Idaho Department of Water Resources

Boise Front Low-Temperature Geothermal Resource Groundwater Management Area Water Year 2023

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Michael McVay P.E., P.G.
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IDAHO DEPARTMENT OF WATER RESOURCES

The Boise Front Low-Temperature Geothermal Resource Groundwater Management Area (GWMA) was designated on June 15, 1987, based on local concerns regarding declining water levels. This report describes the status and trends of withdrawals, re-injection, temperature, and water levels in the Downtown-Table Rock area of the GWMA.

Executive Summary

The combined gross withdrawal from the four district heating systems in the Downtown Boise-Table Rock area of the Boise Front Low-Temperature Geothermal Resource GWMA in Water Year 2023 (WY23) was 993.8 million gallons (mgal), which is 67.9 mgal more than in Water Year 2022 (WY22). The combined net withdrawal (withdrawals less re-injection) in WY23 was 279.0 mgal, which is 17.0 mgal more than in WY22. Approximately 72% of the water withdrawn in WY23 was re-injected, which is the same percentage as in WY22.

The City of Boise (City) system increased withdrawals and re-injection by 45.9 and 12.3 mgal, respectively. The City received approximately 13.1 mgal from the State of Idaho Capitol Mall (State) system during production-well down time in WY23. Including deliveries to the City, the net usage of water by the City system was 7.6 mgal more than in WY22. The Boise Warm Springs Water District (BWSWD) system increased withdrawals by 7.4 mgal.

Peak water levels in unused wells within the Downtown Boise-Table Rock area declined from WY22 to WY23. The shallowest (peak) water level in the BLM well declined 0.9 ft and the deepest (minimum) water level declined 3.1 feet (ft). The Kanta well peak water level declined 0.4 ft and the minimum water level rose 0.4 ft. The peak water level in the BGL #1 well declined 0.5 ft. and the minimum water level declined 1.5 ft. The peak water level in BWSWD #3 declined 4.0 ft, and the minimum declined 0.3 ft. The peak water level in the Harris Ranch West well rose 0.3 ft. and the minimum water level declined 0.7 ft. Peak water levels in the BWSWD East and West production declined 5.0 and 3.6 ft, respectively, from WY22 to WY23.

The maximum daily-average water-supply temperature in the City system was approximately 4.8 °F lower, and the maximum monthly water-supply temperature for the State decreased 0.2 °F from WY22 to WY23. The maximum temperature for the BWSWD system was the same in WY23 as in WY22.

Production, injection, and observation well locations are presented in Appendix A.

Withdrawals, Deliveries, Re-Injection, and Water Use

The WY23 combined gross and net withdrawals from the four Downtown Boise-Table Rock district heating systems were 993.8312.9 mgal and 279.0 mgal, respectively (Figure 1). Gross withdrawals increased 67.9 mgal (+7%), and net withdrawals increased 17.0 mgal (+6%). Approximately 72% of the water withdrawn was re-injected, which is the same percentage as in WY22.

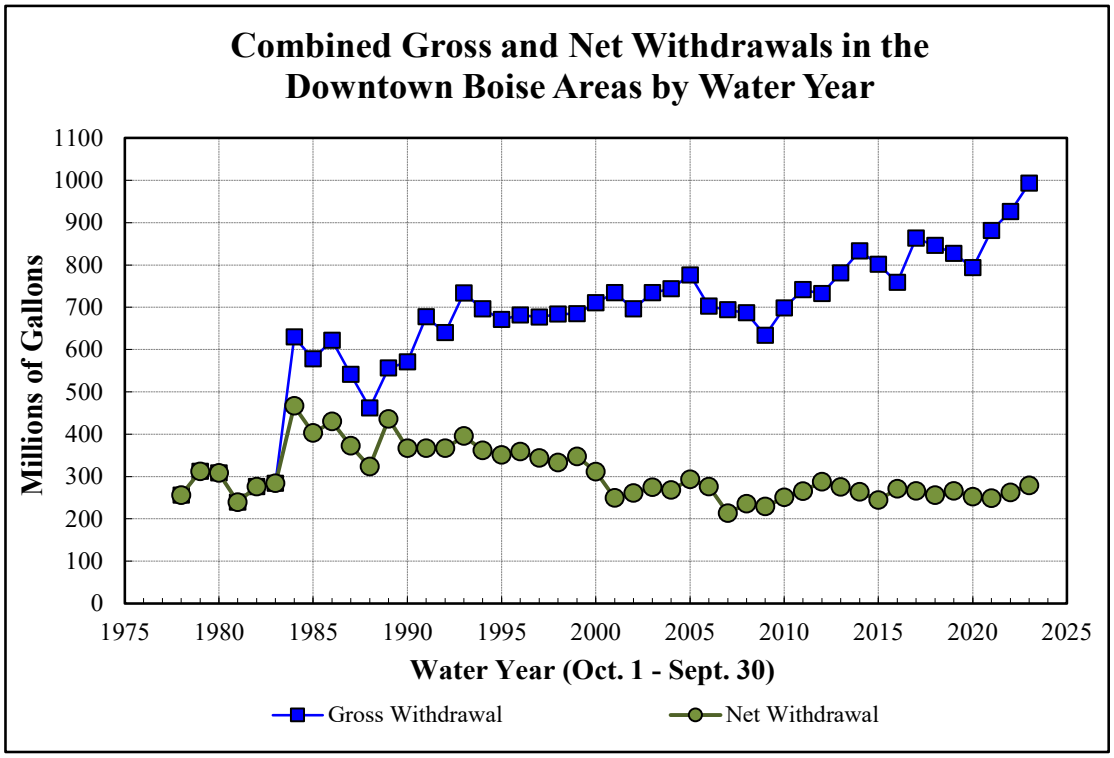

Figure 1. Gross and net withdrawals for the four district heating systems in the Downtown Boise area for water years 1978 through 2023.

Inter-System Deliveries

The City system is configured such that it can deliver water to the BWSWD and State systems, but it can receive water from only the State. The State cannot deliver water directly to BWSWD, and BWSWD cannot deliver water to any of the other systems. The VA is isolated from the other systems.

The City delivered approximately 2.1 mgal to BWSWD in WY23, and because the delivered water was measured by the City production meter, it is incorporated in the gross withdrawal reported by the City (Table 1). The City also delivered approximately 1.2 mgal to the State; however, the production meter was not in service at the time of delivery and this volume was added to the reported withdrawal to determine the City's gross withdrawal.

The State delivered approximately 13.1 mgal to the City in WY23. Water delivered to the City bypasses the State's production meter and was not accounted for in the withdrawal reported by the State (Table 1). However, the delivery is measured by an interconnection meter, and the delivered volume has been added to the reported withdrawal to calculate gross withdrawal by the State (Table 1).

Withdrawals and Re-Injection

The pumping reported by the City totaled 311.7 mgal in WY23; however, deliveries to the State occurred during maintenance on the City production well. Therefore, the delivery of approximately 1.2 mgal was added to the reported pumping to calculate the City's gross withdrawal of 312.9 which is an increase of 45.9 mgal (+17%) from WY22. Re-injection by the City increased by 12.3 mgal (+4%) to 312.4 mgal from WY22 to WY23 (Table 1). Therefore, the WY23 net withdrawal by the City was 0.5 mgal (Table 1). The annual comparison of the City's impact on the aquifer, as well as tracking of production needs, are discussed in the following "Water Usage" section.

The reported withdrawal by the State was 97.8 mgal, which is an increase of 14.7 mgal (+18%; Table 1). The State re-injects 100% of the water produced for the system; however, the State received 1.2 mgal from the City, and the volume received was added to the reported pumping to calculate the volume of water the State injected. The State also delivered 13.1 mgal to the City, and because water delivered to the City bypasses the State production meter, the delivered volume was added to the reported withdrawal to calculate a gross withdrawal of 110.9 mgal by the State. Therefore, the State's net withdrawal was 11.9 mgal in WY23 (Table 1).

Gross withdrawal by BWSWD was 266. mgal, which is an increase of 7.4 mgal (+3%). Because BWSWD does not re-inject, the net withdrawal equals the gross withdrawal (Table 1).

Gross withdrawal by the VA system was 303.4 mgal, which is an increase of 22.7 mgal (+8%). Because the VA re-injects 100% of the water produced, the net withdrawal for WY23 was zero (Table 1).

Table 1. Withdrawal, delivery, and injection (mgal) for the four district geothermal heating systems in the Downtown Boise-Table Rock area for WY23.[1]

System	Reported Withdrawal[2]	Water Delivered	Water Received	Gross Withdrawal	Injection	Net Withdrawal
City	311.7	3.2	13.1	312.9	312.4	0.5
State[3,4]	97.8	13.1	1.2	110.9	99.0	11.9
BWSWD	266.6	NA	2.1	266.6	NA	266.6
VA	303.4	NA	NA	303.4	303.4	0.0

[1]Listed volumes may include rounding errors.

[2]Reported withdrawal is the production volume reported to IDWR.

[3]Reported withdrawal does not include water delivered to the City.

[4]Injection volume has been assumed to equal to the Reported Withdrawal plus the Water Received because the State injects 100% of the water used by the system.

Water Usage

Due to the inter-system deliveries, calculation of the gross and net withdrawals for each system individually may be misleading as to the actual system operation. Calculating net system usage may provide a more accurate description of how the systems operated in WY23.

As stated above, the City received 13.1 mgal from the State in WY23 (Table 2). The water delivered to the City by the State did not flow through the City production meter, and ignoring these deliveries underestimates how much water the City needed in WY23. Therefore, the 13.1 mgal of water provided by the State has been added to the City's reported withdrawals to describe the permit holder's operational needs in WY23. The City's WY23 net usage was 10.3 mgal (Table 2), which is a 7.6 mgal (+282%) increase from WY22. The BWSWD net usage was 268.7 mgal, which is a 9.4 mgal (+4%) increase from WY22. The State injects all the water used by the system.

Table 2. Net usage (mgal) for the four district geothermal heating systems in the Downtown Boise-Table Rock area for WY23.[1]

System	Reported Withdrawal	Water Delivered	Water Received	Injection	Net Usage
City	311.7	3.2	13.1	312.4	10.3
State[2]	97.8	13.1	1.2	99.0	0.0
BWSWD	266.6	NA	2.1	NA	268.7
VA	303.4	NA	NA	303.4	0.0

[1]Listed volumes may include rounding errors.

[2]Injection volume has been assumed to equal to the Reported Withdrawal plus the Water Received because the State injects 100% of the water used by the system.

Note that the total volumes of withdrawal and usage are equal (Table 3). Withdrawal represents the volume of water produced and re-injected/discharged, and usage describes where the withdrawals were utilized and re-injected/discharged (Tables 1 – 3).

Table 3. WY23 withdrawal and usage (mgal), and WY22 – WY23 withdrawal and usage change (%) for the four district geothermal heating systems in the Downtown Boise-Table Rock area.[1]

System	Gross Withdrawal and % change	Gross Usage[3] and % change	Net Withdrawal[4] and % change	Net Usage[5] and % change
City[2]	312.9 (+17%)	322.7 (+7%)	0.5 (-101%)	10.3 (+282%)
State	110.9 (-7%)	99.0 (+19%)	11.9 (-76%)	0.0 (NC[6])
BWSWD	266.6 (+3%)	268.7 (+4%)	266.6 (+3%)	268.7 (+4%)
VA	303.4 (+8%)	303.4 (+8%)	0.0 (NC[6])	0.0 (NC[6])
Total	**993.8 (+7%)**	**993.8 (+7%)**	**279.0 (+6%)**	**279.0 (+6%)**

[1]Listed volumes may include rounding errors.

[2]Gross Withdrawal equal to the reported pumping volume plus the volume delivered to the State because the delivery was calculated using injection meter readings due to City production meter repairs.

[3]Gross Usage equal to Gross Withdrawal plus the volume received from other systems less the volume delivered to other systems.

[4]Net Withdrawal equal to Gross Withdrawal minus the volume re-injected.

[5]Net Usage equal to Gross Usage minus the volume re-injected.

[6]NC = No change.

Withdrawal and Usage Trends

Statistical trends provide a technically defensible assessment of changes over time. Statistical significance indicates that there is a non-zero trend in the data at the chosen confidence interval, and the calculated trend is assumed to be the best linear representation of changes over time. Lack of statistical significance indicates that the trend cannot be considered different than zero (at the chosen confidence interval), and the calculated trend does not represent changes over time. A confidence interval of 95% has been used to determine statistical significance for all Boise Front Low-Temperature Geothermal trends.

Gross withdrawal increased 7% and combined net withdrawal increased 6% from WY22 to WY23. The WY90 to WY23 trends in combined gross and net withdrawals are +7.0 and -4.0 mgal/year, respectively, and both trends are statistically significant (Table 4).

Table 4. Gross and net withdrawal trends for the four district geothermal heating systems in the Downtown Boise-Table Rock area for WY90 to WY23. Bold indicates a statistically significant trend.

Withdrawals	Withdrawal Trend (mgal per year)[1]	Withdrawal Trend p-value[2]
Gross Withdrawals	**7.0**	**0.00**
Gross Usage	**7.0**	**0.00**
Net Withdrawals	**-4.0**	**0.00**
Net Usage	**-4.0**	**0.00**

[1]Trends and significance have been calculated using the Mann-Kendall statistical test (Hirsch and Slack, 1984).
[2]P-values less than 0.05 indicate the trend is significant at the 95% confidence interval.

Water Levels

Both peak and minimum water levels in wells within the Downtown Boise-Table Rock area declined from WY22 to WY23 (Table 5). The peak water level in the Harris Ranch west well was the only water level that was higher in WY23 than in WY22.

Table 5. Peak and minimum water level changes in the Downtown Boise-Table Rock area for WY22 to WY23. Production wells are bolded.

Wells	Peak Water level Change (ft)	Minimum Water Level Change (ft)
BLM Well	-0.9	0.2
Kanta Well	-0.4	0.4
BGL #1	-0.5	-1.5
BWSWD East[1]	-5.0	NA
BWSWD West[1]	-3.6	NA
BWSWD #3	-4.0	-0.3
Harris Ranch West	0.3	-0.7

[1] Minimum water level changes have not been calculated for production wells due to pumping impacts.

The unused BLM well serves as the primary water-level monitoring well for the Downtown Boise-Table Rock area. It is a good indicator of aquifer water levels due to its location near the City, State, and VA wellfields (Figure A-1). The peak water levels in the BLM well declined 0.9 ft and the minimum water levels rose 0.2 ft from WY22 to WY23 (Figure 2).

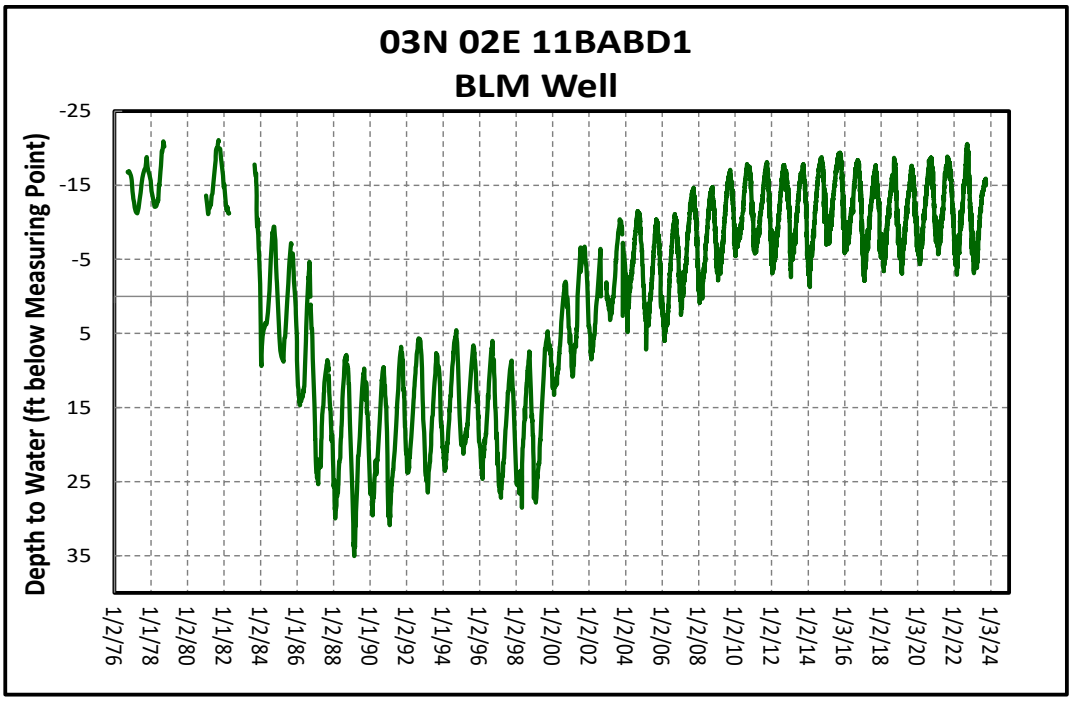

Figure 2. Water levels in the BLM well.

Water-level changes in the Kanta well were similar to those in the BLM well but less pronounced. The peak water levels in the Kanta well declined 0.4 ft and the minimum water levels rose 0.4 ft (Figure 3).

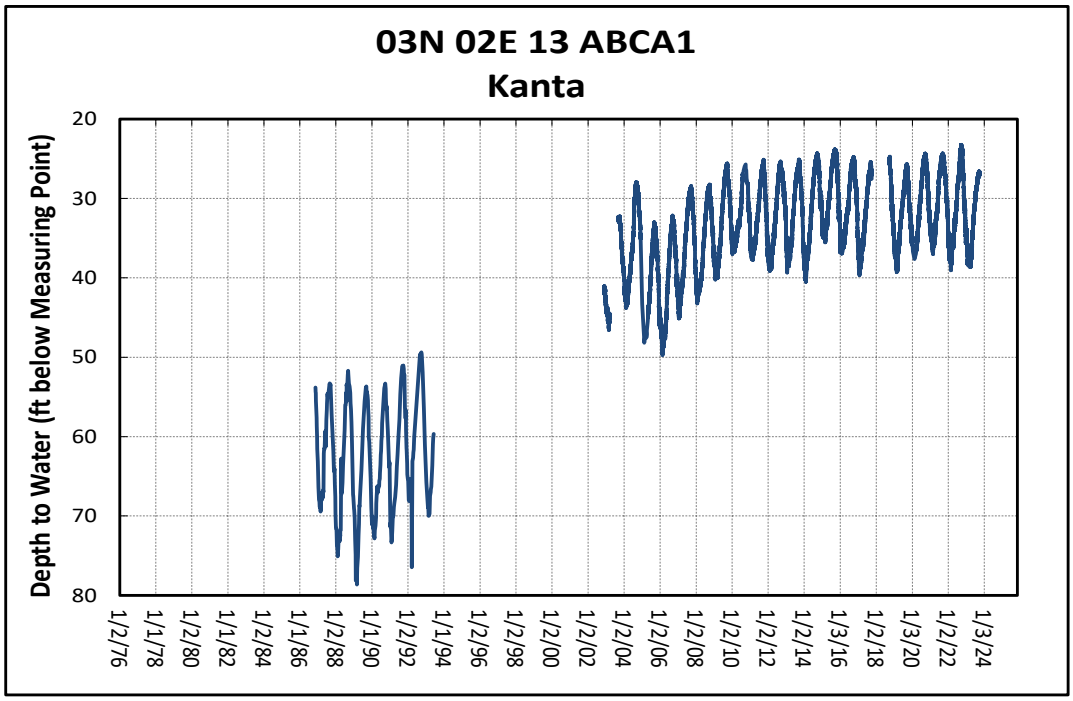

Figure 3. Water levels in the Kanta well.

Peak water levels in the BGL #1 well declined 0.5 ft and the minimum water level declined 1.5 ft from WY22 to WY23 (Figure 4). As was noted in previous reports, the manual measurements don't appear to accurately represent the water level in BGL #1 and have not been analyzed.

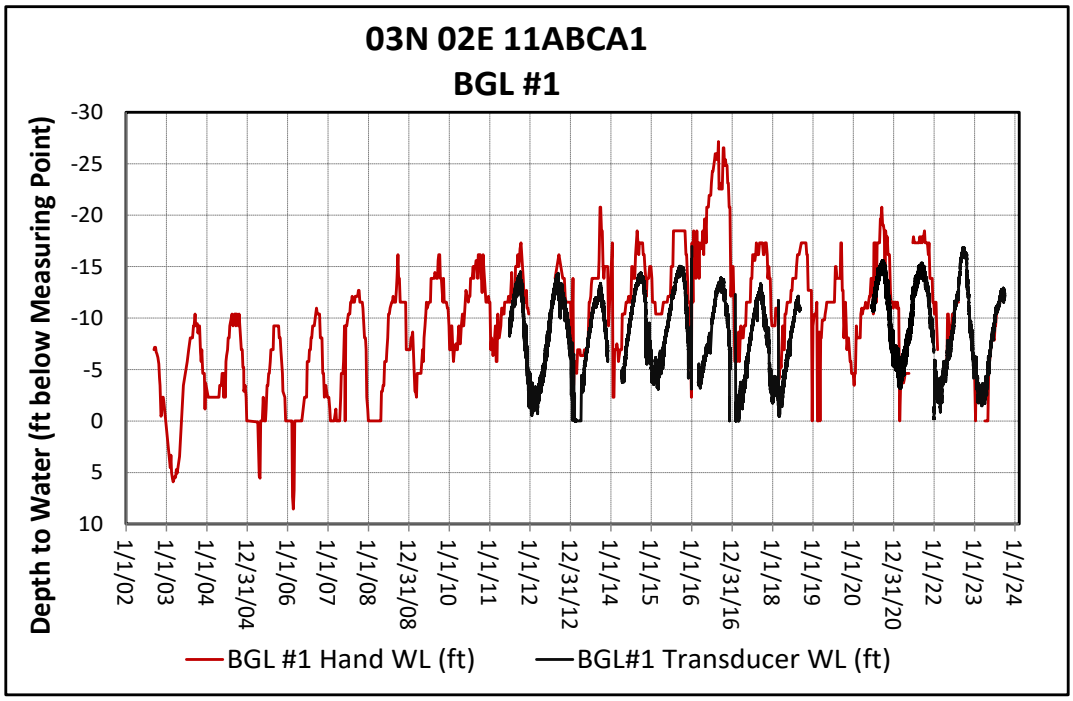

Figure 4. Water levels in the City of Boise BGL #1 well.

The peak water levels in the BWSWD East and West wells declined 5.0 ft and 3.6, respectively. The peak water level in BWSWD Well #3 declined 4.0 ft and the minimum water level declined 0.3 ft. Minimum water levels in the BWSWD East and West wells were not analyzed due to pumping impacts (Figures 5 and 6).

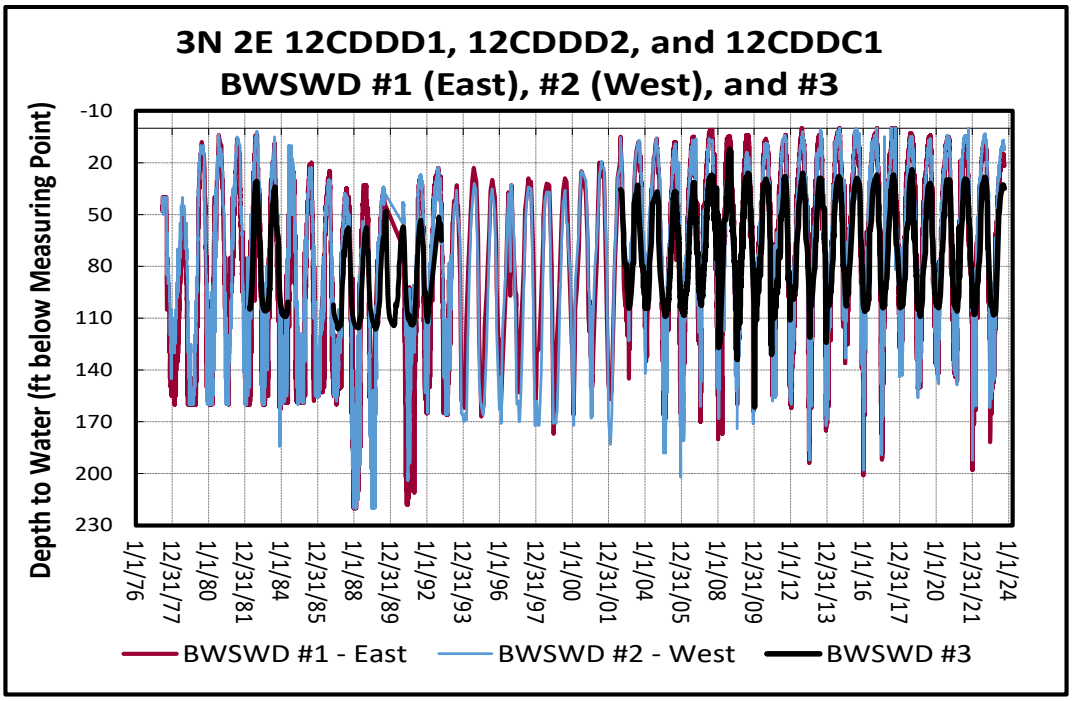

Figure 5. 1977 – 2023 water levels in the BWSWD wells.

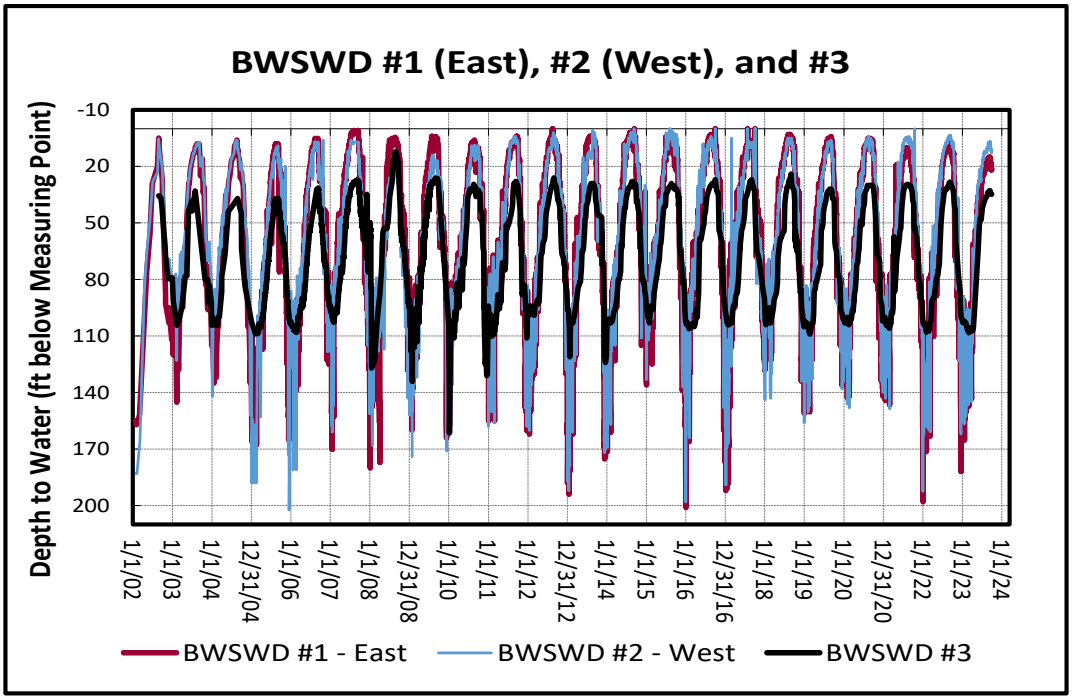

Figure 6. 2002 – 2023 water levels in the BWSWD wells.

The peak water levels in the Harris Ranch West well rose 0.33 ft and the minimum water levels declined 0.7 ft from WY22 to WY23 (Figure 7). Too few measurements were made in the Harris Ranch East well to analyze water level changes from WY22 to WY23.

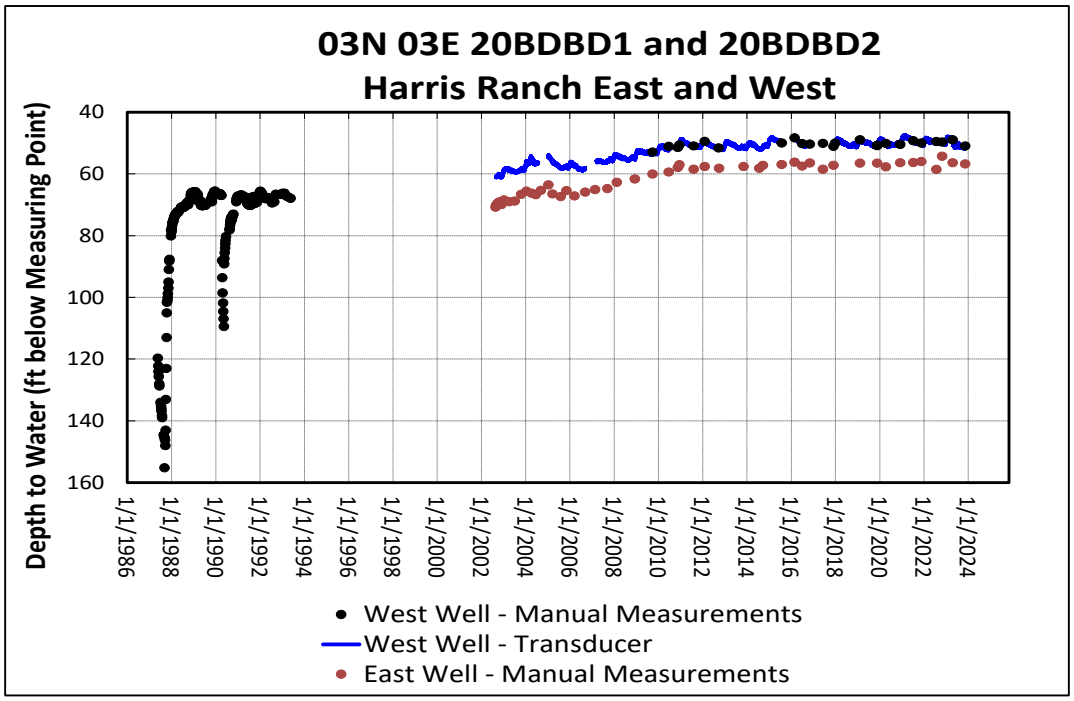

Figure 7. Water levels in the Harris Ranch wells.

Water-Level Trends

Water levels have generally risen over the last 15 years, with statistically significant rising trends in 3 of 4 wells analyzed (Table 6). The water-level trend in BWSWD #3 is not statistically significant. The City BGL #1 well has not been analyzed for trend due to insufficient data.

Table 6. Water-year water-level trends for select wells in the Downtown Boise-Table Rock areas for WY05 to WY23. Bold indicates a statistically significant trend.

Wells	Peak Water Level Trend (ft. per year)[1]	Peak WL Trend p-value[2]	Min Water Level Trend (ft. per year)	Min WL Trend p-value
BLM Well	**0.3**	**0.00**	**0.4**	**0.01**
Kanta Well	**0.3**	**0.00**	**0.4**	**0.01**
City BGL #1[3]	NA	NA	NA	NA
BWSWD #3	-0.1	0.53	0.4	0.19
Harris Ranch[4]	**0.4**	**0.00**	**0.4**	**0.00**

[1] Trends and significance have been calculated using the Mann-Kendall statistical test.

[2] P-values less than 0.05 indicate the trend is significant at the 95% confidence interval.

[3] Trends have not been calculated due to insufficient data.

[4] Water-level trend has been calculated for only the Harris Ranch West transducer data.

Water Supply Temperatures

Water supply temperatures have been used to monitor aquifer temperatures in an effort to identify any potential impacts due to the re-injection of production water. However, well pumping and system usage complicate the assessment of temperature changes in these wells, and it does not appear that these wells give an accurate indication of aquifer temperature changes.

Monitoring aquifer temperature in an unused well with a probe located at the bottom would provide a much better indication of aquifer temperature changes. To this end, the City installed a down-hole temperature logger in the Kanta well in September 2023; however, there are no data available for WY23.

The maximum daily-average water temperature for the City decreased approximately 4.8 °F WY23 (Figure 8). The temperature decline observed over recent years is due the increased use of BGL #3, which relatively cooler than the other production wells.

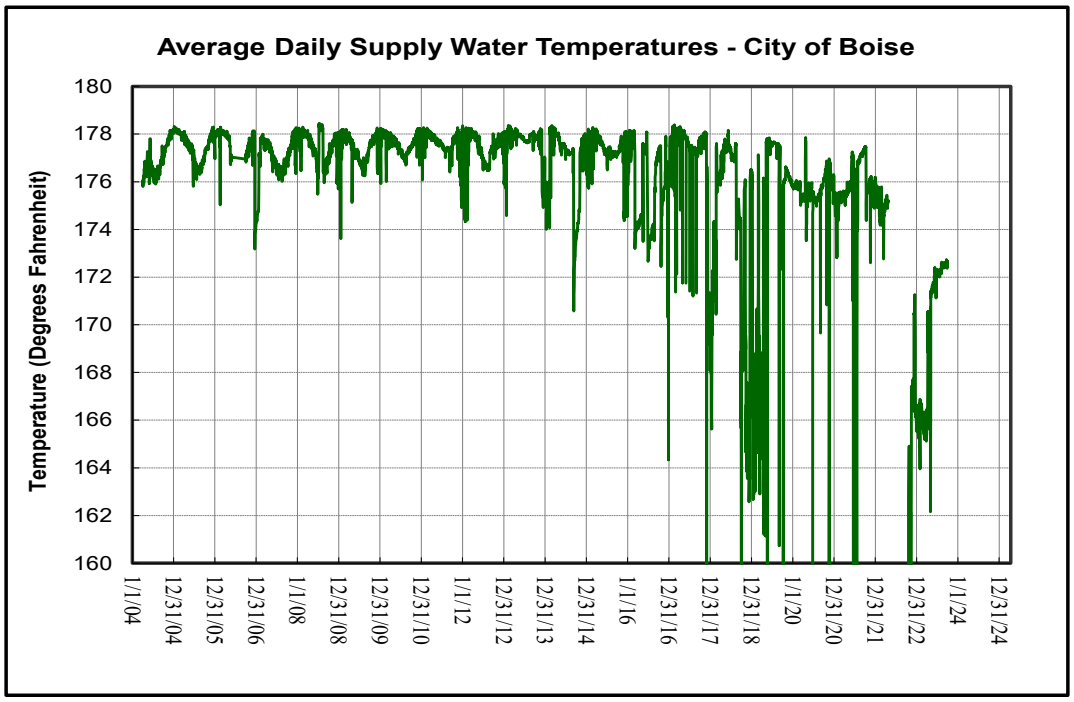

Figure 8. Supply water temperatures for the City system. Readings less than 170°F were omitted from the analysis.

Although the trend of -0.04 °F in City supply temperature is statistically significant, the magnitude of the trend is small and provides little practical significance (Table 7). Furthermore, the trend in City supply temperature incorporates recent temperature changes that have resulted from the increased use of BGL #3 well. The blending of the supply sources obfuscates any potential supply-temperature changes.

The maximum monthly water temperature for the State of Idaho Capitol Mall Production well decreased 0.2 °F from WY22 to WY23 (Figure 9). However, water in the State system cools during inactivity, and temperatures are considered valid only if the readings are preceded by a minimum flow rate of 300 gpm for at least eight hours. This requirement means the number of valid data points varies from year-to-year, and small temperature changes may be the result of the amount of valid temperature data available for analysis.

Despite the variability in temperature due to system operation, visual inspection of Figures 9 and 10 indicate a general decline in temperature over time. There is a statistically significant declining trend of approximately 0.05 °F in the water-year average of maximum monthly temperatures from WY05 to WY23 (Table 7). However, like the trend in City supply temperature, the small magnitude limits the practical significance of the trend.

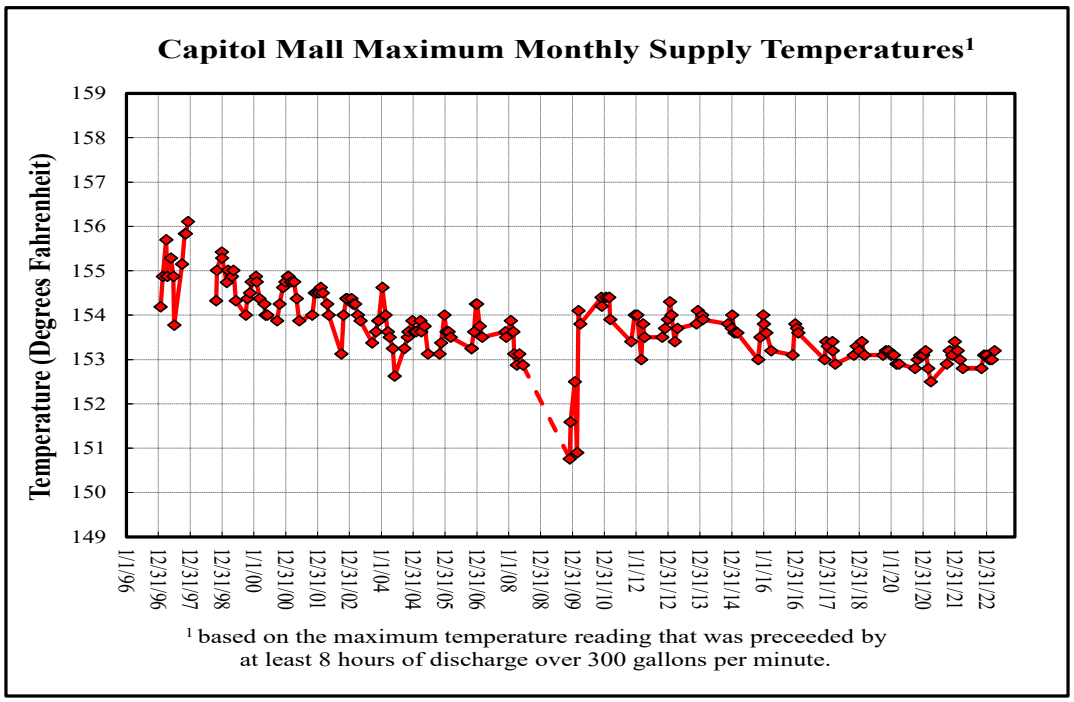

Figure 9. Monthly maximum supply water temperatures for the State system.

The water-year average of the maximum monthly temperature decreased 0.1 °F in WY23 (Figure 10).

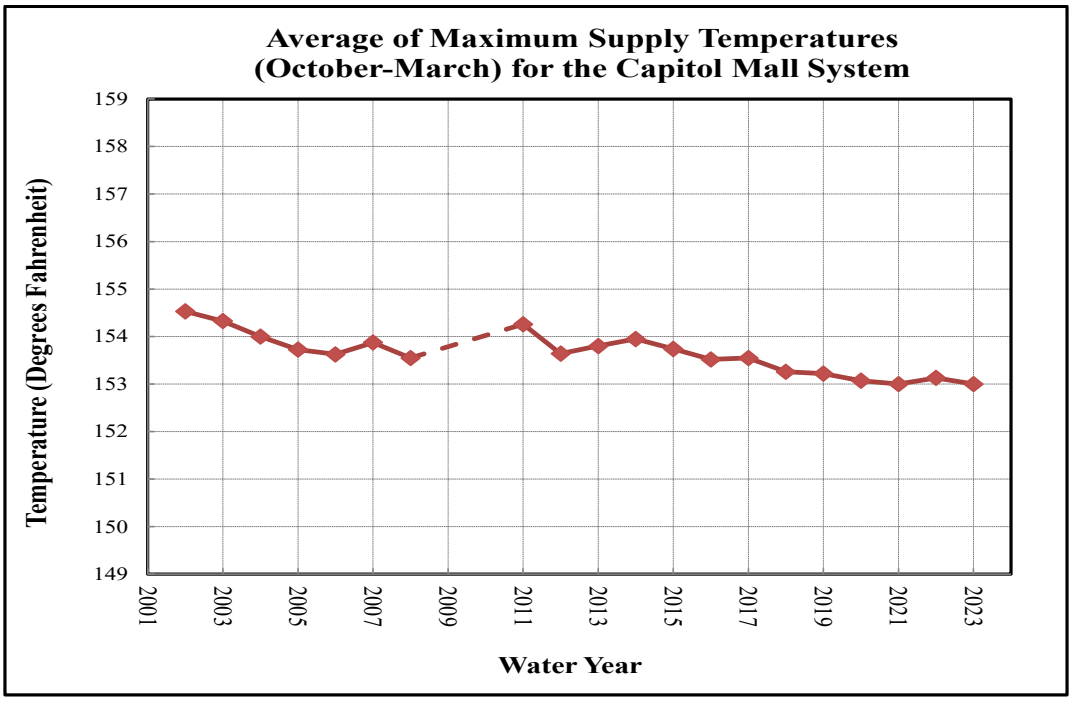

Figure 10. Average maximum monthly supply water temperatures for the State.

The BWSWD maximum annual temperature in WY23 was 179 °F, which is the same as in WY22 (Figure 11). The calculated water-temperature trend from WY05 to WY23 is zero, but the trend is not statistically significant (Table 7). BWSWD blends withdrawals from BWSWD #1 and #2, and changes in the proportion of well usage may result in small temperature changes.

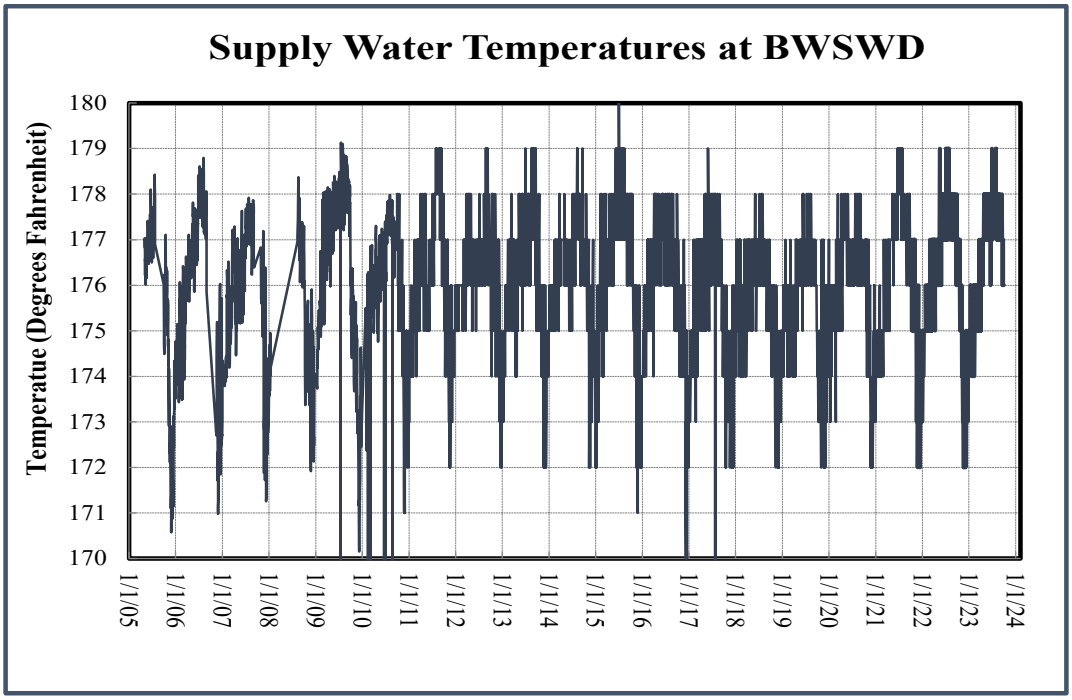

Figure 11. Supply water temperatures for the Boise Warm Springs Water District.

Table 7. Temperature trends for the four district geothermal heating systems in the Downtown Boise-Table Rock area for WY05 – WY23. Bold indicates a statistically significant trend.

System	Calculated Trend (^{0}F per year) [3]	Trend p-value[4]
City	**-0.04**	**0.01**
State[1,2]	**-0.05**	**0.00**
BWSWD	0.00	0.51
VA	NA	NA

[1] Measurements must be preceded by at least 8 hours of discharge over 300 gallons per minute.
[2]Trend has been calculated for the water-year average of monthly maximum temperatures.
[3] Trends and significance have been calculated using the Mann-Kendall statistical test.
[4] P-values less than 0.05 indicate the trend is significant at the 95% confidence interval.

References

Hirsch, R.M., and Slack, J.R., 1984. A nonparametric trend test for seasonal data with serial dependence: Water Resources Research v. 20, p. 727–732.

Appendix A

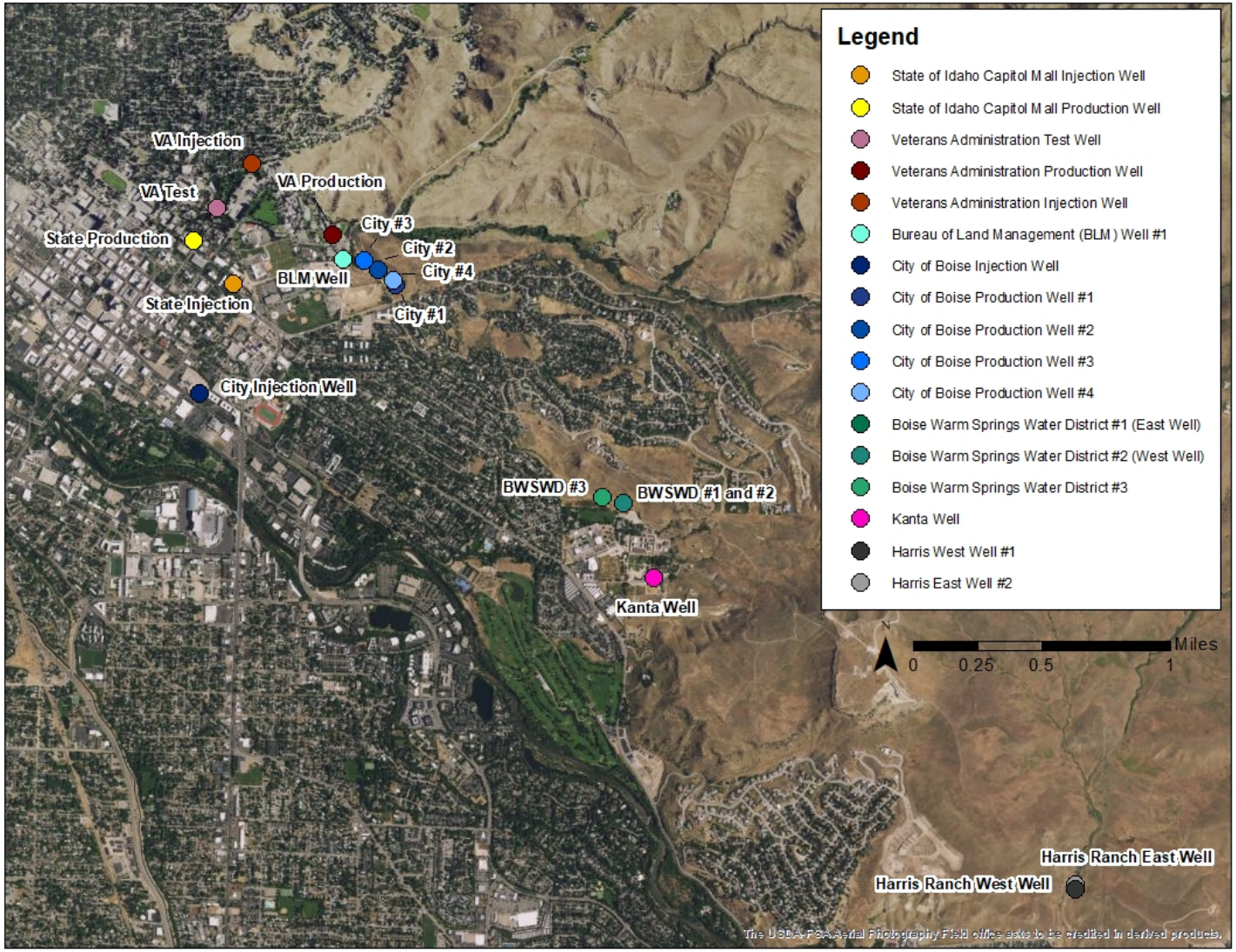

Figure A-1. Well locations in the Downtown Boise-Table Rock area of the Boise Front Low-Temperature Geothermal Resource GWMA.