Idaho Department of Water Resources
Open-File Report

Summary of Groundwater Levels in the Grand View-Bruneau Groundwater Monitoring Network – 2017 Update

By
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Introduction

The Idaho Department of Water Resources (IDWR) manages a groundwater-level monitoring network in the area encompassing the communities of Grand View and Bruneau, in Owyhee County of southwestern Idaho (Figure 1). The monitoring network currently consists of 17 wells within the Grand View-Bruneau Groundwater Management Area (Grand View-Bruneau GWMA). The Grand View-Bruneau GWMA was designated on October 29, 1982 based on concerns that groundwater development had exceeded recharge to the system (IDWR, 1982).

Groundwater conditions in the Grand View Bruneau GWMA are summarized in several reports (Piper, 1924; Littleton and Crosthwaite, 1957; Ralston and Chapman, 1969; Young and Whitehead, 1975; Rightmire, Young and Whitehead, 1976; Young and Lewis, 1982; Berenbrock, 1993; Mink and Lockwood, 1995; Harrington and Bendixsen, 1998). A management plan has not been developed for the area nor has an advisory committee been formed. Currently, data from this IDWR monitoring network provide the primary source of information for management of the groundwater resources in this area.

Purpose and Scope

The purpose of this report is to summarize the status of the groundwater monitoring network and present water-level data collected over the network's history.

Status of the Monitoring Network

Historically, up to 23 wells have been measured regularly as part of the monitoring network; however, the network currently consists of 17 wells (Figure 1). The five wells that are no longer monitored have been dropped from the network due to access restrictions or measurement difficulties.

The 17 wells currently in the network are measured on a monthly basis, although irrigation pumping or other temporary access restrictions can result in short-term data gaps. Transducers have recently been installed in nine of the wells, which allow for twice-daily water-level measurements. However, since the transducers were installed in the fall of 2016, the monthly statistical analyses (based on spring-season measurements) presented in this report only utilize the manually-collected monthly measurements. Table 1 summarizes the historical network and identifies the wells that are currently monitored. Water-level hydrographs for the current monitoring network are displayed in Appendix A.

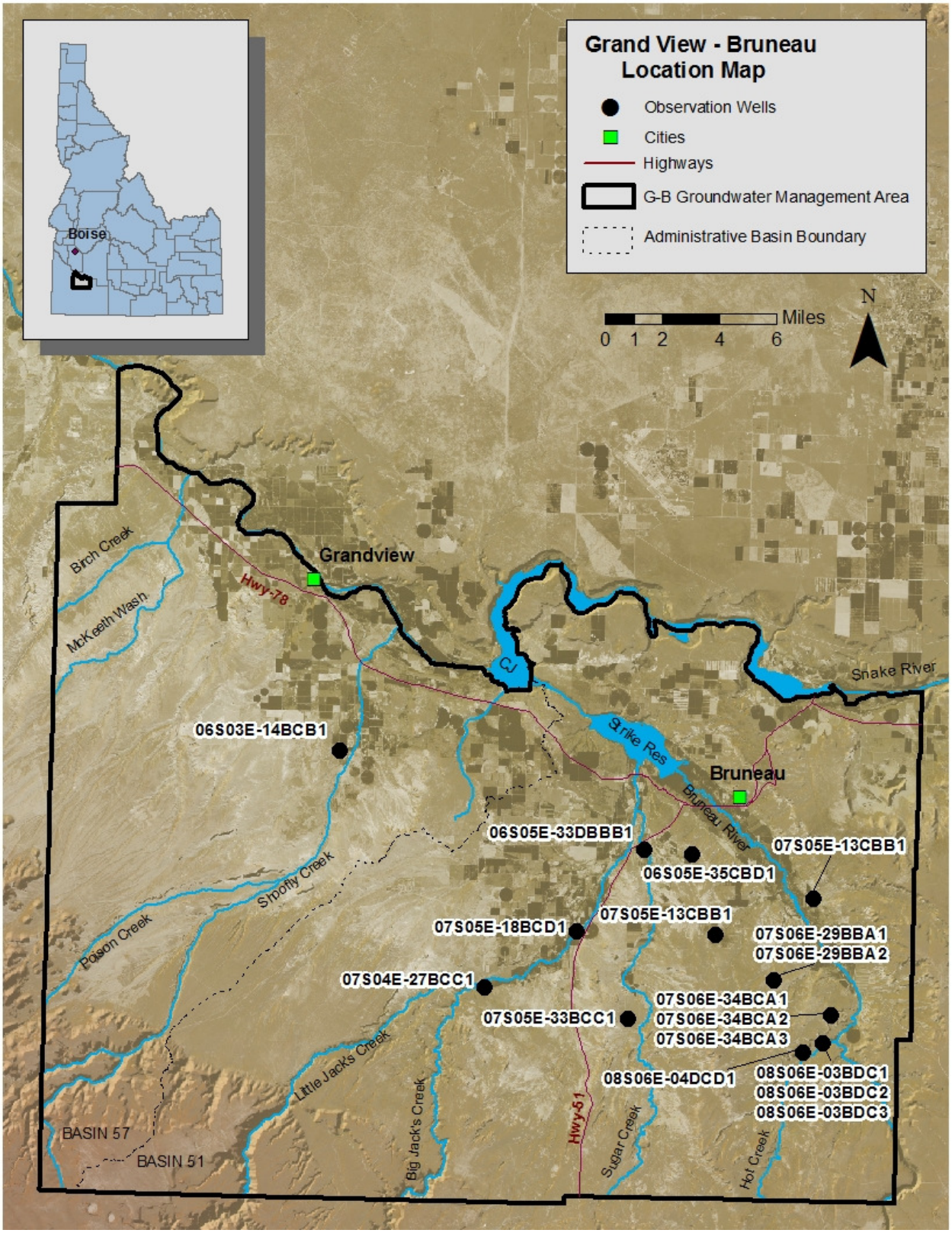

Figure 1. The Grand View – Bruneau Groundwater Monitoring Network.

Table 1. Historical Grand View-Bruneau GWMA monitoring network.

Well ID	Period of Water Level Record	Well Type	Monitoring Frequency
06S03E14BCB1[1]	1953-2017	Monitoring	Monthly. Twice daily beginning in October 2016.
06S04E14ABC1	1957-2008	Irrigation	Dropped (obstruction).
06S05E33DBB1	1953-2017	Domestic	Monthly.
06S05E35CBD1	1980-2017	Irrigation	Monthly.
07S04E27BCC1	1978-2017	Irrigation	Monthly.
07S05E13CBB1	1978-2017	Irrigation	Monthly.
07S05E18BCD1	1954-2017	Irrigation	Monthly.
07S05E19CCC1	1953-2000	Irrigation	Dropped (access problems).
07S05E21CCA1	1978-2007	Irrigation	Dropped (too much oil).
07S05E33BCC1	1994-2017	Domestic	Monthly.
07S06E09BAD2	1953-2014	Irrigation	Monthly. No access from November 2014 through March 2017. Access restored in April 2017.
07S06E26BDA1	1981-2012	Irrigation	Dropped (access problems).
07S06E29BBA1[1]	1990-2017	Monitoring	Monthly. Twice daily beginning in October 2016.
07S06E29BBA2[1]	1990-2017	Monitoring	Monthly. Twice daily beginning in October 2016.
07S06E34BCA1[1]	1990-2017	Monitoring	Monthly. Twice daily beginning in October 2016.
07S06E34BCA2[1]	1990-2017	Monitoring	Monthly. Twice daily beginning in October 2016.
07S06E34BCA3[1]	1990-2017	Monitoring	Monthly. Twice daily beginning in October 2016.
07S06E34DAD1	1979-2002	Irrigation	Dropped (access problems).
08S05E16AAA1	1989-2001	Stock	Dropped (access problems).
08S06E03BCD1[1]	1990-2017	Monitoring	Monthly. Twice daily beginning October in 2016.
08S06E03BCD2	1990-2017	Monitoring	Monthly. Intermittently dry from 2007-2012. Continuously dry since May 2012.
08S06E03BCD3[1]	1990-2017	Monitoring	Monthly. Twice daily beginning in October 2016.
08S06E04DCD1[1]	1990-2017	Monitoring	Monthly. Twice daily beginning in October 2016.
1. Transducer installed in October 2016 and set to collect two measurements per day.			

Analyses of Water Level Data

Historic (period of record), long-term (20-year), and recent (10-year) water-level changes have been analyzed in order to summarize conditions in the Grand View-Bruneau GWMA. Wells that have been dropped from historic monitoring network were not included in the analyses.

General Groundwater Flow

The Grand View-Bruneau area is underlain by a regional warm-water aquifer system. This aquifer system is characterized by multiple confined and partially confined flow zones that exhibit increasing hydraulic head with depth (Berenbrock, 1993). The construction of many wells in the network allow for mixing (hydraulic communication) between multiple flow zones (Mink and Lockwood, 1995). Additionally, it is unclear which flow zone(s) some of the wells represent because some completion depths are unknown and some wells have experienced partially collapsed boreholes. Because the observed water levels represent unknown flow zone(s) or combinations of flow zones, a reliable groundwater flow map cannot be constructed using the monitoring network data. However, previous research in the area indicates that groundwater flow is generally south to north within the Grand View-Bruneau GWMA, and locally can vary from northeastward to northwestward (Littleton and Crosthwaite, 1957; Young and Lewis, 1982; Berenbrock, 1993).

Recent Water-Level Changes

To evaluate recent water-level behavior, non-pumping water-level differences for the period 2008 - 2017 have been calculated for 15 of the 17 wells in the network; two wells were excluded due to insufficient data. Water levels in the 15 wells analyzed were lower in the spring of 2017 than in the spring of 2008. Water-level declines in the Grand View-Bruneau GWMA over the last 10 years range from 2.43 to 16.21 feet (Table 2, Figure 2).

Long-term Water-Level Changes

To evaluate long-term water-level behavior, non-pumping water-level differences for the period 1998 - 2017 have been calculated for 14 of the 17 wells in the network; three wells were excluded due to insufficient data. Water levels in the 14 wells analyzed were lower in the spring of 2017 than in the spring of 1998. Water-level declines in the Grand View-Bruneau GWMA over the last 20 years range from 7.39 to 23.54 feet (Table 2).

Overall Water-Level Changes

To evaluate changes in aquifer conditions, water-level differences between the historic and current water levels have been evaluated. No pumping water levels were included in the analysis. Water levels in all 17 wells currently in the network were lower in the spring of 2017 than they were when the wells were added to the network, and water-level declines range from 7.53 to 66.30 feet (Table 2).

Table 2. Water-level changes for wells currently in the Grand View-Bruneau GWMA monitoring network.

Well Number	10-YR Water Level Change Period	10-YR Water Level Change (feet)	20-YR Water Level Change Period	20-Year Level Water Change (feet)	Overall Water Level Change Period	Overall Water Level Change (feet)
06S03E14BCB1[1]	2007-2017	-10.05	1998-2017	-23.54	1954-2017	-66.30
06S05E33DBB1	2008-2017	-5.47	1998-2017	-10.28	1968-2017	-12.98
06S05E35CBD1	2008-2017	-16.21	1998-2017	-23.07	1980-2017	-19.31
07S04E27BCC1	2008-2017	-8.66	1998-2017	-16.57	1979-2017	-26.50
07S05E13CBB1	2008-2017	-12.66	1998-2017	-18.97	1979-2017	-28.8
07S05E18BCD1	2008-2017	-2.43	1998-2017	-14.87	1954-2017	-44.63
07S05E33BCC1[2]	2008-2017	-7.70	NA	NA	2008-2017	-7.70
07S06E09BAD2[3]	NA	NA	NA	NA	1954-2013	-11.39
07S06E29BBA1[1]	2007-2017	-9.81	1998-2017	-15.58	1991-2017	-17.94
07S06E29BBA2	2008-2017	-4.15	1998-2017	-7.39	1991-2017	-9.17
07S06E34BCA1	2008-2017	-8.41	1998-2017	-15.78	1991-2017	-18.13
07S06E34BCA2	2008-2017	-8.61	1998-2017	-14.72	1991-2017	-16.56
07S06E34BCA3	2008-2017	-8.29	1998-2017	-15.44	1991-2017	-17.19
08S06E03BCD1	2008-2017	-7.66	1998-2017	-14.96	1990-2017	-18.27
08S06E03BCD2[4]	NA	NA	NA	NA	1990-2012	-12.69
08S06E03BCD3[1]	2007-2017	-2.79	1998-2017	-7.81	1990-2017	-7.53
08S06E04DCD1	2008-2017	-8.29	1998-2017	-15.75	1990-2017	-18.07

1. The 10-year water-level change has been calculated using the years 2007 and 2017 due to missing data in 2008.
2. Well added to network in 2008.
3. No access from November 2014 through March 2017.
4. Well intermittently dry since 2007; continuously dry since 2012.

NA indicates the calculation is not applicable due to insufficient data.

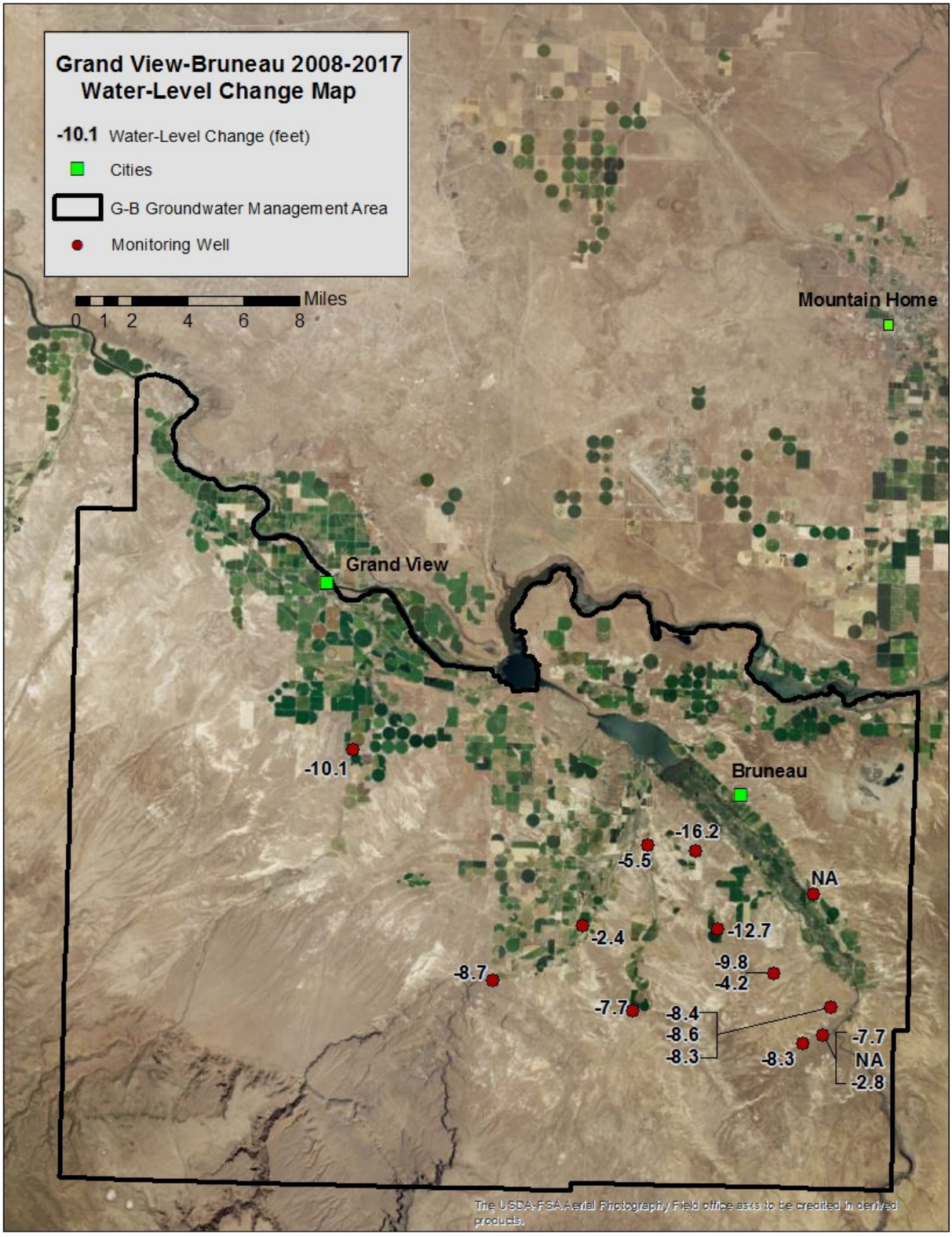

Figure 2. Water-level changes in the GWMA from 2008 to 2017. Locations with multiple values indicate well nests or multiple wells located very near to each other.

Water-level Trends

Short-term climatic variability often results in water-level changes that may not represent the long-term trend in aquifer conditions. And by computing water-level changes at arbitrary time intervals, it is possible to calculate water-level changes that are artifacts of the chosen time interval rather than indications of general aquifer conditions. Therefore, water-level trends have been calculated using a statistical approach known as the Mann-Kendall (MK) test.

The purpose of the MK test is to statistically assess if there is a monotonic upward or downward trend in the variable of interest (e.g., water levels) over time. A monotonic trend means that the variable consistently increases or decreases through time. This trend is defined as the slope of a line that approximates the data. Figure 3 illustrates the concept of using a linear approximation of the data to represent a downward trend.

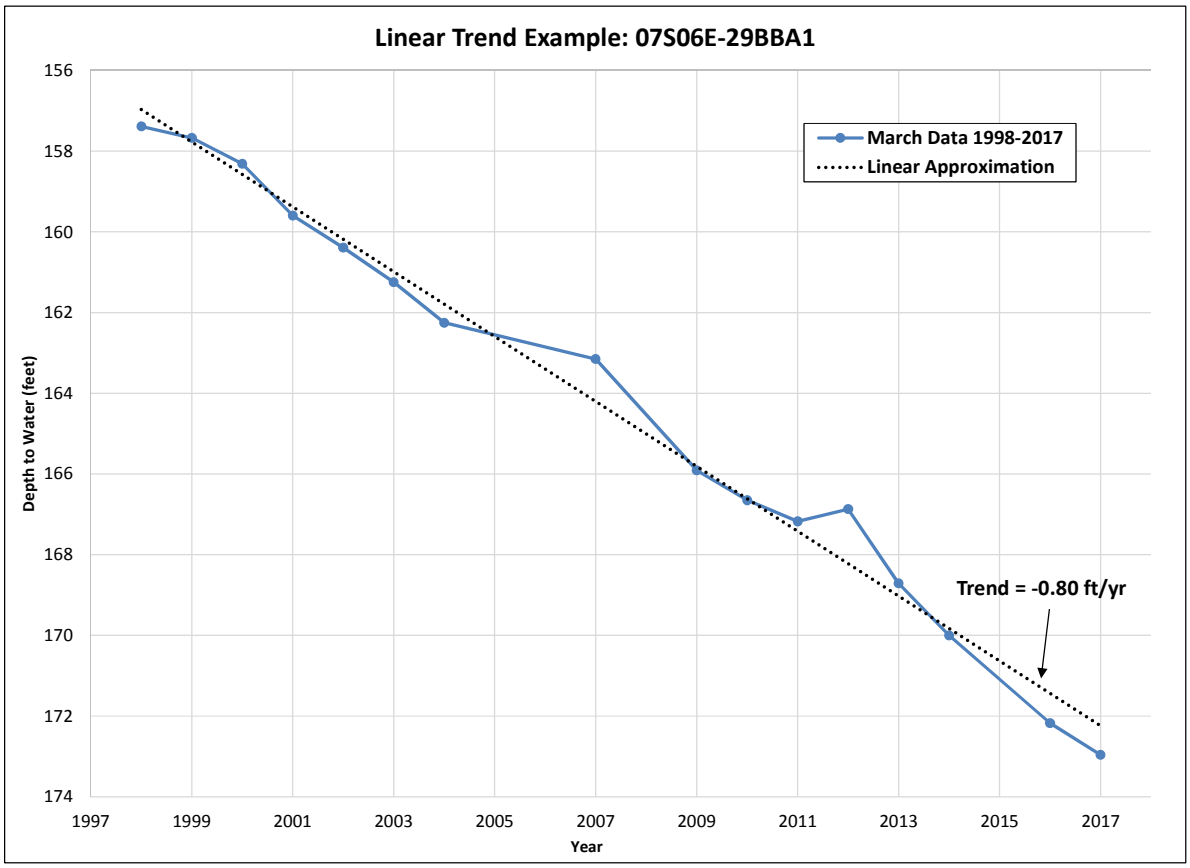

Figure 3. The long-term trend in water-level data is determined by the slope of a linear approximation of the observed March water levels. Data from well 07S06E-29BBA1.

Since hydrologic data are often skewed, contain outlier or missing data, and are often highly variable, the MK test is a reliable method for determining trends in groundwater data (Helsel et al., 2006). Water-level trends for 15 of the 17 wells currently in the network are illustrated in Table 3.

Table 3. Water-level trends for wells currently in the Grand View-Bruneau GWMA monitoring network.

Well Number	10-YR Water Level Trend (feet/year)	10-YR Trend p-value[6]	20-YR Water Level Trend (feet/year)	20-YR Trend p-value[6]	Overall Water Level Trend (feet/year)[5]	Overall Trend p-value[6]
06S03E14BCB1[1]	-0.79	0.0491	-1.20	0.0000	-0.91	0.0000
06S05E33DBB1	-0.79	0.0091	-0.48	0.0000	-0.07	0.0583
06S05E35CBD1	-1.80	0.0318	-1.30	0.0000	-0.91	0.0000
07S04E27BCC1	-0.95	0.0012	-0.85	0.0000	-0.64	0.0000
07S05E13CBB1	-1.36	0.0006	-0.87	0.0000	-0.74	0.0000
07S05E18BCD1	-0.90	0.0073	-0.76	0.0000	-0.64	0.0000
07S05E33BCC1[2]	-0.83	0.0001	NA	NA	-0.83	0.0001
07S06E09BAD2[3]	NA	NA	NA	NA	NA	NA
07S06E29BBA1[1]	-0.94	0.0006	-0.80	0.0000	-0.68	0.0000
07S06E29BBA2	-0.42	0.0002	-0.38	0.0000	-0.35	0.0000
07S06E34BCA1	-0.93	0.0002	-0.83	0.0000	-0.71	0.0000
07S06E34BCA2	-0.93	0.0002	-0.76	0.0000	-0.65	0.0000
07S06E34BCA3	-0.92	0.0002	-0.81	0.0000	-0.66	0.0000
08S06E03BCD1	-0.89	0.0002	-0.83	0.0000	-0.68	0.0000
08S06E03BCD2[4]	NA	NA	NA	NA	NA	NA
08S06E03BCD3[1]	-0.92	0.0003	-0.83	0.0000	-0.65	0.0000
08S06E04DCD1	-0.94	0.0006	-0.80	0.0000	-0.68	0.0000

1. The 10-year water-level trend has been calculated using the years 2007 and 2017 due to missing data in 2008.
2. Well added to network in 2008.
3. No access from November 2014 through March 2017. Water-level trends have not been calculated due to lack of data.
4. Well intermittently dry since 2007; continuously dry since 2012.
5. The overall water-level trend has been calculated for the same time period as the overall water level change (Table 2).
6. A p-value less than 0.05 indicates the trend is significant at the 95% confidence interval.

NA indicates the calculation is not applicable due to insufficient data.

The statistical significance of the trend is calculated by comparing the observations and ranking the differences between them as positive (+1), negative (-1), or equivalent (Meals et al., 2011). A more negative ranking through time indicates a more statistically significant downward trend. Because trend significance is a function of observation rank instead of observation magnitude, it is not affected by the data distribution, and it is less sensitive to outliers and missing data than other statistical methods (Hamed, 2008).

A trend is considered significant at the 95% confidence interval if the p-value is less than 0.05. Results from the MK analyses indicate that all 15 wells included in the analysis exhibit statistically significant downward trends for the given historic, long-term, and recent time frames (Table 3).

Regional Water-level Trend

In order to evaluate regional aquifer conditions it is often helpful to determine if the trends found in individual wells are consistent across the area. The Regional Mann-Kendall (RMK) test calculates the regional water-level trend as the median trend for all wells, and provides the statistical significance of the regional trend. Because the wells have different periods of record, the RMK has been applied to the most recent 10- and 20-year periods (Table 4).

Table 4. Regional water-level trends for wells currently in the monitoring network.

Period	Trend (feet/year)	p-value
Regional 10-yr Trend	-0.88	0.0000
Regional 20-yr Trend	-0.78	0.0000

The RMK analyses indicate statistically significant regional trends of -0.88 feet/year and -0.78 feet/year for the most recent 10- and 20-year periods, respectively.

Seasonal Fluctuations

Seasonal responses to aquifer pumping and recharge are apparent in the hydrographs for each well (Appendix A). The seasonal fluctuations for each well were determined by finding the difference between the shallowest (spring) and deepest (fall) non-pumping measurements. The median, maximum, and minimum seasonal water-level changes for all wells currently in the network are listed in Table 5.

Table 5. Seasonal water-level changes for wells currently in the Grand View-Bruneau GWMA monitoring network.

Well Number	Period of Calculation	Median Seasonal Water Level Change	Minimum Seasonal Water Level Change	Maximum Seasonal Water Level Change
06S03E14BCB1	1990-2016	20.48	12.42	34.55
06S05E33DBB1	1990-2016	21.16	6.00	27.49
06S05E35CBD1	1995-2016	65.45	8.02	78.61
07S04E27BCC1	1990-2016	6.20	1.34	14.40
07S05E13CBB1	1990-2016	21.67	2.16	48.64
07S05E18BCD1	1990-2016	11.91	1.88	30.70
07S05E33BCC1[1]	2008-2016	2.55	1.82	3.26
07S06E09BAD2[2]	NA	NA	NA	NA
07S06E29BBA1	1990-2016	6.03	2.55	13.31
07S06E29BBA2	1990-2016	0.55	0.26	1.78
07S06E34BCA1	1990-2016	6.03	2.63	11.41
07S06E34BCA2	1990-2016	4.97	3.37	6.13
07S06E34BCA3	1990-2016	5.50	1.93	6.84
08S06E03BCD1	1990-2016	5.74	2.49	6.61
08S06E03BCD2[3]	NA	NA	NA	NA
08S06E03BCD3	1990-2016	2.94	0.40	5.51
08S06E04DCD1[4]	1990-2004, 2006-2016	6.05	1.5	7.02

1. Well added to network in 2008.
2. No access from November 2014 through March 2017. Seasonal changes have not been calculated due to lack of data.
3. Well intermittently dry since 2007; continuously dry since 2012.
4. Only one measurement in 2005.

NA indicates the calculation is not applicable due to insufficient data.

Summary

The data collected from the Grand View-Bruneau GWMA groundwater-level monitoring network indicate that water levels in all network wells exhibit statistically significant downward trends during the period-of-record, 20-year, and 10-year time frames. Regionally, water levels in the Grand View-Bruneau GWMA are declining at a median rate of 0.78 feet/year for the period 1998-2017 and 0.88 feet per year for the period 2008-2017. Continuation of this monitoring effort is essential for evaluating the changes in the water-level declines and to ensure that more significant water supply issues do not occur within the management area.

Recommendations

Because the current monitoring wells are concentrated in an area south of Bruneau, it is recommended that the monitoring network be expanded to provide better coverage of the Grand View-Bruneau GWMA. The following recommendations are necessary to provide basic information across the management area:

1. Install or begin monitoring one or more additional wells in the northern portion of the Grand View-Bruneau GWMA between Grand View and Bruneau (06S04E) to replace discontinued well 06S04E-14ABC1.
2. Install or begin monitoring one or more additional wells in the northwestern portion of the Grand View-Bruneau GWMA between Grand View and the northwest boundary (04S02E, 05S02E, 05S03E). Groundwater conditions are currently unknown in this area, and additional wells would provide for more complete monitoring of the aquifer throughout the management area.
3. Install or begin monitoring one or more additional wells in the northeast portion of Grand View-Bruneau GWMA between the Bruneau and Snake rivers (05S04E, 05S05E, 06S05E, 06S06E). Groundwater conditions are currently unknown in this area, and additional wells would provide for more complete monitoring of the aquifer throughout the management area.
4. Install or begin monitoring one or more flowing wells east of the Bruneau River (07S06E) to replace discontinued well 07S06E-26BDA1.
5. Undertake well-head improvements to well 07S05E-18BCD1, or find a replacement well. Degradation of the well-head conditions have resulted in unreliable measurements. This is an important well because it is still flowing and has a long period of record.
6. Install or begin monitoring additional wells throughout the Grand View-Bruneau GWMA to investigate vertical and horizontal compartmentalization within the aquifer system.

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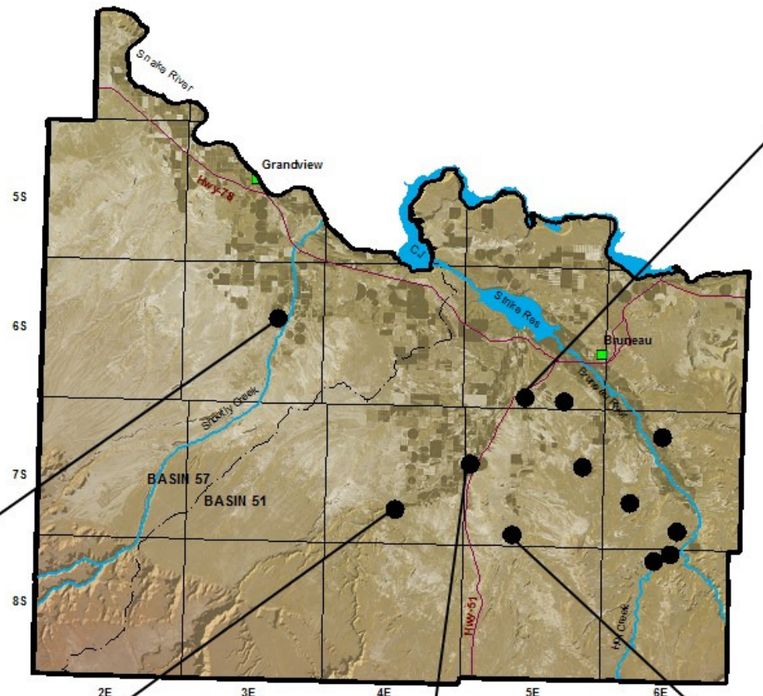
APPENDIX A

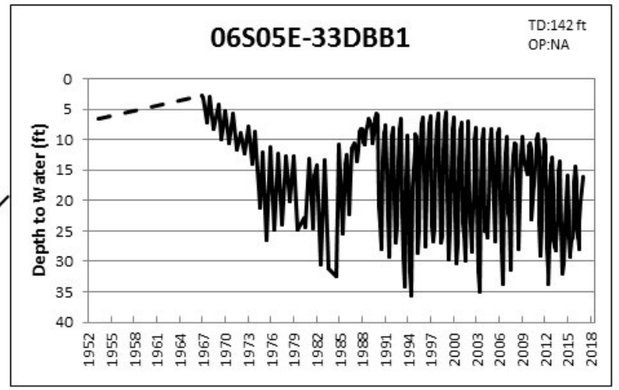
HYDROGRAPHS OF CURLEW VALLEY MONITORING NETWORK

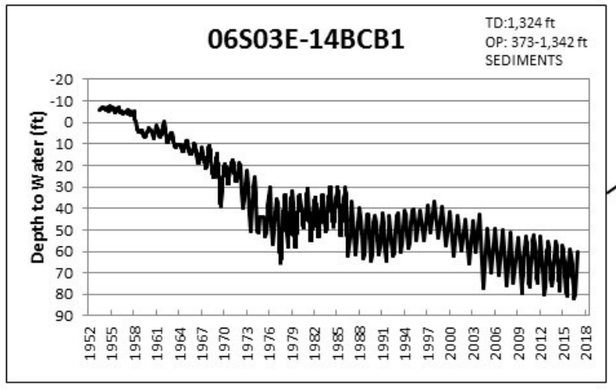
Grandview-Bruneau Hydrographs – West Area

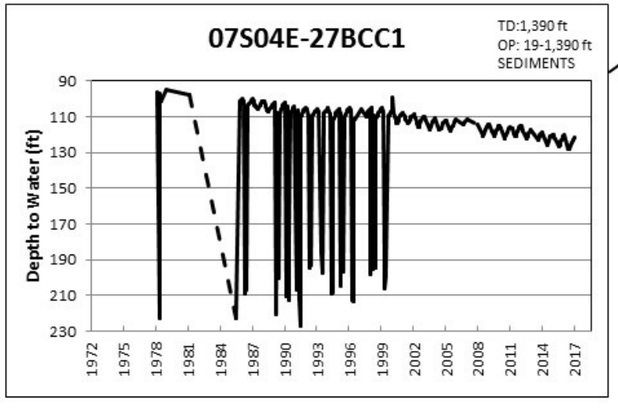
HYDROGRAPH LEGEND

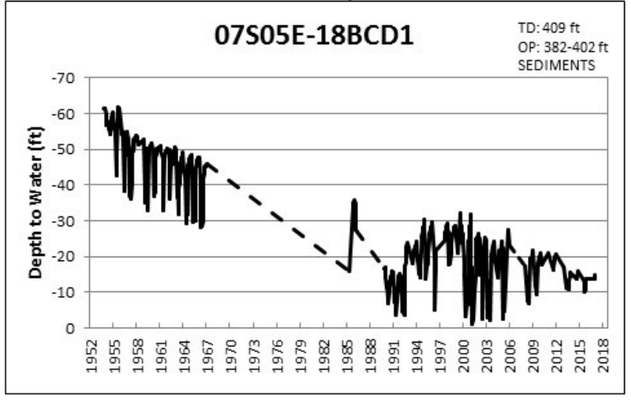
TD: Total Depth
OP: Interval that well is open to aquifer
VOLCANICS: Water Bearing Lithology
NA: Information is unknown
_ _ _ Indicates more than one month between measurements

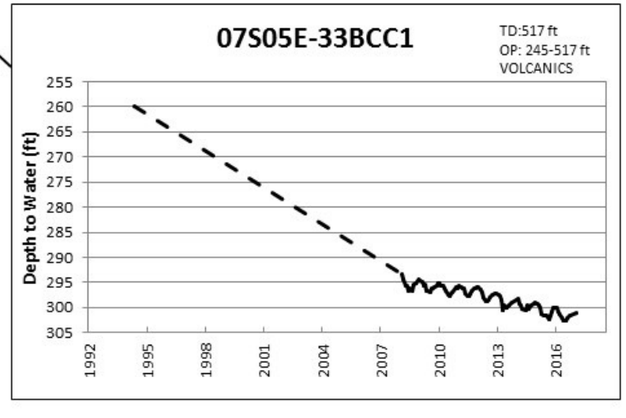








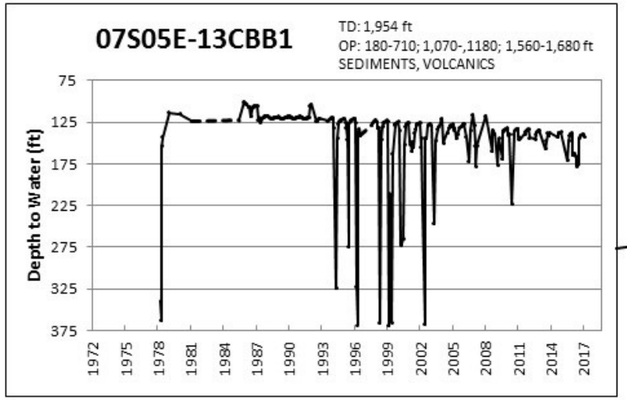


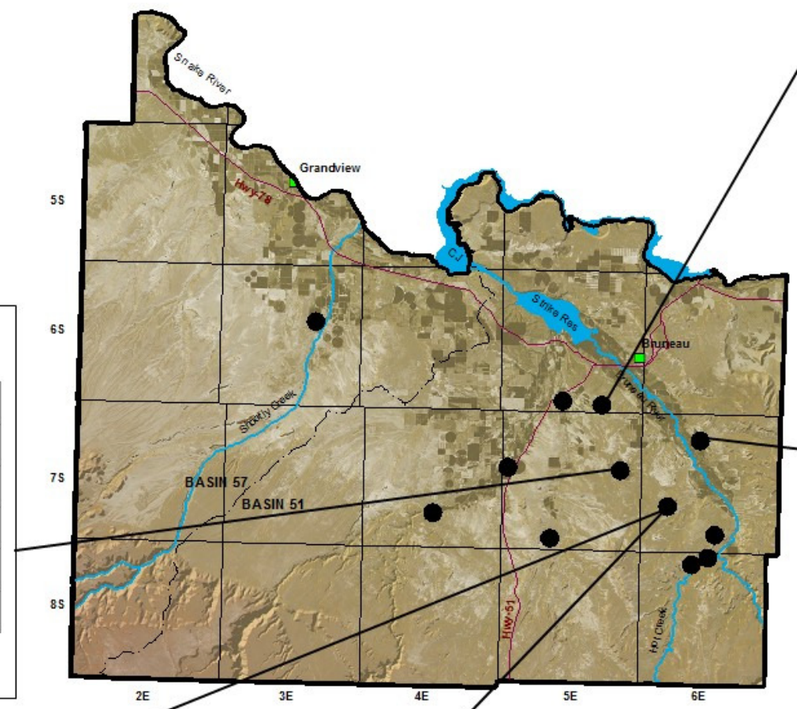


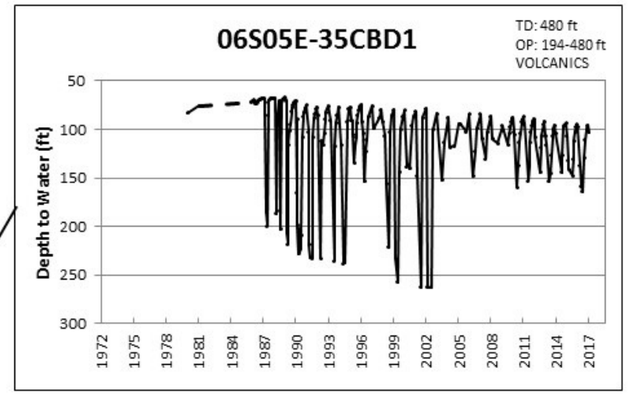
Grandview-Bruneau Hydrographs – East Area

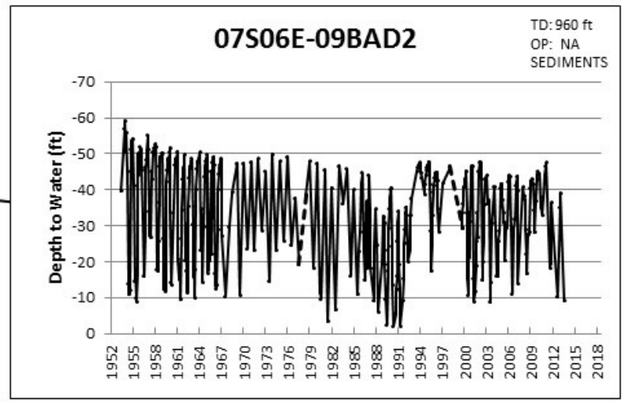
HYDROGRAPH LEGEND

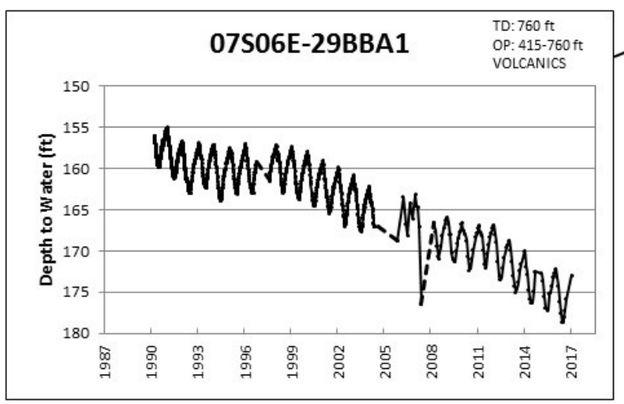
TD: Total Depth
OP: Interval that well is open to aquifer
VOLCANICS: Water Bearing Lithology
NA: Information is unknown
_ _ _ Indicates more than one month between measurements

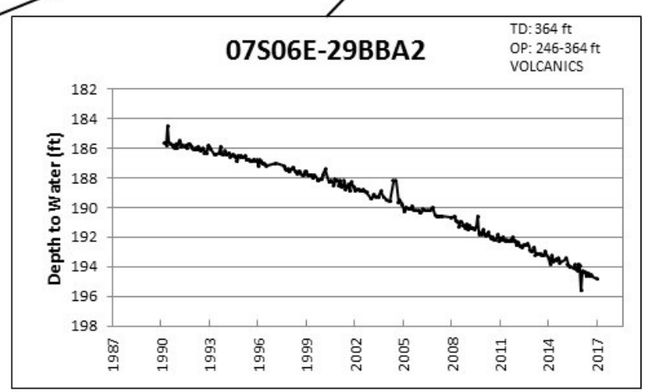












Grandview-Bruneau Hydrographs – Bathtub Area

HYDROGRAPH LEGEND

TD: Total Depth
OP: Interval that well is open to aquifer
VOLCANICS: Water Bearing Lithology
NA: Information is unknown
_ _ _ Indicates more than one month between measurements