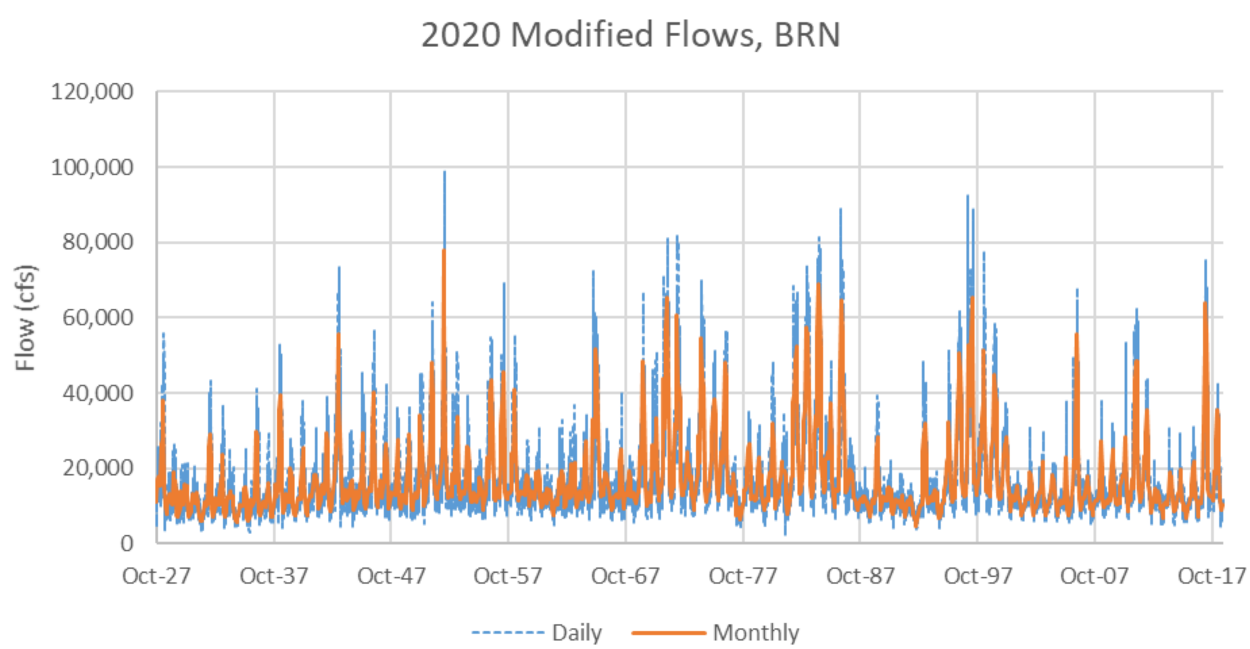


Figure 8. 2020 Modified Flows data set for BRN for water years 1928 to 2018

# 4. Discussion

The Modified Flows calculated in the 2020 level of development update are slightly different than the 2010 Modified Flows (Reclamation 2010; BPA 2011) data set. This is because different models were used (MODSIM for 2010 and RiverWare for 2020), and because the 2020 model was run at a daily timestep instead of monthly. The difference is also due to an updated representation of the groundwater response functions, considered to be more accurate than the 2010 representation, and to a change in the current level demand for the basin.

Figure 9 shows the total annual demand for the Snake River broken down by the Snake, Boise, and Payette subbasins. The decrease in the early 2000s was due to drought conditions, where irrigators took measures such as fallowing land to decrease overall demand. This decrease in demand during the early 2000s caused the 2010 level demands to appear lower, though it was just a reflection of the effect of this drought. From 1994 to 2017, total annual demand for irrigation averaged around 10 million acre-feet annually and the 2020 level demand averages around 9.8 million acre-feet annually.

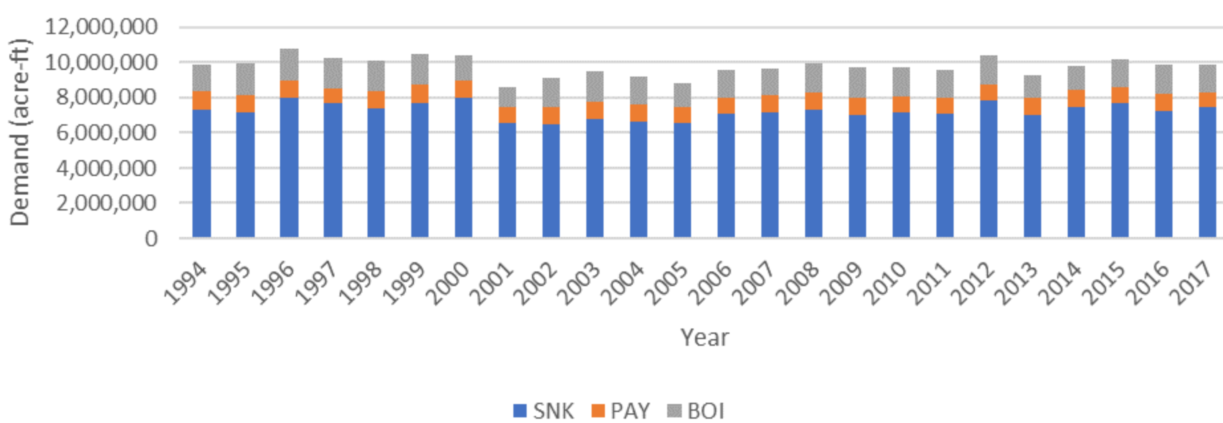


Figure 9. Total annual demand for the Snake, Boise, and Payette subbasins from 1994 to 2017

The differences in annual volume and peaks for 1999 through 2008 (the last ten years of overlap in the two datasets) are presented in Table 4. The annual volumes for the 2020 dataset are six percent larger than the 2010 dataset on average. The maximum monthly volumes for 2020 are five percent larger than the 2010 dataset average and the minimum monthly volumes are four percent larger. Table 5 shows the comparison of the 2020 dataset to historical data for 2009 through 2018. The annual volumes for the modeled dataset are one percent larger than the actual flows. The maximum monthly volumes modeled inflows are one percent smaller than the actual flows and the minimum monthly volumes actual inflows are six percent smaller.

Table 4. Comparison of the 2020 Modified Flows dataset to the 2010 Modified Flows dataset for years 1999 to 2008 (the last 10 years of overlap). All volumes are in acre-feet.

| Year | Annual Volume | | Maximum Monthly Volume | | Minimum Monthly Volume | |
|---|---|---|---|---|---|---|
| | 2020 | 2010 | 2020 | 2010 | 2020 | 2010 |
| 1999 | 18,339,912 | 17,435,221 | 2,690,229 | 2,660,513 | 705,432 | 732,325 |
| 2000 | 13,235,761 | 11,343,452 | 1,693,930 | 1,688,071 | 530,980 | 489,337 |
| 2001 | 8,273,367 | 7,804,078 | 948,537 | 895,114 | 461,969 | 404,432 |
| 2002 | 9,135,381 | 8,698,403 | 1,121,275 | 1,094,267 | 472,315 | 559,525 |
| 2003 | 9,072,097 | 8,431,877 | 1,354,596 | 1,108,033 | 459,778 | 445,754 |
| 2004 | 8,901,386 | 8,525,493 | 1,131,129 | 1,029,135 | 461,814 | 514,172 |
| 2005 | 8,478,417 | 7,873,598 | 1,415,450 | 1,260,811 | 450,731 | 494,707 |
| 2006 | 15,733,917 | 15,132,197 | 3,301,333 | 3,240,117 | 550,842 | 429,399 |
| 2007 | 8,934,296 | 8,176,819 | 1,111,277 | 1,166,607 | 469,897 | 397,311 |
| 2008 | 10,093,191 | 10,005,026 | 1,681,823 | 1,521,431 | 598,977 | 496,930 |
| Averages | 11,019,772 | 10,342,616 | 1,644,958 | 1,566,410 | 516,273 | 496,389 |
| % Difference vs. 2010 | 6% | -- | 5% | -- | 4% | -- |

Table 5. Comparison of the 2020 Modified Flows dataset to measured inflows into Brownlee Dam (BRN) for years 2009 to 2018. All volumes are in acre-feet.

| Year | Annual Volume | | Maximum Monthly Volume | | Minimum Monthly Volume | |
|---|---|---|---|---|---|---|
| | 2020 | Actual | 2020 | Actual | 2020 | Actual |
| 2009 | 10,607,848 | 11,149,745 | 1,549,897 | 1,641,025 | 610,667 | 628,582 |
| 2010 | 10,936,232 | 10,684,106 | 1,688,105 | 1,796,588 | 535,888 | 563,564 |
| 2011 | 17,824,772 | 18,396,635 | 2,971,192 | 3,451,537 | 669,826 | 704,807 |
| 2012 | 13,520,839 | 13,418,543 | 2,123,829 | 2,067,332 | 508,229 | 569,950 |
| 2013 | 8,116,071 | 7,952,257 | 900,909 | 864,696 | 427,269 | 446,327 |
| 2014 | 8,964,535 | 8,908,324 | 1,174,452 | 1,057,388 | 527,973 | 544,205 |
| 2015 | 8,530,452 | 8,196,218 | 1,102,791 | 1,007,008 | 407,992 | 462,109 |
| 2016 | 9,892,536 | 9,731,603 | 1,295,308 | 1,301,752 | 441,897 | 472,860 |
| 2017 | 19,611,225 | 18,980,430 | 3,803,430 | 3,724,760 | 640,350 | 628,086 |

| Year | Annual Volume | | Maximum Monthly Volume | | Minimum Monthly Volume | |
|---|---|---|---|---|---|---|
| | 2020 | Actual | 2020 | Actual | 2020 | Actual |
| 2018 | 13,440,066 | 13,172,225 | 2,120,302 | 1,960,452 | 546,224 | 621,565 |
| Averages | 12,144,458 | 12,059,009 | 1,873,021 | 1,887,254 | 531,632 | 564,205 |
| % Difference vs. Actual | 1% | -- | -1% | -- | -6% | -- |

The comparison of the monthly 2020 Modified Flows data set to the 2010 Modified Flows data set and actual inflows into Brownlee (BRN) is shown in Figure 10. The 2010 data set extends through 2008. The comparison of the daily 2020 Modified Flows data set to the actual inflows is shown for the most recent 10-year period, water years 2009 through 2018, in Figure 11. The 2020 Modified Flows data accurately represent the 2009 through 2018 water years with r-squared values of 0.92 for the daily data.

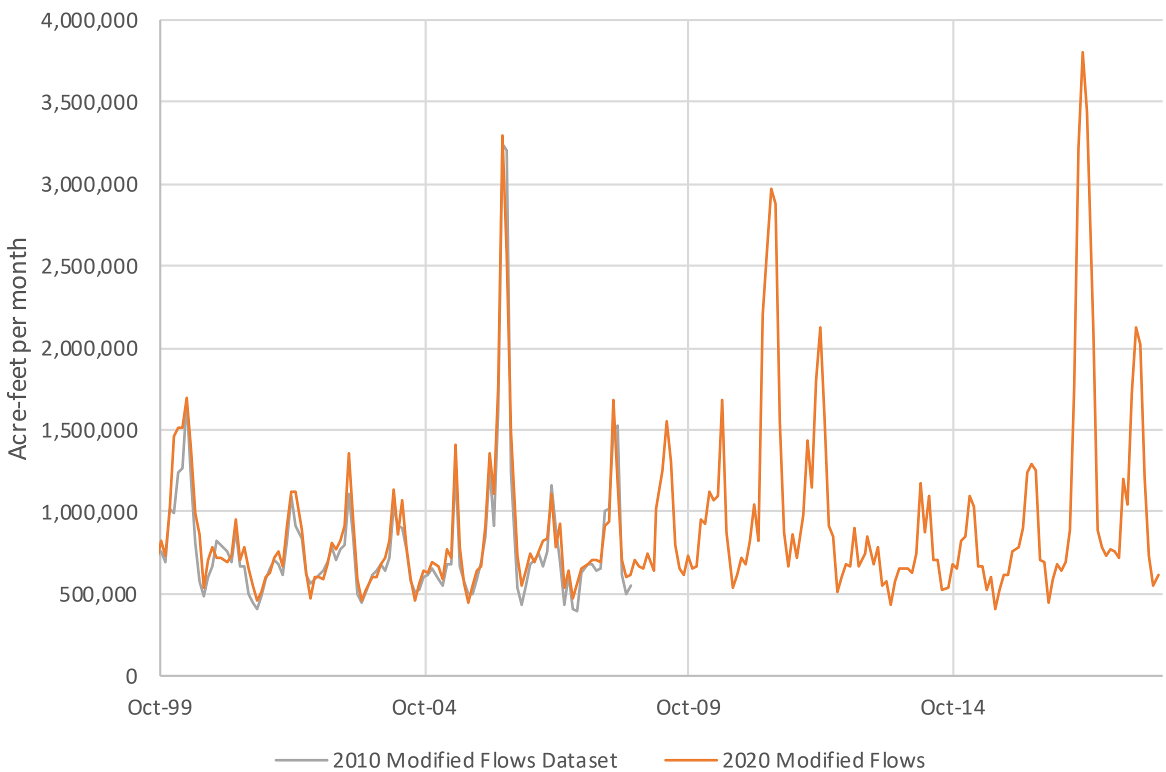


Figure 10. 2020 Modified Flows monthly data set compared with the 2010 Modified Flows data set for water years 1999 to 2018

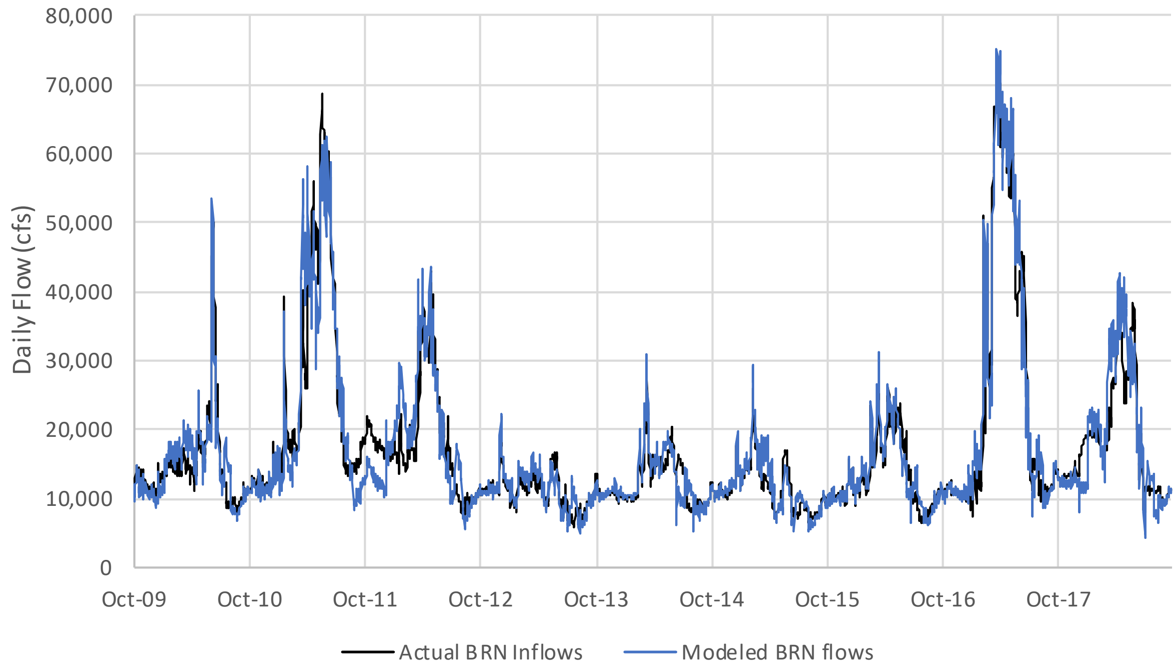


Figure 11. 2020 Modified Flows daily data set compared with the actual flows at BRN for water years 2009 to 2018

# 5. Summary

The 2020 level Modified Flows for the Upper Snake River basin represent operations, demands, and groundwater responses reflective of 2008 through 2019 conditions. These current level conditions were applied to unregulated streamflow from 1929 through 2018 at a daily timestep using a RiverWare model of the basin. Annual volumes reported at the inflow to Brownlee Reservoir are within one percent of measured volumes between 2008 and 2018.

The 2020 level Modified Flows differ from the 2010 level Modified Flows for the Upper Snake River basin largely due to changing models from a monthly MODSIM model to a daily RiverWare model, updating the representation of groundwater responses, and addressing changes to demand. The difference is within six percent of the total annual volume when comparing the years 1998 through 2008.

# 6. Literature Cited


| Parenthetical Reference | Bibliographic Citation |
|---|---|
| BPA 2011 | Bonneville Power Administration (BPA). 2011. *2010 Level Modified Streamflow*. Cooperating agencies: U.S. Army Corps of Engineers and Bureau of Reclamation. DOE/BIP-4352. August 2011. |
| IDWR 2013 | Idaho Department of Water Resources (IDWR). 2013. *Enhanced Snake Plain Aquifer Model Version 2.1 Final Report*. January 2013. |
| Reclamation 2010 | Bureau of Reclamation. 2010. *Modified and Naturalized Flows of the Snake River Basin above Brownlee Reservoir*. May 2010. |
| Reclamation 2017 | Bureau of Reclamation. 2017. *Unregulated Flows in the Upper Deschutes Basin, Oregon*. October 2017. |
| Reclamation 2020 | Bureau of Reclamation. 2020. *Upper Snake RiverWare Model: Model Documentation*. May 2020 Draft. |

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# Appendix A: Gains and Losses Calculations

A MODSIM model of the Upper Snake Basin was used to develop gains and losses for input into the RiverWare model. The detailed equations and data sources are provided below. For each calculation, there is a gainXXX and negXXX output value. This is because MODSIM cannot handle negative values, so wherever there is a loss, it is placed in the negXXX node.

Details of inflow to Henrys Lake (gainHENI/negHENI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| HENI | Henrys Lake Outflow | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| HEN | Henrys Lake historical reservoir contents | Hydromet gage. |
| General Equation | gainHENI/negHENI = (HEN.storage[t] – HEN.storage[t-1]) + HENI | |

Details of local inflow between Henrys Lake and Island Park (gainISLI/negISLI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| HENI | Gage at HENI | Hydromet gage. Lagged 1 day. |
| ISLI | Island Park Outflow | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| ISL | Island Park historical reservoir contents | Hydromet gage. |
| Evap | Evaporation from Island Park | WRCC Island Park |
| General Equation | gainISLI/negISLI = (ISL.storage[t]-ISL.storage[t-1]) + ISLI – HENI[t-1] + Evap | |

Details of local inflow between Island Park and gage at Henrys Fork near Ashton, ID (gainHFAI/negHFAI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| ISLI | Gage at ISLI | Hydromet gage. Lagged 1 day. |
| HFAI | Gage at Henrys Fork near Ashton, ID | Hydromet gage |
| PmpISLToHFAI | Historical diversions | IDWR |
| General Equation | gainHFAI/negHFAI= HFAI – ISLI[t-1] + PmpISLToHFAI | |

Details of inflow to Grassy Lake (gainGRSY/negGRSY) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| GRSY | Grassy Lake Outflow | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| GRS | Grassy Lake historical reservoir contents | Hydromet gage. |
| General Equation | gainGRSY/negGRSY = (GRS.storage[t] – GRS.storage[t-1]) + GRSY | |

Details of local inflow between Grassy Lake and gage at Falls River near Squirrel, ID (gainFALI/negFALI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| GRSY | Gage at GRSY | Hydromet gage. |
| FALI | Gage at Falls River near Squirrel, ID | Hydromet gage |
| General Equation | gainFALI/negFALI= FALI – GRSY | |

Details of local inflow between gage FALI and gage at Falls River near Chester, ID (gainCHEI/negCHEI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| FALI | Gage at FALI | Hydromet gage |
| CHEI | Gage at Falls River near Chester, ID | Hydromet gage |
| Yellow_M | Historical diversions | IDWR |
| Sqrl_Che | Historical diversions | IDWR |
| Farm_Own | Historical diversions | IDWR |
| Enterpri | Historical diversions | IDWR |
| PmpFALIToCHEISou | Historical diversions | IDWR |
| PmpFALIToCHEINor | Historical diversions | IDWR |
| Fall_Riv | Historical diversions | IDWR |
| Chest_CU | Historical diversions | IDWR |
| Chester | Historical diversions | IDWR |
| PumpCHEI | GW pumping from Zones 20 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfCHEI | Return flows from Yellow_M, Sqrl_Che, Farm_Own, PmpFALIToCHEISou, PmpFALIToCHEINor, Chest_CU, PmpISLToHFAI diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainCHEI/negCHEI=CHEI – FALI – rfCHEI + Yellow_M + Sqrl_Che + Farm_Own + Enterpri + PmpFALIToCHEISou + PmpFALIToCHEINOR + Fall_Riv + Chest_CU + Chester + PumpCHEI | |

Details of local inflow above gage at Henrys Fork near Anthony, ID (gainANTI/negANTI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| CHEI | Gage at CHEI | Hydromet gage |
| HFAI | Gage at HFAI | |
| ANTI | Gage at Henrys Fork near Anthony, ID | Hydromet gage. Missing daily data filled in using statistical methods. |
| CXCI | Historical diversions | IDWR |
| Dewey | Historical diversions | IDWR |
| Last_Cha | Historical diversions | IDWR |

| Node Name | Data Description | Data Source |
|---|---|---|
| PmpHFAIToANTI | Historical diversions | IDWR |
| FarmFr_S | Historical diversions | IDWR |
| StAnth_U | Historical diversions | IDWR |
| PumpANTI | GW pumping from Zones 15, 16, 17, 20 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfANTI | Return flows from Yellow_M, Sqrl_Che, Farm_Own, PmpFALIToCHEISou, PmpFALIToCHEINor, Chest_CU, Chester, Fall_Riv, Enterpri, PmpISLToHFAI, StAnth_U, FarmFr_S, Dewey, Last_Cha, PmpHFAIToANTI diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainANTI/negANTI=ANTI – CHEI – HFAI – rfANTI + CXCI + Dewey + Last_Cha + PmpHFAIToANTI + FarmFr_S + StAnth_U + PumpANTI | |

Details of local inflow above gage at Teton River above S Leigh Creek (gainDGGI/negDGGI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| DGGI | Gage at Teton River above S Leigh Creek | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| General Equation | gainDGGI/negDGGI = DGGI | |

Details of local inflow between gage DGGI and gage at Teton River near St. Anthony, ID (gainTEAI/negTEAI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| DGGI | Gage at DGGI | Hydromet gage |
| TEAI | Gage at Teton River near St. Anthony, ID | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| TET | Teton Reservoir historical contents | USGS gage 13054800 |
| CRCI | Crosscut Canal at End | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| CanyonCrk | Historical diversions | IDWR |
| PmpDGGIToTEAI | Historical diversions | IDWR |
| General Equation | gainTEAI/negTEAI=(TET.storage[t] – TET.storage[t-1]) + TEAI – DGGI – CRCI + CanyonCrk + PmpDGGIToTEAI | |

Details of local inflow above Teton River at Mouth (gainTRXI/negTRXI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| TEAI | Gage at TEAI | Hydromet |
| TRXI | Teton River at Mouth flow estimate | USGS gage 13055198 + USGS gage 13055340. Missing data filled in through a statistical relationship to Hydromet gage TEAI through the following equations:<br>13055198 ~= 0.3929*TEAI-20<br>13055340 ~= 0.4809*TEAI-137.81 |
| RexburgC | Historical diversions | IDWR |
| Teton_Is | Historical diversions | IDWR |
| Wilford | Historical diversions | IDWR |
| PmpTEAIToHenrys | Historical diversions | IDWR |
| Siddoway | Historical diversions | IDWR |
| General Equation | gainTRXI/negTRXI= TRXI– TEAI + RexburgC + TetonIs + Wilford + PmpTEAIToHenrys + Siddoway | |

Details of local inflow above gage at Henrys Fork near Rexburg, ID (gainREXI/negREXI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| TRXI | Gage at TRXI | USGS gage 13055198 + USGS gage 13055340 |
| ANTI | Gage at ANTI | Hydromet gage. Lagged 1 day. |
| REXI | Gage at Henrys Fork near Rexburg, ID | Hydromet gage |
| Consol_F | Historical diversions | IDWR |
| Egin_Ind | Historical diversions | IDWR |
| PumpREXI | GW pumping from Zones 11, 14, 15, 16, 17, 18, 19, 20 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfREXI | Return flows from Yellow_M, Sqrl_Che, Farm_Own, PmpFALIToCHEISou, PmpFALIToCHEINor, Chest_CU, Chester, Fall_Riv, Enterpri, PmpISLToHFAI, StAnth_U, FarmFr_S, Dewey, Last_Cha, PmpHFAIToANTI, PmpDGGIToTEAI, CanyonCrk, Wilford, PmpTEAIToHenrys, Teton_Is, Siddoway, Consol_F, Egin_Ind diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainREXI/negREXI= REXI – TRXI – ANTI[t-1] + Consol_F + Egin_Ind + PumpREXI – rfREXI | |

Details of inflow to Jackson Lake (gainJCKY/negJCKY) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| JCKY | Jackson Lake Outflow | Hydromet gage |
| JCK | Jackson Lake historical reservoir contents | Hydromet gage |
| General Equation | gainJCKY/negJCKY = (JCK.storage[t] – JCK.storage[t-1]) + JCKY | |

Details of local inflow between Jackson Lake and gage at Snake River below Flat Creek near Jackson,WY (gainJKSY/negJKSY) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| JCKY | Gage at JCKY | Hydromet gage |
| JKSY | Gage at Snake River below Flat Creek near Jackson, WY | Hydromet gage. Missing data filled in through a statistical relationship to Hydromet gage JCKY through the following equation: ~= 1.8932 *JCKY+903.61 |
| General Equation | gainJKSY/negJKSY= JKSY – JCKY | |

Details of local inflow between gage JKSY and Palisades (gainPALI/negPALI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| JKSY | Gage at JKSY | Hydromet gage. Lagged 1 day. |
| PALI | Palisades Outflow | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| PAL | Palisades historical reservoir contents | Hydromet gage |
| Evap | Evaporation from Palisades | WRCC Palisades |
| General Equation | gainPALI/negPALI = (PAL.storage[t]-PAL.storage[t-1]) + PALI – JKSY[t-1] + Evap | |

Details of local inflow between Palisades and gage at Snake River near Heise, ID (gainHEII/negHEII) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| PALI | Gage at PALI | Hydromet gage |
| HEII | Gage at Snake River near Heise, ID | Hydromet gage |
| PmpPALToHEII | Historical diversions | IDWR |
| PalCanal | Historical diversions | IDWR |
| Riley | Historical diversions | IDWR, ended in 2008 |
| General Equation | gainHEII/negHEII= HEII – PALI + PmpPALToHEII + PalCanal + Riley | |

Details of inflow to Ririe (gainRIRI/negRIRI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| RIRI | Ririe Outflow | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| RIR | Ririe historical reservoir contents | Hydromet gage |
| Evap | Evaporation from Ririe | WRCC Rexburg Ricks College |
| General Equation | gainRIRI/negRIRI = (RIR.storage[t] – RIR.storage[t-1]) + RIRI + Evap | |

Details of local inflow between Ririe and gage at Willow Creek at Mouth near Idaho Falls, ID (gainWFWI/negWFWI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| RIRI | Gage at RIRI | |
| WFWI | Gage at Willow Creek at Mouth near Idaho Falls, ID | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| BlwRRdiv | Historical diversions | IDWR |
| SandCDiv | Historical diversions | IDWR |
| BlwSandC | Historical diversions | IDWR |
| PmpRIRToSnake | Historical diversions | IDWR |
| General Equation | gainWFWI/negWFWI= WFWI – RIRI + BlwRRdiv + SandCDiv + BlwSandC + PmpRIRToSnake | |

Details of local inflow above gage at Snake River near Shelley, ID (gainSHYI/negSHYI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| HEII | Gage at HEII | Hydromet gage |
| REXI | Gage at REXI | Hydromet gage. Lagged 1 day. |
| WFWI | Gage at WFWI | Hydromet gage |
| SHYI | Gage at Snake River near Shelley, ID | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| PmpHEIIToLORI | Historical diversions | IDWR |
| FarmF_En | Historical diversions | IDWR |
| Harrison | Historical diversions | IDWR |
| Burgess | Historical diversions | IDWR |
| Anderson | Historical diversions | IDWR |
| Eagle_Rk | Historical diversions | IDWR |
| LowerDry09 | Historical diversions | IDWR |
| LowerDry55 | Historical diversions | IDWR |
| PmpDryBed | Historical diversions | IDWR |
| Sunnydel | Historical diversions | IDWR |
| ButteMrk | Historical diversions | IDWR |
| BearTrap | Historical diversions | IDWR |

| Node Name | Data Description | Data Source |
|---|---|---|
| PmpLORIToSIFI | Historical diversions | IDWR |
| Osgood | Historical diversions | IDWR |
| PmpSIFIToSHYI | Historical diversions | IDWR |
| GreatWes | Historical diversions | IDWR |
| Idaho | Historical diversions | IDWR |
| SnkRivVa | Historical diversions | IDWR |
| Woodvill | Historical diversions | IDWR |
| PumpLORI | GW pumping from Zones 11, 14, 15, 16, 17, 18, 19, 20 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| PumpSHYI | GW pumping from Zones 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfLORI | Return flows from FarmF_En, Harrison, Sunnydel, PmpDryBed, PmpHEIIToLORI, LowerDry55, BearTrap diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfSHYI | Return flows from LowerDry09, Burgess, PmpLORIToSIFI, ButteMrk, CanyonCr, PmpDGGIToTEAI, Dewey, Last_Cha, StAnthU, Egin_ind, PmpHFAIToANTI, FarmF_En, Harrison, BlwRRdiv, Idaho, GreatWes, Osgood, PmpISLToHFAI, Yellow_M, PmpFALIToCHEISou, PmpFALIToCHEINor, Sqrl_Che, Farm_Own, Anderson, Sunnydel, RexburgC, Chest_CU, PmpHEIIToLORI, PmpDryBed, LowerDry55, BearTrap, Enterpri, Fall_Riv, Chester, FarmFr_S, Consol_F, Wilford, PmpTEAIToHenrys, Siddoway, Teton_Is diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainSHYI/negSHYI= SHYI – HEII – REXI[t-1] – WFWI + PmpHEIIToLORI + FarmF_En + Harrison + Burgess + Anderson + Eagle_Rk + LowerDry09 + LowerDry55 + PmpDryBed + Sunnydel + ButteMrk + BearTrap + PmpLORITOSIFI + Osgood + PmpSIFIToSHYI + GreatWes + Idaho + SnkRivVa + Woodvill + PumpLORI + PumpSHYI – rfLORI – rfSHYI | |

Details of local inflow above gage at Blackfoot River near Shelley, ID (gainBSHI/negBSHI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| BSHI | Blackfoot River near Shelley, ID | USGS gage 13066000. Missing daily data filled in with disaggregated monthly data. |
| General Equation | gainBSHI/negBSHI = BSHI | |

Details of local inflow above gage at Blackfoot River near Blackfoot, ID (gainBLFI/negBLFI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| BSHI | Gage at BSHI | USGS gage 13066000. |
| RSDI | Reservation Drop | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| BLFI | Gage at Blackfoot River near Blackfoot, ID | USGS gage 13068500. Missing daily data filled in with disaggregated monthly data. |
| General Equation | gainBLFI/negBLFI= BLFI – BSHI – RSDI | |

Details of local inflow above gage at Snake River near Blackfoot, ID (gainBFTI/negBFTI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| BLFI | Gage at BLFI | USGS gage 13068500 |
| SHYI | Gage at SHYI | Hydromet gage. Lagged 1 day. |
| BFTI | Gage at Snake River near Blackfoot, ID | Hydromet gage |
| RECI | Reservation Canal | Hydromet gage |
| NewLavas | Historical diversions | IDWR |
| BlkftCor | Historical diversions | IDWR |
| Blackfoot | Historical diversions | IDWR |
| PmpSHYIToBFTI | Historical diversions | IDWR |
| PeopAber | Historical diversions | IDWR |
| Parsons | Historical diversions | IDWR |
| PumpSNAI | GW pumping from Zones 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfSNAI | Return flows from LowerDry09, Burgess, PmpLORIToSIFI, ButteMrk, CanyonCr, PmpDGGIToTEAI, BlkftCor, Last_Cha, StAnthU, Egin_Ind, PmpHFAIToANTI, FarmF_En, Harrison, BlwRRdiv, Idaho, SnkRivVa, GreatWes, Osgood, PmpSIFIToSHYI, Woodvill, Blackfoot, PmpSHYIToBFTI, NewLavas, Anderson, PmpPALToHEII, PalCanal, PmpRIRToSNAI, BlwSandC, SandCDiv, | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |

| Node Name | Data Description | Data Source |
|---|---|---|
| | Sunnydel, RexburgC, PmpHEIIToLORI, PmpDryBed, LowerDry55, BearTrap, Enterpri, Fall_Riv, Chester, FarmFr_S, Consol_F, Wilford, PmpTEAIToHenrys, Siddoway, Teton_Is, Riley diversions | |
| General Equation | gainBFTI/negBFTI= BFTI – BLFI – SHYI[t-1] + NewLavas + BlkftCor + Blackfoot + PmpSHYToBFTI + PeopAber + Parsons + PumpSNAI – rfSNAI | |

Details of local inflow between gage BFTI and American Falls (gainAMFI/negAMFI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| BFTI | Gage at BFTI | Hydromet gage. Lagged 1 day. |
| AMFI | American Falls Outflow | Hydromet gage |
| AMF | American Falls historical reservoir contents | Hydromet gage |
| Portneuf | Portneuf River | USGS gage 13075500 |
| Michaud | Historical diversions | IDWR |
| FallsID | Historical diversions | IDWR |
| PumpAMF | GW pumping from Zones 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfAMF | Return flows from PeopAber, LowerDry09, Burgess, PmpLORIToSIFI, ButteMrk, CanyonCr, PmpDGGIToTEAI, BlkftCor, Dewwy, PmpHFAIToANTI, Last_Cha, StAnthU, Egin_Ind, Michaud, FallsID, FarmF_En, Harrison, BlwRRdiv, Idaho, SnkRivVa, GreatWes, Osgood, PmpSIFIToSHYI, Woodvill, Blackfoot, PmpSHYIToBFTI, NewLavas, Anderson, PmpPALToHEII, PalCanal, PmpRIRToSNAI, BlwSandC, SandCDiv, Sunnydel, RexburgC, Chest_CU, PmpHEIIToLORI, PmpDryBed, LowerDry55, BearTrap, Enterpri, Fall_Riv, Chester, FarmFr_S, Consol_F, Wilford, PmpTEAIToHenrys, Siddoway, Teton_Is, Riley, Parsons diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| Evap | Evaporation from American Falls | WRCC Aberdeen Experimnt Stn |
| General Equation | gainAMFI/negAMFI = (AMF.storage[t]-AMF.storage[t-1]) + AMFI – Portneuf – BFTI[t-1] + Michaud + FallsID + PumpAMF – rfAMF + Evap | |

Details of local inflow between American Falls and Minidoka (gainMINI/negMINI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| AMFI | Gage at AMFI | Hydromet gage |
| MINI | Minidoka Outflow | Hydromet gage |
| MIN | Minidoka historical reservoir contents | Hydromet gage |
| MINsouth | Historical diversions | IDWR |
| MINnorth | Historical diversions | IDWR |
| PmpAMFTToMIN | Historical diversions | IDWR |
| PumpMINI | GW pumping from Zones 3, 4, 5, 6, 7, 8, 9 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfMINI | Return flows from FallsID, PmpAMFTToMIN, MINnorth, Michaud, PeopAber diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| Evap | Evaporation from Minidoka | WRCC Minidoka Dam |
| General Equation | gainMINI/negMINI = (MIN.storage[t]-MIN.storage[t-1]) + MINI– AMFI + MINsouth + MINnorth + PmpAMFTToMIN + PumpMINI – rfMINI + Evap | |

Details of local inflow between Minidoka and gage at Snake River at Milner, ID (gainMILI/negMILI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| MINI | Gage at MINI | Hydromet gage. Lagged 1 day. |
| MILI | Gage at Snake River near Milner, ID | Hydromet gage |
| A_BPump | Historical diversions | IDWR |
| NorthSid | Historical diversions | IDWR |
| PmpMINToMIL | Historical diversions | IDWR |
| SSideTwi | Historical diversions | IDWR |
| MilGood | Historical diversions | IDWR |
| MilLowLi | Historical diversions | IDWR |
| General Equation | gainMILI/negMILI = MILI – MINI[t-1] + A_BPump + NorthSid + PmpMINToMIL + SSideTwi + MilGood + MilLowLi | |

Details of local inflow between gage MILI and gage at Snake River near Kimberly, ID (gainKIMI/negKIMI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| MILI | Gage at MILI | Hydromet gage |
| KIMI | Snake River near Kimberly, ID | USGS gage 13090000 |
| General Equation | gainKIMI/negKIMI = KIMI – MILI | |

Details of local inflow between gage KIMI and gage at Snake River near Buhl, ID (gainBuhl/negBuhl) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| KIMI | Gage at KIMI | USGS gage 13090000. Lagged 1 day. |
| Buhl | Snake River near Buhl, ID | USGS gage 13094000. Missing daily data filled in with disaggregated monthly data. |
| PumpBuhl | GW pumping from Zones 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfBuhl | Return flows from A_BPump, PeopAber, MINsouth, MINnorth, PmpMINToMIL, Micahud, FallsID, MilLowLi, PmpAMFTToMIN, NorthSid, SSideTwi, MilGood, MilLowLi diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainBuhl/negBuhl = Buhl – KIMI[t-1] + PumpBuhl – rfBuhl | |

Details of local inflow between gage Buhl and gage at Snake River below Lower Salmon Falls near Hangerman, ID (gainSnkblwSalmon/negSnkblwSalmon) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| Buhl | Gage at Buhl | USGS gage 13094000 |
| SnkblwSalmon | Gage at Snake River below Lower Salmon Falls near Hangerman, ID | USGS gage 13135000. Missing daily data filled in with disaggregated monthly data. |
| PumpHAGI | GW pumping from Zones 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfHAGI | Return flows from A_BPump, MINsouth, MINnorth, PmpMINToMIL, Micahud, FallsID, MilLowLi, PmpAMFTToMIN, NorthSid, SSideTwi, MilGood diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainSnkblwSalmon/negSnkblwSalmon = SnkblwSalmon – Buhl + PumpHAGI– rfHAGI | |

Details of local inflow between gage SnkBlwSalmon and gage at Snake River at King Hill, ID (gainSKHI/negSKHI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| SnkBlwSalmon | Gage at SnkBlwSalmon | USGS gage 13135000 |
| SKHI | Gage at Snake River at King Hill, ID | Hydromet gage |
| WoodGood | Malad River near Gooding, ID | USGS gage 13152500. Missing daily data filled in with disaggregated monthly data. |
| PumpSKHI | GW pumping from Zones 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfSKHI | Return flows from A_BPump, MINsouth, MINnorth, PmpMINToMIL, MilLowLi, PmpAMFTToMIN, NorthSid, SSideTwi, MilGood diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainSKHI/negSKHI = SKHI – SnkBlwSalmon – WoodGood + PumpSKHI – rfSKHI | |

Details of local inflow between gage SKHI and gage at Snake River near Murphy, ID (gainSWAI/negSWAI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| SKHI | Gage at SKHI | Hydromet gage. Lagged 1 day. |
| SWAI | Gage at Snake River near Murphy, ID | Hydromet gage |
| BruneauR | Bruneau River near Hot Spring, ID | USGS gage 13168500. Missing daily data filled in with disaggregated monthly data. |
| General Equation | gainSWAI/negSWAI = SWAI – SKHI[t-1] – BruneauR | |

Details of inflow to Anderson Ranch (gainANDI/negANDI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| ANDI | Anderson Ranch Outflow | Hydromet gage |
| AND | Anderson Ranch historical reservoir contents | Hydromet gage |
| Evap | Evaporation from Anderson Ranch | WRCC Arrowrock Dam |
| General Equation | gainANDI/negANDI = (AND.storage[t] – AND.storage[t-1]) + ANDI + Evap | |

Details local inflow between Anderson Ranch and Arrowrock (gainARKI/negARKI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| ANDI | Gage at ANDI | Hydromet gage |
| ARKI | Arrowrock Outflow | Hydromet gage |
| BoiTwSp | Boise River nr Twin Springs, ID | Hydromet gage BTSI |
| ARK | Arrowrock historical reservoir contents | Hydromet gage |
| Evap | Evaporation from Arrowrock | WRCC Arrowrock Dam |
| General Equation | gainARKI/negARKI = (ARK.storage[t] – ARK.storage[t-1]) + ARKI – ANDI – BoiTwSp + Evap | |

Details local inflow between Arrowrock and Lucky Peak (gainLUCI/negLUCI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| ARKI | Gage at ARKI | Hydromet gage |
| LUCI | Lucky Peak Outflow | Hydromet gage Missing daily data filled in statistical relation between LUCI and ARKI using unregulated and measured flows |
| LUC | Lucky Peak historical reservoir contents | Hydromet gage |
| Evap | Evaporation from Lucky Peak | WRCC Arrowrock Dam |
| General Equation | gainLUCI/negLUCI = (LUC.storage[t] – LUC.storage[t-1]) + LUCI – ARKI + Evap | |

Details of local inflow between Lucky Peak and gage at Boise River at Glenwood Bridge near Boise, ID (gainBIGI/negBIGI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| LUCI | Gage at LUCI | Hydromet gage |
| BIGI | Gage at Boise River at Glenwood Bridge near Boise, ID | Hydromet gage |
| BubbBois | Historical diversions | IDWR |
| Penitent | Historical diversions | IDWR |
| NewYork | Historical diversions | IDWR |
| Ridenbau | Historical diversions | IDWR |
| Settlers | Historical diversions | IDWR |
| FarmersU | Historical diversions | IDWR |
| Thurman | Historical diversions | IDWR |
| gwReturnBIGI | Groundwater return flows from Penitent, BubbBois, Settlers, Thurman diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| swReturnBIGI | Surface water return flows from Penitent, BubbBois, FarmersU diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainBIGI/negBIGI = BIGI – LUCI + BubbBois + Penitent + NewYork + Ridenbau + Settlers + FarmersU + Thurman – gwReturnBIGI – swReturnBIGI | |

Details of local inflow between gage BIGI and gage at Boise River near Middleton, ID (gainBOMI/negBOMI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| BIGI | Gage at BIGI | Hydromet gage |
| BOMI | Gage at Boise River near Middleton, ID | Hydromet gage |
| NEagleIs | Historical diversions | IDWR |
| Phyllis | Historical diversions | IDWR |
| CanyonCn | Historical diversions | IDWR |
| CaldwHig | Historical diversions | IDWR |
| gwReturnBOMI | Groundwater return flows from NewYork, Penitent, Ridenbau, BubbBois, Settlers, Thurman, FarmersU diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| swReturnBOMI | Surface water return flows from Ridenbau, BubbBois, Settlers, Thurman, FarmersU diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| sw2BOMI | Groundwater return flows from NEagleIs, Phyllis, CanyonCn, CaldwHig diversions | Calculated by the model using response functions that were |

| Node Name | Data Description | Data Source |
|---|---|---|
| | | developed using MODFLOW model of the Upper Snake Basin |
| gw2BOMI | Groundwater return flows from NEagleIs, Phyllis, CayonCn, CaldwHig diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainBOMI/negBOMI = BOMI – BIGI + NEagleIs + Phyllis + CanyonCn + CaldwHig – gwReturnBIGI – swReturnBIGI – sw2BOMI – gw2BOMI | |

Details of local inflow between gage BOMI and gage at Boise River near Parma, ID (gainPARI/negPARI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| BOMI | Gage at BOMI | Hydromet gage |
| PARI | Gage at Boise River near Parma, ID | Hydromet gage |
| Sebree | Historical diversions | IDWR |
| Riversid | Historical diversions | IDWR |
| Eureka2 | Historical diversions | IDWR |
| NotsParm | Historical diversions | IDWR |
| gwReturnPARI | Groundwater return flows from NewYork, Penitent, Ridenbau, BubbBois, Settlers, FarmersU, CaldwHig, CayonCn, NEagleIs, Phyllis diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| swReturnPARI | Surface water return flows from NewYork, Ridenbau, Settlers, Thurman, FarmersU, CaldwHig, CayonCn, NEagleIs, Phyllis diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| sw2PARI | Groundwater return flows from Sebree, Riversid, Eureka2, NotsParm diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| gw2PARi | Groundwater return flows from Sebree, Riversid, Eureka2, NotsParm diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainPARI/negPARI = PARI – BOMI + Sebree + Riversid + Eureka2 + NotsParm – gwReturnPARI – swReturnPARI – sw2PARI – gw2PARI | |

Details of inflow to Deadwood Reservoir (gainDEDI/negDEDI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| DEDI | Deadwood Reservoir Outflow | Hydromet gage |
| DED | Deadwood Reservoir historical reservoir contents | Hydromet gage |
| General Equation | gainDEDI/negDEDI = (DED.storage[t] – DED.storage[t-1]) + DEDI | |

Details of local inflow for South Fork of the Payette River at Lowman, ID (gainPRLI/negPRLI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| PRLI | Gage at South Fork Payette River near Lowman, ID | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| General Equation | gainPRLI/negPRLI = PRLI | |

Details of inflow to Payette Lake (gainPAYI/negPAYI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| PAYI | Payette Lake Outflow | Hydromet gage |
| PAY | Payette Lake historical reservoir contents | Hydromet gage |
| General Equation | gainPAYI/negPAYI = (PAY.storage[t] – PAY.storage[t-1]) + PAYI | |

Details of inflow from Payette Lake to Cascade (gainCSCI/negCSCI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| CSCI | Cascade Outflow | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| CSC | Cascade historical reservoir contents | Hydromet gage |
| PAYI | Gage at PAYI | Hydromet gage. Lagged 1 day. |
| Evap | Evaporation from Cascade | Hydromet gage |
| General Equation | gainCSCI/negCSCI = (CSC.storage[t] – CSC.storage[t-1]) + CSCI – PAYI[t-1] + Evap | |

Details of local inflow between Cascade and gage at North Fork Payette River near Banks, ID (gainPABI/negPABI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| CSCI | Gage at CSCI | Hydromet gage. Lagged 1 day. |
| PABI | Gage at North Fork Payette River near Banks, ID | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| General Equation | gainPABI/negPABI = PABI – CSCI[t-1] | |

Details of local inflow above gage at Payette River near Horseshoe Bend, ID (gainHRSI/negHRSI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| DEDI | Gage at DEDI | Hydromet gage. Lagged 1 day. |
| PRLI | Gage at PRLI | Hydromet gage. Lagged 1 day. |
| PABI | Gage at PABI | Hydromet gage |
| HRSI | Gage at Payette River near Horseshoe Bend, ID | Hydromet gage |
| General Equation | gainHRSI/negHRSI = HRSI – DEDI[t-1] – PRLI[t-1] – PABI | |

Details of inflow from gage HRSI to Black Canyon (gainEMMI/negEMMI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| HRSI | Gage at HRSI | Hydromet gage |
| EMMI | Black Canyon Outflow | Hydromet gage |
| EMM | Black Canyon historical reservoir contents | Hydromet gage |
| NsBlkCan | Historical diversions | IDWR |
| SsBlkCan | Historical diversions | IDWR |
| Evap | Evaporation from Black Canyon | WRCC Emmett 2 E |
| General Equation | gainEMMI/negEMMI = (EMM.storage[t] – EMM.storage[t-1]) + EMMI – HRSI + NsBlkCan + SsBlkCan + Evap | |

Details of inflow from Black Canyon to gage at Payette River near Leatha, ID (gainPLEI/negPLEI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| EMMI | Gage at EMMI | Hydromet gage |
| PLEI | Gage at Payette River near Leatha, ID | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| 640 | Historical diversions | IDWR |
| 640b | Historical diversions | IDWR |
| 655 | Historical diversions | IDWR |
| 7mile | Historical diversions | IDWR |
| rfPLEI | Groundwater return flows from NsBlkCan, SsBlkCan diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainPLEI/negPLEI = PLEI – EMMI + 640 + 640b + 655 + 7mile – rfPLEI | |

Details of inflow from gage PLEI to gage at Payette River near Payette, ID (gainPRPI/negPRPI) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| PLEI | Gage at PLEI | Hydromet gage |
| PRPI | Gage at Payette River near Payette, ID | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |

| Node Name | Data Description | Data Source |
|---|---|---|
| 660_670 | Historical diversions | IDWR |
| 7mile | Canal return from 7mile diversion | IDWR. Lagged 1 day. |
| rfPFBI | Groundwater return flows from NsBlkCan, SsBlkCan, 640, 640b, 655 diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfPNPI | Groundwater return flows from NsBlkCan, SsBlkCan, 640, 640b, 655 diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| rfPRPI | Groundwater return flows from NsBlkCan, SsBlkCan, 640, 640b, 655 diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainPRPI/negPRPI= PRPI – PLEI + 660_670 – 7mile[t-1] – rfPFBI – rfPNPI – rfPRPI | |

Details of local inflow above gage at Snake River near Weiser, ID (gainWEII/negWEII) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| SWAI | Gage at SWAI | Hydromet gage |
| PARI | Gage at PARI | Hydromet gage |
| PRPI | Gage at PRPI | Hydromet gage |
| WEII | Gage at Snake River near Weiser, ID | Hydromet gage |
| OWYI | Lake Owyhee and Owyhee River near Nyssa, OR | Hydromet gage. Missing daily data filled in with disaggregated monthly data. |
| Malheur | Malheur River below Nevada Dam near Vale, OR | Hydromet gage VALO. Missing daily data filled in with disaggregated monthly data. |
| WeiserR | Weiser River near Weiser, ID | USGS gage 13266000. Missing daily data filled in with disaggregated monthly data. |
| rfblwPRPI | Groudwater return flows from 660_670 diversions | Calculated by the model using response functions that were developed using MODFLOW model of the Upper Snake Basin |
| General Equation | gainWEII/negWEII= WEII – SWAI – PARI – PRPI – OWYI – Malheur – Weiser– rfblwPRPI | |

Details of local inflow between gage WEII and Browlee Dam (gainBRN/negBRN) calculation.

| Node Name | Data Description | Data Source |
|---|---|---|
| WEII | Gage at WEII | Hydromet gage |
| BRN_IN | Snake River at Brownlee Dam Outflow | Hydromet gage BRN. Missing daily data filled in with disaggregated monthly data. |
| General Equation | gainWEII/negWEII= BRN_IN – WEII | |

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# Appendix B: Unregulated Flows Calculations

Table B-1. Locations of unregulated flow calculations including the U.S. Geological Survey (USGS) gage numbers and equation to convert gain/loss into unregulated flows

| Site Name | USGS Gage Number | Reclamation Gage Name | Flow Calculation |
|---|---|---|---|
| Henrys Lake Outflow | | HENI | $HENI_{unreg} = HENI_{gain/loss}$ |
| Henrys Fork nr Island Park, ID Island Park Outflow | | ISLI | $ISLI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss}$ |
| Henrys Fork nr Ashton, ID | | HFAI | $HFAI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss}$ |
| Grassy Lake Outflow | | GRS | $GRSY_{unreg} = GRSY_{gain/loss}$ |
| Falls River nr Squirrel, ID | | FALI | $FALI_{unreg} = GRSY_{gain/loss} + FALI_{gain/loss}$ |
| Falls River nr Chester, ID | | CHEI | $CHEI_{unreg} = GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss}$ |
| Henrys Fork at St. Anthony, ID | | ANTI | $ANTI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss}$ |
| Teton River abv S Leigh Creek | | DGGI | $DGGI_{unreg} = DGGI_{gain/loss}$ |
| Teton River nr St. Anthony, ID | | TEAI | $TEAI_{unreg} = DGGI_{gain/loss} + TEAI_{gain/loss}$ |
| Teton River at Mouth (TRXI) | 13055198 + 13055340 | | $TRXI_{unreg} = DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss}$ |
| Henrys Fork nr Rexburg, ID | | REXI | $REXI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss}$ |
| Jackson Lake Outflow | | JCKY | $JCKY_{unreg} = JCKY_{gain/loss}$ |
| Snake River below Flat Creek near Jackson, WY | | JKSY | $JKSY_{unreg} = JCK_{gain/loss} + JKSY_{gain/loss}$ |
| Snake River nr Irwin Palisades Outflow | | PALI | $PALI_{unreg} = JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss}$ |
| Snake River nr Heise, ID | | HEII | $HEII_{unreg} = JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss}$ |
| Willow Cr blw Ririe Dam Ririe Dam Outflow | | RIRI | $RIRI_{unreg} = RIRI_{gain/loss}$ |
| Willow Cr at mouth nr Idaho Falls, ID | | WFWI | $WFWI_{unreg} = RIRI_{gain/loss} + WFWI_{gain/loss}$ |
| Snake River nr Shelley, ID | | SHYI | $SHYI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} +$ |

| Site Name | USGS Gage Number | Reclamation Gage Name | Flow Calculation |
|---|---|---|---|
| | | | $HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss}$ |
| Blackfoot River nr Shelley, ID (BSHI) | 13066000 | | $BSHI_{unreg} = BSHI_{gain/loss}$ |
| Blackfoot River nr Blackfoot, ID | | BLFI | $BLFI_{unreg} = BSHI_{gain/loss} + BLFI_{gain/loss}$ |
| Snake River nr Blackfoot, ID | | BFTI | $BFTI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss}$ |
| Portneuf River at Pocatello, ID (Portneuf) | 13075500 | | $Portneuf_{unreg} = Portneuf_{gain/loss}$ |
| Snake River at Neeley American Falls Outflow | | AMFI | $AMFI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PAL_{Igain/loss} + HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss} + Portneuf_{gain/loss} + AMFI_{gain/loss}$ |
| Snake River nr Minidoka, ID | | MINI | $MINI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss} + Portneuf_{gain/loss} + AMFI_{gain/loss} + MINI_{gain/loss}$ |
| Snake River at Milner, ID | | MILI | $MILI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss} + Portneuf_{gain/loss} + AMFI_{gain/loss} + MINI_{gain/loss} + MILI_{gain/loss}$ |
| Snake River nr Kimberly, ID | | KIMI | $KIMI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss} +$ |

| Site Name | USGS Gage Number | Reclamation Gage Name | Flow Calculation |
|---|---|---|---|
| | | | $Portneuf_{gain/loss} + AMFI_{gain/loss} + MINI_{gain/loss} + MILI_{gain/loss} + KIMI_{gain/loss}$ |
| Snake River nr Buhl, ID (Buhl) | 13094000 | | $Buhl_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss} + RIR_{Igain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss} + Portneuf_{gain/loss} + AMFI_{gain/loss} + MINI_{gain/loss} + MILI_{gain/loss} + KIMI_{gain/loss} + Buhl_{gain/loss}$ |
| Snake River blw Lower Salmon Falls nr Hagerman, ID (SnkblwLSalmon) | 13135000 | | $SnkblwLSalmon_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss} + Portneuf_{gain/loss} + AMFI_{gain/loss} + MINI_{gain/loss} + MILI_{gain/loss} + KIMI_{gain/loss} + Buhl_{gain/loss} + SnkblwLSalmon_{gain/loss}$ |
| Malad River nr Gooding, ID (Woodgood) | 13152500 | | $Woodgood_{unreg} = Woodgood_{gain/loss}$ |
| Snake River at King Hill, ID | | SKHI | $SKHI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss} + Portneuf_{gain/loss} + AMFI_{gain/loss} + MINI_{gain/loss} + MILI_{gain/loss} + KIMI_{gain/loss} + Buhl_{gain/loss} + SnkblwLSalmon_{gain/loss} + Woodgood_{gain/loss} + SKHI_{gain/loss}$ |
| Bruneau River nr Hot Spring, ID (BruneauR) | 13168500 | | $BruneaR_{unreg} = BruneaR_{gain/loss}$ |
| Snake River nr Murphy, ID | | SWAI | $SKHI_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss} + Portneuf_{gain/loss} + AMFI_{gain/loss} + MINI_{gain/loss} + MILI_{gain/loss} + KIMI_{gain/loss} + Buhl_{gain/loss} + SnkblwLSalmon_{gain/loss} + Woodgood_{gain/loss} + SKHI_{gain/loss} + BruneaR_{gain/loss} + SWAI_{gain/loss}$ |

| Site Name | USGS Gage Number | Reclamation Gage Name | Flow Calculation |
|---|---|---|---|
| SF Boise River at Anderson Ranch | | ANDI | $ANDI_{unreg} = ANDI_{gain/loss}$ |
| Boise River nr Twin Springs, ID (TwSp) | | BTSI | $TwSp_{unreg} = TwSp_{gain/loss}$ |
| Boise River Arrowrock Outflow | | ARKI | $ARKI_{unreg} = ANDI_{gain/loss} + TwSp_{gain/loss} + ARKI_{gain/loss}$ |
| Boise River Lucky Peak Outflow | | LUCI | $LUCI_{unreg} = ANDI_{gain/loss} + TwSp_{gain/loss} + ARKI_{gain/loss} + LUCI_{gain/loss}$ |
| Boise River at Glenwood Bridge nr Boise, ID | | BIGI | $BIGI_{unreg} = ANDI_{gain/loss} + TwSp_{gain/loss} + ARK_{Igain/loss} + LUC_{Igain/loss} + BIGI_{gain/loss}$ |
| Boise River nr Middleton, ID | | BOMI | $BOMI_{unreg} = ANDI_{gain/loss} + TwSp_{gain/loss} + ARKI_{gain/loss} + LUCI_{gain/loss} + BIGI_{gain/loss} + BOMI_{gain/loss}$ |
| Boise River nr Parma, ID | | PARI | $PARI_{unreg} = ANDI_{gain/loss} + TwSp_{gain/loss} + ARKI_{gain/loss} + LUCI_{gain/loss} + BIGI_{gain/loss} + BOMI_{gain/loss} + PARI_{gain/loss}$ |
| Deadwood River Deadwood Reservoir Outflow | | DEDI | $DEDI_{unreg} = DEDI_{gain/loss}$ |
| South Fork Payette River at Lowman, ID | | PRLI | $PRLI_{unreg} = PRLI_{gain/loss}$ |
| NF Payette River at McCall | | PAYI | $PAYI_{unreg} = PAYI_{gain/loss}$ |
| NF Payette River Cascade Dam Outflow | | CSCI | $CSCI_{unreg} = PAYI_{gain/loss} + CSCI_{gain/loss}$ |
| NF Payette River nr Banks, ID | | PABI | $PABI_{unreg} = PAYI_{gain/loss} + CSCI_{gain/loss} + PABI_{gain/loss}$ |
| Payette River nr Horseshoe Bend, ID | | HRSI | $HRSI_{unreg} = DEDI_{gain/loss} + PRLI_{gain/loss} + PAYI_{gain/loss} + CSCI_{gain/loss} + PABI_{gain/loss} + HRSI_{gain/loss}$ |
| Payette River Black Canyon Reservoir Outflow | | EMMI | $EMMI_{unreg} = DEDI_{gain/loss} + PRLI_{gain/loss} + PAYI_{gain/loss} + CSCI_{gain/loss} + PABI_{gain/loss} + HRSI_{gain/loss} + EMMI_{gain/loss}$ |
| Payette River nr Leatha, ID | | PLEI | $PLEI_{unreg} = DEDI_{gain/loss} + PRLI_{gain/loss} + PAYI_{gain/loss} + CSCI_{gain/loss} + PABI_{gain/loss} + HRSI_{gain/loss} + EMMI_{gain/loss} + PLEI_{gain/loss}$ |
| Payette River nr Payette, ID | | PRPI | $PRPI_{unreg} = DEDI_{gain/loss} + PRLI_{gain/loss} + PAYI_{gain/loss} + CSCI_{gain/loss} + PABI_{gain/loss} + HRSI_{gain/loss} + EMMI_{gain/loss} + PLEI_{gain/loss} + PRPI_{gain/loss}$ |
| Weiser River nr Weiser, ID (Weirserr) | 13266000 | | $Weiserr_{unreg} = Weiserr_{gain/loss}$ |
| Malheur River blw Nevada Dam nr Vale, OR (Malheur) | | VALO | $Malheur_{unreg} = Malheur_{gain/loss}$ |

| Site Name | USGS Gage Number | Reclamation Gage Name | Flow Calculation |
|---|---|---|---|
| Lake Owyhee and Owyhee River near Nyssa, OR | | OWYI | $OWYI_{unreg} = OWYI_{gain/loss}$ |
| Snake River nr Weiser, ID | | WEII | $WEII_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss} + Portneuf_{gain/loss} + AMFI_{gain/loss} + MINI_{gain/loss} + MILI_{gain/loss} + KIMI_{gain/loss} + Buhl_{gain/loss} + SnkblwLSalmon_{gain/loss} + Woodgood_{gain/loss} + SKHI_{gain/loss} + BruneaR_{gain/loss} + SWAI_{gain/loss} + ANDI_{gain/loss} + TwSp_{gain/loss} + ARKI_{gain/loss} + LUCI_{gain/loss} + BIGI_{gain/loss} + BOMI_{gain/loss} + PARI_{gain/loss} + DEDI_{gain/loss} + PRLI_{gain/loss} + PAYI_{gain/loss} + CSCI_{gain/loss} + PABI_{gain/loss} + HRSI_{gain/loss} + EMMI_{gain/loss} + PLEI_{gain/loss} + PRPI_{gain/loss} + Weiserr_{gain/loss} + Malheur_{gain/loss} + OWYI_{gain/loss} + WEII_{gain/loss}$ |
| Snake River at Brownlee Dam Outflow | | BRN | $BRN_{unreg} = HENI_{gain/loss} + ISLI_{gain/loss} + HFAI_{gain/loss} + GRSY_{gain/loss} + FALI_{gain/loss} + CHEI_{gain/loss} + ANTI_{gain/loss} + DGGI_{gain/loss} + TEAI_{gain/loss} + TRXI_{gain/loss} + REXI_{gain/loss} + JCKY_{gain/loss} + JKSY_{gain/loss} + PALI_{gain/loss} + HEII_{gain/loss} + RIRI_{gain/loss} + WFWI_{gain/loss} + SHYI_{gain/loss} + BLFI_{gain/loss} + BFTI_{gain/loss} + Portneuf_{gain/loss} + AMFI_{gain/loss} + MINI_{gain/loss} + MILI_{gain/loss} + KIMI_{gain/loss} + Buhl_{gain/loss} + SnkblwLSalmon_{gain/loss} + Woodgood_{gain/loss} + SKHI_{gain/loss} + BruneaR_{gain/loss} + SWAI_{gain/loss} + ANDI_{gain/loss} + TwSp_{gain/loss} + ARKI_{gain/loss} + LUCI_{gain/loss} + BIGI_{gain/loss} + BOMI_{gain/loss} + PARI_{gain/loss} + DEDI_{gain/loss} + PRLI_{gain/loss} + PAYI_{gain/loss} + CSCI_{gain/loss} + PABI_{gain/loss} + HRSI_{gain/loss} + EMMI_{gain/loss} + PLEI_{gain/loss} + PRPI_{gain/loss} + Weiserr_{gain/loss} + Malheur_{gain/loss} + OWYI_{gain/loss} + WEII_{gain/loss} + BRN_{gain/loss}$ |

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# Appendix C: Unregulated Flows Data

Table C-1. Unregulated flows into Brownlee Dam (BRN) for water years 1928 to 2018 (acre-feet per month)

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | 1,279,592 | 1,557,644 | 1,232,387 | 1,229,026 | 936,517 | 2,045,679 | 2,041,802 | 5,145,847 | 2,760,507 | 1,604,438 | 1,015,034 | 959,374 |
| 1929 | 1,186,319 | 994,916 | 800,678 | 799,467 | 626,970 | 1,385,098 | 1,650,291 | 2,691,019 | 2,629,532 | 1,245,474 | 878,988 | 911,649 |
| 1930 | 1,017,801 | 944,899 | 854,949 | 650,459 | 965,934 | 1,080,333 | 1,591,638 | 2,233,785 | 2,023,478 | 1,071,817 | 998,652 | 901,206 |
| 1931 | 1,174,036 | 858,446 | 779,420 | 714,130 | 661,580 | 1,037,266 | 1,246,865 | 1,673,133 | 1,194,186 | 596,900 | 605,240 | 654,973 |
| 1932 | 773,644 | 731,605 | 689,563 | 613,920 | 600,141 | 1,655,609 | 2,211,930 | 3,813,082 | 3,543,531 | 1,469,924 | 867,206 | 830,748 |
| 1933 | 921,659 | 941,412 | 741,936 | 724,566 | 622,696 | 974,969 | 1,634,272 | 2,438,676 | 3,653,947 | 1,093,214 | 800,148 | 750,401 |
| 1934 | 835,296 | 845,228 | 835,761 | 978,288 | 713,999 | 1,028,708 | 1,528,824 | 1,532,407 | 976,941 | 613,057 | 524,258 | 577,858 |
| 1935 | 777,915 | 698,280 | 674,169 | 663,384 | 585,679 | 795,793 | 1,629,967 | 2,432,027 | 2,691,737 | 1,138,476 | 680,690 | 677,463 |
| 1936 | 795,785 | 812,562 | 652,971 | 749,048 | 827,001 | 1,106,858 | 2,939,247 | 4,348,143 | 3,066,887 | 1,186,440 | 887,280 | 855,955 |
| 1937 | 913,691 | 854,070 | 721,969 | 639,117 | 648,362 | 1,001,451 | 1,608,704 | 2,666,652 | 2,059,268 | 985,304 | 671,939 | 710,013 |
| 1938 | 909,461 | 896,403 | 1,174,028 | 903,734 | 843,164 | 1,744,345 | 2,806,616 | 4,368,597 | 4,020,962 | 1,968,238 | 970,994 | 900,855 |
| 1939 | 1,204,313 | 1,082,834 | 932,646 | 822,667 | 736,507 | 1,639,386 | 2,157,302 | 2,670,580 | 1,694,998 | 1,094,359 | 785,967 | 891,905 |
| 1940 | 1,014,224 | 840,159 | 819,407 | 855,706 | 1,132,697 | 1,642,505 | 2,336,933 | 2,823,492 | 1,949,231 | 915,669 | 693,783 | 965,327 |
| 1941 | 1,129,480 | 1,013,681 | 936,923 | 893,516 | 982,727 | 1,394,944 | 1,619,638 | 2,707,185 | 2,416,634 | 1,137,282 | 1,048,380 | 984,217 |
| 1942 | 1,172,050 | 1,160,135 | 1,232,572 | 820,645 | 941,868 | 1,177,357 | 2,591,895 | 3,031,857 | 2,944,389 | 1,407,240 | 862,709 | 909,785 |
| 1943 | 1,022,650 | 1,168,587 | 1,216,557 | 1,513,066 | 1,451,006 | 2,117,080 | 4,601,644 | 3,933,712 | 4,425,868 | 2,857,582 | 1,342,378 | 1,081,392 |
| 1944 | 1,350,549 | 1,181,821 | 975,159 | 829,547 | 861,573 | 1,051,948 | 1,471,639 | 2,107,536 | 2,621,124 | 1,290,345 | 849,021 | 873,387 |
| 1945 | 1,070,805 | 1,053,240 | 861,665 | 916,666 | 1,115,202 | 1,180,039 | 1,561,065 | 3,395,353 | 3,508,607 | 1,758,238 | 1,114,045 | 1,153,651 |
| 1946 | 1,286,551 | 1,179,265 | 1,183,083 | 1,057,384 | 918,079 | 2,096,762 | 3,439,982 | 4,032,538 | 2,929,300 | 1,453,767 | 1,013,604 | 1,128,242 |
| 1947 | 1,408,889 | 1,282,625 | 1,320,774 | 881,969 | 1,037,864 | 1,319,924 | 1,731,644 | 3,694,466 | 3,141,958 | 1,520,603 | 1,099,437 | 1,048,624 |
| 1948 | 1,249,793 | 1,130,786 | 1,049,348 | 1,027,640 | 912,178 | 1,028,169 | 1,861,815 | 3,494,812 | 3,513,292 | 1,338,376 | 1,007,119 | 1,028,865 |
| 1949 | 1,218,712 | 1,033,941 | 921,801 | 760,001 | 905,714 | 1,582,015 | 2,284,707 | 4,084,086 | 2,793,152 | 1,283,555 | 960,233 | 939,932 |
| 1950 | 1,283,655 | 1,048,481 | 889,027 | 918,018 | 997,134 | 1,508,196 | 2,309,594 | 3,336,365 | 4,414,239 | 2,531,273 | 1,301,664 | 1,232,975 |
| 1951 | 1,434,119 | 1,265,582 | 1,179,808 | 1,034,633 | 1,435,937 | 1,468,545 | 3,024,572 | 4,296,465 | 3,458,777 | 2,018,365 | 1,522,805 | 1,168,423 |
| 1952 | 1,492,100 | 1,225,788 | 1,304,805 | 1,071,648 | 1,015,758 | 1,509,407 | 5,029,826 | 5,917,514 | 3,855,068 | 1,807,735 | 1,208,890 | 1,136,668 |
| 1953 | 1,127,617 | 983,334 | 987,198 | 1,406,141 | 1,031,507 | 1,155,864 | 1,937,208 | 2,899,656 | 4,546,427 | 1,998,187 | 1,135,372 | 1,038,567 |
| 1954 | 1,121,188 | 1,106,931 | 998,256 | 1,024,390 | 1,005,745 | 1,236,406 | 2,062,207 | 3,703,364 | 3,060,430 | 1,857,259 | 1,139,543 | 1,041,028 |
| 1955 | 1,136,836 | 1,059,274 | 901,650 | 860,805 | 730,218 | 941,650 | 1,357,979 | 2,596,992 | 3,002,806 | 1,531,126 | 1,008,998 | 928,561 |
| 1956 | 1,019,847 | 1,118,051 | 1,779,067 | 1,488,032 | 1,002,835 | 1,566,915 | 2,889,801 | 4,918,627 | 4,512,930 | 1,847,670 | 1,225,683 | 1,091,119 |
| 1957 | 1,320,144 | 1,154,903 | 1,106,016 | 883,685 | 1,393,671 | 1,962,645 | 2,331,752 | 4,911,922 | 4,107,643 | 1,865,744 | 1,121,988 | 1,117,547 |
| 1958 | 1,236,724 | 1,057,192 | 1,102,143 | 936,521 | 1,438,461 | 1,373,050 | 2,499,282 | 4,942,956 | 3,205,604 | 1,269,270 | 1,040,477 | 1,037,764 |
| 1959 | 1,091,468 | 1,103,649 | 1,078,826 | 1,053,435 | 874,817 | 1,031,882 | 1,615,338 | 2,477,382 | 3,156,134 | 1,331,321 | 999,295 | 1,235,645 |
| 1960 | 1,437,956 | 1,051,052 | 949,484 | 890,588 | 942,660 | 1,504,489 | 2,039,253 | 2,575,906 | 2,588,938 | 1,009,700 | 920,764 | 949,657 |
| 1961 | 1,038,956 | 1,059,968 | 903,300 | 781,833 | 1,027,477 | 1,061,158 | 1,264,170 | 2,333,152 | 2,173,217 | 773,781 | 680,761 | 948,388 |
| 1962 | 1,200,377 | 965,955 | 862,844 | 811,930 | 1,271,084 | 1,156,275 | 2,507,352 | 3,368,597 | 3,288,807 | 1,626,774 | 1,065,145 | 952,700 |

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1963 | 1,335,230 | 1,160,497 | 1,138,246 | 905,972 | 1,566,255 | 1,011,905 | 1,527,778 | 3,016,242 | 3,469,047 | 1,388,419 | 958,946 | 1,134,794 |
| 1964 | 956,171 | 1,147,066 | 988,732 | 934,963 | 824,216 | 1,096,536 | 1,917,850 | 3,169,934 | 4,340,517 | 1,951,047 | 1,117,143 | 1,089,524 |
| 1965 | 1,093,032 | 1,152,453 | 2,434,095 | 1,961,400 | 1,641,766 | 1,473,578 | 3,195,644 | 4,432,237 | 5,036,027 | 2,632,878 | 1,639,073 | 1,401,469 |
| 1966 | 1,306,457 | 1,109,949 | 1,045,422 | 1,114,296 | 901,523 | 1,181,626 | 1,634,917 | 2,616,284 | 2,018,733 | 1,022,087 | 845,997 | 962,078 |
| 1967 | 1,107,738 | 1,039,445 | 995,749 | 1,094,630 | 896,648 | 1,039,405 | 1,279,698 | 3,040,387 | 4,445,954 | 2,090,893 | 1,090,165 | 1,074,585 |
| 1968 | 1,316,796 | 1,120,045 | 1,005,151 | 943,741 | 1,260,190 | 1,226,663 | 1,192,447 | 2,322,964 | 3,165,029 | 1,406,028 | 1,528,220 | 1,218,453 |
| 1969 | 1,231,825 | 1,186,567 | 1,047,639 | 1,548,296 | 1,086,949 | 1,468,923 | 3,662,736 | 4,506,788 | 3,094,665 | 1,520,264 | 1,081,149 | 1,155,221 |
| 1970 | 1,318,289 | 1,022,264 | 941,150 | 1,903,495 | 1,218,575 | 1,279,112 | 1,405,537 | 3,744,997 | 4,731,254 | 2,150,683 | 1,197,525 | 1,408,629 |
| 1971 | 1,331,848 | 1,353,148 | 1,379,978 | 2,371,949 | 1,401,625 | 1,885,373 | 3,253,433 | 5,912,738 | 5,658,205 | 2,872,430 | 1,521,128 | 1,444,357 |
| 1972 | 1,592,474 | 1,294,073 | 1,292,382 | 1,543,390 | 1,531,670 | 3,355,406 | 2,447,569 | 4,536,679 | 5,336,447 | 2,176,796 | 1,481,627 | 1,475,003 |
| 1973 | 1,567,132 | 1,260,762 | 1,210,362 | 1,270,723 | 1,023,112 | 1,284,614 | 1,691,183 | 2,980,896 | 2,515,575 | 1,370,199 | 1,054,919 | 1,267,700 |
| 1974 | 1,353,423 | 1,487,212 | 1,381,731 | 1,682,971 | 1,107,612 | 2,241,291 | 3,172,366 | 4,447,958 | 5,797,970 | 2,468,127 | 1,404,162 | 1,198,087 |
| 1975 | 1,377,316 | 1,143,652 | 1,125,724 | 1,106,686 | 1,113,214 | 1,604,750 | 2,024,045 | 3,929,636 | 5,145,062 | 3,185,007 | 1,514,329 | 1,286,080 |
| 1976 | 1,588,073 | 1,273,605 | 1,399,543 | 1,235,156 | 1,156,467 | 1,594,984 | 2,869,230 | 5,019,986 | 3,714,626 | 2,044,589 | 1,622,250 | 1,504,840 |
| 1977 | 1,406,133 | 1,011,615 | 980,798 | 965,340 | 825,863 | 860,645 | 922,235 | 1,265,376 | 1,265,626 | 692,617 | 746,808 | 866,057 |
| 1978 | 1,010,725 | 899,273 | 1,264,447 | 1,196,541 | 1,130,072 | 1,588,215 | 2,506,729 | 3,798,357 | 3,986,011 | 2,460,235 | 1,329,792 | 1,397,619 |
| 1979 | 1,198,517 | 1,001,478 | 982,016 | 1,003,295 | 1,113,343 | 1,511,311 | 1,501,484 | 3,175,975 | 2,472,751 | 1,183,525 | 1,090,877 | 974,397 |
| 1980 | 1,160,840 | 966,056 | 955,745 | 1,246,359 | 1,311,247 | 1,217,860 | 2,244,149 | 4,191,917 | 3,491,923 | 1,734,611 | 1,106,869 | 1,339,319 |
| 1981 | 1,199,991 | 1,116,681 | 1,294,606 | 1,120,868 | 1,269,169 | 1,268,035 | 1,876,933 | 2,862,780 | 2,866,707 | 1,104,606 | 873,713 | 943,484 |
| 1982 | 1,195,394 | 1,108,951 | 1,390,819 | 1,133,235 | 2,228,822 | 2,129,550 | 2,859,605 | 5,263,385 | 5,075,492 | 3,424,648 | 1,532,909 | 1,497,922 |
| 1983 | 1,598,908 | 1,360,986 | 1,483,742 | 1,586,450 | 1,694,578 | 3,290,188 | 3,047,808 | 5,308,024 | 5,217,817 | 2,864,936 | 1,715,108 | 1,454,544 |
| 1984 | 1,675,719 | 1,636,044 | 1,644,654 | 1,683,042 | 1,443,042 | 3,068,942 | 4,099,544 | 6,013,642 | 5,652,652 | 2,887,816 | 1,735,925 | 1,593,012 |
| 1985 | 1,623,865 | 1,474,172 | 1,317,073 | 1,219,638 | 1,149,671 | 1,544,936 | 2,937,010 | 3,629,205 | 2,313,243 | 1,287,620 | 1,124,888 | 1,487,284 |
| 1986 | 1,444,204 | 1,192,677 | 1,218,016 | 1,244,740 | 2,634,447 | 3,526,436 | 3,574,533 | 4,348,574 | 5,101,691 | 2,099,910 | 1,462,909 | 1,594,386 |
| 1987 | 1,519,710 | 1,255,267 | 1,097,055 | 1,026,913 | 1,035,891 | 1,348,835 | 1,598,010 | 2,331,606 | 1,466,043 | 1,134,371 | 979,899 | 1,020,798 |
| 1988 | 1,088,298 | 947,708 | 965,418 | 962,310 | 930,789 | 1,056,043 | 1,680,684 | 2,379,868 | 1,875,879 | 796,882 | 707,913 | 867,545 |
| 1989 | 948,293 | 963,711 | 912,751 | 887,957 | 905,168 | 2,164,918 | 2,931,605 | 3,459,860 | 2,839,552 | 1,370,708 | 1,106,322 | 1,112,709 |
| 1990 | 1,263,762 | 1,027,479 | 951,854 | 1,005,677 | 842,163 | 1,168,719 | 1,971,794 | 2,110,989 | 2,349,708 | 1,137,653 | 904,239 | 912,517 |
| 1991 | 1,130,076 | 935,555 | 825,291 | 907,070 | 855,627 | 991,718 | 1,208,763 | 2,562,731 | 2,616,764 | 1,166,489 | 895,023 | 1,036,342 |
| 1992 | 1,066,992 | 968,668 | 930,720 | 850,423 | 976,058 | 999,546 | 1,338,461 | 1,698,958 | 1,010,133 | 775,444 | 615,155 | 746,549 |
| 1993 | 812,029 | 747,415 | 778,750 | 831,301 | 767,537 | 2,135,424 | 2,494,523 | 4,612,466 | 3,663,150 | 1,715,853 | 1,362,484 | 1,094,674 |
| 1994 | 1,243,779 | 923,936 | 977,058 | 960,274 | 853,101 | 1,037,236 | 1,563,165 | 2,491,964 | 1,399,722 | 806,266 | 765,947 | 821,772 |
| 1995 | 1,003,549 | 826,183 | 955,506 | 1,166,899 | 1,270,865 | 1,790,892 | 2,079,383 | 4,007,828 | 4,451,322 | 2,565,964 | 1,315,408 | 1,215,693 |
| 1996 | 1,283,980 | 1,143,050 | 1,435,065 | 1,231,816 | 1,829,153 | 2,044,439 | 3,005,432 | 4,937,101 | 5,011,722 | 2,199,713 | 1,311,826 | 1,348,367 |
| 1997 | 1,296,505 | 1,290,131 | 1,842,903 | 2,965,841 | 1,520,844 | 2,213,102 | 3,367,803 | 6,391,798 | 5,702,919 | 2,601,725 | 1,749,272 | 1,524,376 |
| 1998 | 1,537,401 | 1,211,603 | 1,103,502 | 1,306,408 | 1,225,962 | 1,871,169 | 2,314,952 | 5,405,203 | 4,285,444 | 2,484,227 | 1,391,114 | 1,480,627 |
| 1999 | 1,388,330 | 1,149,840 | 1,171,477 | 1,323,830 | 1,341,040 | 2,266,660 | 2,677,904 | 4,527,220 | 5,120,911 | 2,304,579 | 1,484,574 | 1,339,347 |
| 2000 | 1,351,820 | 1,078,957 | 1,116,363 | 1,205,076 | 1,476,379 | 1,595,350 | 2,597,137 | 3,351,271 | 2,305,542 | 1,241,684 | 964,230 | 1,148,666 |
| 2001 | 1,248,263 | 964,453 | 960,275 | 950,030 | 897,189 | 1,225,329 | 1,368,763 | 2,154,087 | 1,222,191 | 883,440 | 767,176 | 808,465 |
| 2002 | 899,441 | 863,664 | 945,717 | 1,003,953 | 869,617 | 1,275,375 | 2,109,153 | 2,697,309 | 2,530,977 | 1,066,314 | 807,295 | 932,267 |

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 937,887 | 798,283 | 912,056 | 1,113,389 | 1,038,237 | 1,255,827 | 1,712,707 | 3,098,911 | 2,624,740 | 969,168 | 784,264 | 857,082 |
| 2004 | 904,460 | 824,421 | 937,370 | 934,168 | 1,091,897 | 1,654,646 | 1,877,163 | 2,517,232 | 2,235,849 | 1,206,846 | 897,586 | 985,208 |
| 2005 | 1,078,666 | 857,241 | 961,058 | 926,330 | 801,510 | 1,086,187 | 1,505,617 | 3,512,038 | 2,349,247 | 1,176,892 | 824,942 | 905,773 |
| 2006 | 1,053,608 | 946,861 | 1,277,095 | 1,710,261 | 1,273,922 | 2,091,302 | 4,471,626 | 5,481,723 | 3,304,456 | 1,333,697 | 982,228 | 1,100,203 |
| 2007 | 1,203,967 | 1,046,622 | 1,097,612 | 982,026 | 1,037,076 | 1,481,438 | 1,662,512 | 2,410,413 | 1,418,707 | 803,653 | 750,961 | 898,140 |
| 2008 | 1,111,976 | 981,890 | 984,739 | 963,435 | 938,304 | 1,258,490 | 1,491,013 | 3,867,369 | 3,657,451 | 1,800,340 | 951,464 | 1,008,861 |
| 2009 | 1,110,098 | 976,875 | 911,253 | 1,021,950 | 898,952 | 1,298,737 | 1,785,872 | 3,611,855 | 3,820,074 | 1,712,541 | 1,112,930 | 1,040,205 |
| 2010 | 1,251,469 | 920,752 | 906,063 | 1,058,251 | 969,057 | 1,219,289 | 1,797,309 | 2,205,101 | 4,145,229 | 1,444,966 | 954,166 | 994,019 |
| 2011 | 1,145,599 | 933,026 | 1,177,163 | 1,377,185 | 1,020,934 | 1,793,648 | 2,632,003 | 4,869,015 | 5,805,827 | 3,542,952 | 1,471,958 | 1,264,243 |
| 2012 | 1,470,006 | 1,083,040 | 1,017,744 | 1,212,481 | 1,053,652 | 1,770,254 | 3,018,765 | 3,365,007 | 2,585,691 | 1,273,934 | 851,126 | 980,677 |
| 2013 | 1,085,822 | 971,512 | 1,254,959 | 903,023 | 939,642 | 1,152,681 | 1,451,998 | 2,456,639 | 1,622,639 | 852,855 | 698,756 | 1,006,776 |
| 2014 | 1,053,179 | 887,931 | 869,720 | 861,563 | 1,037,435 | 1,583,789 | 1,680,111 | 3,439,552 | 2,741,899 | 1,464,090 | 1,175,405 | 1,063,169 |
| 2015 | 1,175,128 | 972,689 | 1,189,375 | 1,135,707 | 1,409,485 | 1,324,869 | 1,520,142 | 2,502,402 | 1,729,711 | 972,256 | 802,915 | 910,372 |
| 2016 | 992,497 | 854,307 | 1,069,416 | 1,065,569 | 1,193,014 | 1,779,192 | 2,510,870 | 3,076,960 | 2,062,752 | 974,037 | 738,869 | 927,340 |
| 2017 | 1,199,439 | 1,002,150 | 981,607 | 1,086,996 | 2,092,859 | 3,470,512 | 3,992,209 | 5,492,617 | 4,987,197 | 2,060,611 | 1,263,348 | 1,380,772 |
| 2018 | 1,278,453 | 1,270,962 | 1,118,921 | 1,224,830 | 1,010,520 | 1,377,467 | 2,426,764 | 4,361,431 | 2,910,944 | 1,317,323 | 1,018,168 | 1,028,827 |

Table C-2. Unregulated flows into Brownlee Dam (BRN) for water years 1928 to 2018 (cfs)

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | 20,810 | 26,177 | 20,043 | 19,988 | 16,281 | 33,269 | 34,313 | 83,688 | 46,391 | 26,093 | 16,508 | 16,123 |
| 1929 | 19,293 | 16,720 | 13,022 | 13,002 | 11,289 | 22,526 | 27,734 | 43,765 | 44,190 | 20,255 | 14,295 | 15,321 |
| 1930 | 16,553 | 15,879 | 13,904 | 10,579 | 17,392 | 17,570 | 26,748 | 36,329 | 34,005 | 17,431 | 16,241 | 15,145 |
| 1931 | 19,094 | 14,426 | 12,676 | 11,614 | 11,912 | 16,869 | 20,954 | 27,211 | 20,069 | 9,708 | 9,843 | 11,007 |
| 1932 | 12,582 | 12,295 | 11,214 | 9,984 | 10,433 | 26,926 | 37,172 | 62,013 | 59,550 | 23,906 | 14,104 | 13,961 |
| 1933 | 14,989 | 15,821 | 12,066 | 11,784 | 11,212 | 15,856 | 27,464 | 39,661 | 61,406 | 17,779 | 13,013 | 12,611 |
| 1934 | 13,585 | 14,204 | 13,592 | 15,910 | 12,856 | 16,730 | 25,692 | 24,922 | 16,418 | 9,970 | 8,526 | 9,711 |
| 1935 | 12,651 | 11,735 | 10,964 | 10,789 | 10,546 | 12,942 | 27,392 | 39,553 | 45,235 | 18,515 | 11,070 | 11,385 |
| 1936 | 12,942 | 13,655 | 10,619 | 12,182 | 14,377 | 18,001 | 49,395 | 70,715 | 51,540 | 19,295 | 14,430 | 14,385 |
| 1937 | 14,860 | 14,353 | 11,742 | 10,394 | 11,674 | 16,287 | 27,035 | 43,368 | 34,607 | 16,024 | 10,928 | 11,932 |
| 1938 | 14,791 | 15,064 | 19,093 | 14,698 | 15,182 | 28,369 | 47,166 | 71,047 | 67,574 | 32,010 | 15,791 | 15,139 |
| 1939 | 19,586 | 18,197 | 15,168 | 13,379 | 13,261 | 26,662 | 36,254 | 43,432 | 28,485 | 17,798 | 12,782 | 14,989 |
| 1940 | 16,495 | 14,119 | 13,326 | 13,917 | 19,692 | 26,712 | 39,273 | 45,919 | 32,757 | 14,892 | 11,283 | 16,223 |
| 1941 | 18,369 | 17,035 | 15,237 | 14,531 | 17,695 | 22,686 | 27,219 | 44,028 | 40,612 | 18,496 | 17,050 | 16,540 |
| 1942 | 19,061 | 19,496 | 20,046 | 13,346 | 16,959 | 19,148 | 43,558 | 49,308 | 49,481 | 22,886 | 14,030 | 15,289 |
| 1943 | 16,632 | 19,638 | 19,785 | 24,607 | 26,126 | 34,431 | 77,332 | 63,975 | 74,378 | 46,473 | 21,831 | 18,173 |
| 1944 | 21,964 | 19,861 | 15,859 | 13,491 | 14,978 | 17,108 | 24,731 | 34,275 | 44,049 | 20,985 | 13,808 | 14,678 |
| 1945 | 17,415 | 17,700 | 14,013 | 14,908 | 20,080 | 19,191 | 26,234 | 55,219 | 58,963 | 28,595 | 18,118 | 19,387 |
| 1946 | 20,923 | 19,818 | 19,241 | 17,196 | 16,531 | 34,100 | 57,810 | 65,582 | 49,228 | 23,643 | 16,484 | 18,960 |
| 1947 | 22,913 | 21,555 | 21,480 | 14,344 | 18,687 | 21,466 | 29,101 | 60,084 | 52,802 | 24,730 | 17,880 | 17,622 |
| 1948 | 20,326 | 19,003 | 17,066 | 16,713 | 15,858 | 16,721 | 31,288 | 56,837 | 59,042 | 21,766 | 16,379 | 17,290 |

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1949 | 19,820 | 17,376 | 14,991 | 12,360 | 16,308 | 25,729 | 38,395 | 66,420 | 46,940 | 20,875 | 15,616 | 15,796 |
| 1950 | 20,876 | 17,620 | 14,458 | 14,930 | 17,954 | 24,528 | 38,813 | 54,260 | 74,183 | 41,167 | 21,169 | 20,721 |
| 1951 | 23,323 | 21,268 | 19,187 | 16,826 | 25,855 | 23,883 | 50,829 | 69,874 | 58,126 | 32,825 | 24,766 | 19,636 |
| 1952 | 24,266 | 20,600 | 21,220 | 17,428 | 17,659 | 24,548 | 84,528 | 96,238 | 64,786 | 29,400 | 19,660 | 19,102 |
| 1953 | 18,339 | 16,525 | 16,055 | 22,868 | 18,573 | 18,798 | 32,555 | 47,158 | 76,404 | 32,497 | 18,465 | 17,453 |
| 1954 | 18,234 | 18,602 | 16,235 | 16,660 | 18,109 | 20,108 | 34,656 | 60,229 | 51,431 | 30,205 | 18,533 | 17,495 |
| 1955 | 18,489 | 17,801 | 14,664 | 13,999 | 13,148 | 15,314 | 22,821 | 42,235 | 50,463 | 24,901 | 16,410 | 15,605 |
| 1956 | 16,586 | 18,789 | 28,933 | 24,200 | 17,434 | 25,483 | 48,564 | 79,993 | 75,841 | 30,049 | 19,934 | 18,337 |
| 1957 | 21,470 | 19,409 | 17,987 | 14,372 | 25,094 | 31,919 | 39,186 | 79,884 | 69,030 | 30,343 | 18,247 | 18,781 |
| 1958 | 20,113 | 17,766 | 17,924 | 15,231 | 25,900 | 22,330 | 42,001 | 80,388 | 53,871 | 20,642 | 16,921 | 17,440 |
| 1959 | 17,751 | 18,547 | 17,545 | 17,132 | 15,752 | 16,782 | 27,146 | 40,290 | 53,040 | 21,652 | 16,252 | 20,765 |
| 1960 | 23,386 | 17,663 | 15,442 | 14,484 | 16,388 | 24,468 | 34,270 | 41,892 | 43,508 | 16,421 | 14,975 | 15,959 |
| 1961 | 16,897 | 17,813 | 14,691 | 12,715 | 18,500 | 17,258 | 21,245 | 37,945 | 36,522 | 12,584 | 11,071 | 15,938 |
| 1962 | 19,522 | 16,233 | 14,033 | 13,205 | 22,887 | 18,805 | 42,137 | 54,784 | 55,269 | 26,457 | 17,323 | 16,010 |
| 1963 | 21,715 | 19,503 | 18,512 | 14,734 | 28,202 | 16,457 | 25,675 | 49,054 | 58,298 | 22,580 | 15,596 | 19,071 |
| 1964 | 15,550 | 19,277 | 16,080 | 15,206 | 14,329 | 17,833 | 32,230 | 51,553 | 72,944 | 31,730 | 18,168 | 18,310 |
| 1965 | 17,776 | 19,367 | 39,586 | 31,899 | 29,561 | 23,965 | 53,704 | 72,082 | 84,632 | 42,819 | 26,657 | 23,552 |
| 1966 | 21,247 | 18,653 | 17,002 | 18,122 | 16,233 | 19,217 | 27,475 | 42,549 | 33,925 | 16,622 | 13,759 | 16,168 |
| 1967 | 18,015 | 17,468 | 16,194 | 17,802 | 16,145 | 16,904 | 21,506 | 49,446 | 74,716 | 34,005 | 17,730 | 18,059 |
| 1968 | 21,415 | 18,823 | 16,347 | 15,348 | 21,908 | 19,949 | 20,039 | 37,779 | 53,189 | 22,867 | 24,854 | 20,476 |
| 1969 | 20,033 | 19,941 | 17,038 | 25,180 | 19,571 | 23,889 | 61,553 | 73,295 | 52,007 | 24,724 | 17,583 | 19,414 |
| 1970 | 21,440 | 17,179 | 15,306 | 30,957 | 21,941 | 20,802 | 23,620 | 60,906 | 79,510 | 34,977 | 19,476 | 23,672 |
| 1971 | 21,660 | 22,740 | 22,443 | 38,575 | 25,237 | 30,662 | 54,675 | 96,160 | 95,088 | 46,715 | 24,738 | 24,273 |
| 1972 | 25,899 | 21,747 | 21,018 | 25,100 | 26,628 | 54,570 | 41,132 | 73,781 | 89,681 | 35,402 | 24,096 | 24,788 |
| 1973 | 25,487 | 21,187 | 19,684 | 20,666 | 18,422 | 20,892 | 28,421 | 48,479 | 42,275 | 22,284 | 17,156 | 21,304 |
| 1974 | 22,011 | 24,993 | 22,471 | 27,370 | 19,943 | 36,451 | 53,313 | 72,338 | 97,437 | 40,140 | 22,836 | 20,134 |
| 1975 | 22,400 | 19,219 | 18,308 | 17,998 | 20,044 | 26,098 | 34,015 | 63,908 | 86,464 | 51,798 | 24,628 | 21,613 |
| 1976 | 25,827 | 21,403 | 22,761 | 20,088 | 20,105 | 25,940 | 48,218 | 81,641 | 62,425 | 33,252 | 26,383 | 25,289 |
| 1977 | 22,868 | 17,000 | 15,951 | 15,700 | 14,870 | 13,997 | 15,498 | 20,579 | 21,269 | 11,264 | 12,145 | 14,554 |
| 1978 | 16,438 | 15,113 | 20,564 | 19,460 | 20,348 | 25,829 | 42,126 | 61,773 | 66,986 | 40,011 | 21,627 | 23,487 |
| 1979 | 19,492 | 16,830 | 15,971 | 16,317 | 20,047 | 24,579 | 25,233 | 51,652 | 41,555 | 19,248 | 17,741 | 16,375 |
| 1980 | 18,879 | 16,235 | 15,543 | 20,270 | 22,796 | 19,806 | 37,714 | 68,174 | 58,683 | 28,210 | 18,001 | 22,508 |
| 1981 | 19,516 | 18,766 | 21,054 | 18,229 | 22,852 | 20,622 | 31,542 | 46,558 | 48,176 | 17,964 | 14,209 | 15,856 |
| 1982 | 19,441 | 18,636 | 22,619 | 18,430 | 40,131 | 34,633 | 48,057 | 85,599 | 85,295 | 55,696 | 24,930 | 25,173 |
| 1983 | 26,003 | 22,872 | 24,130 | 25,801 | 30,512 | 53,509 | 51,219 | 86,325 | 87,687 | 46,593 | 27,893 | 24,444 |
| 1984 | 27,253 | 27,494 | 26,747 | 27,372 | 25,087 | 49,911 | 68,894 | 97,801 | 94,995 | 46,965 | 28,232 | 26,771 |
| 1985 | 26,409 | 24,774 | 21,420 | 19,835 | 20,701 | 25,126 | 49,357 | 59,022 | 38,875 | 20,941 | 18,294 | 24,994 |
| 1986 | 23,487 | 20,043 | 19,809 | 20,243 | 47,435 | 57,351 | 60,071 | 70,722 | 85,735 | 34,151 | 23,792 | 26,794 |
| 1987 | 24,715 | 21,095 | 17,842 | 16,701 | 18,652 | 21,936 | 26,855 | 37,919 | 24,637 | 18,449 | 15,936 | 17,155 |
| 1988 | 17,699 | 15,927 | 15,701 | 15,650 | 16,182 | 17,175 | 28,244 | 38,704 | 31,525 | 12,960 | 11,513 | 14,579 |

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989 | 15,422 | 16,195 | 14,844 | 14,441 | 16,298 | 35,209 | 49,267 | 56,268 | 47,720 | 22,292 | 17,992 | 18,699 |
| 1990 | 20,553 | 17,267 | 15,480 | 16,356 | 15,164 | 19,007 | 33,137 | 34,331 | 39,488 | 18,502 | 14,706 | 15,335 |
| 1991 | 18,379 | 15,722 | 13,422 | 14,752 | 15,406 | 16,129 | 20,314 | 41,678 | 43,976 | 18,971 | 14,556 | 17,416 |
| 1992 | 17,353 | 16,279 | 15,136 | 13,831 | 16,969 | 16,256 | 22,493 | 27,630 | 16,976 | 12,611 | 10,004 | 12,546 |
| 1993 | 13,206 | 12,561 | 12,665 | 13,520 | 13,820 | 34,729 | 41,921 | 75,013 | 61,560 | 27,905 | 22,158 | 18,396 |
| 1994 | 20,228 | 15,527 | 15,890 | 15,617 | 15,361 | 16,869 | 26,269 | 40,527 | 23,523 | 13,112 | 12,457 | 13,810 |
| 1995 | 16,321 | 13,884 | 15,540 | 18,978 | 22,883 | 29,126 | 34,945 | 65,180 | 74,806 | 41,731 | 21,393 | 20,430 |
| 1996 | 20,882 | 19,209 | 23,339 | 20,033 | 31,799 | 33,249 | 50,507 | 80,293 | 84,224 | 35,774 | 21,334 | 22,660 |
| 1997 | 21,085 | 21,681 | 29,972 | 48,234 | 27,384 | 35,992 | 56,597 | 103,951 | 95,839 | 42,312 | 28,449 | 25,618 |
| 1998 | 25,003 | 20,361 | 17,946 | 21,246 | 22,074 | 30,431 | 38,903 | 87,906 | 72,018 | 40,401 | 22,624 | 24,882 |
| 1999 | 22,579 | 19,323 | 19,052 | 21,530 | 24,146 | 36,863 | 45,003 | 73,627 | 86,059 | 37,480 | 24,144 | 22,508 |
| 2000 | 21,985 | 18,132 | 18,156 | 19,598 | 25,667 | 25,945 | 43,646 | 54,502 | 38,745 | 20,194 | 15,681 | 19,304 |
| 2001 | 20,301 | 16,208 | 15,617 | 15,451 | 16,155 | 19,928 | 23,002 | 35,032 | 20,539 | 14,368 | 12,477 | 13,586 |
| 2002 | 14,628 | 14,514 | 15,380 | 16,327 | 15,658 | 20,742 | 35,445 | 43,867 | 42,534 | 17,342 | 13,129 | 15,667 |
| 2003 | 15,253 | 13,415 | 14,833 | 18,107 | 18,694 | 20,424 | 28,783 | 50,398 | 44,110 | 15,762 | 12,755 | 14,404 |
| 2004 | 14,709 | 13,855 | 15,245 | 15,193 | 18,982 | 26,910 | 31,546 | 40,938 | 37,574 | 19,627 | 14,598 | 16,557 |
| 2005 | 17,543 | 14,406 | 15,630 | 15,065 | 14,432 | 17,665 | 25,302 | 57,117 | 39,480 | 19,140 | 13,416 | 15,222 |
| 2006 | 17,135 | 15,912 | 20,770 | 27,814 | 22,938 | 34,011 | 75,147 | 89,150 | 55,532 | 21,690 | 15,974 | 18,489 |
| 2007 | 19,580 | 17,589 | 17,851 | 15,971 | 18,673 | 24,093 | 27,939 | 39,201 | 23,842 | 13,070 | 12,213 | 15,094 |
| 2008 | 18,084 | 16,501 | 16,015 | 15,669 | 16,312 | 20,467 | 25,057 | 62,896 | 61,465 | 29,279 | 15,474 | 16,954 |
| 2009 | 18,054 | 16,417 | 14,820 | 16,620 | 16,186 | 21,122 | 30,012 | 58,740 | 64,198 | 27,851 | 18,100 | 17,481 |
| 2010 | 20,353 | 15,474 | 14,735 | 17,211 | 17,449 | 19,830 | 30,204 | 35,862 | 69,662 | 23,500 | 15,518 | 16,705 |
| 2011 | 18,631 | 15,680 | 19,144 | 22,397 | 18,383 | 29,170 | 44,232 | 79,186 | 97,569 | 57,620 | 23,939 | 21,246 |
| 2012 | 23,907 | 18,201 | 16,552 | 19,719 | 18,318 | 28,790 | 50,731 | 54,726 | 43,453 | 20,718 | 13,842 | 16,481 |
| 2013 | 17,659 | 16,327 | 20,410 | 14,686 | 16,919 | 18,746 | 24,401 | 39,953 | 27,269 | 13,870 | 11,364 | 16,919 |
| 2014 | 17,128 | 14,922 | 14,144 | 14,012 | 18,680 | 25,757 | 28,235 | 55,938 | 46,078 | 23,811 | 19,116 | 17,867 |
| 2015 | 19,111 | 16,346 | 19,343 | 18,470 | 25,379 | 21,547 | 25,546 | 40,697 | 29,068 | 15,812 | 13,058 | 15,299 |
| 2016 | 16,141 | 14,357 | 17,392 | 17,330 | 20,740 | 28,935 | 42,196 | 50,041 | 34,665 | 15,841 | 12,016 | 15,584 |
| 2017 | 19,507 | 16,841 | 15,964 | 17,678 | 37,683 | 56,442 | 67,090 | 89,328 | 83,811 | 33,512 | 20,546 | 23,204 |
| 2018 | 20,792 | 21,359 | 18,197 | 19,920 | 18,195 | 22,402 | 40,783 | 70,931 | 48,919 | 21,424 | 16,559 | 17,290 |

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# Appendix D: Modified Flows Data

Table D-1. Modified flows into Brownlee Dam (BRN) for water years 1928 to 2018 (acre-feet per month)

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | 675,341 | 1,016,559 | 1,076,434 | 1,107,357 | 896,328 | 1,635,183 | 1,646,751 | 2,301,881 | 911,698 | 589,537 | 488,668 | 598,585 |
| 1929 | 708,126 | 781,807 | 748,242 | 719,243 | 550,897 | 1,136,689 | 1,008,714 | 978,837 | 817,484 | 466,267 | 440,187 | 490,271 |
| 1930 | 595,715 | 768,198 | 730,130 | 616,082 | 848,203 | 801,061 | 710,523 | 897,935 | 653,707 | 448,161 | 477,820 | 512,131 |
| 1931 | 639,784 | 722,670 | 705,015 | 678,844 | 579,125 | 814,661 | 664,624 | 596,580 | 434,678 | 375,415 | 369,316 | 402,701 |
| 1932 | 493,583 | 639,653 | 655,608 | 616,150 | 591,343 | 1,379,712 | 1,430,544 | 1,692,966 | 1,273,521 | 564,231 | 428,492 | 514,983 |
| 1933 | 620,917 | 724,157 | 707,381 | 628,614 | 565,638 | 816,488 | 925,548 | 1,066,504 | 1,339,135 | 496,387 | 447,775 | 514,497 |
| 1934 | 598,322 | 738,684 | 731,852 | 833,221 | 648,103 | 736,877 | 724,725 | 570,578 | 421,759 | 367,533 | 344,168 | 387,004 |
| 1935 | 485,186 | 606,540 | 629,477 | 601,783 | 528,720 | 641,736 | 847,489 | 843,619 | 733,831 | 405,937 | 377,234 | 392,992 |
| 1936 | 514,767 | 665,451 | 603,332 | 651,152 | 692,264 | 884,470 | 1,655,083 | 1,630,978 | 1,033,818 | 507,300 | 468,670 | 544,654 |
| 1937 | 607,587 | 666,071 | 677,374 | 592,981 | 556,410 | 776,076 | 960,148 | 922,228 | 696,756 | 440,819 | 428,907 | 485,143 |
| 1938 | 597,871 | 747,446 | 937,230 | 752,294 | 748,573 | 1,414,188 | 1,890,446 | 2,388,335 | 1,532,123 | 906,042 | 509,227 | 582,468 |
| 1939 | 729,723 | 771,810 | 746,795 | 656,527 | 599,032 | 1,198,285 | 1,052,096 | 912,408 | 576,986 | 480,602 | 467,094 | 563,210 |
| 1940 | 630,528 | 694,409 | 703,419 | 708,156 | 916,786 | 1,223,460 | 1,434,966 | 1,212,917 | 705,891 | 487,488 | 458,655 | 634,845 |
| 1941 | 696,439 | 764,690 | 777,058 | 751,887 | 821,977 | 1,077,044 | 928,247 | 1,053,083 | 947,188 | 557,873 | 572,807 | 617,286 |
| 1942 | 708,841 | 843,562 | 928,955 | 786,726 | 827,404 | 916,742 | 1,594,422 | 1,524,985 | 1,129,013 | 616,920 | 516,470 | 614,575 |
| 1943 | 695,118 | 845,128 | 1,038,477 | 1,374,179 | 1,319,538 | 1,829,905 | 3,148,830 | 2,265,394 | 1,711,906 | 1,109,761 | 645,167 | 678,069 |
| 1944 | 810,481 | 842,189 | 788,131 | 711,090 | 700,487 | 791,537 | 839,343 | 888,892 | 939,691 | 566,170 | 550,105 | 600,079 |
| 1945 | 700,618 | 826,361 | 732,183 | 755,197 | 900,501 | 890,064 | 974,753 | 1,572,702 | 1,392,932 | 672,199 | 568,926 | 663,862 |
| 1946 | 737,207 | 836,342 | 927,774 | 883,537 | 730,089 | 1,769,639 | 2,224,488 | 1,898,397 | 1,094,005 | 693,795 | 582,043 | 720,382 |
| 1947 | 857,446 | 904,942 | 1,009,638 | 746,267 | 836,735 | 940,306 | 1,139,549 | 1,593,003 | 1,184,760 | 619,221 | 573,845 | 688,439 |
| 1948 | 801,363 | 818,844 | 822,496 | 834,475 | 748,333 | 786,575 | 988,778 | 1,640,130 | 1,322,721 | 629,867 | 571,686 | 683,146 |
| 1949 | 795,053 | 772,195 | 766,850 | 664,735 | 807,346 | 1,245,212 | 1,183,023 | 1,704,194 | 940,552 | 578,806 | 542,803 | 636,418 |
| 1950 | 778,691 | 803,741 | 739,848 | 747,921 | 784,703 | 1,367,704 | 1,840,671 | 1,643,107 | 1,415,472 | 891,535 | 601,636 | 685,054 |
| 1951 | 846,841 | 861,675 | 1,071,055 | 1,200,691 | 1,507,113 | 1,847,953 | 2,786,403 | 2,381,325 | 1,176,569 | 971,450 | 747,917 | 694,782 |
| 1952 | 916,363 | 880,516 | 1,027,418 | 1,140,449 | 1,164,502 | 1,591,193 | 4,521,067 | 3,508,878 | 1,467,919 | 1,135,129 | 710,881 | 740,646 |
| 1953 | 814,194 | 786,876 | 764,985 | 1,145,432 | 919,564 | 942,203 | 1,230,526 | 1,499,243 | 1,971,455 | 895,465 | 827,484 | 697,817 |
| 1954 | 810,722 | 840,699 | 822,772 | 819,382 | 835,550 | 932,311 | 1,288,935 | 1,504,879 | 1,126,680 | 929,552 | 631,365 | 660,237 |
| 1955 | 804,702 | 803,762 | 791,457 | 732,545 | 625,655 | 762,467 | 810,453 | 966,424 | 895,459 | 850,776 | 544,363 | 583,759 |
| 1956 | 700,864 | 791,988 | 1,275,041 | 1,252,581 | 970,878 | 1,608,682 | 2,312,248 | 2,633,410 | 1,805,797 | 903,084 | 763,437 | 685,267 |
| 1957 | 894,428 | 870,870 | 890,108 | 757,697 | 1,146,600 | 1,889,370 | 2,063,686 | 2,740,247 | 1,493,235 | 846,728 | 740,397 | 698,187 |
| 1958 | 835,130 | 781,570 | 848,058 | 875,478 | 1,276,598 | 1,277,796 | 1,878,748 | 2,473,268 | 1,424,529 | 931,466 | 685,686 | 695,495 |
| 1959 | 808,785 | 823,550 | 822,170 | 829,174 | 735,761 | 772,060 | 814,627 | 946,844 | 948,533 | 817,651 | 619,983 | 793,268 |
| 1960 | 860,519 | 777,497 | 766,178 | 706,484 | 813,428 | 1,144,485 | 949,529 | 1,073,919 | 907,529 | 719,501 | 590,794 | 617,926 |
| 1961 | 725,733 | 791,216 | 760,403 | 661,100 | 814,768 | 836,593 | 670,616 | 780,990 | 664,443 | 524,670 | 453,335 | 516,031 |
| 1962 | 656,650 | 692,825 | 702,333 | 637,504 | 963,839 | 804,182 | 988,876 | 1,047,729 | 984,666 | 814,732 | 589,506 | 596,725 |
| 1963 | 852,931 | 842,499 | 880,168 | 728,175 | 1,129,868 | 759,552 | 888,139 | 1,238,053 | 1,231,084 | 835,905 | 612,142 | 668,089 |

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1964 | 756,880 | 834,930 | 799,061 | 733,521 | 683,473 | 837,521 | 1,092,251 | 1,232,670 | 1,550,627 | 743,123 | 731,899 | 666,260 |
| 1965 | 791,287 | 839,360 | 1,895,898 | 1,924,293 | 1,656,636 | 1,726,042 | 3,047,519 | 2,872,604 | 1,869,813 | 1,079,563 | 1,085,736 | 745,552 |
| 1966 | 817,889 | 814,535 | 798,750 | 1,166,079 | 973,150 | 1,092,835 | 875,711 | 772,835 | 623,987 | 744,653 | 524,324 | 580,138 |
| 1967 | 726,786 | 754,304 | 790,310 | 819,708 | 703,122 | 739,124 | 689,070 | 1,148,299 | 1,408,094 | 868,921 | 568,761 | 613,899 |
| 1968 | 801,866 | 815,743 | 781,634 | 878,878 | 1,092,985 | 990,374 | 750,161 | 680,840 | 717,422 | 723,699 | 720,480 | 638,083 |
| 1969 | 798,804 | 845,698 | 812,888 | 1,411,138 | 1,101,362 | 1,452,826 | 2,756,808 | 2,239,846 | 1,140,608 | 962,449 | 597,049 | 668,870 |
| 1970 | 827,428 | 769,560 | 687,483 | 1,591,351 | 1,056,780 | 1,076,866 | 1,240,607 | 1,809,817 | 1,946,486 | 1,017,098 | 719,551 | 777,550 |
| 1971 | 844,341 | 916,020 | 1,096,059 | 2,625,922 | 1,647,494 | 2,480,730 | 3,366,661 | 3,984,475 | 2,431,345 | 1,161,828 | 945,384 | 718,267 |
| 1972 | 911,567 | 851,130 | 1,424,101 | 1,965,068 | 1,742,739 | 3,688,893 | 2,408,370 | 2,500,996 | 2,199,573 | 1,033,173 | 791,764 | 760,941 |
| 1973 | 875,001 | 868,186 | 1,144,667 | 1,489,573 | 1,126,909 | 1,277,162 | 986,280 | 940,735 | 694,132 | 769,833 | 545,788 | 708,892 |
| 1974 | 829,052 | 960,613 | 1,037,638 | 1,596,191 | 1,154,265 | 2,690,645 | 3,248,119 | 2,707,298 | 2,442,472 | 1,151,382 | 818,437 | 665,643 |
| 1975 | 868,688 | 857,404 | 851,723 | 1,156,578 | 1,200,329 | 1,817,978 | 2,004,521 | 2,259,336 | 1,970,599 | 1,340,170 | 893,099 | 685,291 |
| 1976 | 881,725 | 884,007 | 1,404,315 | 1,484,798 | 1,215,422 | 2,074,383 | 2,836,889 | 2,661,229 | 1,449,751 | 839,105 | 915,199 | 834,237 |
| 1977 | 802,295 | 865,900 | 1,089,705 | 1,139,476 | 793,951 | 742,823 | 435,673 | 557,443 | 557,432 | 383,502 | 379,383 | 452,321 |
| 1978 | 603,739 | 651,616 | 851,605 | 888,495 | 876,007 | 1,190,646 | 1,450,800 | 1,587,498 | 1,146,386 | 706,860 | 798,074 | 735,637 |
| 1979 | 692,372 | 726,947 | 719,046 | 1,026,555 | 1,074,129 | 1,378,299 | 961,896 | 934,686 | 728,553 | 667,263 | 527,488 | 583,888 |
| 1980 | 676,990 | 725,773 | 705,928 | 1,037,379 | 1,078,668 | 1,056,159 | 1,522,262 | 1,914,943 | 1,556,556 | 818,101 | 553,028 | 744,117 |
| 1981 | 743,234 | 780,507 | 905,320 | 1,029,256 | 1,169,852 | 1,147,952 | 1,065,119 | 1,102,011 | 987,337 | 657,254 | 479,724 | 580,436 |
| 1982 | 721,711 | 777,442 | 1,015,858 | 1,029,370 | 2,023,100 | 2,356,253 | 2,905,898 | 3,202,178 | 2,175,851 | 1,447,070 | 969,862 | 784,101 |
| 1983 | 864,410 | 1,014,547 | 1,644,234 | 1,963,621 | 1,937,537 | 3,446,811 | 3,118,298 | 3,428,485 | 2,395,297 | 1,352,723 | 947,116 | 718,018 |
| 1984 | 880,323 | 1,150,620 | 1,682,315 | 2,072,651 | 1,767,668 | 3,437,713 | 4,021,345 | 3,801,384 | 2,989,324 | 1,267,334 | 1,078,840 | 803,370 |
| 1985 | 916,241 | 1,336,653 | 1,377,530 | 1,490,861 | 1,248,451 | 1,498,989 | 2,051,137 | 1,402,394 | 919,040 | 758,056 | 592,047 | 856,788 |
| 1986 | 885,603 | 828,841 | 871,217 | 1,095,575 | 2,529,597 | 3,886,721 | 3,247,094 | 2,599,262 | 2,077,375 | 926,916 | 837,451 | 843,307 |
| 1987 | 988,486 | 1,163,981 | 1,219,383 | 1,185,958 | 979,357 | 1,127,146 | 731,449 | 662,374 | 670,216 | 612,993 | 536,883 | 599,240 |
| 1988 | 688,457 | 688,045 | 721,160 | 687,267 | 718,240 | 755,923 | 668,499 | 638,318 | 645,798 | 490,826 | 431,872 | 521,037 |
| 1989 | 591,409 | 680,058 | 689,715 | 659,129 | 697,692 | 1,559,888 | 1,615,616 | 1,125,196 | 794,200 | 648,171 | 552,121 | 656,026 |
| 1990 | 768,562 | 725,789 | 699,896 | 710,641 | 643,838 | 895,215 | 837,045 | 796,042 | 858,413 | 474,139 | 470,367 | 559,119 |
| 1991 | 697,060 | 690,160 | 675,146 | 696,352 | 629,400 | 647,193 | 576,536 | 739,968 | 611,139 | 589,221 | 433,268 | 547,765 |
| 1992 | 631,003 | 662,735 | 684,502 | 636,472 | 715,433 | 645,997 | 499,595 | 434,252 | 393,263 | 358,018 | 281,965 | 365,815 |
| 1993 | 495,181 | 570,689 | 576,506 | 629,908 | 570,537 | 1,526,228 | 1,599,744 | 1,854,961 | 1,320,412 | 763,570 | 657,851 | 648,483 |
| 1994 | 761,848 | 675,682 | 699,424 | 699,462 | 734,198 | 880,831 | 719,472 | 770,497 | 572,812 | 410,398 | 412,588 | 470,591 |
| 1995 | 626,326 | 614,750 | 692,500 | 872,699 | 885,183 | 1,222,320 | 1,205,255 | 1,961,530 | 1,549,277 | 854,481 | 869,204 | 667,605 |
| 1996 | 747,267 | 716,021 | 898,220 | 1,486,161 | 2,007,366 | 2,735,927 | 3,007,369 | 2,801,810 | 2,017,431 | 1,063,695 | 783,404 | 739,120 |
| 1997 | 781,779 | 799,104 | 1,340,426 | 3,099,427 | 2,007,186 | 2,796,590 | 3,276,671 | 3,993,335 | 3,083,214 | 984,646 | 1,024,648 | 758,532 |
| 1998 | 855,589 | 978,175 | 1,188,085 | 1,515,926 | 1,336,090 | 1,978,795 | 2,101,871 | 3,093,737 | 1,814,879 | 1,154,573 | 857,537 | 806,022 |
| 1999 | 835,896 | 752,335 | 1,045,793 | 1,547,950 | 1,402,998 | 2,639,087 | 2,547,806 | 2,391,478 | 2,179,796 | 1,120,891 | 779,283 | 702,135 |
| 2000 | 823,467 | 734,415 | 1,010,376 | 1,449,180 | 1,499,835 | 1,462,802 | 1,507,080 | 1,295,564 | 986,168 | 784,686 | 507,460 | 703,225 |
| 2001 | 783,847 | 721,765 | 713,890 | 694,796 | 734,958 | 941,545 | 702,750 | 748,125 | 655,510 | 546,976 | 446,921 | 490,387 |
| 2002 | 585,285 | 617,532 | 720,619 | 761,520 | 665,695 | 892,428 | 1,064,627 | 971,938 | 833,946 | 613,645 | 465,053 | 582,049 |
| 2003 | 589,266 | 579,269 | 675,153 | 810,167 | 775,880 | 820,296 | 826,355 | 1,234,780 | 892,644 | 572,924 | 458,343 | 530,262 |

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 597,507 | 606,612 | 679,073 | 716,305 | 829,535 | 1,127,706 | 836,503 | 925,686 | 796,945 | 537,873 | 453,846 | 544,711 |
| 2005 | 627,069 | 620,842 | 695,158 | 672,263 | 587,901 | 745,850 | 700,997 | 1,294,759 | 808,125 | 508,565 | 438,344 | 527,158 |
| 2006 | 632,420 | 656,784 | 901,375 | 1,321,196 | 1,079,760 | 1,721,771 | 3,177,872 | 2,533,689 | 1,441,814 | 738,314 | 548,945 | 645,965 |
| 2007 | 745,975 | 693,822 | 762,351 | 824,254 | 825,259 | 1,061,926 | 769,206 | 791,918 | 606,036 | 568,656 | 459,251 | 547,278 |
| 2008 | 649,453 | 681,029 | 703,465 | 711,748 | 689,834 | 904,400 | 854,153 | 1,577,603 | 1,130,429 | 685,895 | 601,993 | 620,082 |
| 2009 | 693,265 | 670,862 | 659,378 | 750,168 | 636,259 | 1,002,009 | 1,173,552 | 1,395,649 | 1,219,962 | 775,647 | 656,264 | 610,618 |
| 2010 | 732,271 | 655,034 | 662,788 | 957,978 | 924,762 | 1,121,135 | 1,009,716 | 981,612 | 1,517,232 | 843,978 | 531,681 | 610,417 |
| 2011 | 707,220 | 681,582 | 821,267 | 1,049,818 | 786,208 | 2,042,160 | 2,426,602 | 2,941,381 | 2,839,762 | 1,546,592 | 873,861 | 666,101 |
| 2012 | 862,444 | 721,463 | 982,269 | 1,431,381 | 1,144,899 | 1,601,896 | 2,044,765 | 1,521,240 | 856,120 | 849,988 | 495,746 | 608,291 |
| 2013 | 671,908 | 666,131 | 869,611 | 655,981 | 729,745 | 828,293 | 677,519 | 689,789 | 588,199 | 510,911 | 399,753 | 555,471 |
| 2014 | 642,685 | 647,079 | 658,431 | 626,988 | 723,863 | 1,084,697 | 822,912 | 1,065,808 | 688,579 | 699,756 | 514,449 | 513,999 |
| 2015 | 663,045 | 656,324 | 824,874 | 847,443 | 1,049,725 | 964,819 | 660,768 | 617,388 | 514,200 | 590,100 | 403,586 | 501,630 |
| 2016 | 599,456 | 612,263 | 757,703 | 780,751 | 901,713 | 1,175,606 | 1,180,031 | 1,177,684 | 663,576 | 678,582 | 439,745 | 594,024 |
| 2017 | 672,701 | 639,398 | 683,104 | 827,794 | 1,671,052 | 3,062,014 | 3,802,554 | 3,396,868 | 2,061,080 | 879,399 | 788,466 | 734,174 |
| 2018 | 768,112 | 752,818 | 713,632 | 1,197,860 | 1,030,246 | 1,647,458 | 1,955,630 | 1,935,692 | 1,181,438 | 706,378 | 543,461 | 612,330 |

Table D-2. Modified flows into Brownlee Dam (BRN) for water years 1928 to 2018 (cfs)

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | 10,983 | 17,084 | 17,507 | 18,009 | 15,583 | 26,594 | 27,675 | 37,437 | 15,322 | 9,588 | 7,947 | 10,060 |
| 1929 | 11,517 | 13,139 | 12,169 | 11,697 | 9,919 | 18,486 | 16,952 | 15,919 | 13,738 | 7,583 | 7,159 | 8,239 |
| 1930 | 9,688 | 12,910 | 11,874 | 10,020 | 15,273 | 13,028 | 11,941 | 14,604 | 10,986 | 7,289 | 7,771 | 8,607 |
| 1931 | 10,405 | 12,145 | 11,466 | 11,040 | 10,428 | 13,249 | 11,169 | 9,702 | 7,305 | 6,106 | 6,006 | 6,768 |
| 1932 | 8,027 | 10,750 | 10,662 | 10,021 | 10,281 | 22,439 | 24,041 | 27,533 | 21,402 | 9,176 | 6,969 | 8,655 |
| 1933 | 10,098 | 12,170 | 11,504 | 10,223 | 10,185 | 13,279 | 15,554 | 17,345 | 22,505 | 8,073 | 7,282 | 8,646 |
| 1934 | 9,731 | 12,414 | 11,902 | 13,551 | 11,670 | 11,984 | 12,179 | 9,280 | 7,088 | 5,977 | 5,597 | 6,504 |
| 1935 | 7,891 | 10,193 | 10,237 | 9,787 | 9,520 | 10,437 | 14,243 | 13,720 | 12,332 | 6,602 | 6,135 | 6,604 |
| 1936 | 8,372 | 11,183 | 9,812 | 10,590 | 12,035 | 14,385 | 27,815 | 26,525 | 17,374 | 8,250 | 7,622 | 9,153 |
| 1937 | 9,881 | 11,194 | 11,016 | 9,644 | 10,019 | 12,622 | 16,136 | 14,999 | 11,709 | 7,169 | 6,976 | 8,153 |
| 1938 | 9,723 | 12,561 | 15,243 | 12,235 | 13,479 | 23,000 | 31,770 | 38,843 | 25,748 | 14,735 | 8,282 | 9,789 |
| 1939 | 11,868 | 12,971 | 12,145 | 10,677 | 10,786 | 19,488 | 17,681 | 14,839 | 9,697 | 7,816 | 7,597 | 9,465 |
| 1940 | 10,255 | 11,670 | 11,440 | 11,517 | 15,938 | 19,898 | 24,115 | 19,726 | 11,863 | 7,928 | 7,459 | 10,669 |
| 1941 | 11,327 | 12,851 | 12,638 | 12,228 | 14,800 | 17,516 | 15,600 | 17,127 | 15,918 | 9,073 | 9,316 | 10,374 |
| 1942 | 11,528 | 14,177 | 15,108 | 12,795 | 14,898 | 14,909 | 26,795 | 24,802 | 18,974 | 10,033 | 8,400 | 10,328 |
| 1943 | 11,305 | 14,203 | 16,889 | 22,349 | 23,760 | 29,761 | 52,918 | 36,843 | 28,770 | 18,049 | 10,493 | 11,395 |
| 1944 | 13,181 | 14,153 | 12,818 | 11,565 | 12,178 | 12,873 | 14,106 | 14,456 | 15,792 | 9,208 | 8,947 | 10,085 |
| 1945 | 11,394 | 13,887 | 11,908 | 12,282 | 16,214 | 14,476 | 16,381 | 25,578 | 23,409 | 10,932 | 9,253 | 11,157 |
| 1946 | 11,990 | 14,055 | 15,089 | 14,369 | 13,146 | 28,780 | 37,384 | 30,874 | 18,385 | 11,283 | 9,466 | 12,106 |
| 1947 | 13,945 | 15,208 | 16,420 | 12,137 | 15,066 | 15,293 | 19,151 | 25,908 | 19,911 | 10,071 | 9,333 | 11,570 |
| 1948 | 13,033 | 13,761 | 13,377 | 13,571 | 13,010 | 12,792 | 16,617 | 26,674 | 22,229 | 10,244 | 9,298 | 11,481 |
| 1949 | 12,930 | 12,977 | 12,472 | 10,811 | 14,537 | 20,251 | 19,881 | 27,716 | 15,807 | 9,413 | 8,828 | 10,695 |

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 12,664 | 13,507 | 12,032 | 12,164 | 14,129 | 22,244 | 30,934 | 26,723 | 23,788 | 14,499 | 9,785 | 11,513 |
| 1951 | 13,773 | 14,481 | 17,419 | 19,527 | 27,137 | 30,054 | 46,827 | 38,729 | 19,773 | 15,799 | 12,164 | 11,676 |
| 1952 | 14,903 | 14,798 | 16,709 | 18,548 | 20,245 | 25,878 | 75,979 | 57,066 | 24,669 | 18,461 | 11,561 | 12,447 |
| 1953 | 13,242 | 13,224 | 12,441 | 18,629 | 16,558 | 15,323 | 20,680 | 24,383 | 33,131 | 14,563 | 13,458 | 11,727 |
| 1954 | 13,185 | 14,128 | 13,381 | 13,326 | 15,045 | 15,163 | 21,661 | 24,475 | 18,934 | 15,118 | 10,268 | 11,096 |
| 1955 | 13,087 | 13,508 | 12,872 | 11,914 | 11,266 | 12,400 | 13,620 | 15,717 | 15,049 | 13,837 | 8,853 | 9,810 |
| 1956 | 11,398 | 13,310 | 20,737 | 20,371 | 16,879 | 26,163 | 38,859 | 42,828 | 30,347 | 14,687 | 12,416 | 11,516 |
| 1957 | 14,546 | 14,635 | 14,476 | 12,323 | 20,646 | 30,728 | 34,681 | 44,566 | 25,095 | 13,771 | 12,041 | 11,733 |
| 1958 | 13,582 | 13,135 | 13,792 | 14,238 | 22,986 | 20,781 | 31,573 | 40,224 | 23,940 | 15,149 | 11,152 | 11,688 |
| 1959 | 13,154 | 13,840 | 13,371 | 13,485 | 13,248 | 12,556 | 13,690 | 15,399 | 15,941 | 13,298 | 10,083 | 13,331 |
| 1960 | 13,995 | 13,066 | 12,461 | 11,490 | 14,141 | 18,613 | 15,957 | 17,466 | 15,252 | 11,702 | 9,608 | 10,385 |
| 1961 | 11,803 | 13,297 | 12,367 | 10,752 | 14,671 | 13,606 | 11,270 | 12,702 | 11,166 | 8,533 | 7,373 | 8,672 |
| 1962 | 10,679 | 11,643 | 11,422 | 10,368 | 17,355 | 13,079 | 16,619 | 17,040 | 16,548 | 13,250 | 9,587 | 10,028 |
| 1963 | 13,872 | 14,159 | 14,315 | 11,843 | 20,344 | 12,353 | 14,926 | 20,135 | 20,689 | 13,595 | 9,956 | 11,228 |
| 1964 | 12,309 | 14,031 | 12,995 | 11,930 | 11,882 | 13,621 | 18,356 | 20,047 | 26,059 | 12,086 | 11,903 | 11,197 |
| 1965 | 12,869 | 14,106 | 30,834 | 31,296 | 29,829 | 28,071 | 51,215 | 46,718 | 31,423 | 17,557 | 17,658 | 12,529 |
| 1966 | 13,302 | 13,689 | 12,990 | 18,964 | 17,523 | 17,773 | 14,717 | 12,569 | 10,486 | 12,111 | 8,527 | 9,750 |
| 1967 | 11,820 | 12,677 | 12,853 | 13,331 | 12,660 | 12,021 | 11,580 | 18,675 | 23,664 | 14,132 | 9,250 | 10,317 |
| 1968 | 13,041 | 13,709 | 12,712 | 14,294 | 19,002 | 16,107 | 12,607 | 11,073 | 12,057 | 11,770 | 11,717 | 10,723 |
| 1969 | 12,991 | 14,212 | 13,220 | 22,950 | 19,831 | 23,628 | 46,330 | 36,428 | 19,169 | 15,653 | 9,710 | 11,241 |
| 1970 | 13,457 | 12,933 | 11,181 | 25,881 | 19,028 | 17,514 | 20,849 | 29,434 | 32,712 | 16,542 | 11,702 | 13,067 |
| 1971 | 13,732 | 15,394 | 17,826 | 42,707 | 29,665 | 40,345 | 56,579 | 64,801 | 40,860 | 18,895 | 15,375 | 12,071 |
| 1972 | 14,825 | 14,304 | 23,161 | 31,959 | 30,298 | 59,994 | 40,474 | 40,675 | 36,965 | 16,803 | 12,877 | 12,788 |
| 1973 | 14,231 | 14,590 | 18,616 | 24,226 | 20,291 | 20,771 | 16,575 | 15,300 | 11,665 | 12,520 | 8,876 | 11,913 |
| 1974 | 13,483 | 16,144 | 16,876 | 25,960 | 20,784 | 43,759 | 54,586 | 44,030 | 41,047 | 18,725 | 13,311 | 11,187 |
| 1975 | 14,128 | 14,409 | 13,852 | 18,810 | 21,613 | 29,567 | 33,687 | 36,745 | 33,117 | 21,796 | 14,525 | 11,517 |
| 1976 | 14,340 | 14,856 | 22,839 | 24,148 | 21,130 | 33,737 | 47,676 | 43,281 | 24,364 | 13,647 | 14,884 | 14,020 |
| 1977 | 13,048 | 14,552 | 17,722 | 18,532 | 14,296 | 12,081 | 7,322 | 9,066 | 9,368 | 6,237 | 6,170 | 7,602 |
| 1978 | 9,819 | 10,951 | 13,850 | 14,450 | 15,773 | 19,364 | 24,382 | 25,818 | 19,266 | 11,496 | 12,979 | 12,363 |
| 1979 | 11,260 | 12,217 | 11,694 | 16,695 | 19,341 | 22,416 | 16,165 | 15,201 | 12,244 | 10,852 | 8,579 | 9,813 |
| 1980 | 11,010 | 12,197 | 11,481 | 16,871 | 18,753 | 17,177 | 25,582 | 31,144 | 26,159 | 13,305 | 8,994 | 12,505 |
| 1981 | 12,088 | 13,117 | 14,724 | 16,739 | 21,064 | 18,670 | 17,900 | 17,922 | 16,593 | 10,689 | 7,802 | 9,755 |
| 1982 | 11,738 | 13,065 | 16,521 | 16,741 | 36,428 | 38,321 | 48,835 | 52,078 | 36,566 | 23,534 | 15,773 | 13,177 |
| 1983 | 14,058 | 17,050 | 26,741 | 31,935 | 34,887 | 56,057 | 52,405 | 55,759 | 40,254 | 22,000 | 15,403 | 12,067 |
| 1984 | 14,317 | 19,337 | 27,360 | 33,708 | 30,731 | 55,909 | 67,581 | 61,824 | 50,237 | 20,611 | 17,546 | 13,501 |
| 1985 | 14,901 | 22,463 | 22,403 | 24,247 | 22,480 | 24,379 | 34,471 | 22,808 | 15,445 | 12,329 | 9,629 | 14,399 |
| 1986 | 14,403 | 13,929 | 14,169 | 17,818 | 45,548 | 63,211 | 54,569 | 42,273 | 34,911 | 15,075 | 13,620 | 14,172 |
| 1987 | 16,076 | 19,561 | 19,831 | 19,288 | 17,634 | 18,331 | 12,292 | 10,772 | 11,263 | 9,969 | 8,732 | 10,071 |
| 1988 | 11,197 | 11,563 | 11,729 | 11,177 | 12,487 | 12,294 | 11,235 | 10,381 | 10,853 | 7,983 | 7,024 | 8,756 |
| 1989 | 9,618 | 11,429 | 11,217 | 10,720 | 12,563 | 25,369 | 27,151 | 18,300 | 13,347 | 10,541 | 8,979 | 11,025 |

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | 12,499 | 12,197 | 11,383 | 11,557 | 11,593 | 14,559 | 14,067 | 12,946 | 14,426 | 7,711 | 7,650 | 9,396 |
| 1991 | 11,337 | 11,599 | 10,980 | 11,325 | 11,333 | 10,526 | 9,689 | 12,034 | 10,271 | 9,583 | 7,046 | 9,205 |
| 1992 | 10,262 | 11,138 | 11,132 | 10,351 | 12,438 | 10,506 | 8,396 | 7,062 | 6,609 | 5,823 | 4,586 | 6,148 |
| 1993 | 8,053 | 9,591 | 9,376 | 10,244 | 10,273 | 24,822 | 26,885 | 30,168 | 22,190 | 12,418 | 10,699 | 10,898 |
| 1994 | 12,390 | 11,355 | 11,375 | 11,376 | 13,220 | 14,325 | 12,091 | 12,531 | 9,626 | 6,674 | 6,710 | 7,909 |
| 1995 | 10,186 | 10,331 | 11,262 | 14,193 | 15,939 | 19,879 | 20,255 | 31,901 | 26,036 | 13,897 | 14,136 | 11,219 |
| 1996 | 12,153 | 12,033 | 14,608 | 24,170 | 34,898 | 44,496 | 50,541 | 45,567 | 33,904 | 17,299 | 12,741 | 12,421 |
| 1997 | 12,714 | 13,429 | 21,800 | 50,407 | 36,141 | 45,482 | 55,066 | 64,945 | 51,815 | 16,014 | 16,664 | 12,748 |
| 1998 | 13,915 | 16,439 | 19,322 | 24,654 | 24,058 | 32,182 | 35,323 | 50,315 | 30,500 | 18,777 | 13,947 | 13,546 |
| 1999 | 13,595 | 12,643 | 17,008 | 25,175 | 25,262 | 42,921 | 42,817 | 38,894 | 36,633 | 18,230 | 12,674 | 11,800 |
| 2000 | 13,392 | 12,342 | 16,432 | 23,569 | 26,075 | 23,790 | 25,327 | 21,070 | 16,573 | 12,762 | 8,253 | 11,818 |
| 2001 | 12,748 | 12,130 | 11,610 | 11,300 | 13,234 | 15,313 | 11,810 | 12,167 | 11,016 | 8,896 | 7,268 | 8,241 |
| 2002 | 9,519 | 10,378 | 11,720 | 12,385 | 11,986 | 14,514 | 17,892 | 15,807 | 14,015 | 9,980 | 7,563 | 9,782 |
| 2003 | 9,583 | 9,735 | 10,980 | 13,176 | 13,970 | 13,341 | 13,887 | 20,082 | 15,001 | 9,318 | 7,454 | 8,911 |
| 2004 | 9,718 | 10,194 | 11,044 | 11,650 | 14,422 | 18,340 | 14,058 | 15,055 | 13,393 | 8,748 | 7,381 | 9,154 |
| 2005 | 10,198 | 10,434 | 11,306 | 10,933 | 10,586 | 12,130 | 11,781 | 21,057 | 13,581 | 8,271 | 7,129 | 8,859 |
| 2006 | 10,285 | 11,038 | 14,659 | 21,487 | 19,442 | 28,002 | 53,406 | 41,207 | 24,230 | 12,008 | 8,928 | 10,856 |
| 2007 | 12,132 | 11,660 | 12,398 | 13,405 | 14,860 | 17,271 | 12,927 | 12,879 | 10,185 | 9,248 | 7,469 | 9,197 |
| 2008 | 10,562 | 11,445 | 11,441 | 11,575 | 11,993 | 14,709 | 14,355 | 25,657 | 18,997 | 11,155 | 9,790 | 10,421 |
| 2009 | 11,275 | 11,274 | 10,724 | 12,200 | 11,456 | 16,296 | 19,722 | 22,698 | 20,502 | 12,615 | 10,673 | 10,262 |
| 2010 | 11,909 | 11,008 | 10,779 | 15,580 | 16,651 | 18,234 | 16,969 | 15,964 | 25,498 | 13,726 | 8,647 | 10,258 |
| 2011 | 11,502 | 11,454 | 13,357 | 17,074 | 14,156 | 33,213 | 40,780 | 47,837 | 47,724 | 25,153 | 14,212 | 11,194 |
| 2012 | 14,026 | 12,125 | 15,975 | 23,279 | 19,904 | 26,052 | 34,363 | 24,741 | 14,388 | 13,824 | 8,063 | 10,223 |
| 2013 | 10,928 | 11,195 | 14,143 | 10,669 | 13,140 | 13,471 | 11,386 | 11,218 | 9,885 | 8,309 | 6,501 | 9,335 |
| 2014 | 10,452 | 10,875 | 10,708 | 10,197 | 13,034 | 17,641 | 13,830 | 17,334 | 11,572 | 11,380 | 8,367 | 8,638 |
| 2015 | 10,783 | 11,030 | 13,415 | 13,782 | 18,901 | 15,691 | 11,105 | 10,041 | 8,641 | 9,597 | 6,564 | 8,430 |
| 2016 | 9,749 | 10,289 | 12,323 | 12,698 | 15,676 | 19,119 | 19,831 | 19,153 | 11,152 | 11,036 | 7,152 | 9,983 |
| 2017 | 10,940 | 10,745 | 11,110 | 13,463 | 30,089 | 49,799 | 63,904 | 55,245 | 34,638 | 14,302 | 12,823 | 12,338 |
| 2018 | 12,492 | 12,652 | 11,606 | 19,481 | 18,551 | 26,793 | 32,865 | 31,481 | 19,855 | 11,488 | 8,839 | 10,291 |

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