Design Document: Transient Wood River Stage

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Design document description and purpose

The U.S. Geological Survey (USGS), in collaboration with the Idaho Department of Water Resources (IDWR) is constructing a numerical groundwater-flow model of the Wood River Valley aquifer system in order to simulate potential anthropogenic and climatic effects on groundwater and surface-water resources. This model will serve as a tool for water-rights administration and water-resource management and planning. The study will be conducted over a 3-year period from late 2012 until model and report completion in 2015. One of the goals of the modeling study is to develop the model in an open and transparent manner. To this end, a Technical Advisory Committee was formed to provide for transparency in model development and to serve as a vehicle for stakeholder input. Technical representation was solicited by the IDWR and includes such interested parties as water-user groups and current USGS cooperating organizations in the Wood River Valley.

The design, construction, and calibration of a groundwater-flow model requires a number of decisions such as the number of layers, model cell size, or methodologies used to represent processes such as evapotranspiration or pumpage. While these decisions will be documented in a final USGS report, intermediate decision documents will be prepared in order to facilitate technical discussion and ease preparation of the report. These decision documents should be considered preliminary status reports and not final products.

Problem statement

Ground water and surface water interaction in the Wood River Valley Model will be simulated using the MODFLOW-USG River package (Panday and others, 2013). Along with identifying the grid cells, riverbed conductance, and river bottom elevation, the River package requires river stage, the elevation of the river surface within the model cell. Locations of streamflow gages, along the Big Wood River are shown in Figure 1 and the period of record for each station is shown in Table 1. The Big Wood River is hydraulically connected to the Wood River Valley Aquifer for most of its length between the Big Wood

River near Ketchum gage and the Big Wood River at Stanton Crossing gage; thus the head in the aquifer responds to changes in river stage.

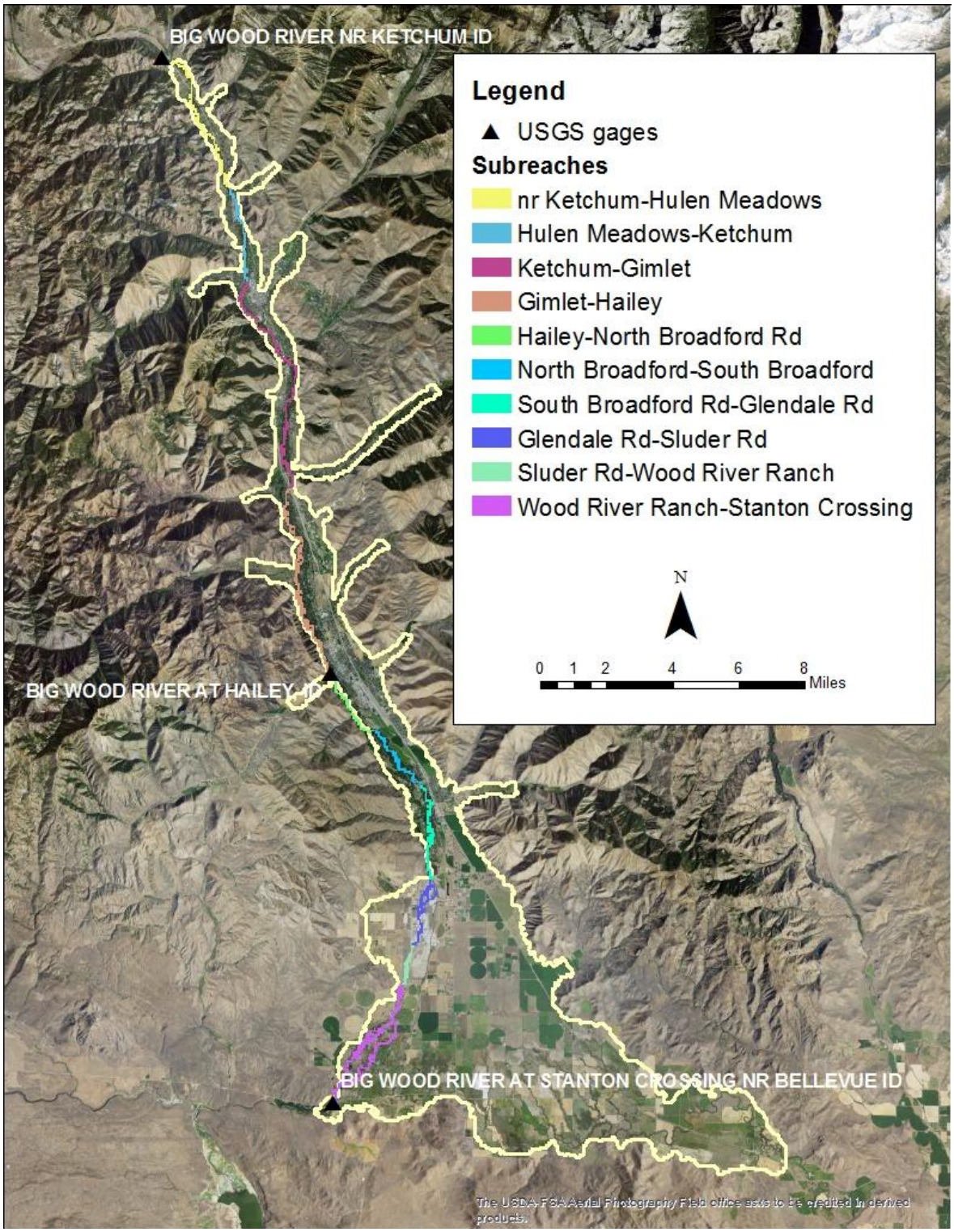

Figure 1. Location of streamflow gages on the Big Wood River.

Table 1. Period of record for streamflow gaging stations.

Station Name	Period of Record
Big Wood River near Ketchum	May 1948-September 1971 April 2011-present
Big Wood River at Hailey	July 1915-present
Big Wood River at Stanton Crossing	September 1996-present

The model calibration period is January 1995 to December 2010. The only streamflow gage with a continuous record during the calibration period is the Big Wood River at Hailey. The Big Wood River at Stanton Crossing gage is missing January 1995 to September 1996, and no data from the Big Wood River near Ketchum were collected during the calibration period.

Data availability, filtering and filling in the gaps

The raw data from the USGS is collected every 15 minutes. The 15-minute data for all gages was converted to average daily values and plotted in Microsoft Excel. Figure 2 shows the average daily stage from the Big Wood River at Hailey gage.

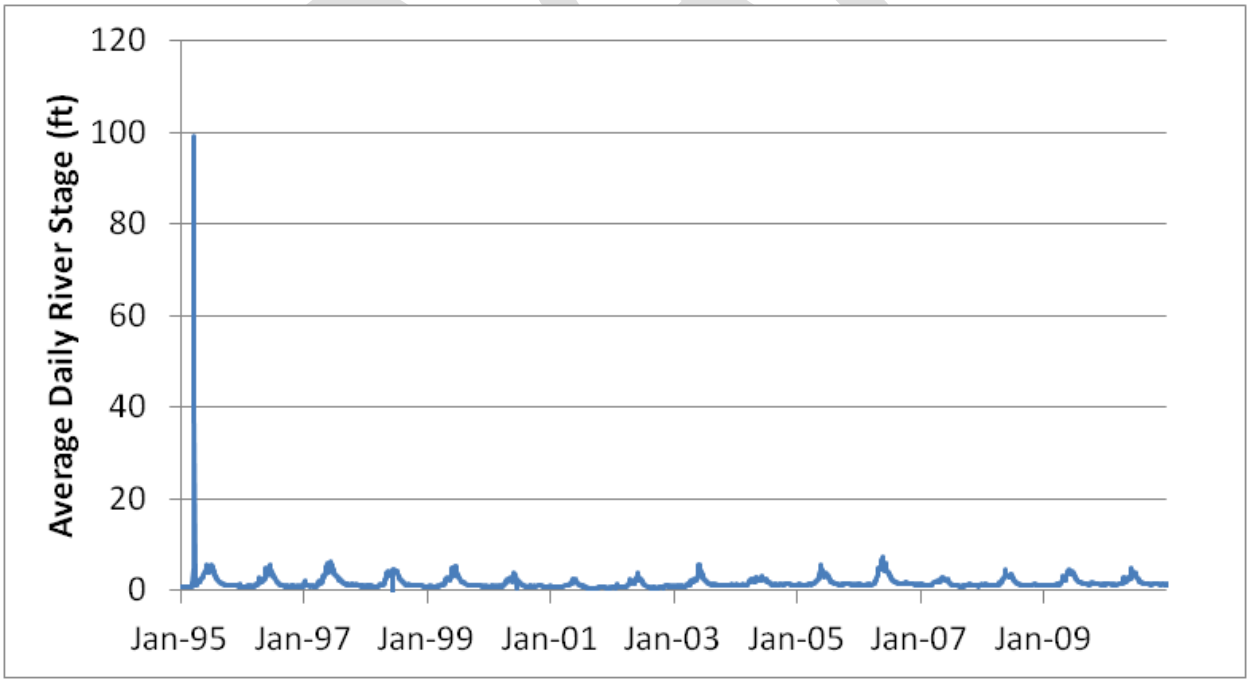

Figure 2. Average daily stage for model calibration period from the Big Wood River at Hailey gage.

The spike to a stage of above 99 ft in March of 1995 is probably the result of ice. This spike was removed by assuming the previous day's stage was a better estimate of stage than the data impacted by ice. Figure 3 shows the adjusted data.

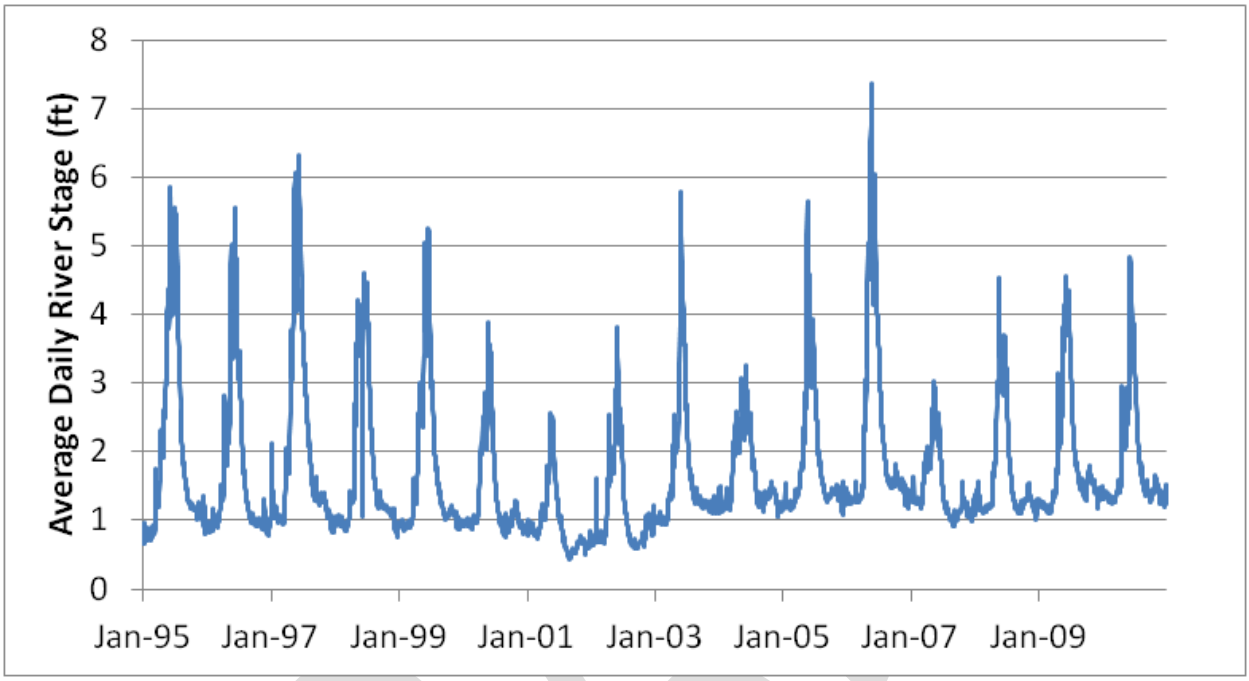

Figure 3. Adjusted average daily stage for model calibration period from the Big Wood River a**t Hailey gage.**

The adjusted average daily data shown in Figure 3 was then converted to average monthly data which is shown in Figure 4.

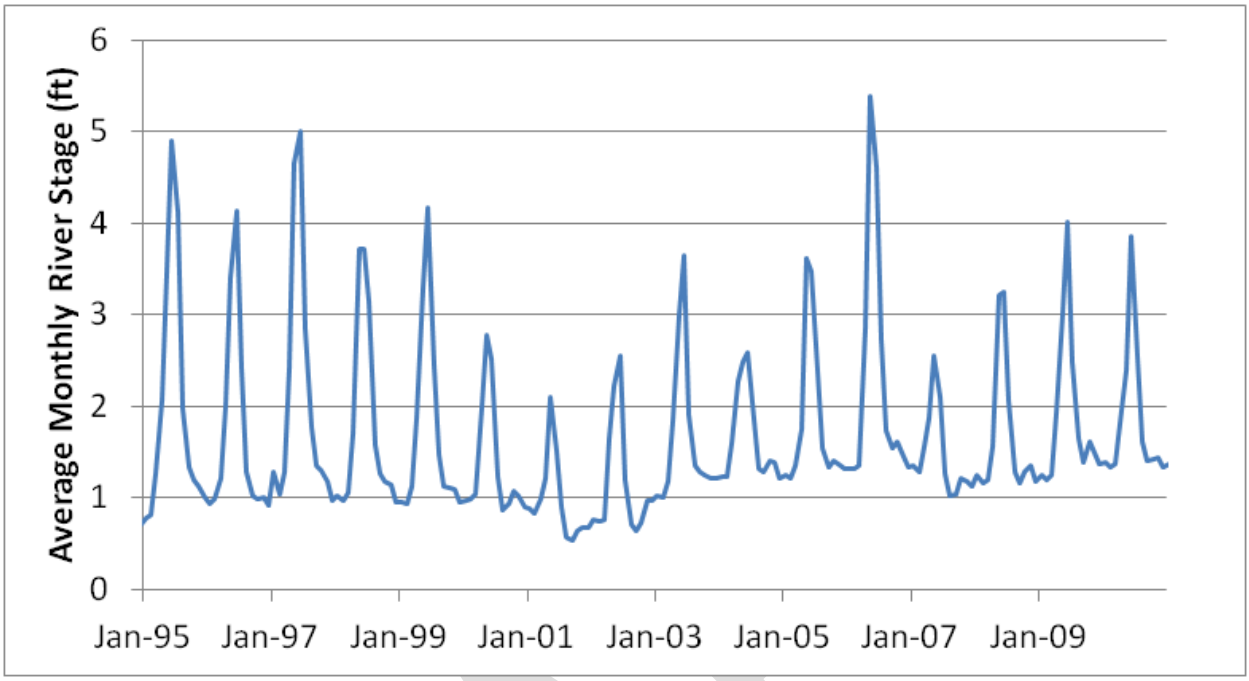

Figure 4. Average monthly stage for model calibration period from the Big Wood River at Hailey gage.

Figures 5 shows the average daily data from the Big Wood River at Stanton Crossing gage.

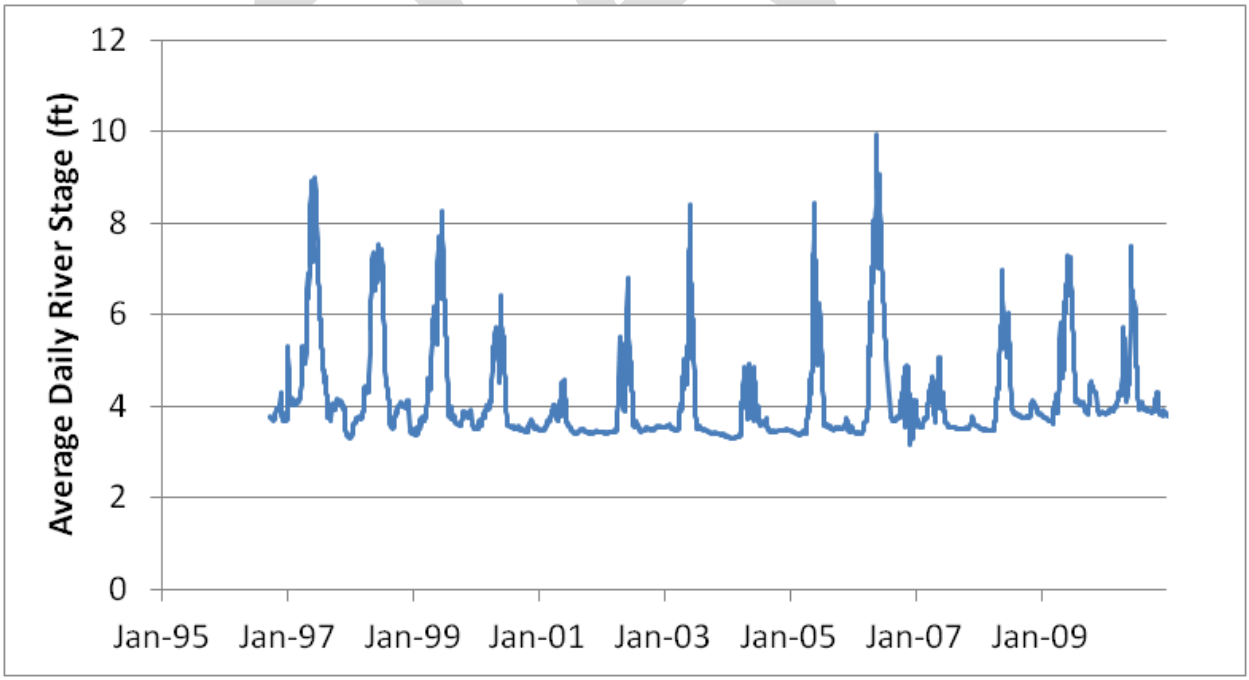

Figure 5. Average daily data from the Big Wood River at Stanton Crossing gage.

These data show no evidence of icing so the data were converted to average monthly values with no adjustments. Figure 6 shows a plot of the average monthly data.

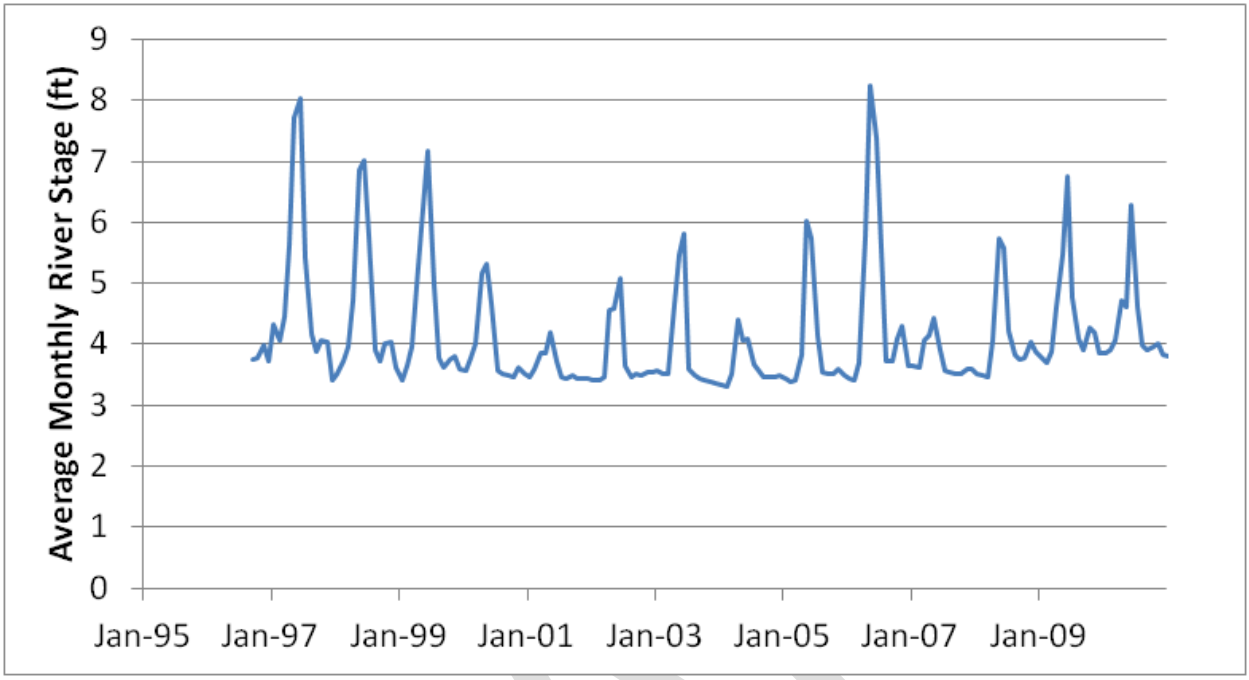

Figure 6. Average monthly data from the Big Wood River at Stanton Crossing gage.

The Big Wood River at Stanton Crossing gage is missing data from January 1995 to September 1996. The missing data were replaced with average values for the missing months. Figure 7 shows measured average monthly data from the Big Wood River at Stanton Crossing gage with the missing data populated with averages for the respective months.

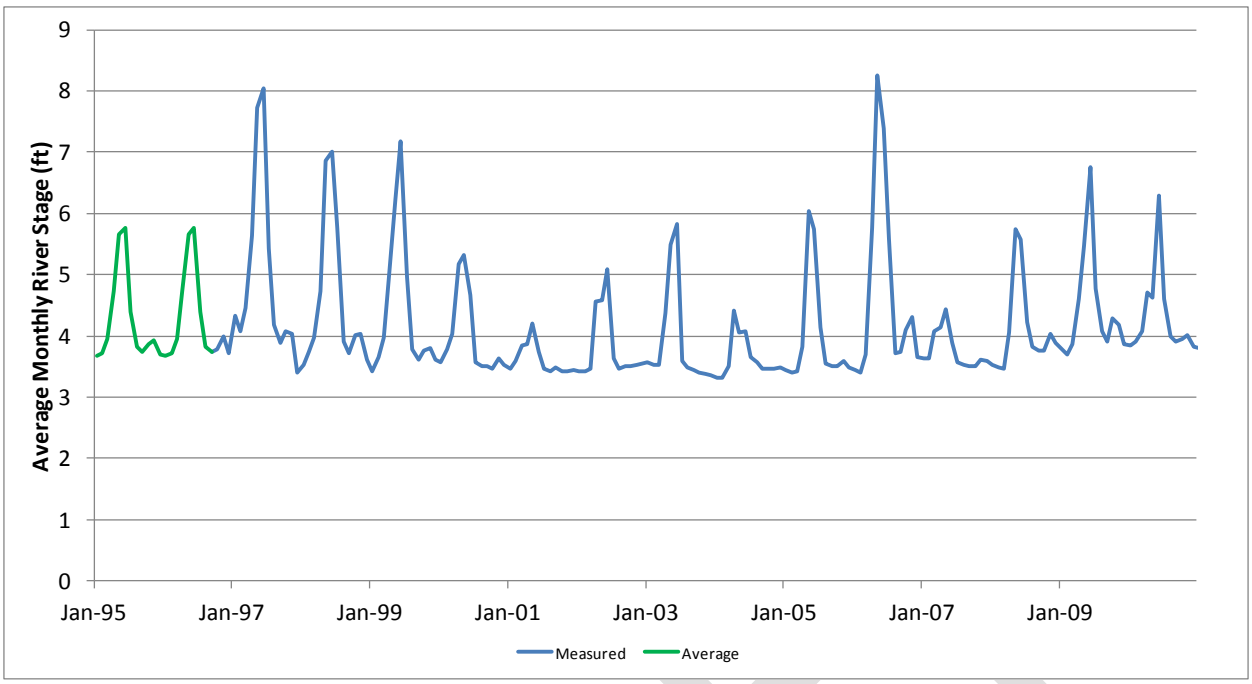

Figure 7. Average monthly data from the Big Wood River at Stanton Crossing gage with missing data replaced by averages for the respective months.

The gaging station at the Big Wood River near Ketchum was not in operation during the model calibration period. The data from April 2011 to present can be correlated with data from April 2011 to present from the gage at the Big Wood River at Hailey to allow calculation of what the stage would have been during the calibration period. Figure 8 shows the correlation between the Big Wood River at Hailey gage and the Big Wood River near Ketchum gage.

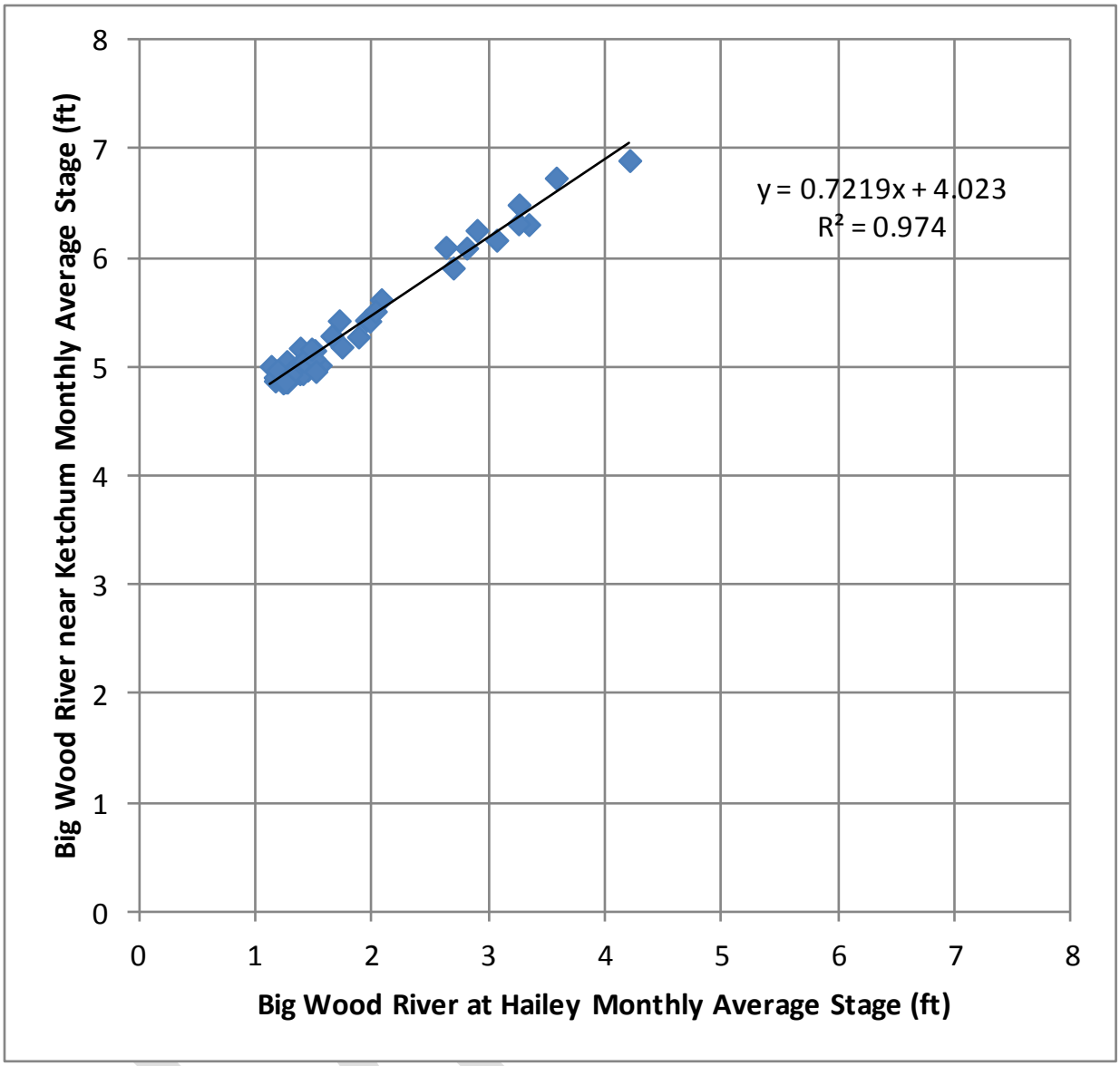

Figure 8. Correlation between stage recorded Near Ketchum and the Big Wood River at Hailey (Apr 2011-Dec 2014).

Figure 9 shows the calculated stage using the regression equation from Figure 8 and the average monthly stage data from the Big Wood River at Hailey gage shown in Figure 4.

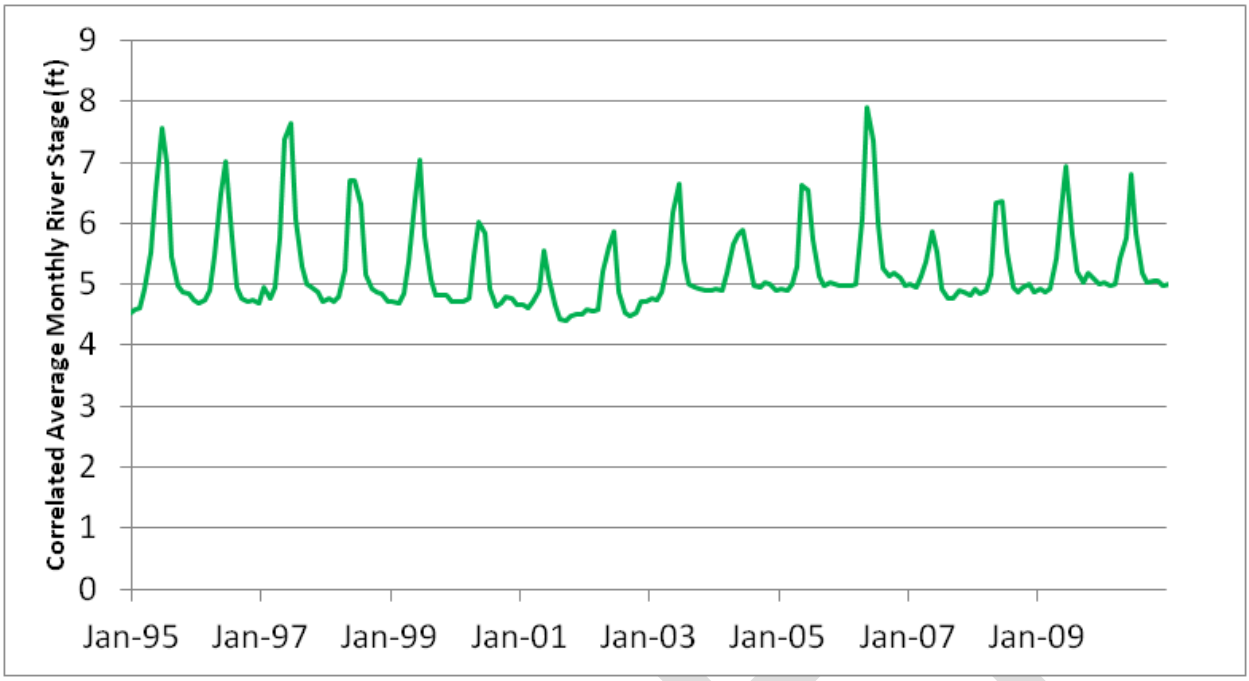

Figure 9. Correlated Big Wood River near Ketchum average monthly stage data.

Converting stage data to model input

The preliminary MODFLOW river file for the Wood River Valley Model was populated with stage data extracted from the 10 m Nation Elevation Dataset (NED). This data will be adjusted up when the river stage is above average and down when the stage is below average. Thus, an average river stage for the model period will be calculated and the average subtracted from the monthly average stage for each gaging station. Figures 10 (Big Wood River near Ketchum gage), 11 (Big Wood River at Hailey gage) and 12 (Big Wood River at Stanton Crossing gage) show the results of these calculations.

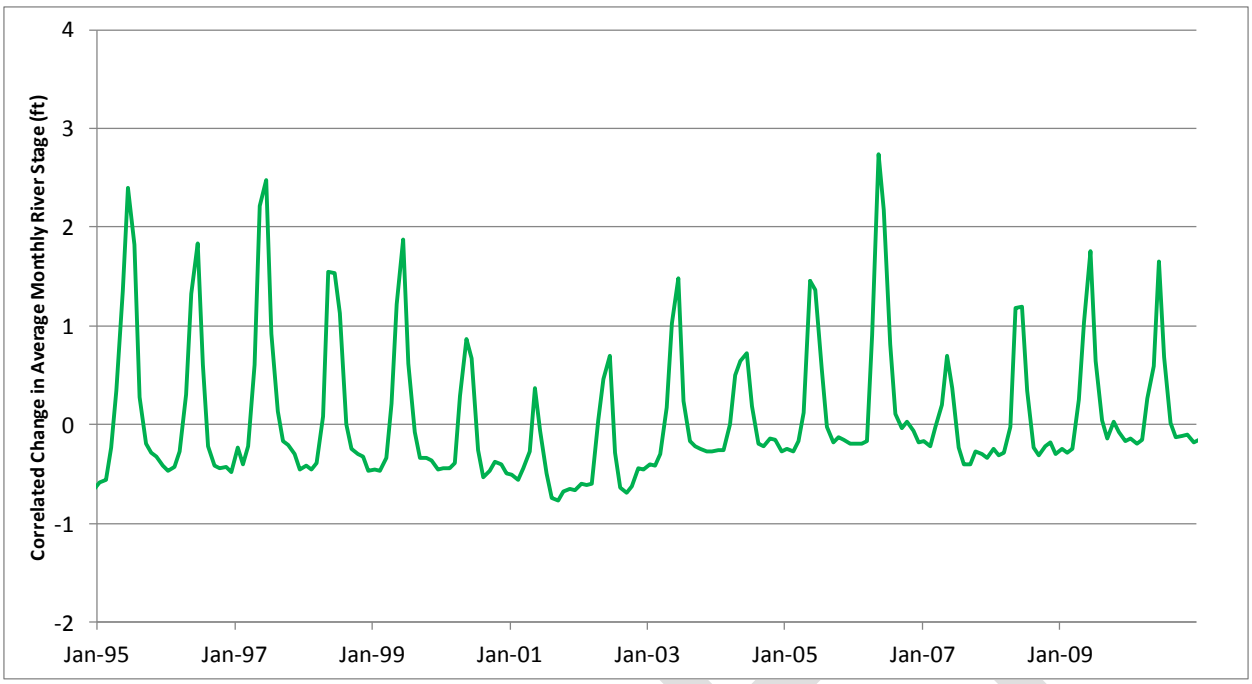

Figure 10. Correlated change in average monthly stage for the Big Wood River near Ketchum gage.

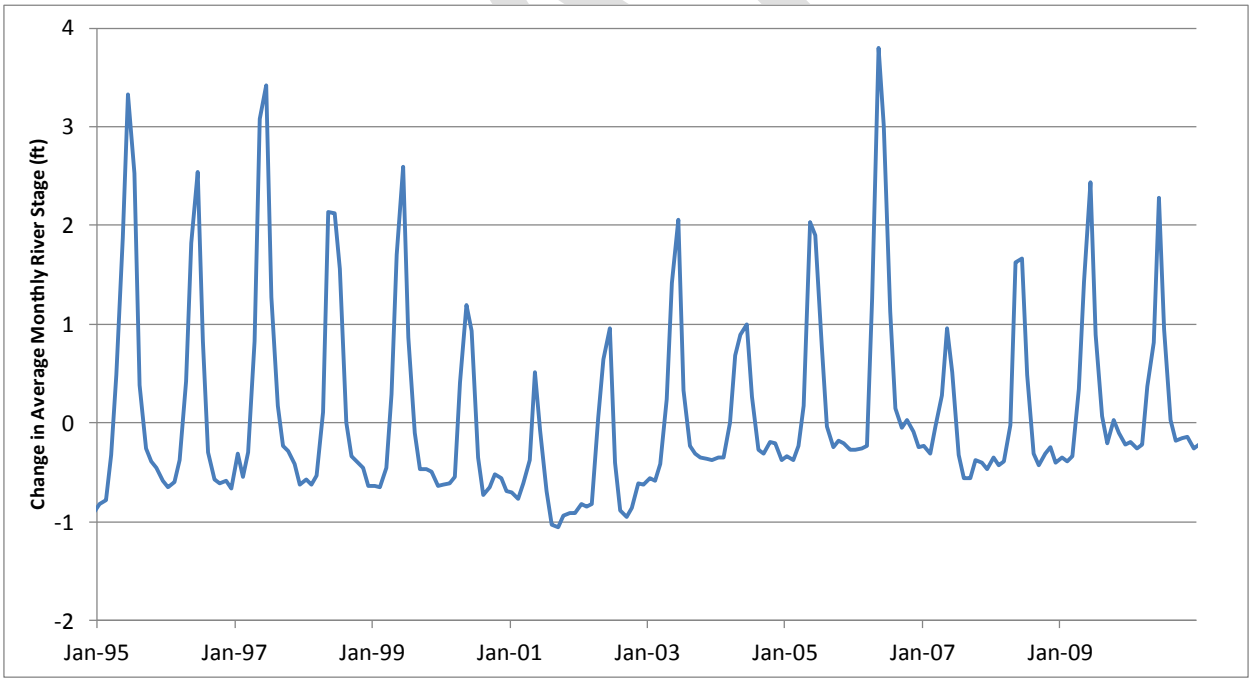

Figure 11. Change in average monthly stage for the Big Wood River at Hailey gage.

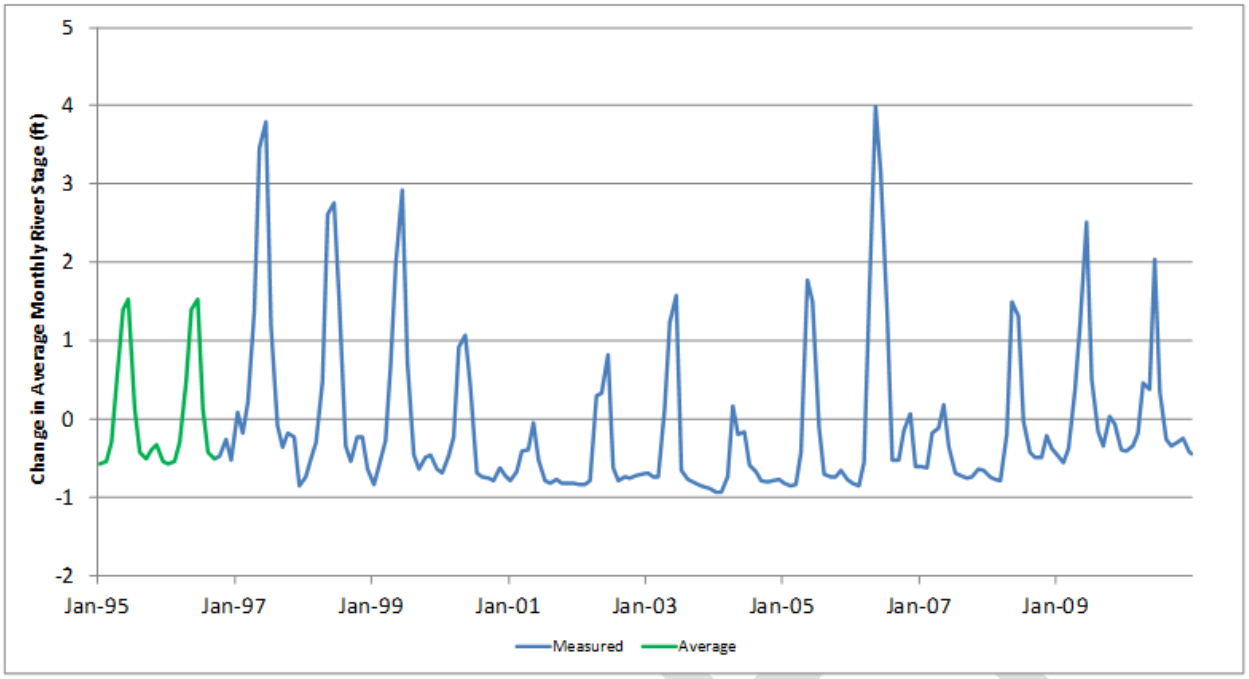

Figure 12. Measured and average monthly average change in stage Big Wood River at Stanton Crossing gage.

The graphs shown in Figures 10, 11 and 12 show changes in stage at the respective gages identified in Figure 1. The stage in river cells between the gages also needs to fluctuate seasonally during the calibration period. The Big Wood River is hydraulically connected between the Big Wood River near Ketchum and the Big Wood River at Hailey gages and there is a strong correlation between the Big Wood River near Ketchum and the Big Wood River at Hailey gages as evidenced by the regression equation shown in Figure 8, thus it makes sense to interpolate the stage between the Big Wood River near Ketchum and the Big Wood River at Hailey gages.

Water District 37 Watermaster Kevin Lakey indicates that the entire flow of the Big Wood River at Glendale is routed into the Bypass Canal on the day the Cottonwood water rights are cut. When this occurs, the Big Wood River between Glendale Road and Wood River Ranch is dry and remains dry until the Bypass Canal is shut down, usually sometime between November 1 and November 17. Table 2, based on data supplied by Water District 37 and 37M shows that the Big Wood River is usually dry between Glendale Road and Wood River Ranch (Figure 1) from sometime in July or August until early November. Because the river goes dry between the Big Wood River at Hailey gage and the Big Wood River at Stanton Crossing gage, it does not make sense to interpolate stage between these two gages. The changes observed at the Big Wood River at Hailey gage will be extended down to Glendale Road

(Figure 1). The change data from the Big Wood River at Stanton Crossing will be used for the model cells between the Big Wood River at Stanton Crossing gage and Wood River Ranch.

Table 2. Date on which the Big Wood River goes dry between Glendale Road and Wood River Ranch.

Year	Date
1995	8/18/1995
1996	8/15/1996
1997	8/26/1997
1998	8/6/1998
1999	8/9/1999
2000	6/29/2000
2001	6/5/2001
2002	7/2/2002
2003	Assume early July based on Stanton Crossing gage
2004	5/24/2004
2005	7/20/2005
2006	7/19/2006
2007	6/25/2007
2008	7/15/2008
2009	7/22/2009
2010	7/19/2010

The Glendale Road to Wood River Ranch reach, which goes dry annually, will be represented by the stage extracted from the 10m NED when not dry and by setting the stage equal to the river bottom when dry.

Summary

The stage data for the transient version of the Wood River Valley Aquifer model river file will be adjusted as follows:

- Interpolate between the change data from the Big Wood River near Ketchum gage and the Big Wood River at Hailey gage to populate the river cells between the Big Wood River near Ketchum and the Big Wood River at Hailey gages.
- Use the Big Wood River at Hailey gage change data to populate the stage in the river cells between the Big Wood River at Hailey gage to Glendale Road.

- For Glendale Road to Wood River Ranch, use 10 m DEM elevations when not dry and set stage equal to river bottom when dry as indicated in Table 2.
- Use the Big Wood River at Stanton Crossing change data for Stanton Crossing to Wood River Ranch.

References

Panday, S., C.D. Langevin, R.G. Niswonger, M. Ibaraki, and J.D. Hughes, 2013, MODFLOW-USG Version 1: An Unstructured Grid Version of MODFLOW for Simulating Groundwater Flow and Tightly Coupled Processes Using and Control Volume Finite-Difference Formulation. Techniques and Methods 6-A45. 66p.

1995-2010, Annual Reports for Water Distribution and Hydrometric Works in Water District 37 & 37M.