2012 Summer Water Supply Season – Retrospective

Prepared: February 7, 2013, Portland Water Bureau

The following retrospective describes the 2012 drawdown season including the weather, demands, groundwater use, conservation, and fish flows.

Weather

The accumulation of snowpack during the winter of 2011-12 was generally above average. The low elevation snow monitoring site at South Fork (2690' elevation) recorded a maximum accumulation of 12.5 inches of snow water equivalent (SWE; the depth of liquid water if the snowpack was completely melted). The mid-elevation site at North Fork (3060' elevation) recorded a maximum of 36.2 inches SWE. The highest elevation site at Blazed Alder (3650' elevation) had a maximum SWE of 43.5 inches SWE. These SWE accumulations were well above average: 198%, 184%, and 134% of the averages, respectively, at the three monitoring sites. These amounts were very close to the maximum snowpack recorded in the winter of 2010-11, but the timing of the 2011-12 maximum, around April 1, was about a month earlier than the year before and was more typical of when peak snowpack is observed. Snow is not usually a significant contributor to summer supply from Bull Run because, at the elevations in the watershed, the spring snowmelt is typically finished by early June. When the snowpack is significantly greater than normal, however, it can help delay the onset of drawdown. Snow water equivalent data are presented graphically in Figure 1.

Precipitation during 2012 was, overall, well above average. Total rainfall for the calendar year was 100.73" at Headworks, the first time since 1996 that the total exceeded 100" and one of only nine years to exceed 100" since record keeping began in 1899. Figure 2 shows monthly precipitation at Headworks. All but the summer months of July, August, and September were wetter than average. March was the wettest month, with 16.19" of rainfall recorded at Headworks. The wettest month relative to historical record was June, with 8.85", or 231% of the historical June average.

Temperatures in Portland were cooler than normal for the first half of 2012 and warmer than normal for the second half. With the exception of April, monthly average temperatures ranged from 0.3 ^{o}F to 3.2 ^{o}F below average from January through July (April was 0.7 ^{o}F above average). From August through December, Portland temperatures ranged from 1.1 ^{o}F to 2.4 ^{o}F above average. There were no remarkably hot or cold periods during any part of 2012. The hottest day of the year was August 4, when a high temperature of 102 ^{o}F was measured at Portland's airport. This was the first day in three years that the temperature in Portland exceeded 100 ^{o}F.

Demand

Historic winter base demand was on average approximately 100 million gallons per day (MGD) at its peak, from 1979-1991. Demand over the past 5 years has been about 15% lower than this. In 2012, demand ran about 99% of the average for the previous five years; Figure 3 shows demand from 2012 and the preceding five-year period. Monthly averages ranged from 90% to 104% of the average for the previous five years. January, June, July, August and December demands were slightly above their previous five years' averages; the remaining months were all less than their respective averages.

Bull Run Supply

Drawdown of the Bull Run reservoirs began on July 17th, about two weeks later than average for the timing of drawdown's onset. The reservoirs reached their minimum storage on October 14th, when 7.3 billion gallons (75% of baseline storage) had been withdrawn. The reservoirs completed filling on October 29th. Figure 4 shows drawdown of Bull Run reservoirs.

Groundwater Use

Ample supply conditions in the Bull Run watershed did not necessitate the use of the Columbia South Shore Well Field for seasonal supply augmentation in 2012. However, for purposes of exercising equipment, identifying needed repairs and training operators, a short groundwater maintenance operation took place between August 6th and August 23rd. This operation allowed Water Bureau operations staff to exercise all available supply wells, booster pumps and water quality treatment equipment and take semiannual groundwater quality samples. A total of about 41 million gallons of groundwater was delivered to the distribution system during the maintenance operation. Instantaneous rates ranged between 17 and 19 MGD for about six hours per day on each of the first six days, for a daily average of about 5.3 MGD; and instantaneous rates ranged between 7 and 10 MGD for about six hours per day on five additional days, for a daily average of about 1.8 MGD. Figure 5 shows instantaneous and cumulative groundwater discharge by aquifer during this maintenance operation. During the operation, the Sand and Gravel Aquifer (SGA) provided 62% of the total groundwater contribution to the distribution system, the Blue Lake Aquifer (BLA) provided 28%, and the Troutdale Sandstone Aquifer (TSA) provided 10%.

Prior to the summer supply season, storms in the Bull Run watershed in January and February 2012 caused increased turbidity levels as a result of a landslide on the South Fork of the Bull Run River, and the Columbia South Shore Well Field was activated twice for emergency supply. Groundwater operations from January 21st to January 31st provided a total of about 0.80 billion gallons of groundwater to the distribution system at discharge rates of up to 85 MGD, and groundwater operations from February 23rd to February 27th provided a total of about 0.22 billion gallons of groundwater to the distribution system at discharge rates of up to 54 MGD. Figures 6 and 7 show instantaneous and cumulative groundwater discharge by aquifer during these two emergency operations. During the two turbidity events, the SGA provided 61% of the total groundwater contribution to the distribution system, the BLA provided 30%, and the TSA provided 9%.

Rainfall-Runoff and Groundwater Use Models

Prior to 2007, decisions about summer supply operations were primarily based on a deterministic Rainfall-Runoff model that incorporates 90-day weather forecasts to predict demand and reservoir inflow. Since 2007, a probabilistic Groundwater Use Model has been incorporated into summer supply planning as well.

The Groundwater Use Model uses current-year demand projections,[1] historical reservoir inflows, and anticipated fish flow releases into the Lower Bull Run River to develop a series of reservoir drawdown curves—one for each weather year from 1940 to 2011. These projected drawdown curves are used to determine suggested groundwater pumping rates based on the remaining volume of Bull Run storage above baseline elevations, and the calendar date. These pump rates keep the Bull Run Reservoirs above their baseline storage levels for all of the 72 weather years while minimizing the volume of pumped groundwater and attempting to maintain a relatively constant pumping rate throughout the drawdown season. Both the Rainfall-Runoff and Groundwater Use models use the assumption that temperatures and precipitation patterns in 2012 would be within the range of observed weather since 1940.

[1] The demand projections used in the Groundwater Use Model are the same demand projections—generated by the Water Bureau's Demand Model using historical weather data—that are incorporated into the Rainfall-Runoff Model. The Rainfall-Runoff Model also uses this Demand Model to generate new demand projections throughout the summer as new weather forecasts become available.

The Water Bureau began getting weather forecasts and using the Rainfall-Runoff Model to generate drawdown curves in April. With early forecasts, the model projected a potential need for as much as 3.9 BG of additional supply under the warmest and driest forecast, although the most probable forecast was that Bull Run streamflow and reservoir storage would be more than sufficient to meet demand. By August 2nd, the date of the first forecast made after reservoir drawdown began on July 17th, the warm-dry forecast indicated that as much as 0.7 BG would be needed, while the most probable (median) forecast showed a surplus of about 5.4 BG. The actual course of reservoir drawdown tracked the projections of the Rainfall-Runoff Model between the median and warm-dry forecasts. Figure 8 shows the earliest drawdown projections along with the actual drawdown that was experienced in 2012.

The Groundwater Use Model was also run in April before drawdown began. While the Rainfall-Runoff Model is updated as new long range weather forecasts become available, the Groundwater Use Model does not incorporate weather forecasts and is therefore run only once each year. Subsequent application of the Groundwater Use Model involves comparison of the actual course of drawdown to the groundwater pumping curves generated by the model. Figure 9 shows the groundwater pumping curves that were developed, along with the actual reservoir volume that was observed during the drawdown season. For any date during drawdown, if the actual storage volume drops below one of the groundwater curves, that determines a suggested minimum pump rate.

Instream Flows and Fish Habitat Management

The minimum flow in the lower Bull Run River was 120 cfs until June 15th. From June 16th to the end of September, the flow target in the lower Bull Run River varied depending on the weather forecasts to meet a specific water temperature goal. When the air temperature increased, the city slightly increased flows to maintain the water temperature in the lower river for juvenile salmon and steelhead rearing conditions. The city's water temperature goal was to keep the 7-day average of the daily maximum water temperatures at the hottest point on the Bull Run River (at Larson's Bridge) to below 21 °C (approximately 70 °F). The 7-day average of the daily maxima was as high as 20.1 °C in 2012 and thus met the goal. The average maximum daily water temperature at Larson's Bridge from June 16th through September 30th was 16.8 °C.

In October and November, the city maintained minimum flows in the lower Bull Run River to provide habitat for spawning salmon. For the month of October, the flow targets were 50% of the reservoir inflow (calculated on a weekly basis) with a minimum of 70 cfs and a maximum of 400 cfs. In November, the targets changed to 40% of the reservoir inflow with a minimum of 150 cfs and a cap of 400 cfs. Starting in December, the minimum flow in the lower Bull Run River was set at 120 cfs and remains there until spring. Figures 10 and 11 show water temperatures and flows throughout the drawdown season, respectively.

Cold Water Transfer Study

In preparation for the construction of multiple level intakes at Bull Run Dam 2, a cold water transfer study was conducted in July 2012. This was a test to determine if cold water from Reservoir 1 could effectively be banked in Reservoir 2 to help in managing cold water releases from Dam 2 to the Bull Run River and into the distribution system. A total of 1.05 BG cold water from the bottom of Reservoir 1 was released into Reservoir 2 while it was at full capacity. A portion of this water was observed at the base of Reservoir 2. Data limitations prevented a full analysis of how the cold water mixed into higher levels of Reservoir 2.

Conservation

The bureau's water efficiency program worked with commercial, industrial, government, residential and multi-family customers to help them meet their water efficiency goals. The program helps customers determine the reasons for high use, assists with green building projects, and helps customers keep costs low in a tough economy.

The residential efficiency programs included home water assessments, community education at events, youth education through a school assembly program, water-wise plant and efficient irrigation education at its demonstration garden, and distribution of water efficiency devices. Through the Regional Water Providers Consortium, the bureau provided additional education at nursery events, to multi-family property managers, and through the media campaign which included television and radio.

The bureau's Business, Industry and Government (BIG) water efficiency program assisted commercial customers with unintended water losses, summer cooling load reduction and irrigation advice. A growing number of commercial customers are becoming focused on green building strategies as well as lowering their overall costs for water and sewer. BIG continued to provide technical assistance to the Bureau of Planning and Sustainability's "Sustainability at Work" program as well as supporting increased demand from commercial customers seeking greater efficiency to offset large increases in a new BES extra strength surcharge program for fats, oils and greases (FOG). Staff also spoke at a water efficiency conference and as a guest instructor for Mt. Hood College's Sustainable Building Advisor Program.

Conclusions

The reservoirs reached a minimum of 2.6 BG usable storage on October 14th. The Rainfall-Runoff and Groundwater Use models were used to make conservative decisions about whether and when to operate groundwater for supply augmentation. Groundwater was not required for summer water supply in 2012.

The groundwater maintenance operation performed in August 2012 allowed the bureau to exercise equipment and identify needed repairs. In addition, operational personnel were able to cross train on skills and knowledge needed for running the groundwater system.

The city was able to meet all the in-town and fish demands using its baseline primary resources—Bull Run reservoirs, streamflow, and conservation. Meetings of the Supply Planning Group, which occurred twice a month, were integral to the success of the management of the summer operations. The group balances multiple objectives in order to ensure a reliable high quality water supply for all users while effectively managing costs.

Figure 1: Snow Water Equivalent, in Inches, at Snow Monitoring Sites in Bull Run during the Winter of 2011-12

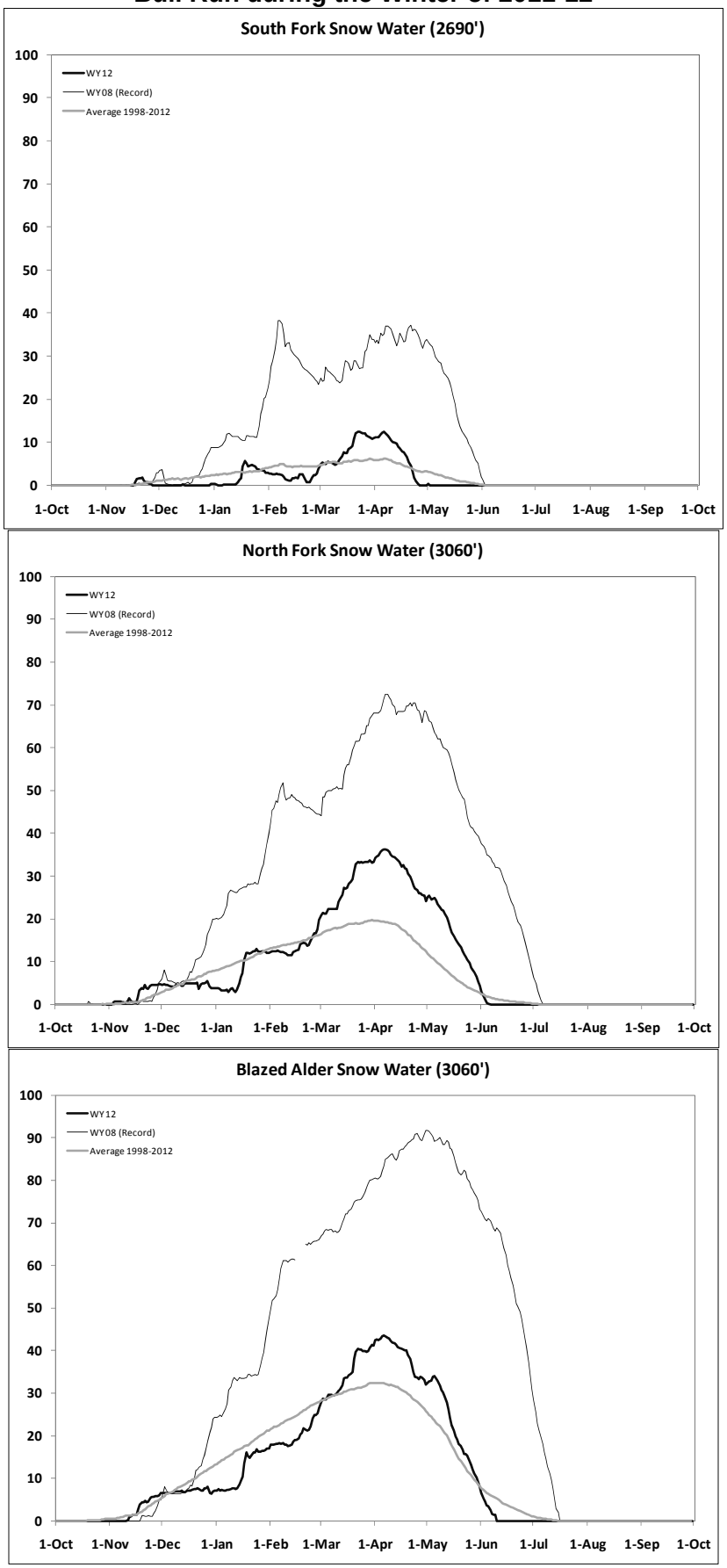


Figure 2: Monthly Precipitation at Headworks, Bull Run, Oregon

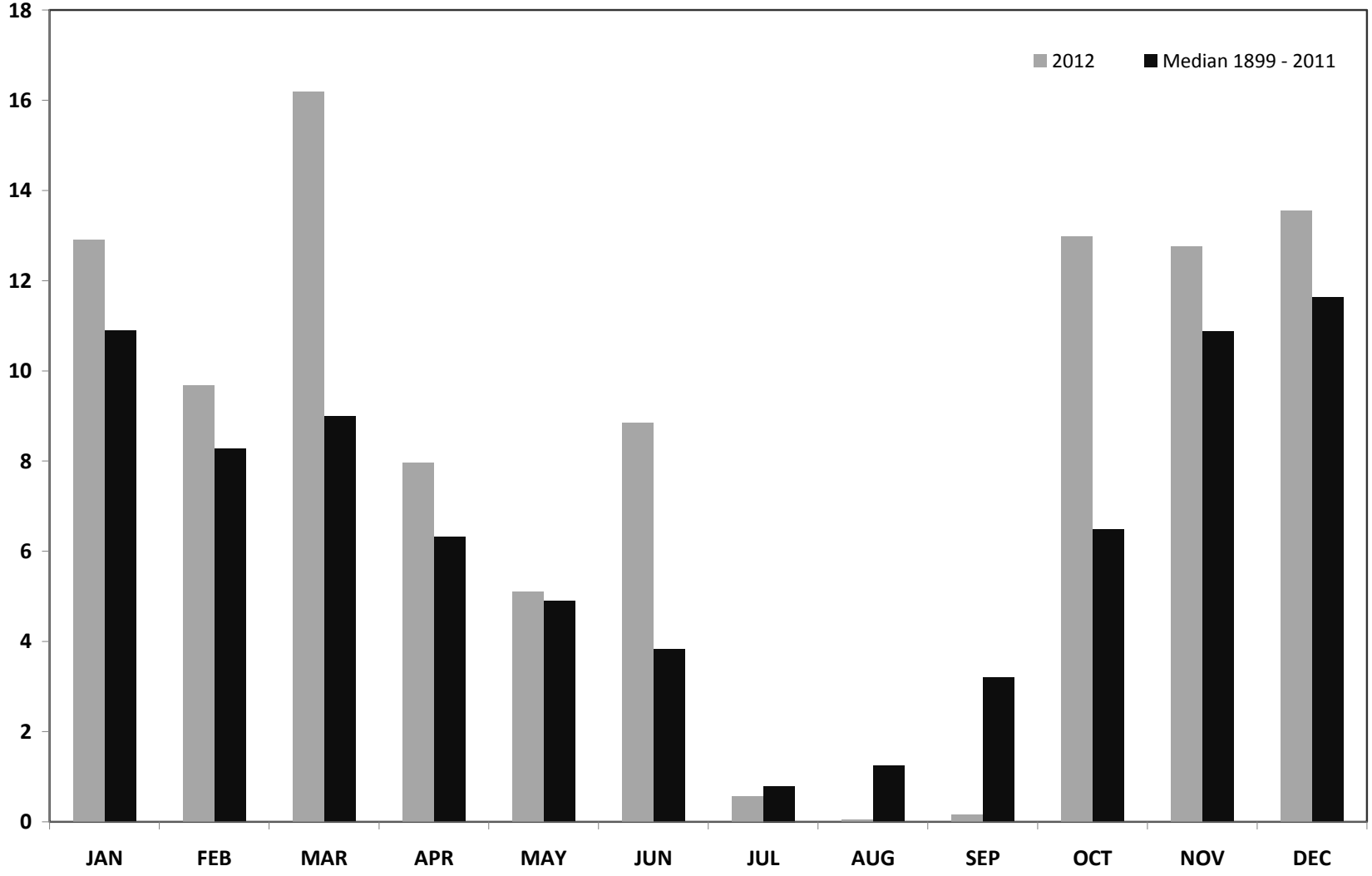


Figure 3: 2012 Demand Compared to Previous Five Years

7-day Moving Averages

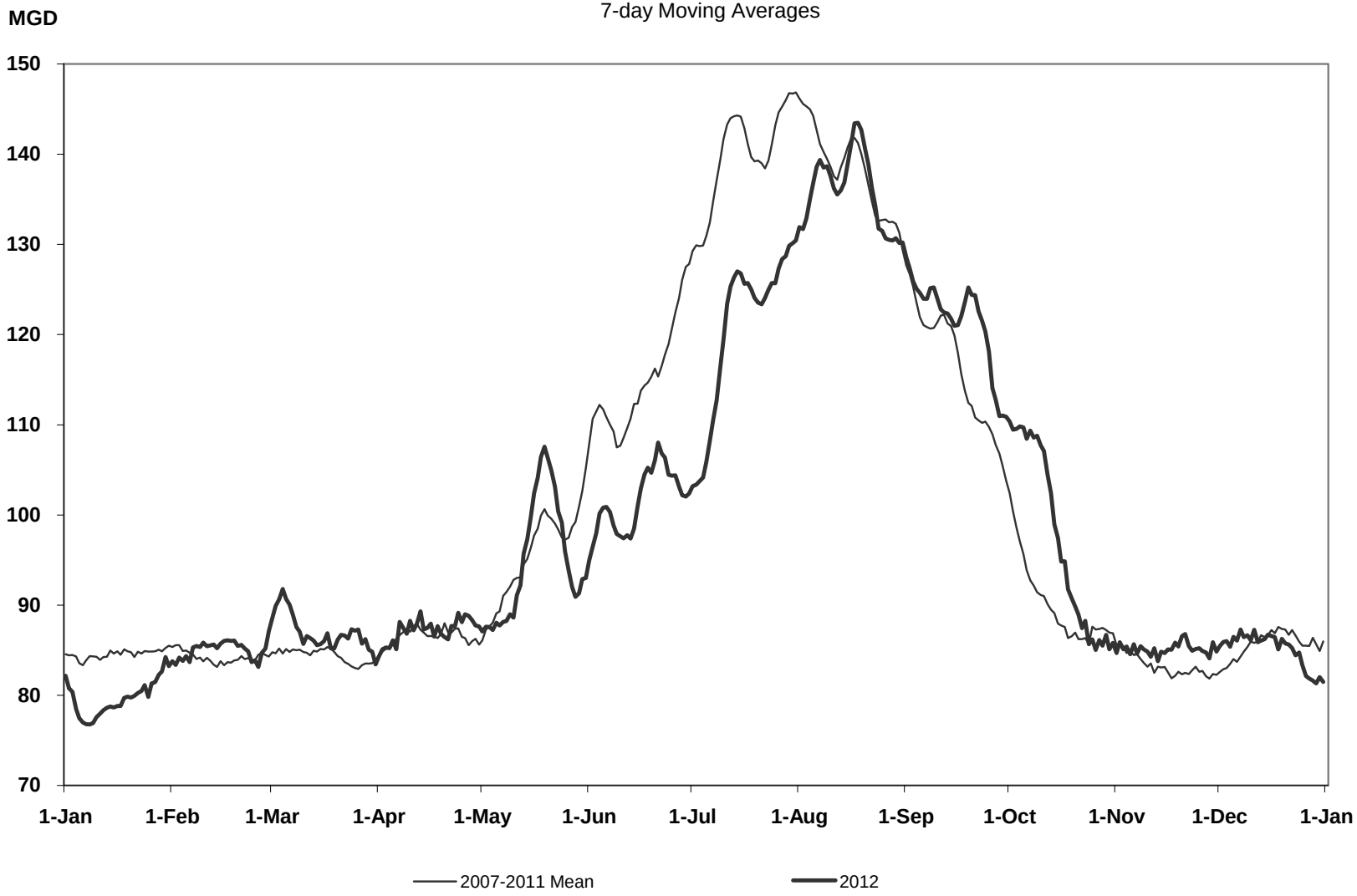


Figure 4: 2012 Bull Run Reservoir Drawdown and Refill

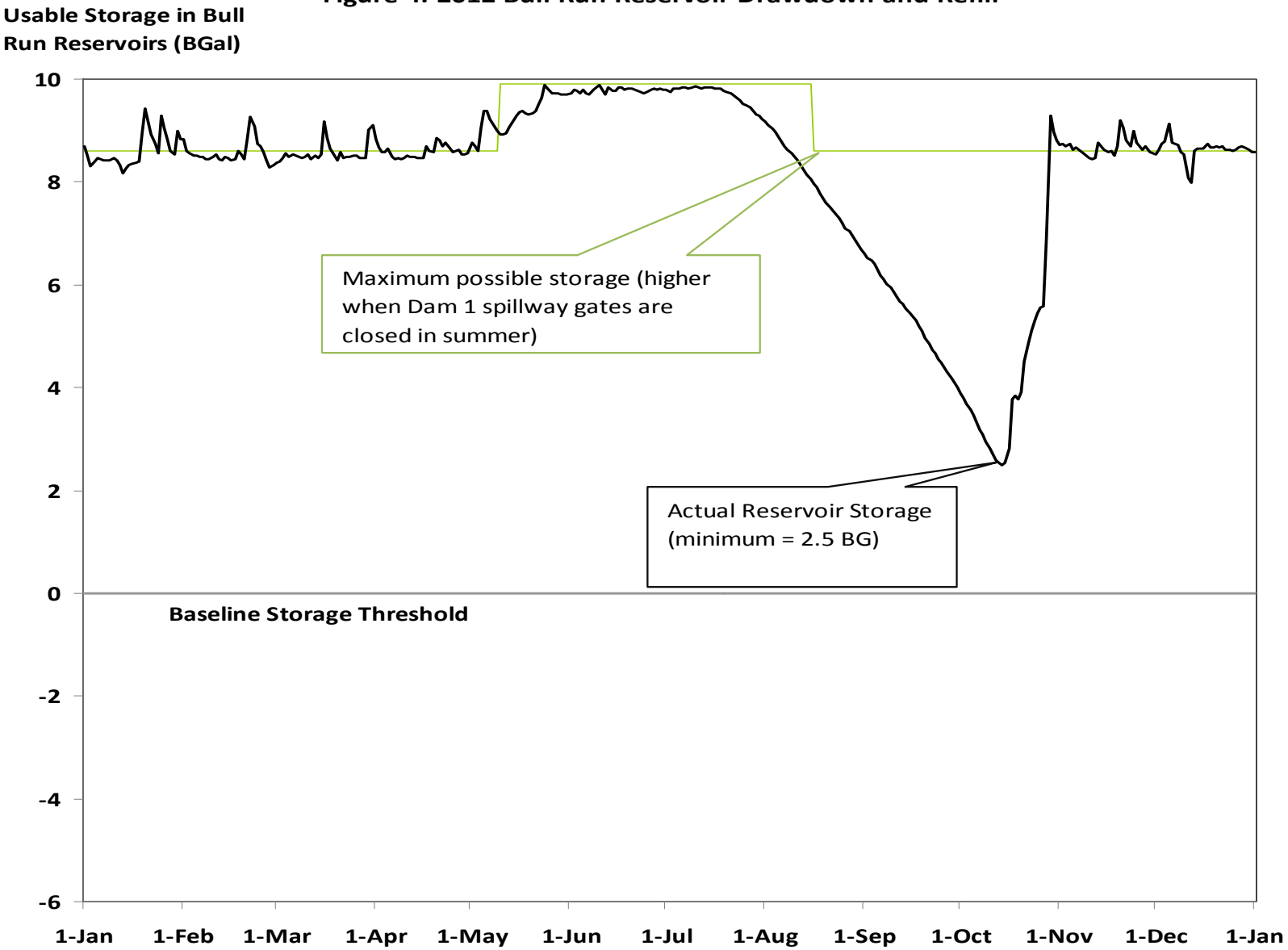


Figure 5: August 2012 Groundwater Maintenance Operation Discharge to Supply

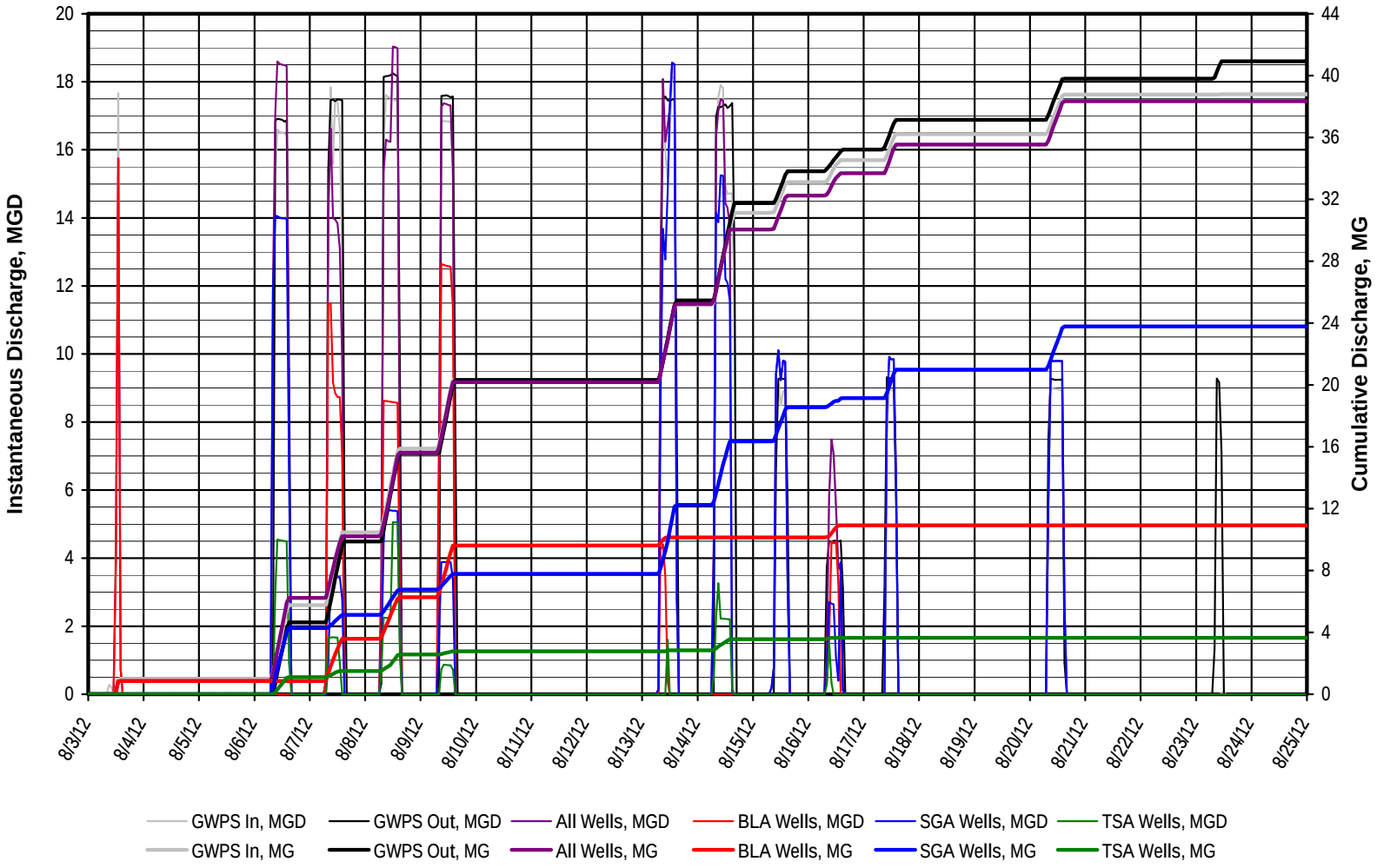


Figure 6: January 2012 Turbidity Event Groundwater Discharge to Supply

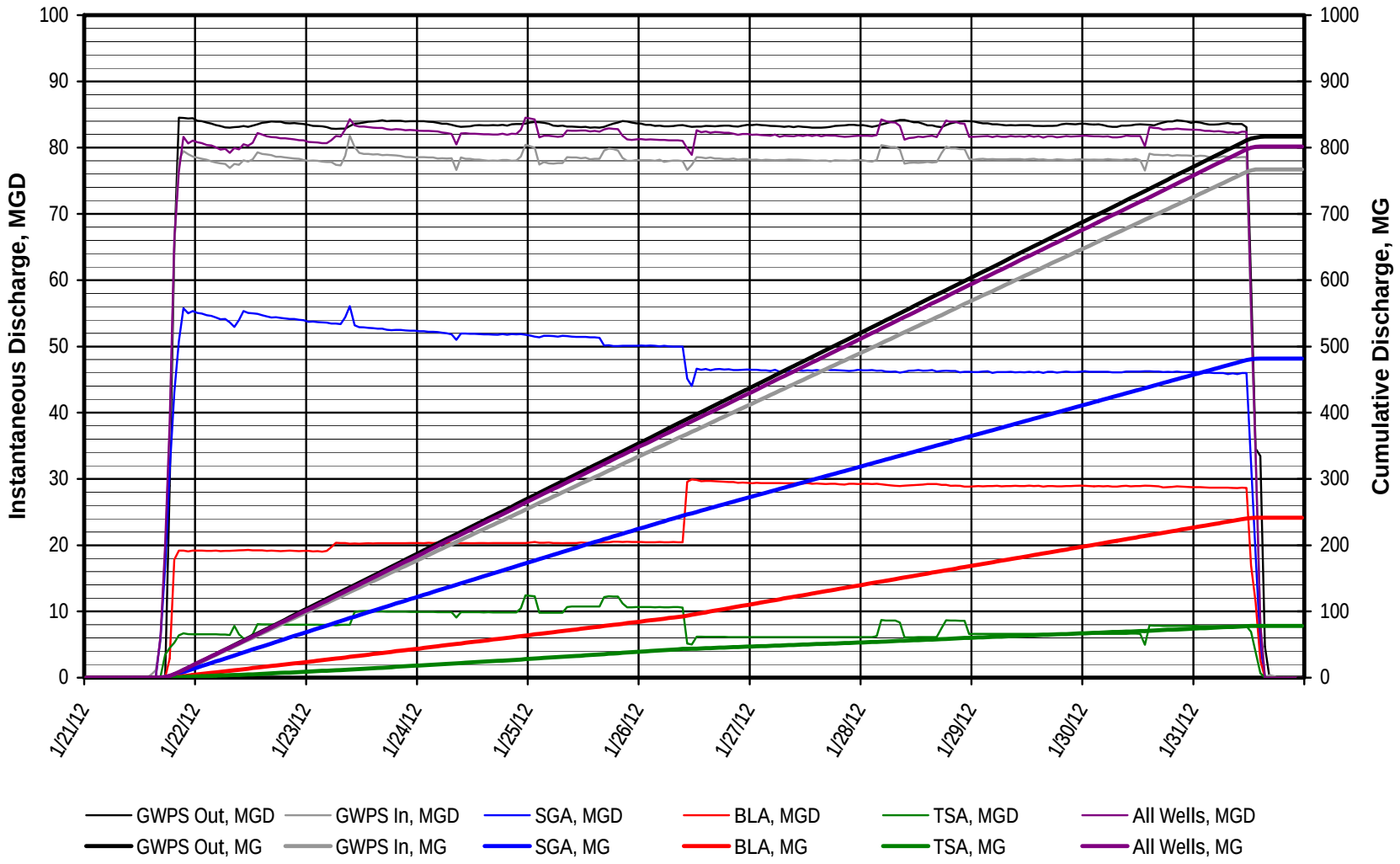


Figure 7: February 2012 Turbidity Event Groundwater Discharge to Supply

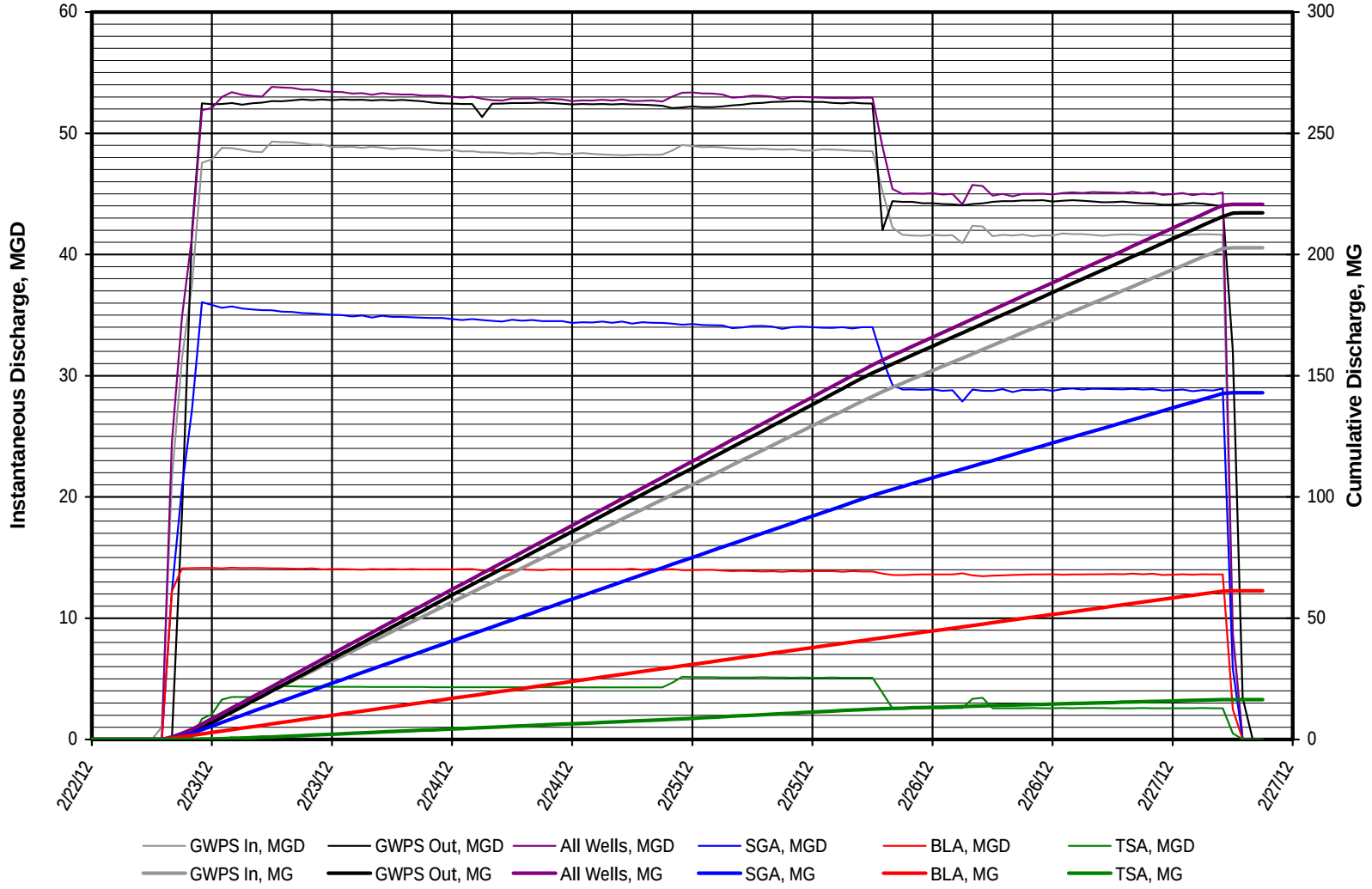


Figure 8: April 18, 2012 Drawdown Projections and Actual Drawdown

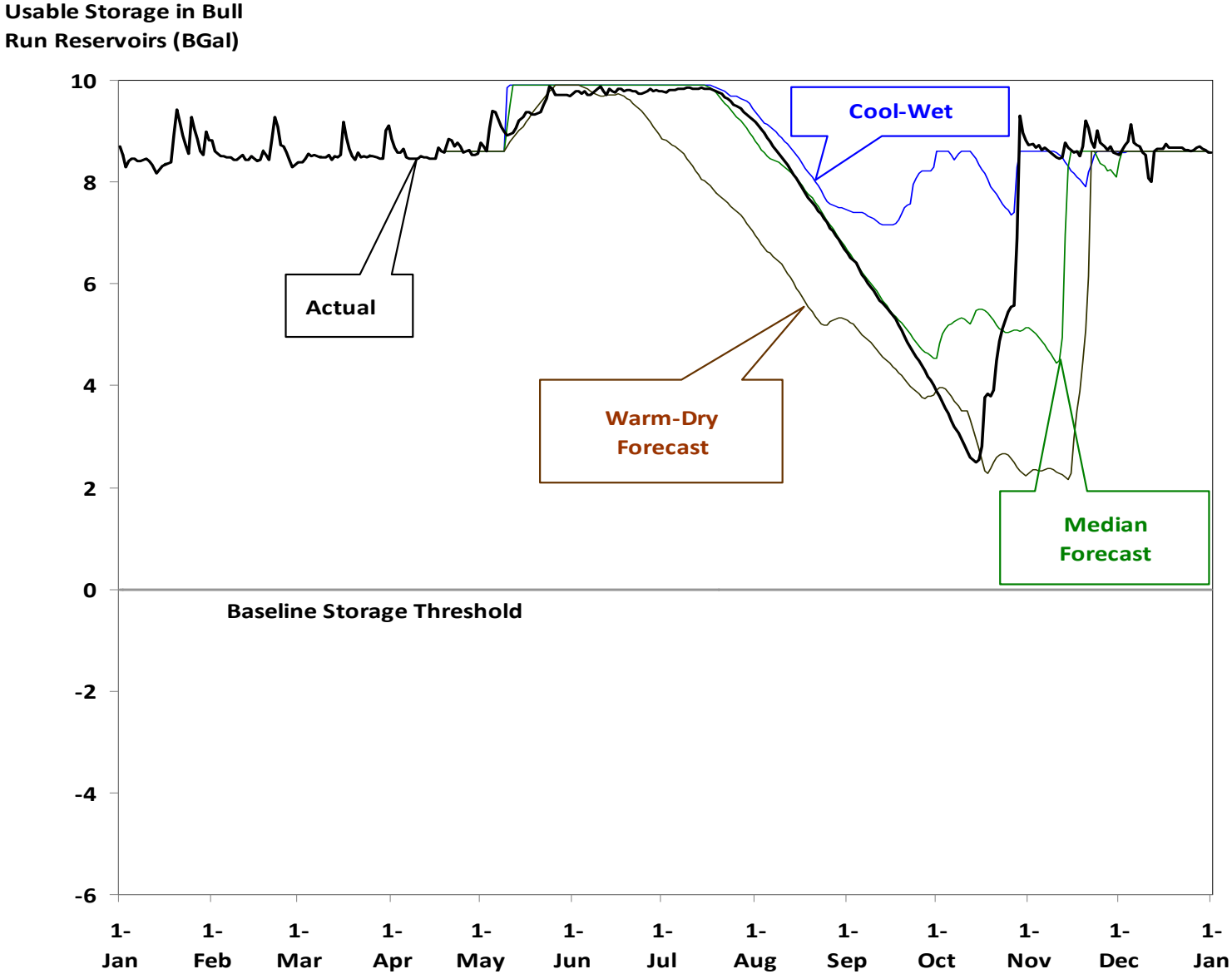
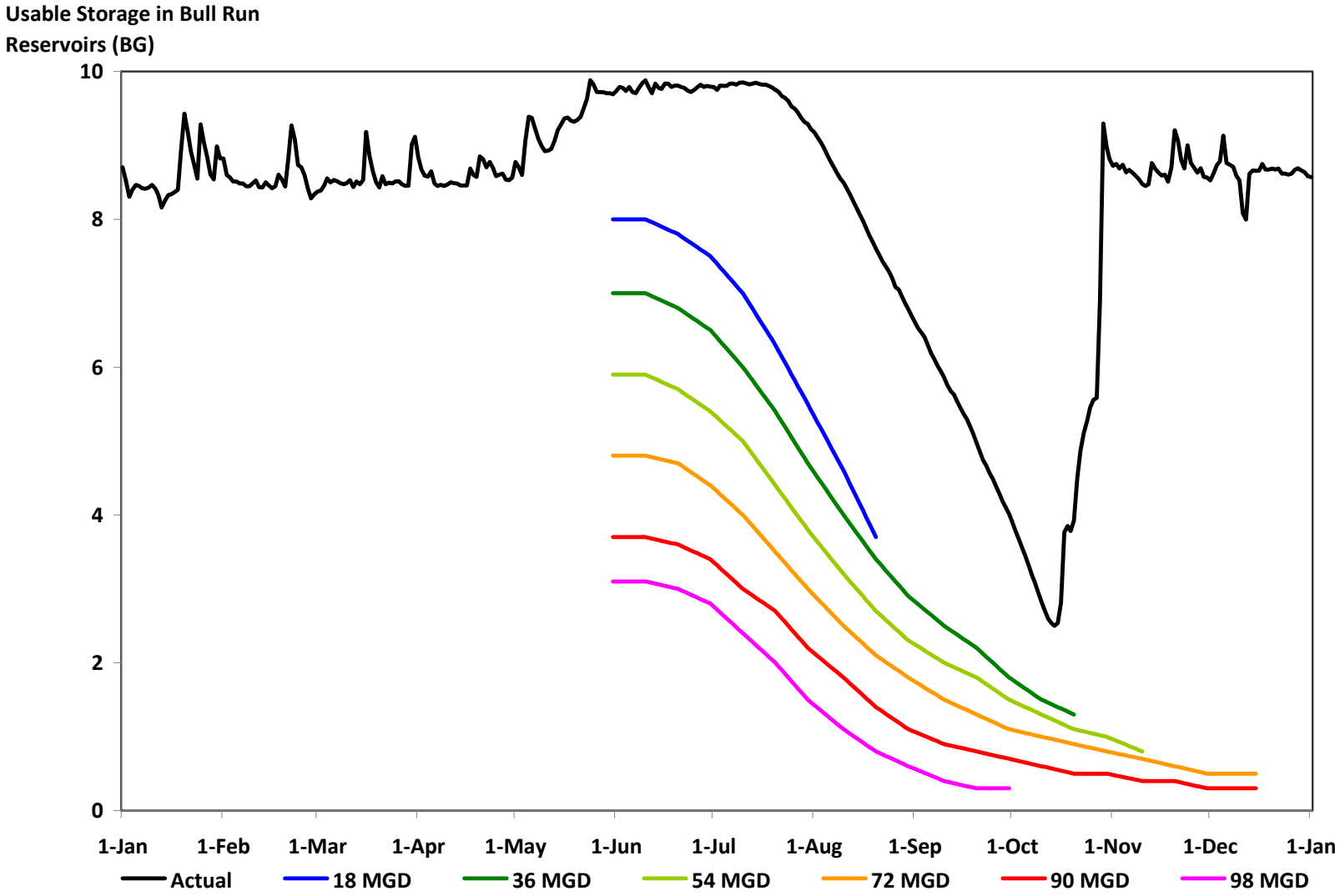


Figure 9: 2012 Observed Storage Volume and Modeled Groundwater Pump Rates



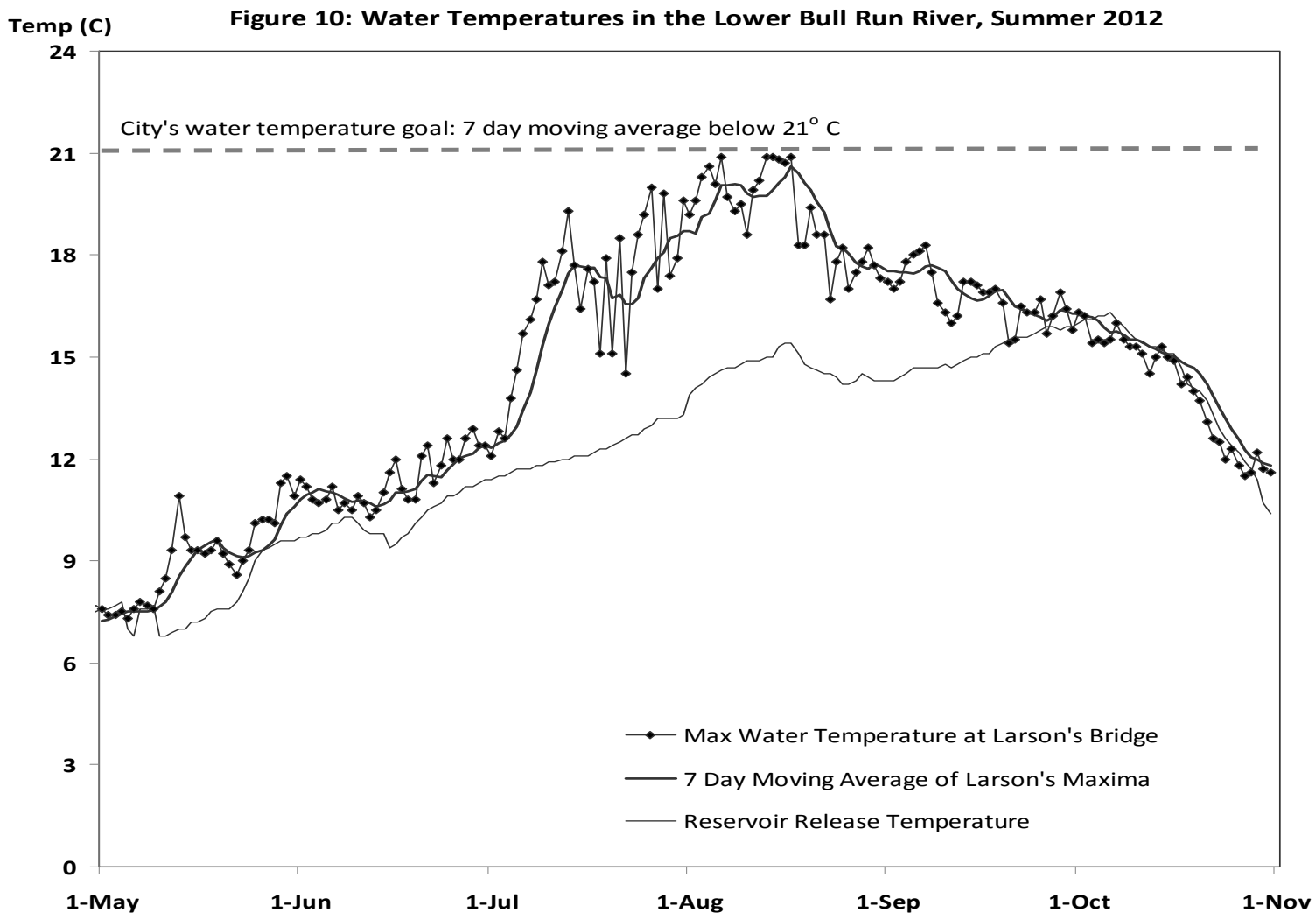


Figure 10: Water Temperatures in the Lower Bull Run River, Summer 2012
Temp (C)
24
21
18
15
12
9
6
3
0
City's water temperature goal: 7 day moving average below 21° C
Max Water Temperature at Larson's Bridge
7 Day Moving Average of Larson's Maxima
Reservoir Release Temperature
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov

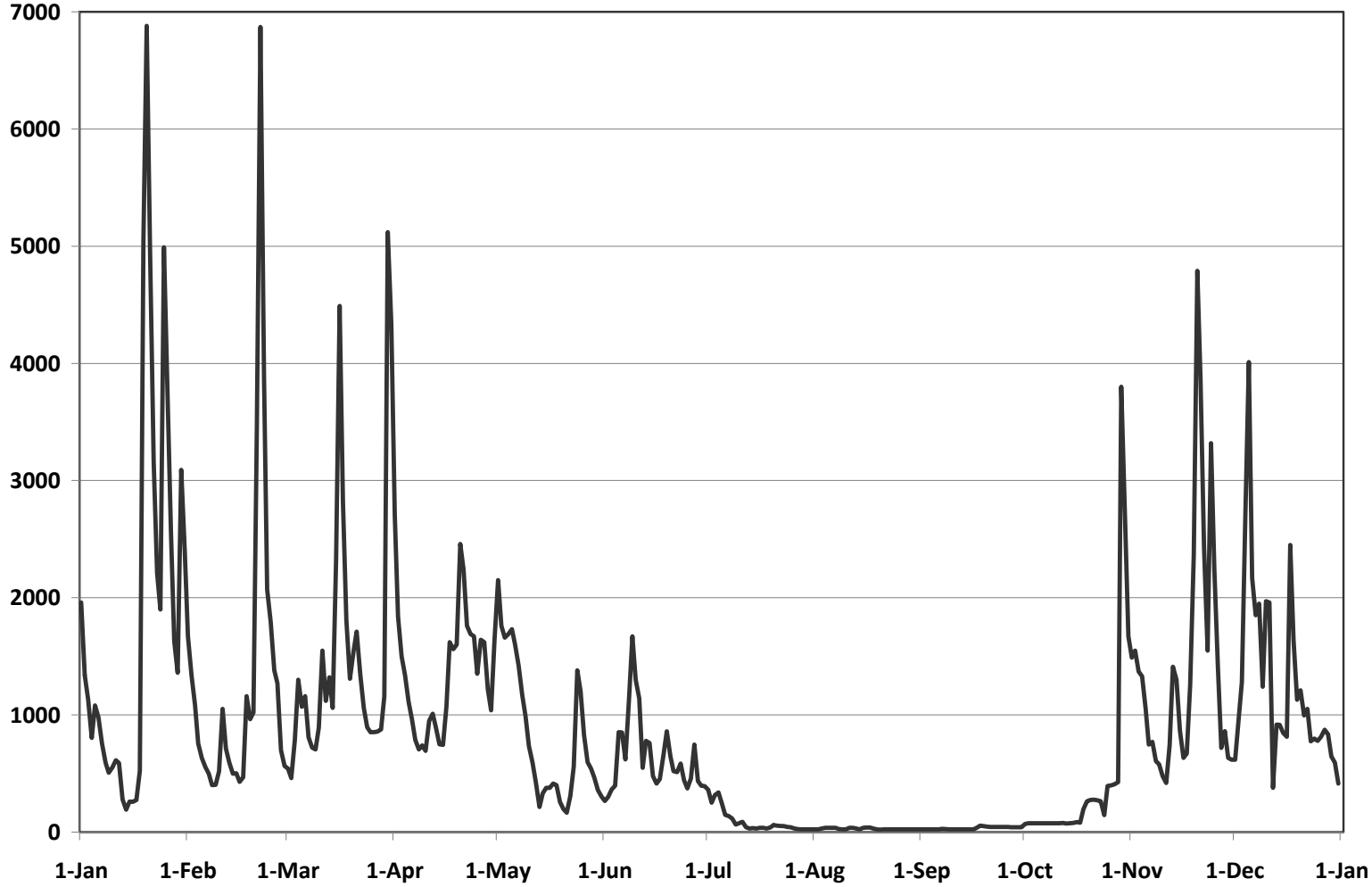



Figure 11: 2012 Flow in the Lower Bull Run River Below Headworks