# GEOTHERMAL DEVELOPMENT IN THE BOISE AREA

The first two geothermal wells in the United States were drilled near Boise, Idaho, in 1890 and 1891 (Boise City Public Works, 1993). The wells were completed near some thermal springs located about two miles east of Boise (Figure 5). Both wells were drilled to depths of 400 feet (Table 1). Although there are no well driller's reports for the two wells, it is assumed that the wells were completed in the rhyolite rocks of the Idavada Group. The wells are believed to have been drilled through a major down-to-the-southwest normal fault that trends northwest/southeast along the toe of the Boise Front Foothills. This fault and other associated faulting are interpreted to be the conduits for upward migration of geothermal water along the Boise Front.



**Figure 5.** Original well house for the Boise Warm Springs Water District's two geothermal production wells (from Burnham and Wood, 1983).

By 1892, the water from the wells was being used to heat homes, businesses and a 15,000 square foot Natatorium in east Boise. The Natatorium no longer exists but the

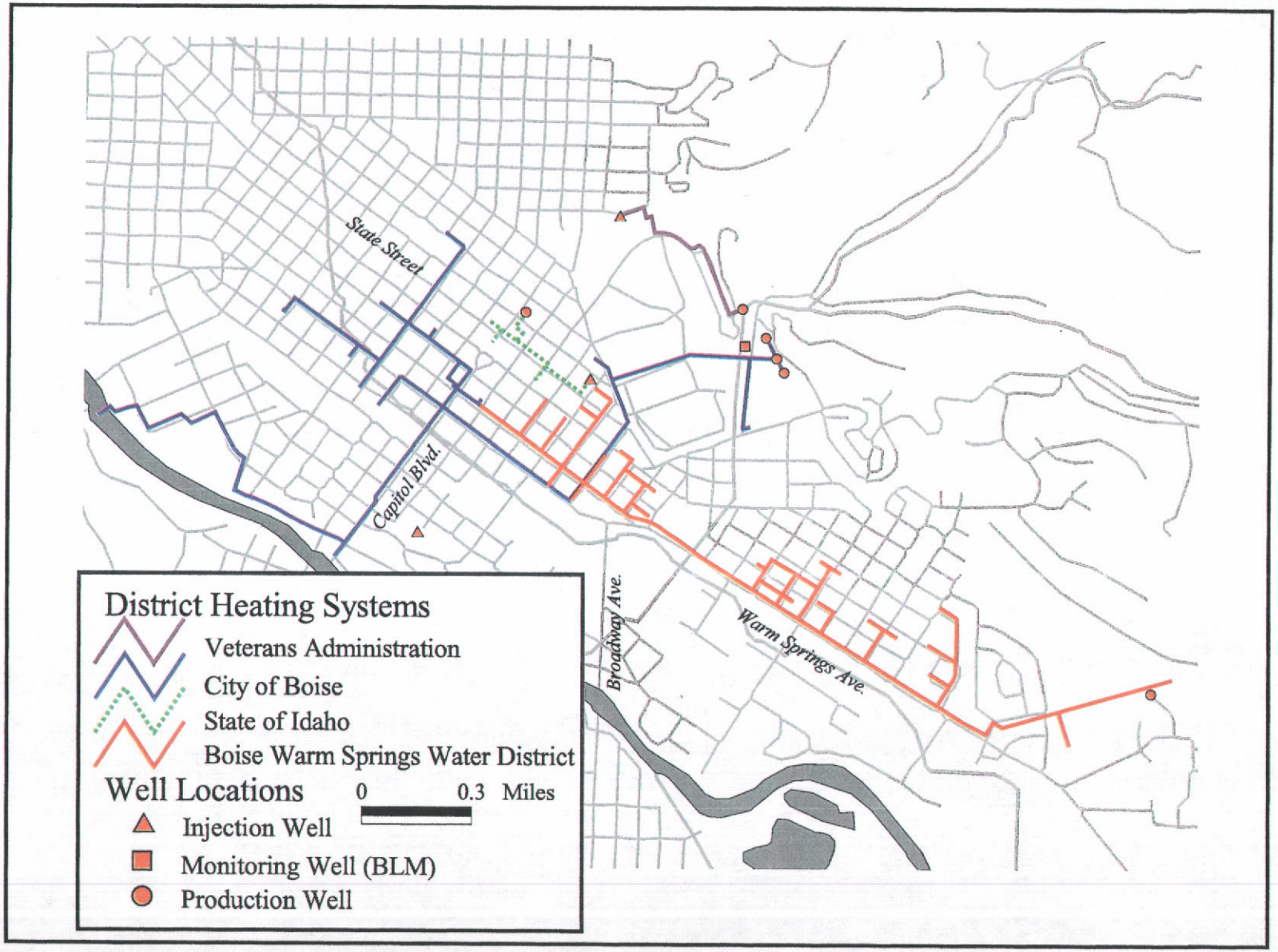
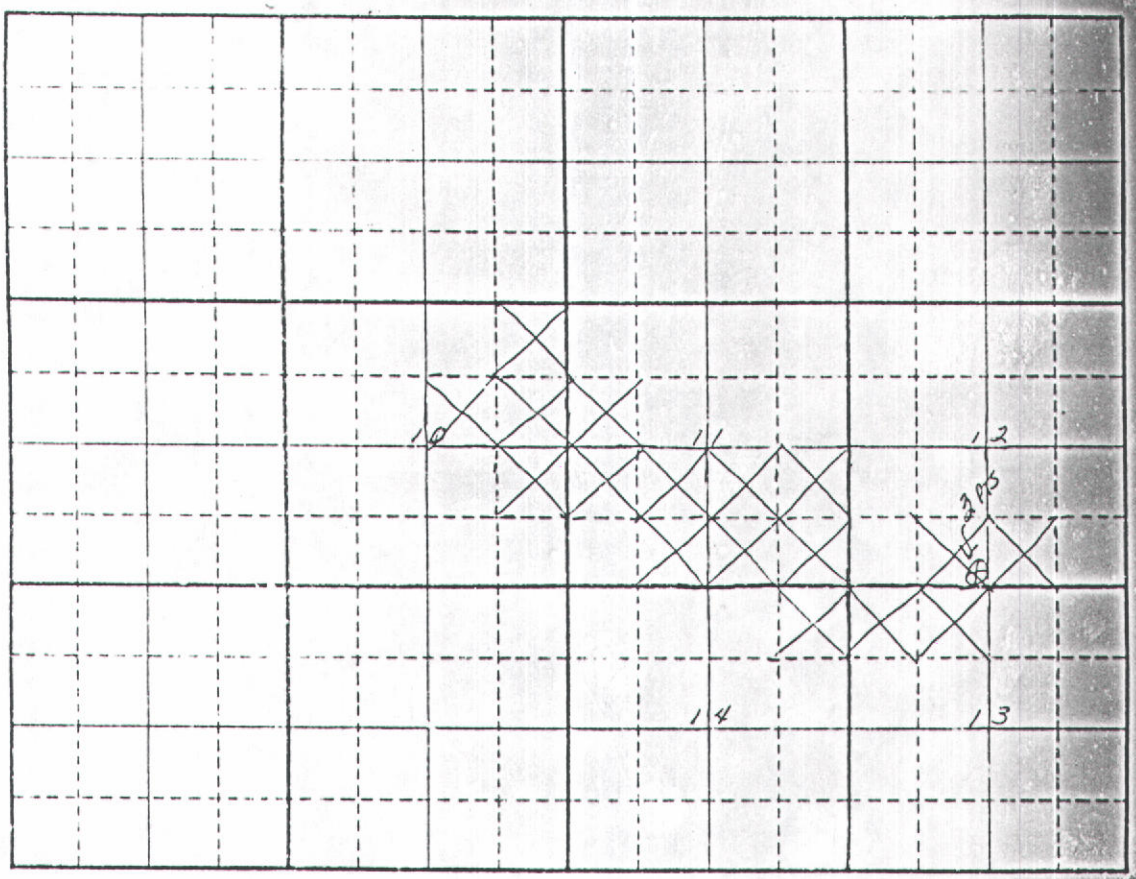



**Figure 6.** Geothermal well locations and distribution lines for the four district heating systems in the Boise area (This map was modified from a map received from the City of Boise Public Works Department in 1996).

(8) Remarks




Scale: 2 inches equal 1 mile.

Map should show the location of the point of diversion and the place of use of the water by 40-acre subdivisions, section, township and range of the public land survey system.

State of Idaho )
) ss.
County of Ada )

Be it known that the undersigned, being duly sworn, deposes and says that he, she, they submitted the foregoing claim to a water right, together with all attached information, and that the matters and facts therein are true to the best of the affiant's knowledge.

Terence O'Rourke
Boise Warm Springs Water District
(Claimant)

Sworn to before me this 22nd day of April, 1983.

Robert H. Griffiths
Notary Public
Residing at Boise, Idaho

ROBERT H. GRIFFITHS NOTARY PUBLIC STATE OF IDAHO

My commission expires

FOR DEPARTMENT USE ONLY

Received by [illegible] Date 5-12-83 Exception filed by: Forwarded to claimant by: Date
Prelim. check by [illegible] Date 6-14-83 & 4-19-84
~~$20.00~~ fee received by [illegible] Date 5-12-83 # 28823
Published in Idaho Statesman
Dates 6/30, 7/7/83

4-16-84

30 cfs

NOTICE OF WATER RIGHT LOCATION.

To Whom it May Concern:

Notice is hereby given that the ARTESIAN HOT and COLD WATER COMPANY, Limited, a corporation organized under the laws of the State of Idaho, with its principal place of business at Boise City, in Ada County, in said State, has appropriated and does hereby claim the waters flowing from three artesian wells near which this notice is posted, and each and every of said wells, to the extent of four and two hundred and seventy-three one thousandths cubic feet per second of time; which said wells through and by means of which said water is diverted and appropriated are situated in the Southeast quarter of the Southeast quarter of the Southwest quarter of Section Twelve (12) in Township Three (3) North, Range Two (2) East of Boise Meridian, in Ada County, State of Idaho.

That the purposes for which said water is claimed are for domestic uses and for bathing and heating purposes and to warm the waters of a large plunge or swimming bath at a place of public resort, belonging to said Company, known as the "Natatorium," situated about Three Thousand feet in a South-Westerly direction from said wells; and also for sale for domestic uses and for bathing and heating purposes; and all other purposes for which hot water may be used, and for irrigation and sprinkling in Boise City, in said county and along or near the line of conduit or pipes used in conveying said water from said wells to and through the streets and alleys of Boise City.

That the place or locality of the intended use of said water is at said Natatorium and the grounds surrounding the same, and in said Boise City, and along and near the line of the conduit and pipes used, or that may be used in conveying said water as hereinafter described.

That the general course, length and destination of the conduit or pipes by which it is proposed to divert said water is as follows: Commencing at each of said wells and running North of West about one hundred and sixty feet through separate pipes to a

1

Recorded ... Deputy.

4.273 cfs

SESESW, 12, T3N, R2E.

Dom, Heat, Bathing.

In Boise City

common main pipe; thence South 70 degrees 25 minutes West, 251.4 feet to the South side of the public road, known as Warm Springs Avenue; thence Westerly along said Avenue, 300 feet to a Tee in said pipe by which a part of said water is diverted and runs in a South Easterly direction 302 feet to said Natatorium building; and from said Tee running in a Westerly direction along said Warm Springs Avenue 5608 feet to the junction of Idaho Street in Boise City; thence Westerly along Idaho Street 5363 feet to a point 120 feet East of the East line of Thirteenth Street and about 13945 feet from said wells; together with all the lateral pipes and conduits connecting said main conduit with the buildings and premises where said water is or may be used.

Posted at or near the point of intended diversion, on the 23d day of November, 1899.

ARTESIAN HOT & COLD WATER COMPANY, Limited,
Appropriator and Claimant,
By _____
President.

Attest: _____
Secretary.

State of Idaho,)
)ss.
County of Ada. )

Benjamin S. Rowe, of Boise City, Ada County, State of Idaho, being first duly sworn, deposes and says: That he is of lawful age and is the Secretary of the Artesian Hot and Cold Water Company, Limited, a corporation, and the appropriator and claimant of the water right described in the foregoing Notice. That the statements in said notice are true, and that the original Notice, of which the foregoing is a true copy, was posted in a conspicuous place near the artesian wells of said Company, the point of diversion of said water, at five o'clock P.M. of the twenty-third day of November, 1899.

Subscribed and sworn to before me, this twenty-fourth day of November, 1899. _____

Richard H. Johnson
Notary Public.

PRINTED BY
A. H. & C. WATER CO.

# NOTICE OF WATER RIGHT LOCATION

TO WHOM IT MAY CONCERN:

Notice is hereby given that the Artesian Hot and Cold Water Company, Limited, a corporation created and existing under the laws of the State of Idaho, with its principal place of business at Boise City, Ada County, in said State heretofore on the 5th day of November, 1894, appropriated and is the owner and claimant of the following described water rights, to-wit: The waters flowing from three artesian wells and each and every of said wells, to the extent of four and two hundred and seventy-three one thousandths cubix feet per second of time; which said wells through and by means of which said water is diverted and appropriated are situated in the South-east quarter of the South-east quarter of the South-west quarter of Section Twelve (12) in Township Three (3) North, Range Two (2) East of Boise Meridian, in Ada County, State of Idaho.

That the location and specific uses for which said water is claimed are for domestic and for bathing and heating purposes and to warm the waters of a large plunge or swimming bath at a place of public resort, belonging to said company, known as the "Natatorium", situated about three thousand feet in a South-westerly direction from said wells; and also for sale for domestic uses and for bathing and heating purposes, and for all other purposes for which hot water may be used, and for irrigating and sprinkling, in Boise City in said County and along or near the line of the conduit or pipes used in conveying said water from said wells to and through the streets and alleys of Boise City, commencing at each of said wells and running North of West about one hundred and sixty feet through separate pipes to a common pipe; thence South 70 degrees 15 minutes West 2514 feet to the South-west side of the public road known as Warm Springs Avenue; thence Westerly along said Avenue, 300 feet to a tee in said pipe by which a part of said water is diverted and runs in a South-westerly direction, 200 feet to said Natatorium building; and from said tee running in a Westerly direction along said Warm Springs Avenue, 5600 feet to the junction of Idaho Street in Boise City; thence Westerly along Idaho Street, 5263 feet to a point 120 feet East of the east line of Thirteenth Street and about 1.3943 feet from said wells; together with all the lateral and distributing pipes and conduits connecting said main conduit with the buildings and premises where said water is or may be used.

Dated November 24th, 1899.

Artesian Hot & Cold Water Company, Limited,
Owner and Claimant.
By C.W.Moore, President.

Attest: B.H.Howe,
Secretary.

State of Idaho, )
:- ss.
County of Ada. )

Benjamin S.Howe, of Boise City, Ada County, State of Idaho, being first duly sworn deposes and says: That he is of lawful age and is the Secretary of the Artesian Hot and Cold Water Comapny, Limited, the corporation named in the foregoing notice and the owner and claimant of the water right described in said notice; and that the statements in said notice are true.

Benjamin S.Howe

Subscribed and sworn to be fore me this twenty-fifth day of November, 1899.

( SEAL )

Richard H.Johnson
Notary Public

( U.S.I.R.3. )
( ---------- )
( Nov.25,1899 )
(10¢ cancelled)

Recorded at the request of Walter Kaufe at 2 P.M., November 25,1899
Recorded at the request of Walter Kaufe at 2 P.M., November 25, 1899

[illegible] Recorder. By [illegible] Deputy.

RETAIN IN —— 63-9160

ARTESIAN WELLS #
APPROPRIATED BY #
A. H. & C. WATER CO. #

# NOTICE OF WATER RIGHT LOCATION

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Dated November 24th, 1899.

Artesian Hot & Cold Water Company, Limited,
Owner and Claimant.

Attest: B.H.Howe, Secretary. By C.W.Moore, President.

State of Idaho, )
:- ss.
County of Ada. )

Benjamin S.Howe, of Boise City, Ada County, State of Idaho, being first duly sworn deposes and says: That he is of lawful age and is the Secretary of the Artesian Hot and Cold Water Company, Limited, the corporation named in the foregoing notice and the owner and claimant of the water right described in said notice; and that the statements in said notice are true.

Benjamin S.Howe

Subscribed and sworn to before me this twenty-fifth day of November, 1899.

Richard H.Johnson
Notary Public

( SEAL )

( U.S.I.R.S. )
( ---------- )
( Nov.25,1899 )
(10¢ cancelled)

Recorded at the request of Walter Keeffe at 2 P.M., November 25, 1899

[illegible] Recorder, By [illegible] Deputy.

11-5-1894

4.273 c.f.s.

SE SE SW, 12 T3N, R2E

63-1160

ARTESIAN WELLS
APPROPRIATED BY
A.H. & C. WATER CO.

# NOTICE OF WATER RIGHT

## LOCATION.

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Notice is hereby given that the ARTESIAN HOT AND COLD WATER COMPany, Limited, a corporation organized under the laws of the State of Idaho, with its principal place of business at Boise City, in Ada County, in said State, has appropriated and does hereby claim the waters flowing from three artesian wells near which this notice is posted, and each and every of said wells, to the extent of four and two hundred and seventy-three one thousandths cubic feet per second of time, which said wells through and by means of which said water is diverted and appropriated are situated in the South-east quarter of the South-east quarter of the South-west quarter of Section Twelve (12) in Township Three (3) North, Range Two (2) East of Boise Meridian, in Ada County, State of Idaho.

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That the general course, length and destination of the conduit or pipes by which it is proposed to divert said water is as follows: Commencing at each of said wells and running North of West about one hundred and sixty feet through separate pipes to a common main pipe; thence South 70 degrees 15 minutes West, 2514 feet to the South side of the public road,known as Warm Springs Avenue; thence Westerly along said Avenue, 300 feet to a Tee in said pipes by which a part of said water is diverted and runs in a Southeasterly direction 302 feet to said Natatorium building; and from said Tee running in a Westerly direction along said Warm Springs Avenue 5603 feet to the junction of Idaho Street in Boise City; thence Westerly along Idaho Street 5363 feet to a point 120 feet East of the East line of Thirteenth Street and about 13945 feet from said wells; together with all the lateral pipes and conduits connecting said main conduit with the buildings and premises where said water is or may be used.

Posted at or near the point of intended diversion, on the 23d day of November, 1899.

Artesian Hot & Cold Water Company, Limited,
Appropriator and Claimant,
By C.W.Moore President.

Attest:B.S.Howe
Secretary

State of Idaho, )
:- ss.
County of Ada. )

Benjamin S.Howe, of Boise City, Ada County, State of Idaho, being first duly sworn, deposes and says; that he of lawful age and is the Secretary of the Artesian Hot and Cold Water Company, Limited, a corporation, and the appropriator and claimant of the water right described in the foregoing notice. That the statements in said notice are true, and that the original notice, of which the foregoing is a true copy was posted in a conspicuous place near the artesian wells of said company, the point of diversion of said water, at five o'clock P.M. of the twenty-third day of November, 1899.

B.S.Howe

Subscribed and sworn to before me
this twenty-fourth day of November,1899.

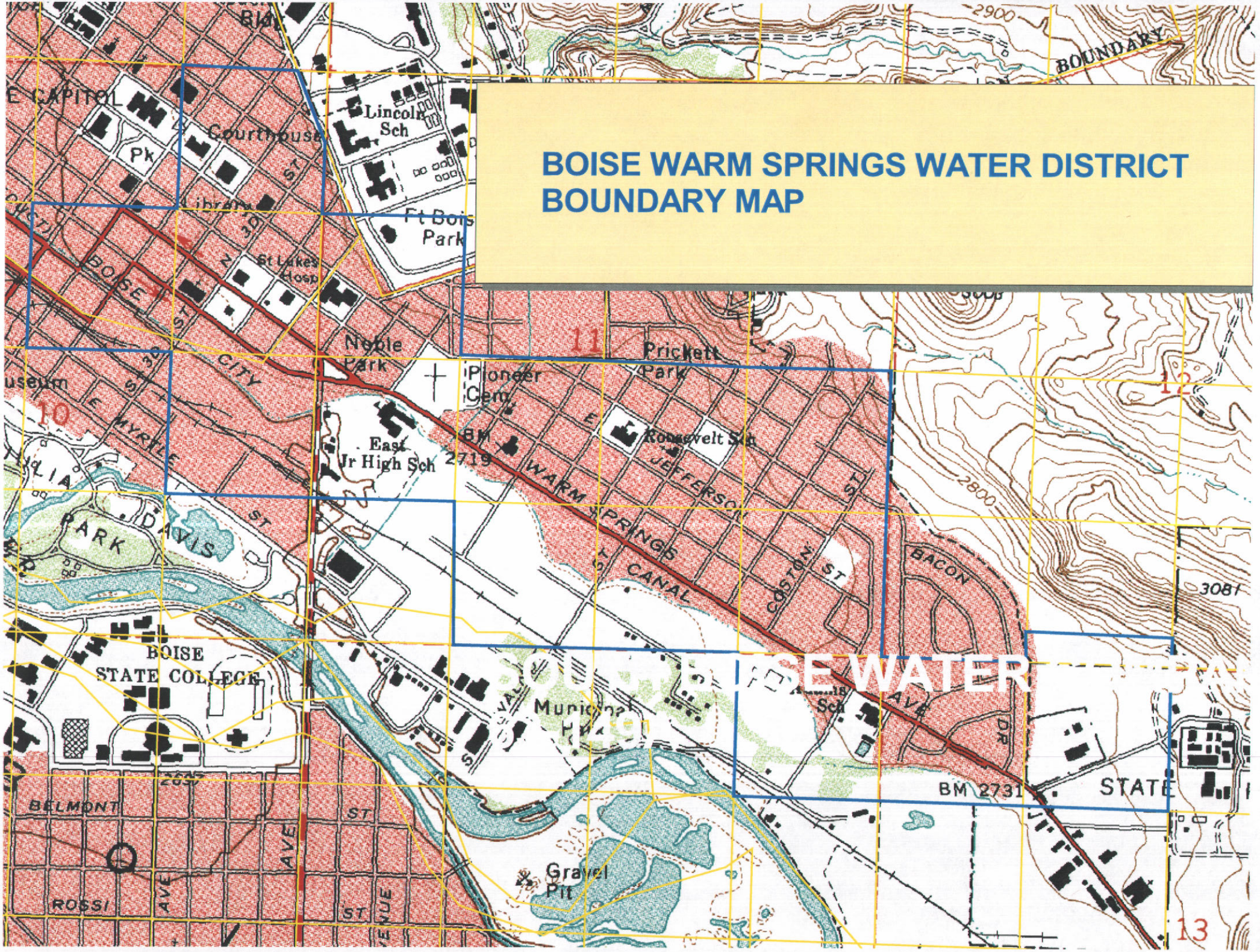
Richard H.Johnson
Notary Public

( SEAL )

( U.S.I.R.S. )
( B.S.H. )
( 11-24-99 )
(10¢ cancelled )

Recorded at the request of B.S.Howe at 2.30 P.M., November 24, 1899.

# BOISE WARM SPRINGS WATER DISTRICT BOUNDARY MAP



BOISE WARM SPRINGS WATER DISTRICT
PHOTOGRAPHS DATED 10/14/2002

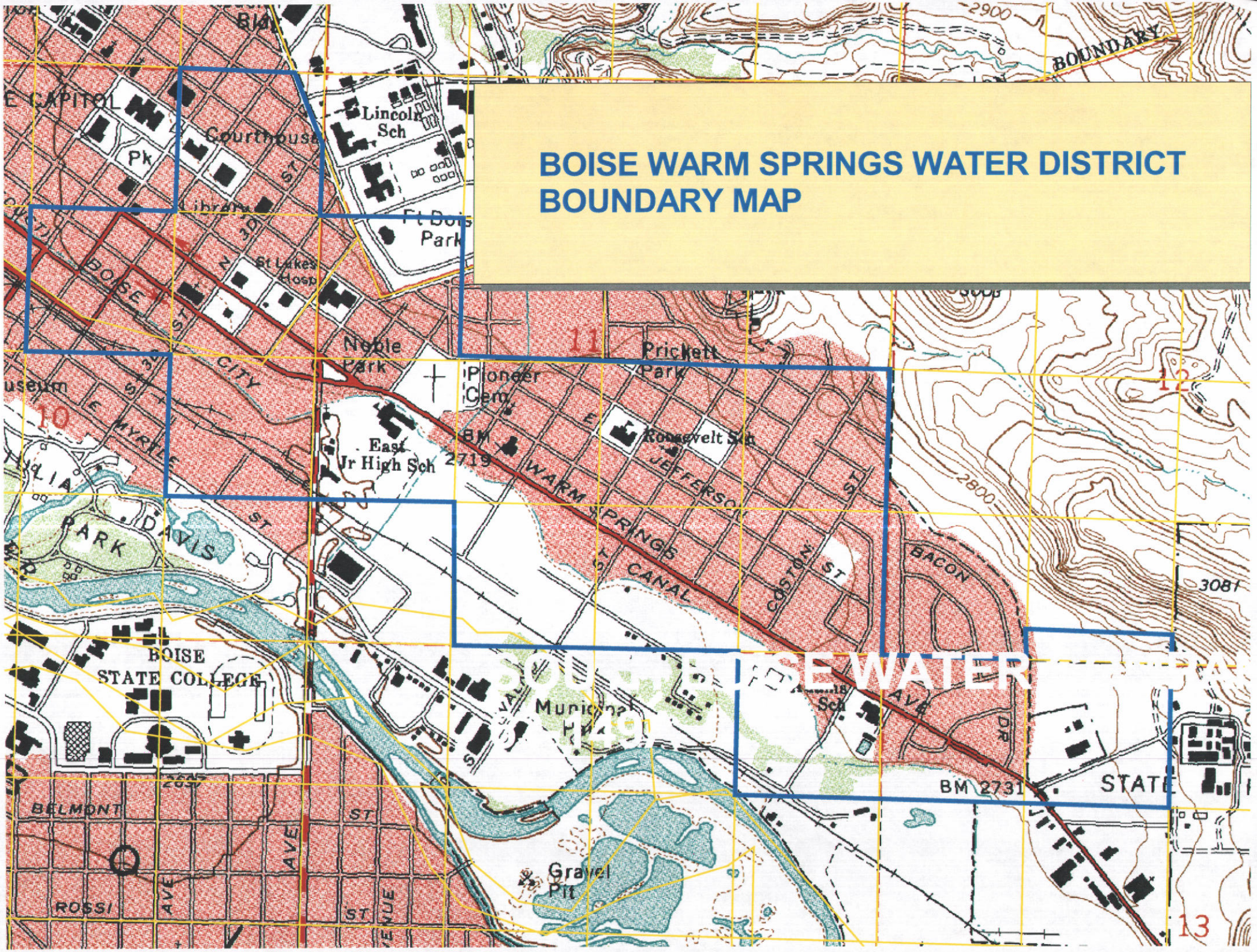
PHOTO #1




PUMP HOUSE AND POD SITE BEHIND THE OLD STATE PENETENTARY.

PHOTO #2

# BOISE WARM SPRINGS WATER DISTRICT BOUNDARY MAP

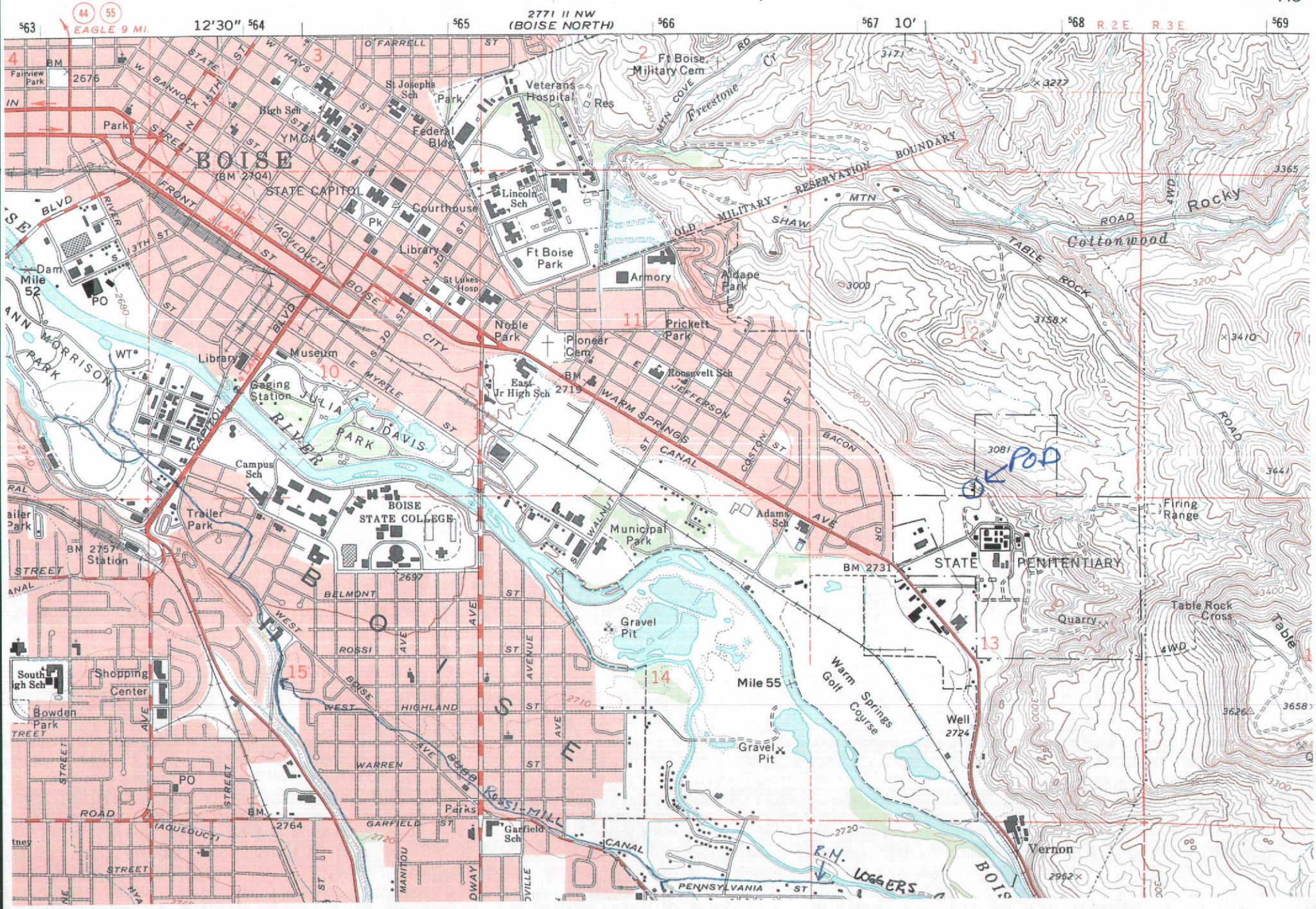


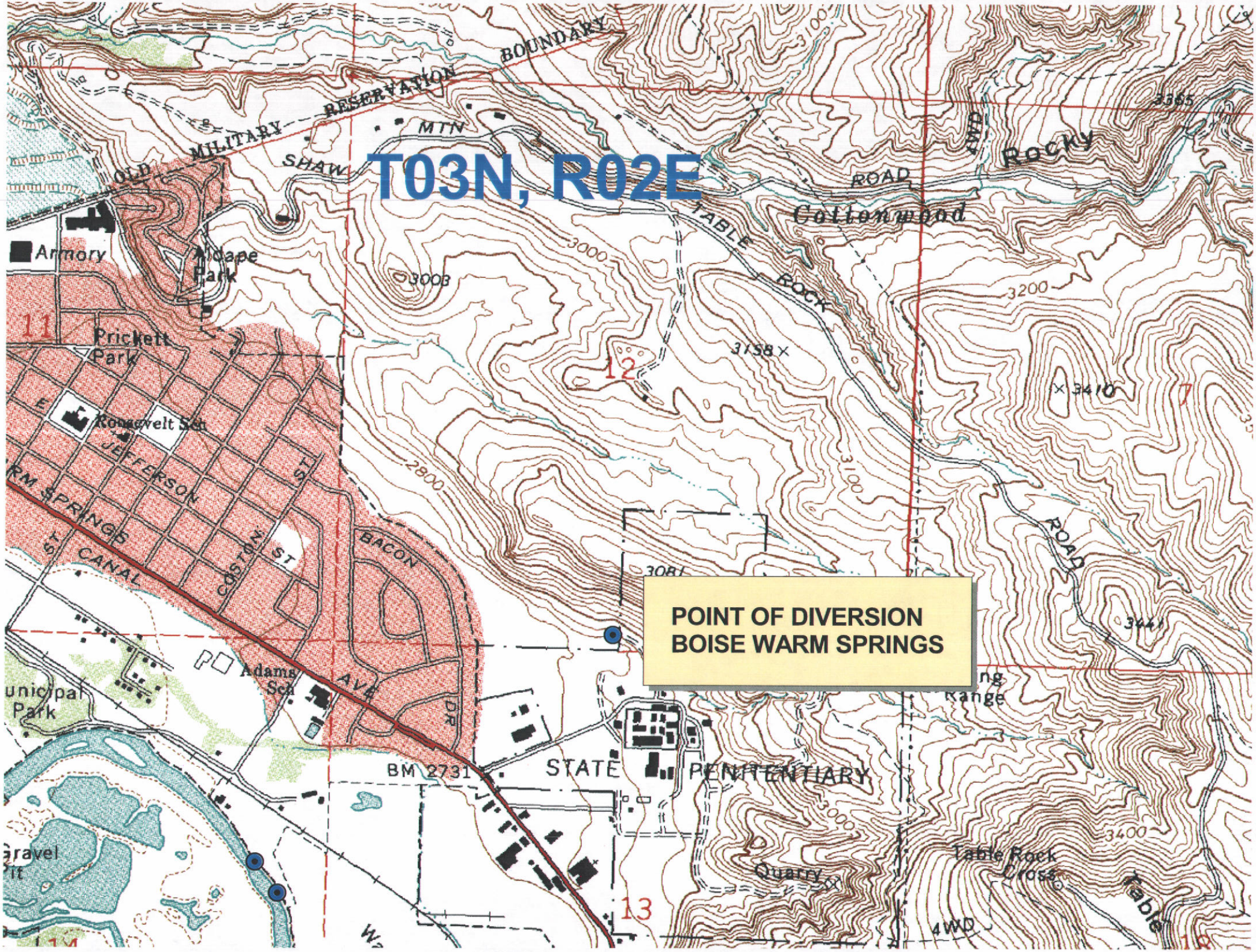
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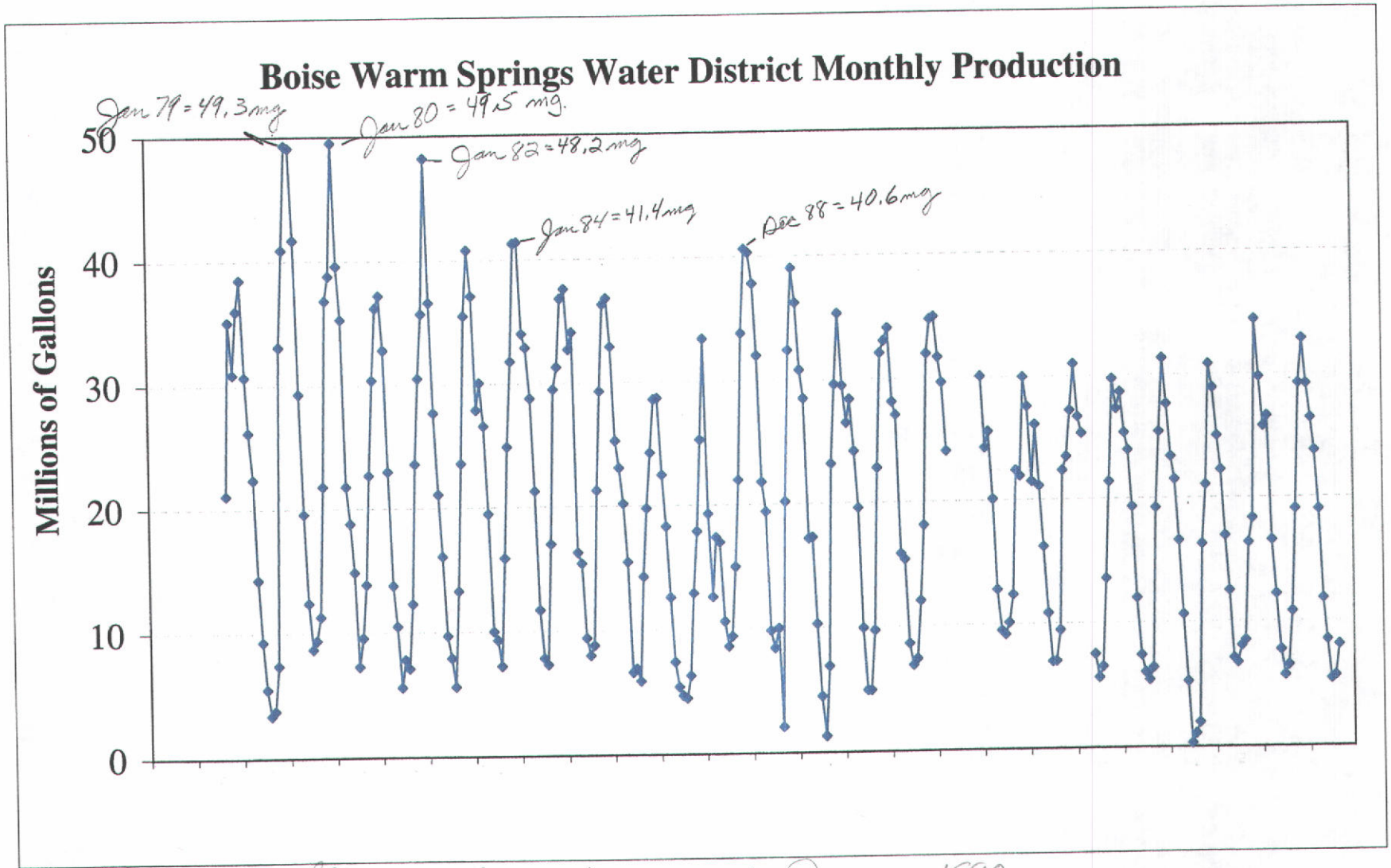
T03N, R02E

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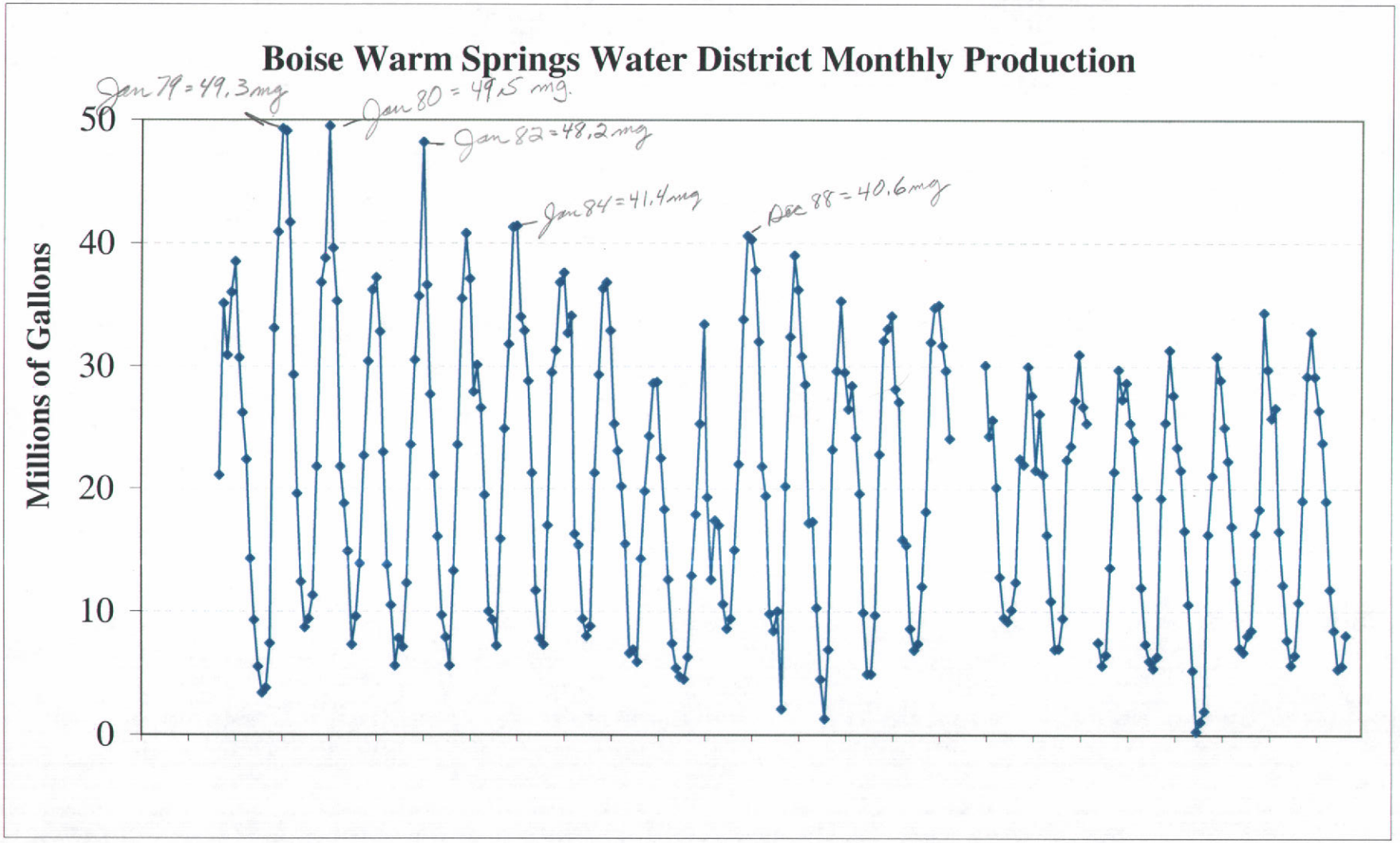



T03N, R02E
POINT OF DIVERSION
BOISE WARM SPRINGS
MILITARY RESERVATION BOUNDARY
OLD SHAW MTN
TABLE ROCK ROAD
Cottonwood
Armory
Prickett Park
Roosevelt Sch
JEFFERSON ST
BOISE WARM SPRINGS CANAL
COLTON ST
BACON
Adams Sch
AVE
BM 2731
STATE PENITENTIARY
Quarry
Table Rock Cross
4WD
Municipal Park
Gravel Pit
11
12
13
7
18
3000
3100
3200
2800
3158
3410
3081
3441
3400




The highest monthly production is 49.5 mg in January 1980.

49.5 mg ÷ 31 = 1,596,774.2 gpd ÷ 24 hrs = 66532.258 gph ÷ 60 = 1108.87 gpm ÷ 448.8 ≅ 2.47 cfs. average production.


Boise Warm Springs Water District Monthly Production
Jan 79 = 49.3 mg
Jan 80 = 49.5 mg.
Jan 82 = 48.2 mg
Jan 84 = 41.4 mg
Dec 88 = 40.6 mg
Millions of Gallons
50
40
30
20
10
0

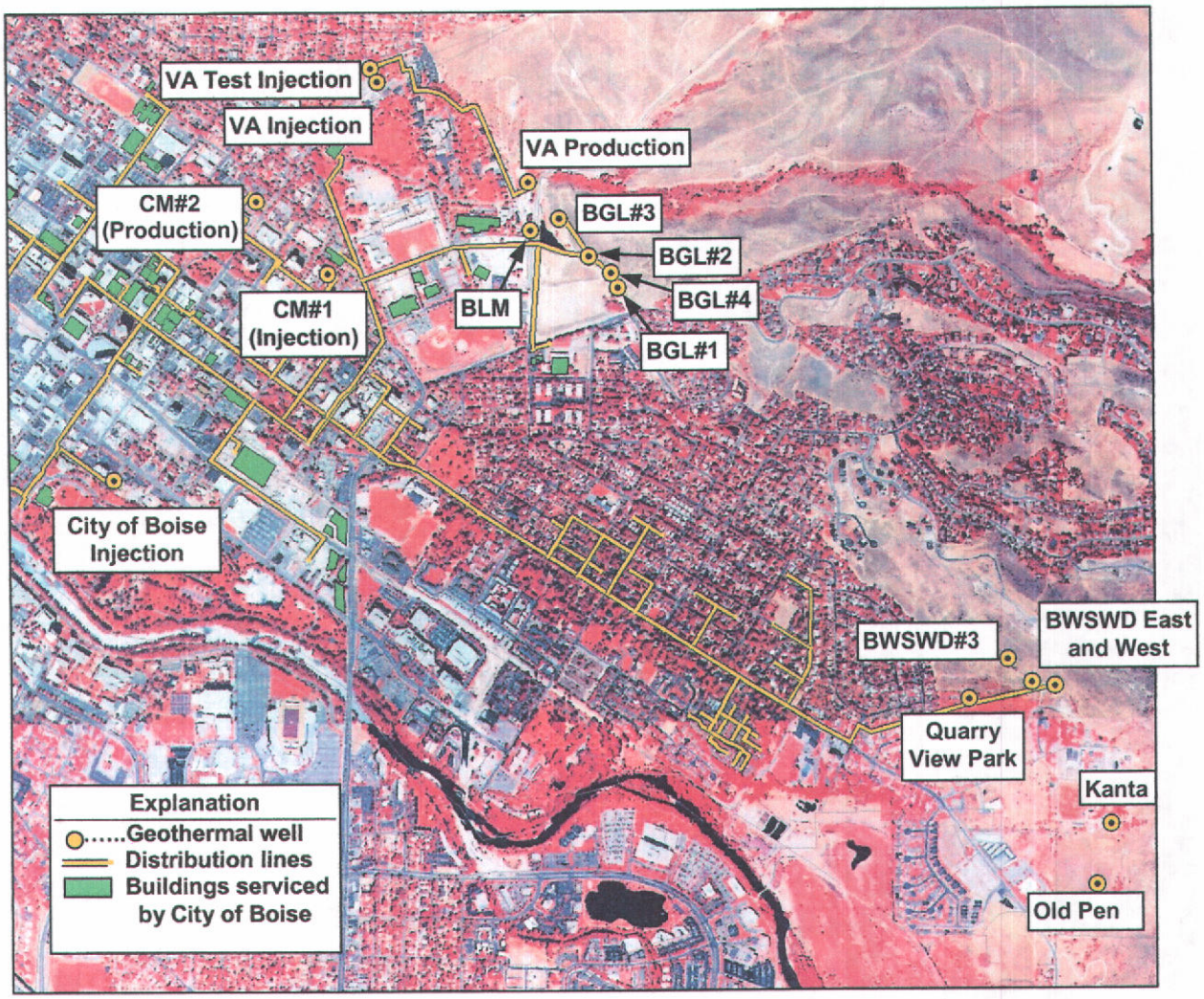
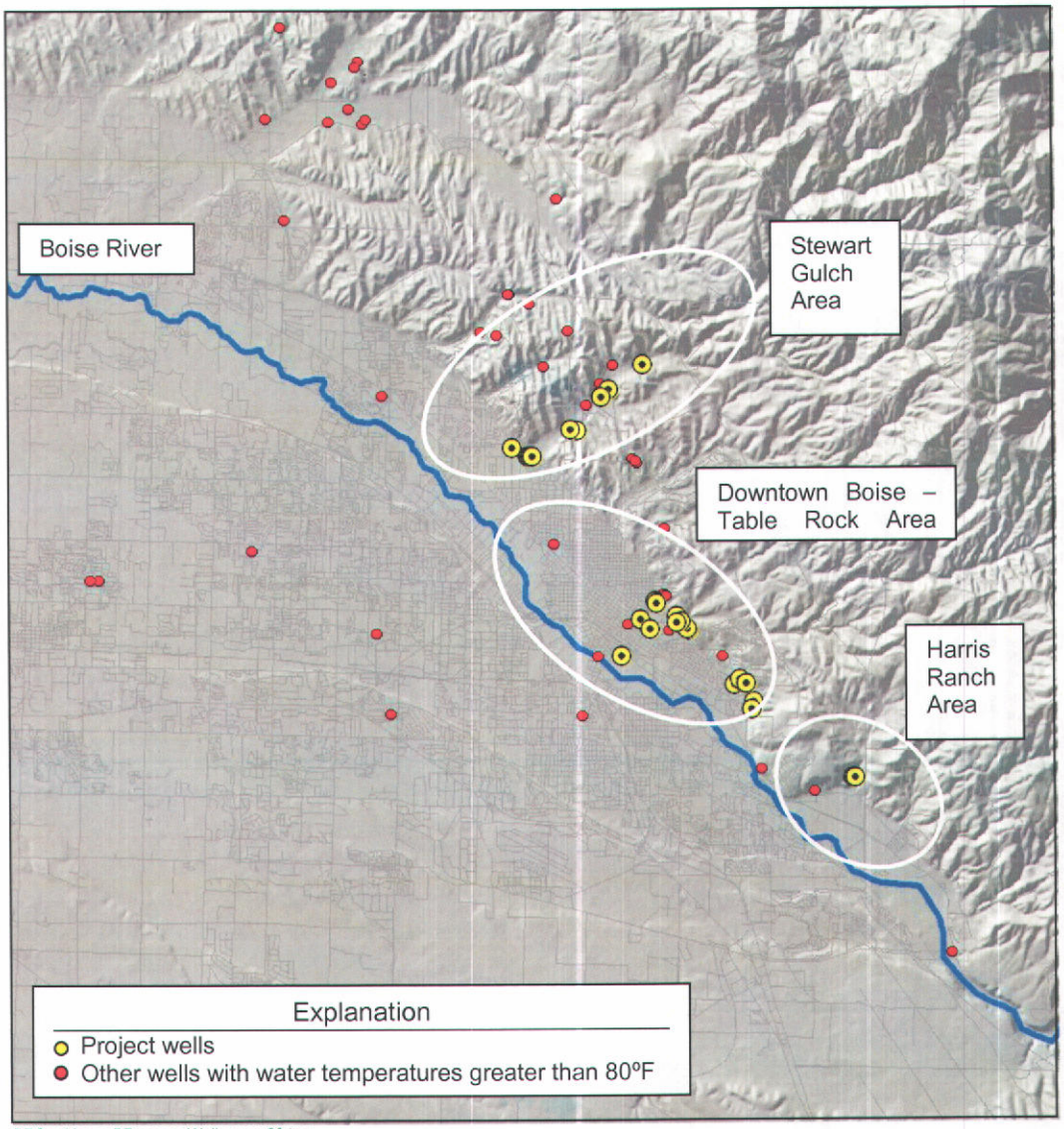



Figure 4-1: Locations of selected geothermal wells in the downtown Boise – Table Rock Area.

The BWSWD currently distributes geothermal water for space heating and domestic use in the eastern part of Boise (Figure 4-1). Spent geothermal water does not return to the geothermal aquifer, but (1) drains into shallow injection wells at points of use; (2) discharges to surface channels draining to the Boise River; or (3) discharges to the Boise River via the municipal sewer system. The primary distribution line along Warm Springs Avenue is connected to the City's geothermal distribution system (although under ordinary circumstances a valve between the two systems remains closed). Production data from the BWSWD system are available beginning in 1978. Production has steadily decreased from a high of 312 million gallons in the 1979 water year to an average of 214 million gallons per water year between 1994 and 2002 (Table 4-3, Figure 4-2). Production slowed between 1986 and 1988 (Figure 4-2), apparently because decreasing water levels caused pumps to break suction; the pumps were



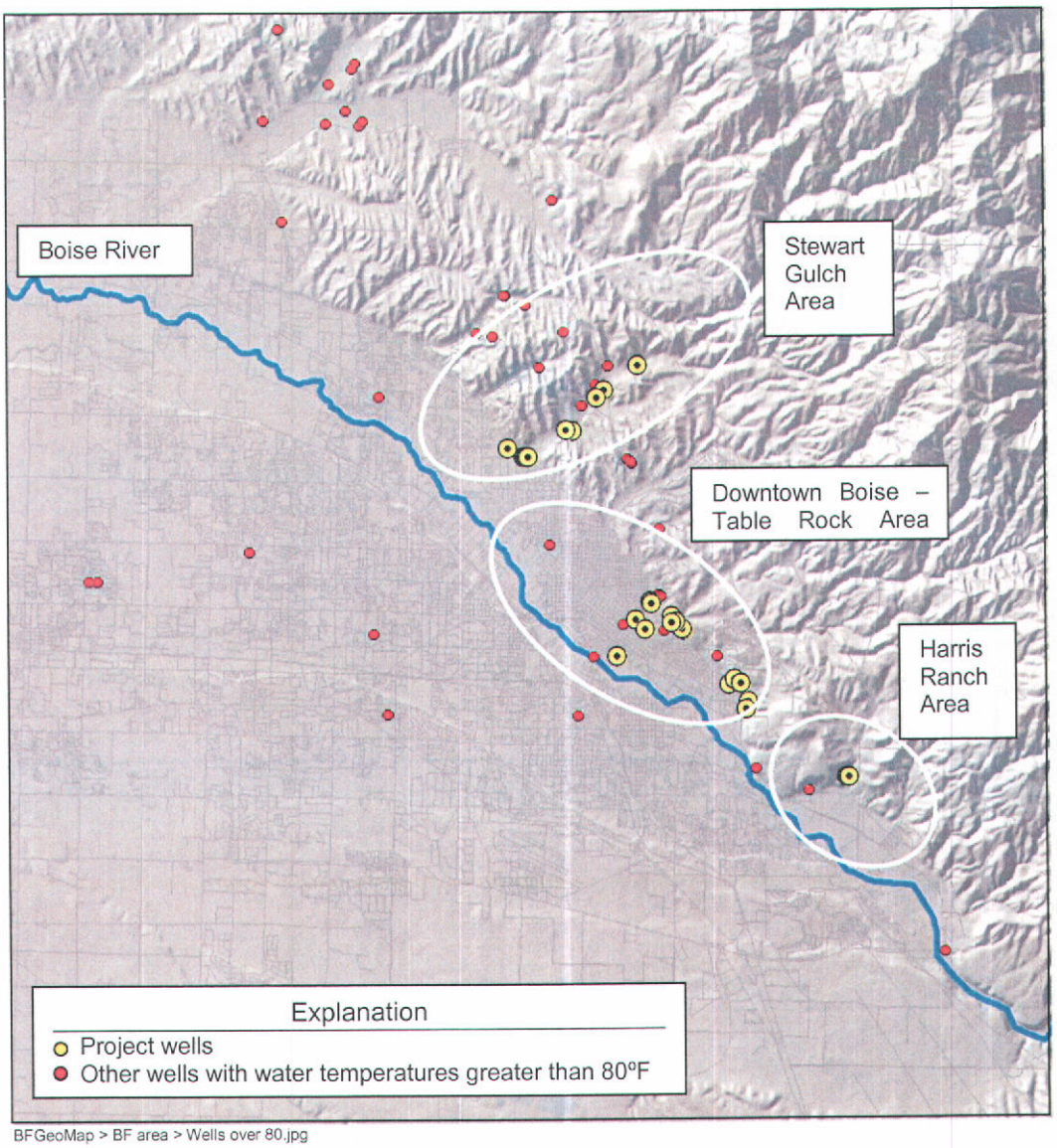

BFGeoMap > BF area > Wells over 80.jpg

Figure 1-1: Map of the Boise Front area showing primary production areas.

## 1.2. Purpose and Objectives

The purpose of this study was to provide insight and tools for the long-term management of the Boise geothermal aquifer system. Specific objectives included the following:

1. Review and refine the conceptual understanding of the Boise geothermal aquifer.
2. Consolidate existing hydrologic and production data into a Microsoft Access database.




BFGeoMap > BF area > Wells over 80.jpg

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1. Review and refine the conceptual understanding of the Boise geothermal aquifer.
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with other spatial data used by IDWR. Well elevations are included in both U.S. and metric units (see Section 2.2 for datum explanation).

Several well names and/or well identifiers have been used for geothermal data over the years. The current identifier is the "GeoWellID", which is consistent with other Idaho geothermal well data. Previous identifiers were included for reference (such as "IDWRWellID", USGS station name, or common name). The "GeoWellID" should be used for linking all future tables and data.

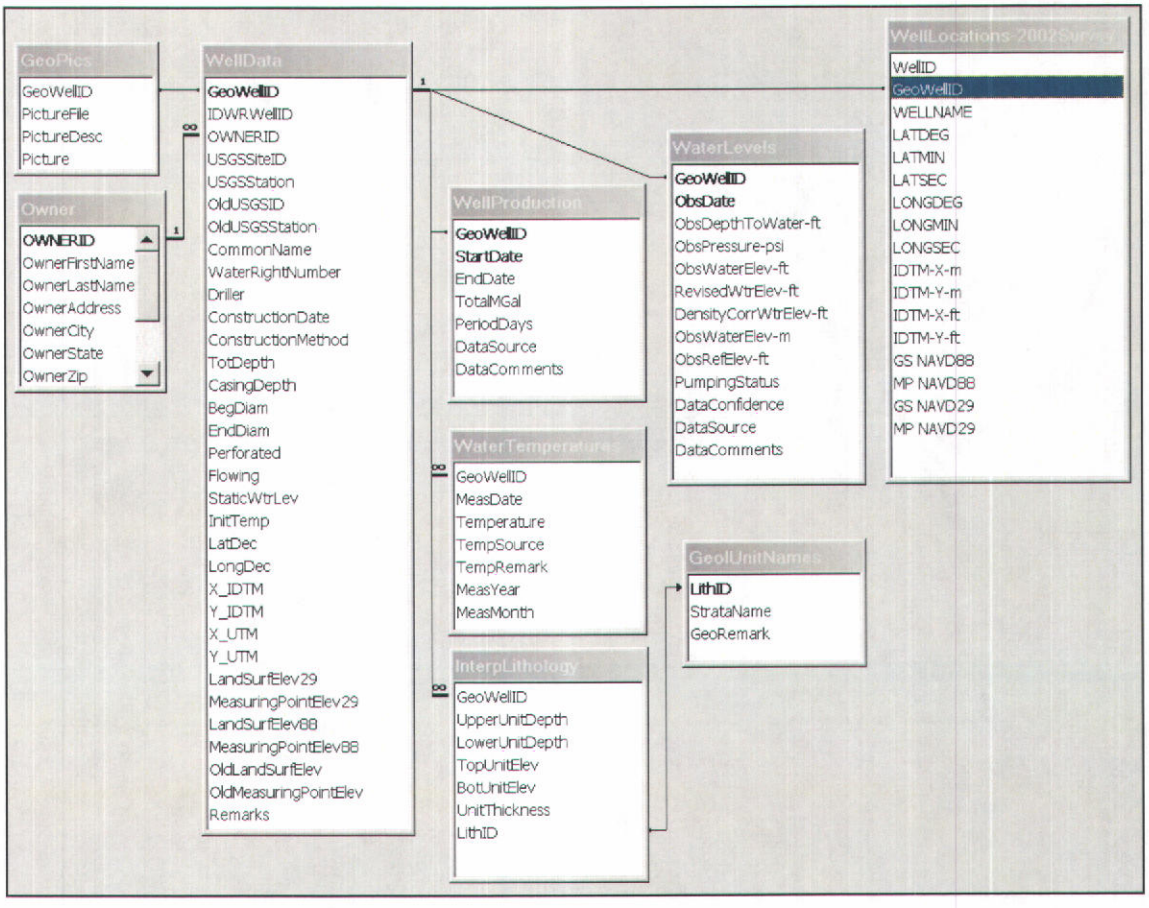
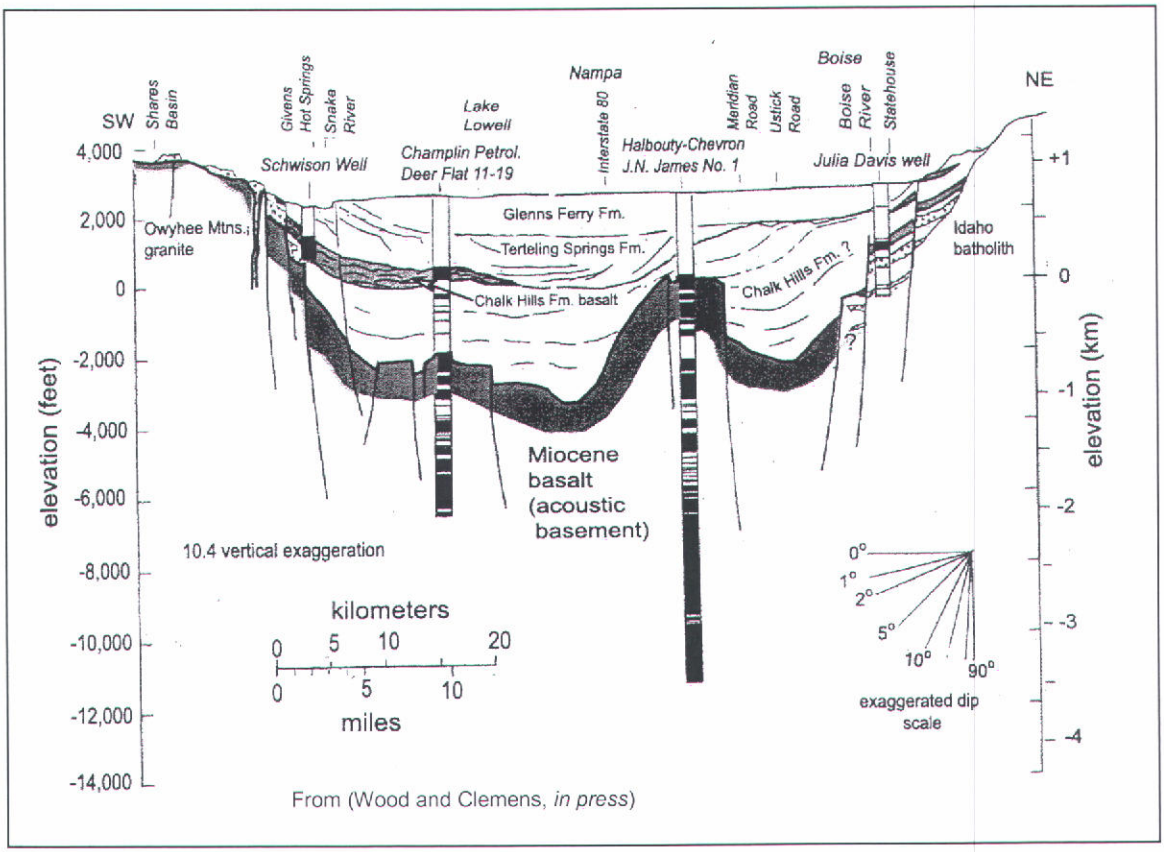



Figure 2-1: Database components and relationships.

oolitic sands), small deltaic deposits, and thick accumulations of lake muds basinward. Wood and Clemens (*in press*) hypothesize that Lake Idaho began to recede about 4 million years ago, with the outlet downcutting at a rate of approximately 400 feet per million years. Sediments from the basin margins filled the receding lake, forming interbedded sand and mud sequences and extensive lacustrine deltaic deposits. The Glenns Ferry Formation includes most of the sediments associated with the slowly lowering lake level, and are represented in the Boise Foothills by a 200-foot thick coarse sand unit with Gilbert-type foreset bedding (Pierce Gulch sand). Basinward, Pierce Gulch sands – reworked Terteling Springs sands (E. Squires, *written communication*) – are thought to form the primary aquifer section of the Treasure Valley.



From (Wood and Clemens, *in press*)

Figure 3-1: Cross-section of the Western Snake River Plain

Volcanic activity returned to the Western Snake River plain during the late stages of Lake Idaho, erupting from a line of vents referred to as the Kuna-Mountain Home volcanic rift (Wood and Clemens, *in press*). These Quaternary basalt flows, assigned to the upper Snake River Group (Malde, 1991, p.266; Malde and Powers, 1962), flowed across portions of the ancestral Snake River Valley in an area that is now south

of the Boise River (Malde, 1991, p.266). The Snake River then changed course, incising at its present location along the southern margin of the basalt flows. More recent eruptions (from Kuna Butte and other local sources) spilled lava into the canyon south of Melba. The Snake River has since incised this basalt (Malde, 1991, p.267).

## 3.3. General Aquifer Description

The Boise Front geothermal aquifers reside in a complex series of igneous rocks and interbedded sediments. Depending on location, geothermal water is found in Cretaceous granite associated with the Idaho Batholith, Tertiary rhyolite and associated sediments, and/or Tertiary basalt and basalt tuffs (Figure 3-2).

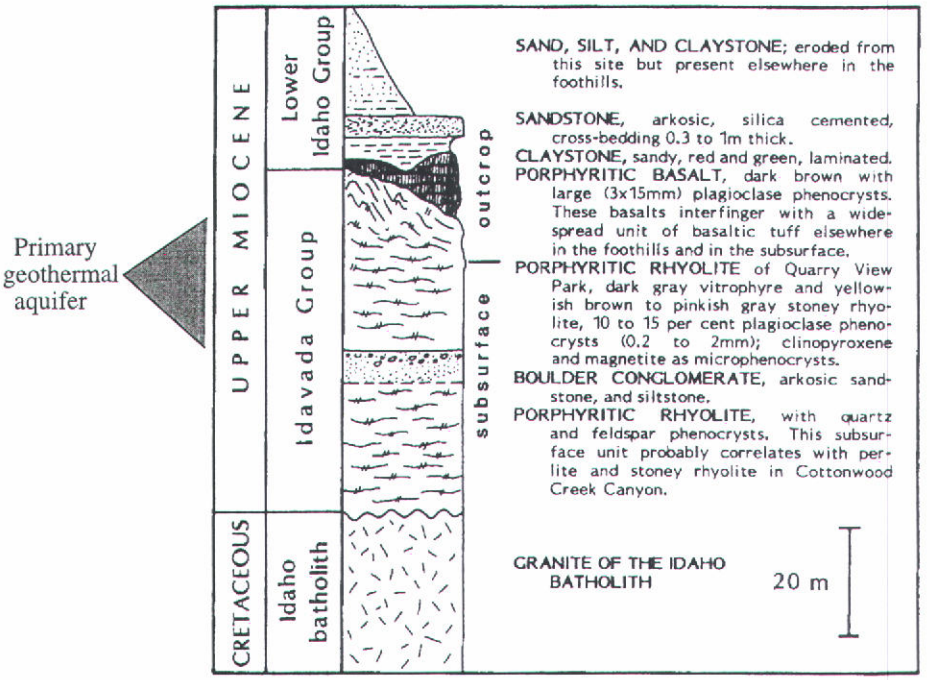



Figure 3-2: Stratigraphic section from rocks related to the geothermal system (Wood and Burnham, 1987)

Geothermal water is associated with fractures along a northwest trending fault zone that marks the northeastern boundary of the Snake River Plain (Figure 3-3). Faults, fractures, and joint systems within the volcanic units presumably serve as conduits for horizontal and vertical ground water movement. The range-front faults have an apparent offset of 200 to 800 feet, based on seismic evidence. The deeper geologic strata appear to dip between four to seven degrees to the southwest on the downthrown side of the primary foothills fault system. Additional minor faults are present on both sides of the main fault system. Because of sedimentary cover, the faults southwest of

the main fault zone are known or inferred primarily from seismic imaging. Most of current successful geothermal production wells in the system are concentrated along the downthrown side of the main fault system.

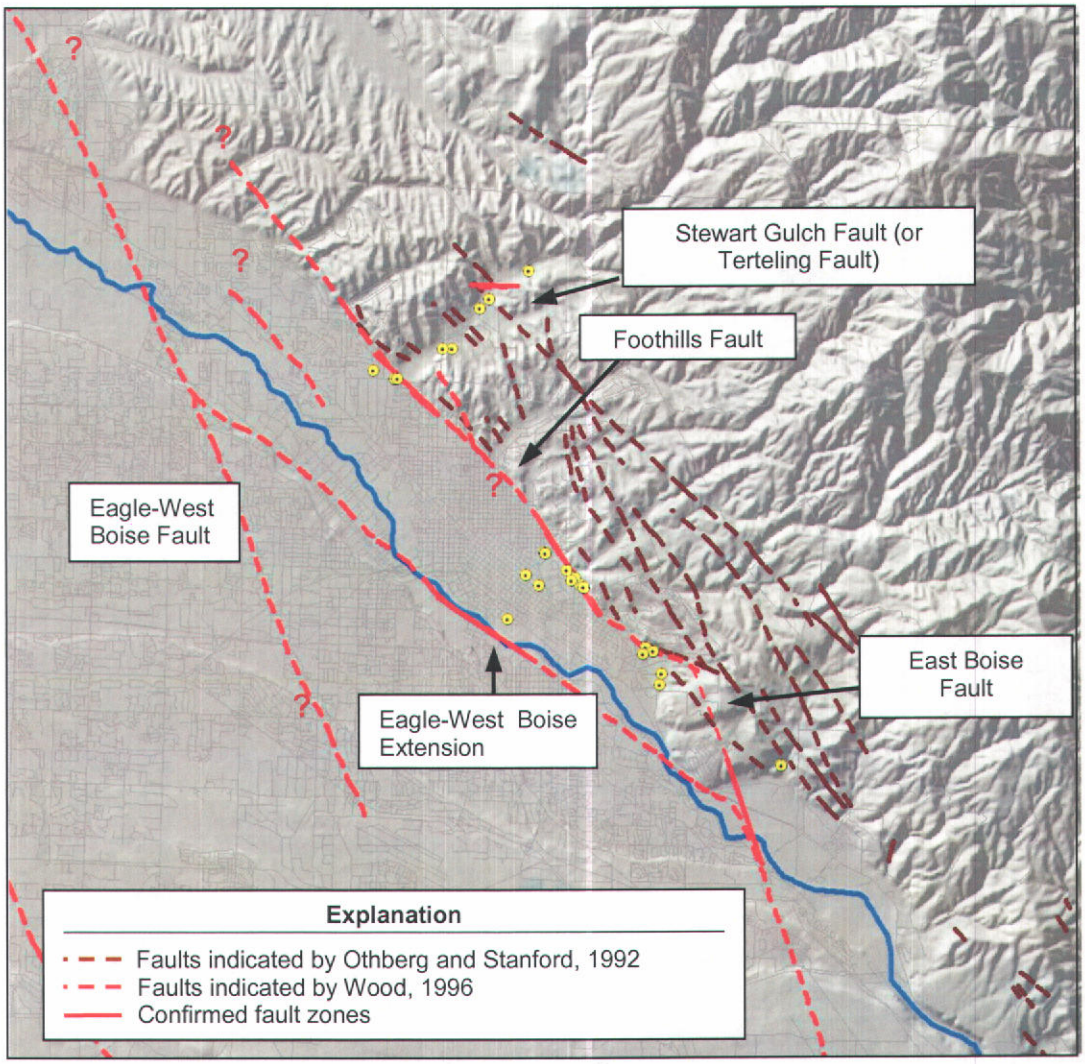



Figure 3-3: Faults in vicinity of Boise Front geothermal aquifer system.

Tertiary Basalt, including fractured and unfractured basalt and basalt tuffs, extends throughout most of the project area. Geothermal wells in the Stewart Gulch area produce geothermal water from this basalt zone (no wells except the Terteling Motorcycle well penetrate through the basalt). Approximate elevations for the upper surface of the Tertiary basalts are shown in Figure 3-4. Tertiary rhyolite and associated sediments are considered the primary geothermal production aquifers in the downtown Boise area (Figure 3-2). The extent of the rhyolite aquifer into the valley is unknown, but no wells in the central portion of the valley have encountered rhyolite. Rhyolite

flows and domes are thought to have erupted near valley margins (Wood and Clemens, *in press*), and as such, may be highly non-uniform in the Boise Front area (Ed Squires, 2002, personal communication). Two rhyolite zones are present in the Boise-downtown area, separated by a boulder conglomerate, sandstone, or siltstone (Wood and Burnham, 1987).

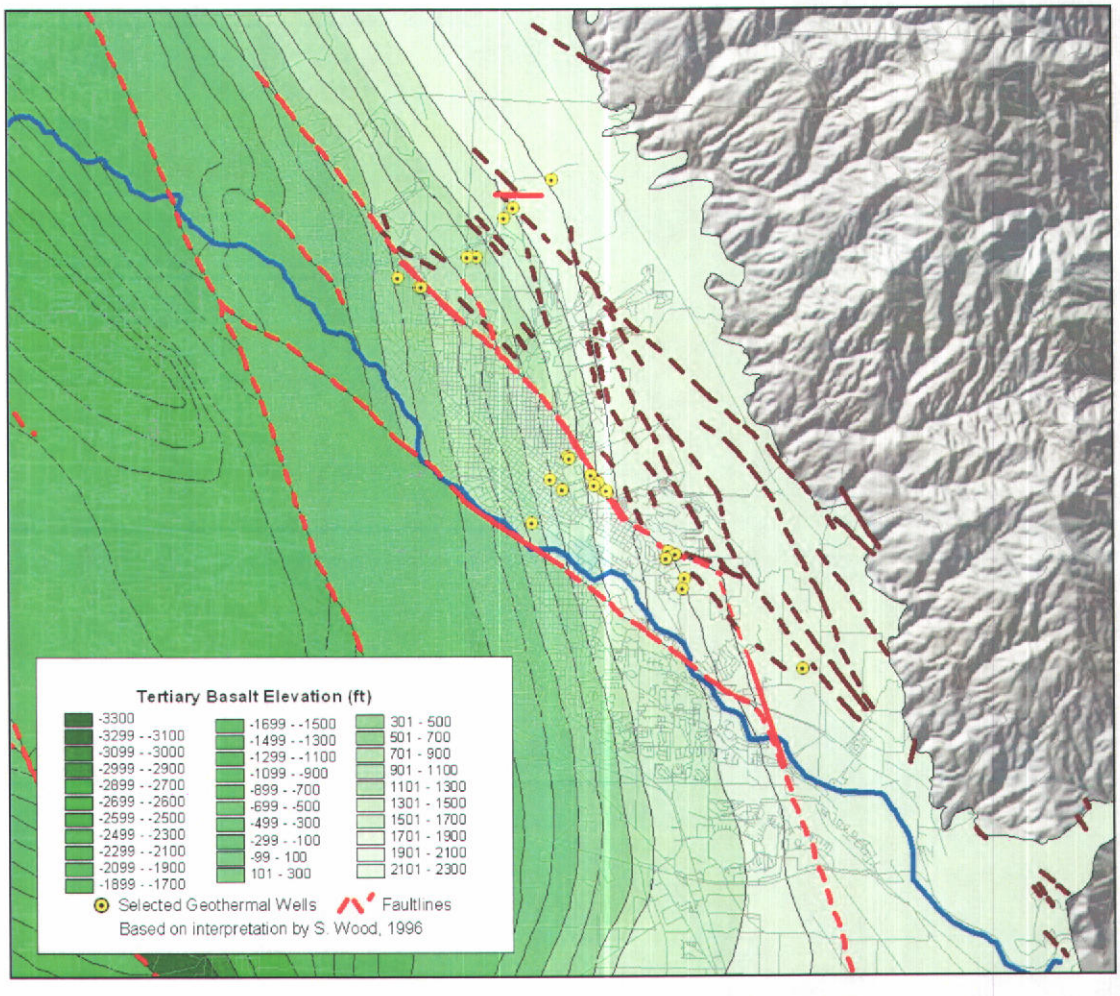



Figure 3-4: Approximate elevations of the upper surface of Tertiary basalt.

There is general consensus that the geothermal flow system is largely dominated by the basin margin fault-fracture zone. Effective permeabilities within the faults (especially in portions of the Foothills Fault) are likely larger than the conductivity transverse to the faults. However, there are insufficient data to quantify the longitudinal or transverse effective hydraulic conductivity tensors or even to determine relative hydraulic conductivities. Development of successful wells located away from exposed faults along the front (e.g., Capitol Mall wells, City Injection, Veteran's, and BLM), and demonstrated hydraulic connection between these wells, demonstrates that the

the main fault zone are known or inferred primarily from seismic imaging. Most of current successful geothermal production wells in the system are concentrated along the downthrown side of the main fault system.

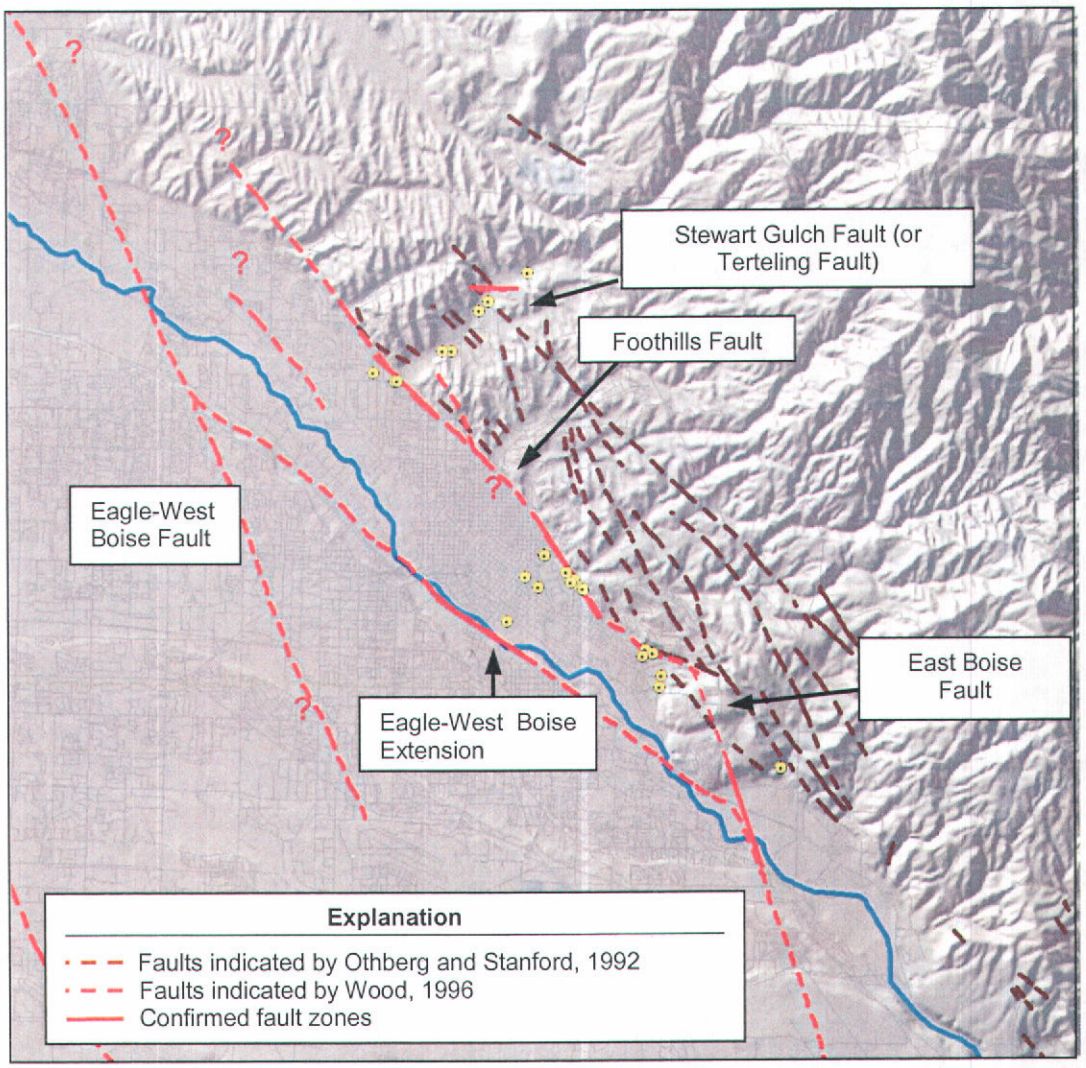



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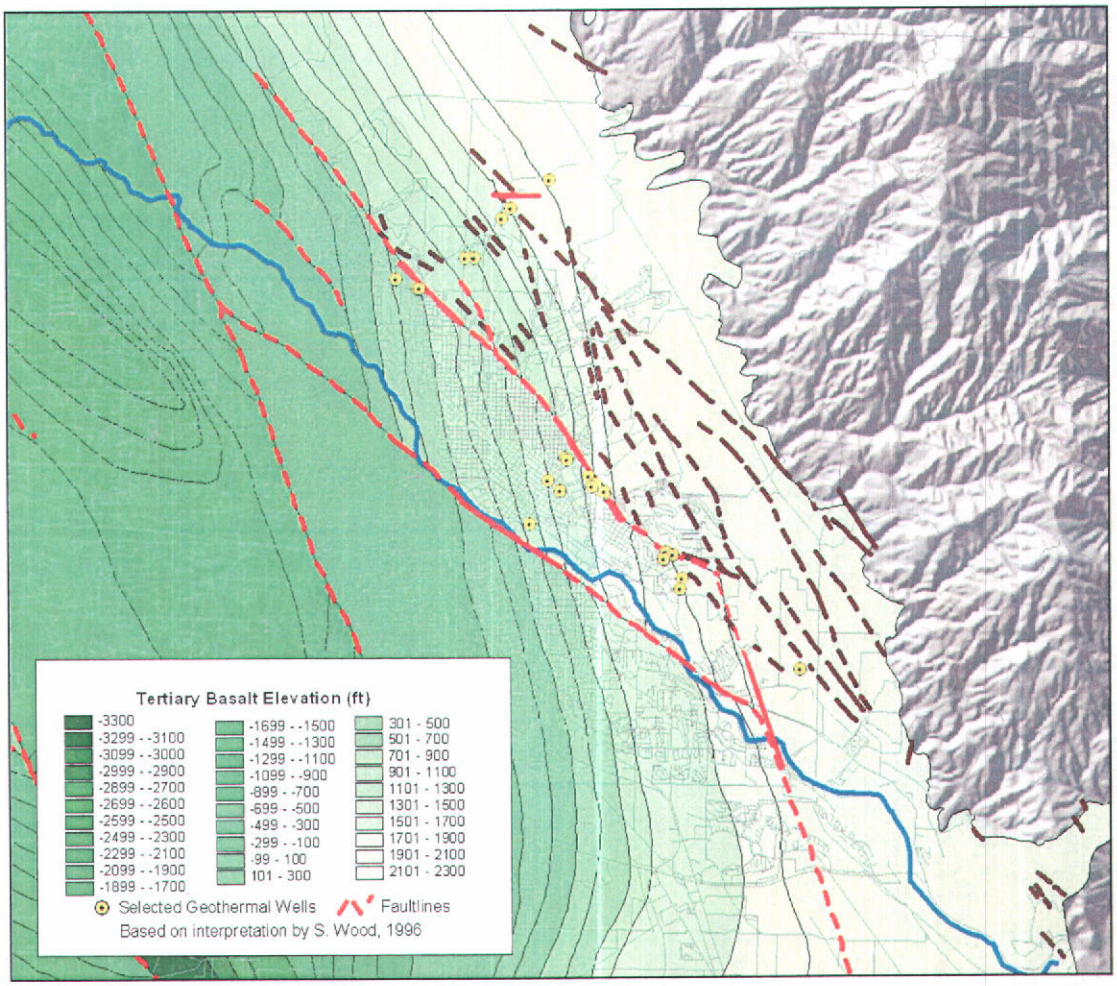
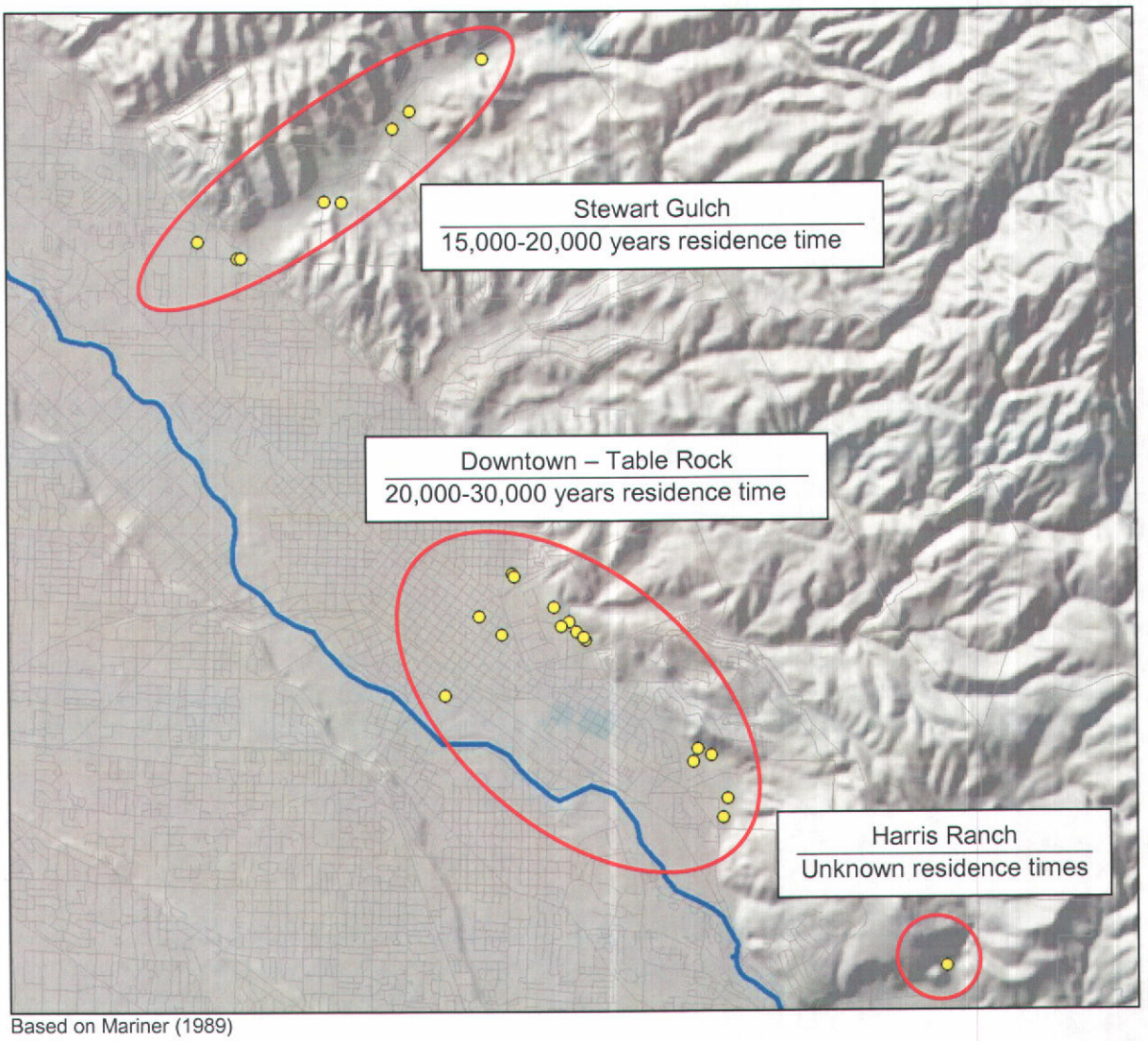



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the Boise thermal waters by mixing. Thus, the Stewart Gulch thermal water is of a similar origin to the Boise thermal water, but based on the USGS study (Mariner et al., 1989), water in the Stewart Gulch has experienced little if any mixing with thermal water in the Boise area.




Based on Mariner (1989)

Figure 3-5: Estimated thermal water residence times.

## 3.5. Origin of the Geothermal Water

Both the Idaho Batholith and the Snake River Plain are situated in a region of high geologic heat flow. A geothermal "belt" marked by hot springs and warm water wells is found along the northern margin of the Snake River Plain from Weiser to the northwest to beyond Bliss to the southeast. The concentration of heat flow and hot

springs along the margin of the plain could be caused both by convective heat transfer from upward-moving hot water along fault zones and by the refraction of heat flow that diffuses at the interface of the granite mass with the layered sediments and volcanics (Wood and Burnham, 1987).

The origin of these thermal waters has not been fully explained. Mayo et al. (1984) indicated that at the time "most researchers agree that radiogenic decay in the granitic rocks of the Idaho Batholith is the principal source of heat" in the geothermal system. The source of water is thought to be recharge from precipitation in the mountains to the north that follows a deep path of circulation through the batholith and rises along the frontal fault system. A conceptual geothermal water circulation loop (Figure 3-6) has been proposed (Wood and Burnham, 1987, p.121; Wood and Low, 1988, p.32-33), in which meteoric water from surrounding highlands circulates to a depth of about one mile over a horizontal distance of about six miles, through deep fractures in the Idaho batholith. This concept of a long path of circulation appears consistent with the age-dating based on carbon-14 and dissolved helium concentrations (see section 3.4).

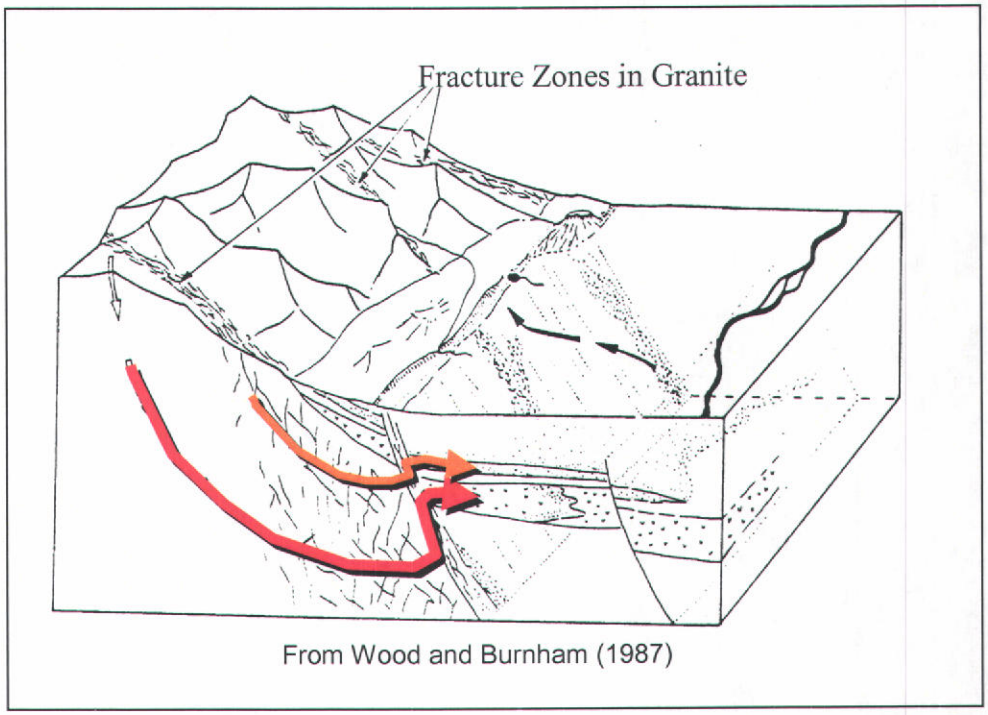



Figure 3-6: Conceptual model of ground water circulation through fractured granite into rhyolite aquifers along the foothills fault beneath the northeastern part of the city.

Smith (1981) also recognized that geothermal heat probably is originating with radioactive minerals within the underlying and surrounding granitic batholith. Smith

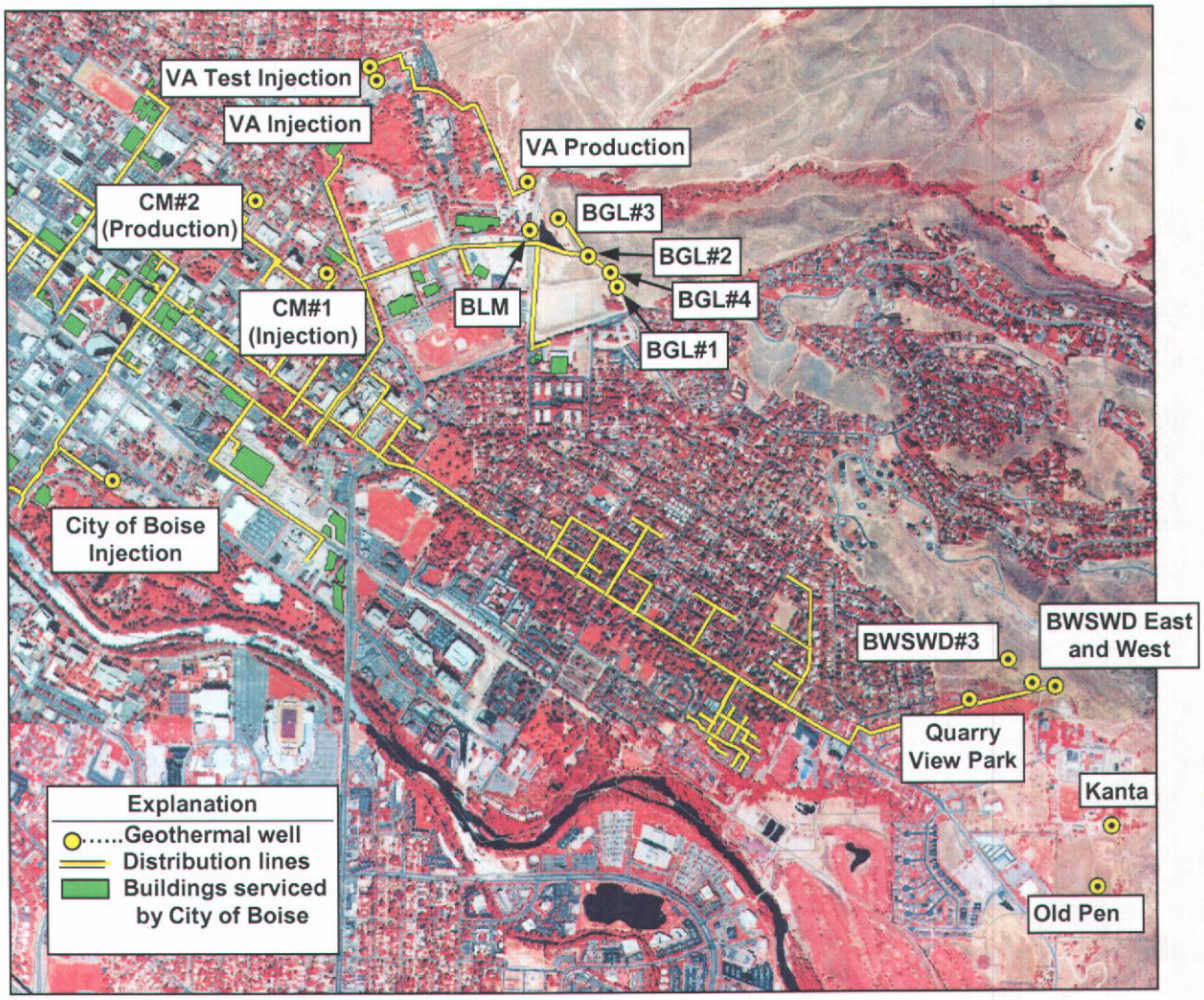



Figure 4-1: Locations of selected geothermal wells in the downtown Boise – Table Rock Area.

The BWSWD currently distributes geothermal water for space heating and domestic use in the eastern part of Boise (Figure 4-1). Spent geothermal water does not return to the geothermal aquifer, but (1) drains into shallow injection wells at points of use; (2) discharges to surface channels draining to the Boise River; or (3) discharges to the Boise River via the municipal sewer system. The primary distribution line along Warm Springs Avenue is connected to the City's geothermal distribution system (although under ordinary circumstances a valve between the two systems remains closed). Production data from the BWSWD system are available beginning in 1978. Production has steadily decreased from a high of 312 million gallons in the 1979 water year to an average of 214 million gallons per water year between 1994 and 2002 (Table 4-3, Figure 4-2). Production slowed between 1986 and 1988 (Figure 4-2), apparently because decreasing water levels caused pumps to break suction; the pumps were

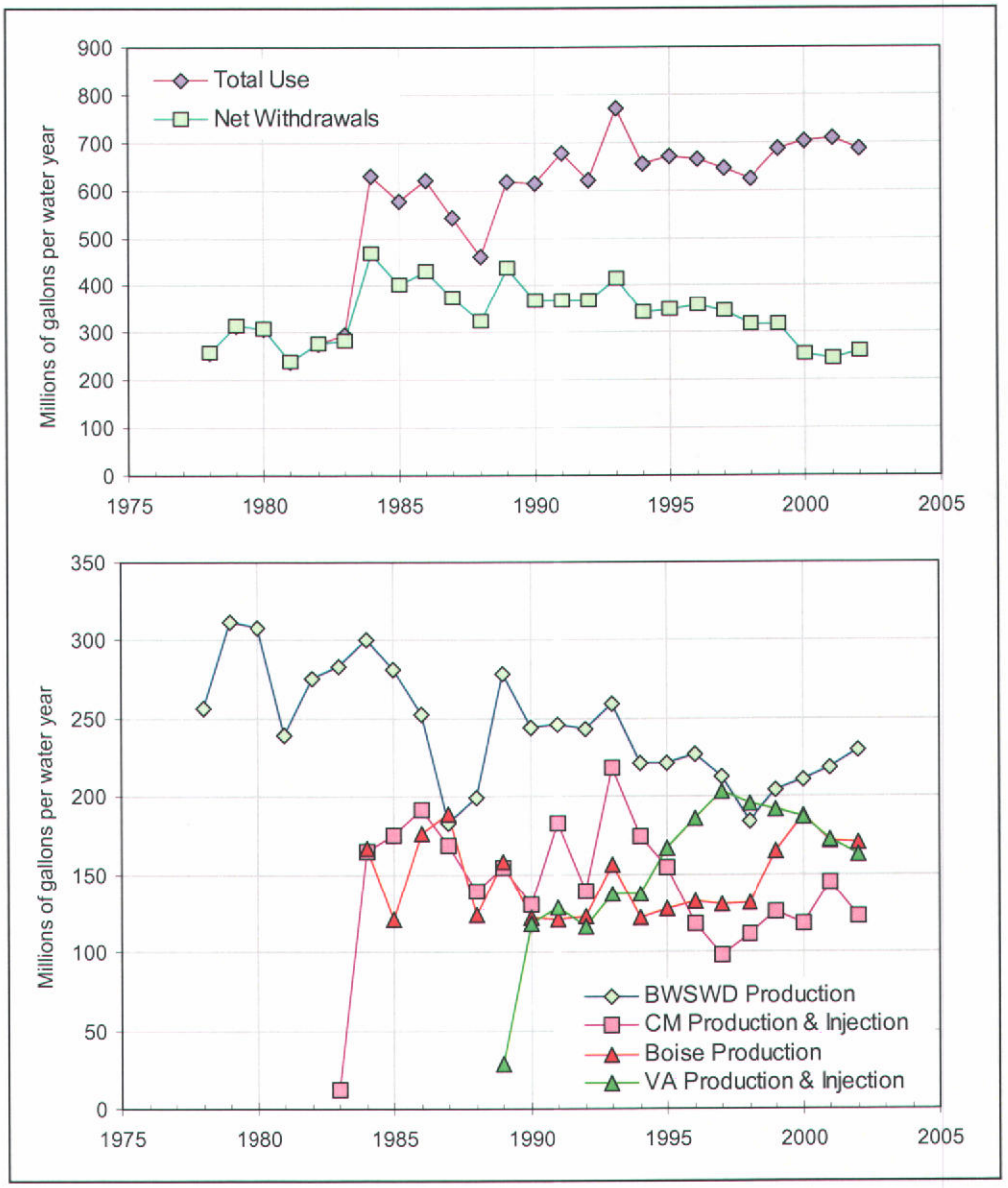



Figure 4-2: Annual geothermal production in the downtown Boise – Table Rock area.

Three new geothermal systems were developed in the downtown Boise area during the 1980s based on results from geothermal exploration during the late 1970s. First, the State of Idaho began heating the state Capitol building and surrounding office buildings with geothermal heat. The State Capitol Mall (CM) system began operation in the fall of 1982, and has withdrawn approximately 150 million gallons per year since that time. Production in the State of Idaho system spiked in 1993, although the reason for the production spike is unclear. All of the effluent is re-injected into the geothermal aquifer through the CM#1 well (Figure 4-1).

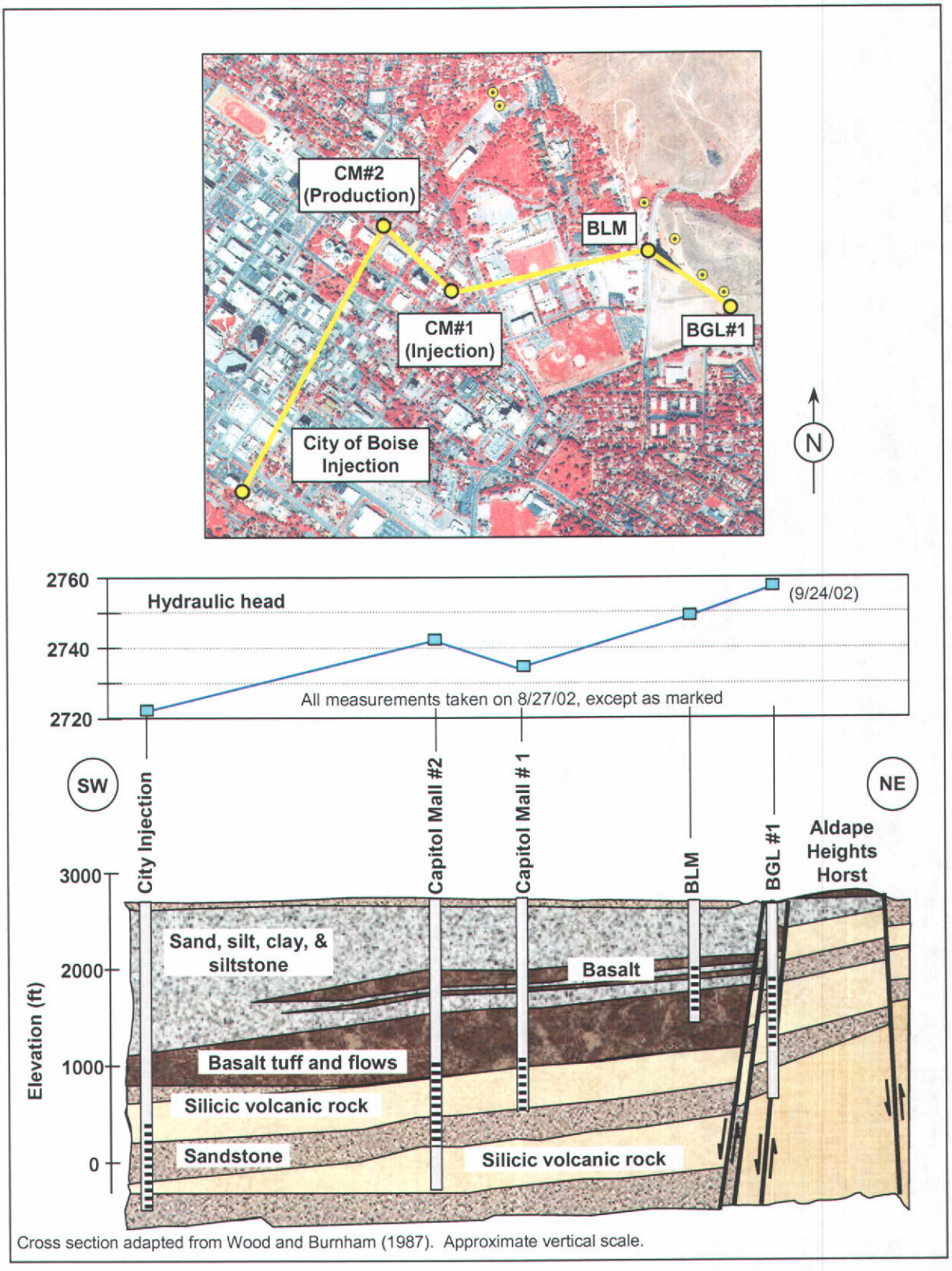



Figure 4-3: Stratigraphy of the Boise Front geothermal aquifer in the downtown Boise area.

well was drilled in the summer of 1965. Two water level measurements in 1983 (Figure 4-10) indicated a depth-to-water of approximately 50 feet, and recent (2002) measurements indicate a depth to water of approximately 50 feet. If the 1983 measurements are accurate, then water levels in the Old Pen well decreased in the 1980s to a level of 70-75 feet below ground surface, but have returned to a depth of approximately 52 feet between 1987 and 2002. These changes could correspond with the beginning of withdrawals by the City of Boise in the early 1980s and partial injection in 1999, or may reflect other local conditions.

8. Recent data from the Quarry View well (Figure 4-12) indicate similar water levels in both Quarry View piezometers over time, which suggests hydraulic connection between the zones in which the Quarry View piezometers are completed. A general decrease in water levels during the summer suggests possible local irrigation influences.

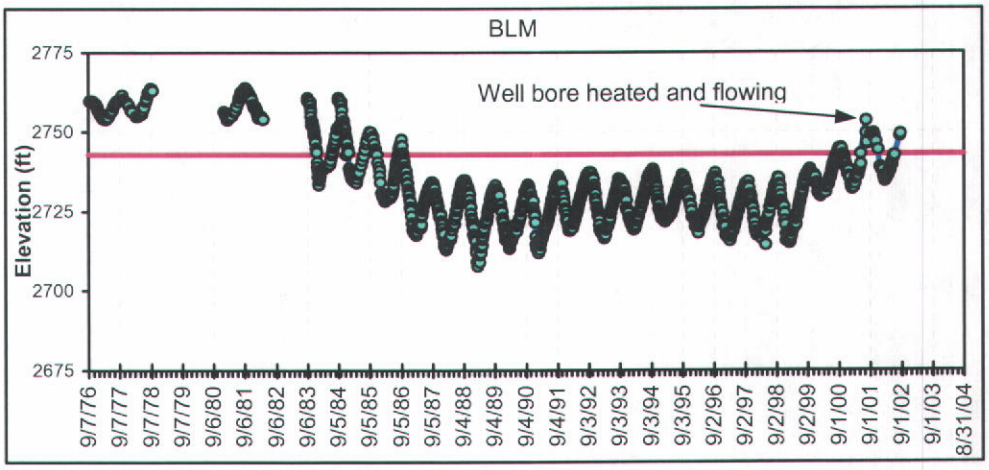



Figure 4-4: Hydrograph for the BLM well.

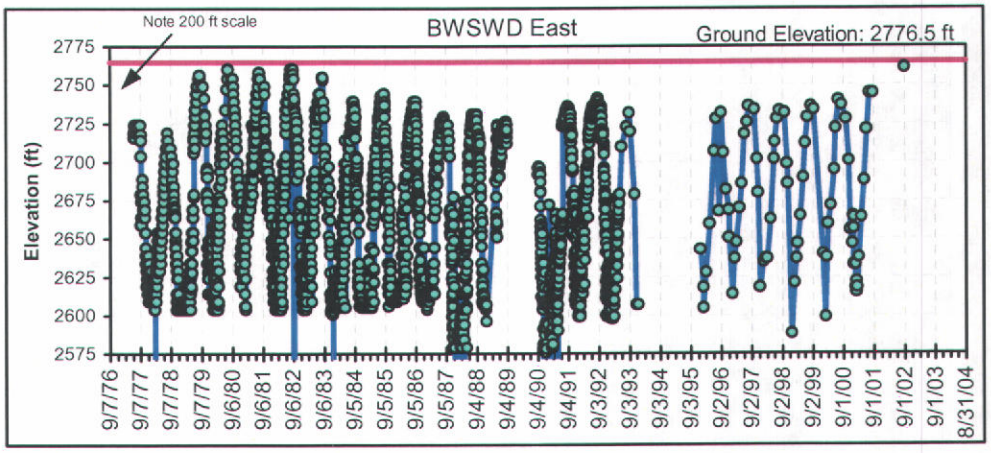



Figure 4-5: Hydrograph for BWSWD East well.

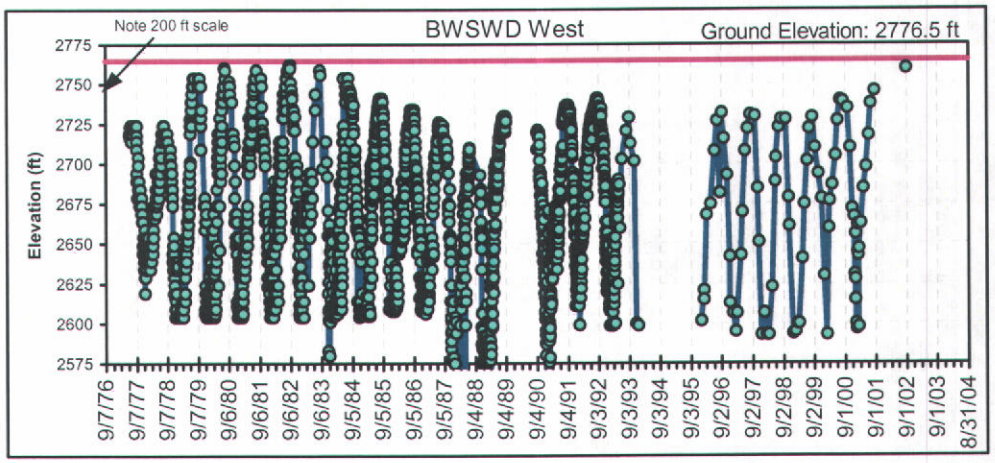



Figure 4-6: Hydrograph for the BWSWD West well.

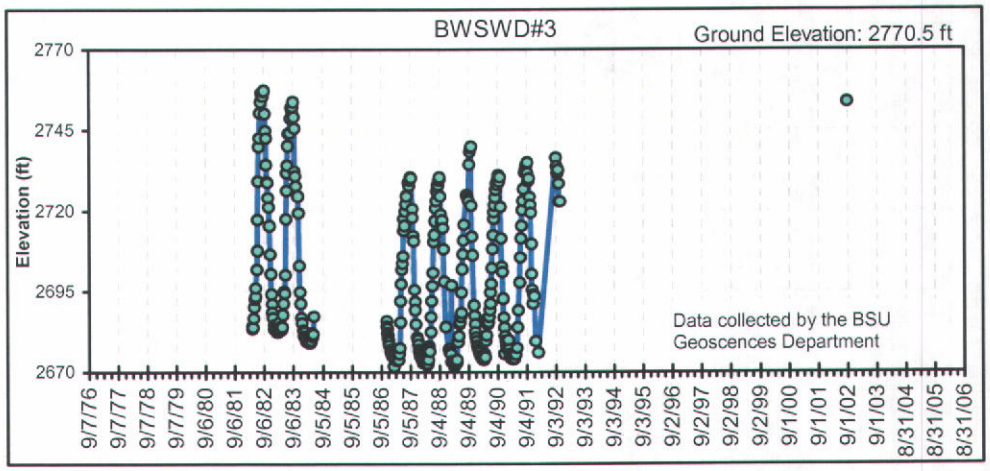



Figure 4-7: Hydrograph for the BWSWD #3 well.

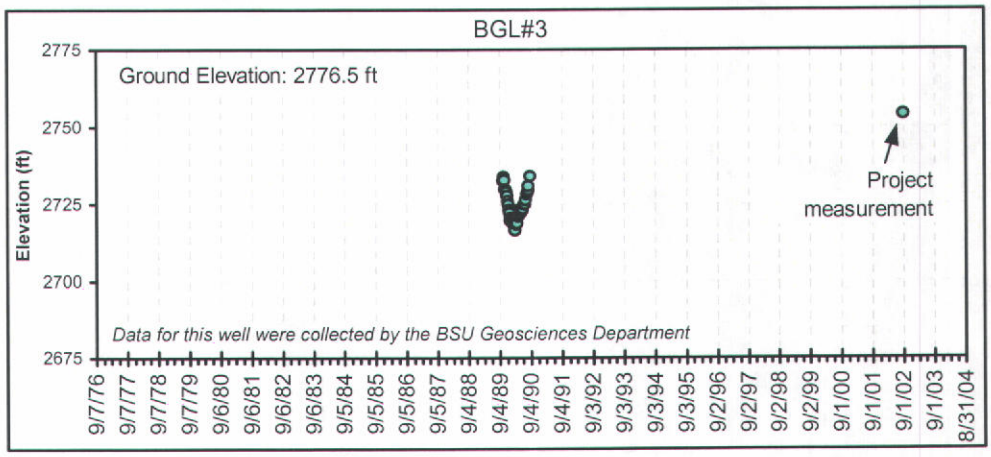



Figure 4-8: Hydrograph for the BGL #3 well.

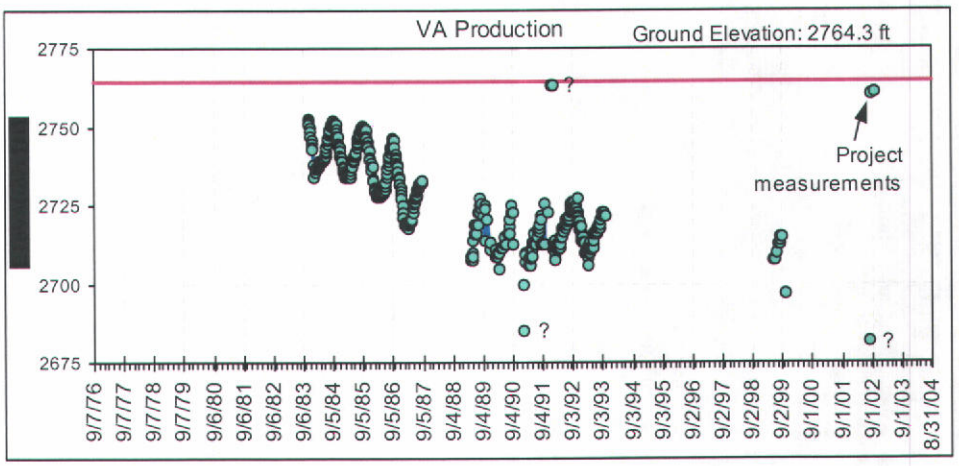



Figure 4-9: Hydrograph for the VA Production well.

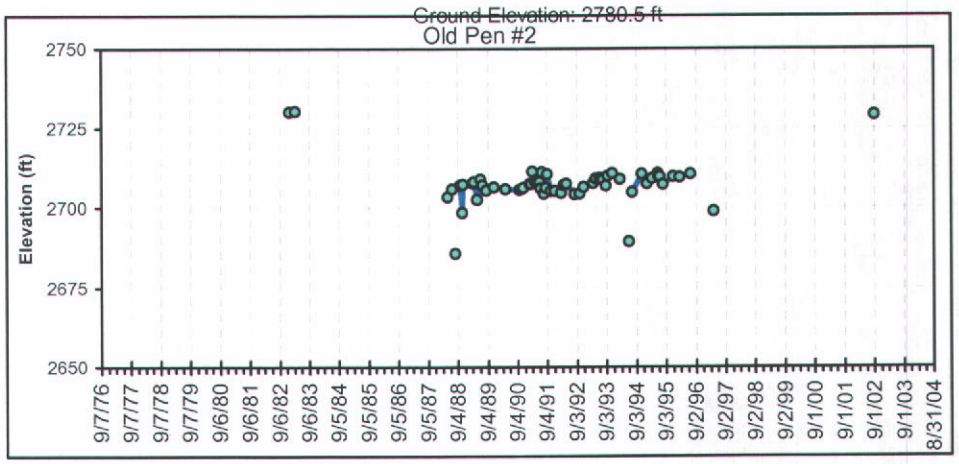



Figure 4-10: Hydrograph for the Old Pen well.

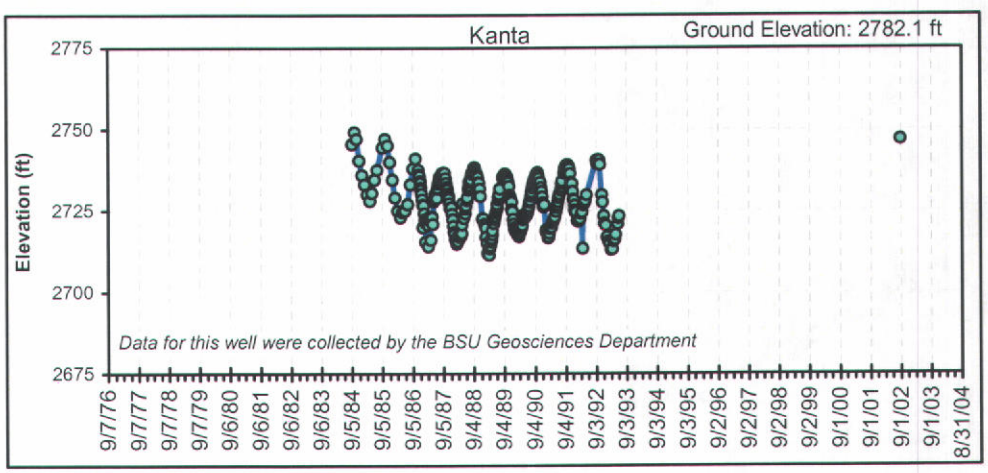



Figure 4-11: Hydrograph for the Kanta well.

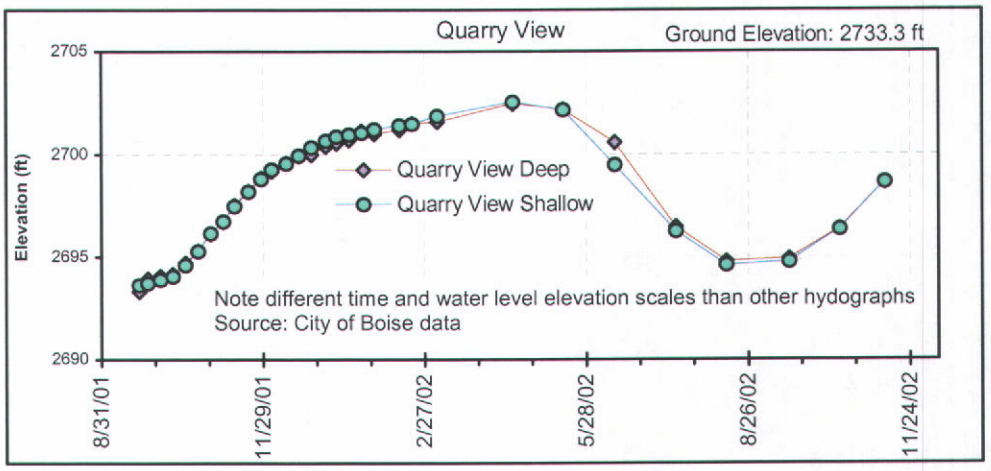



Figure 4-12: Hydrographs for Quarry View wells.

### 4.1.4. Temperature Data

Few current temperature data are available for Boise – Table Rock area wells. One of the only complete long-term records is for water temperatures in the CM #2 well (Figure 4-13). Low recorded temperatures during summer months probably reflect the well bore cooling during times of little or no flow.

There appears to be a downward temperature trend from about 1983-1990 (Figure 4-13). This period may reflect the time that it took for the circulation loop between the two Capitol Mall wells to reach temperature equilibrium. Conversely, the decrease in temperature also corresponds with decreasing water levels in the BLM well, which in turn corresponds with the initiation of pumping in the City wells.

Temperatures since 1990 appear to have remained relatively steady. Temperatures do not appear to have risen after 1999 when the City began re-injecting water[3], and when water levels began to recover. Temperatures in 2002 appear slightly less than previous years – this may reflect a slight decrease or an aging temperature sensor (the temperature sensor in this well should be checked).

Temperatures in the City wells have remained relatively stable since City production began (Kent Johnson, *personal communication*), as have temperatures in the BWSWD wells (Dick Clark, *personal communication*). Of the BWSWD wells, Griffiths (1990) wrote that the "geothermal water comes from the wells at a temperature of

[3] Based on recorded CM #2 temperatures and anecdotal user information.

approximately 172 degrees Fahrenheit and has shown no change during the last thirty years of personal experience."

### 4.1.5. Aquifer Test Data

A summary of the various well and aquifer tests evaluated for this study is provided in Table 4-4. Also included are transmissivity values used in previous modeling efforts. The range of calculated transmissivities reflects the varied nature of the tests and the heterogeneity of the the aquifer. The 7-day test of BGL #2 in 1982, which utilized observation at all BGL wells, the BLM well, and both CM wells for analysis, indicated that hydraulic boundaries or significant lateral changes in permeability are present within the aquifer.

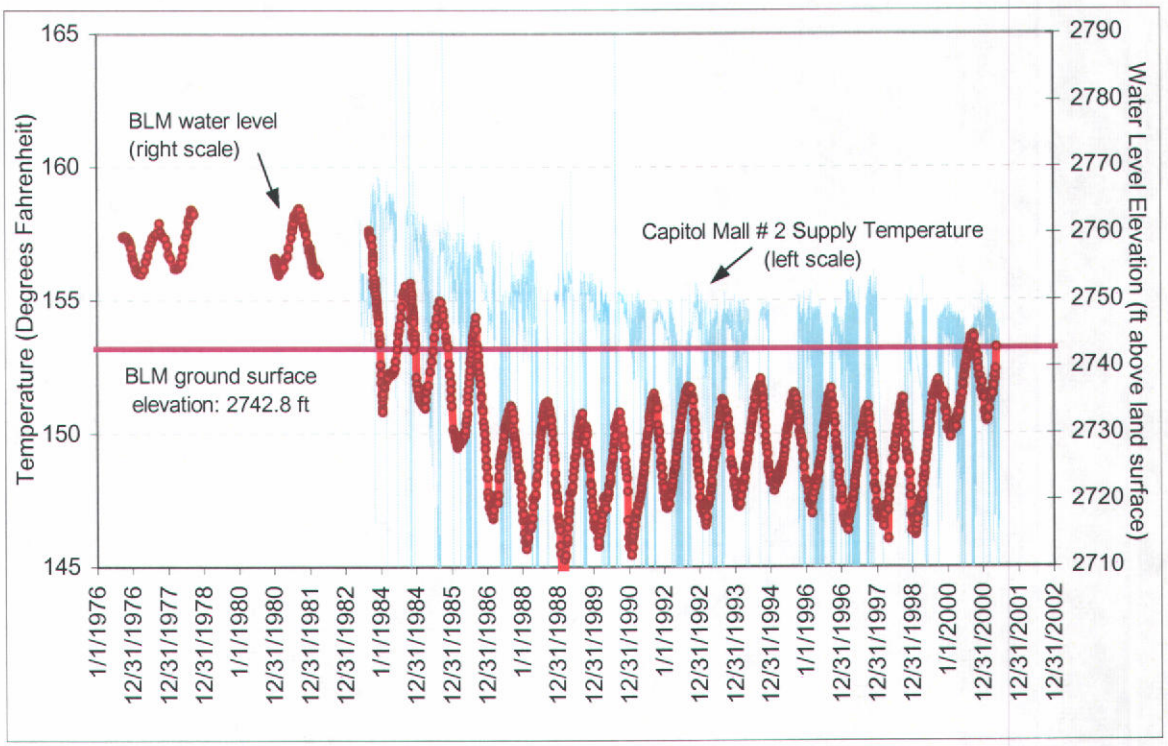



Figure 4-13: CM #2 discharge temperatures and BLM water levels.

## 4.2. Stewart Gulch Area

### 4.2.1. Description of Use and Development

The Stewart Gulch area is located approximately two to three miles northeast of the downtown Boise area (Figure 4-14). Primary thermal water users in this area include

prohibited diversions by Tiegs and Ryan. The apparent intent of the decree was to protect artesian pressure in the Silkey Wells.

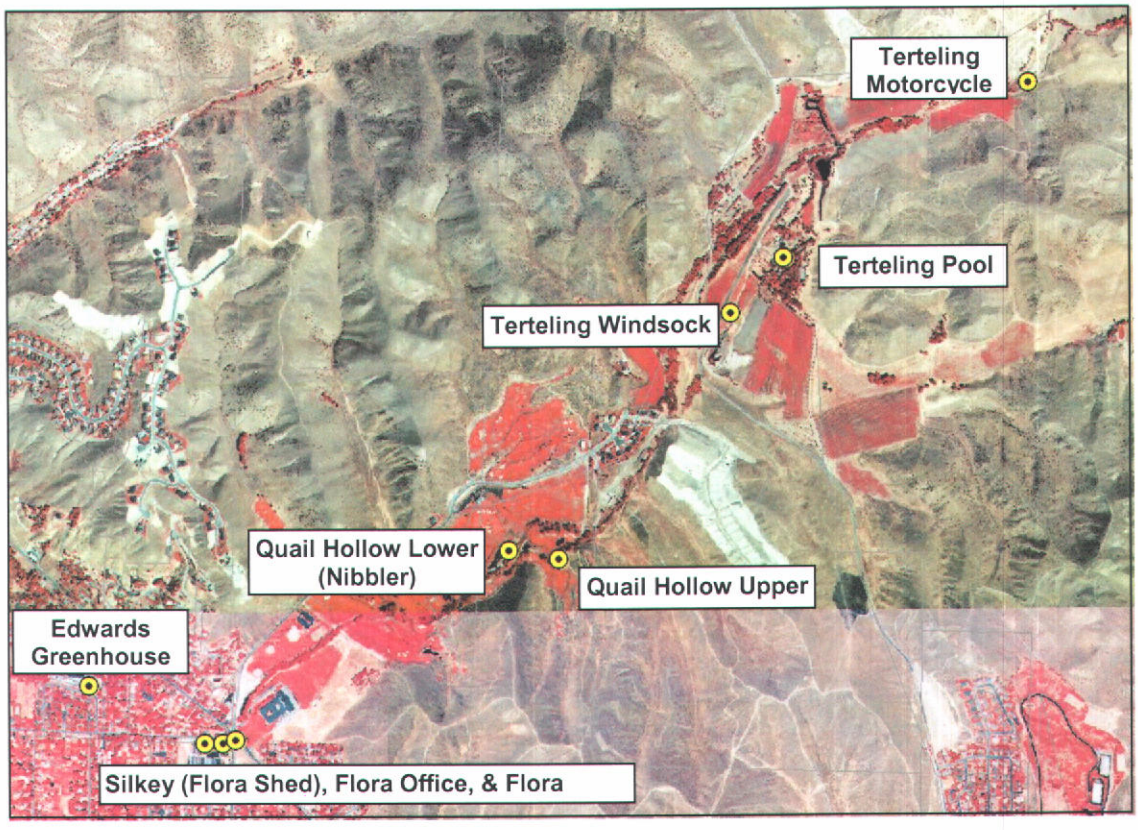



Figure 4-14: Locations of selected geothermal wells in the Stewart Gulch Area.

| Well | Alternate Name | Entity | Current Use |
|---|---|---|---|
| Terteling Motorcycle[4] | | Terteling Ranch | Irrigation |
| Terteling Windsock | | Terteling Ranch | Space heating |
| Terteling Pool | | Terteling Ranch | Water and space heating |
| Quail Hollow Upper | Tee Ltd. | Quail Hollow Golf Course | Irrigation |
| Quail Hollow Lower | Nibbler | Quail Hollow Golf Course | Irrigation |
| Edwards | | Edwards Greenhouse | Commercial (space heating) |
| Flora Office | | The Terteling Company (formerly Flora Greenhouse) | Commercial (space heating) |
| Silkey | Flora Shed | The Terteling Company (formerly Flora Greenhouse) | Commercial (space heating) |
| Tiegs | Flora Triangle | The Terteling Company | Commercial (currently used |

[4] All references to the Terteling Motorcycle well in this report refer to a geothermal well; a cold-water well also is present at the same location.

well was drilled in the summer of 1965. Two water level measurements in 1983 (Figure 4-10) indicated a depth-to-water of approximately 50 feet, and recent (2002) measurements indicate a depth to water of approximately 50 feet. If the 1983 measurements are accurate, then water levels in the Old Pen well decreased in the 1980s to a level of 70-75 feet below ground surface, but have returned to a depth of approximately 52 feet between 1987 and 2002. These changes could correspond with the beginning of withdrawals by the City of Boise in the early 1980s and partial injection in 1999, or may reflect other local conditions.

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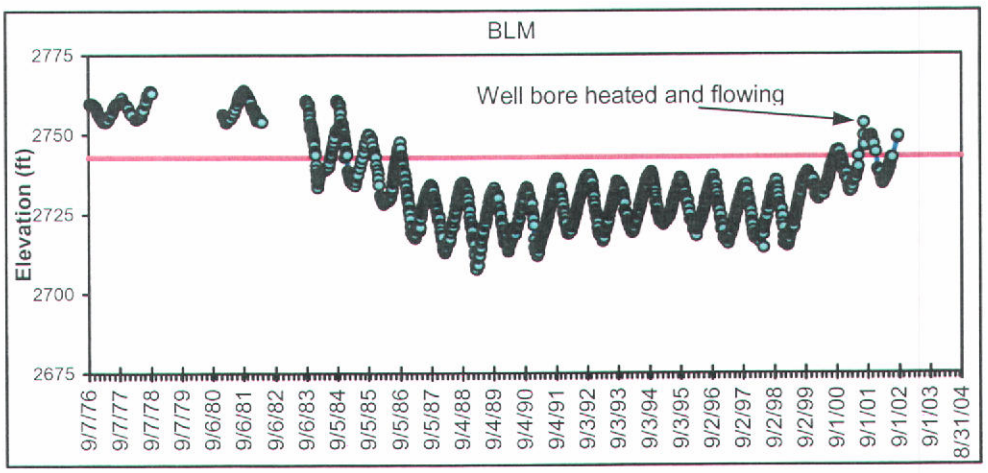



Figure 4-4: Hydrograph for the BLM well.

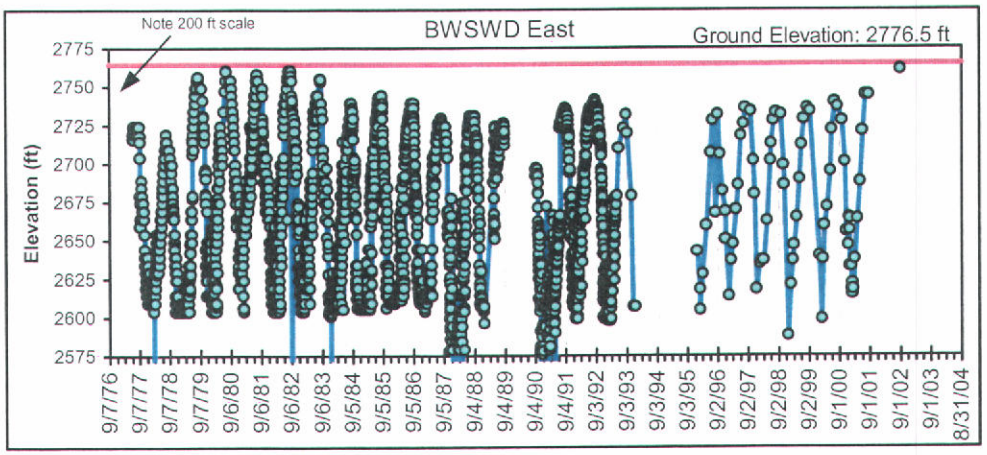



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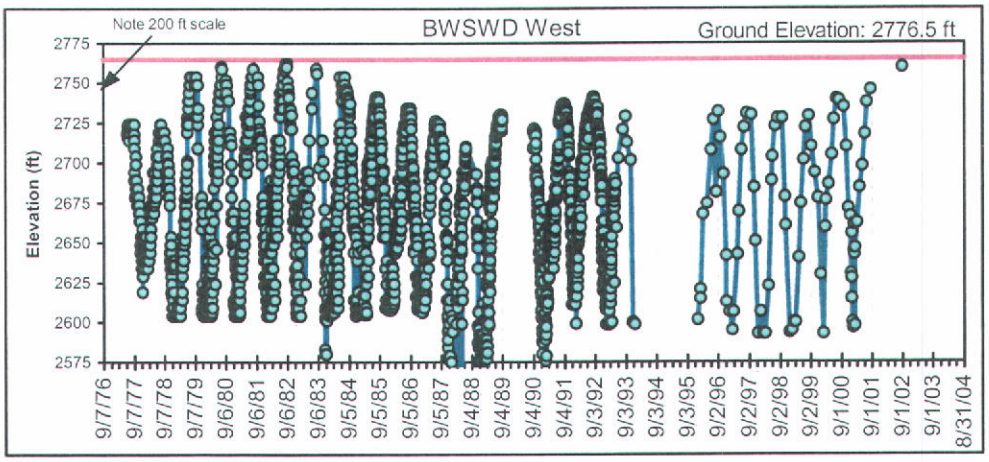



Figure 4-6: Hydrograph for the BWSWD West well.

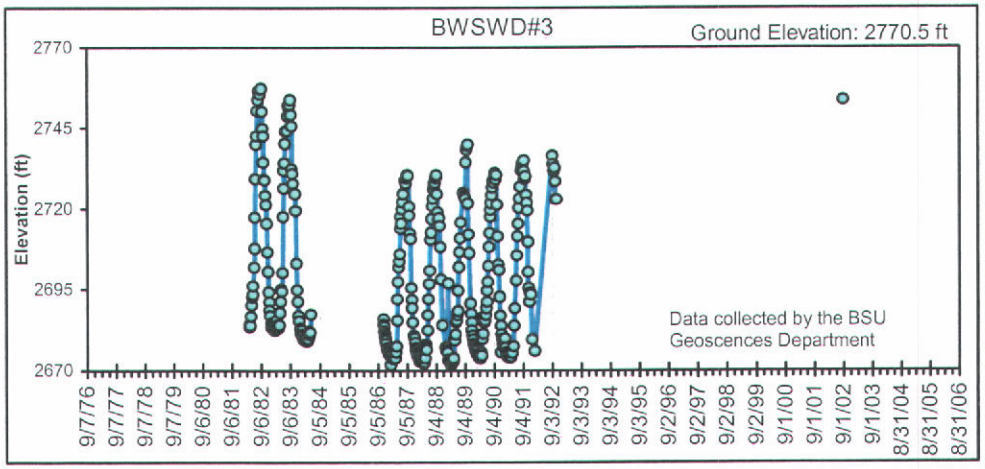



Figure 4-7: Hydrograph for the BWSWD #3 well.

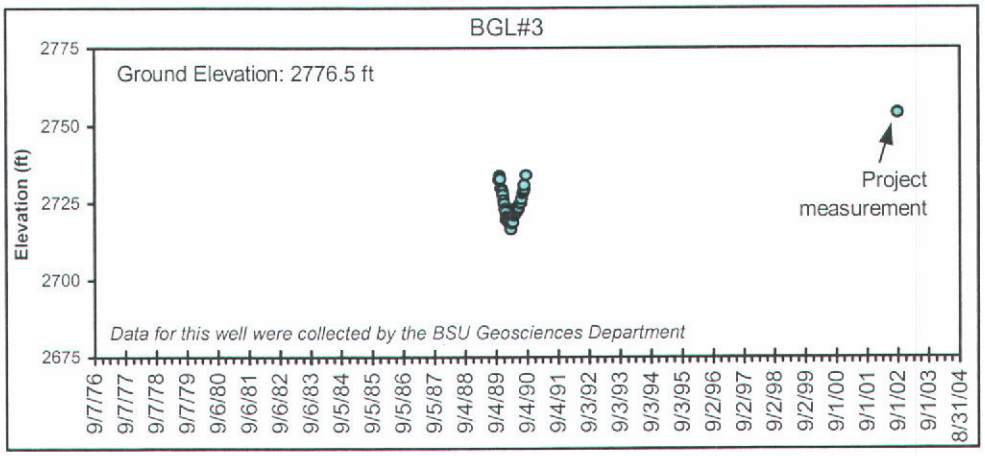



Figure 4-8: Hydrograph for the BGL #3 well.

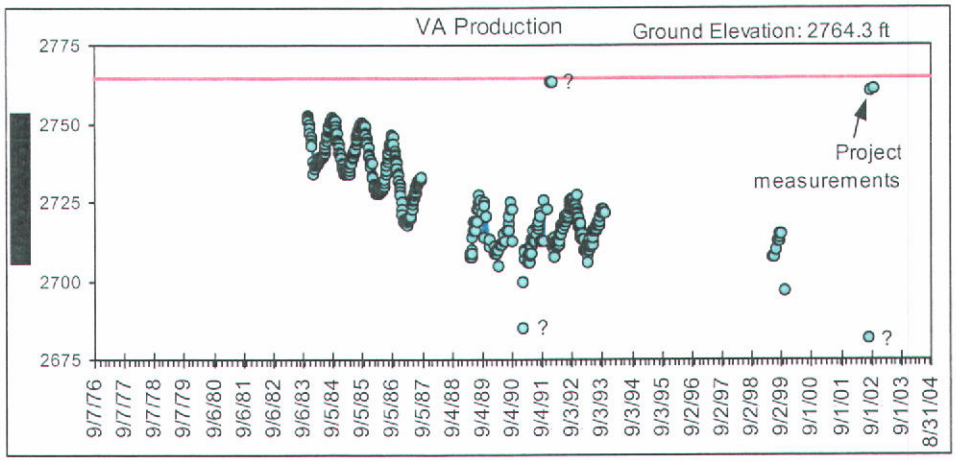



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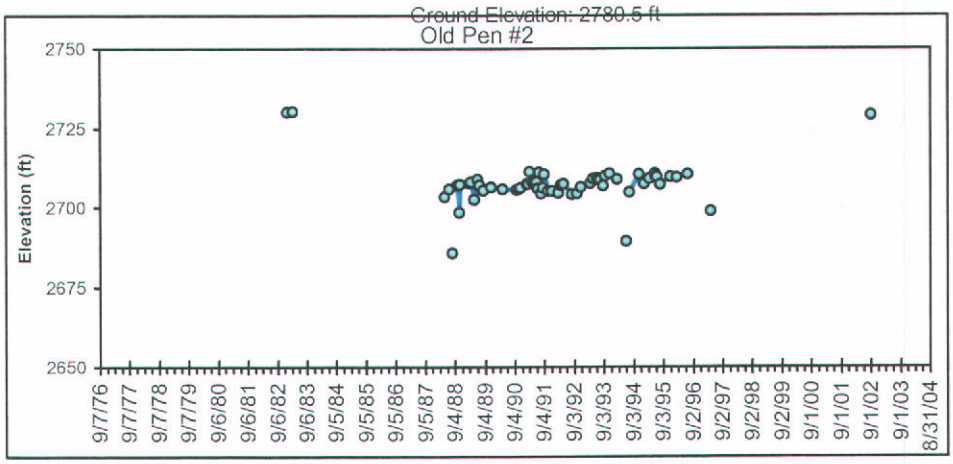



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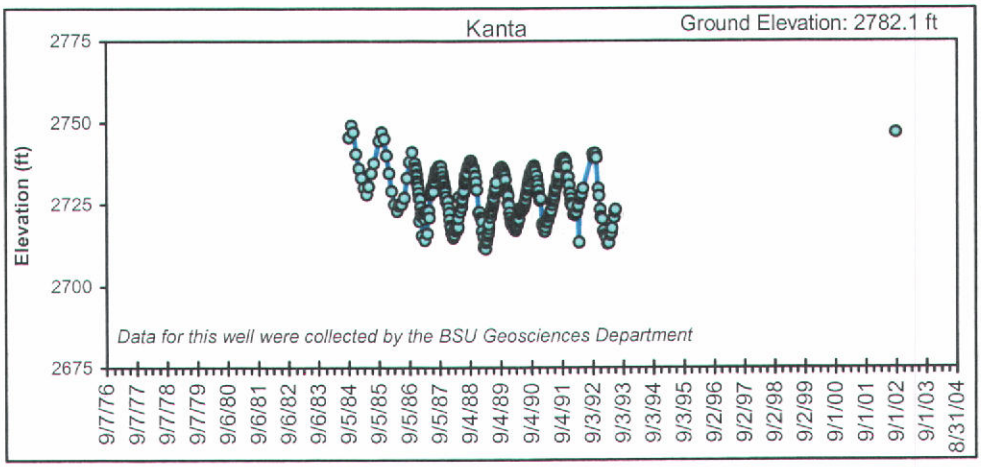



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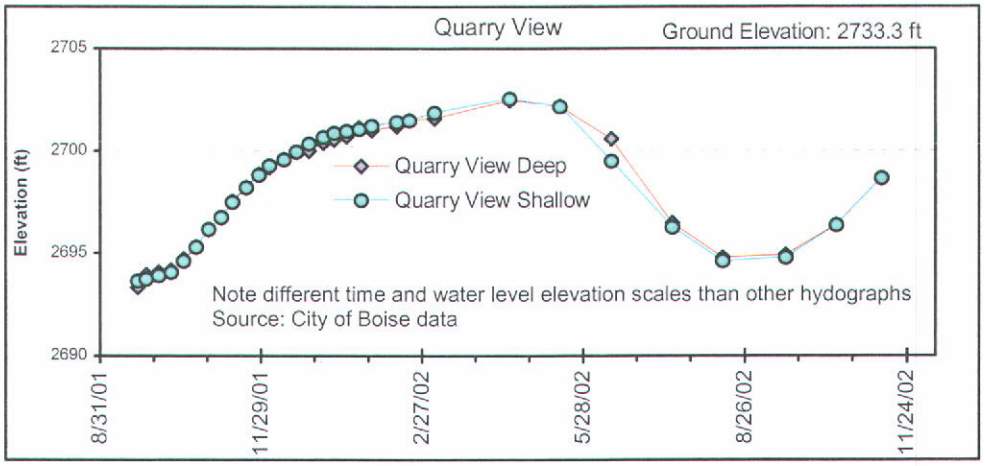



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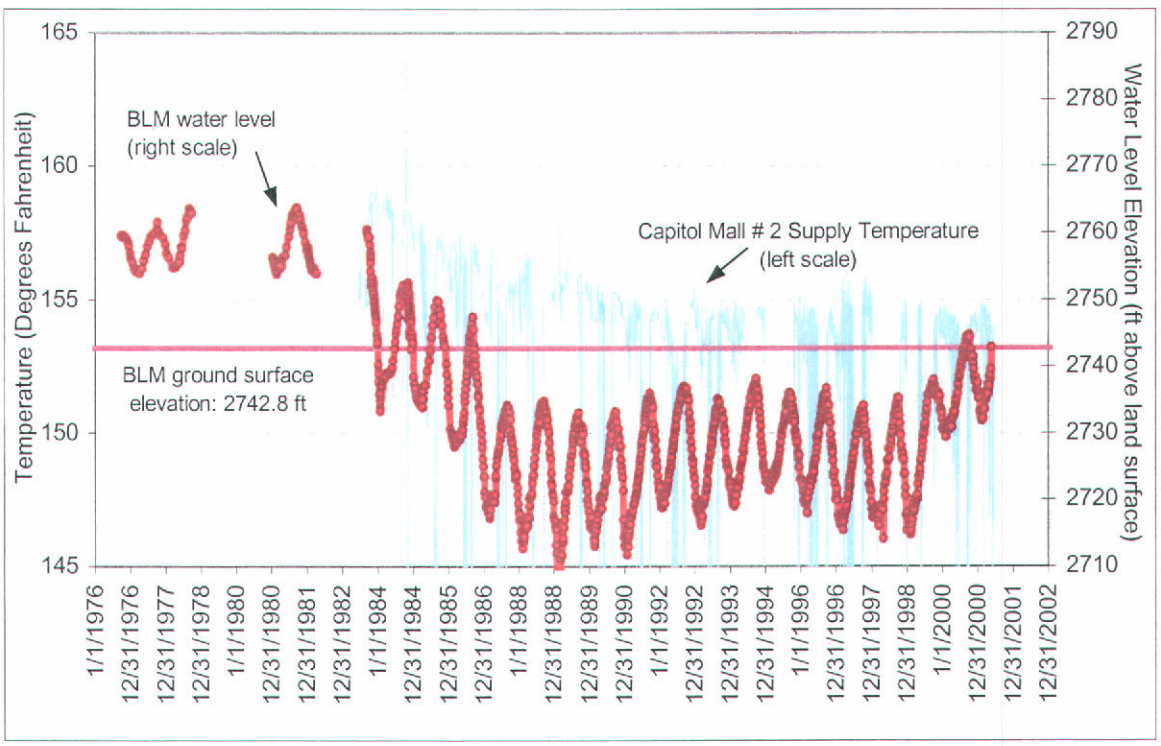



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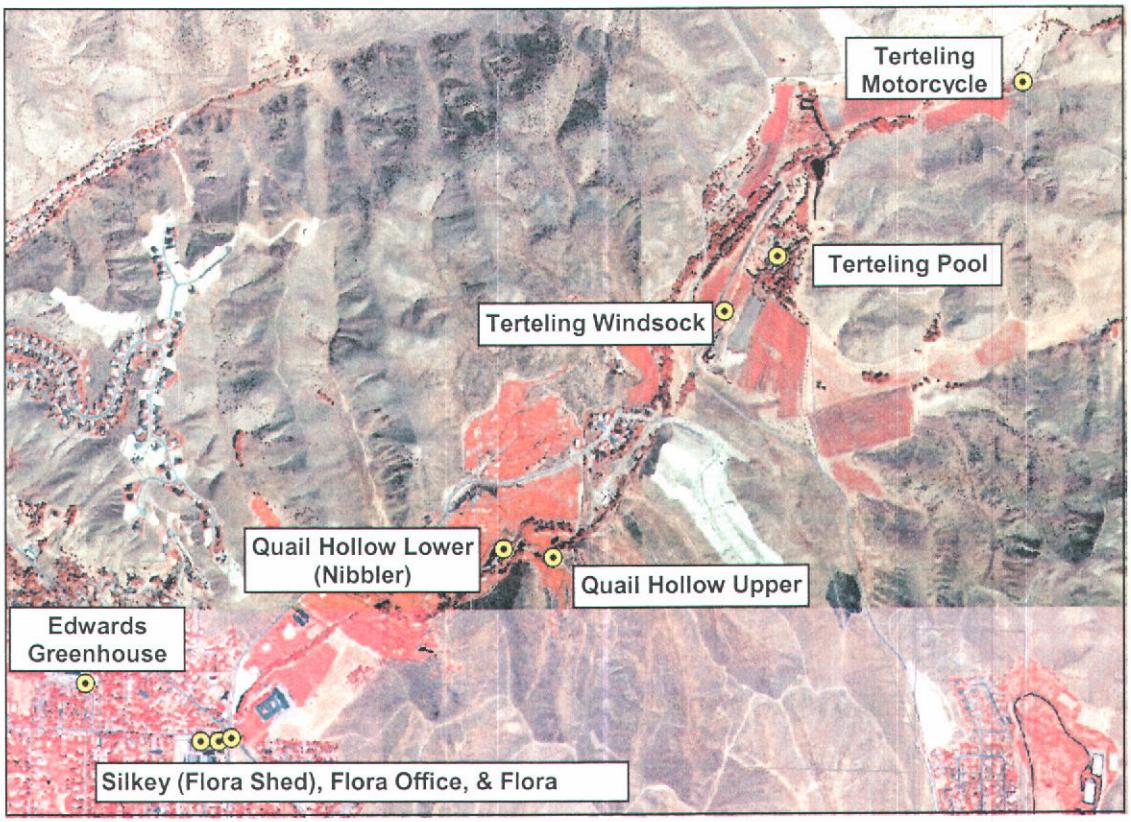
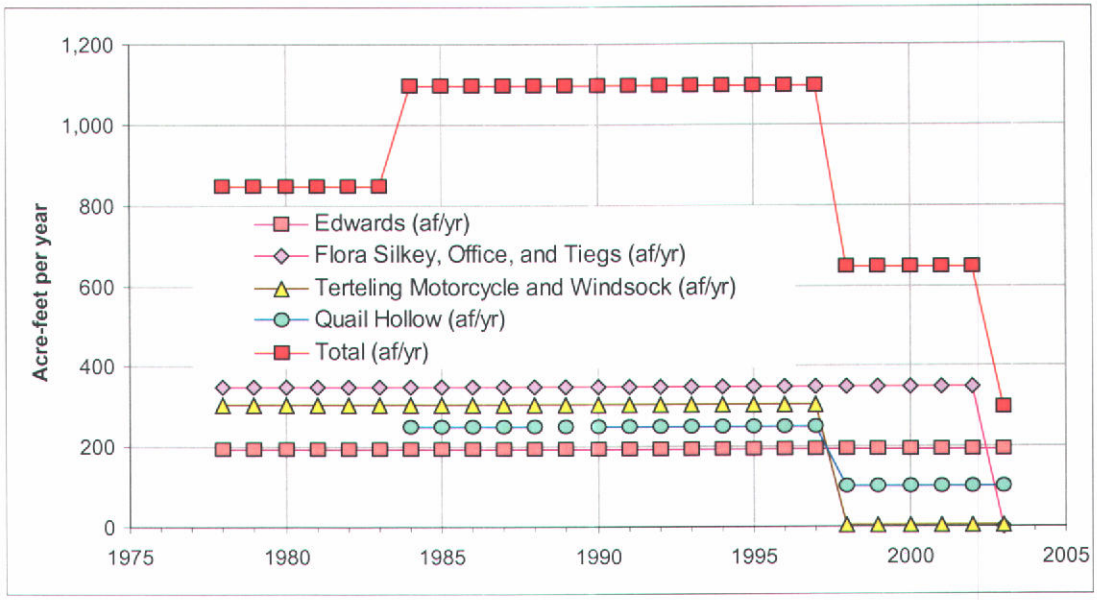



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| Quail Hollow Upper | Tee Ltd. | Quail Hollow Golf Course | Irrigation |
| Quail Hollow Lower | Nibbler | Quail Hollow Golf Course | Irrigation |
| Edwards | | Edwards Greenhouse | Commercial (space heating) |
| Flora Office | | The Terteling Company (formerly Flora Greenhouse) | Commercial (space heating) |
| Silkey | Flora Shed | The Terteling Company (formerly Flora Greenhouse) | Commercial (space heating) |
| Tiegs | Flora Triangle | The Terteling Company | Commercial (currently used |

[4] All references to the Terteling Motorcycle well in this report refer to a geothermal well; a cold-water well also is present at the same location.




This figure does not include production from the Terteling Windsock well that is now being used to heat the Terteling greenhouses (using water rights formerly held by the Flora Company), nor does it include remaining production at the Flora facility.

Figure 4-15: Estimated geothermal production in Stewart Gulch, 1978 to present.

### 4.2.2. Hydrogeology[5]

Two Tertiary basalt layers appear to be the primary source of thermal water in the Stewart Gulch wells. In contrast to wells in the Boise downtown area, no rhyolite has been confirmed in the Stewart Gulch wells (Stewart Gulch wells have not penetrated through the basalt). Water-bearing zones within the basalt layers appear to be at discrete intervals. For instance, water had to be added to the Quail Hollow well during drilling (with cable-tool) to suspend cuttings prior to reaching the bottom of the well. Down-hole camera footage of the Terteling wells shows most basalt fractures to be filled with calcium carbonate precipitates.

A thick mudstone section of the Terteling Springs Formation overlies the thermal basalt aquifers. Over 1,100 feet of this low-permeability unit overlies the basalt aquifer at the Flora Greenhouses, based on drilling logs from nearby wells and interpretation of natural gamma-ray geophysical logs. Midway up the gulch, at Quail Hollow and lower Terteling Ranch, the mudstone is continuous from land surface to the top of the basalt aquifer at 750 feet. At the upper Terteling Ranch, the basalt aquifer is overlain by sandstone of the sandy facies of the Terteling Springs Formation. At the lower gulch area, Pleistocene floodplain gravels of the Snake River Formation along the Boise River overlie the mudstone. The upper portion of the gulch has a sandy facies

[5] Most of the text in Section 4.2.2 was provided by Ed Squires, Hydro Logic, Inc., with permission from the Terteling family.

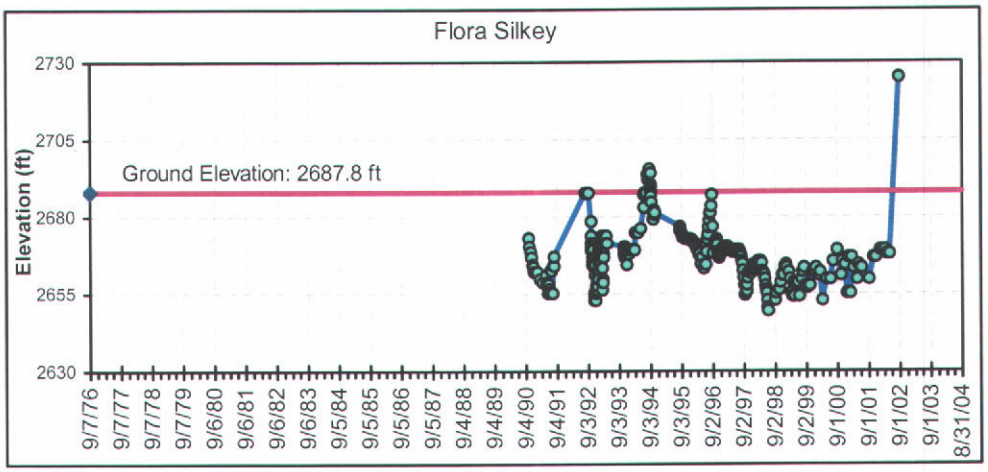



Figure 4-16: Hydrograph for the Silkey (Flora Shed) well.

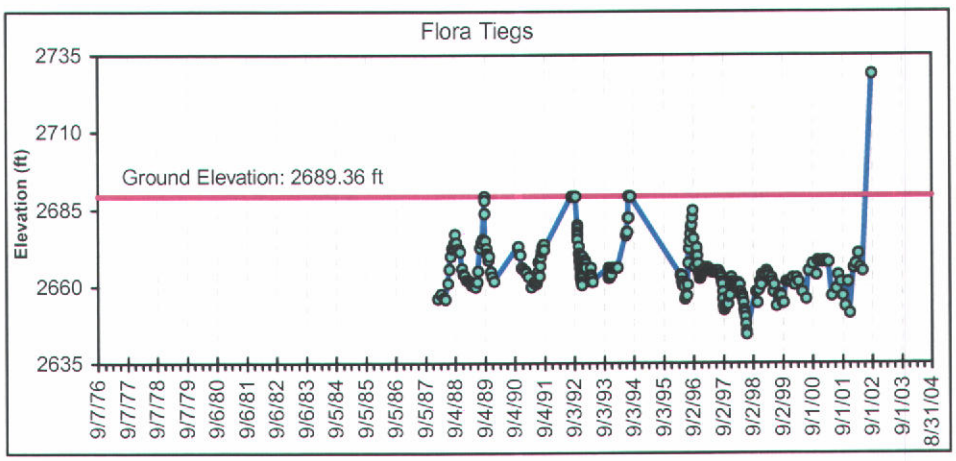



Figure 4-17: Hydrograph for the Flora Tiegs well.

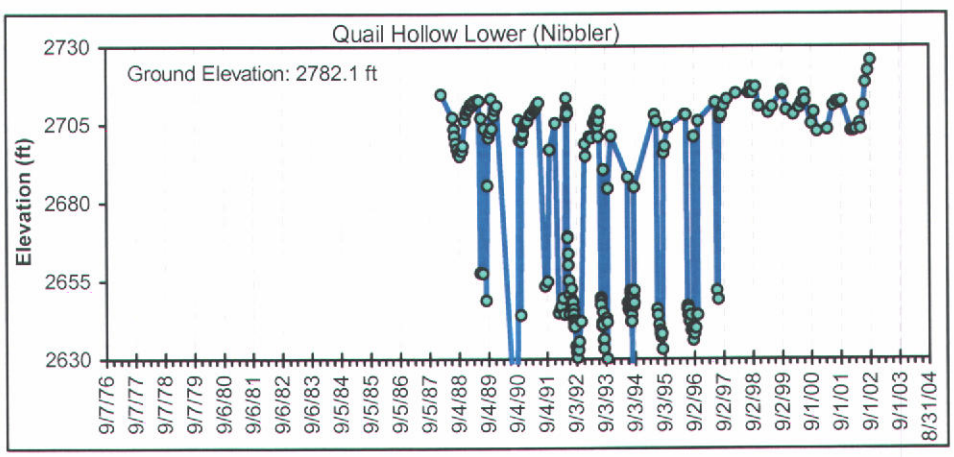



Figure 4-18: Hydrograph for the Quail Hollow Lower (Nibbler) well.

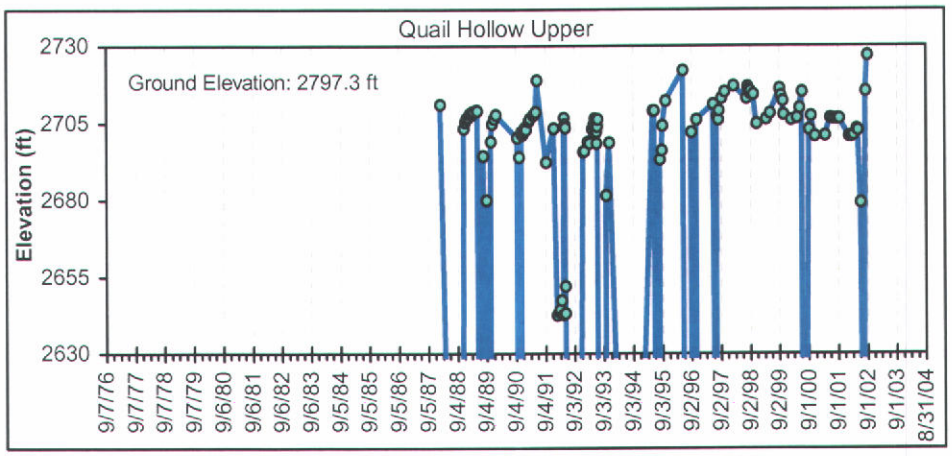



Figure 4-19: Hydrograph for the Quail Hollow Upper well.

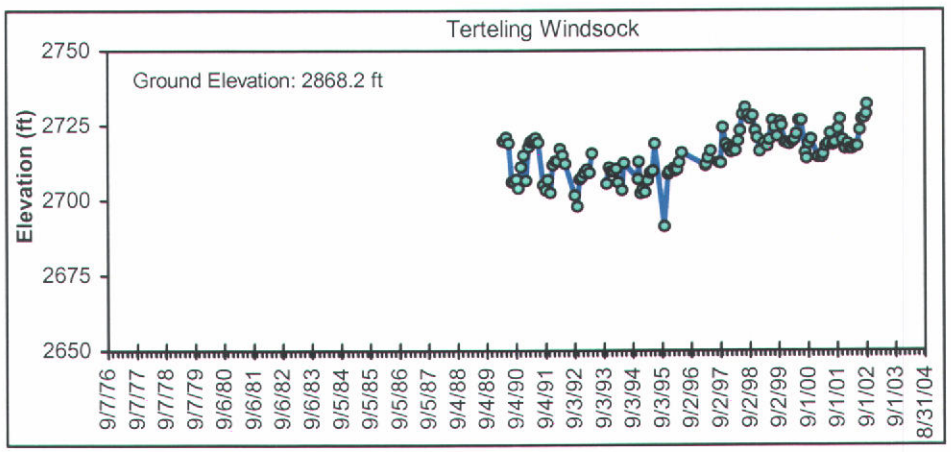



Figure 4-20: Hydrograph for the Terteling Windsock well.

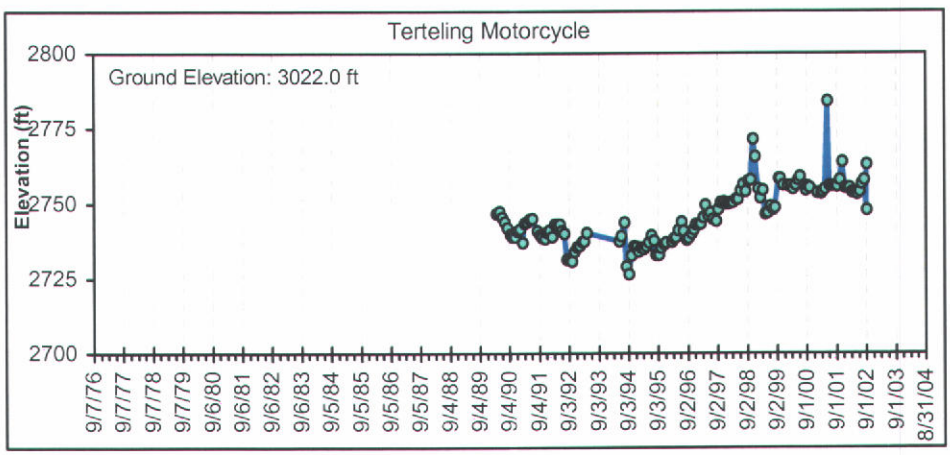



Figure 4-21: Hydrograph for the Terteling Motorcycle geothermal well.

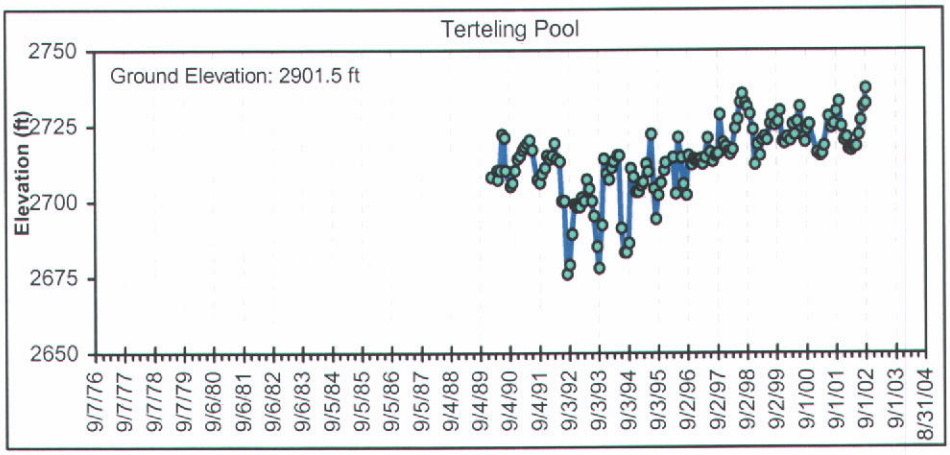



Figure 4-22: Hydrograph for the Terteling Pool well.

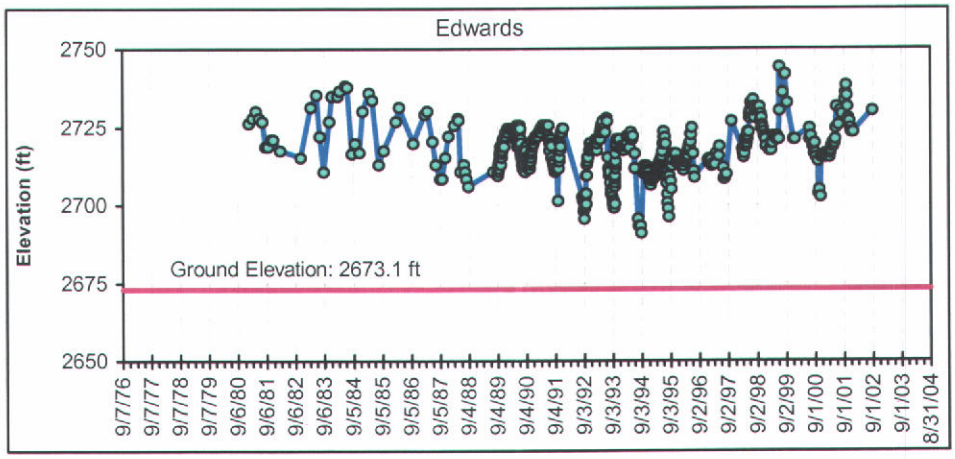



Figure 4-23: Hydrograph for the Edwards Greenhouse well.

### 4.2.4. Temperature Data

Long-term temperature data are not available for this area, although it appears by anecdotal information that temperatures have remained relatively stable.

### 4.2.5. Aquifer Test Data

Several pumping tests have been conducted in the Stewart Gulch area. However, to the author's knowledge, hydraulic property values from these tests have not been calculated.

## 4.3. Harris Ranch

### 4.3.2. Hydrogeology

The primary source of geothermal water to the Harris Ranch wells appears to be fractured Cretaceous granite (based on interpretation of 1977 and 1987 Driller's Reports for the Harris West well). No basalt or rhyolite was encountered in this or other nearby shallower wells. The East Boise Fault may bisect the area between East Boise and the Harris Ranch area (the BWSWD-East and BWSWD-West wells appear to be located near this fault).

### 4.3.3. Water Levels

Water-level monitoring at the Harris-West well was conducted from May 1987 through May 1993, and resumed in August 2002. Water level monitoring in the Harris-East well began in August 2002. The water levels did not show any significant seasonal fluctuation (except in those years when the East Well was pumped for irrigation purposes). The water level in late August 2002 (61 feet below top of casing) was approximately 8 feet higher than water levels in late August of 1988, 1991, and 1992. Water levels in the East Well in August 2002 were 10 feet lower than in the West Well.

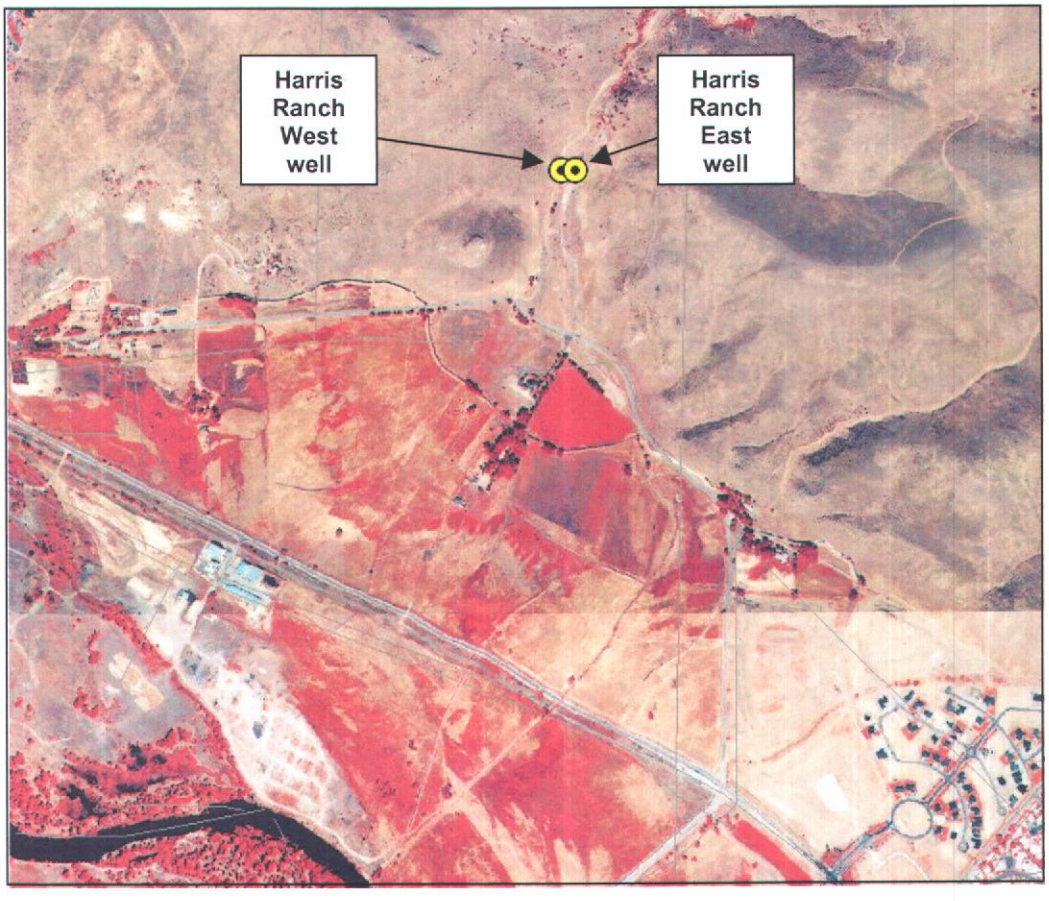



Figure 4-24: Geothermal wells in the Harris Ranch area.

The West Well hydrograph shows that pumping occurred during 1987 and 1990. There is no record of pumping in the Harris East well since that time.

The information above suggests the following:

1. The water level in the geothermal aquifer at the former Kelly's Hot Springs has likely declined by approximately 100 feet since 1891, coinciding with initiation of withdrawals in BWSWD wells. This estimate is based on (1) the 70-foot depth to water in the Harris East Well and (2) an estimated 30 feet of surface elevation difference between the well and the former hot spring. Further investigation of Kelly's Hot Spring (elevation, history from 1890 to 1918, etc.) is warranted.

2. The degree of hydraulic connection between the Harris West Well and the geothermal aquifer in the downtown area can not be determined on the basis of current data. On-going monitoring is needed to determine if heating season fluctuations can be measured at the East or West Well.

3. It is possible that water levels have recovered by approximately 8 feet since the early 1990s (Figure 4-25).

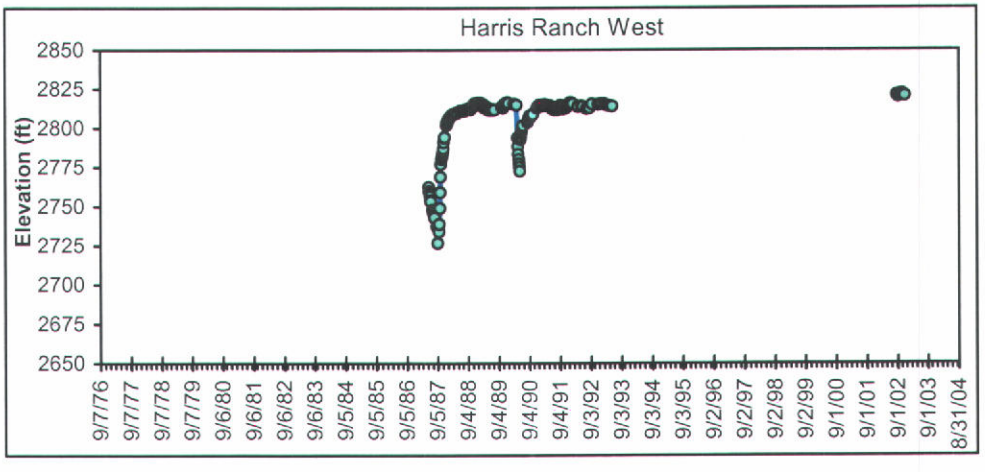



Figure 4-25: Hydrograph for the Harris Ranch West well.

### 4.3.4. Temperature Data

Long-term temperature data are not available for this area.

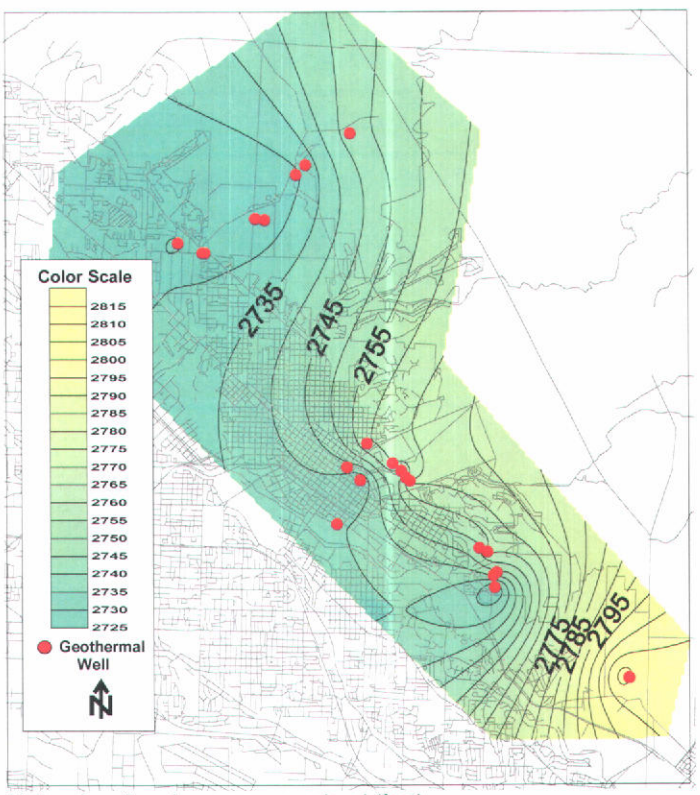
### 4.3.5. Aquifer Test Data

There are no known aquifer test data for this area.

## 5.2. Interpreted Hydraulic Gradient

The hydraulic head data collected in the August 2002 mass measurement were used to estimate horizontal hydraulic gradients in the Boise Front geothermal aquifer system. Hydraulic gradients were illustrated using two forms of spatial interpolation: kriging (Figure 5-1) and minimum curvature (Figure 5-2).

In general, the potentiometric surface in Figure 5-1 suggests westerly to southwesterly flow in the Stewart Gulch and Boise – Table Rock areas. There are not enough data points to estimate gradient directions within the Harris Ranch area. Based on these potentiometric surface maps, it appears that there is a hydraulic gradient from the Harris Ranch area toward the Boise – Table Rock area, which is consistent with the general westerly (or southwesterly) gradients observed in the downtown Boise and Stewart Gulch areas. Furthermore, it appears unlikely that there is northwesterly flow from the Boise – Table Rock area toward Stewart Gulch.

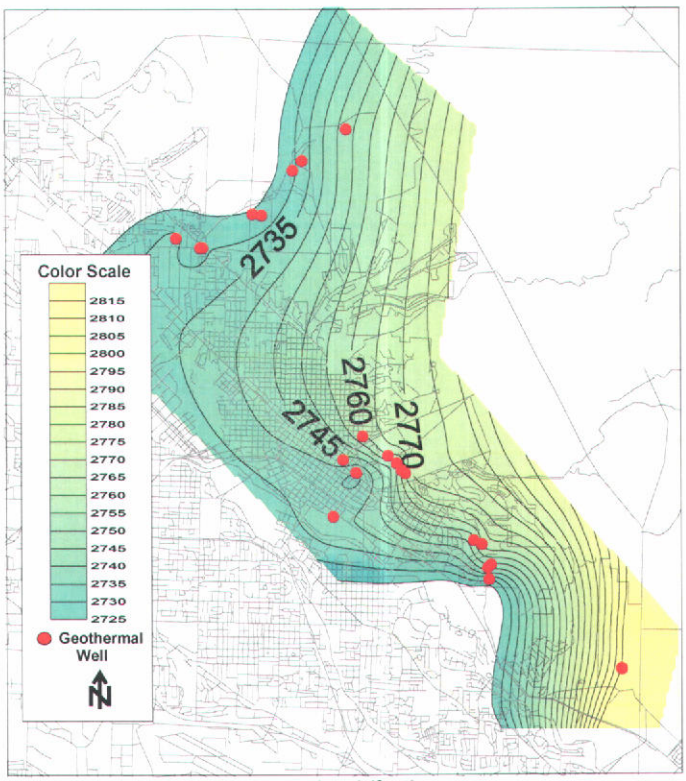



Units: elevation above mean sea level (feet).

Figure 5-1: Potentiometric surface (interpolated with "kriging", using a default linear variogram model).

The horizontal gradient maps may include error associated with (1) water column density differences between wells, (2) different well completion depths, and spatial

interpolation error. First, the mass measurement included wells that had been shut-in for a long time, wells that were flowing (at small rates), and wells that had recently been flowing. Nonetheless, there is general consistency in measurements within groups of wells, suggesting that the hydraulic gradient observations indicated are "in the ballpark." Second, different wells are completed at different depths, so the horizontal gradients indicated may reflect both vertical and horizontal components. Finally, spatial interpolation error may have been introduced because of the relatively small number of points and the spatial distribution (clustering) of the points.




Units: elevation above mean sea level (feet).

Figure 5-2: Potentiometric surface (interpolated with "minimum curvature", using default interpolation values).




Civil Engineering
Structural Engineering
**Land Surveying**

**RODNEY L. BALDWIN**
**P.E./L.S.**

4066 HAWTHORNE WAY
BOISE, IDAHO 83703-3923
TELEPHONE: (208) 343-4135
rmjmbald@cableone.net FAX: 344-3596

RECEIVED
MAR 27 2006
DEPARTMENT OF
WATER RESOURCES

**IN THE DISTRICT COURT OF THE FIFTH JUDICIAL DISTRICT OF THE STATE OF IDAHO, IN AND FOR THE COUNTY OF TWIN FALLS**

| | | |
|---|---|---|
| **In Re SRBA** | **A.** | **Subcase 63-5073** |
| **Case No. 39576** | | **OBJECTION** |

Please fill in the following information:

**B. NAME AND ADDRESS OF PERSON OBJECTING**

Name: Boise Warm Springs Water District
Address: 2440 Old Penitentiary Road
Boise, Idaho 83712

Daytime Phone: 208-344-3596

Name and Address of Attorney, if any:

Bruce M. Smith
225 N. Ninth Street, Ste. 420
Boise, ID 83702

**C. CLAIMANT OF WATER RIGHT AS LISTED IN DIRECTOR'S REPORT**

Name: Boise Warm Springs Water District
Address: 2440 Old Penitentiary Road
Boise, Idaho 83712

**D.** I object to the following elements as recommended in the Director's Report. (Please check the appropriate box(es)).

1. ☐ **Name and Address**
   Should be: _____

2. ☐ **Source**
   Should be: _____

3. ■ **Quantity**
   Should be: As claimed

4. ☐ **Priority Date**
   Should be: _____

5. ☐ **Point of Diversion**
   Should be: _____

6. ☐ **Instream Flow Beginning and Ending Point**
   Should be: _____

7. ☐ **Purpose(s) of Use**
   Should be: _____

8. ☐ **Period of Year**
   Should be: _____

9. ■ **Place of Use**
   Should be: As claimed

10. ☐ **I object because**

    ☐ This water right should not exist.

    ☐ This water right was not recommended, but should be recommended with the elements described above.

**E.** **REASONS SUPPORT OBJECTION(S):** The claim as made represents the amount of the water right. The place of use as claimed represents the area where water can be used pursuant to the right

F. **VERIFICATION**

State of Idaho )
)
County of Ada )

BRUCE M. SMITH, duly sworn, upon oath, deposes and says:

That I am the party/claimant filing this objection, as defined by I.C. § § 42-1401A(1) and (6) or that I am the attorney for the party/claimant objection and that I have read this objection, know its contents and believe that the statements are true to the best of my knowledge.

Bruce M. Smith
Attorney for Boise Warm Springs Water District

Subscribed and sworn to before me on: March 3rd, 2006.

JENNIFER JENSEN NOTARY PUBLIC STATE OF IDAHO

Notary Public for Idaho
Residing at: Boise
My Commission Expires: 6-5-06

## CERTIFICATE OF MAILING

I certify that on March 23, 2006, I mailed the original and copies of this objection, including all attachments, to the following persons:

1. Original to:

   Clerk of the District Court
   Snake River Basin Adjudication
   253 Third Avenue North
   P.O. Box 2707
   Twin Falls, ID 83303-2707

2. One copy to the claimant of the water right at the following address:

   Boise Warm Springs Water District
   2440 Old Penitentiary Road
   Boise, Idaho 83712

3. Copies to:

   IDWR Document Depository
   P.O. Box 83720
   Boise, ID 83720-0098

   United State Department of Justice
   Environment & National Resources Division
   550 W. Fort Street, MSC 033
   Boise, ID 83724

   Chief, Natural Resources Division
   Office of Attorney General
   P.O. Box 44449
   Boise, ID 83711-4449

05/12/2005

IDAHO DEPARTMENT OF WATER RESOURCES

PRELIMINARY RECOMMENDATION OF WATER RIGHTS ACQUIRED UNDER STATE LAW

---

RIGHT NUMBER: 63-5073

NAME AND ADDRESS: BOISE WARM SPRINGS WATER DIST
2440 OLD PENITENTIARY RD
BOISE ID 83712

SOURCE: GROUND WATER TRIBUTARY:

QUANTITY: 3.750 CFS
958.000 AFY

PRIORITY DATE: 11/05/1894

POINT OF DIVERSION:

T03N R02E S12 SESESW Within ADA County

PURPOSE AND PERIOD OF USE:

| PURPOSE OF USE | PERIOD OF USE | QUANTITY |
|---|---|---|
| DOMESTIC | 01/01 12/31 | 3.750 CFS |
| HEATING | 01/01 12/31 | 3.750 CFS |

PLACE OF USE: DOMESTIC Within ADA County

| | |
|---|---|
| T03N R02E S10 NENE | T03N R02E S10 Lot 3 SWNE |
| T03N R02E S10 Lot 1 SENE | T03N R02E S10 Lot 2 NESE |
| T03N R02E S11 Lot 4 SWNW | T03N R02E S11 NESW |
| T03N R02E S11 NWSW | T03N R02E S11 Lot 6 SESW |
| T03N R02E S11 NESE | T03N R02E S11 NWSE |
| T03N R02E S11 SWSE | T03N R02E S11 SESE |
| T03N R02E S12 SESW | T03N R02E S13 NENW |
| T03N R02E S13 NWNW | T03N R02E S14 NENE |

HEATING Within ADA County

| | |
|---|---|
| T03N R02E S10 NENE | T03N R02E S10 Lot 3 SWNE |
| T03N R02E S10 Lot 1 SENE | T03N R02E S10 Lot 2 NESE |
| T03N R02E S11 Lot 4 SWNW | T03N R02E S11 NESW |
| T03N R02E S11 NWSW | T03N R02E S11 Lot 6 SESW |
| T03N R02E S11 NESE | T03N R02E S11 NWSE |
| T03N R02E S11 SWSE | T03N R02E S11 SESE |
| T03N R02E S12 SESW | T03N R02E S13 NENW |
| T03N R02E S13 NWNW | T03N R02E S14 NENE |

PLACE OF USE IS WITHIN THE SERVICE AREA OF THE BOISE WARM SPRINGS WATER DISTRICT

The boundary encompassing the place of use for this water right is described with a digital boundary as defined by I.C. Section 42-202B(2) and authorized pursuant to I.C. Section 42-1411(2)(h). The data comprising the digital boundary are incorporated herein by reference and are stored on a CD-ROM disk issued in duplicate originals on file with the SRBA District Court and the Idaho Department of Water Resources. A map depicting the place of use is attached hereto to illustrate the place of use described by the digital boundary.

OTHER PROVISIONS NECESSARY FOR DEFINITION OR ADMINISTRATION OF THIS WATER RIGHT:

This partial decree is subject to such general provisions necessary for the definition of the rights or for the efficient administration of the water rights as may be ultimately determined by the Court at a point in time no later than the entry of a final unified decree. Section 42-1412(6), Idaho Code.

EXPLANATORY MATERIAL: Beneficial Use

THE USE IS LIMITED TO 266 RESIDENTIAL AND COMMERCIAL SERVICES WITH THE BOUNDARY OF THE BOISE WARM SPRINGS WATER DISTRICT.

WATER IS LOW TEMPERATURE GEOTHERMAL WATER.

WATER TEMPERATURE MEASURED AT 172 DEGREES F.

RECEIVED
JUN 23 2005
WATER RESOURCES
WESTERN REGION

**NOTICE OF ERROR**
**REPLY**

Please type or print clearly, fill out this form completely and mail.

Return this for to IDWR by the deadline date printed below if you want IDWR to change your recommendation or you want to let IDWR know that you agree with its recommendation.

**YOUR DEADLINE FOR RETURNING A NOTICE OF ERROR REPLY IS: June 24, 2005**

Water right number: 63-5073
BOISE WARM SPRINGS WATER DIST
2440 OLD PENETENTIARY ROAD
BOISE ID 83717
Telephone Number: (208) 342-3162

1. Describe the portion of the proposed recommendation with which you disagree (e.g. priority date, period of use, source):

***Quantity***
***Purpose of Use / Period of Use***
***Place of Use***
***Explanatory Material***

2. Describe the changes you wish to make in the proposed recommendation:

***Quantity should be 12.89 cfs***
***Purpose and Period of Use should reflect 12.89 cfs for heating and 12.89 cfs for domestic.***
***Place of Use should include all service areas subsequently annexed.***
***Reference to limiting service to 266 services should be deleted.***

3. Give a brief explanation as to why you disagree with these portions:

***BWSWD's right is 12.89 cfs, not 3.75 cfs. The place of use/purpose/period of use should reflect that the actual number of services and location of those service areas can change over time due to annexation.***

_____ **I AGREE with this proposed recommendation: no changes need to be made.**

**DATE:** 6/23/05 **SIGNATURE:** _____

Please print your name: Bruce Smith

IDWR Regional Office, 2735 Airport Way, Boise, ID 83705 2083342190

BOISE WARM SPRINGS WATER DISTRICT

ADDITIONAL INFORMATION

DATE: JUNE 28, 2005

BY: MEL SCHULTE

The principal contact during the review and field exam was Rodney Baldwin, P.E. (343-4135). The company attorney is Bruce Smith. The most recent contact is Bob Sutter, a new addition to the board of directors. (345-3599)

The claim is based on a Statutory Claim for Domestic and Heating uses in the downtown and Eastern parts of Boise City. The claim specifies a diversion rate of 12.819 cfs from three low temp geothermal wells located behind the old State Penitentiary in East Boise.

The primary issue associated with this claim is the diversion rate. The Statutory claim and SRBA claim are based on posted notices that indicate the intention of developing 4.273 cfs from three artesian wells. (3 X 4.273 = 12.819 cfs) Three wells were never put into production. Two wells have been historically pumped and used but the third well never met diversion standards and is currently use as a monitoring well.

The three wells are included in the Boise Front Low Temperature Geothermal Resource Area and are also in the ground water management area established in 1987. There is an abundance of data concerning the wells on file with Ken Neely at the State Office, IDWR.

The recommended diversion rate of 3.75 cfs and the annual volume of 958 AF are based on information provided by Bob Sutter that he obtained in the company's production records from 1977 to 1989. (See the memo dated 3/5/2005 prepared by Bob Sutter) The information provided by Bob changed our initial recommended diversion rate of 2.45 cfs and annual volume of 770 AF to 3.75 cfs and 958 AF. Bruce Smith will most likely challenge the recommended rate and volume numbers mentioned above. He is interpreting a section of Idaho Code to mean that the diversion rate claimed in a statutory claim is the diversion rate guaranteed by the Code.

There is concern by the district that the limitation of 266 residential and commercial services is too restrictive to their future growth. The number 266 is the number they provided in their original claim filed in 1989. Their statutory claim filed in 1983 indicates they service the Idaho Dept of Health & Agriculture labs, 238 households for heating and 207 households for domestic. It appears the total number of services described in the statutory claims is 239 so the number we recommended, 266, is the larger of the two. Bob Sutter searched their records to find out how many of the services not is use in the mid-1980's still had pipes attached to their main lines but "valved-off". He arrived at the number 351 that includes current users and non-users with "valved-off" lines. The district wants us to use the "stubbed-in" policy used in licensing as a determination as to how many service units we recommend. After a discussion with Dave Tuthill and Nick Spencer it is our opinion the "stubbed-in" policy does not apply in determining the number of uses in a beneficial use claim. Therefore, we will leave the number of service units at 266.

The POD was established by GPS and USGS topo map Boise South, Idaho.

The notice of error filing by Bruce Smith indicates disagreement with our entire recommendation but no changes were made. He did not provide any additional evidence to support his notice of error filing so it is apparent that he wants to take the recommendation to the objection period.

MTS

**CONFIDENTIAL ATTORNEY WORK PRODUCT**
**NBS NOTES TO FILE 3-21-06**
**WATER RIGHT NO. 63-5073**

**NOTES RE BOISE WARM SPRINGS WATER DISTRICT RIGHTS PER RESEARCH INTO BRUCE SMITH'S QUESTION AS TO WHY THE CAP ON THE NUMBER OF HOOK-UPS**

This right is recommended for domestic and heating. It has a diversion rate of 3.75 cfs and a diversion volume limiter. A further limitation is a cap of 266 hook-ups. Bruce Smith is concerned about why we have a cap on the number of hook-ups because it limits the company's ability to expand service to new users.

According to Jan and Dave it has been our historic practice on domestic uses to list the number of units served as a further measure of the extent of historic beneficial use in order to avoid enlargement of the right. The idea is that if a user is going to add more hook-ups he is going to be enlarging the right and needs to file an application for a new water right in order to do that. Moreover, we cannot treat the use as municipal because 42-202B(6) excludes geothermal use from the definition of municipal.

However, the question in this case is whether a limit on hook-ups is necessary if you have both a diversion rate limit and a diversion volume limit. If for instance, through addition of insulation to existing homes the amount of water used for geothermal heating is reduced by one-half per house, why cannot the company hook up additional houses so long as neither the diversion rate nor diversion volume limiter is exceeded? According to Dave the reason for this might be that the diversion volume limiter might not be an accurate measure of the historic diversion volume—i.e. it might simply be the diversion rate multiplied out over 24 hours per day times 365 days in a year. If this is how it is calculated it does not serve as an accurate measure of the historic annual volume diverted, and hence cannot serve as a usable limiter on the use.

If on the other hand, the diversion volume recommended is an accurate measure of historic use, based upon credible historic data, then it would serve as a useful limit to prevent enlargement of the right. According to Dave, if we have a good diversion volume measurement to serve as an accurate measurement of historic beneficial use, we should not care if the company increases the number of hook-ups through more efficient use of the resource so long as the historic diversion rate and volume are not exceeded.

Therefore, if we have a good diversion volume number we would not need a cap on the number of hook-ups. Accordingly, if we are to remove the cap on the number of hook-ups per Bruce Smith's concerns, we first need to determine how good the diversion volume number is as a measure of historic beneficial use. Therefore, we need to find out where the diversion volume number on the recommendation came from, and, if it is not an accurate measure of historic use, then we need to ask Bruce and Bob Suiter to provide us an accurate number if we are going to agree to remove the cap on the number of hook-ups.

Field Exam Date

# STATE OF IDAHO
# DEPARTMENT OF WATER RESOURCES
# ADJUDICATION FIELD REPORT

## Prior to Field Exam

- ☐ Copy of Claim, claim has been signed, sealed, and dated by notary?
- ☐ Check fees paid
- ☐ Well logs (if needed)
- ☐ Copy of topo or NAPP
- ☐ Check of Govt. Lots, if needed, Govt. Plat/Tax lot information
- ☐ Check POD & POU overlap, see below – include overlapping right for exam
- ☐ Evidence of Priority – if none, talk with claimant

## CLAIMANT INFORMATION – verify contact information is complete

Claim No(s) 63-5073

Owner: Boise Warm Springs Water Dist Phone No. 343-4135 = Rod Baldwin
345-3599 = Bob Sutter

Current Address: _____

- ☐ No change NAME IS THE SAME
- ☐ NEW OWNER _____
- ☐ No change Address
- ☐ NEW ADDRESS _____
- ☐ How long owned property? _____

Accompanied by: Rod Baldwin

## PRIORITY DATE

- ☑ No change – Complete evidence submitted or not necessary
- ☐ Incomplete – Claimant should be asked when water was first used and submit proof of date.
- ☐ Priority date is acceptable/within mandatory filing dates?

Priority date, per claimant, is: 11-5-1894

(If priority date, based on your exam, seems questionable, explain below.)

The information available supports the first use being some where between 1891 and 1896.

**Source:** Groundwater **Tributary to** _____

- ☑ No Change –SAME SOURCE
- ☐ Source found is different than claimed: _____

## POINT OF DIVERSION

- ☑ No change
- ☐ POD found is different than claimed: _____
- ☐ If different, when did POD change? _____

**DIVERSION AND DELIVERY SYSTEM**

Points of Diversion:

| ID # | Govt Lot # | 1/4 | 1/4 | 1/4 | Sec. | Twp. | Rge. | County | Method of Determination/Remarks GPS ID |
|---|---|---|---|---|---|---|---|---|---|
| | | SE | SE | SW | 12 | 3N | 2E | Ada | USGS map + GPS |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

Description of diverting works

Two 60 hp pumps deliver water to a pipeline system

**OVERLAP REVIEW**

Other water rights with the same point of diversion: None

Does overlap add acres or uses to existing system, increase rate of flow or volume, or other? Explain:

**WATER USES**

- ☐ No change
- ☐ Different Uses

Use Domestic From 1-1 To 12-31 Amount 3.75 CFS _____ AFA

Use Heating From 1-1 To 12-31 Amount 3.75 CFS _____ AFA

Use _____ From _____ To _____ Amount _____ CFS _____ AFA

**TOTAL VOLUME – Groundwater only**

* ☑ Incomplete on claim, the total is, Amount 3.75 CFS 958 AFA *

- ☐ Changes found, the new total is, Amount _____ CFS _____ AFA
- ☐ More than 1" per Acre? Yes ____(claimant must complete excess flow sheet)

312.2 mg average annual volume in 1979. ÷ 325,850 = 958 AF

**NON-IRRIGATION USES:**

- ☑ No change
- ☐ Changes Exam found: Domestic # of homes _____ Stock # _____

  Types _____ Additional comments: Serves domestic and heating uses for homes and commercial.

**PLACE OF USE:**

* * ☑ No Change

- ☐ Changes shown below:

| See below. Place of Use | | | NE | | | | NW | | | | SW | | | | SE | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TWP | RGE | SEC | NE | NW | SW | SE | NE | NW | SW | SE | NE | NW | SW | SE | NE | NW | SW | SE | |
| | | | | | | | | | | | | | | | | | | | |
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Overlap with other water rights: _____

Does overlap increase rate of flow, volume, additional acres, different source for same acres? Explain:

**Delivery System Narrative:** Two wells with 60 hp pumps divert water at an average 15 psi to a pipeline system. According to Rod Baldwin the system doesn't exceed 15 psi due to the condition of the system. A third well on site is used for monitoring

| Well or Diversion Identification No GPS ID | Motor Make | Hp | Motor Serial No. | Pump Make | Pump Serial No. or Discharge size |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

**FLOW MEASUREMENTS:**

Attach appropriate documents

**NARRATIVE/REMARKS/COMMENTS**

* The annual volume is based on the average maximum production of 312.2 million gallons in the year 1979 (See attached report dated June 1998) The diversion rate is based on data provided by Bob Sutter (See memo dated 3-5-05. Summary of Uses and Proposed Uses - Boise Front Ground Water Management Area. (See attached dated 6-1988.

** Used within the service area of the Boise Warm Springs Water District. Historical

The BWSWD is within the Boise Front Low Temp.

Geothermal Resource Management Area and the production is monitored and recorded by Ron Neely of IDWR. Those records are available as well as the information in the Boise Front Geothermal Aquifer study. (See attached draft.)

2616 residential and commercial services.

The water temp of 172° F was provided by Rod Baldwin

Bob Sytter obtained additional information that changed our first recommendation from 2.45 cfs to 3.75 cfs and 770 AF to 958 AF.

**AFTER EXAM THE FILE SHOULD CONTAIN:**

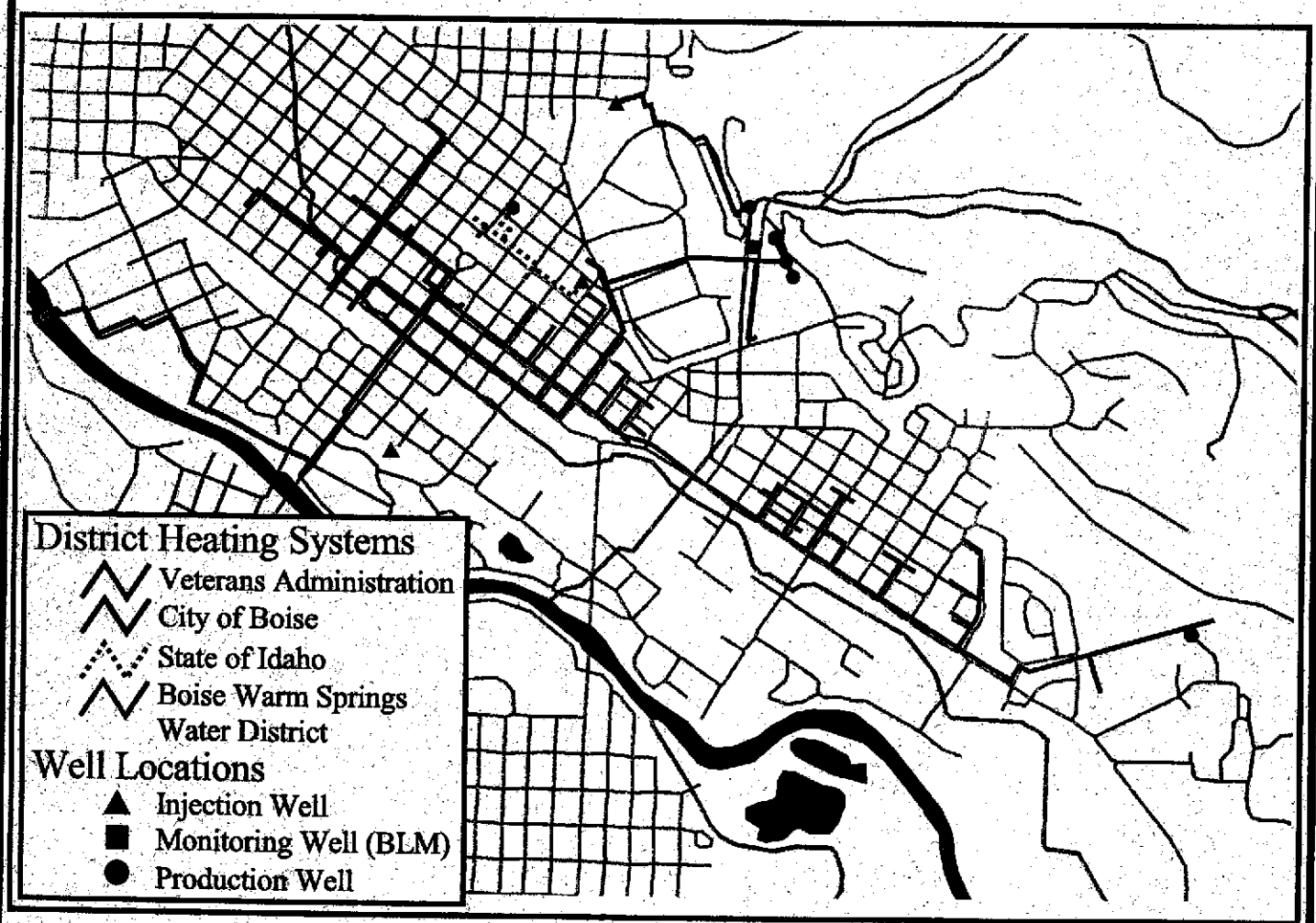
- ☐ Completed claim checklist
- ☐ Photographs of POD's and POU
- ☐ GPS readings
- ☐ Completed map and or GIS layout showing POD's and POU

DATE EXAM CONDUCTED: 10-14-02

FIELD EXAMINER: Mel Schulte

# PRODUCTION, TEMPERATURE, AND WATER LEVEL DATA FOR THE FOUR HEATING SYSTEMS IN THE BOISE FRONT LOW TEMPERATURE GEOTHERMAL RESOURCE AREA, 1977-1997

By
Kenneth W. Neely




Idaho Department of Water Resources
Open-File Report
June, 1998

# GEOTHERMAL DEVELOPMENT IN THE BOISE AREA

The first two geothermal wells in the United States were drilled near Boise, Idaho, in 1890 and 1891 (Boise City Public Works, 1993). The wells were completed near some thermal springs located about two miles east of Boise (Figure 5). Both wells were drilled to depths of 400 feet (Table 1). Although there are no well driller's reports for the two wells, it is assumed that the wells were completed in the rhyolite rocks of the Idavada Group. The wells are believed to have been drilled through a major down-to-the-southwest normal fault that trends northwest/southeast along the toe of the Boise Front Foothills. This fault and other associated faulting are interpreted to be the conduits for upward migration of geothermal water along the Boise Front.



**Figure 5.** Original well house for the Boise Warm Springs Water District's two geothermal production wells (from Burnham and Wood, 1983).

By 1892, the water from the wells was being used to heat homes, businesses and a 15,000 square foot Natatorium in east Boise. The Natatorium no longer exists but the

geothermal water is still being used to heat 226 homes and 36 commercial buildings on and near Warm Springs Avenue and in part of the downtown Boise area (Figure 6). Today, the Boise Warm Springs Water District (BWSWD) maintains the production wells and delivers the water to the customers. The used geothermal water is discharged to the Boise River through the city sewer system (Berkeley Group, Inc., 1990). BWSWD drilled a third well in 1981 about 650 feet northwest of the two production wells. The well, which is believed to be on the upthrown side of the fault, did not encounter sufficient quantities of geothermal water for production. The well is being used for monitoring water levels.

**Table 1.** Selected wells in the Boise Front geothermal area.

| System | Well Name | Location | Reported Depth (feet below land surface) | Year Drilled | Use[1] |
|---|---|---|---|---|---|
| Boise Warm Springs Water District (BWSWD) | BWSWD West | 3N 2E 12CDDD1 | 400 | 1891 | A |
| | BWSWD East | 3N 2E 12CDDD2 | 400 | 1891 | A |
| | BWSWD #3 | 3N 2E 12CDDC1 | 587 | 1981 | U,M |
| State of Idaho Capitol Mall (State or CM) | CM #1 | 3N 2E 10AADA1 | 2,152 | 1981 | I |
| | CM #2 | 3N 2E 10AABB1 | 3,030 | 1981 | A |
| City of Boise (previously owned by Boise Geothermal Limited (BGL)) | BGL #1 | 3N 2E 11ABCA1 | 2,008 | 1981 | U |
| | BGL #2 | 3N 2E 11ABBC1 | 880 | 1981 | A |
| | BGL #3 | 3N 2E 11BAAA1 | 1,897 | 1981 | A |
| | BGL #4 | 3N 2E 11ABCB2 | 1,103 | 1981 | A |
| Veterans Administration Regional Hospital (VA) | VA #1 | 3N 2E 02CDCD1 | 1,666 | 1983 | A |
| | VA #2 | 3N 2E 02CBCC2 | 1,840 | 1983 | U |
| | VA #3 | 3N 2E 02CBCC3 | 2,300 | 1987 | I |
| Other | BLM | 3N 2E 11BABD1 | 1,222 | 1976 | M |

[1] Use codes: A = heating; I = injection; M = monitoring; U = unused.

In the mid-1970's, the increasing cost of heating created new interests in alternate heat sources such as geothermal. In 1976, EGG /INEL drilled the Bureau of Land Management (BLM) and Beard exploration wells, along with three geothermal test holes, in the downtown Boise area. At about the same time, the State of Idaho Capitol Mall complex was expanding. This development prompted then-Governor Andrus to request a federal study to determine the feasibility of geothermal heat for the State's building in downtown Boise (Austin, 1978).

The State Health Laboratory was retrofitted for geothermal heat as a pilot project in 1977. The success of the State Health Laboratory project motivated the State of Idaho to drill

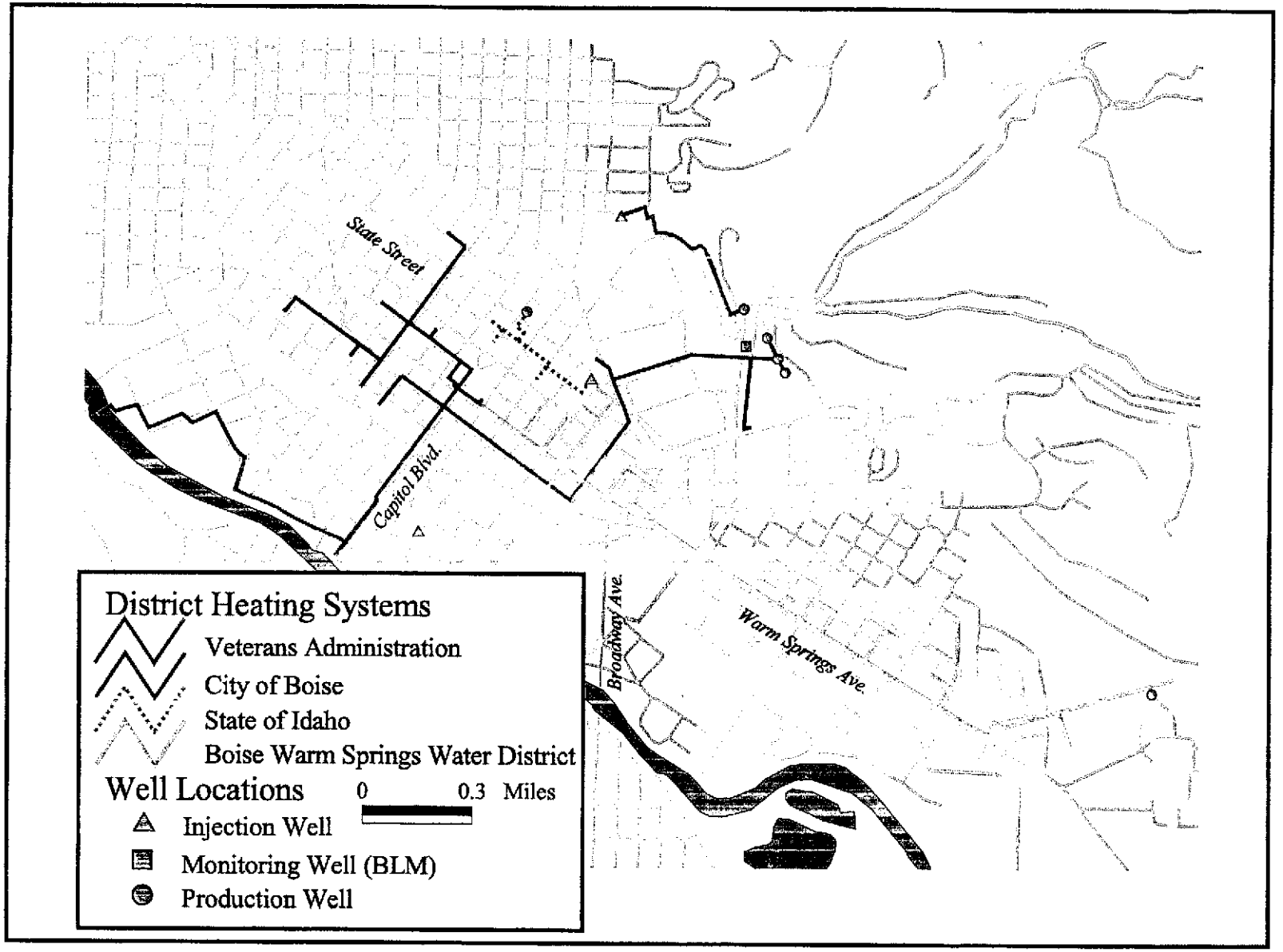



**Figure 6.** Geothermal well locations and distribution lines for the four district heating systems in the Boise area (This map was modified from a map received from the City of Boise Public Works Department in 1996).

# GEOTHERMAL MONITORING DATA

Data collection for the four systems is accomplished through manual readings and computer data loggers. The BWSWD and the State systems currently use electronic devices to capture monitoring data. Automation of data collection using data loggers has been discussed for the City and Va systems but has not been implemented yet.

The BWSWD began recording production data in September, 1977 (Boise Warm Springs Water District, 1989). Production data are currently being recorded using two methods: 1) hand-written daily logs, and 2) a data logger. The BWSWD submits a summary of the hand-written logs to IDWR that lists production by month and by year. The data logger captures a production value once every 10 minutes. IDWR downloads the datalogger every three months.

Maximum monthly production for the BWSWD has decreased over the past 20 years from almost 50 million gallons per month to about 30 million gallons (Figure 11). Annual production by water year for the BWSWD has decreased from a peak of over 300 million gallons to about 220 million gallons (Table 2; Figure 12). The reasons for the decline are: 1) better heating efficiencies because of the addition of new pipe insulation on main and service

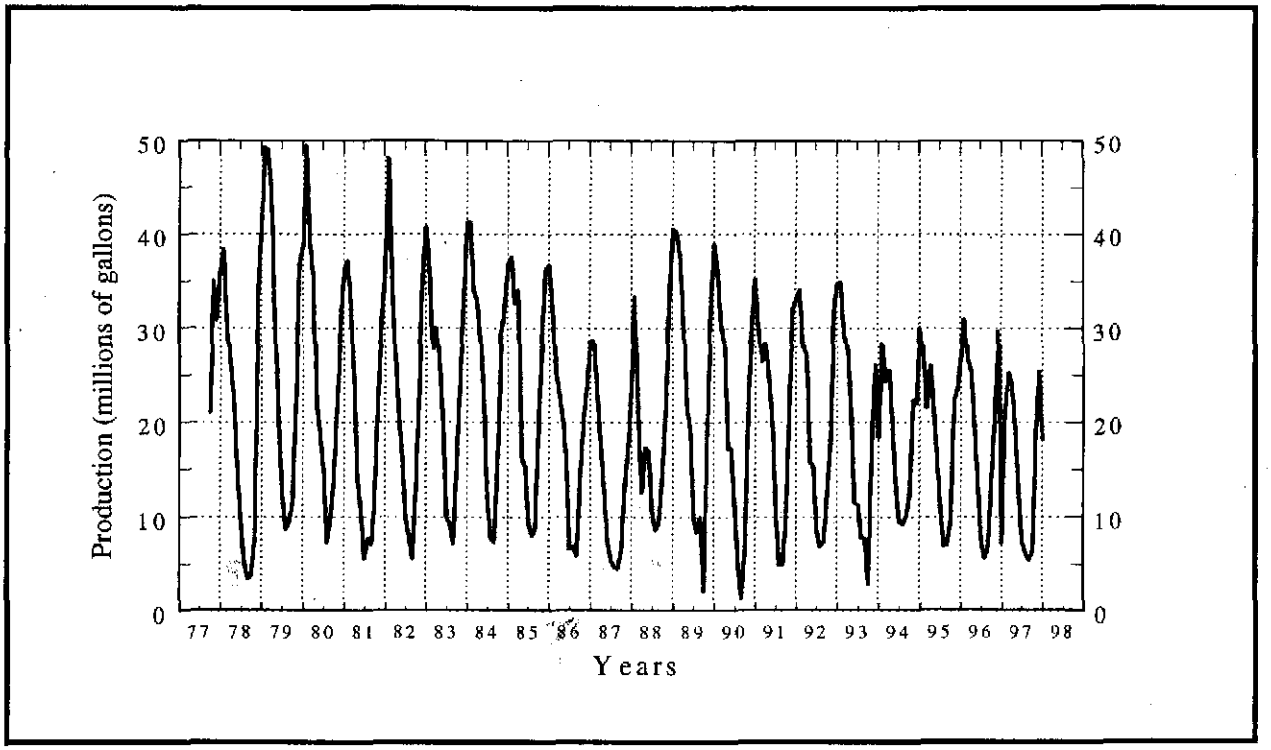



**Figure 11.** Monthly production for the Boise Warm Springs Water District heating system, 1977-1997.

**Table 2.** Production By Water Year[1] For The Four Heating Systems In The Boise Front Geothermal Area.

| PRODUCTION IN MILLIONS OF GALLONS | | | | | |
|---|---|---|---|---|---|
| **Water Year** | **BWSWD** | **State** | **City** | **VA** | **Total** |
| 1978 | 256.0 | | | | 256.0 |
| 1979 | 312.2 | | | | 312.2 |
| 1780 | 308.1 | | | | 308.1 |
| 1981 | 239.4 | | | | 239.4 |
| 1982 | 276.0 | | | | 276.0 |
| 1983 | 283.5 | | | | 283.5 |
| 1984 | 300.1 | 162.9 | 166.7 | | 629.7 |
| 1985 | 281.1 | 175.4 | 121.4 | | 577.9 |
| 1986 | 253.2 | 192.0 | 176.8 | | 622.0 |
| 1987 | 183.3 | 169.1 | 188.9 | | 541.3 |
| 1988 | 199.4 | 138.8 | 123.8 | | 462.0 |
| 1989 | 278.0 | 120.0 | 158.0 | | 556.0 |
| 1990 | 244.6 | 68.3 | 122.3 | 118.2 | 553.4 |
| 1991 | 245.7 | 177.6 | 121.3 | 115.4 | 660.0 |
| 1992 | 243.3 | 139.0 | 123.3 | 116.7 | 622.3 |
| 1993 | 239.3 | 177.6 | 156.0 | 137.0 | 709.9 |
| 1994 | 214.7 | 179.6 | 122.5 | 137.4 | 654.2 |
| 1995 | 221.2 | 150.8 | 129.9 | 151.4 | 653.3 |
| 1996 | 226.6 | 119.6 | 132.1 | 186.2 | 664.5 |
| 1997 | 212.8 | 112.2 | 130.7 | 203.6 | 659.3 |
| Average production | 250.9 (1978-1997) | 155.0 (1984-1997, minus 1990) | 141.0 (1984-1997) | 145.7 (1990-1997) | 660.5 (1991-1997) |

[1]Water year runs from October 1 to September 30. For example, water year 1978 started on October 1, 1977 and ended on September 30, 1978.

250.9 mg ÷ 325,850 = 770 AF

Form No. 243
7-78

Claim No. 63-5073

# STATE OF IDAHO
# DEPARTMENT OF WATER RESOURCES

# CLAIM TO A WATER RIGHT

Under the provisions of Section 42-243, Idaho Code, any person using or claiming rights to the public waters of Idaho established by diversion and application to a beneficial use must file a claim with the Department of Water Resources on or before June 30, 1963. Exempted from this filing are single family domestic uses as defined in Section 42-230(d), Idaho Code. Also exempted are rights represented by a permit, license, decree, adjudicated right, or a previously filed claim.

The filing of this claim does not confirm the water right claimed but failure to file may result in forfeiture of a water right.

Notice is hereby given that Boise Warm Springs Water District
(Name of Claimant)

P.O. Box 114, Boise, Idaho 83701 Telephone No. 342-3162
(Mailing Address) (Zip Code)

claims a right to the diversion and beneficial use of the surface or ground water. The extent and nature of said claim is as follows:

(1) Date of priority: (When was the water first applied to a beneficial use) 05 November 1894

A claim is not acceptable on a ground water source with a priority later than March 25, 1963 or on a surface water source with a priority later than May 20, 1971. An exception is that a claim may be filed on single family domestic use from a ground water source.

(2) Describe the source of water: (Name of stream, lake, spring, etc., or ground water)
Groundwater tributary to

(3) Describe the purpose for which the water has been used and the time during the year when you have used the right claimed:

| | (cfs, gpd, AFA) | (Domestic, Irrigation, Stock, Etc.) | Period of Use (Both dates inclusive) (Mo., Day) | | (Mo., Day) |
|---|---|---|---|---|---|
| Quantity | | Use Heating & Domestic | Period of Use From 01JAN | To | 31DEC |
| Quantity | 12.819 c.f.s. | Use | Period of Use From | To | |
| Quantity | 4.273 c.f.s. | Use | Period of Use From | To | |
| Quantity | from each of | Use | Period of Use From | To | |
| Quantity | three wells | Use | Period of Use From | To | |

(4) 2,664 MGD OR TOTAL QUANTITY USED.
(cfs, gpd, AFA) 12.8 CFS - TOTAL

(5) A) Point of diversion: (Location of point where water is diverted from its source)
SE ¼ SW ¼ Sec. 12 Twp. 3 N Rge. 2 E B.M., County of Ada
Additional points of diversion:

B) Describe means of diversion of water: (Pump and pipeline, well, diversion dam, reservoir, length of ditch and field, etc.). Give sizes and capacities: be as specific as possible. Describe any changes in the system and give the date of the change. Three Well Wells & Pumps and Pipeline.

(6) A) Describe location of use by listing number of irrigated acres within each 40-acre tract in appropriate box. If use is not for irrigation, place an "X" in appropriate box to show location.

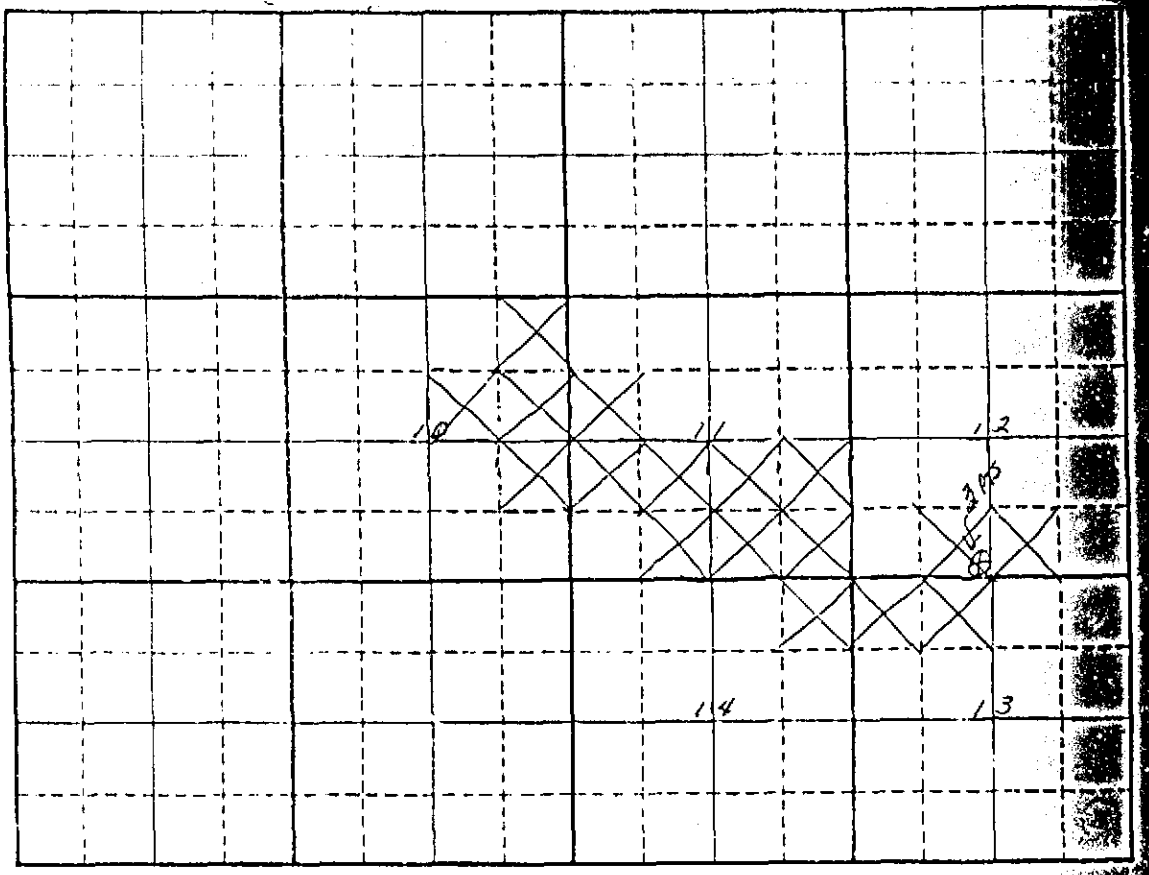
| T | R | SEC. | NE¼ | | | | NW¼ | | | | SW¼ | | | | SE¼ | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NE¼ | NW¼ | SW¼ | SE¼ | NE¼ | NW¼ | SW¼ | SE¼ | NE¼ | NW¼ | SW¼ | SE¼ | NE¼ | NW¼ | SW¼ | SE¼ | |
| 3N | 2E | 10 | X | | X | X | | | | | | | | | X | | | | |
| | | 11 | | | | | | | X | | X | X | | X | X | X | X | X | |
| | | 12 | | | | | | | | | | | | X | | | X | | |
| | | 13 | | | | | X | X | | | | | | | | | | | |
| | | 14 | X | | | | | | | | | | | | | | | | |

No. of acres

B) If water is used for other than irrigation, fully describe that use, being as specific as possible: State of Idaho Department of Health & Agriculture Laboratories, 238 Households for Space Heating; 207 Households for Domestic Supplies

NOTE: Include here the type and number of stock watered:

(7) If you are claiming water as a member of an organization, list name of organization:




Scale: 2 inches equal 1 mile.

Map should show the location of the point of diversion and the place of use of the water by 40-acre subdivisions, section, township and range of the public land survey system.

State of Idaho )
) ss.
County of Ada )

Be it known that the undersigned, being duly sworn, deposes and says that he, she, they subscribed the foregoing claim to a water right, together with all attached information, and that the matters and facts thereon are true to the best of the affiant's knowledge.

Terence O'Rourke
Boise Warm Springs Water District
(Claimant)

Sworn to before me this 22nd day of April, 1983.

Robert H. Griffiths
Notary Public
Residing at Boise, Idaho

ROBERT H. GRIFFITHS
NOTARY PUBLIC
STATE OF IDAHO

My commission expires

FOR DEPARTMENT USE ONLY

Received by [illegible] Date 7-14-83 Exception filed by: Forwarded to claimant by Date

Prelim. check by JO Date 6-14-83 & 7-19-84

~~$30.00~~ fee received by [illegible] Date 5-12-83 # 28972

Published in Idaho Statesman

Dates 6/30, 7/7/83

NOTICE OF WATER RIGHT LOCATION.

To Whom it May Concern:

Notice is hereby given that the ARTESIAN HOT and COLD WATER COMPANY, Limited, a corporation organized under the laws of the State of Idaho, with its principal place of business at Boise City, in Ada County, in said State, has appropriated and does hereby claim the waters flowing from three artesian wells near which this notice is posted, and each and every of said wells, to the extent of four and two hundred and seventy-three one thousandths cubic feet per second of time; which said wells through and by means of which said water is diverted and appropriated are situated in the Southeast quarter of the Southeast quarter of the Southwest quarter of Section Twelve (12) in Township Three (3) North, Range Two (2) East of Boise Meridian, in Ada County, State of Idaho.

That the purposes for which said water is claimed are for domestic uses and for bathing and heating purposes and to warm the waters of a large plunge or swimming bath at a place of public resort, belonging to said Company, known as the "Natatorium," situated about Three Thousand feet in a South-Westerly direction from said wells; and also for sale for domestic uses and for bathing and heating purposes; and all other purposes for which hot water may be used, and for irrigation and sprinkling in Boise City, in said county and along or near the line of conduit or pipes used in conveying said water from said wells to and through the streets and alleys of Boise City.

That the place or locality of the intended use of said water is at said Natatorium and the grounds surrounding the same, and in said Boise City, and along and near the line of the conduit and pipes used, or that may be used in conveying said water as hereinafter described.

That the general course, length and destination of the conduit or pipes by which it is proposed to divert said water is as follows: Commencing at each of said wells and running North of West about one hundred and sixty feet through separate pipes to a

1

4.273 c/s

SESESW, 12, T3N, R2E

Dom, Heat, Bathing.

In Boise City

common main pipe; thence South 70 degrees 35 minutes East [illegible] feet to the South side of the public road, known as Warm Springs Avenue; thence Westerly along said Avenue, 360 feet to a T in said pipe by which a part of said water is diverted and runs [illegible] South Easterly direction 302 feet to said Natatorium building; from said Tee running in a Westerly direction along said Warm Springs Avenue 5606 feet to the junction of Idaho Street in said City; thence Westerly along Idaho Street 5363 feet to a point 120 feet East of the East line of Thirteenth Street and about 13945 feet from said Falls; together with all the lateral pipes and conduits connecting said main conduit with the buildings and premises where said water is or may be used.

Posted at or near the point of intended diversion, on the 23d day of November, 1895.

ARTESIAN HOT & COLD WATER COMPANY, Limited,
Appropriator and Claimant,

By _____ President.

Attest: _____
Secretary.

State of Idaho, }
County of Ada. } ss.

Benjamin S. Rowe, of Boise City, Ada County, State of Idaho, being first duly sworn, deposes and says: That he is of lawful age and is the Secretary of the Artesian Hot and Cold Water Company, Limited, a corporation, and the appropriator and claimant of the water right described in the foregoing Notice. That the statements in said notice are true, and that the original Notice, of which the foregoing is a true copy, was posted in a conspicuous place near the artesian wells of said Company, the point of diversion of said water, at five o'clock P.M. of the twenty-third day of November, 1895.

Subscribed and sworn to before me this twenty-fourth day of November, 1895. } _____

Richard H. Johnson
Notary Public.

STAMPED BY
A. H. & C. WATER CO.

# NOTICE OF WATER RIGHT LOCATION

TO WHOM IT MAY CONCERN:

Notice is hereby given that the Artesian Hot and Cold Water Company, Limited, a corporation created and existing under the laws of the State of Idaho, with its principal place of business at Boise City, Ada County, in said State heretofore on the 5th day of November, 1894, appropriated and is the owner and claimant of the following described water rights, to-wit: The waters flowing from three artesian wells and each and every of said wells, to the extent of four and two hundred and seventy-three one thousandths cubic feet per second of time; which said wells through and by means of which said water is diverted and appropriated are situated in the South-east quarter of the South-east quarter of the South-west quarter of Section Twelve (12) in Township Three (3) North, Range Two (2) East of Boise Meridian, in Ada County, State of Idaho.

That the location and specific uses for which said water is claimed are for domestic and for bathing and heating purposes and to warm the waters of a large plunge or swimming bath at a place of public resort, belonging to said company, known as the "Natatorium", situated about three thousand feet in a South-westerly direction from said wells; and also for sale for domestic uses and for bathing and heating purposes, and for all other purposes for which hot water may be used, and for irrigating and sprinkling, in Boise City in said County and along or near the line of the conduit or pipes used in conveying said water from said wells to and through the streets and alleys of Boise City, commencing at each of said wells and running North of West about one hundred and sixty feet through separate pipes to a common pipe; thence South 70 degrees 15 minutes West 2514 feet to the South-west side of the public road known as Warm Springs Avenue; thence Westerly along said Avenue, 300 feet to a tee in said pipe by which a part of said water is diverted and runs in a South-westerly direction, 200 feet to said Natatorium building; and from said tee running in a Westerly direction along said Warm Springs Avenue, 5600 feet to the junction of Idaho Street in Boise City; thence Westerly along Idaho Street, 5363 feet to a point 120 feet East of the east line of Thirteenth Street and about 1.2.3 feet from said wells; together with all the lateral and distributing pipes and conduits connecting said main conduit with the buildings and premises where said water is or may be used.

Dated November 24th, 1899.

Artesian Hot & Cold Water Company, Limited,
Owner and Claimant.

Attest: B.H.Howe, Secretary. By C.W.Moore, President.

State of Idaho, )
:- ss.
County of Ada. )

Benjamin S.Howe, of Boise City, Ada County, State of Idaho, being first duly sworn deposes and says: That he is of lawful age and is the Secretary of the Artesian Hot and Cold Water Company, Limited, the corporation named in the foregoing notice and the owner and claimant of the water right described in said notice; and that the statements in said notice are true.

Benjamin S.Howe

Subscribed and sworn to before me this twenty-fifth day of November, 1899.

( SEAL ) Richard H.Johnson
Notary Public

( U.S.I.R.3. )
( ---------- )
( Nov.25,1899 )
(10¢ cancelled)

Recorded at the request of Walter Kearns at 2 P.M., November 25, 1899.
Recorded at the request of Walter Kearns at 2 P.M., November 25, 1899.

Recorder. By Deputy.

Return in 65-9150

ARTESIAN WELLS
APPROPRIATED BY
A. H. & C. WATER CO.

NOTICE OF WATER RIGHT LOCATION

TO WHOM IT MAY CONCERN:

Notice is hereby given that the Artesian Hot and Cold Water Company, Limited, a corporation created and existing under the laws of the State of Idaho, with its principal place of business at Boise City, Ada County, in said State heretofore on the 5th day of November, 1894, appropriated and is the owner and claimant of the following described water rights, to-wit: The water flowing from three artesian wells and each and every of said wells, to the extent of four and two hundred and seventy-three one thousandths cubic feet per second of time; which said wells through and by means of which said water is diverted and appropriated are situated in the South-east quarter of the South-east quarter of the South-west quarter of Section Twelve (12) in Township Three (3) North, Range Two (2) East of Boise Meridian, in Ada County, State of Idaho.

That the location and specific uses for which said water is claimed are for domestic and for bathing and heating purposes and to warm the waters of a large plunge or swimming bath at a place of public resort, belonging to said company, known as the "Natatorium", situated about three thousand feet in a South-westerly direction from said wells; and also for sale for domestic uses and for bathing and heating purposes, and for all other purposes for which hot water may be used, and for irrigating and sprinkling, in Boise City in said County and along or near the line of the conduit or pipes used in conveying said water from said wells to and through the streets and alleys of Boise City, commencing at each of said wells and running North of West about one hundred and sixty feet through separate pipes to a common pipe; thence South 70 degrees 15 minutes West 2514 feet to the South-west side of the public road known as Warm Springs Avenue; thence Westerly along said Avenue, 300 feet to a tee in said pipe by which a part of said water is diverted and runs in a South-westerly direction, 200 feet to said Natatorium building; and from said tee running in a Westerly direction along said Warm Springs Avenue, 5608 feet to the junction of Idaho Street in Boise City; thence Westerly along Idaho Street, 5363 feet to a point 120 feet East of the east line of Thirteenth Street and about 10945 feet from said wells; together with all the lateral and distributing pipes and conduits connecting said main conduit with the buildings and premises where said water is or may be used.

Dated November 24th, 1899.

Artesian Hot & Cold Water Company, Limited,
Owner and Claimant.

Attest: B.H.Howe, Secretary. By C.W.Moore, President.

State of Idaho, )
:- ss.
County of Ada. )

Benjamin S.Howe, of Boise City, Ada County, State of Idaho, being first duly sworn deposes and says: That he is of lawful age and is the Secretary of the Artesian Hot and Cold Water Company, Limited, the corporation named in the foregoing notice and the owner and claimant of the water right described in said notice; and that the statements in said notice are true.

Benjamin S.Howe

Subscribed and sworn to before me this twenty-fifth day of November, 1899.

Richard H.Johnson
Notary Public

( SEAL )

( U.S.I.R.S. )
( ---------- )
( Nov.25,1899 )
( 10¢ cancelled )

Recorded at the request of Walter Keefe at 2 P.M. November 25, 1899

[illegible] Recorder. By [illegible] Deputy.

ARTESIAN WELLS
APPROPRIATED BY
H. & C. WATER CO.

# NOTICE OF WATER RIGHT

## LOCATION

TO WHOM IT MAY CONCERN:

Notice is hereby given that the ARTESIAN HOT AND COLD WATER COMPANY, Limited, a corporation organized under the laws of the State of Idaho, with its principal place of business at Boise City, in Ada County, in said State, has appropriated and does hereby claim the waters flowing from three artesian wells near which this notice is posted, and each and every of said wells, to the extent of four and two hundred and seventy-three one thousandths cubic feet per second of time, which said wells through and by means of which said water is diverted and appropriated are situated in the South-east quarter of the South-east quarter of the South-west quarter of Section twelve (12) in Township Three (3) North, Range Two (2) East of Boise Meridian, in Ada County, State of Idaho.

That the purposes for which said water is claimed are for domestic uses and for bathing and heating purposes and to warm the waters of a large plunge or swimming bath at a place of public resort, belonging to said Company, known as the "Natatorium," situated about three thousand feet in a South-westerly direction from said wells; and also for sale for domestic uses and for bathing and heating purposes; and all other purposes for which hot water may be used, and for irrigation and sprinkling in Boise City, in said County and along or near the line of conduit of pipes used in conveying said water from said wells to and through the streets and alleys of Boise City.

That the place or locality of the intended use of said water is at said Natatorium and the grounds surrounding the same, and in said Boise City and along and near the line of the of the conduit and pipes used, or that may be used in conveying said water as hereinafter described.

That the general course, length and destination of the conduit or pipes by which it is proposed to divert said water is as follows: Commencing at each of said wells and running North of West about one hundred and sixty feet through separate pipes to a common main pipe; thence South 70 degrees 15 minutes West, 2514 feet to the South side of the public road, known as Warm Springs Avenue; thence Westerly along said Avenue, 300 feet to a Tee in said pipes by which a part of said water is diverted and runs in a Southeasterly direction 302 feet to said Natatorium building; and from said Tee running in a Westerly direction along said Warm Springs Avenue 5608 feet to the junction of Idaho Street in Boise City; thence Westerly along Idaho Street 6363 feet to a point 120 feet East of the East line of Thirteenth Street and about 13945 feet from said wells; together with all the lateral pipes and conduits connecting said main conduit with the buildings and premises where said water is or may be used.

Posted at or near the point of intended diversion, on the 23d day of November, 1899.

Artesian Hot & Cold Water Company, Limited,
Appropriator and Claimant,
By C.W.Moore President.

Attest: B.S.Howe
Secretary

State of Idaho, )
:- ss.
County of Ada. )

Benjamin S.Howe, of Boise City, Ada County, State of Idaho, being first duly sworn, deposes and says; that he of lawful age and is the Secretary of the Artesian Hot and Cold Water Company, Limited, a corporation, and the appropriator and claimant of the water right described in the foregoing notice. That the statements in said notice are true, and that the original notice, of which the foregoing is a true copy was posted in a conspicuous place near the artesian wells of said company, the point of diversion of said water, at five o'clock P.M. of the twenty-third day of November, 1899.

B.S.Howe

Subscribed and sworn to before me this twenty-fourth day of November, 1899.

Richard H.Johnson
Notary Public

( SEAL )

( U.S.I.R.S. )
( B.S.H. )
( 11-24-99 )
(10¢ cancelled )

Recorded at the request of B.S.Howe at 2:30 P.M. November 24, 1899.

IDAHO DEPARTMENT OF WATER RESOURCES

Adjudication Recommendation Report 63-5073 V1

WATER RIGHT NUMBER: 63-5073 V1

| Owner Type | Name and Address |
|---|---|
| Current Owner | BOISE WARM SPRINGS WATER DIST<br>2440 OLD PENITENTIARY RD<br>BOISE, ID 83712<br>(208)342-3162 |
| Attorney | MOORE SMITH BUXTON & TURCKE, CHTD<br>ATTN:BRUCE SMITH<br>225 N 9TH ST, STE 420<br>BOISE, ID 83702<br>(208)331-1800 |

Priority Date: 11/05/1894

Basis: Beneficial Use

Status: Active

| Source | Tributary |
|---|---|
| GROUND WATER | |

| Beneficial Use | From | To | Diversion Rate | Annual Volume |
|---|---|---|---|---|
| DOMESTIC | 01/01 | 12/31 | 3.750 CFS | |
| HEATING | 01/01 | 12/31 | 3.750 CFS | |
| | | Total Diversion: | 3.750 CFS | 958.00 AF |

Location of Point(s) of Diversion

GROUND WATER SE1/4SE1/4SW1/4 Sec. 12, Twp 03N, Rge 02E, B.M.

ADA County

Place of Use

DOMESTIC Within ADA County

| | | | |
|---|---|---|---|
| T03N R02E S10 | NENE | T03N R02E S10 Lot | 3 SWNE |
| T03N R02E S10 Lot | 1 SENE | T03N R02E S10 Lot | 2 NESE |
| T03N R02E S11 Lot | 4 SWNW | T03N R02E S11 | NESW |
| T03N R02E S11 | NWSW | T03N R02E S11 Lot | 6 SESW |
| T03N R02E S11 | NESE | T03N R02E S11 | NWSE |
| T03N R02E S11 | SWSE | T03N R02E S11 | SESE |
| T03N R02E S12 | SESW | T03N R02E S13 | NENW |
| T03N R02E S13 | NWNW | T03N R02E S14 | NENE |

HEATING Within ADA County

| | | | |
|---|---|---|---|
| T03N R02E S10 | NENE | T03N R02E S10 Lot | 3 SWNE |
| T03N R02E S10 Lot | 1 SENE | T03N R02E S10 Lot | 2 NESE |
| T03N R02E S11 Lot | 4 SWNW | T03N R02E S11 | NESW |
| T03N R02E S11 | NWSW | T03N R02E S11 Lot | 6 SESW |

IDAHO DEPARTMENT OF WATER RESOURCES

Adjudication Recommendation Report 63-5073 V1

| | | | |
|---|---|---|---|
| T03N R02E S11 | NESE | T03N R02E S11 | NWSE |
| T03N R02E S11 | SWSE | T03N R02E S11 | SESE |
| T03N R02E S12 | SESW | T03N R02E S13 | NENW |
| T03N R02E S13 | NWNW | T03N R02E S14 | NENE |

Conditions of Approval:

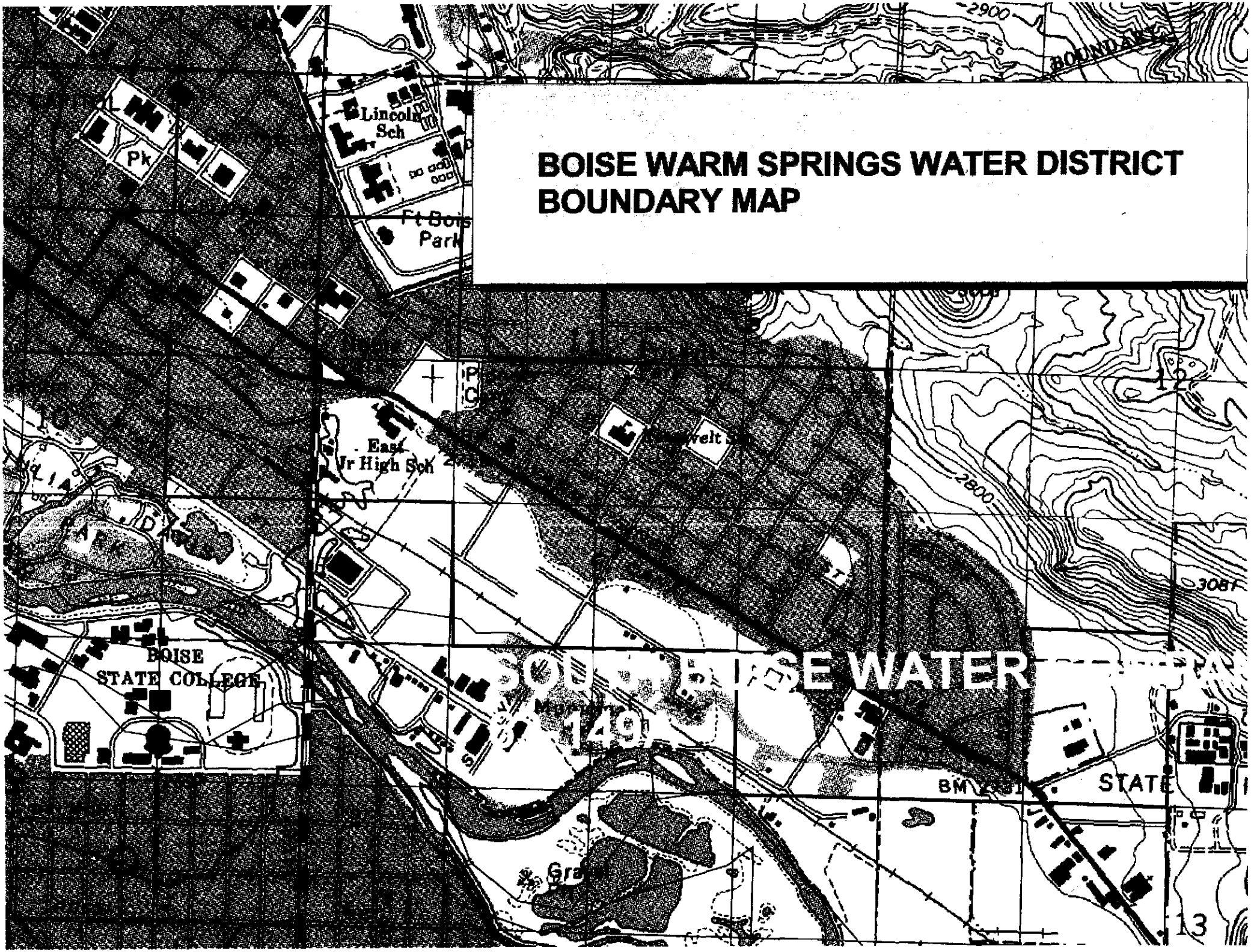
1. 129 PLACE OF USE IS WITHIN THE SERVICE AREA OF THE BOISE WARM SPRINGS WATER DISTRICT
2. 135 The boundary encompassing the place of use for this water right is described with a digital boundary as defined by I.C. Section 42-202B(2) and authorized pursuant to I.C. Section 42-1411(2)(h). The data comprising the digital boundary are incorporated herein by reference and are stored on a CD-ROM disk issued in duplicate originals on file with the SRBA District Court and the Idaho Department of Water Resources. A map depicting the place of use is attached hereto to illustrate the place of use described by the digital boundary.
3. C18 This partial decree is subject to such general provisions necessary for the definition of the rights or for the efficient administration of the water rights as may be ultimately determined by the Court at a point in time no later than the entry of a final unified decree. Section 42-1412(6), Idaho Code.

Remarks:

1. Explanatory THE USE IS LIMITED TO 266 RESIDENTIAL AND COMMERCIAL SERVICES WITH THE BOUNDARY OF THE BOISE WARM SPRINGS WATER DISTRICT.
2. Explanatory WATER TEMPERATURE MEASURED AT 172 DEGREES F.
3. Explanatory WATER IS LOW TEMPERATURE GEOTHERMAL WATER.

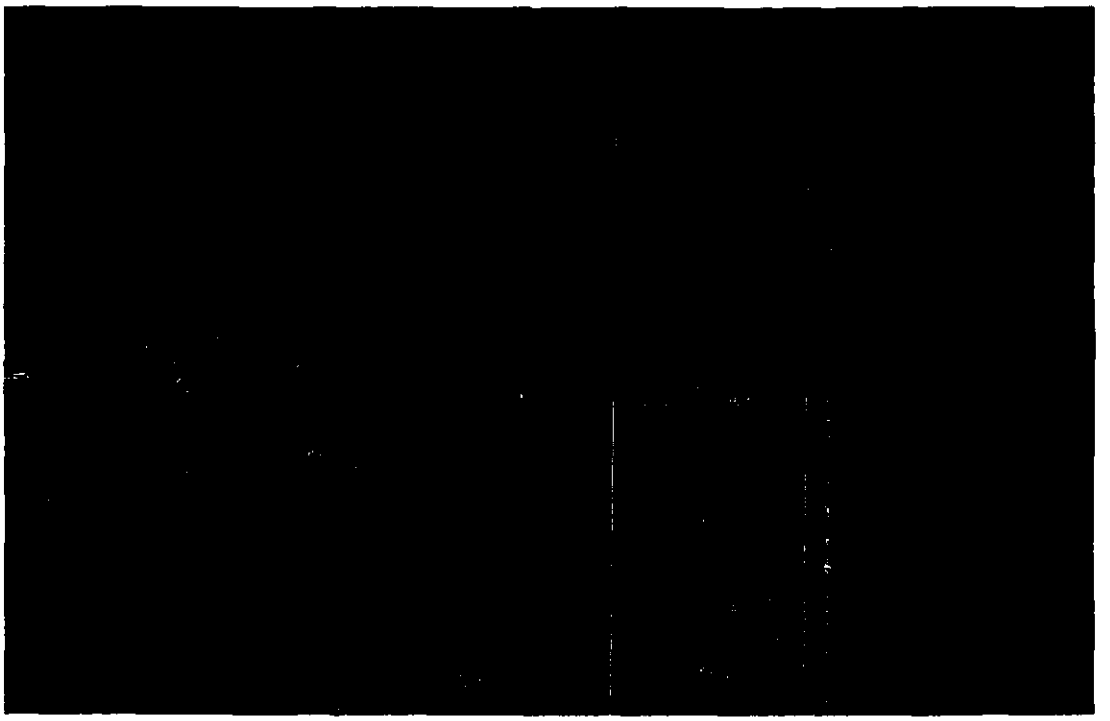
Comments:

1. mschulte 3/26/2004 GROUND WATER MANAGEMENT AREA
Comment: THIS RIGHT IS WITHIN THE BOISE FRONT LOW TEMPERATURE GEOTHERMAL GROUND WATER MANAGEMENT AREA AND THE USE OF WATER UNDER THIS RIGHT MUST BE MONITORED AND REPORTED TO THE IDAHO DEPARTMENT OF WATER RESOURCES


BOISE WARM SPRINGS WATER DISTRICT
BOUNDARY MAP
Lincoln Sch
Pk
Ft Bois Park
East Jr High Sch
BOISE STATE COLLEGE
BOISE WATER
Murgoitio
1149
STATE
12
13

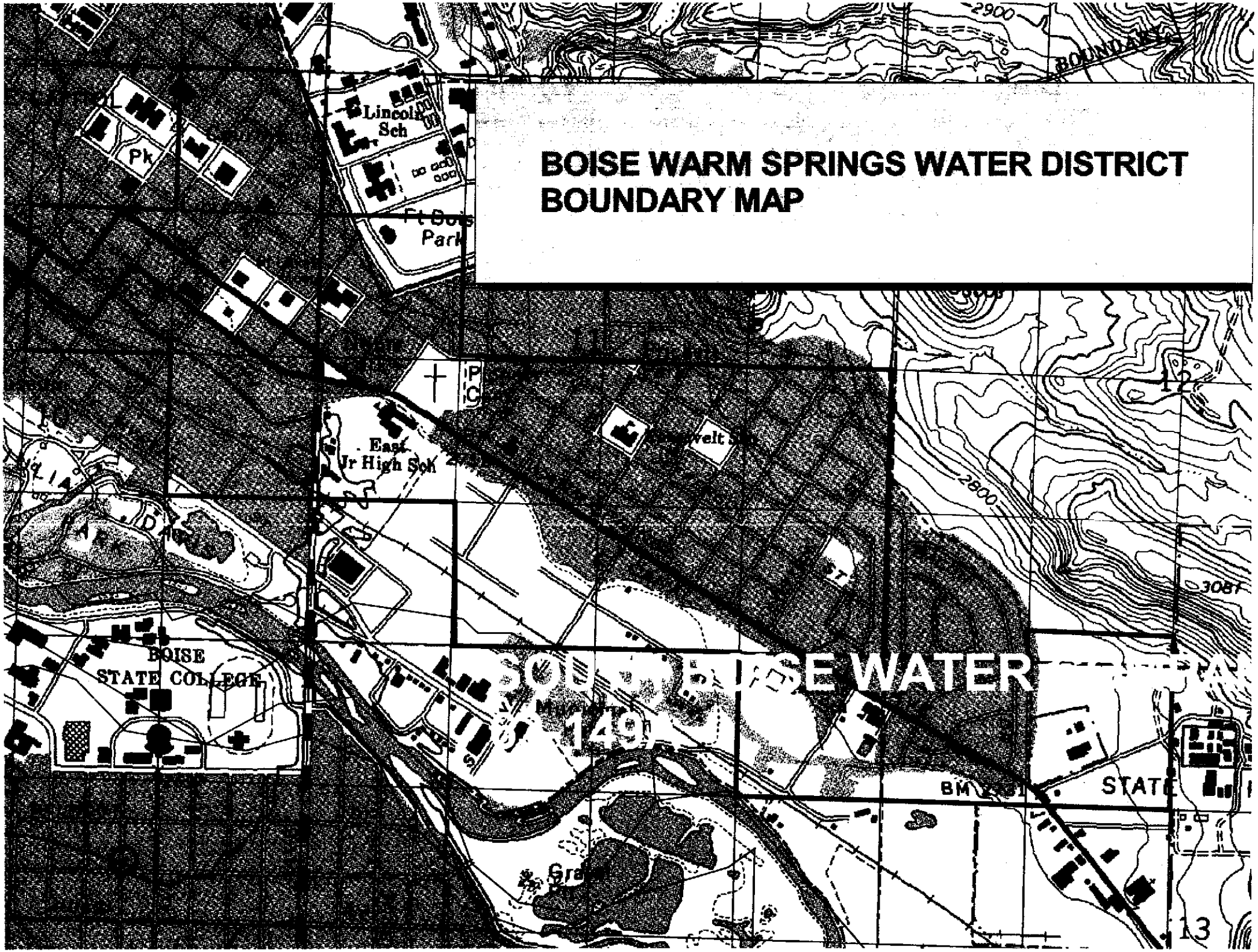
BOISE WARM SPRINGS WATER DISTRICT
PHOTOGRAPHS DATED 10/14/2002

PHOTO #1



PUMP HOUSE AND POD SITE BEHIND THE OLD STATE PENETENTARY.

PHOTO #2

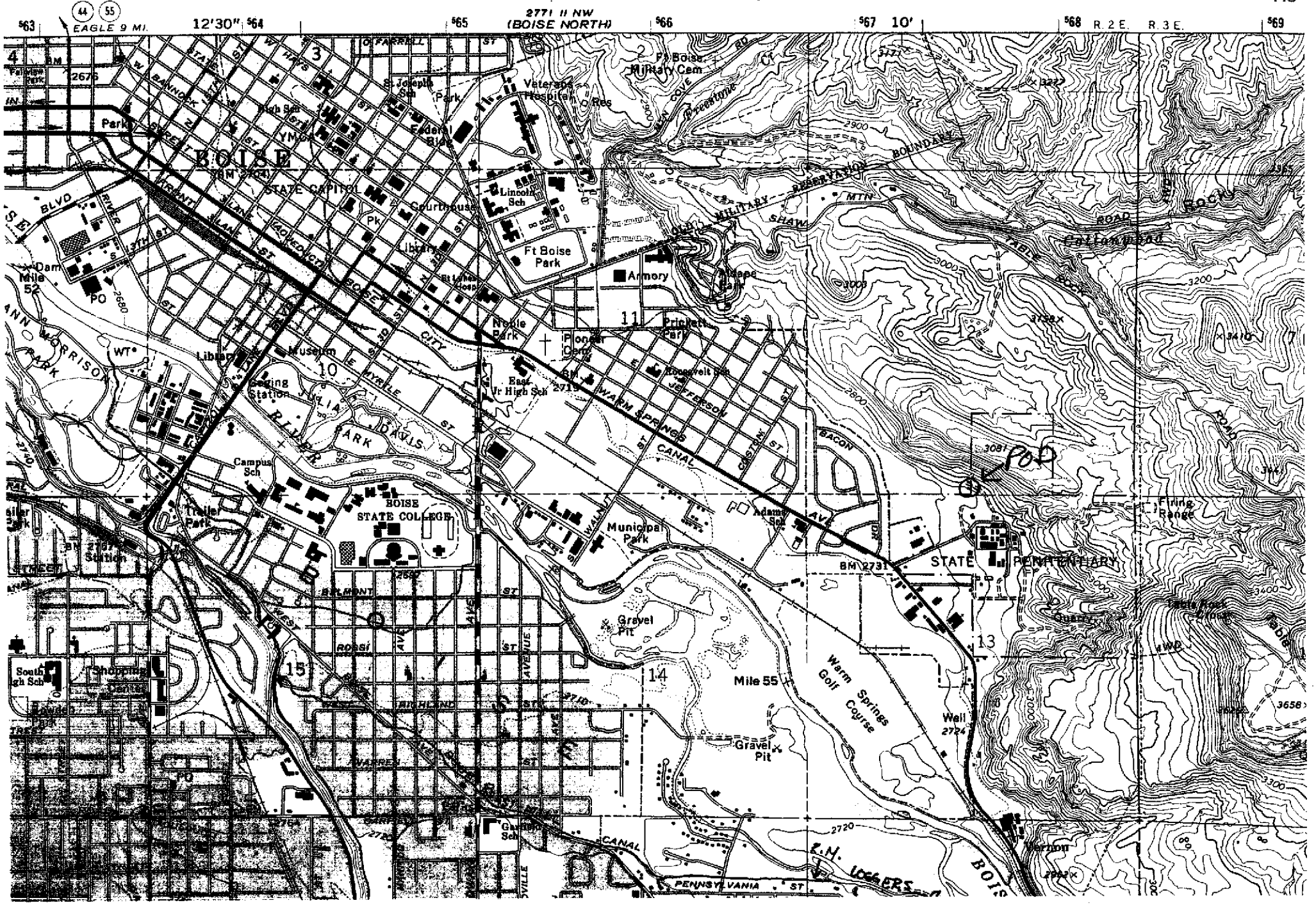

BOISE WARM SPRINGS WATER DISTRICT
BOUNDARY MAP
Lincoln Sch
Pk
Ft Boise Park
East Jr High Sch
BOISE STATE COLLEGE
BOISE WATER
149
STATE
12
13

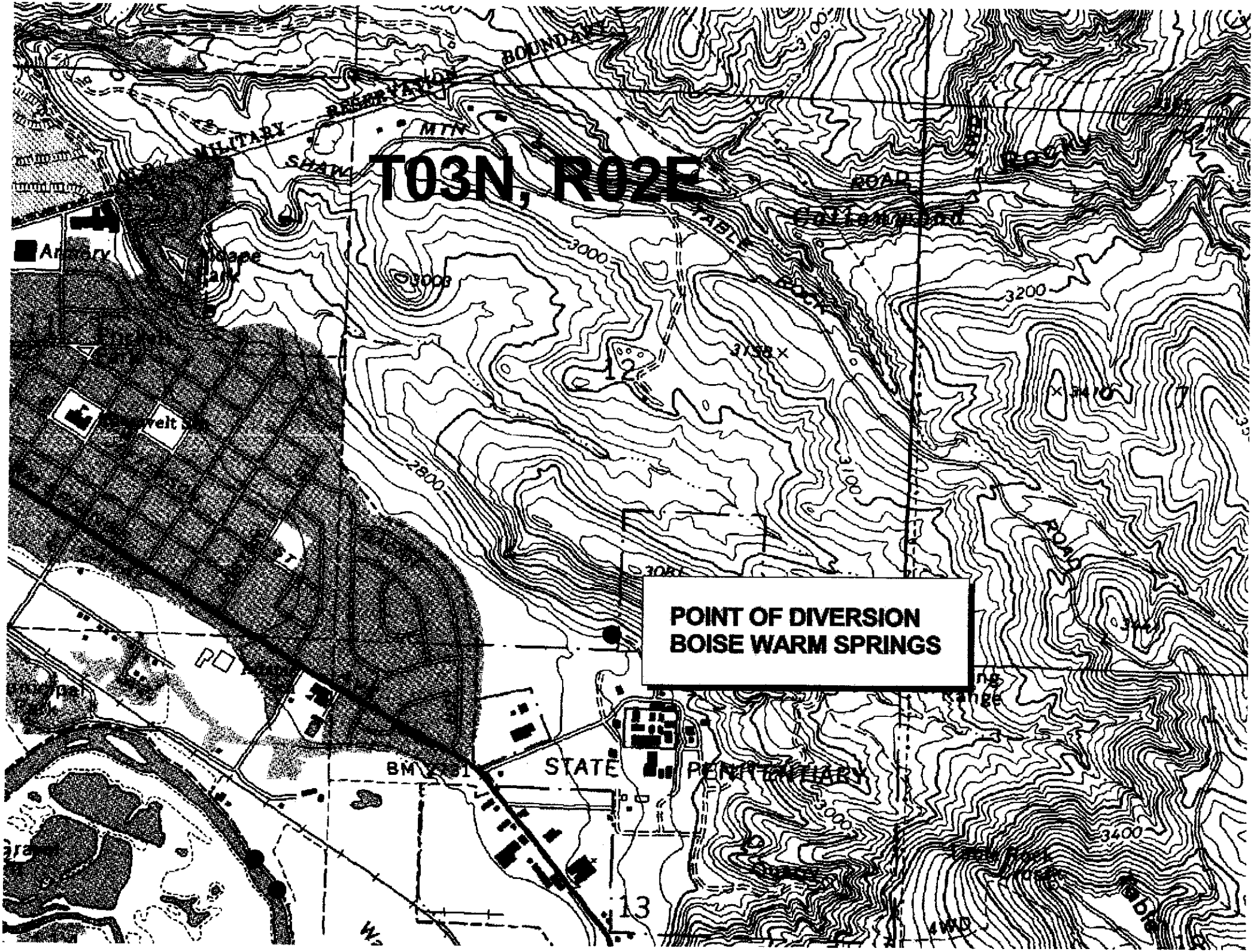
63-5073

T03N, R02E

BC

7.5




T03N, R02E
POINT OF DIVERSION
BOISE WARM SPRINGS
STATE PENITENTIARY
MILITARY RESERVATION
BOUNDARY
MTN
ROAD
FABLE
BLOCK
12
13
3000
3200
2800
3100
3400
4WD

IDAHO DEPARTMENT OF WATER RESOURCES

Water Right Report 63-5073

WATER RIGHT NUMBER: 63-5073

| Owner Type | Name and Address |
|---|---|
| Current Owner | BOISE WARM SPRINGS WATER DISTRICT<br>PO BOX 114<br>BOISE, ID 83701 |

Priority Date: 11/05/1894

Basis: Statutory Claim

Status: Active

Source: GROUND WATER

Tributary

| Beneficial Use | From To | Diversion Rate | Annual Volume |
|---|---|---|---|
| HEATING | 1/01 to 12/31 | 12.819 CFS | |
| DOMESTIC | 1/01 to 12/31 | 4.273 CFS | |
| | Total Diversion: | 12.800 CFS | |

Location of Point(s) of Diversion

GROUND WATER SE SE1/4SW1/4 Sec. 12, Twp 03N, Rge 02E, B.M.

ADA County

POD is about 100' NW of the SE corner of the SESW, 12.

On SDE 10-18-02.

Place of Use

HEATING

| Twp Rge Sec | NE | | | | NW | | | | SW | | | | SE | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NE | NW | SW | SE | NE | NW | SW | SE | NE | NW | SW | SE | NE | NW | SW | SE | |
| 03N 02E 10 | X | | X | X | | | | | | | | | X | | | | |
| 03N 02E 11 | | | | | | | X | | X | X | | X | X | X | X | X | |
| 03N 02E 12 | | | | | | | | | | | | X | | | X | | |
| 03N 02E 13 | | | | | X | X | | | | | | | | | | | |
| 03N 02E 14 | X | | | | | | | | | | | | | | | | |

DOMESTIC same as HEATING

Conditions of Approval:

Remarks:

IDAHO DEPARTMENT OF WATER RESOURCES

Water Right Report 63-5073

1. General P/U 680 AC.

Comments:

Dates and Other Information:

Licensed Date:
Decreed Date:
Water Supply Bank Enrollment Accepted:
Water Supply Bank Enrollment Removed:
Enlargement Use Priority Date:
Enlargement Statute Priority Date:
Formal Action Date:
State or Federal:
Owner Name Connector:
Water District Number:
Generic Max Rate Per Acre:
Generic Max Volume Per Acre:
Decree Defendant:
Decree Plaintiff:
Civil Case Number:
Judicial District:
Swan Falls Trust or Nontrust:
Swan Falls Dismissed:
DLE Act Number:
Carey Act Number:
Mitigation Plan: False

IDAHO DEPARTMENT OF WATER RESOURCES

Adjudication Claim Report 63-5073

WATER RIGHT NUMBER: 63-5073

| Owner Type | Name and Address |
|---|---|
| Current Owner | BOISE WARM SPRINGS WATER DISTRICT<br>2440 OLD PENITENTIARY RD<br>BOISE, ID 83712<br>(208)342-3162 |

Priority Date: 11/05/1894

Basis:

Status: Active

Source: GROUND WATER

Tributary:

| Beneficial Use | From | To | Diversion Rate | Annual Volume |
|---|---|---|---|---|
| DOMESTIC | 1/01 | 12/31 | 4.000 CFS | |
| HEATING | 1/01 | 12/31 | 8.819 CFS | |
| | | Total Diversion: | 12.819 CFS | |

should possibly be 4.273 cfs total (See posted notices)

Location of Point(s) of Diversion

GROUND WATER SE1/4SE1/4SW1/4 Sec. 12, Twp 03N, Rge 02E, B.M.

ADA County

Place of Use

DOMESTIC

| Twp Rge Sec | NE | | | | NW | | | | SW | | | | SE | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NE | NW | SW | SE | NE | NW | SW | SE | NE | NW | SW | SE | NE | NW | SW | SE | |
| 03N 02E 10 | X | | X | X | | | | | | | | | X | | | | |
| 03N 02E 11 | | | | | | | X | | X | X | | X | X | X | X | X | |
| 03N 02E 12 | | | | | | | | | | | | X | | | | | |
| 03N 02E 13 | | | | | X | X | | | | | | | | | | | |
| 03N 02E 14 | X | | | | | | | | | | | | | | | | |

HEATING

| Twp Rge Sec | NE | | | | NW | | | | SW | | | | SE | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NE | NW | SW | SE | NE | NW | SW | SE | NE | NW | SW | SE | NE | NW | SW | SE | |

IDAHO DEPARTMENT OF WATER RESOURCES

Adjudication Claim Report 63-5073

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 03N 02E 10 | X | | X | X | | | | | | | | | X | | | |
| 03N 02E 11 | | | | | | | X | | X | X | | X | X | X | X | X |
| 03N 02E 12 | | | | | | | | | | | | X | | | | |
| 03N 02E 13 | | | | | X | X | | | | | | | | | | |
| 03N 02E 14 | X | | | | | | | | | | | | | | | |

Conditions of Approval:

Remarks:

1. General DISTRICT OWNS WELL SITE. CITIZENS IN DISTRICT OWN INDIVIDUAL PARCELS. DISTRICT PROVIDES SERVICE TO STATE OF IDAHO HEALTH AND AGRICULTURE, CORRECTIONS AS WELL AS RESIDENCES AND COMMERCIAL OFFICE. 3 WELLS AT 400' X 12", 2 PUMPS, 16000' +- TRANSMISSION AND DISTRIBUTION SYSTEM, 266 SERVICE CONNECTIONS. ONE WELL INACTIVE AT THIS TIME. BOISE GEOTHERMAL AQUIFER.

Comments:

Dates and Other Information:

Claim Received Date: 7/14/1989
Enlargement Use Priority Date:
Enlargement Statute Priority Date:
State or Federal: S
Owner Name Connector:
Water District Number:
Generic Max Rate Per Acre:
Generic Max Volume Per Acre:
Swan Falls Trust or Nontrust:
Swan Falls Dismissed:
DLE Act Number:
Carey Act Number:
Mitigation Plan: False

IDAHO DEPARTMENT OF WATER RESOURCES

Water Permit Report 63-9160

WATER RIGHT NUMBER: 63-9160

| Owner Type | Name and Address |
|---|---|
| Current Owner | BOISE WARM SPRINGS WATER DIST<br>2440 OLD PENITENTIARY RD<br>BOISE, ID 83712<br>(208)342-3162 |

Priority Date: 06/27/1978

Basis:

Status: Active

| Source | Tributary |
|---|---|
| GROUND WATER | |

| Beneficial Use | From | To | Diversion Rate | Annual Volume |
|---|---|---|---|---|
| HEATING | 1/01 | 12/31 | 4.000 CFS | |
| DOMESTIC | 1/01 | 12/31 | 4.000 CFS | |
| | | Total Diversion: | 4.000 CFS | |

Location of Point(s) of Diversion

GROUND WATER SE1/4SW1/4 Sec. 12, Twp 03N, Rge 02E, B.M.

ADA County

Place of Use

Conditions of Approval:

1. 004 The issuance of this right does not grant any right-of-way or easement across the land of another.
2. 010 Return water shall be treated to insure that the effluent meets interstate stream water quality standards.
3. 01C A flow measurement port or other device as specified by the Department shall be installed by the right holder to provide for the installation of measuring equipment and the determination of the rate of diversion by the Department.

Remarks:

1. General P/U WITHIN BOISE WARM SPRINGS WATER DIST.

Comments:

1. SKAGGS 9/10/1991 MORATORIUM HOLD
Comment: On hold in Boise Front Low Temperature Geothermal GWMA Moratorium; request for extension of time pending.

Dates and Other Information:

BEFORE THE DIRECTOR OF THE DEPARTMENT OF WATER RESOURCES

OF THE

STATE OF IDAHO

| | |
|---|---|
| IN THE MATTER OF THE BOISE FRONT LOW TEMPERATURE GEOTHERMAL RESOURCE GROUND WATER MANAGEMENT AREA | ORDER ESTABLISHING A GROUND WATER MANAGEMENT AREA |

This matter having come before the Director of the Department of Water Resources as a result of declining water levels reported in the low temperature geothermal resource system, the Director Finds, Concludes and Orders as follows:

FINDINGS OF FACT

1. The Director of the Department of Water Resources has the responsibility to administer the ground water basins of the State to protect prior rights yet allow full economic development.

2. There is a growing concern that the present stage of permitted development of the low temperature geothermal resource system in the Boise Front Area may be approaching the conditions of a critical ground water area.

3. Two of the three major users of the thermal system came on line in the early 1980's.

4. Outstanding, approved permits allow for the additional development of more than 30 cubic feet per second from the low temperature geothermal resource system.

5. The early priority user of the thermal system has expressed concern over declines in production and recovery of their wells over the past few years.

RECEIVED
JUN 18 1987
Department of Water Resources
Western Regional Office

6. A preliminary study performed by Boise State University on several wells in a portion of the low temperature geothermal resource system indicates that the resource may be limited and that significant declines in water levels in pumped and monitored wells within the system are occurring.

## CONCLUSIONS OF LAW

1. Section 42-226, Idaho Code, declares all ground waters to be the property of the State, and charges the State with supervising the appropriation and allotment of the same so that early appropriation of underground water are protected in the maintenance of reasonable groundwater pumping levels.

2. In order to establish whether withdrawals from the low temperature geothermal resource system are exceeding the capacity of the system to provide an ongoing supply of water and to protect early appropriators, all existing wells and future wells that obtain water either from a depth greater than 300 feet and/or a temperature of 85°F within the area designated, must be monitored and controlled.

3. Section 42-233b, Idaho Code, authorizes the Director of the Idaho Department of Water Resources to designate areas as "ground water management areas" to allow increased management of the ground water resources.

## ORDER

NOW, THEREFORE, IT IS HEREBY ORDERED that the following described area be included within and designated as the "Boise Front Low Temperature Geothermal Resource Ground Water Management Area" pursuant to provisions of Section 42-233b, Idaho Code:

From a point of beginning at the Northeast corner of Sec. 8, T4N, R2E; thence southerly 1 mile to the southeast corner of Sec. 8; thence easterly approximately 3 miles to the northeast corner of Sec. 14; then southerly 2 miles to the southeast corner of Sec. 23; thence easterly 2 miles to the northeast corner of Sec. 30, T4N, R3E; thence southerly 2 miles to the southeast corner of Sec. 31; thence easterly approximately 1 mile to the southeast corner of Sec. 32; thence southerly approximately 2 miles to the northwest corner of Sec. 16, T3N, R3E; thence easterly 1 mile to the northeast corner of Sec. 16; thence southerly 1 mile to the southeast corner of Sec. 16; thence easterly 1 mile to the southeast corner of Sec. 15; thence southerly approximately 5 miles to the southeast corner of Sec. 10, T2N, R3E; thence westerly approximately 9 miles to the southwest corner of Sec. 8, T2N, R2E; thence northerly 4 miles to the southwest corner of Sec. 20, T3N, R2E; thence westerly approximately 2 miles to the southwest corner of Sec. 24, T3N, R1E; thence northerly approximately 4 miles to the southwest corner of Sec. 36, T4N, R1E; thence westerly 2 miles to the southwest corner of Sec. 34; thence northerly approximately 5 miles to the northwest corner of Sec. 10; thence easterly approximately 5 miles to the point of beginning.

IT IS FURTHER HEREBY ORDERED that the resource of concern is the ground water greater than 85°F and/or the ground water at a depth of 300 feet or more below land surface.

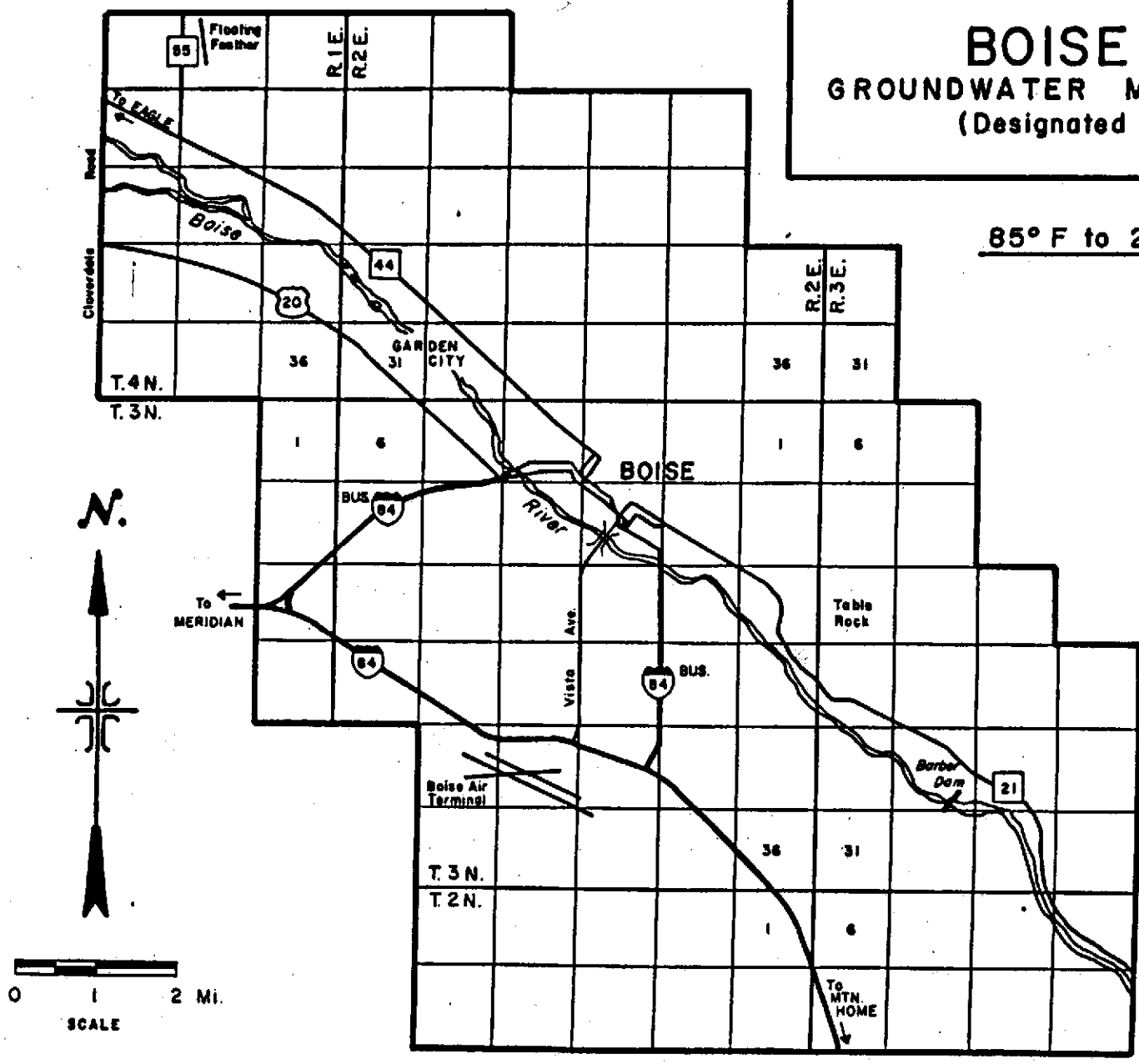
DATED this 15th day of June 1987.

A. KENNETH DUNN
Director

# BOISE FRONT
## GROUNDWATER MANAGEMENT AREA
(Designated June 15, 1987)

85° F to 212° F Water

OR cold water ≥ 300'




DEPARTMENT OF WATER RESOURCES

BEFORE THE DEPARTMENT OF WATER RESOURCES

OF THE

STATE OF IDAHO

| | |
|---|---|
| IN THE MATTER OF A COMPREHENSIVE MONITORING PROGRAM IN THE BOISE FRONT LOW TEMPERATURE GEOTHERMAL RESOURCE GROUND WATER MANAGEMENT AREA | ORDER REQUIRING MONITORING AND RECORD KEEPING |

This matter having come before the Director of the Department of Water Resources (Department) as a result of reported water level declines of the Boise Front Low Temperature Geothermal Resource Ground Water Management Area, and the need for a comprehensive monitoring system, the Director finds, concludes and orders as follows:

FINDINGS OF FACT

1. The Director of the Department has the responsibility to administer the ground water basins of the State to protect prior rights yet allow full economic development.

2. The Boise Front Low Temperature Geothermal Resource Ground Water Management Area was designated by the Director on June 15, 1987.

3. A preliminary study performed by Boise State University on several wells in a portion of the management area indicates that the resource may be limited and that significant declines in water levels in pumped and monitored wells within the system are occurring.

## CONCLUSIONS OF LAW

1. Section 42-226, Idaho Code, declares all ground waters to be the property of the State, and charges the State with supervising the appropriation and allotment of the same so that early appropriation of underground water are protected in the maintenance of reasonable groundwater pumping levels.

2. Section 42-233b, Idaho Code, authorizes the Director of the Department of Water Resources to require all water right holders within a designated ground water management area to report withdrawals and other necessary information for the purpose of assisting him in determining water usage and available ground water supplies.

## ORDER

NOW, THEREFORE, IT IS HEREBY ORDERED that Boise Geothermal LTD shall install and maintain equipment and forward to the Department on a monthly basis the following information:

1. Continuous withdrawal rate and withdrawal volume amounts.

2. Continuous casing pressure and/or drawdown measurements on production and injection wells.

3. Temperature of withdrawn and injected fluids on a daily basis.

IT IS FURTHER ORDERED that within thirty (30) days of this Order Boise Geothermal LTD shall submit a written proposal to the Department for review and approval describing a monitoring pro-

gram and equipment to be used and/or installed to comply with this order.

Dated this 29TH day of July, 1987.

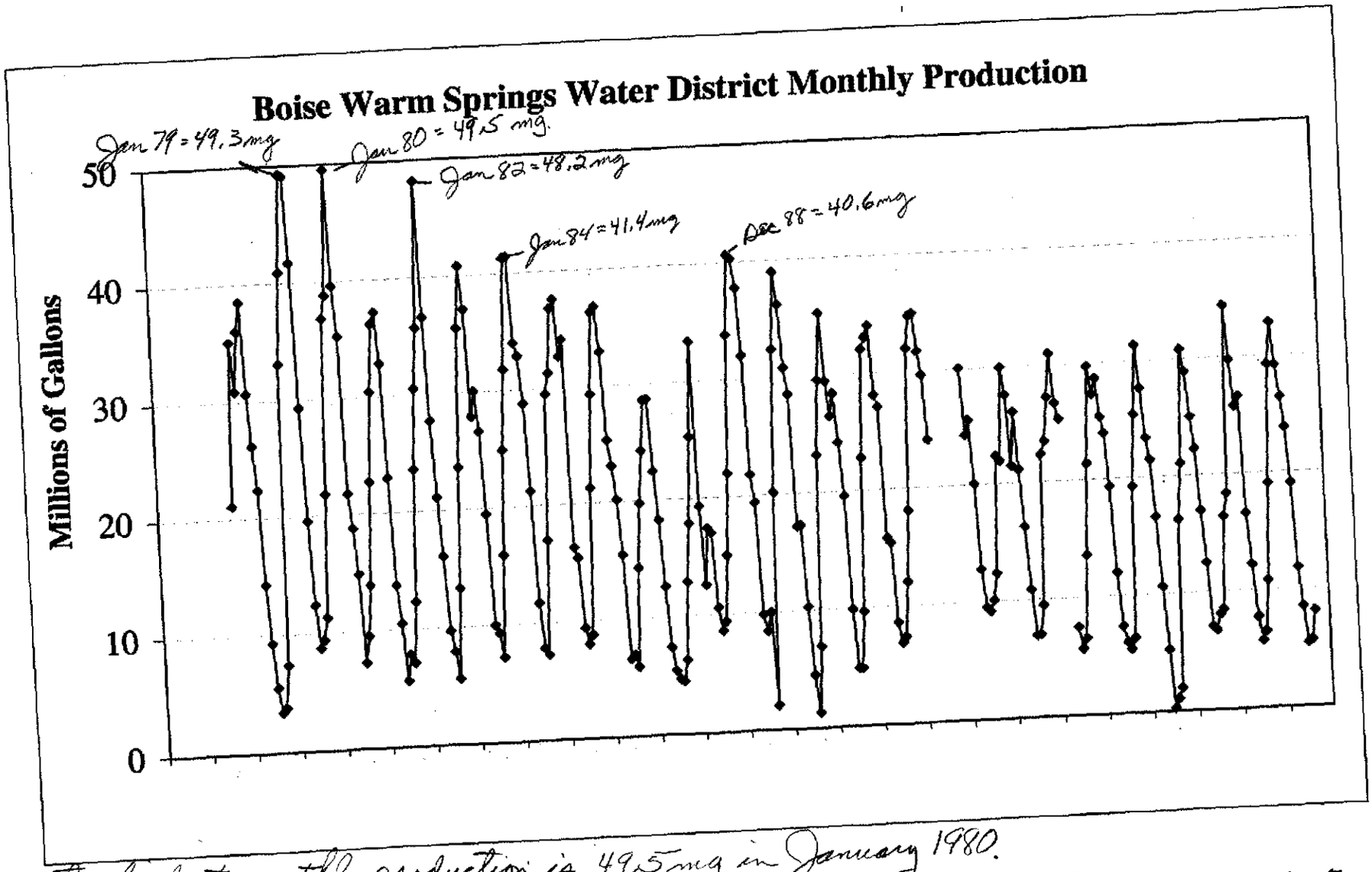
NORMAN C. YOUNG
Acting Director

Summary of BWSWD diversion rate data:

1. Monthly production records from Ken Neely's Boise Front Low-Temp Geothermal Resource Area indicate Jan 1980 to be the highest month for historical production at 49.5 mg.
49.5 mg = 2.47 cfs av. rate.

2. Summary of Uses and Proposed Uses to be attached as support data to the Management Policy for the Boise Front Ground Water Management Area dated June 1988 indicates a diversion rate capacity of 2.45 cfs. based on Bob Griffiths, Mgr. records.

3. A theoretical estimate using pump Hp, discharge pressure and drawdown depths provided by Rod Baldwin indicate a diversion rate of 3.70 cfs.




the highest monthly production is 49.5 mg in January 1980.
49.5 mg ÷ 31 = 1,596,774.2 gpd ÷ 24 hrs = 66532.258 gph ÷ 60 = 1108.87 gpm ÷
448.8 ≅ 2.47 cfs. average production.

Dave T.

JUN 3 1988
Department of Water Resources
Western Regional Office

June 1988

# MANAGEMENT POLICY

# FOR

# THE BOISE FRONT GROUND WATER MANAGEMENT AREA

## I. GENERAL

### A. Introduction

Beneficial use of warm ground water for its heat value is a part of the heritage of the Boise area. Wells were constructed as early as the 1890's to increase the available supply. Policies intended to foster the use of renewable energy resources caused a renewed interest in development of the heat resources in the 1970's. Several significant space heating projects commenced using warm water in the early 1980's, and projects to continue expanding the use are now being pursued.

The recent increase of diversions from the aquifer, however, have been accompanied by decreases in aquifer water levels and pressures. Some reduction in temperature has been measured in at least one of the producing systems. On June 15, 1987, the Idaho Department of Water Resources (IDWR) designated the Boise Front Ground Water Management Area (BFGWMA) to allow increased management of the resource (Figure #1). The continued interest in additional development as represented by applications and undeveloped permits continues to concern some existing users. Several petitions were filed in January 1988, seeking a suspension of processing of applications and a moratorium on further development of undeveloped permits.

The purpose of this draft plan is to summarize the present knowledge of the aquifer and the low temperature geothermal resource, review legal responsibilities and authorities, and to propose a policy to guide IDWR administrative actions.

### B. The Aquifer

The Boise area is underlain by three aquifer systems: A shallow cold water system, a deeper cold water artesian system and a still deeper low temperature geothermal artesian system. Not all three aquifers exist in all areas. The low temperature geothermal aquifer system, which is the only aquifer addressed in this plan, is thought to be a fractured media ground water system which

SUMMARY OF USES AND PROPOSED USES
BOISE FRONT LOW TEMPERATURE GEOTHERMAL RESOURCE
GROUND WATER MANAGEMENT AREA



| Owner/User Name | Well Ident. No. | Water Right Number Basin 63 | Present Primary Use | Secondary Use | Water Right Diversion Rate (cfs) | Present Diversion Rate Capacity (cfs) | Planned Increase In Diversion Rate (cfs) | Present Annual Volume of Diversion (acre-feet) | Present Annual Volume Re-injected (acre-feet) |
|---|---|---|---|---|---|---|---|---|---|
| Boise W.S.W.D. | West<br>East | 63-5073 S | Heating | Domestic | 12.80 | 2.45<br>Bob Griffiths Records | 0 | 797.4 | 0 |
| Boise W.S.W.D. | #3 | 63-9160 P | Heating | Domestic | 4.0 | 0 | 4 | 0 | 0 |
| BGL | 1, 2, 3, 4 | 63-9139 P | Heating | Irrigation<br>Commercial<br>Municipal<br>Fish | 12.0 | 8.91<br>letter from City | 1.5+ | 614 | 0 |
| City of Boise | | 63-9138 P | Heating | Irrigation<br>Commercial<br>Municipal<br>Fish | 8.0 | 0 | | | |
| State of Idaho | #2 Prod.<br>#1 Inj. | 63-9341 P | Heating | None | 5.57 | 1.8<br>State Records | 0 | 583 | 583 |
| State of Idaho | | 63-9215 P | Heating | None | 9 | 0 | 0 | 0 | 0 |

TABLE 2*

SUMMARY - WELL CONSTRUCTION
BOISE FRONT LOW TEMPERATURE GEOTHERMAL RESOURCE
GROUND WATER MANAGEMENT AREA



| Owner | Well Ident. No. | Location | Date Drilled | Driller | Log Filed (Yes-No) | Reported Depth (ft.) | Casing Depth (Unperf.) (ft.) | Seal Depth (ft.) | Depth to Water or Pressure (ft. or psi) | Temperature at Land surface |
|---|---|---|---|---|---|---|---|---|---|---|
| Boise Warm Springs Water Dist. West | West | T3N R2E S12 SE SE SW | 1892? | Unknown | No Video Log 1980-81 | 400' | 16"-150' | Unkn. | Under max div. 160' - 220' | 170°F |
| Boise Warm Springs Water Dist. East | East | T3N R2E S12 SE SE SW | 1892? | Unknown | No Video Log 1980-81 | 406' | 16"-154' | Unkn. | Under max.div. 160' - 220' | 170°F |
| Boise Warm Springs Water District #3 | #3 | T3N R2E S12 SE SE SW | 1980-81 | Tony Engleman | Yes Montgomery Eng.-Kelly | 587' | 214' | Unkn. | 43' - 112' | 144°F |
| Boise Geothermal Ltd. | #1 | T3N R2E S11 SW NW NE | 3/16/81 | Holman | Yes | 2008' | 12"-874' | 874' | 5-6 psi | 171°F |
| Boise Geothermal Ltd. | #2 | T3N R2E S11 NW NW NE | 4/17/81 | Holman | Yes | 880' | 12"-642' | 642' | 7-8 psi | 171°F |
| Boise Geothermal Ltd. | #3 | T3N R2E S11 NE NE NW | 5/15/81 | Holman | Yes | 1879' | 12"-653' | 653' | Unknown | 171°F |
| Boise Geothermal Ltd. | #4 | T3N R2E S11 SW NW NE | 5/25/81 | Holman | Yes | 1103' | 12"-598' | 598' | Unknown | 171°F |
| Capitol Mall (Injection) | #1 | T3N R2E S10 SE NE NE | 8/11/80 | Hiddleston | Yes | 2152' | 8 5/8"-1640' | 1750' | 14.8 psi 10 psi, cool | 160°F |
| Capitol Mall (Production) | #2 | T3N R2E S10 NW NE NE | 6/29/81 | Holman | Yes | 3030' | 12"-1260' | 1260' | 20-22 psi, hot | 155.8°F |

THEORETICAL HORSEPOWER EQUATION WORKSHEET (cjh 1/92)

Water Right No.: A63-5073
Examiner: mel schulte
Date of Field Exam: 10/14/2002

| P/D No.: | OPTION 1<br>East Well | OPTION 2<br>West Well | OPTION 3<br>Two Wells |
|---|---|---|---|
| PUMP HORSEPOWER | 60 | 60 | 120 |
| BOOSTER HORSEPOWER | 0 | 0 | 0 |
| PUMPING LEVEL | 155 | 155 | 155 |
| DISCHARGE PRESSURE | 15 | 15 | 15 |
| RATE OF FLOW (cfs) | 1.95 | 1.95 | 3.90 |

**BOISE WARM SPRINGS WATER DISTRICT**
2440 OLD PENITENTIARY ROAD
BOISE, IDAHO 83712

FROM: ROD BALDWIN
Ph: 343-4135
Fax: 343-4211

8/21/01

TO: KEN NEELY
IDAHO DEPARTMENT OF WATER RESOURCES

RE: 2001 BWSWD PUMPING AMOUNTS AND WELL DRAWDOWN.

KEN:

ENCLOSED FOR YOU INFORMATION ARE THE TODATE PUMPING AMOUNTS AND WELL DRAWDOWNS FOR THE BOISE WARM SPRINGS WATER DISTRICT.

IF YOU HAVE ANY QUESTIONS OR COMMENTS, PLEASE LET ME KNOW.

THANKS,

ROD BALDWIN

**BOISE WARM SPRINGS WATER DISTRICT**
2440 OLD PENITENTIARY ROAD
BOISE, IDAHO 83712

**MONTHLY WELL DRAWDOWN DEPTHS**
MAXIMUM DRAWDOWN DEPTH RECORDED

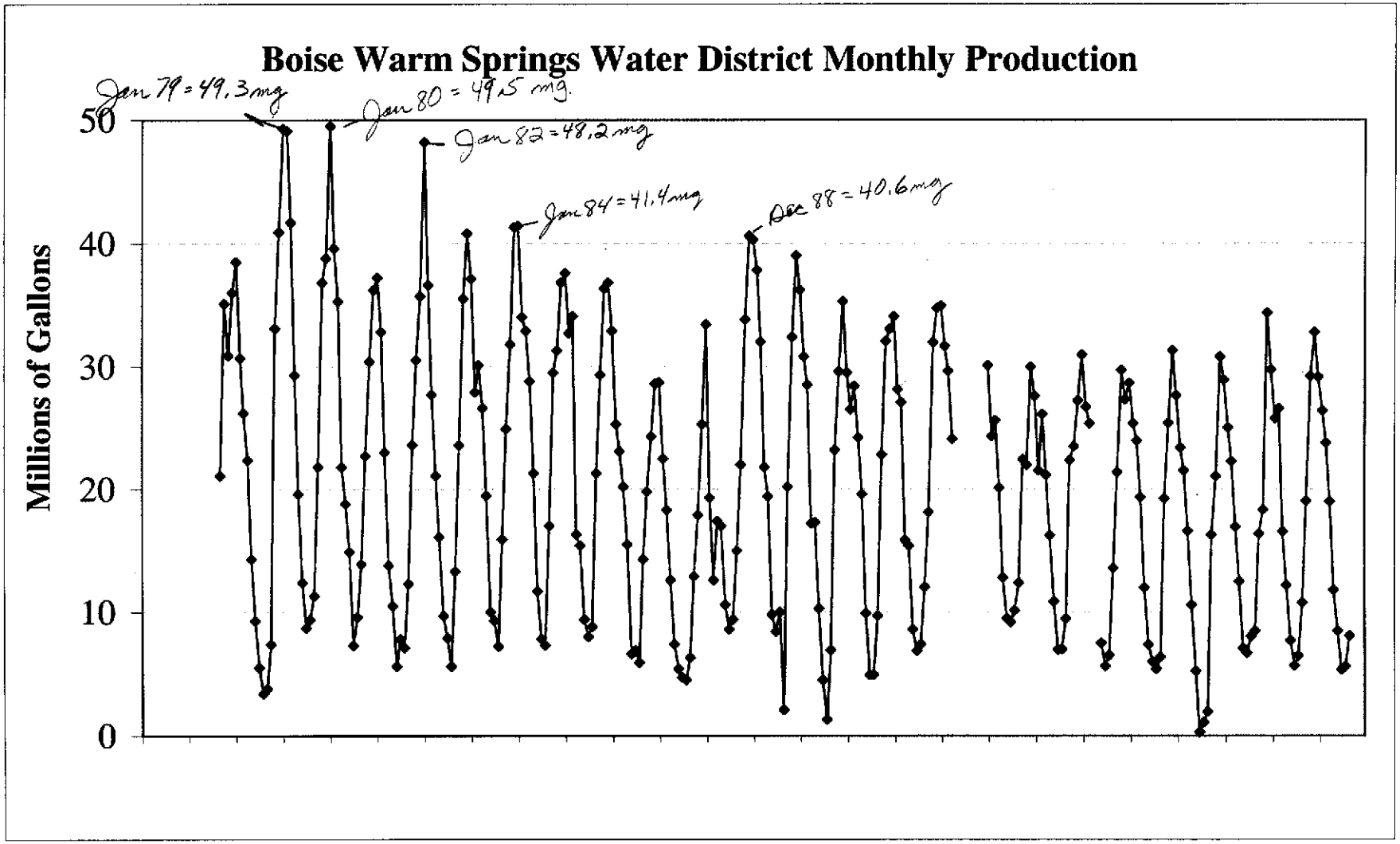
| MONTH | EAST WELL | WEST WELL |
|---|---|---|
| 01/10/93 | 156 | 166 |
| 02/15/93 | 157 | 166 |
| 03/13/93 | 148 | 165 |
| 04/15/93 | 103 | 140 |
| 05/10/93 | 86 | 105 |
| 06/05/93 | 55 | 62 |
| 07/28/93 | 42 | 44 |
| 08/25/93 | 33 | 36 |
| 09/10/93 | 45 | 52 |
| 10/30/93 | 86 | 63 |
| 11/25/93 | 158 | 165 |
| 12/15/93 | 158 | 166 |
| 01/16/94 | | |
| 02/01/94 | | |
| 03/01/94 | | |
| 04/01/94 | | |
| 05/01/94 | | |
| 06/01/94 | | |
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| 07/01/95 | | |
| 08/01/95 | | |
| 09/01/95 | | |
| 10/01/95 | | |
| 11/01/95 | | |
| 12/28/95 | 122 | 163 |
| 01/31/96 | 147 | 144 |
| 02/01/96 | 160 | 150 |
| 03/01/96 | 137 | 97 |
| 04/20/96 | 105 | 90 |
| 05/04/96 | 97 | 83 |
| 06/01/96 | 58 | 57 |
| 07/02/96 | 37 | 38 |
| 08/31/96 | 33 | 33 |

| | | |
|---|---|---|
| 09/26/96 | 59 | 49 |
| 10/28/96 | 83 | 72 |
| 11/30/96 | 96 | 123 |
| 12/04/96 | 114 | 152 |
| 01/13/97 | 151 | 158 |
| 02/08/97 | 128 | 170 |
| 03/01/97 | 117 | 158 |
| 04/11/97 | 95 | 122 |
| 05/02/97 | 79 | 95 |
| 06/01/97 | 47 | 57 |
| 07/01/97 | 39 | 43 |
| 08/01/97 | 29 | 34 |
| 09/29/97 | 31 | 35 |
| 10/28/97 | 63 | 80 |
| 11/15/97 | 85 | 114 |
| 12/13/97 | 147 | 172 |
| 01/16/98 | 130 | 158 |
| 02/10/98 | 128 | 172 |
| 03/06/98 | 128 | 172 |
| 04/15/98 | 102 | 142 |
| 05/28/98 | 63 | 76 |
| 06/01/98 | 52 | 61 |
| 07/01/98 | 37 | 42 |
| 08/06/98 | 32 | 37 |
| 09/28/98 | 33 | 37 |
| 10/30/98 | 66 | 86 |
| 11/10/98 | 79 | 104 |
| 12/21/98 | 177 | 171 |
| 01/26/99 | 144 | 170 |
| 02/15/99 | 128 | 165 |
| 03/06/99 | 118 | 165 |
| 04/09/99 | 100 | 124 |
| 05/05/99 | 75 | 90 |
| 06/03/99 | 53 | 63 |
| 07/03/99 | 36 | 43 |
| 08/08/99 | 29 | 36 |
| 09/08/99 | 31 | 55 |
| 10/21/99 | | 70 |
| 11/23/99 | | 87 |
| 12/27/99 | 125 | 135 |
| 01/29/00 | 166 | 172 |
| 02/19/00 | 127 | 105 |
| 03/01/00 | 105 | 88 |
| 04/01/00 | 93 | 78 |
| 05/11/00 | 70 | 60 |
| 06/01/00 | 43 | 38 |
| 07/03/00 | 25 | 25 |
| 08/06/00 | 28 | 26 |
| 09/30/00 | 37 | 30 |
| 10/31/00 | 64 | 55 |
| 11/20/00 | 109 | 93 |
| 12/11/00 | 118 | 98 |
| 12/19/00 | 100 | 134 |

| | | |
|---|---|---|
| 12/19/00 | | |
| 12/27/00 | 120 | |
| 12/29/00 | 101 | 104 |
| 12/31/00 | 108 | 137 |
| 01/08/01 | 132 | 150 |
| 01/17/01 | | 109 |
| 01/22/01 | | 165 |
| 01/23/01 | 132 | 168 |
| 02/02/01 | 147 | 103 |
| 02/08/01 | 150 | 120 |
| 02/10/01 | 143 | 122 |
| 03/03/01 | 147 | 167 |
| 04/03/01 | 127 | 118 |
| 05/04/01 | 101 | 102 |
| 06/04/01 | 77 | 80 |
| 07/01/01 | 44 | 67 |
| 08/13/01 | 20 | 47 |
| | 20 | 27 |
| | | 19 |

Water levels from Jan 1993 to August 2001 for East & West wells

Average drawdown level in January = 155'


Boise Warm Springs Water District Monthly Production
Millions of Gallons
50
40
30
20
10
0
Jan 79 = 49.3 mg
Jan 80 = 49.5 mg.
Jan 82 = 48.2 mg
Jan 84 = 41.4 mg
Dec 88 = 40.6 mg

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# Hydrogeologic Conditions in the Boise Front Geothermal Aquifer

*Prepared for:*

**City of Boise, Idaho**

*and*

**National Renewable Energy Laboratory, Golden, CO**

*Prepared by*

Christian R. Petrich
**Idaho Water Resources Research Institute**
**University of Idaho – Boise**




**Report Number: 2003-___**

Draft 8/13/2003

University of Idaho

## ABSTRACT

An extensive geothermal aquifer system underlies the Boise area along the Boise Foothills. Proposed increases in thermal water use have led to concerns about potential long-term impacts to the geothermal aquifer system, and the ability of current aquifer monitoring to detect possible changes.

The purpose of this study was to provide insight and tools for the long-term management of the Boise geothermal aquifer system. Specific objectives included conducting a mass measurement of geothermal ground water levels, the development of a database using existing data, reviewing hydrologic conditions in the aquifer, and constructing a numerical model to evaluate production capacity of the aquifer. The primary areas of interest for this study included the Harris Ranch, Downtown Boise – Table Rock, and Stewart Gulch areas. This report includes a summary of hydrologic conditions in the geothermal aquifer system. A description of model construction and simulation results are presented in a separate volume (Zyvoloski et al., *in preparation*).

The Boise Front geothermal aquifers reside in a complex series of igneous rocks and interbedded sediments. Geothermal water is associated with fractures along a northwest trending fault zone along the Boise Foothills. Thermal water in the downtown Boise – Table Rock area is drawn from granite, Tertiary rhyolite and associated sediments, and/or Tertiary basalt and basalt tuffs, and typically ranges in temperature from 135 to 175°F. Geothermal water in the Harris Ranch area resides in fractured granite. Two Tertiary basalt layers appear to be the primary source of 90 to 125°F thermal water in the Stewart Gulch wells. Potentiometric surface maps based on the 2002 mass measurements indicate westerly or southwesterly horizontal hydraulic gradients in all three of these areas.

Water levels in the Boise – Table Rock area began to decrease in 1984, coinciding with the initiation of City of Boise withdrawals. Water levels stabilized from about 1987 through 1998, as net withdrawals stabilized at a lower rate. The water levels in the Boise – Table Rock area began to rise beginning in the fall of 1999, apparently in response to the City's re-injection of thermal water. A number of wells in this area have experienced water level increases since 1999, including the Bureau of Land Management (BLM) monitoring well, Veteran's Administration (VA) production well, Boise Warm Springs Water District (BWSWD) wells, and Kanta well.

Water levels in the Edwards well (Stewart Gulch) began to decline in 1984, coincident with the initiation of pumping both by the City of Boise and Quail Hollow Golf Course. Water levels also rose in several Stewart Gulch wells during the late 1990s. However, no additional water level rises were noted that might be attributed to City of Boise injection beginning in 1999. The Stewart Gulch water level rises appear to be associated with changes in local withdrawal patterns.

Current data are insufficient to describe the degree of hydraulic connection, if any, between the Stewart Gulch and Boise – Table Rock areas. However, there appears to be some degree of hydraulic connection between geothermal aquifers in the Harris Ranch and Boise – Table Rock areas, based on historical observations.

# 4. LOCAL GEOTHERMAL SYSTEM CHARACTERISTICS

This chapter outlines geothermal water use and hydrogeologic characteristics for three areas: (1) downtown Boise – Table Rock, (2) Stewart Gulch, and (3) Harris Ranch (Figure 1-1). These areas are grouped together because of some hydrologic and water use similarities within the areas. The grouping is not intended as an implication regarding a degree of hydraulic connection between the areas.

## 4.1. Downtown Boise – Table Rock Area

### 4.1.1. Description of Use and Development

Geothermal water in the downtown Boise – Table Rock area (hereafter known as the "Boise – Table Rock area") ranges in temperature from 134 to 175°F, and is used for space heating by the (1) Boise Warm Springs Water District (BWSWD), (2) City of Boise (City), (3) State of Idaho Capitol Mall system (CM), and (4) U.S. Division of Veteran's Services (VA). Primary geothermal wells in this area are listed in Table 4-1, and are shown in Figure 4-1.

Geothermal resources in the Boise area were noted at the end of the 19th century. Russell (1903) mentions warm water wells and at least one "tepid" spring located in the Military Reserve area, presumably in the Cottonwood Creek area. These occurrences are also described by Lindgren in 1898 (Russell, 1903). Substantial development of geothermal resources in the Boise area began in 1891 (Table 4-2), when the first geothermal well in this area was drilled at, or near, the site of the present Boise Warm Springs Water District well house. This well first struck warm water beginning at 80 feet, with the water becoming progressively hotter and the flow increasing with depth. A flow of 150 gpm of 154°F degree water was encountered at a depth of 308 feet. However, it was at 400 feet that "a tremendous flow of water" was encountered (Waag and Wood, 1987b, quoting the Idaho Statesman, 1/30/1891). A second well was then drilled 50 feet from the first, with similar results. In combination, the two wells reportedly produced an artesian flow in excess of 800,000 gallons per day (555 gpm) of 170°F water (Wells, 1971). Lindgren reported that the artesian pressure was sufficient for the water level to rise approximately 50 feet above ground surface in 1896 or early 1897 (Waag and Wood, 1987b). Development of the geothermal resource for heating, domestic, and bathing use commenced soon afterward. A third well was drilled in 1895 in order to maintain production.

In approximately 1909, air-lift pumps were installed to maintain or increase production in these wells. The air-lift pumps were not satisfactory, however, as the aerated water was highly corrosive and caused the distribution pipes to fail within four years. At that time (approximately 1913), a new well, 16 inches in diameter, was drilled and one of

the existing wells was enlarged to 16 inches. Both of these wells were equipped with line-shaft turbine pumps. These wells are probably the two wells that are in use today by the Boise Warm Springs Water District (BWSWD). The fate of the other two original wells is unknown.

From the early 1900s until the mid 1980s the BWSWD system was the only major user of thermal water in the Boise – Table Rock area. Production records are scarce or non-existent, but it is assumed that the annual production from the BWSWD wells was approximately 250 to 300 million gallons per year (750 to 900 acre-feet per year, or af/yr). Some additional production also occurred from smaller warm water wells at the Idaho State Penitentiary, and from private wells (Koch, Behrman, etc.) No estimates of production are available from these wells.

| Well | Alternate Name | Entity | Current Use |
|---|---|---|---|
| BWSWD-East | BWSWD#2 | BWSWD | Primary pumping |
| BWSWD-West | BWSWD#1 | BWSWD | Secondary pumping |
| BWSWD#3 | | BWSWD | Monitoring well |
| BGL#1 | Boise Geothermal Ltd #1 | City of Boise | Monitoring well |
| BGL#2 | Boise Geothermal Ltd #2 | City of Boise | Secondary pumping |
| BGL#3 | Boise Geothermal Ltd #3 | City of Boise | Secondary pumping |
| BGL#4 | Boise Geothermal Ltd #4 | City of Boise | Primary pumping |
| Beard | BHW-1 | City of Boise | Test well (adjacent to BGL#4) |
| Boise City Injection | | City of Boise | Injection |
| Capitol Mall 1 | CM-1 | State of Idaho | Injection |
| Capitol Mall 2 | CM-2 | State of Idaho | Production |
| VA Test injection | VA Test | Veteran's Administration | Monitoring |
| VA injection | VA-2 | Veteran's Administration | Injection |
| VA Production | VA-1 | Veteran's Administration | Production |
| BLM | BEH-1 | Bureau of Land Management | Monitoring |
| Kanta | | Idaho Department of Lands | Monitoring |
| Old Pen | Old Pen #1 | Idaho Department of Lands | Monitoring |

Table 4-1: List of primary geothermal wells in the Boise – Table Rock area.

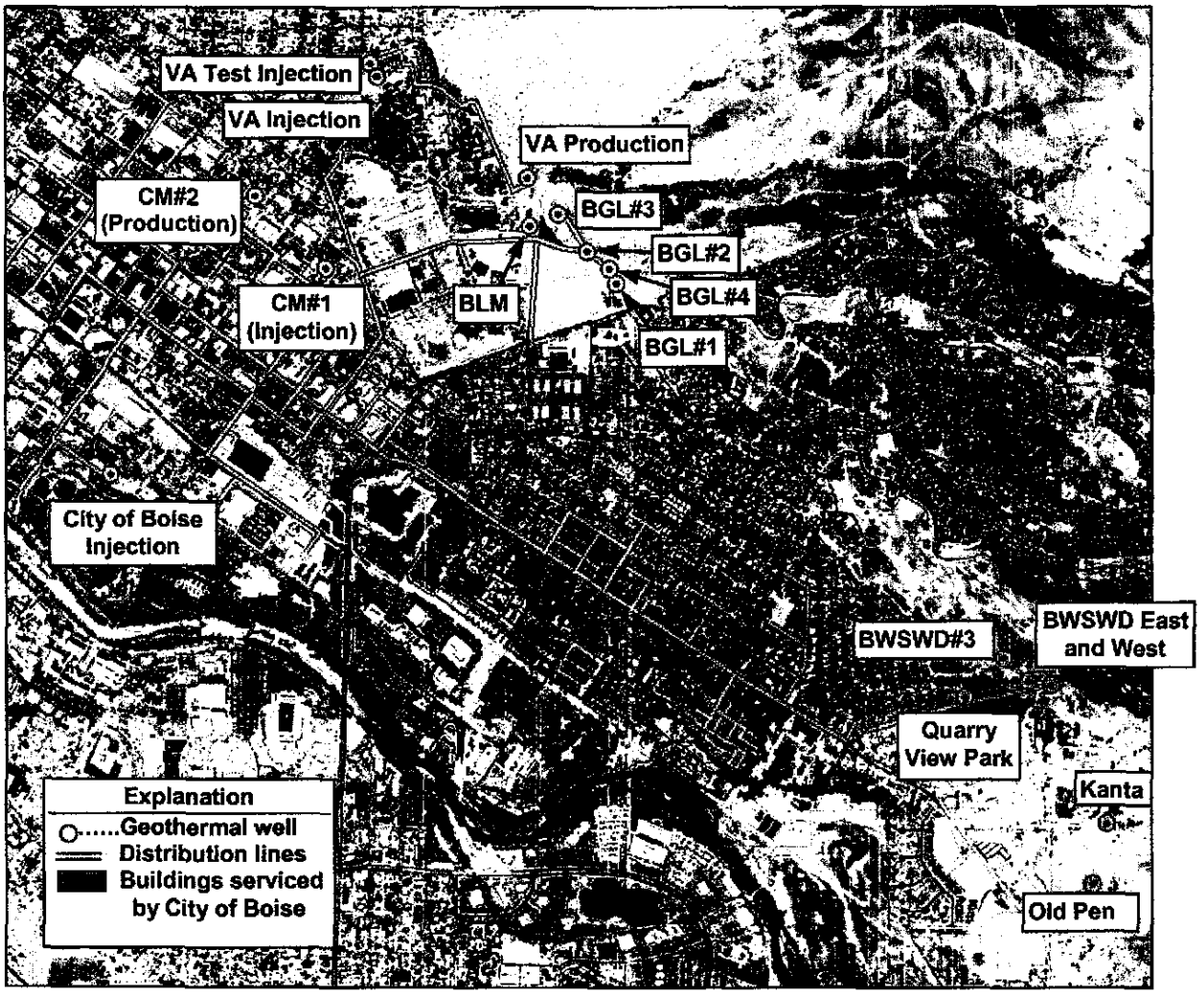



Figure 4-1: Locations of selected geothermal wells in the downtown Boise – Table Rock Area.

The BWSWD currently distributes geothermal water for space heating and domestic use in the eastern part of Boise (Figure 4-1). Spent geothermal water does not return to the geothermal aquifer, but (1) drains into shallow injection wells at points of use; (2) discharges to surface channels draining to the Boise River; or (3) discharges to the Boise River via the municipal sewer system. The primary distribution line along Warm Springs Avenue is connected to the City's geothermal distribution system (although under ordinary circumstances a valve between the two systems remains closed). Production data from the BWSWD system are available beginning in 1978. Production has steadily decreased from a high of 312 million gallons in the 1979 water year to an average of 214 million gallons per water year between 1994 and 2002 (Table 4-3, Figure 4-2). Production slowed between 1986 and 1988 (Figure 4-2), apparently because decreasing water levels caused pumps to break suction; the pumps were

lowered and increased pumping resumed in 1989 (T. Scanlan, C. Brockway, *personal communication*).

| Time | Event | Source |
|---|---|---|
| 1890 | Warm springs and wells in Military Reserve area; Kelly Hot Springs operating | Russell (1903) citing Lindgren (1898), Wells (1971) |
| 1891 | Two BWSWD Wells completed, 0.8 mgd | Wells (1971) |
| 1895 | Third BWSWD well drilled | Hand written notes from BWSWD (1909) - attached to 1909 Tariff Rules |
| 1896-7 | Three BWSWD well in operation; 50 foot shut-in pressure, 550 gpm | Russell (1903) citing Lindgren (1898), also Waag and Wood (1987b)citing Lindgren (1898) |
| 1908 | Air pumps installed on BWSWD wells | Hand written notes from BWSWD (attached to 1909 Tariff Rules) |
| 1913 +/- | New 16-inch well drilled and one existing well enlarged to 16 inches; turbine pumps installed in both wells at the BWSWD | Wells (1971) (citing 1918 Tariff Rules); four years after installation of air pumps |
| 1917 +/- | Kelly Hot Springs dried up | MacGregor (1999, pg 81) |
| 8/6/1965 | Old Pen Irrigation Well Drilled | Drillers report |
| 1976 | BLM and Beard Wells Drilled | Berkeley Group (1990, pg 45) |
| 3/21/1977 | Harris Well 1 constructed | Driller's report; Water right (63-8627) |
| 12/1980 | Capitol Mall Well No. 1 completed/tested | Anderson and Kelly (1981a) |
| 6/1981 | BWSWD No. 3 Completed | Anderson and Kelly (1981b) |
| 9/1981 | Capitol Mall Well 2 Tested | Anderson and Kelly (1981a) |
| 4/1982 | BGL Wells 2 and 4 Tested | Anderson and Kelly (1982b) |
| 11/1982 | Capitol Mall Wells Operating; assume 160-205 Mgal/yr (500 af/yr) | Berkeley Group (1990, pg 21); Neely (1995, pg 17) |
| 9/1983 | VA Production Well completed | Anderson and Kelly (1983) |
| 10/1983 | BGL Wells Operating; 121-189 Mgal/yr (400 af/yr) | Berkeley Group (1990, pg 33);; Neely (2001) |
| 1984 | Quarry View Well On | Scanlan (*written communication*) |
| 1986 | Harris East(?) Well Completed | Waag & Wood (Waag and Wood, 1987b) |
| 1/1987 | VA Injection Well completed | Montgomery Engineers (1987) |
| 11/1988 | VA Wells Operational; 118-204 Mgal/y (500 af/yr) | Berkeley Group, pg. 33; Neely 8/28/01 |
| 2/1988 | Quarry View Well off; pump removed | Scanlan (*written communication*) |
| 1998 +/- | Old Pen Well Off | Scanlan (*written communication*) |
| 4/1998 | City Injection Well Drilled & Tested | Montgomery Watson (1998) |
| 2/1999 | City Injection Well Operational | City of Boise |

Table 4-2: Chronology of geothermal development and/or responses in the downtown Boise – Table Rock area.

| Year | BWSWD | Capitol Mall | Boise City | | | VA | Summary | |
|---|---|---|---|---|---|---|---|---|
| | Production | Production & Injection | Production | Injection | Net With-drawals | Production & Injection | Total Use | Net With-drawals |
| 1978 | 256.1 | | | | | | 256.1 | 256.1 |
| 1979 | 312.2 | | | | | | 312.2 | 312.2 |
| 1980 | 308.1 | | | | | | 308.1 | 308.1 |
| 1981 | 239.4 | | | | | | 239.4 | 239.4 |
| 1982 | 276.0 | | | | | | 276.0 | 276.0 |
| 1983 | 283.5 | 12.8 | | | | | 296.3 | 283.5 |
| 1984 | 300.2 | 164.6 | 166.7 | | 166.7 | | 631.5 | 466.9 |
| 1985 | 281.2 | 175.4 | 121.4 | | 121.4 | | 578.0 | 402.6 |
| 1986 | 253.1 | 192.0 | 176.8 | | 176.8 | | 622.0 | 429.9 |
| 1987 | 183.1 | 169.1 | 188.9 | | 188.9 | | 541.1 | 372.0 |
| 1988 | 199.4 | 138.8 | 123.8 | | 123.8 | | 462.1 | 323.2 |
| 1989 | 278.0 | 154.4 | 158.0 | | 158.0 | 28.48 | 618.9 | 436.0 |
| 1990 | 244.6 | 130.5 | 122.3 | | 122.3 | 118.21 | 615.7 | 366.9 |
| 1991 | 245.7 | 182.7 | 121.3 | | 121.3 | 129.08 | 678.8 | 367.0 |
| 1992 | 243.3 | 139.0 | 123.3 | | 123.3 | 116.69 | 622.3 | 366.6 |
| 1993 | 259.2 | 217.9 | 156.0 | | 156.0 | 137.01 | 770.2 | 415.2 |
| 1994 | 220.8 | 174.5 | 122.5 | | 122.5 | 137.42 | 655.2 | 343.3 |
| 1995 | 221.2 | 154.3 | 127.9 | | 127.9 | 166.715 | 670.1 | 349.1 |
| 1996 | 226.6 | 118.7 | 132.1 | | 132.1 | 186.22 | 663.7 | 358.8 |
| 1997 | 212.8 | 98.6 | 130.7 | | 130.7 | 203.61 | 645.7 | 343.5 |
| 1998 | 184.2 | 111.6 | 131.2 | | 131.2 | 195.95 | 623.0 | 315.4 |
| 1999 | 204.0 | 125.5 | 164.9 | 53.6 | 111.3 | 191.64 | 686.1 | 315.3 |
| 2000 | 210.5 | 117.9 | 188.0 | 145.8 | 42.2 | 186.95 | 703.3 | 252.6 |
| 2001 | 218.7 | 144.8 | 172.0 | 145.6 | 26.4 | 172.96 | 708.5 | 245.1 |
| 2002 | 230.1 | 123.3 | 170.7 | 139.8 | 30.9 | 163.1 | 687.1 | 261.0 |

Units: millions of gallons per water year (October 1 through September 31); all data supplied by users

Table 4-3: Production and injection of geothermal water in the Boise – Table Rock area, 1978-2002.

The Idaho State Penitentiary drilled a warm-water (97°F discharge, 134°F bottom hole temperature) well for irrigation in 1965 (Old Pen Well). The well was used for irrigating approximately 20 acres (80 af/yr +/-) until the early 1970s. This well was later used for irrigating the Idaho Botanical Garden property from the mid 1980s through the late 1990s, with diversion volumes progressively increasing from 2 to 25 acre-feet annually over that period. Another irrigation well in the Penitentiary area, the Quarry View Park well, was operated for irrigation from 1984 through 1987, producing approximately 25 acre-feet annually of 134°F water. The Kanta-Yanke well was completed in 1983, but was never equipped with a pump for production. It produced 161°F water during test pumping (IDWR driller's report).

# IDAHO STATE HISTORICAL SOCIETY REFERENCE SERIES

## BOISE NATURAL HOT WATER HEATING SYSTEM

Number 500 1977

After two decades of speculation concerning possible development of local geothermal energy, drilling for natural hot water was commenced in a warm-water swamp near the state penitentiary late in 1890. Warm water was found by December 24, and a month later, a large flow of hot water was struck. By spring 800,000 gallons per day of 170° water, pure enough for domestic use, flowed from the new well. Plans were made for a resort--the traditional commercial use for hot water--and a handsome large natatorium was opened on May 25, 1892. In the meantime, a new concept to utilize geothermal power was tried out. Elegant new mansions were being built along Warm Springs Avenue (the road that led to Kelly's Hot Springs, a resort farther up the valley behind Tablerock), and during February of 1892, C. W. Moore tried out natural hot water heat in his new dwelling. When he found that his novel heating system performed beautifully, H. B. Eastman (who had started the town's water system) also began to use natural hot water in his new house close by. A Warm Springs Avenue community heating line, planned at a cost of $20,000 was slated to save $50,000 a year in customer's heating bills. Wooden pipes (which provided superior insulation) were used initially. Abandoned in 1896 as "dangerous and useless," wooden pipes did not work. But with new metal pipe, the system grew. Water temperature proved stable over the years, and two large pumps increased production from a daily 800,000-gallon natural flow to 1,200,000. Rates remained more than reasonable: two dollars a month for a small house (up to eight rooms) and three dollars for a larger one. Nine miles of pipe (about half in main lines and half in feeders) served all the area that the system could accommodate.

Hot water heating continues to serve a section of the city that this innovative enterprise did so much to develop. Warm Springs Avenue retains most of its outstanding mansions, including C. W. Moore's home that pioneered the system. A number of commercial business structures utilized this service, although they require supplemental heat for a few days in some winters. As late as 1958, 244 customers employed natural hot water that served for domestic use as well as heat. New Customer's were not accepted until 1974, when about 200 house owners and a half-dozen businesses took over the system at a time when repair and renovation became necessary.

***Publications--450 N. 4th Street, Boise, ID 83702--208-334-3428***

MEL - COPY OF EMAIL TO DAVE.

**Shurte, Jan**

**From:** Shurte, Jan
**Sent:** Monday, September 08, 2003 5:29 PM
**To:** Tuthill, Dave
**Cc:** Schulte, Mel; Shurte, Jan
**Subject:** Boise Warm Springs Water District claims

Hi Dave,

Mel and I have been discussing the water rights for the Warm Springs Water District. He has come up with a few studies conducted by the Department on the two wels used by the district.

These studies include one done by Ken Neely in June 1998 concerning the four heating systems in the Boise Front geothermal area from 1977 to 1997. The other is one we think you may have worked on? for the Boise Front GW Mngmnt Area and contains a summary of uses for various wells, including these two. There may be other studies the Department has done that we do not know of, which brings me to the subject of this email.

Would it be possible to have someone from the state office aj section research the records at the state office for studies, measurements over time, any information used in compiling studies on the geothermal water in the Boise Front. We would then have a file representing the Department's studies for what we will likely be recommending in the adjudication. For example, in Ken Neely's report he states that the wels were drilled in 1890 and 1891 for the Warm Springs District. These are b/u claims, so maybe he has copies of historical documents he researched for the study that would be helpful. Mel does have a copy of a chart of monthly production for Warm Springs Water District from the above study, however, it would be good to have where the measurement information came from as the diversion rates on these claims are already in question-per their attorney Bruce Smith. These are just a few examples of how this information would help. It seems wise to utilize our own studies as much as possible, however, with Mel's schedule it is hard for him to spend a lot of time at the state office researching.

Please let me know what you think of this idea.

Thanks,
Jan

State of Idaho
DEPARTMENT OF WATER RESOURCES
1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 - (208) 327-7900

CECIL D. ANDRUS
GOVERNOR
R. KEITH HIGGINSON
DIRECTOR

July 17, 1989

Boise Warm Springs Water District
2440 Old Penitentiary Road
Boise, Idaho 83712

Attn: Mr. Robert Griffiths

Re: Snake River Basin Adjudication SRBA
Claim #A63-05073 - Ada County

Dear Mr. Giffiths:

The Notice of Claim form referenced above has been received. We are forwarding to you a data-entered copy of the claim along with the yellow copy of your original filing. We are also enclosing Receipt #C008280 in the amount of $1,331.90, for the filing fees.

Please review the data-entered copy of your claim to assure that it is in agreement with your water right.

If you have any questions, do not hesitate to call.

Sincerely,

Jeff Peppersack

Jeff Peppersack
Engineering Specialist

JP:mcc:state
Enclosures:
Claim #A63-05073
Notice of Claim (yellow copy)
Receipt #C008280

MICROFILMED
AUG 2 0 1992

F-10

State of Idaho
# DEPARTMENT OF WATER RESOURCES
WESTERN REGION, 450 W. State Street, Boise, Idaho

JOHN V. EVANS
Governor

A. KENNETH DUNN
Director

Mailing address:
Statehouse
Boise, Idaho 83720
(208) 334-2190

April 24, 1984

BOISE WARM SPRINGS WATER DIST.
P.O. BOX 114
BOISE ID 83701

RE: Claim No. 63-5073

Dear Claimant:

The Department of Water Resources has completed the advertising of your claim to a water right, and no further action is authorized under Section 42-243 and 42-244, IDAHO CODE. Your claim will be retained in our files and will be available at any time for use by you or the court.

The filing and advertising of the claim does not confirm the water right claimed, but will serve to record and preserve the information and the evidence which you included in your claim.

If, at a later date, you find that you have additional information or supporting evidence that you would like to have included with the claim, you may have that information or evidence added at a time. Please refer to the claim identification number when corresponding with this office.

We are enclosing a copy of your claim for your records. If you have questions, or if this office may be of further assistance, please feel free to contact us.

Yours truly,

DAVID B. SHAW
Western Region Supervisor

Enclosure

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Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

# Boise Warm Springs

1.) Do we have historical info on the three wells - measurements, etc.?
— Ken Neeley or Boise Front Geothermal aquifer file -

1.) Two wells used for production - since when? - Third well never met diversion standards - monitoring well

2) 172°

~~3) 35 homes for domestic use + Dept of Ag. lab~~

4. Historic info appears to a div. rate from 2-3 fs. Ken Neeley has a bundle of data.

Pump - 60 hp. x 2.

15 psi = standard pressure due to condition of the system

Form 204
3-81

For Office Use Only
Fee Received $
Date
Receipt #

6-24

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

# REQUEST FOR EXTENSION OF TIME

**To provide additional time in which to submit proof of beneficial use on a water right permit**

Boise Warm Springs Water District of 2440 Old Penitentiary Road, Boise 83712
(Name) (Address)

State of Idaho, deposes and says:

That he is the holder, or the duly authorized agent of the holder*, of Permit to Appropriate the Public Water of the State of Idaho No 63-9160

That under the terms and conditions of said permit, work thereunder was required to be completed on or before 01 January 1985, 19

That he has heretofore performed the following work described under said permit: Drilled and cased well to depth of 600 feet. Location was based on recommendations following a geological study of the area.
(This must be filled out if no work has been completed put none)

Costing: 50,000.00

That he is unable to complete the remainder of the work within the required time for the following reasons, to-wit: present well does not produce sufficient quantity or temperature. We propose to retain a geologist and drill another well at a different location on this property.

Wherefore, he asks that the Department of Water Resources extend the time for the completion of obligations under said permit to 01 January 1990, 19
(1 yr minimum, 5 yrs maximum)

NOTE
AS OF JULY 1, 1980 THERE IS A $15.00 CHARGE FOR REQUESTS FOR EXTENSION OF TIME

T. O'Rourke, Chairman
(Signature)*
*IF OTHER THAN HOLDER, Power of Attorney must be supplied

## ACTION OF THE DIRECTOR, DEPARTMENT OF WATER RESOURCES

IT IS HEREBY ORDERED that the above application for extension of time be APPROVED and the time within which to submit the proof of beneficial use is extended to January 1, 1990.

MICROFILMED
AUG 20 1992

Signed this 2nd day of January, 19 85

R. Glen Saxton
Chief, Operations Bureau

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

# SUPPLEMENTAL REPORT BY IDWR SETTING FORTH ITS PRACTICE FOR LICENSING OR RECOMMENDING DOMESTIC RIGHTS FOR WHICH THE DELIVERY SYSTEM IS IN PLACE

In Re SRBA
Twin Falls County Civil Case No. 39576
Subcase No. 63-07035C

Supplemental Report to the SRBA District Court

Prepared by the Idaho Department of Water Resources
Karl J. Dreher, Director
David R. Tuthill Jr., Adjudication Bureau Chief

February 10, 2000

## BACKGROUND

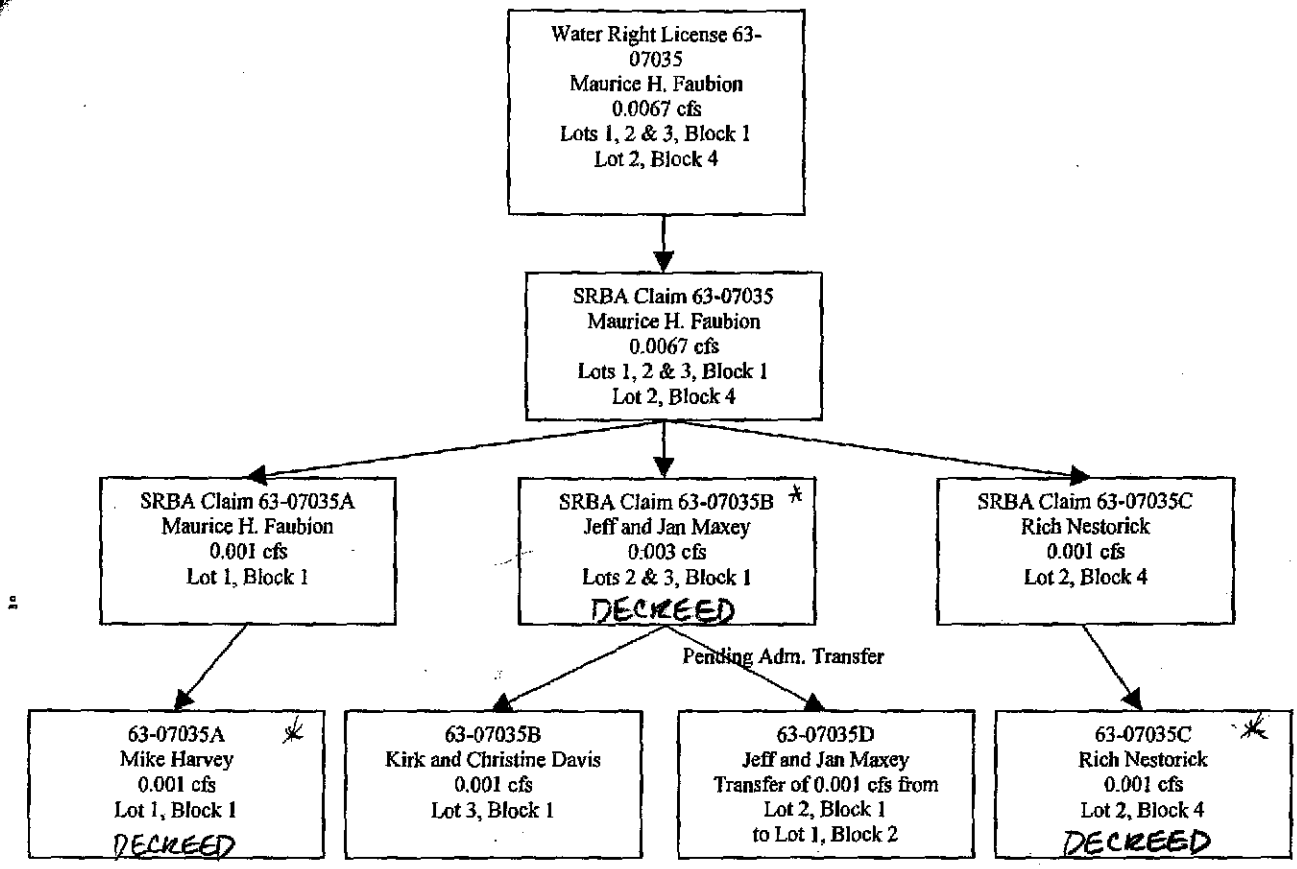
In 1967, Maurice Faubion applied for a permit to appropriate the water of an unnamed spring in the Robie Creek area near Boise. Mr. Faubion sought to develop the spring for domestic use on four cabin sites. The application was approved, and assigned the number 63-07035. A copy of the approved permit is attached as Exhibit 1.

IDWR received Mr. Faubion's *Proof of Application of Water to Beneficial Use* on November 17, 1969. A copy of the form is attached as Exhibit 2. Mr. Faubion indicated that a quantity of 3 gallons per minute was being diverted from the unnamed spring into a storage tank and subsequently being delivered via pipeline to four cabin sites in The Pines Subdivision.

IDWR staff conducted a field examination of Permit 63-07035 on November 25, 1969. A copy of the *Report of Examiner* is attached as Exhibit 3. The examiner found the diversion works to be as described by Mr. Faubion on the *Proof.* The spring flow was collected at the source, piped to a storage tank, then piped underground to four cabin sites. The examiner's report further states, "One hydrant is now located and *in use* on each lot." (emphasis added). IDWR understands a hydrant to be a discharge valve from a water mainline, most commonly a faucet. IDWR also refers to this type of development as "stubbed-in".

A license for water right 63-07035 was issued on November 25, 1969. The license reflected the domestic use of water from the unnamed spring on four lots in The Pines Subdivision.

Mr. Faubion filed an SRBA claim on his water right in 1989. The claim represented the right as licensed. Subsequent to that filing, all four lots have changed ownership as represented by the following diagram:




The Director's recommendations for the resulting water rights divided the "parent" right into four separate rights, one for each original, stubbed-in lot. IDWR has previously discussed with the court the need to add additional language to these recommendations to overcome the limitations of our current database and associated printing equipment.[1]

The bottom tier of this chart represents the current ownership of the water rights resulting from the sale of lots originally shown on license 63-07035.

## GENERAL LICENSING CONSIDERATIONS

IDWR has a longstanding practice of licensing domestic water use for stubbed-in lots in subdivisions. This practice recognizes that the development and sale of subdivision lots may take longer than the period IDWR can authorize for the development of the water delivery

[1] IDWR's current database cannot store quantity values with greater precision than 0.001 cfs. The four water rights arising from 63-07035 would each have a quantity of 0.001675 cfs.

system to those lots. A developer may go to considerable expense and effort to construct a water distribution system to lots that may not sell for a number of years. By issuing a water right license for domestic uses that have been stubbed-in, IDWR avoids large numbers of individual filings as the lots are sold. This allows the developer to obtain necessary funding for development by assuring financial institutions that a water right is available for each parcel being sold.

Another important reason for this practice is to circumvent problems with water delivery in times of shortage. It would be nearly impossible to administer delivery if each neighbor in a subdivision had a different priority date from the same delivery system.

**RECOMMENDATION OF 63-07035**

At the time of licensing 63-07035, IDWR followed its historical guidelines concerning stubbed-in developments. In addition, it would not have been unusual for "cabin site" owners in that area to use domestic water other than in permanent dwellings. For instance: a travel trailer might be "hooked-up" during the summer months but removed in the winter, water might be used for irrigation of trees or other landscaping. Water might even be used by the lot owners for camping trips to their own property. The United States Forest Service holds many licensed rights for domestic use that amount to a single faucet or hand-pump providing water to campers. In such circumstances, where the water was physically available to the stubbed-in lots, IDWR assumed the beneficial use of water might be intermittent. (The field exam notes that the faucets were not only stubbed-in but *used.*) The possibility of intermittent use would have been considered both at the time of licensing and recommendation in the SRBA.

Respectfully Submitted,

February 11, 2000

Roxanne Brown, Sr. Water Resource Agent
Idaho Dept. of Water Resources

# BOISE . .RM SPRINGS WATER STRICT

P.O. BOX 114 BOISE, IDAHO 83701

Board of Directors

HAROLD T. 'BUCK' JONES
DOROTHY L. MOTT
CARL E. NICHOLSON
TERENCE O'ROUARK
H. T. PLUMB

Treasurer

12 April 1984

Idaho Department of Water Resources
450 W. State Street
Statehouse
Boise, Idaho 83720

Attn: Jan Grover
Senior Water Resources Agent Re: 63-5073

Gentlemen:
I am returning Claim No. 63-5073 with the following revisions which were discussed in your letter of 09 February 1984.

Item No. 3 was intended to be a restatement of the original water right dated 24 November 1899 which is presently on file with the Idaho Department of Water Resources. Our copy from the original is not highly reproducible. Please refer to the original which is in the Department's archives. At the present time, two of the wells are equipped with pumps and motors and are being used for production of water which is delivered to a pipeline for distribution. The original claim was for three wells as shown.

Item 3 also states that the "Use" is "Heating & Domestic". This water is pumped to a pipeline-type distribution system at a temperature of 172 Degrees Fahrenheit and is not suitable for irrigation or other crop raising purposes. There is no Irrigation use and the water is used for residential space heating in approximately 240 homes in the east area of Boise City.

Item 6 requested a description of the " Location of Use". the intent of the response was to provide the location of the various residences which are a part of the District and do receive services from the District. It appears that all response to Item 6 should be deleted from the Claim and the location of the property which is a part of the District would not be referred to in the Claim.

Following the deletion of the "Location of Use from Item 6, all of the markings on the map should also be deleted.

Hopefully, these corrections will make the Claim conform to the Department's standards. If I may clarify any other items for you, please do not hesitate to call the office of the District at 342-3162 and leave a message on the recorder. You may also call my office at 345-3216. The District has no full time employees and only the Watermaster is salaried.

Sincerely,

BOISE WARM SPRINGS WATER DISTRICT

Robert H. Griffiths

Robert H. Griffiths, P.E.
Manager

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# Historic Service Connections of Boise Warm Springs Water District

In 1989 Robert Griffiths, manager of the Boise Warm Springs Water District (BWSWD), analyzed the total number of service connections that existed after 1952. Griffiths prepared two lists. The first was a listing of the Boise Water Corporation accounts dating from 1952 to 1973 and the second was a list of the BWSWD accounts that existed in 1989.

Between 1952 and 1989 some of the service connections were shut off at the delivery point adjacent to the property being served. The main reason for this was that in the period from 1952 to 1970, relatively cheap alternative energy such as hydropower and natural gas caused some homeowners to opt for more "modern" and possibly convenient forms of energy. The service valve at the point of delivery adjacent to the property was not removed but simply shut off. Had the homeowner desired to reconnect, it would have been an easy task to reactivate the service since the service connection remained in place and supply lines served adjacent properties.

Between 1970 and 1989 the increasing cost of other forms of energy caused other homeowners to connect to the BWSWD geothermal system as a cheaper alternative. These service connections are included in the BWSWD list of active accounts in the 1989.

The maximum historic recorded water use by the BWSWD occurred in the early 1980's during periods of extremely cold weather. The total number of service connections that existed concurrently with this period of maximum use can be found by comparing the two lists and eliminating duplicate connections between the two lists. Using this method, a total of 351 service connections can be identified as being present in the BWSWD in the mid-1980's.

Bob Sutter
Boise Warm Springs Water District

Service connections ?
vs service uses
connections = 351
uses = 266 ?

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| | Acct No. | | Street |
|---|---|---|---|
| | | | |
| 1 | 0010 | | Warm Springs Avenue |
| 2 | 0020 | | Warm Springs Avenue |
| 3 | 0030 | | Warm Springs Avenue |
| 4 | 0040 | | Warm Springs Avenue |
| 5 | 0050 | | Warm Springs Avenue |
| 6 | 0060 | | Warm Springs Avenue |
| 7 | 0070 | | Warm Springs Avenue |
| 8 | 0071 | | Warm Springs Avenue |
| 9 | 0080 | | Warm Springs Avenue |
| 10 | 0090 | | Warm Springs Avenue |
| 11 | 0100 | | Warm Springs Avenue |
| 12 | 0110 | | Warm Springs Avenue |
| 13 | 0120 | | Warm Springs Avenue |
| 14 | 0130 | | Warm Springs Avenue |
| 15 | 0140 | | Warm Springs Avenue |
| 16 | 0141 | | Warm Springs Avenue |
| 17 | 0142 | | Warm Springs Avenue |
| 18 | 0150 | | Warm Springs Avenue |
| 19 | 0160 | | Warm Springs Avenue |
| 20 | 0170 | | Warm Springs Avenue |
| 21 | 0180 | | Warm Springs Avenue |
| 22 | 0190 | | Warm Springs Avenue |
| 23 | 0200 | | Warm Springs Avenue |
| 24 | 0210 | | Warm Springs Avenue |
| 25 | 0220 | | Warm Springs Avenue |
| 26 | 0221 | | Warm Springs Avenue |
| 27 | 0230 | | Warm Springs Avenue |
| 28 | 0240 | | Warm Springs Avenue |
| 29 | 0250 | | Warm Springs Avenue |
| 30 | 0251 | | Warm Springs Avenue |
| 31 | 0252 | | Warm Springs Avenue |
| 32 | 0254 | | Warm Springs Avenue |
| 33 | 0257 | | Warm Springs Avenue |
| 34 | 0260 | | Warm Springs Avenue |
| 35 | 0270 | | Warm Springs Avenue |
| 36 | 0280 | | Warm Springs Avenue |
| 37 | 0290 | | Warm Springs Avenue |
| 38 | 0300 | | Warm Springs Avenue |
| 39 | 0310 | | Warm Springs Avenue |
| 40 | 0320 | | Warm Springs Avenue |
| 41 | 0330 | | Warm Springs Avenue |
| 42 | 0340 | | Warm Springs Avenue |
| 43 | 0350 | | Warm Springs Avenue |
| 44 | 0360 | | Warm Springs Avenue |
| 45 | 0370 | | Warm Springs Avenue |
| 46 | 0380 | | Warm Springs Avenue |
| 47 | 0390 | | Warm Springs Avenue |
| 48 | 0400 | | Warm Springs Avenue |
| 49 | 0410 | | Warm Springs Avenue |
| 50 | 0420 | | Warm Springs Avenue |

| | | | |
|---|---|---|---|
| 51 | 0430 | | Warm Springs Avenue |
| 52 | 0440 | | Warm Springs Avenue |
| 53 | 0450 | | Warm Springs Avenue |
| 54 | 0460 | | Warm Springs Avenue |
| 55 | 0470 | | Warm Springs Avenue |
| 56 | 0480 | | Warm Springs Avenue |
| 57 | 0490 | | Warm Springs Avenue |
| 58 | 0500 | | Warm Springs Avenue |
| 59 | 0510 | | Warm Springs Avenue |
| 60 | 0520 | | Warm Springs Avenue |
| 61 | 0530 | | Warm Springs Avenue |
| 62 | 0540 | | Warm Springs Avenue |
| 63 | 0550 | | Warm Springs Avenue |
| 64 | 0555 | | Warm Springs Avenue |
| 65 | 0560 | | Warm Springs Avenue |
| 66 | 0565 | | Warm Springs Avenue |
| 67 | 0570 | | Warm Springs Avenue |
| 68 | 0580 | | Warm Springs Avenue |
| 69 | 0590 | | Warm Springs Avenue |
| 70 | 0595 | | Warm Springs Avenue |
| 71 | 0610 | | Warm Springs Avenue |
| 72 | 0620 | | Warm Springs Avenue |
| 73 | 0630 | | Warm Springs Avenue |
| 74 | 0640 | | Warm Springs Avenue |
| 75 | 0650 | | Warm Springs Avenue |
| 76 | 0660 | | Warm Springs Avenue |
| 77 | 0670 | | Warm Springs Avenue |
| 78 | 0675 | | Warm Springs Avenue |
| 79 | 0680 | | Warm Springs Avenue |
| 80 | 0690 | | Warm Springs Avenue |
| 81 | 0700 | | Warm Springs Avenue |
| 82 | 0710 | | Warm Springs Avenue |
| 83 | 0720 | | Warm Springs Avenue |
| 84 | 0730 | | Warm Springs Avenue |
| 85 | 0740 | | Warm Springs Avenue |
| 86 | 0750 | | Warm Springs Avenue |
| 87 | 0760 | | Warm Springs Avenue |
| 88 | 0770 | | Warm Springs Avenue |
| 89 | 0780 | | Warm Springs Avenue |
| 90 | 0790 | | Warm Springs Avenue |
| 91 | 0800 | | Warm Springs Avenue |
| 92 | 0810 | | Warm Springs Avenue |
| 93 | 0811 | | Warm Springs Avenue |
| 94 | 0820 | | Warm Springs Avenue |
| 95 | 0830 | | Warm Springs Avenue |
| 96 | 0840 | | Warm Springs Avenue |
| 97 | 0845 | | Warm Springs Avenue |
| 98 | 0850 | | Warm Springs Avenue |
| 99 | 0860 | | Warm Springs Avenue |
| 100 | 0870 | | Jantoni Drive |
| 101 | 0880 | | Warm Springs Avenue |
| 102 | 0890 | | Warm Springs Avenue |

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| | | | |
|---|---|---|---|
| 103 | 0900 | | Warm Springs Avenue |
| 104 | 0910 | | Warm Springs Avenue |
| 105 | 0911 | | Warm Springs Avenue |
| 106 | 0912 | | Jantoni Drive |
| 107 | 0913 | | Warm Springs Avenue |
| 108 | 0920 | | Warm Springs Avenue |
| 109 | 0921 | | Warm Springs Avenue |
| 110 | 0922 | | Warm Springs Avenue |
| 111 | 0929 | | Louisa |
| 112 | 0930 | | East Idaho |
| 113 | 0940 | | East Idaho |
| 114 | 0950 | | East Idaho |
| 115 | 0960 | | East Idaho |
| 116 | 0970 | | East Idaho |
| 117 | 0980 | | East Idaho |
| 118 | 0990 | | East Idaho |
| 119 | 1000 | | East Idaho |
| 120 | 1010 | | East Idaho |
| 121 | 1020 | | East Idaho |
| 122 | 1030 | | East Idaho |
| 123 | 1040 | | East Idaho |
| 124 | 1050 | | East Idaho |
| 125 | 1060 | | East Idaho |
| 126 | 1070 | | East Bannock |
| 127 | 1080 | | East Bannock |
| 128 | 1090 | | East Bannock |
| 129 | 1100 | | East Bannock |
| 130 | 1110 | | East Bannock |
| 131 | 1111 | | East Bannock |
| 132 | 1114 | | East Bannock |
| 133 | 1116 | | East Bannock |
| 134 | 1120 | | East Bannock |
| 135 | 1130 | | East Bannock |
| 136 | 1140 | | East Bannock |
| 137 | 1150 | | East Bannock |
| 138 | 1160 | | East Bannock |
| 139 | 1161 | | East Bannock |
| 140 | 1170 | | East Bannock |
| 141 | 1180 | | East Bannock |
| 142 | 1190 | | East Bannock |
| 143 | 1200 | | East Bannock |
| 144 | 1210 | | East Bannock |
| 145 | 1220 | | East Bannock |
| 146 | 1230 | | East Bannock |
| 147 | 1240 | | East Bannock |
| 148 | 1250 | | East Bannock |
| 149 | 1260 | | East Bannock |
| 150 | 1270 | | East Bannock |
| 151 | 1280 | | East Bannock |
| 152 | 1290 | | East Idaho |
| 153 | 1300 | | East Idaho |
| 154 | 1310 | | East Idaho |

| | | | |
|---|---|---|---|
| 155 | 1320 | | North Elm Avenue |
| 156 | 1330 | | East Jefferson |
| 157 | 1340 | | East Jefferson |
| 158 | 1350 | | East Jefferson |
| 159 | 1358 | | East Jefferson |
| 160 | 1360 | | East Jefferson |
| 161 | 1370 | | East Jefferson |
| 162 | 1380 | | East State |
| 163 | 1390 | | Main Street |
| 164 | 1400 | | Main Street |
| 165 | 1410 | | Main Street |
| 166 | 1420 | | Main Street |
| 167 | 1430 | | Main Street |
| 168 | 1440 | | Main Street |
| 169 | 1450 | | Main Street |
| 170 | 1460 | | Main Street |
| 171 | 1470 | | Main Street |
| 172 | 1480 | | Main Street |
| 173 | 1490 | | Main Street |
| 174 | 1500 | | Main Street |
| 175 | 1510 | | Main Street |
| 176 | 1520 | | Main Street |
| 177 | 1530 | | Main Street |
| 178 | 1540 | | Main Street |
| 179 | 1550 | | Main Street |
| 180 | 1560 | | West Idaho |
| 181 | 1570 | | West Idaho |
| 182 | 1580 | | West Idaho |
| 183 | 1590 | | West Idaho |
| 184 | 1600 | | West Idaho |
| 185 | 1610 | | West Idaho |
| 186 | 1615 | | West Idaho |
| 187 | 1620 | | West Idaho |
| 188 | 1630 | | West Idaho |
| 189 | 1640 | | West Idaho |
| 190 | 1650 | | West Idaho |
| 191 | 1652 | | West Idaho |
| 192 | 1660 | | West Idaho |
| 193 | 1670 | | West Idaho |
| 194 | 1680 | | West Idaho |
| 195 | 1690 | | West Idaho |
| 196 | 1700 | | West Idaho |
| 197 | 1710 | | West Idaho |
| 198 | 1720 | | West Idaho |
| 199 | 1730 | | West Idaho |
| 200 | 1740 | | West Idaho |
| 201 | 1750 | | West Idaho |
| 202 | 1760 | | West Idaho |
| 203 | 1770 | | West Bannock |
| 204 | 1780 | | West Bannock |
| 205 | 1790 | | West Bannock |
| 206 | 1795 | | West Bannock |

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| | | | |
|---|---|---|---|
| 207 | 1800 | | West Bannock |
| 208 | 1810 | | West Bannock |
| 209 | 1820 | | West Bannock |
| 210 | 1825 | | West Bannock |
| 211 | 1830 | | West Bannock |
| 212 | 1840 | | West Bannock |
| 213 | 1841 | | West Bannock |
| 214 | 1850 | | West Bannock |
| 215 | 1860 | | West Bannock |
| 216 | 1870 | | West Bannock |
| 217 | 1880 | | West Bannock |
| 218 | 1890 | | West Bannock |
| 219 | 1900 | | West Bannock |
| 220 | 1910 | | West Jefferson |
| 221 | 1920 | | West Jefferson |
| 222 | 1930 | | West Jefferson |
| 223 | 1931 | | West Jefferson |
| 224 | 1940 | | West Jefferson |
| 225 | 1950 | | West Jefferson |
| 226 | 1960 | | West Jefferson |
| 227 | 1965 | | West Jefferson |
| 228 | 1967 | | West Washington |
| 229 | 1970 | | West Jefferson |
| 230 | 1980 | | West Jefferson |
| 231 | 1990 | | West Jefferson |
| 232 | 2000 | | West Jefferson |
| 233 | 2010 | | West Jefferson |
| 234 | 2011 | | West State |
| 235 | 2020 | | West State |
| 236 | 2030 | | Locust Street |
| 237 | 2040 | | Locust Street |
| 238 | 2050 | | North Walnut Avenue |
| 239 | 2060 | | North Walnut Avenue |
| 240 | 2070 | | North Walnut Avenue |
| 241 | 2080 | | North Walnut Avenue |
| 242 | 2085 | | North Maple Avenue |
| 243 | 2090 | | North Maple Avenue |
| 244 | 2100 | | North Elm Avenue |
| 245 | 2110 | | North 1st |
| 246 | 2120 | | North 4th Street |
| 247 | 2130 | | North 5th Street |
| 248 | 2140 | | North 6th Street |
| 249 | 2150 | | North 7th Street |
| 250 | 2160 | | North 8th Street |
| 251 | 2170 | | North 8th Street |
| 252 | 2180 | | North 8th Street |
| 253 | 2190 | | North 8th Street |
| 254 | 2200 | | West Bannock |
| 255 | 2210 | | North 12th Street |
| 256 | 2211 | | North 12th Street |
| 257 | 3000 | | Warm Springs Avenue |
| 258 | 3020 | | Warm Springs Avenue |

| | | | |
|---|---|---|---|
| 259 | 3030 | | Warm Springs Avenue |
| 260 | 3051 | | Warm Springs Avenue |
| 261 | 3190 | | East Bannock |
| 262 | 3220 | | Warm Springs Avenue |
| 263 | 3270 | | East Bannock |
| 264 | 3330 | | Main Street |
| 265 | 3340 | | Old Penitentiary Road |
| 266 | 3350 | | West State |
| 267 | 3360 | | West State |
| 268 | 3364 | | West State |
| 269 | 3400 | | Old Penitentiary Road |
| 270 | 3410 | | Mobely Drive |
| 271 | 3510 | | Mobely Drive |
| 272 | 3520 | | Mobely Drive |
| 273 | 3530 | | Mobely Drive |
| 274 | 3540 | | Mobely Drive |
| 275 | 3550 | | Mobely Drive |
| 276 | 3560 | | Mobely Drive |
| 277 | 3566 | | Mobely Drive |
| 278 | 3570 | | Mobely Drive |
| 279 | 3580 | | Mobely Drive |
| 280 | 3590 | | Mobely Drive |
| 281 | 3600 | | Mobely Drive |
| 282 | 3610 | | Mobely Drive |
| 283 | 3620 | | Mobely Drive |
| 284 | 3630 | | Mobely Drive |
| 285 | 3640 | | Mobely Drive |
| 286 | 3650 | | Mobely Drive |
| 287 | 3660 | | Mobely Drive |
| 288 | 3667 | | Jantoni Drive |
| 289 | 3670 | | Jantoni Drive |
| 290 | 3680 | | Jantoni Drive |
| 291 | 3690 | | East Jefferson |
| 292 | 3700 | | Mobely Drive |
| 293 | 3810 | | South Coston |
| 294 | 3820 | | South Coston |
| 295 | 3830 | | South Coston |
| 296 | 3840 | | South Coston |
| 297 | 3850 | | South Coston |
| 298 | 3860 | | South Coston |
| 299 | 3870 | | South Coston |
| 300 | 3880 | | Lenz Lane |
| 301 | 3890 | | Lenz Lane |
| 302 | 3900 | | Lenz Lane |
| 303 | 3910 | | Lenz Lane |
| 304 | 3920 | | Lenz Lane |
| 305 | 3930 | | Lenz Lane |
| 306 | 3940 | | Lenz Lane |
| 307 | 3950 | | Lenz Lane |
| 308 | 3960 | | Lenz Lane |
| 309 | 3970 | | Lenz Lane |
| 310 | 3980 | | Lenz Lane |

RECEIVED
MAR 29 2005
WATER RESOURCES
WESTERN REGION

| | | | |
|---|---|---|---|
| 311 | 3990 | | Lenz Lane |
| 312 | 4000 | | Lenz Lane |
| 313 | 4010 | | Lenz Lane |
| 314 | 4020 | | Lenz Lane |
| 315 | 4030 | | Lenz Lane |
| 316 | 4040 | | Lenz Lane |
| 317 | 4050 | | Lenz Lane |
| 318 | 4060 | | Lenz Lane |
| 319 | 4070 | | Lenz Lane |
| 320 | 4080 | | Lenz Lane |
| 321 | 4090 | | Lenz Lane |
| 322 | 4100 | | Lenz Lane |
| 323 | 4110 | | Lenz Lane |
| 324 | 4120 | | South Mobley Drive |
| 325 | 4130 | | South Mobley Drive |
| 326 | 4140 | | South Mobley Drive |
| 327 | 4150 | | South Mobley Drive |
| 328 | 4160 | | South Mobley Drive |
| 329 | 4170 | | South Mobley Drive |
| 330 | 4180 | | South Mobley Drive |
| 331 | 4190 | | South Mobley Drive |
| 332 | 4200 | | South Mobley Drive |
| 333 | 4210 | | South Mobley Drive |
| 334 | 4220 | | South Mobley Drive |
| 335 | 4230 | | South Mobley Drive |
| 336 | 4240 | | South Mobley Drive |
| 337 | 4250 | | Lewis Street |
| 338 | 4260 | | Lewis Street |
| 339 | 4270 | | Lewis Street |
| 340 | 4280 | | Lewis Street |
| 341 | 4290 | | Lewis Street |
| 342 | 4300 | | Lewis Street |
| 343 | 4310 | | Lewis Street |
| 344 | 4320 | | McGuffin Lane |
| 345 | 4330 | | McGuffin Lane |
| 346 | 4340 | | McGuffin Lane |
| 347 | 4360 | | McGuffin Lane |
| 348 | 4380 | | McGuffin Lane |
| 349 | 4400 | | McGuffin Lane |
| 350 | 4410 | | McGuffin Lane |
| 351 | 4420 | | McGuffin Lane |

Historic Recorded Maximum Water Use of Boise Warm Springs Water District

In 1989 Robert Griffiths, manager of the Boise Warm Springs Water District (BWSWD), prepared a report titled "Geothermal Production 1977-1989." He used a Lotus program to summarize the daily rates of diversion by using the total recorded volume for each day and the time between meter readings.

Inspection of the average daily pumping rates calculated in the report shows that there were 18 occurrences of rates above 1600 gallons per minute (gpm). Some occurrences were not used because they appeared to be anomalies due to questionable readings. Comparing these occurrences with dates and daily temperature records indicate these maximum rates of diversion occurred during the months of December through February when temperatures were near 0 degrees Fahrenheit or below for extended periods.

By averaging the five highest values observed, a reasonable estimate can be made of the maximum historic recorded diversion by the (BWSWD) wells. In late January of 1979 temperatures were very cold reaching 13 below zero. On January 25, 1693 gpm was recorded, and on January 29, 1651 gpm. Again in late January 1980 a cold spell occurred with temperatures reaching 7 below zero. On January 21, 1980 an average rate of 1737 gpm was recorded and on January 28, 1980 a rate of 1659 gpm was calculated. On February 5th of 1982, a rate of 1699 gpm was recorded when temperatures fell to zero. In all the above cases, temperatures were low for an extended period and pumping rates were frequently above 1600 gpm. The average of the above five readings is 1688 gpm or about 3.75 cfs.

Neely reported maximum annual volume diverted by the BWSWD as 312.2 million gallons in 1979. This is equivalent to 958 acre-feet per year.

Bob Sutter
Boise Warm Springs Water District

March 8, 2005

*BOISE WARM SPRINGS WATER DISTRICT*

# GEOTHERMAL PRODUCTION 1977 - 1989

# *BOISE WARM SPRINGS WATER DISTRICT*

GEOTHERMAL PRODUCTION

1977 - 1989

INDEX


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QJAN79
BOISE WARM SPRINGS WATER DISTRICT
DAILY PRODUCTION FOR MONTH OF JANUARY 1979 

| DATE | TIME | ELAPSE TIME | RATE OBSER | METER READING | QUANTITY M GAL | AVE. RATE | ADJUSTED QUANTITY |
|---|---|---|---|---|---|---|---|
| 01JAN79 | 10 | | | 499712 | | | |
| 02 | 8.5 | 1350 | 800 | 500770 | 1058 | 783.70 | |
| 03 | 8 | 1410 | 790 | 501933 | 1163 | 824.82 | |
| 04 | 8.5 | 1470 | 800 | 503077 | 1144 | 778.23 | |
| 05 | 8.5 | 1440 | 800 | 504265 | 1188 | 825 | |
| 06 | 9 | 1470 | 800 | 505437 | 1172 | 797.27 | |
| 07 | 9.5 | 1470 | 800 | 506666 | 1229 | 836.05 | |
| 08 | 7 | 1290 | 820 | 507709 | 1043 | 808.52 | |
| 09 | 8.5 | 1530 | 820 | 508974 | 1265 | 826.79 | |
| 10JAN79 | 9.5 | 1500 | 1000 | 510540 | 1566 | 1044 | |
| 11 | 8.75 | 1395 | 850 | 511724 | 1184 | 848.74 | |
| 12 | 6.25 | 1290 | 800 | 512796 | 1072 | 831.00 | |
| 13 | 6.5 | 1455 | 800 | 514035 | 1239 | 851.54 | |
| 14 | 8.75 | 1575 | 820 | 515455 | 1420 | 901.58 | |
| 15 | 8.5 | 1425 | 910 | 516758 | 1303 | 914.38 | |
| 16 | 8.5 | 1440 | 950 | 517880 | 1122 | 779.16 | |
| 17 | 8 | 1410 | 1000 | 519208 | 1328 | 941.84 | |
| 18 | 8.5 | 1470 | 1000 | 520620 | 1412 | 960.54 | |
| 19 | 8.25 | 1425 | 920 | 522005 | 1385 | 971.92 | |
| 20JAN79 | 8 | 1425 | 1100 | 523400 | 1395 | 978.94 | |
| 21 | 8 | 1440 | 1050 | 524737 | 1337 | 928.47 | |
| 22 | 9 | 1500 | 1000 | 526190 | 1453 | 968.66 | |
| 23 | 9 | 1440 | 1100 | 528034 | 1844 | 1280.5 | |
| 24 | 8.5 | 1410 | 1110 | 530316 | 2282 | 1618.4 | |
| 25 | 8.5 | 1440 | 1100 | 532694 | 2378 | 1651.3 | |
| 26 | 8.5 | 1440 | 1120 | | 2337 | 1622.9 | |
| 27 | 9 | 1470 | 1120 | | 2337 | 1589.7 | |
| 28 | 9.5 | 1470 | 800 | | 2337 | 1589.7 | |
| 29 | 8.5 | 1380 | 1180 | | 2337 | 1693.4 | |
| 30JAN79 | 9 | 1470 | 1660 | 544381 | 2339 | 1591.1 | -13 °F |
| 31JAN79 | 8 | 1380 | 1530 | 546656 | 2275 | 1648.5 | |
| 01FEB79 | 8.75 | 1485 | 1500 | 549030 | 2374 | 1598.6 | |
| | | | 800 | | | | |
| TOTAL MINUTES | | 44565 | | | | | |
| SUBTOTAL M GAL | | | | | 49318 | | |
| TOTAL ADJ M GAL | | | | | | | 0 |
| TOTAL M GAL | | | | | 49318 | | |
| AVE. RATE | | | | | | 1106.6 | |

QJAN79

QJAN80
BOISE WARM SPRINGS WATER DISTRICT
DAILY PRODUCTION FOR MONTH OF JANUARY 1980 

| DATE | TIME | ELAPSE TIME | RATE OBSER | METER READING | QUANTITY M GAL | AVE. RATE | ADJUSTED QUANTITY |
|---|---|---|---|---|---|---|---|
| 01JAN80 | 7 | | | 827894 | | | |
| 02 | 9.5 | 1590 | 900 | 829257 | 1363 | 857.23 | |
| 03 | 9 | 1410 | 850 | 830500 | 1243 | 881.56 | |
| 04 | 9 | 1440 | 850 | 831710 | 1210 | 840.27 | |
| 05 | 9 | 1440 | 900 | 832949 | 1239 | 860.41 | |
| 06 | 7 | 1320 | 1000 | 834046 | 1097 | 831.06 | |
| 07 | 9 | 1560 | 1600 | 835700 | 1654 | 1060.2 | |
| 08 | 8.5 | 1410 | 1250 | 837115 | 1415 | 1003.5 | |
| 09 | 8.5 | 1440 | 950 | 839067 | 1952 | 1355.5 | |
| 10JAN80 | 8.75 | 1455 | 925 | 840278 | 1211 | 832.30 | |
| 11 | 8.5 | 1425 | 950 | 841544 | 1266 | 888.42 | |
| 12 | 9 | 1470 | 900 | 842720 | 1176 | 800 | |
| 13 | 9 | 1440 | 900 | 843860 | 1140 | 791.66 | |
| 14 | 8.5 | 1410 | 800 | 844959 | 1099 | 779.43 | |
| 15 | 9 | 1470 | 800 | 846080 | 1121 | 762.58 | |
| 16 | 8.5 | 1410 | 820 | 847144 | 1064 | 754.60 | |
| 17 | 8.5 | 1440 | 800 | 848410 | 1266 | 879.16 | |
| 18 | 8.5 | 1440 | 950 | 849616 | 1206 | 837.5 | |
| 19 | 8.5 | 1440 | 980 | 850881 | 1265 | 878.47 | |
| 20JAN80 | 9 | 1470 | 1600 | 852121 | 1240 | 843.53 | |
| 21 | 8.5 | 1410 | 1100 | 854570 | 2449 | 1736.8 | |
| 22 | 8.5 | 1440 | 1650 | 856931 | 2361 | 1639.5 | |
| 23 | 8.5 | 1440 | 1600 | 859255 | 2324 | 1613.8 | |
| 24 | 8.5 | 1440 | 1600 | 860830 | 1575 | 1093.7 | |
| 25 | 8.5 | 1440 | 1650 | 863095 | 2265 | 1572.9 | |
| 26 | 10 | 1530 | 1650 | 864670 | 1575 | 1029.4 | |
| 27 | 9.5 | 1410 | 1700 | 866930 | 2260 | 1602.8 | |
| 28 | 8.5 | 1380 | 1750 | 869220 | 2290 | 1659.4 | |
| 29 | 8.5 | 1440 | 1600 | 871468 | 2248 | 1561.1 | |
| 30JAN80 | 7.75 | 1395 | 1700 | 873600 | 2132 | 1528.3 | |
| 31JAN80 | 9 | 1515 | 1700 | 876010 | 2410 | 1590.7 | |
| 01FEB80 | 7.5 | 1350 | 1650 | 877412 | 1402 | 1038.5 | |

| | | | | |
|---|---|---|---|---|
| TOTAL MINUTES | 44670 | | | |
| SUBTOTAL M GAL | | 49518 | | |
| TOTAL ADJ M GAL | | | | 0 |
| TOTAL M GAL | | 49518 | | |
| AVE. RATE | | | 1108.5 | |

QJAN80

QFEB82
BOISE WARM SPRINGS WATER DISTRICT
DAILY PRODUCTION FOR MONTH OF FEBRUARY 1982 

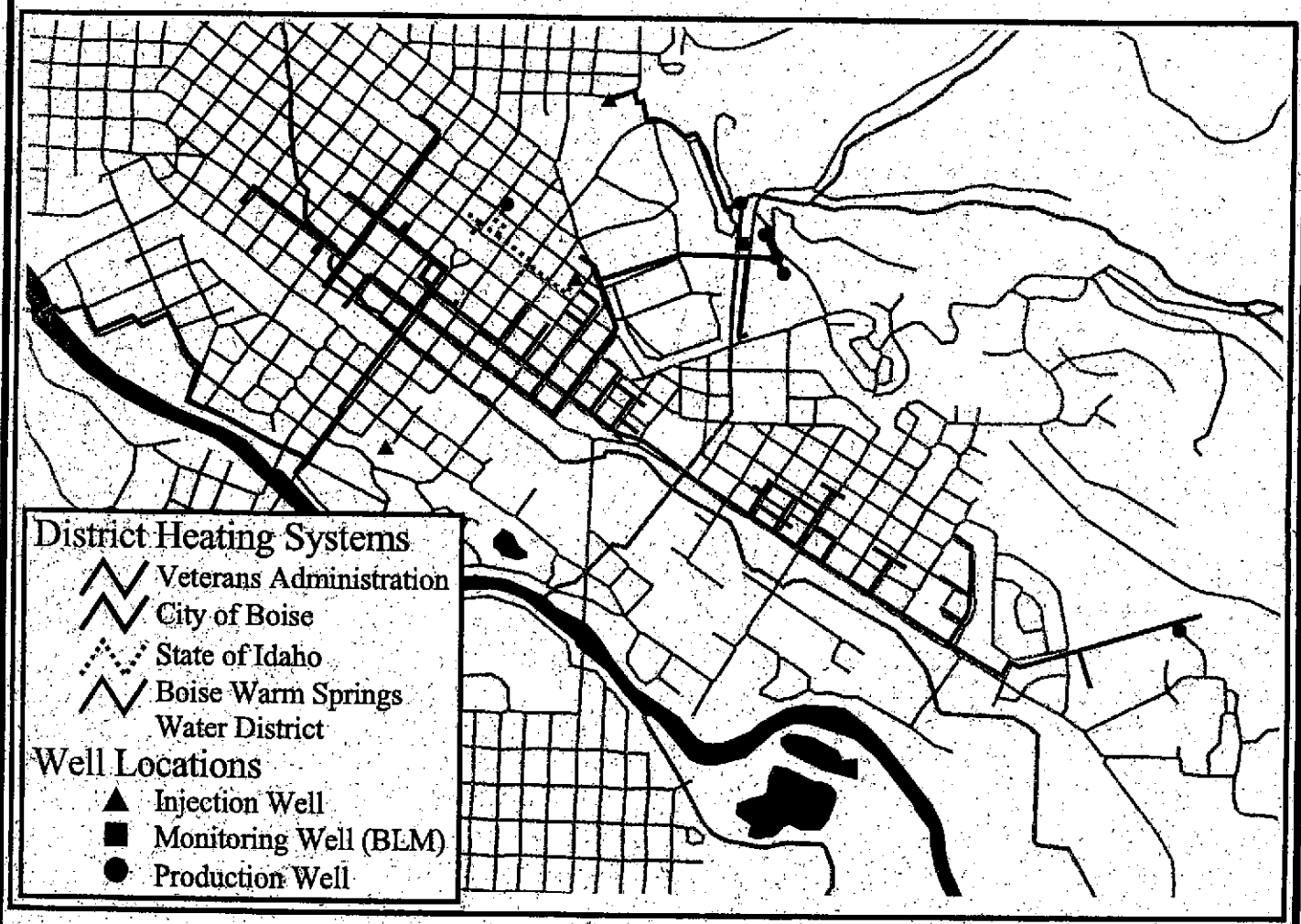
| DATE | TIME | ELAPSE TIME | RATE OBSER | METER READING | QUANTITY M GAL | AVE. RATE | ADJUSTED QUANTITY |
|---|---|---|---|---|---|---|---|
| 01FEB82 | 9.5 | | 1200 | 405823 | | | |
| 02 | 9.5 | 1440 | 1200 | 407840 | 2017 | 1400.6 | |
| 03 | 9 | 1410 | 1400 | 409100 | 1260 | 893.61 | |
| 04 | 9.5 | 1470 | 1400 | 410110 | 1010 | 687.07 | |
| 05 | 9 | 1410 | 1400 | 412506 | 2396 | 1699.2 | |
| 06 | 9.5 | 1470 | 1500 | 414475 | 1969 | 1339.4 | |
| 07 | 9.5 | 1440 | 1450 | 416666 | 2191 | 1521.5 | 0°F |
| 08 | 9 | 1410 | 1150 | 417940 | 1274 | 903.54 | |
| 09 | 8.5 | 1410 | 1000 | 419204 | 1264 | 896.45 | |
| 10FEB82 | 8.5 | 1440 | 1100 | 420500 | 1296 | 900 | |
| 11 | 8.5 | 1440 | 900 | 421750 | 1250 | 868.05 | |
| 12 | 9.25 | 1485 | 1150 | 423066 | 1316 | 886.19 | |
| 13 | 8.5 | 1395 | 1100 | 424722 | 1656 | 1187.0 | |
| 14 | 10 | 1530 | 1000 | 426147 | 1425 | 931.37 | |
| 15 | 9 | 1380 | 700 | 427250 | 1103 | 799.27 | |
| 16 | 9 | 1440 | 650 | 428397 | 1147 | 796.52 | |
| 17 | 9.5 | 1470 | 1000 | 429550 | 1153 | 784.35 | |
| 18 | 8 | 1350 | 960 | 430660 | 1110 | 822.22 | |
| 19 | 8 | 1440 | 900 | 431770 | 1110 | 770.83 | |
| 20FEB82 | 9.5 | 1530 | 750 | 432860 | 1090 | 712.41 | |
| 21 | 8.5 | 1380 | 500 | 433683 | 823 | 596.37 | |
| 22 | 8 | 1410 | 650 | 434678 | 995 | 705.67 | |
| 23 | 8.75 | 1485 | 850 | 435842 | 1164 | 783.83 | |
| 24 | 8.5 | 1425 | 800 | 437060 | 1218 | 854.73 | |
| 25 | 9.5 | 1500 | 750 | 438255 | 1195 | 796.66 | |
| 26 | 8.75 | 1395 | 550 | 439300 | 1045 | 749.10 | |
| 27 | 9 | 1455 | 550 | 440360 | 1060 | 728.52 | |
| 28FEB82 | 9.5 | 1470 | 550 | 441500 | 1140 | 775.51 | |
| 01MAR82 | 8.75 | 1395 | 500 | 442423 | 923 | 661.64 | |

| | | | | |
|---|---|---|---|---|
| TOTAL MINUTES | 40275 | | | |
| SUBTOTAL M GAL | | 36600 | | |
| TOTAL ADJ M GAL | | | | 0 |
| TOTAL M GAL | | 36600 | | |
| AVE. RATE | | | 908.75 | |

QFEB82

# PRODUCTION, TEMPERATURE, AND WATER LEVEL DATA FOR THE FOUR HEATING SYSTEMS IN THE BOISE FRONT LOW TEMPERATURE GEOTHERMAL RESOURCE AREA, 1977-1997

By
Kenneth W. Neely




Idaho Department of Water Resources
Open-File Report
June, 1998

**Table 2.** Production By Water Year[1] For The Four Heating Systems In The Boise Front Geothermal Area.

| PRODUCTION IN MILLIONS OF GALLONS | | | | | |
|---|---|---|---|---|---|
| **Water Year** | **BWSWD** | **State** | **City** | **VA** | **Total** |
| 1978 | 256.0 | | | | 256.0 |
| 1979 | 312.2 | | | | 312.2 |
| 1780 | 308.1 | | | | 308.1 |
| 1981 | 239.4 | | | | 239.4 |
| 1982 | 276.0 | | | | 276.0 |
| 1983 | 283.5 | | | | 283.5 |
| 1984 | 300.1 | 162.9 | 166.7 | | 629.7 |
| 1985 | 281.1 | 175.4 | 121.4 | | 577.9 |
| 1986 | 253.2 | 192.0 | 176.8 | | 622.0 |
| 1987 | 183.3 | 169.1 | 188.9 | | 541.3 |
| 1988 | 199.4 | 138.8 | 123.8 | | 462.0 |
| 1989 | 278.0 | 120.0 | 158.0 | | 556.0 |
| 1990 | 244.6 | 68.3 | 122.3 | 118.2 | 553.4 |
| 1991 | 245.7 | 177.6 | 121.3 | 115.4 | 660.0 |
| 1992 | 243.3 | 139.0 | 123.3 | 116.7 | 622.3 |
| 1993 | 239.3 | 177.6 | 156.0 | 137.0 | 709.9 |
| 1994 | 214.7 | 179.6 | 122.5 | 137.4 | 654.2 |
| 1995 | 221.2 | 150.8 | 129.9 | 151.4 | 653.3 |
| 1996 | 226.6 | 119.6 | 132.1 | 186.2 | 664.5 |
| 1997 | 212.8 | 112.2 | 130.7 | 203.6 | 659.3 |
| Average production | 250.9 (1978-1997) | 155.0 (1984-1997, minus 1990) | 141.0 (1984-1997) | 145.7 (1990-1997) | 660.5 (1991-1997) |

[1]Water year runs from October 1 to September 30. For example, water year 1978 started on October 1, 1977 and ended on September 30, 1978.

250.9 mg ÷ 325,850 = 770 AF

312.2 mg ÷ 325,850 = 958 AF

IN THE DISTRICT COURT OF THE FIFTH JUDICIAL DISTRICT OF THE STATE OF IDAHO,
IN AND FOR THE COUNTY OF TWIN FALLS

IN RE THE GENERAL ADJUDICATION
OF RIGHTS TO THE USE OF WATER FROM
THE SNAKE RIVER BASIN WATER SYSTEM

CIVIL CASE NUMBER: 39576

Ident. Number 63-5073
Date Received: 7/14/1989
Receipt No: C008280
Received By:

AMENDED

**NOTICE OF CLAIM TO A WATER RIGHT**
**ACQUIRED UNDER STATE LAW**

1. Name of Claimant(s)

BOISE WARM SPRINGS WATER DIST Phone: (208)342-3162
2440 OLD PENITENTIARY RD
BOISE ID USA 83712

2. Date of Priority: 11/05/1894

3. Source: GROUND WATER Trib. to:

4. Point of Diversion:

| Township | Range | Section | 1/4 | 1/4 | 1/4 | Lot | County | Type |
|---|---|---|---|---|---|---|---|---|
| 03N | 02E | 12 | SE | SE | SW | | ADA | |

5. Description of diverting works:

WELLS, PUMPS & PIPELINE. SEE REMARKS

6. Water is used for the following purposes:

| Purpose | From | To | C.F.S. | (or) A.F.A |
|---|---|---|---|---|
| HEATING | 1/01 | 12/31 | 8.819 | |
| DOMESTIC | 1/01 | 12/31 | 4 | |

7. Total Quantity Appropriated is:
12.819 C.F.S.

8. Total consumptive use:

9. Non-irrigation uses:

10. Place of use:

| Township | Range | Section | 1/4 | of 1/4 | Lot | Use | Acres |
|---|---|---|---|---|---|---|---|
| 03N | 02E | 10 | NE | NE | | DOMESTIC | |
| | | | SW | NE | | DOMESTIC | |
| | | | SE | NE | | DOMESTIC | |
| | | | NE | SE | | DOMESTIC | |
| | | | NE | NE | | HEATING | |
| | | | SW | NE | | HEATING | |
| | | | SE | NE | | HEATING | |
| | | | NE | SE | | HEATING | |
| 03N | 02E | 11 | SW | NW | | HEATING | |
| | | | NE | SW | | HEATING | |
| | | | NW | SW | | HEATING | |
| | | | SE | SW | | HEATING | |
| | | | NE | SE | | HEATING | |
| | | | NW | SE | | HEATING | |
| | | | SW | SE | | HEATING | |
| | | | SE | SE | | HEATING | |
| | | | SW | NW | | DOMESTIC | |
| | | | NE | SW | | DOMESTIC | |
| | | | NW | SW | | DOMESTIC | |
| | | | SE | SW | | DOMESTIC | |
| | | | NE | SE | | DOMESTIC | |
| | | | NW | SE | | DOMESTIC | |
| | | | SW | SE | | DOMESTIC | |
| | | | SE | SE | | DOMESTIC | |
| 03N | 02E | 12 | SE | SW | | DOMESTIC | |
| | | | SW | SE | | DOMESTIC | |
| | | | SE | SW | | HEATING | |
| | | | SW | SE | | HEATING | |
| 03N | 02E | 13 | NE | NW | | HEATING | |
| | | | NW | NW | | HEATING | |
| | | | NE | NW | | DOMESTIC | |
| | | | NW | NW | | DOMESTIC | |
| 03N | 02E | 14 | NE | NE | | DOMESTIC | |
| | | | NE | NE | | HEATING | |

11. Place of use in counties: ADA

12. Do you own the property listed above as place of use? No

13. Other Water Rights Used:

14. Remarks:

LOW TEMPERATURE GEOTHERMAL USE FOR CUSTOMERS IN DISTRICT.

DISTRICT OWNS WELL SITE. CITIZENS IN DISTRICT OWN INDIVIDUAL PARCELS. DISTRICT PROVIDES SERVICE TO STATE OF IDAHO HEALTH AND AGRICULTURE, CORRECTIONS AS WELL AS RESIDENCES AND COMMERCIAL OFFICE.
3 WELLS AT 400 FT X 12 INCH, 2 PUMPS, 16000 FT +- TRANSMISSION AND DISTRIBUTION SYSTEM, 266 SERVICE CONNECTIONS. ONE WELL INACTIVE AT THIS TIME.
BOISE GEOTHERMAL AQUIFER.

15. Basis of Claim: Beneficial Use

RECEIVED
MAR 17 2005
WATER RESOURCES
WESTERN REGION

IN THE DISTRICT COURT OF THE FIFTH JUDICIAL DISTRICT OF THE STATE OF IDAHO, IN AND FOR THE COUNTY OF TWIN FALLS

CIVIL CASE NO. 39576
Indent. No. 63-5073
Date Received 3-17-05
Receipt No. _____

**IN RE GENERAL ADJUDICATION OF RIGHTS TO THE USE OF WATER FROM THE SNAKE RIVER BASIN WATER SYSTEM**

# NOTICE OF CLAIM TO A WATER RIGHT
ACQUIRED UNDER STATE LAW

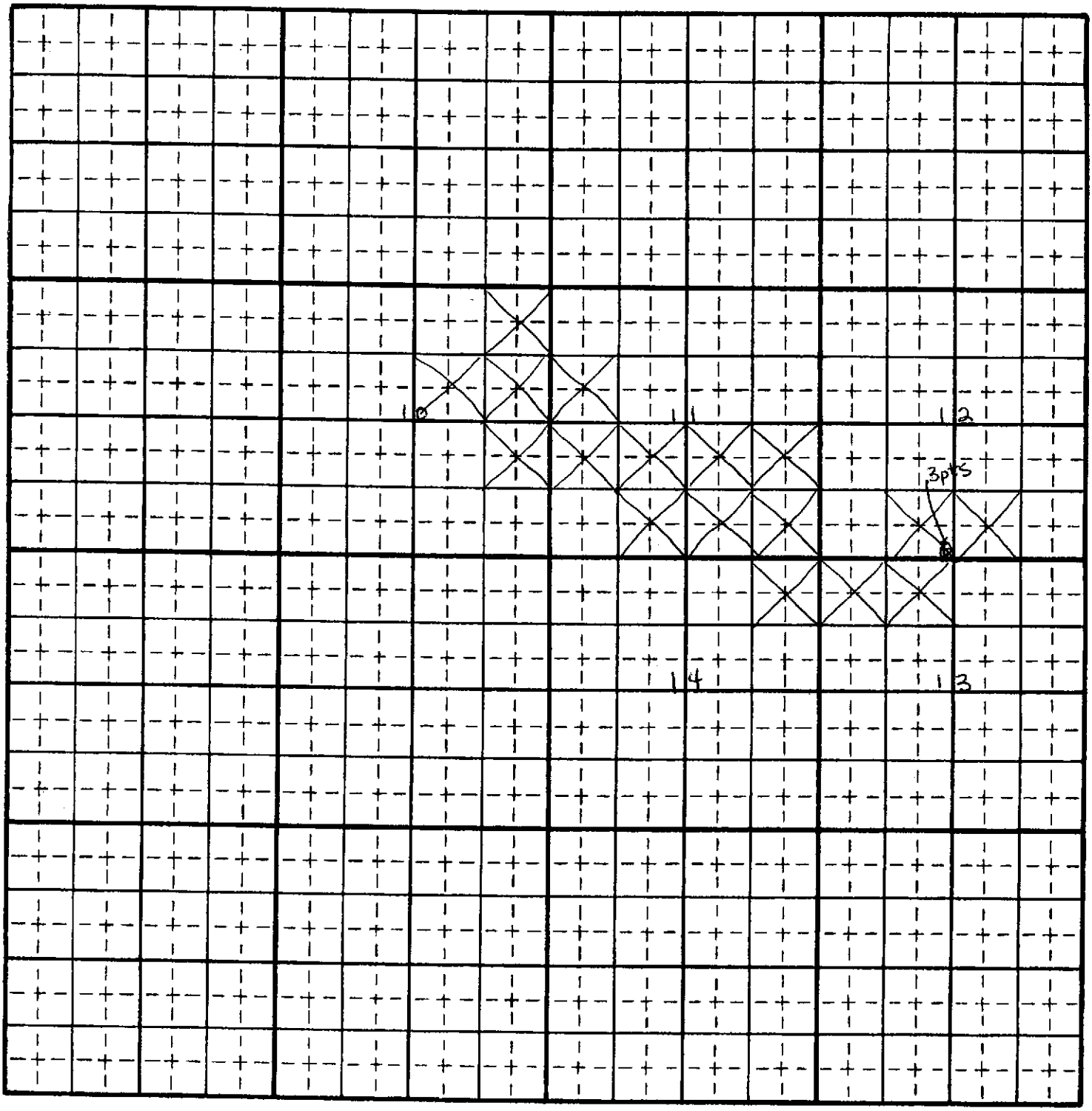
*AMENDED* *AMENDED*

1. Name of Claimant(s): Boise Warm Springs Water District Phone (208) 342-3162
   Mailing Address: 2440 Old Penitentiary Road Zip 83712
2. Date of Priority (Only one (1) per claim) 11-05-1894
3. Source of water supply (a) Groundwater
   which is tributary to (b) _____
4. a. Location of existing point of diversion is: Township 03N Range 02E Section 12
   SE ¼ of SE ¼ of SW ¼, Govt. Lot, _____ B.M., County of Ada
   Additional points of diversion if any: _____
   b. If instream flow, beginning of point of claimed instream flow is: N/A
   Township _____ Range _____ Section ____, ____ ¼ of _____ ¼ of _____¼,
   Govt. Lot, _____ B.M., County of _____
   ending point is: Township _____ Range _____ Section ____, ____ ¼ of _____ ¼
   of _____¼, Govt. Lot, _____ B.M., County of _____
5. Description of existing diversion works (Dams, Reservoirs, Ditches, Wells, Pumps, Pipelines, Headgates, Etc), including the dates of any changes or enlargements in use, the diversion works as constructed and as enlarged and the depth of each well.

   Three (3) wells and pipeline

Map of Project: show clearly the point of diversion, place of use, section number, township, and range number.

Scale: 2 inches equals 1 mile




Last Name _____ Ident No. _____

6. Water is claimed for the following purposes:

| | (both dates are inclusive) | | (cfs) | (acre feet) |
|---|---|---|---|---|
| For heating & domestic purposes from 1/01 | to 12/31 | amount 12.819 | or | |
| For _____ purposes from _____ | to _____ | amount _____ | or | |
| For _____ purposes from _____ | to _____ | amount _____ | or | |
| For _____ purposes from _____ | to _____ | amount _____ | or | |

7. Total quantity claimed (a) 12.819 (cfs) and/or (b) N/A (acre feet)
8. Total consumptive use claimed is N/A acre per annum.
9. Non-irrigation uses; describe fully (eg. Domestic: Give number of households served; Stockwater: Type and number of livestock, etc.) Low temperature geothermal use for customers in district
10. Description of place of use:
    a. If water is for irrigation, indicate acreage in each subdivision in the tabulation below.
    b. If water is used for other purposes, place a symbol of use (example: D for Domestic) in the corresponding place of use below. See instructions for standard symbols.

| TWP | RNG | SEC | NE ¼ | | | | NW ¼ | | | | SW ¼ | | | | SE ¼ | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NE ¼ | NW ¼ | SW ¼ | SE ¼ | NE ¼ | NW ¼ | SW ¼ | SE ¼ | NE ¼ | NW ¼ | SW ¼ | SE ¼ | NE ¼ | NW ¼ | SW ¼ | SE ¼ | |
| 3N | 2E | 10 | X | | X | X | | | | | | | | | X | | | | |
| | | 11 | | | | | | | X | | X | X | | X | X | X | X | X | |
| | | 12 | | | | | | | | | | | | X | | | X | | |
| | | 13 | | | | | X | X | | | | | | | | | | | |
| | | 14 | X | | | | | | | | | | | | | | | | |

Total number of acres irrigated *

* Place of use also includes all annexed properties as added from time to time.

11. In which county (ies) are lands listed above as place of use located? Ada
12. Do you own the property listed above a place of use? Yes _____ No X
    If your answer is No, describe in Remarks below the authority you have to claim this water right.
13. Describe any other water rights used at the same place and for the same purposes as described above. _____

14. Remarks:

District owns wells and distribution system. Customers own individual buildings and homes.

District provides service to State Health and Agriculture Department.

15. Basis of claim (check one) Beneficial Use ___ Posted Notice ___ License ___ Permit ___

Decree ____ Statutory ___X___

If applicable provide IDWR Water Right Number 63-5073

Court _____ Case No. _____ Decree Date _____

Plaintiff v. Defendant _____

16. Signature(s)

(a) By signing below, I/We acknowledge that I/We have received, read, and understand the form entitled "How you will receive notice in the Snake River Basin Adjudication." (b) I/We do \ do not ____ wish to receive and pay a small annual fee for monthly copies of the docket sheet.
Number of attachments _____

**For Individuals:** I do solemnly swear or affirm that the statements contained in the foregoing document are true and correct.

Signature of Claimant(s) _____ Date _____

_____ Date _____

**For Organizations:** I do solemnly swear or affirm that I am CHAIRMAN of BOISE WARM SPRINGS WATER DIST that I have signed the foregoing document in the space below as CHAIRMAN of DISTRICT and that the statements contained in the foregoing document are true and correct.

Signature of Authorized Agent D Douglas Tindley

Title and Organization CHAIRMAN BWSWD Date 3/16/05

State of Idaho/or _____ )
)
County of ADA )

Subscribed and sworn (or affirmed) before me this 16th day of March, 2005.

SEAL

Notary Public Jennifer Jensen
Residing at Boise ID
My Commission Expires 6/5/06

17. Notice of Appearance:

Notice is hereby given that I, Bruce M. Smith will be acting as attorney as law on behalf of the claimant signing above, and that all notices required by law to be mailed by the director to the claimant signing above should be mailed to me at the address listed below.

Signature _____

Address 225 N. 9th, Ste. 420 Boise ID 83702

Date 3/16/05

IN THE DISTRICT COURT OF THE FIFTH JUDICIAL DISTRICT OF THE STATE OF IDAHO,
IN AND FOR THE COUNTY OF TWIN FALLS

IN RE THE GENERAL ADJUDICATION
OF RIGHTS TO THE USE OF WATER FROM
THE SNAKE RIVER BASIN WATER SYSTEM.

CIVIL CASE NUMBER: 39576

Ident. Number: **A63-05073**
Date Received: 7/14/1989
Receipt No: C008280
Received By: _____

**NOTICE OF CLAIM TO A WATER RIGHT**
**ACQUIRED UNDER STATE LAW**

1. Name: BOISE WARM SPRINGS WATER DISTRICT 208-342-3162
   Address: 2440 OLD PENITENTIARY ROAD
   BOISE, ID 83712

2. Date of Priority: NOV 05, 1894

3. Source: GROUNDWATER Trib. to:

4. Point of Diversion:

| Township | Range | Section | 1/4 of 1/4 of 1/4 | Lot | County |
|---|---|---|---|---|---|
| 03N | 02E | 12 | SE SE SW | | ADA |

5. Description of diverting works:
   WELLS, PUMPS & PIPELINE. SEE REMARKS

6. Water is used for the following purposes:

| Purpose | From | To | C.F.S (or) | A.F.A. |
|---|---|---|---|---|
| HEATING | 01/01 | 12/31 | 8.819 | |
| DOMESTIC | 01/01 | 12/31 | 4.000 | |

7. Total Quantity Appropriated is:
   12.819 C.F.S. (and/or) A.F.A.

8. Total consumptive use is 155.0 Acre Feet Per Annum.

9. Non-irrigation uses:
   HEAT AND DOMESTIC USES FOR 266 RESIDENCES AND COMMERCIAL

10. Place of Use:

| Township | Range | Section | 1/4 of 1/4 | Lot | Use | Acres |
|---|---|---|---|---|---|---|
| 03N | 02E | 10 | NE NE | | HEAT | |
| | | | NE NE | | DOMEST | |



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10. Place of Use: Continued

| Township | Range | Section | 1/4 of 1/4 | | Lot | Use | Acres |
|---|---|---|---|---|---|---|---|
| 03N | 02E | 10 | SW | NE | | HEAT | |
| | | | SW | NE | | DOMEST | |
| | | | SE | NE | | DOMEST | |
| | | | SE | NE | | HEAT | |
| | | | NE | SE | | DOMEST | |
| | | | NE | SE | | HEAT | |
| | | 11 | SW | NW | | DOMEST | |
| | | | SW | NW | | HEAT | |
| | | | NE | SW | | DOMEST | |
| | | | NE | SW | | HEAT | |
| | | | NW | SW | | DOMEST | |
| | | | NW | SW | | HEAT | |
| | | | SE | SW | | DOMEST | |
| | | | SE | SW | | HEAT | |
| | | | NE | SE | | DOMEST | |
| | | | NE | SE | | HEAT | |
| | | | NW | SE | | DOMEST | |
| | | | NW | SE | | HEAT | |
| | | | SW | SE | | DOMEST | |
| | | | SW | SE | | HEAT | |
| | | | SE | SE | | DOMEST | |
| | | | SE | SE | | HEAT | |
| | | 12 | SE | SW | | DOMEST | |
| | | | SE | SW | | HEAT | |
| | | 13 | NE | NW | | DOMEST | |
| | | | NE | NW | | HEAT | |
| | | | NW | NW | | DOMEST | |
| | | | NW | NW | | HEAT | |
| | | 14 | NE | NE | | DOMEST | |
| | | | NE | NE | | HEAT | |

11. Place of use in counties: ADA

12. Do you own the property listed above as place of use? YES

13. Other Water Rights Used:
63-09160

14. Remarks:
DISTRICT OWNS WELL SITE. CITIZENS IN DISTRICT OWN INDIVIDUAL PARCELS. DISTRICT PROVIDES SERVICE TO STATE OF IDAHO HEALTH AND AGRICULTURE, CORRECTIONS AS WELL AS RESIDENCES AND COMMERCIAL OFFICE.
3 WELLS AT 400' X 12", 2 PUMPS, 16000' +- TRANSMISSION AND DISTRIBUTION SYSTEM, 266 SERVICE CONNECTIONS. ONE WELL INACTIVE



MICROFILMED
AUG 2 0 1992

14. Remarks: Continued
AT THIS TIME.
BOISE GEOTHERMAL AQUIFER.

15. Basis of Claim: POSTED NOTICE

16. Signature(s)

(a.) By signing below, I/We acknowledge that I/We have received, read and understand the form entitled "How you will receive notice in the Snake River Basin Adjudication." (b.) I/We do ____ do not ____ wish to receive and pay a small annual fee for monthly copies of the docket sheet.

Number of attachments: _____

**For Organizations:**

I do solemnly swear or affirm that I am _____ of
Title
_____, that I have signed the foregoing
Organization
document in the space below as _____ of
Title
_____ and that the statements contained in the
Organization
foregoing document are true and correct.

_____
Signature of Authorized Agent

_____
Title and Organization

_____
Date

State of Idaho )
) SS.
County of _____ )

Subscribed and sworn (or affirmed) before me this _____ day

of _____ 19 _____

_____
Notary Public

Seal

Residing at _____

My Commission Expires _____



MICROFILMED
AUG 2 0 1992

Form No. 42-1409 (2) a 1/88

IN THE DISTRICT COURT OF THE FIFTH JUDICIAL DISTRICT OF THE STATE OF IDAHO, IN AND FOR THE COUNTY OF TWIN FALLS

**IN RE THE GENERAL ADJUDICATION OF RIGHTS TO THE USE OF WATER FROM THE SNAKE RIVER BASIN WATER SYSTEM**

CIVIL CASE NUMBER: 39576
Ident. Number A63-05073
Date Received 7/14/89
Receipt Number C008280 gp

# NOTICE OF CLAIM TO A WATER RIGHT

## ACQUIRED UNDER STATE LAW

**Please type or print clearly**

1. Name of Claimant (s) Boise Warm Springs Water District Phone (208) 342-3162
   Mailing Address 2440 Old Penitentiary Road Zip 83712
   Boise, Idaho
2. Date of Priority (Only one (1) per claim) 05 November 1894
3. Source of water supply (a) Boise Geothermal Aquifer
   which is tributary to (b) _____
4. a. Location of existing point of diversion is: Township 3N Range 2E Section 12,
   SE 1/4 of SE 1/4 of SW 1/4, Govt. Lot, _____ B.M., County of Ada
   Additional points of diversion if any: _____
   b. If instream flow, beginning point of claimed instream flow is:
   Township _____ Range _____ Section _____, _____ 1/4 of _____ 1/4 of _____ 1/4,
   Govt. Lot _____ B.M., County of _____
   ending point is: Township _____ Range _____ Section _____, _____ 1/4 of _____ 1/4 of
   _____ 1/4, Govt. Lot _____ B.M., County of _____
5. Description of existing diversion works (Dams, Reservoirs, Ditches, Wells, Pumps, Pipelines, Headgates, Etc), including the dates of any changes or enlargements in use, the dimensions of the diversion works as constructed and as enlarged and the depth of each well. 3 Wells @ 400' x 12"
   2 Pumps, 16000' ± Transmission & Distribution System, 266 Service Connections
   One Well Injecting at Present Time

MICROFILMED
AUG 2 0 1992

6. Water is claimed for the following purposes:

(both dates are inclusive) (cfs) 8,819 (acre feet)

For Heating purposes from 01JAN to 31DEC amount ~~12,819~~ or _____

For Domestic purposes from 01JAN to 31DEC amount ~~12,819~~ 4,000 or _____

For _____ purposes from _____ to _____ amount _____ or _____

For _____ purposes from _____ to _____ amount _____ or _____

7. Total quantity claimed (a) 12,819 (cfs) and/or (b) _____ (acre feet)

8. Total consumptive use claimed is 155 acre feet per annum.

9. Non-irrigation uses; describe fully (eg. Domestic: Give number of households served; Stockwater: Type and number of livestock Etc.) Heat & Domestic - 266 Residence & Commercial

10. Description of place of use:
   a. If water is for irrigation, indicate acreage in each subdivision in the tabulation below.
   b. If water is used for other purposes, place a symbol of use (example: D for Domestic) in the corresponding place of use below. See instructions for standard symbols.

| TWP | RNG | SEC | NE 1/4 | | | | NW 1/4 | | | | SW 1/4 | | | | SE 1/4 | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NE1/4 | NW1/4 | SW1/4 | SE1/4 | NE1/4 | NW1/4 | SW1/4 | SE1/4 | NE1/4 | NW1/4 | SW1/4 | SE1/4 | NE1/4 | NW1/4 | SW1/4 | SE1/4 | |
| 3N | 2E | 10 | X | | X | X | | | | | | | | | X | | | | ~~160~~ |
| | | 11 | | | | | | | X | | X | X | | X | X | X | X | X | ~~320~~ |
| | | | | | | | | | | | | | | | | | | | |
| | | 12 | | | | | | | | | | | X | X | | | X | | ~~80~~ |
| | | 13 | | | | | X | X | | | | | | | | | | | ~~80~~ |
| | | | | | | | | | | | | | | | | | | | |
| | | 14 | X | | | | | | | | | | | | | | | | ~~80~~ |

Total number of acres ~~irrigated~~ Heat & Dom 680

11. In which county (ies) are lands listed above as place of use located? Ada

12. Do you own the property listed above as place of use? Yes _____ No X
If your answer is No, describe in Remarks below the authority you have to claim this water right.

13. Describe any other water rights used at the same place and for the same purposes as described above.
63-9160 or None ( )

14. Remarks: District owns well site, Citizens in District own individual parcels.
District provides service to State of Idaho Health & Agriculture, Corrections as well as Residences and Commercial office.

MICROFILMED
AUG 20 1992

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

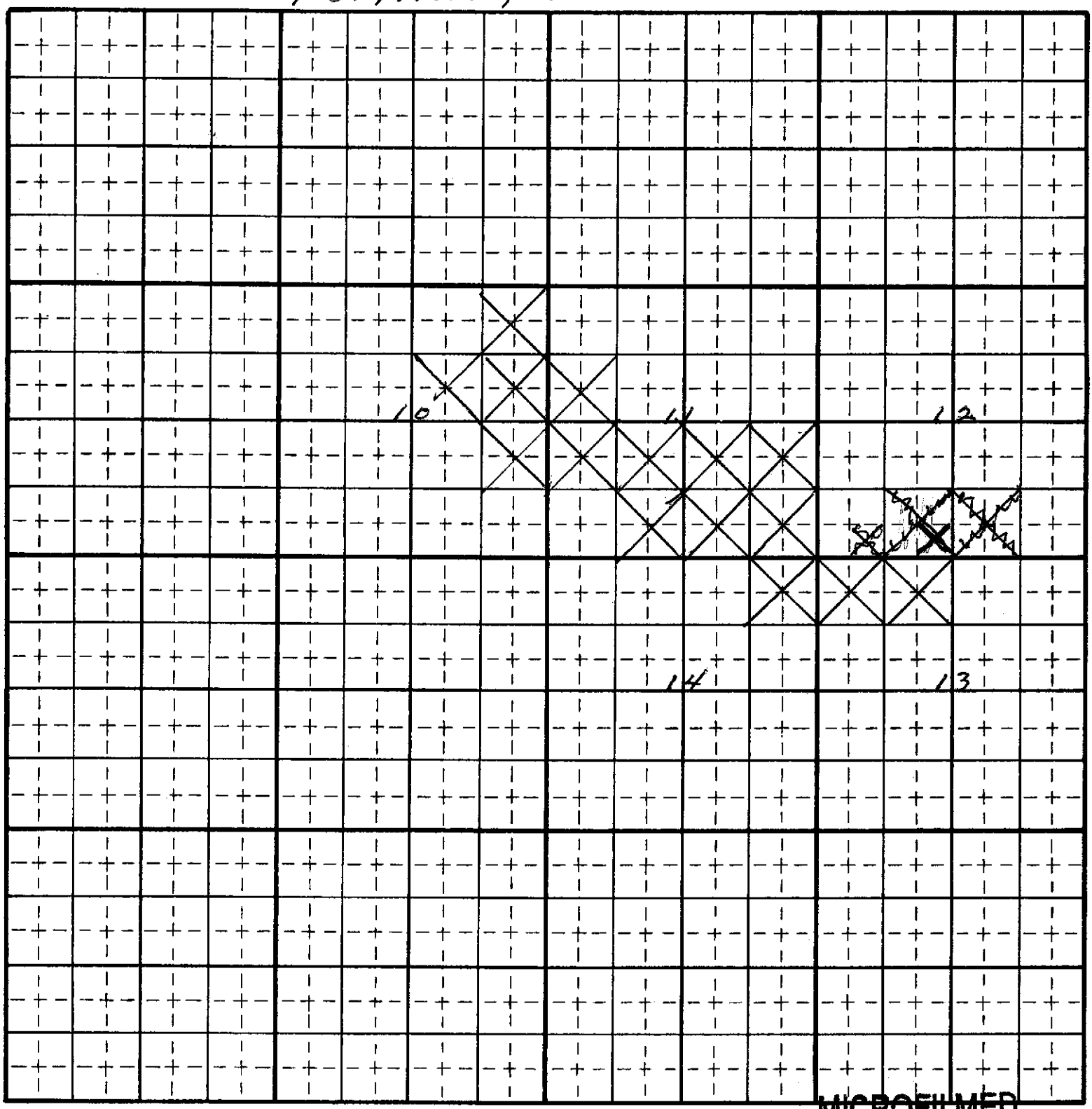
Last Name _____ Ident No. A63-05073

Copies: White -State, Yellow-Claimant

Map of Project: show clearly the point of diversion, place of use, section number, township, and range number.

Scale: 2 inches equals 1 mile

T 3 N, R 2 E, B M




MICROFILMED
AUG 2 0 1992

Last Name

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

Ident No. A63-05073

*Copies: White-State, Yellow-Claimant*

15. Basis of Claim (check one) Beneficial Use [redacted] Posted Notice X License [redacted] Permit [redacted]
Decree ____

If applicable provide IDWR Water Right Number 63-5073 & ~~63-9462~~

Court ____ Case Number ____ Decree Date ____

Plaintiff vs Defendant ____

16. Signature (s)

(a.) By signing below, I/We acknowledge that I/We have received, read, and understand the form entitled "How you will receive notice in the Snake River Basin Adjudication." (b.) I/We do [redacted] do not X wish to receive and pay a small annual fee for monthly copies of the docket sheet.

Number of attachments 16

**For Individuals:** I do solemnly swear or affirm that the statements contained in the foregoing document are true and correct.

Signature of Claimant (s) ____ Date ____

____ Date ____

**For Organizations:** I do solemnly swear or affirm that I am Secretary (Title) of Boise Warm Springs Water District (Organization), that I have signed the foregoing document in the space below as Secretary (Title) of Boise Warm Springs (Organization) and that the statements contained in the foregoing document are true and correct. Water District

Signature of Authorized Agent Robert H. Jeffries

Title and Organization Boise Warm Springs Water District Date 04 July 1989

State of Idaho/or ____ )
) SS.
County of ADA )

Subscribed and sworn (or affirmed) before me this 6TH day of JULY 19 89

SEAL

Notary Public Jeff Pappenh

Residing at BOISE, IDAHO

My Commission Expires 11/8/1994

Please Print Name

17. Notice of Appearance:

Notice is hereby given that I, ____ will be acting as attorney at law on behalf of the claimant signing above, and that all notices required by law to be mailed by the director to the claimant signing above should be mailed to me at the address listed below.

Signature ____

Address ____

Date ____

MICROFILMED
AUG 2 0 1992

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

Last Name ____ Ident. Number A63-05073

*Copies White-State, Yellow-Claimant*

1 - 869 C-3

ARTESIAN WELLS #
APPROPRIATED BY #
A.H. & C. WATER CO. # NOTICE OF WATER RIGHT

LOCATION.

TO WHOM IT MAY CONCERN:

Notice is hereby given that the ARTESIAN HOT AND COLD WATER COMPany, Limited, a corporation organized under the laws of the State of Idaho, with its principal place of business at Boise City, in Ada County, in said State, has appropriated and does hereby claim the waters flowing from three artesian wells near which this notice is posted, and each and every of said wells, to the extent of four and two hundred and seventy-three one thousandths cubic feet per second of time, which said wells through and by means of which said water is diverted and appropriated are situated in the South-east quarter of the South-east quarter of the South-west quarter of Section Twelve (12) in Township Three (3) North, Range Two (2) East of Boise Meridian, in Ada County, State of Idaho.

That the purposes for which said water is claimed are for domestic uses and for bathing and heating purposes and to warm the waters of a large plunge or swimming bath at a placeof public resort, belonging to said Company, known as the "Natatorium," situated about three thousand feet in a South-westerly direction from said wells; and also for sale for domestic uses and for bathing and heating purposes; and all other purposes for which hot water may be used, and for irrigation and sprinkling in Boise City, in said County and along or near the line of conduit of pipes used in conveying said water from said wells to and through the streets and alleys of Boise City.

That the place or locality of the intended use of said water is at said Natatorium and the grounds surrounding the same, and in said Boise City and along and near the line of the or the conduit and pipes used, or that may be used in conveying said water as hereinafter described.

That the general course, length and destination of the conduit or pipes by which it is proposed to divert said water is as follows: Commencing at each of said wells and running North of West about one hundred and sixty feet through separate pipes to a common main pipe; thence South 70 degrees 15 minutes West, 2514 feet to the South side of the public road,known as Warm Springs Avenue; thence Westerly along said Avenue, 300 feet to a Tee in said pipes by which a part of said water is diverted and runs in a Southeasterly direction 302 feet to said Natatorium building; and from said Tee running in a Westerly direction along said Warm Springs Avenue 5608 feet to the junction of Idaho Street in Boise City; thence Westerly along Idaho Street 5363 feet to a point 120 feet East of the East line of Thirteenth Street and about 13345 feet from said wells; together with all the lateral pipes and conduits connecting said main conduit with the buildings and premises where said water is or may be used.

Posted on or near the point of intended diversion, on the 23d day of November, 1899.

Artesian Hot & Cold Water Company, Limited,
Appropriator and Claimant,
By C.W.Moore President.

Attest:B.S.Howe
Secretary

State of Idaho, )
:- ss.
County of Ada. )

Benjamin S.Howe, of Boise City, Ada County, State of Idaho, being first duly sworn, deposes and says; that he of lawful age and is the Secretary of the Artesian Hot and Cold Water Company, Limited, a corporation, and the appropriator and claimant of the water right described in the foregoing notice. That the statements in said notice are true, and that the original notice, of which the foregoing is a true copy was posted in a conspicuous place near the artesian wells of said company, the point of diversion of said water, at five o'clock P.M. of the twenty-third day of November, 1899.

B.S.Howe

Subscribed and sworn to before me
this twenty-fourth day of November, 1899.

Richard H.Johnson
( SEAL ) Notary Public

( U.S.I.R.S. )
( B.S.H. )
( 11-24-99 )
(10¢ cancelled )

Recorded at the request of B.S.Howe at 2.30 P.M., November 24, 1899.

[illegible] Recorder, By [illegible] deputy.

MICROFILMED
AUG 2 0 1992
Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

1-870 C-4

ARTESIAN WELLS #
APPROPRIATED BY #
A. H. & C. WATER CO. #

# NOTICE OF WATER RIGHT LOCATION

TO WHOM IT MAY CONCERN:

Notice is hereby given that the Artesian Hot and Cold Water Company, Limited, a corporation created and existing under the laws of the State of Idaho, with its principal place of business at Boise City, Ada County, in said State heretofore on the 5th day of November, 1894, appropriated and is the owner and claimant of the following described water rights, to-wit: The waters flowing from three artesian wells and each and every of said wells, to the extent of four and two hundred and seventy-three one thousandths cubic feet per second of time; which said wells through and by means of which said water is diverted and appropriated are situated in the South-east quarter of the South-east quarter of the South-west quarter of Section Twelve (12) in Township Three (3) North, Range Two (2) East of Boise Meridian, in Ada County, State of Idaho.

That the location and specific uses for which said water is claimed are for domestic and for bathing and heating purposes and to warm the waters of a large plunge or swimming bath at a place of public resort, belonging to said company, known as the "Natatorium", situated about three thousand feet in a South-westerly direction from said wells; and also for sale for domestic uses and for bathing and heating purposes, and for all other purposes for which hot water may be used, and for irrigating and sprinkling, in Boise City in said County and along or near the line of the conduit or pipes used in conveying said water from said wells to and through the streets and alleys of Boise City, commencing at each of said wells and running North of West about one hundred and sixty feet through separate pipes to a common pipe; thence South 70 degrees 15 minutes West 2514 feet to the South-west side of the public road known as Warm Springs Avenue; thence Westerly along said Avenue, 300 feet to a tee in said pipe by which a part of said water is diverted and runs in a South-westerly direction, 300 feet to said Natatorium building; and from said tee running in a Westerly direction along said Warm Springs Avenue, 5608 feet to the junction of Idaho Street in Boise City; thence Westerly along Idaho Street, 5367 feet to a point 120 feet East of the east line of Thirteenth Street and about 13945 feet from said wells; together with all the lateral and distributing pipes and conduits connecting said main conduit with the buildings and premises where said water is or may be used.

Dated November 24th, 1899.

Artesian Hot & Cold Water Company, Limited,
Owner and Claimant.

Attest: B.H.Howe, Secretary. By C.W.Moore, President.

State of Idaho, )
:- ss.
County of Ada. )

Benjamin S.Howe, of Boise City, Ada County, State of Idaho, being first duly sworn deposes and says: That he is of lawful age and is the Secretary of the Artesian Hot and Cold Water Company, Limited, the corporation named in the foregoing notice and the owner and claimant of the water right described in said notice; and that the statements in said notice are true.

Benjamin S.Howe

Subscribed and sworn to before me this twenty-fifth day of November, 1899.

( SEAL ) Richard H.Johnson
Notary Public

( U.S.I.R.S. )
( ---------- )
( Nov.25,1899 )
( 10¢ cancelled )

Recorded at the request of Walter Keefe at 2 P.M., November 25,1899

[illegible] Recorder, By [illegible] Deputy.

MICROFILMED
AUG 2 0 1992

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

C-5

File No. 47-4...

STATE OF IDAHO,
OFFICE OF STATE ENGINEER

This instrument was received and filed in the office of the State Engineer at 2 o'clock minutes past 2 P. M. this 2nd day of June, A. D. 1927 and abstract of same duly entered in Book No. 1 of Water Locations, at Page 6

State Engineer.

NOTICE OF WATER RIGHT LOCATION.

Ada County

State of Idaho.

STOREWATER WATER--

ARGENTINE HOT and COLD WATER COMPANY, Limited a corporation,

Appropriator and Claimant.

MICROFILMED
AUG 2 0 1992

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

C-4

NOTICE OF WATER RIGHT LOCATION.

To Whom it May Concern:

Notice is hereby given that the ALLEN HOT and COLD WATER COMPANY, Limited, a corporation organized under the laws of the State of Idaho, with its principal place of business at Boise City, in Ada County, in said State, has appropriated and does hereby claim the waters flowing from three artesian wells near which this notice is posted, and each and every of said wells, to the extent of four and two hundred and seventy-three one thousandths cubic feet per second of time; which said wells through and by means of which said water is diverted and appropriated are situated in the Southeast quarter of the Southeast quarter of the Southwest quarter of Section Twelve (12) in Township Three (3) North, Range Two (2) East of Boise Meridian, in Ada County, State of Idaho.

That the purposes for which said water is claimed are for domestic uses and for bathing and heating purposes and to warm the waters of a large plunge or swimming bath at a place of public resort, belonging to said Company, known as the "Natatorium," situated about Three thousand feet in a South-Westerly direction from said wells; and also for sale for domestic uses and for bathing and heating purposes; and all other purposes for which hot water may be used, and for irrigation and sprinkling in Boise City, in said county and along or near the line of conduit or pipes used in conveying said water from said wells to and through the streets and alleys of Boise City.

That the place or locality of the intended use of said water is at said Natatorium and the grounds surrounding the same, and in said Boise City, and along and near the line of the conduit and pipes used, or that may be used in conveying said water as hereinafter described.

That the general course, length and destination of the conduit or pipes by which it is proposed to divert said water is as follows: Commencing at each of said wells and running North of West about one hundred and sixty feet through separate pipes to a



MICROFILMED
AUG 2 0 1992

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

common main pipe; Thence South 70 degrees 15 minutes West, 2014 feet to the South side of the public road, known as Warm Springs Avenue; Thence Westerly along said Avenue, 300 feet to a Tee in said pipe by which a part of said water is diverted and runs in a South Easterly direction 302 feet to said Natatorium building; and from said Tee running in a Westerly direction along said Warm Springs Avenue 5608 feet to the junction of Idaho Street in Boise City; thence Westerly along Idaho Street 5363 feet to a point 120 feet East of the East line of Thirteenth Street and about 13945 feet from said wells; together with all the lateral pipes and conduits connecting said main conduit with the buildings and premises where said water is or may be used.

Posted at or near the point of intended diversion, on the 23rd day of November, 1899.

ARTESIAN HOT & COLD WATER COMPANY, Limited,

Appropriator and Claimant,

By _____
President.

Attest: _____
Secretary.

State of Idaho,
)ss.
County of Ada.

Benjamin S. Howe, of Boise City, Ada County, State of Idaho, being first duly sworn, deposes and says: That he is of lawful age and is the Secretary of the Artesian Hot and Cold Water Company, Limited, a corporation, and the appropriator and claimant of the water right described in the foregoing Notice. That the statements in said notice are true, and that the original Notice, of which the foregoing is a true copy, was posted in a conspicuous place near the artesian wells of said Company, the point of diversion of said water, at five o'clock P.M. of the twenty-third day of November, 1899.

Subscribed and sworn to before me this twenty-fourth day of November, 1899.

_____

_____
Notary Public.

MICROFILMED
AUG 2 0 1992

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

D-10

893826

WATER RIGHT DEED

THIS INDENTURE, Made this 18th day of June, 1974, between NATATORIUM COMPANY, an Idaho corporation, Grantor, and BOISE WARM SPRINGS WATER DISTRICT, a water district organized under the State of Idaho, Grantee,

WITNESSETH, That the Grantor does by these presents convey, transfer and set over unto the Grantee and to its successors and assigns all of the right, title and interest of the Grantor in and to the water and water rights, described as follows, to-wit:

1. Notice of Water Right filed by Natatorium's predecessor, Artesian Hot & Cold Water Company, Limited, recorded in Book 2 of Water Rights at page 583, records of Ada County, Idaho, on November 24, 1899.

2. Notice of Water Right filed by Natatorium's predecessor, Artesian Hot & Cold Water Company, Limited, recorded in Book 2 of Water Rights at page 584, records of Ada County, Idaho, on November 25, 1899.

TO HAVE AND TO HOLD, the said water and water rights unto the Grantee and its successors and assigns for so long as there is continued use by the Grantee of the above described water rights for hot water heating purposes. In the event the Grantee ceases to use said water rights for hot water heating purposes, title thereto shall automatically revert to the Grantor, its successors and/or assigns.

IN WITNESS WHEREOF, this Water Right Deed has been duly executed by and on behalf of the Grantor the day and year herein first above written.

NATATORIUM COMPANY

By George B. Flegal, Jr.

ATTEST:

Peter Kelley

MICROFILMED
AUG 2 0 1992

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

STATE OF IDAHO )
: ss.
County of Ada )

On this 15th day of June, 1974, before me, a notary public in and for said State, personally appeared George D. Hogue, Jr. and Peter Keller, known to me to be the President and Asst. Secretary, respectively, of the corporation that executed the foregoing instrument, and acknowledged to me that such corporation executed the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal, the day and year in this certificate first above written.

Corinne B. Leonard
Notary Public for Idaho,
Residing at Boise, Idaho.

STATE OF IDAHO, COUNTY OF ADA
and at the request of M. J. Mallamo Jr.
35 minutes past 2 P.M. on the 24 day of July 1974
Jenny Lee
2.00

MICROFILMED
AUG 2 0 1992



Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

Form No. 243
7/78

Claim No. [illegible]

F-2

# STATE OF IDAHO
# DEPARTMENT OF WATER RESOURCES

# CLAIM TO A WATER RIGHT

Under the provisions of Section 42-243, Idaho Code, any person using or claiming rights to the public waters of Idaho established by diversion and application to a beneficial use must file a claim with the Department of Water Resources on or before June 30, 1982. Exempted from this filing are single family domestic uses as defined in Section 42-230(d), Idaho Code. Also exempted are rights represented by a permit, license, decree, adjudicated right, or a previously filed claim.

**The filing of this claim does not confirm the water right claimed but failure to file may result in forfeiture of a water right.**

Notice is hereby given that Boise Warm Springs Water District (Name of Claimant)

P.O. Box 114, Boise, Idaho 83701 (Mailing Address) (Zip Code) Telephone No. 342-3162

claims a right to the diversion and beneficial use of the surface or ground water. The extent and nature of said claim is as follows:

(1) Date of priority: (When was the water first applied to a beneficial use) 05 November 1894

A claim is not acceptable on a ground water source with a priority later than March 25, 1963 or on a surface water source with a priority later than May 20, 1971. An exception is that a claim may be filed on single family domestic use from a ground water source.

(2) Describe the source of water: (Name of stream, lake, spring, etc., or ground water)
Groundwater tributary to

(3) Describe the purpose for which the water has been used and the time during the year when you have used the right claimed:

| | (cfs, gpd, AFA) | (Domestic, Irrigation, Stock, Etc.) | (Both dates inclusive) Period of Use From (Mo., Day) | To (Mo., Day) |
|---|---|---|---|---|
| Quantity | | Use Heating & Domestic | Period of Use From 01JAN | To 31DEC |
| Quantity | 12.819 c.f.s. | Use | Period of Use From | To |
| Quantity | 4.273 c.f.s. | Use | Period of Use From | To |
| Quantity | from each of | Use | Period of Use From | To |
| Quantity | three wells | Use | Period of Use From | To |

(4) 2,464.160 (cfs, gpm, AFA) TOTAL QUANTITY USED.

(5) A) Point of diversion: (Location of point where water is diverted from its source)
SE ¼ SW ¼, Sec. 12 Twp. 3 N Rge. 2 E B.M., County of Ada
Additional points of diversion:

B) Describe means of diversion of water: (Pump and pipeline, well, diversion dam, reservoir, length of ditch and field, etc.). Give sizes and capacities: be as specific as possible. Describe any changes in the system and give the date of the change. Two Hot Wells, Pumps and Pipeline

(6) A) Describe location of use by listing number of irrigated acres within each 40-acre tract in appropriate box. If use is not for irrigation, place an "X" in appropriate box to show location.

| T | R | SEC. | NE¼ NE¼ | NE¼ NW¼ | NE¼ SW¼ | NE¼ SE¼ | NW¼ NE¼ | NW¼ NW¼ | NW¼ SW¼ | NW¼ SE¼ | SW¼ NE¼ | SW¼ NW¼ | SW¼ SW¼ | SW¼ SE¼ | SE¼ NE¼ | SE¼ NW¼ | SE¼ SW¼ | SE¼ SE¼ | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3N | 2E | 10 | X | | X | X | | | | | | | | | X | | | | 160 |
| | | 11 | | | | | | X | | | X | X | | X | X | X | X | X | 320 |
| | | 12 | | | | | | | | | | | X | | | | X | | 80 |
| | | 13 | | | | | X | X | | | | | | | | | | | 80 |
| | | 14 | | | | | | | | | | | | | | | | | 80 |

No. of acres 640

B) If water is used for other than irrigation, fully describe that use, being as specific as possible: State of Idaho Department of Health & Agriculture Laboratories, 238 Households for Space Heating; 207 Households for Domestic Services

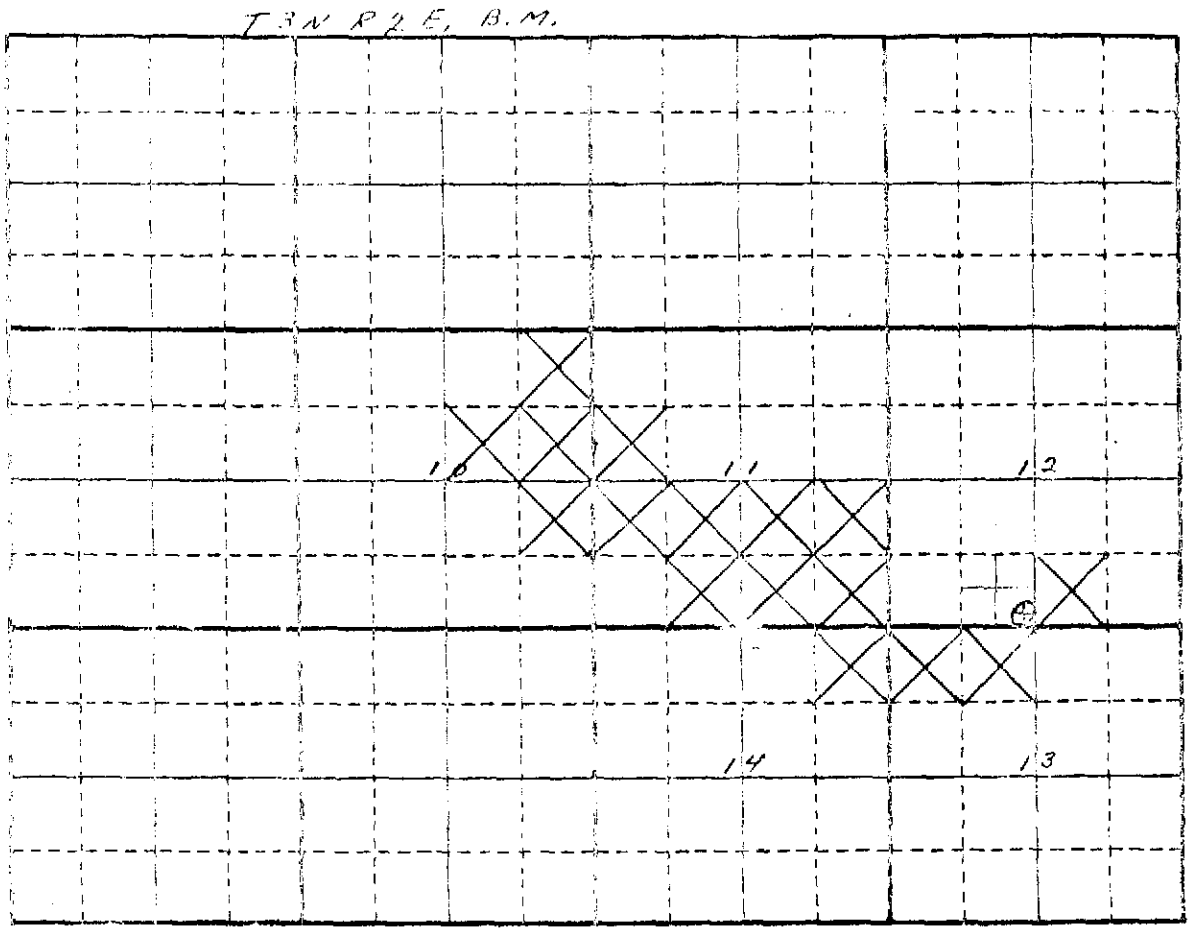
NOTE: Include here the type and number of stock watered:

(7) If you are claiming water as a member of an organization, list name of organization:

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2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

E-3




Scale 2 inches equal 1 mile.

Map should show the location of the point of diversion and the place of use of the water by 40-acre subdivisions, section, township and range of the public land survey system.

State of Idaho )
) ss.
County of Ada )

Be it known that the undersigned, being duly sworn, deposes and says that he, she, they subscribed the foregoing claim to a water right, together with all attached information, and that the matters and facts therein are true to the best of the affiant's knowledge.

Laverne O'Rourke
Boise Warm Springs Water District
(Claimant)

Sworn to before me this 22nd day of April, 1983.

Robert H. Griffiths
Notary Public
Residing at Boise, Idaho

ROBERT H. GRIFFITHS NOTARY PUBLIC STATE OF IDAHO

My commission expires

FOR DEPARTMENT USE ONLY

Received by Date Exception filed by: Fowarded to claimant by: Date
Publication check by Date
~~Proof of publication~~ received by Date
Published in
Dates

- 30 -

MICROFILMED
AUG 20 1992

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

Form 202
3/78

Idaho No. 63-9160

6-1

# STATE OF IDAHO
# DEPARTMENT OF WATER RESOURCES
# APPLICATION FOR PERMIT

JUN

To appropriate the public waters of the State of Idaho

1. Name of applicant Boise Warm Springs Water District Phone 375-0201

Post office address P.O. Box 114, Boise, Idaho 83701

2. Source of water supply Groundwater which is a tributary of NA

3. Location of point of diversion is SE¼ SE ¼ of SW ¼ of Section 12 Township 3 North

Range 2 East B.M. Ada County, additional points of diversion if any:

None

4. Water will be used for the following purposes:

Amount 4.0 cfs for Domestic & Space Heating purposes from January 1 to December 31 (both dates inclusive)
(cfs or acre-feet per annum)

Amount _____ for _____ purposes from _____ to _____ (both dates inclusive)
(cfs or acre-feet per annum)

Amount _____ for _____ purposes from _____ to _____ (both dates inclusive)
(cfs or acre-feet per annum)

Amount _____ for _____ purposes from _____ to _____ (both dates inclusive)
(cfs or acre-feet per annum)

5. Total quantity to be appropriated:

a. 4.0 cubic feet per second and/or b. NA acre-feet per annum.

6. Proposed diverting works:

a. Description of ditches, flumes, pumps, headgates, etc. One well, pump & motor and 10" mainline to connect to existing system

b. Height of storage dam NA feet, active reservoir capacity NA acre-feet; total reservoir capacity NA acre-feet, materials used in storage dam: NA

Period of year when water will be diverted to storage NA (Month/Day) to NA (Month/Day) inclusive.

c. Proposed well diameter is 20 inches; proposed depth of well is 400 feet.

7. Time required for the completion of the works and application of the water to the proposed beneficial use is five (5) years *(minimum 1 year – maximum 5 years)*.

8. Description of proposed uses:

a. If water is not for irrigation: See attached map of service area 13 and 14

(1) Give the place of use of water: ____ ¼ of ____ ¼ of Section 3, 10, 11, Township 3 North

Range 2 East B.M.

(2) Amount of power to be generated: NA horsepower under NA feet of head.

(3) List number of each kind of livestock to be watered NA

(4) Name of municipality to be served Central Business District and East Boise, or number of families to be supplied with domestic water 220.

(5) If water is to be used for other purposes describe: Hot Water Space Heating & Domestic

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Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

G-2

b. If water is for irrigation, indicate acreage in each subdivision in the tabulation below: NA

| TWP. | RANGE | SEC. | NE¼ | NW¼ | SW¼ | SE¼ | NE¼ | NW¼ | SW¼ | SE¼ | NE¼ | NW¼ | SW¼ | SE¼ | NE¼ | NW¼ | SW¼ | SE¼ | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | |

Total number of acres to be irrigated NA

c. Describe any other water rights used for the same purposes as described above. Two existing wells constructed in 1990, recorded 4.273 cfs Nov. 24, 1899 Book 2, p 583, 584 of Water Rights, Ada County, priority date Nov. 5, 1894.

9. a. Who owns the property at the point of diversion Applicant

b. Who owns the land to be irrigated or place of use Patrons of the District

c. If the property is owned by a person other than the applicant, describe the arrangement enabling the applicant to make this filing Private land owner's property is a part of a quasi-municipal public agency

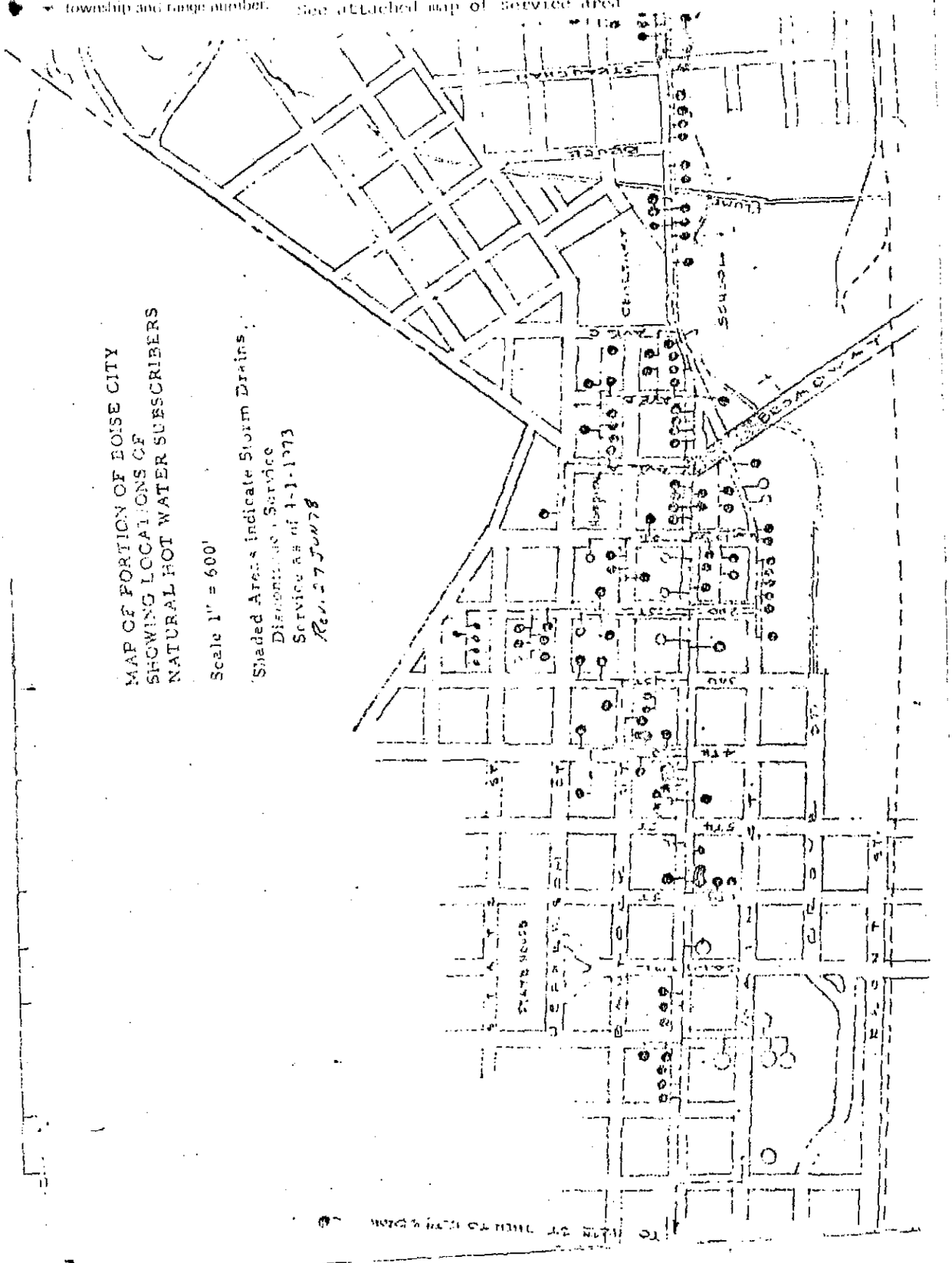
10. Remarks

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BOISE IDAHO 83712

6-3

11. Map of proposed project: show clearly the proposed point of diversion, place of use, section number, township and range number. See attached map of service area




Boise Warm Springs Water District

Applicant

by Robert H. Griffiths, P.E.
Secretary

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AUG 20 1992

Boise Warm Springs Water District
2460 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

Proposed Priority 6/27/78

6-19

Received by [illegible] Date 6/27/78 Time 2:45 PM

Preliminary check by RLH Fee $ 55.00 # 11150

Receipted by [illegible] Date 6-28-78

Publication prepared by [illegible] Date 6-29-78

Published in The Idaho Statesman

Publication dates 7-6 & 7-13-78

Publication approved [illegible] Date 7-17-78

Protests filed by: Davison, Copple, Copple & Copple by Terry C Copple for Joe F. Kanda

withdrawn by stipulation of 6/18/79

Copies of protests forwarded by

Hearing held by Date

Recommended for (approval) denial by DJS JC

ACTION OF THE DIRECTOR, DEPARTMENT OF WATER RESOURCES

This is to certify that I have examined Application for Permit to appropriate the public waters of the State of Idaho No. 63-9160, and said application is hereby APPROVED.

1. Approval of said application is subject to the following limitations and conditions:

   a. SUBJECT TO ALL PRIOR WATER RIGHTS.

   b. Proof of construction of works and application of water to beneficial use shall be submitted on or before January 1, 1985.

   c. The rate of diversion, if water is to be used for irrigation under this permit, when combined with all other water rights for the same land shall not exceed 0.02 cubic feet per second for each acre of land.

   d. 1. An access port or other device as specified by the Department shall be installed by the permit holder to provide for the installation of measuring equipment and the determination of the rate of diversion by the Department. 2. The issuance of this permit in no way grants any right-of-way or easement across the land of another. 3. Return flow if discharged to a groundwater system must be authorized by a separate injection well permit, and return flow if discharged to a surface water system shall meet intrastate water quality standards.

Witness my hand this 8th day of January 19 80.

L. Glen Saxton
Chief Operations Bureau

MICROFILMED
AUG 2 1992

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

Form 204
1-81

| For Office Use Only |
|---|
| Fee Received |
| Date |
| Receipt # |

6-21

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

# REQUEST FOR EXTENSION OF TIME

**To provide additional time in which to submit proof of beneficial use on a water right permit**

Boise Warm Springs Water District of 2440 Old Penitentiary Road, Boise 83712
(Name) (Address)

State of Idaho, deposes and says:

That he is the holder, or the duly authorized agent of the holder*, of Permit to Appropriate the Public Water of the State of Idaho No 63-9160

That under the terms and conditions of said permit, work thereunder was required to be completed on or before 01 January 1985, 19

That he has heretofore performed the following work described under said permit: Drilled and cased well to depth of 600 feet. Location was based on recommendations following a geological study of the area.
(This must be filled out if no work has been completed per note.)

Costing $ 50,000.00

That he is unable to complete the remainder of the work within the required time for the following reasons, to-wit: present well does not produce sufficient quantity or temperature. We propose to retain a geologist and drill another well at a different location on this property.

Wherefore, he asks that the Department of Water Resources extend the time for the completion of obligations under said permit to 01 January 1990, 19
(1 yr minimum, 5 yrs maximum)

NOTE:

(Signature)*

GRIFFITHS ENGINEERING
4121 ALPINE ST. 345-1216
BOISE, IDAHO 83705

2126

Pay to the order of Idaho Department of Water Resources 12 December 19 84 92-1/1241

Fifteen and no/100 — $15.00 Dollars

IDAHO FIRST NATIONAL BANK
FAIRVIEW OFFICE
P.O. BOX 7217
Boise, Idaho 83707

For 63-9160 Boise Warm Springs Water R. H. Griffiths

"02126" 124100014" 1100540 2230"

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AUG 2 0 1992

Boise Warm Springs Water District
2440 OLD PENITENTIARY ROAD
BOISE IDAHO 83712

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# Hydrogeologic Conditions in the Boise Front Geothermal Aquifer

*Prepared for:*

**City of Boise, Idaho**

*and*

**National Renewable Energy Laboratory, Golden, CO**

*Prepared by*

Christian R. Petrich
**Idaho Water Resources Research Institute**
**University of Idaho – Boise**




**Report Number: 2003-___**

Draft 8/13/2003

University of Idaho

## ABSTRACT

An extensive geothermal aquifer system underlies the Boise area along the Boise Foothills. Proposed increases in thermal water use have led to concerns about potential long-term impacts to the geothermal aquifer system, and the ability of current aquifer monitoring to detect possible changes.

The purpose of this study was to provide insight and tools for the long-term management of the Boise geothermal aquifer system. Specific objectives included conducting a mass measurement of geothermal ground water levels, the development of a database using existing data, reviewing hydrologic conditions in the aquifer, and constructing a numerical model to evaluate production capacity of the aquifer. The primary areas of interest for this study included the Harris Ranch, Downtown Boise – Table Rock, and Stewart Gulch areas. This report includes a summary of hydrologic conditions in the geothermal aquifer system. A description of model construction and simulation results are presented in a separate volume (Zyvoloski et al., *in preparation*).

The Boise Front geothermal aquifers reside in a complex series of igneous rocks and interbedded sediments. Geothermal water is associated with fractures along a northwest trending fault zone along the Boise Foothills. Thermal water in the downtown Boise – Table Rock area is drawn from granite, Tertiary rhyolite and associated sediments, and/or Tertiary basalt and basalt tuffs, and typically ranges in temperature from 135 to 175°F. Geothermal water in the Harris Ranch area resides in fractured granite. Two Tertiary basalt layers appear to be the primary source of 90 to 125°F thermal water in the Stewart Gulch wells. Potentiometric surface maps based on the 2002 mass measurements indicate westerly or southwesterly horizontal hydraulic gradients in all three of these areas.

Water levels in the Boise – Table Rock area began to decrease in 1984, coinciding with the initiation of City of Boise withdrawals. Water levels stabilized from about 1987 through 1998, as net withdrawals stabilized at a lower rate. The water levels in the Boise – Table Rock area began to rise beginning in the fall of 1999, apparently in response to the City's re-injection of thermal water. A number of wells in this area have experienced water level increases since 1999, including the Bureau of Land Management (BLM) monitoring well, Veteran's Administration (VA) production well, Boise Warm Springs Water District (BWSWD) wells, and Kanta well.

Water levels in the Edwards well (Stewart Gulch) began to decline in 1984, coincident with the initiation of pumping both by the City of Boise and Quail Hollow Golf Course. Water levels also rose in several Stewart Gulch wells during the late 1990s. However, no additional water level rises were noted that might be attributed to City of Boise injection beginning in 1999. The Stewart Gulch water level rises appear to be associated with changes in local withdrawal patterns.

Current data are insufficient to describe the degree of hydraulic connection, if any, between the Stewart Gulch and Boise – Table Rock areas. However, there appears to be some degree of hydraulic connection between geothermal aquifers in the Harris Ranch and Boise – Table Rock areas, based on historical observations.

# Acknowledgements

This work was made possible by a grant from the National Renewable Energy Laboratory (NREL) and the City of Boise, Idaho. Terry Scanlan (Scanlan Engineering) has provided data, a chronology of geothermal development, and hydrogeologic descriptions of aquifer characteristics. Ed Squires (Hydro Logic, Inc.) provided data and a description of hydrogeologic characteristics of the Stewart Gulch area. In addition, substantial in-kind support and data have been provided by the Idaho Department of Water Resources (IDWR): Ken Neely has provided data and project assistance, Linda Davis has provided GIS support, and Bruce Tuttle has provided database development. The Boise Warm Springs Water District (BWSWD), the City of Boise, The Terteling Company, the Flora Company, Quail Hollow Golf Course, Harris Ranch, Edwards Greenhouses, Veteran's Administration Hospital (VA), the Idaho Department of Administration, and the U.S. Geologic Survey have provided data, access to wells, and logistical support. Last but not least, this project would not have been possible without the research efforts over the last 25 years by Will Burnham, Jack Kelly, Spencer Wood, and many others.

This report has been reviewed by a project Technical Committee, and represents a consensus understanding of the committee. The committee consists of the following individuals:

- Chuck Brockway, Brockway Engineering (on behalf of the Boise Warm Springs Water District)
- Paul Castelin, Idaho Department of Water Resources
- Sherl Chapman / Steve Hannula, ERO Resources (on behalf of Harris Ranch)
- Kent Johnson, City of Boise
- Ken Neely, Idaho Department of Water Resources
- Deb Parliman, U.S. Geological Survey
- Lee Liberty, Boise State University
- Clarence Robison, University of Idaho
- Terry Scanlan, Scanlan Engineering (on behalf of the City of Boise)
- Ed Squires, Hydro Logic, Inc. (on behalf of the Terteling Family)

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# 1. INTRODUCTION

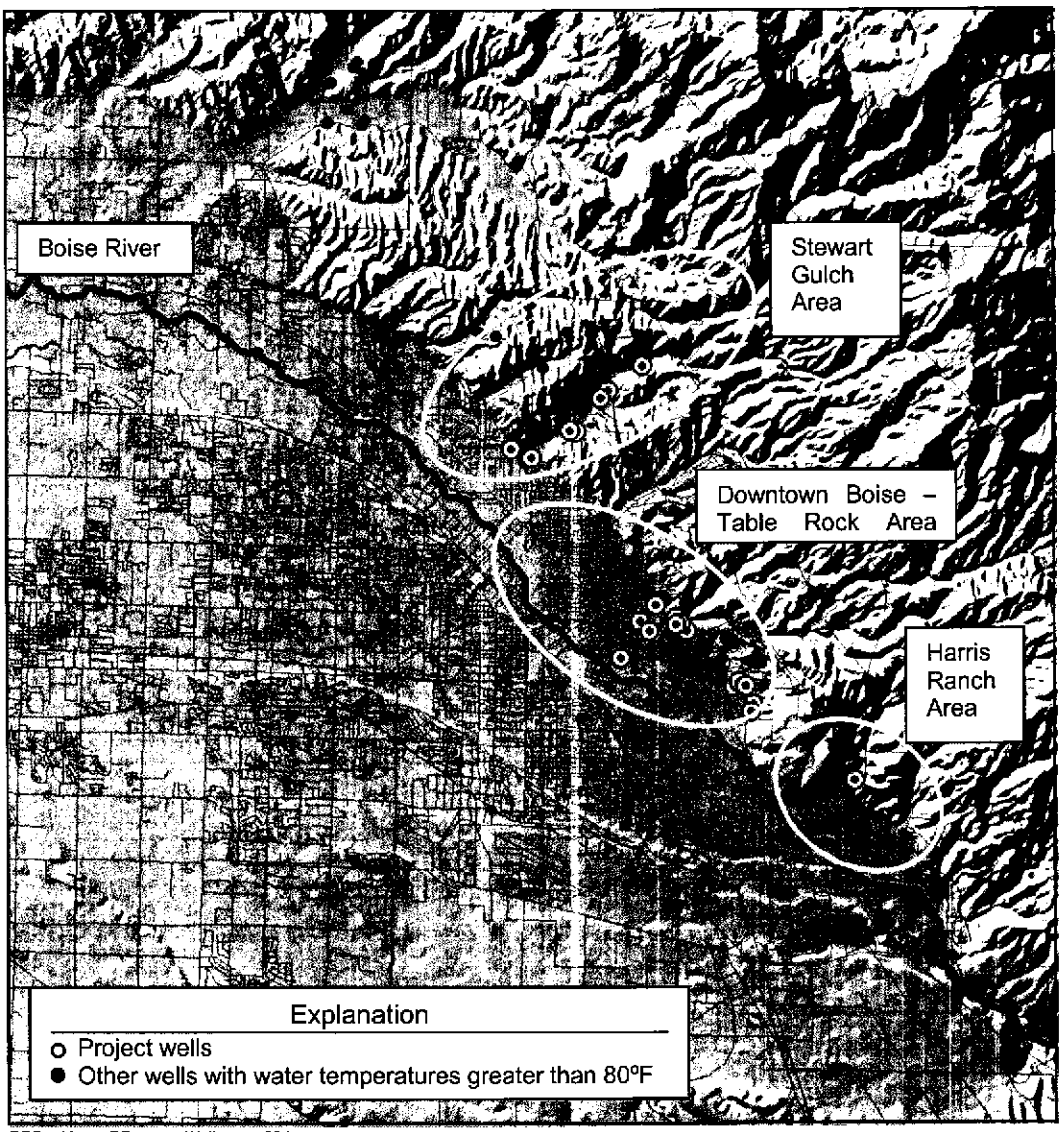
## 1.1. Description of Project Area

An extensive geothermal aquifer system underlies the Boise area along the Boise Foothills – an area known as the Boise Front. Wells in this area with water temperatures ranging from about 80°F to 170°F are shown in Figure 1-1. The lateral extent of the aquifer along the northwest-southeast orientation of the Boise Front is unclear, although thermal ground water is known to exist further west in the Dry Creek area, further east near Mayfield, and to the south near the Snake River.

Development of hot ground water began in the Boise area in 1891. Geothermal wells with elevated water temperatures are clustered along the Boise Front in several areas, including Harris Ranch, downtown Boise – Table Rock, Crane Creek, and Stewart Gulch (Figure 1-1). Thermal water from these wells is withdrawn for space heating, irrigation, and domestic purposes by a variety of private, commercial, and government users.

The motivation for this study arose from a request by the City of Boise to expand current levels of production (and subsequent re-injection) under existing water right permits. This production increase would be used to meet projected demand for geothermal heat in the downtown area. The proposed production increase led to concerns about possible water level and/or temperature changes in the geothermal system. The City of Boise and other major users therefore sought additional hydraulic, thermal, and hydrogeologic information about the geothermal aquifer system, and the development and implementation of a monitoring plan.

The primary focus of this study is on three areas: Harris Ranch, downtown Boise – Table Rock, and Stewart Gulch (Figure 1-1). Wells in these areas generally represent the warmest wells in the Boise Front geothermal system, generally share a common use (space heating), and have more available data than wells in other areas along the Boise Front. Users in these three areas expressed concern about possible effects associated with proposed increases in thermal water withdrawals (with re-injection) by the City of Boise.




BFGeoMap > BF area > Wells over 80.jpg

Figure 1-1: Map of the Boise Front area showing primary production areas.

## 1.2. Purpose and Objectives

The purpose of this study was to provide insight and tools for the long-term management of the Boise geothermal aquifer system. Specific objectives included the following:

1. Review and refine the conceptual understanding of the Boise geothermal aquifer.
2. Consolidate existing hydrologic and production data into a Microsoft Access database.

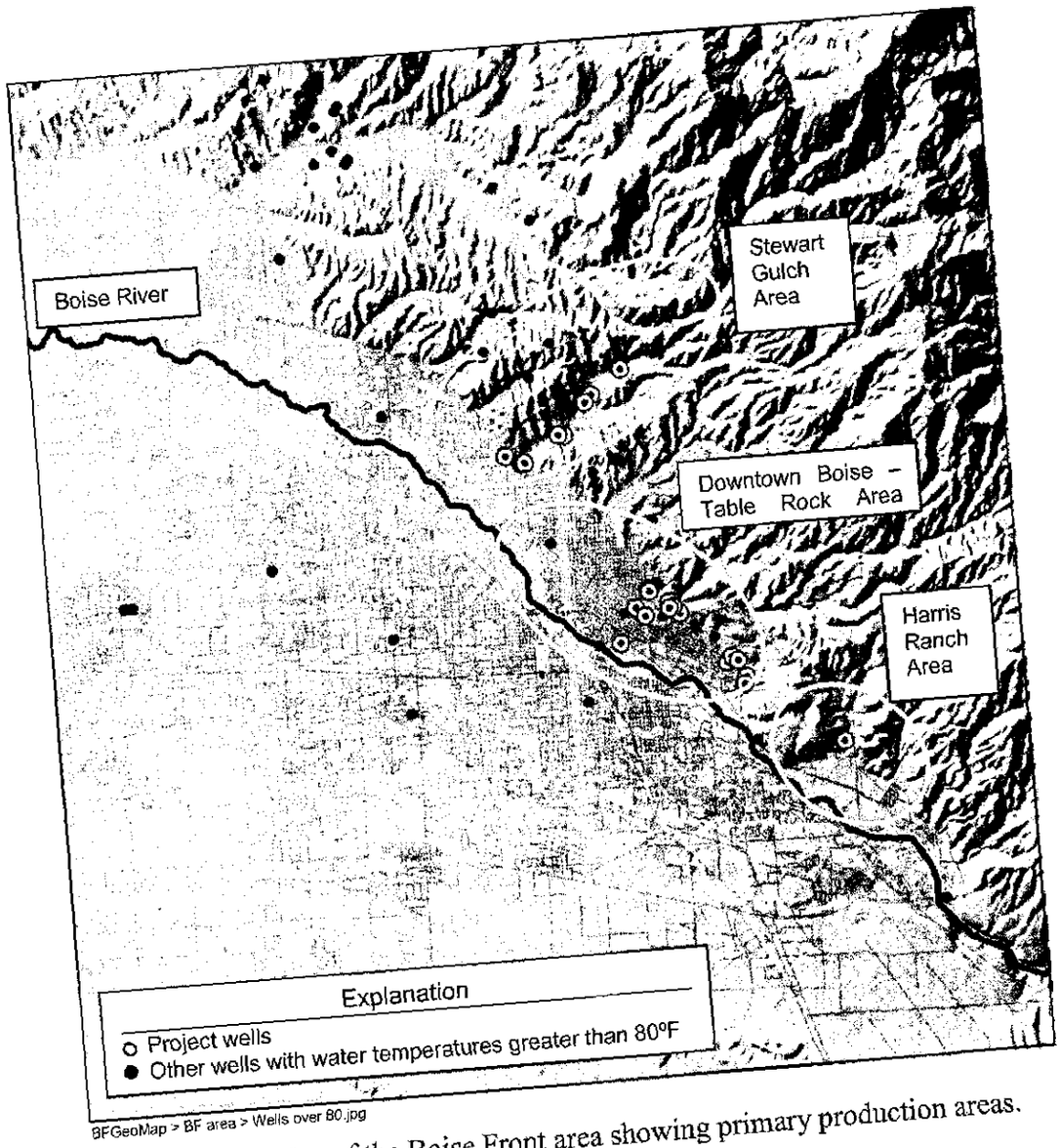



Figure 1-1: Map of the Boise Front area showing primary production areas.

## 1.2. Purpose and Objectives

The purpose of this study was to provide insight and tools for the long-term management of the Boise geothermal aquifer system. Specific objectives included the following:

1. Review and refine the conceptual understanding of the Boise geothermal aquifer.
2. Consolidate existing hydrologic and production data into a Microsoft Access database.

3. Construct a numerical model capable of simulating hydraulic heads and water temperatures in the Boise Front area.
4. Calibrate the model on the basis of hydraulic head and temperature observations using methods that quantify calibration confidence.
5. Evaluate increased production capacity of the geothermal system on the basis of projected geothermal re-injection effects.
6. Evaluate potential hydraulic and thermal effects of increased production and re-injection by the City of Boise on wells in the Boise –Table Rock, Harris Ranch, and Stewart Gulch areas.

## 1.3. Report Organization

This report consists of a (1) general description of the Boise Front geothermal aquifer system, (2) detailed description of geothermal development and hydrogeologic conditions in four sub-areas, (3) summary of a recent mass measurement of water levels in geothermal wells, (4) and a conceptual model of ground water flow in the Boise Front geothermal aquifer system. A companion volume contains a description of model construction, calibration, and simulation results (Zyvoloski et al., *in preparation*). A final summary provides conclusions and recommendations based on the hydrogeologic assessment and simulation results (Petrich, *in preparation*).

# 2. DESCRIPTION OF DATA

## 2.1. Previous Studies

Numerous published and unpublished studies over the past 25 years have focused on the Boise Front geothermal aquifer system (Anderson and Kelly, 1981a; Anderson and Kelly, 1981b; Anderson and Kelly, 1982a; Anderson and Kelly, 1982b; Anderson and Kelly, 1983; Anderson, 1981; Burnham and Wood, 1992; Clemens, 1993; Higgenson and Barnett, 1987; IDWR, 1947; IDWR, 1988; James M. Montgomery Consulting Engineers, 1987; Liberty, 1996a; Liberty, 1996b; MacGregor, 1999; Mariner et al., 1989; Mayo et al., 1984; Mink and Graham, 1977; Montgomery-Watson, 1994a; Montgomery-Watson, 1994b; Montgomery-Watson, 1998; Morgan, 1988; Neely, 1995; Neely, 1996; Neely, 1998; Russell, 1902; Russell, 1903; Squires et al., 1993; Squires et al., 1992; Waag and Wood, 1987b; Wells, 1971; Wood, 1997; Wood and Burnham, 1987; Wood and Clemens, *in press*). These studies were conducted to develop a better understanding of system hydrogeology, drill production wells, drill injection wells, and simulate system behavior. This study builds on these reports and associated data.

## 2.2. Data Overview

Data used in this study were obtained from the Idaho Department of Water Resources (IDWR), U.S. Geological Survey, individual users, and private consultants. Many production and water level data obtained from IDWR were collected by geothermal water users, private consultants, faculty and students from the Boise State University (BSU) Geosciences Department, and others. Spatial data (obtained from IDWR) include political boundaries, hydrography, major roads, digital elevation data, and registered air-photo images. Well information was taken from Montgomery-Watson reports (1994a) and augmented with information collected from driller's reports and consultant's files (E. Squires, T. Scanlan).

Well elevations of selected wells (primarily geothermal wells in the Stewart Gulch, Boise – Table Rock, and Harris Ranch areas) were surveyed by the City of Boise with a survey-grade Global Positioning System device. Measurement point and ground surface locations are provided in Appendix C. Elevations were surveyed using the NAVD88 datum. However, most of the IDWR elevation data are in the NAVD29 datum. In the Boise Front area, the NAVD29 datum is 3.14 feet less than the NAVD88 datum. Data presented in this report, unless otherwise noted, are presented using the NAVD29 datum.

Water level data were obtained from IDWR. The sources of many of these data were geothermal users or their representatives. The IDWR data included water level data collected as part of a 1994 study (Montgomery-Watson, 1994a; Montgomery-Watson, 1994b). Measuring point elevations generally were given for these existing data, but the basis for the elevations was not always clear, nor was the precise location of the well measuring point. Hydrographs were plotted using the elevations given for the time during which the data were collected.

Production and re-injection data were obtained from IDWR. The City of Boise (Kent Johnson) supplied post-1999 projection and re-injection data for the city system. The original sources of IDWR production data were geothermal users.

Borehole geophysical logs have been recorded in a number of geothermal wells. These logs have been kept by geothermal users and/or consultants. Available geophysical logs were scanned and stored as images as part of this study. Wells from which geophysical logs were scanned are listed in Appendix G.

## 2.3. Data Quality

The quality of existing data obtained from hand measurements, installed transducers, pressure gauges, etc., is highly variable. Installed measuring equipment in geothermal production wells is prone to malfunction over time. Measurements taken in operating production and injection wells may reflect atypical hydrologic conditions. Pressure gauges and transducers for measurements conducted as part of this project (Section 5) were new; double pressure gauges were used to verify readings. During project measurements several installed system gauges were observed as being inaccurate and/or inoperative. Similarly, totalizer readings used for estimating production data may be suspect – at least one totalizer was not functioning during the mass measurement in August, 2002. Thus, the pre-2002 data probably vary in accuracy; some pre-2002 data may be suspect. Some of the hydrographs in Section 4 include exceptionally high or low data points that may reflect erroneous measurements or data entry.

## 2.4. Database Description

Existing well information and water level and production data, and new data collected as part of this study, were integrated into a Microsoft Access database. Database fields and relationships are shown in Figure 2-1. Explanations for fields are included in database tables.

The spatial data projection for map components is IDaho Transverse Mercator (IDTM). Spatial data are stored in metric units. The IDTM projection was used for consistency

with other spatial data used by IDWR. Well elevations are included in both U.S. and metric units (see Section 2.2 for datum explanation).

Several well names and/or well identifiers have been used for geothermal data over the years. The current identifier is the "GeoWellID", which is consistent with other Idaho geothermal well data. Previous identifiers were included for reference (such as "IDWRWellID", USGS station name, or common name). The "GeoWellID" should be used for linking all future tables and data.

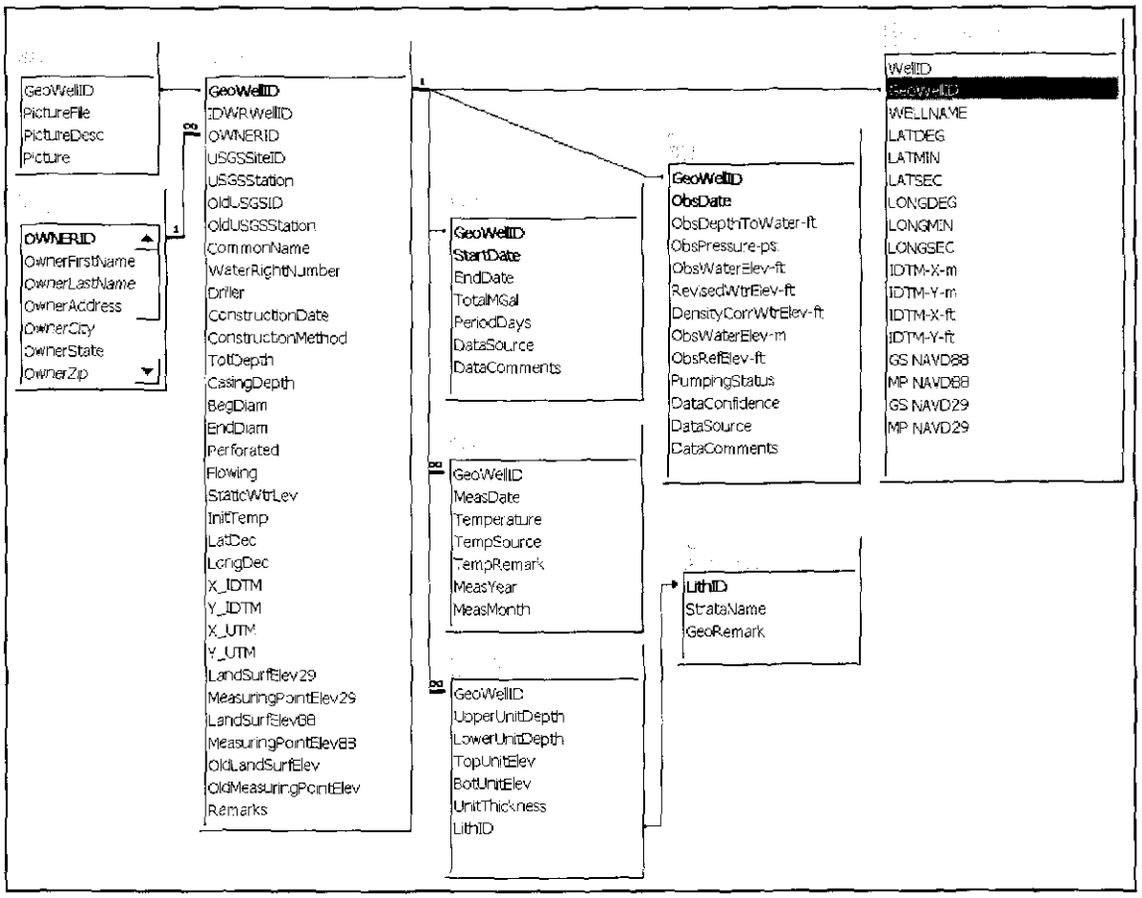



Figure 2-1: Database components and relationships.

# 3. BOISE FRONT GEOTHERMAL AQUIFER CHARACTERISTICS

## 3.1. Introduction

This section consists of a general description of the Boise Front geothermal aquifer system, including geologic setting, general hydrogeologic characteristics, structural influences, water chemistry, and general origin of the geothermal water. A more detailed description of aquifer characteristics in the Boise – Table Rock, Stewart Gulch, and Harris Ranch sub-areas is provided in subsequent sections.

## 3.2. Regional Hydrogeologic Setting

The lower Boise River sub-basin (Treasure Valley) is located along the northern margin of the northwest-trending topographic depression known as the Western Snake River Plain. The Western Snake River Plain is a Neogene-aged continental rift basin (Wood and Clemens, *in press*) separating Cretaceous-age granitic mountains of west-central Idaho from the granitic/volcanic Owhyee mountains in southwestern Idaho. The Western Snake River Plain has the appearance of a northwest trending graben associated with continental rifting (Mabey, 1982; Wood and Anderson, 1981). The Western Snake River Plain extends from about Twin Falls, Idaho northwestward to Vale, Oregon. The Snake River Plain is about 30 miles wide in the section containing the lower Boise River.

The Western Snake River Plain is believed to have been formed by crustal extension (Malde, 1991) that began forming about 11 million years ago, with major faulting that occurred between 11 and 9 million years ago (Wood and Clemens, *in press*). Miocene-aged rhyolite flows and domes are present along the margins of the western plain. Rhyolite is present in the Boise Foothills near Boise, but not in deep basinward wells (e.g., the 14,100 foot-deep J.N. James well near Meridian did not encounter rhyolite). For this reason Wood and Clemens (*in press*) hypothesize that much of the plain may have been an upland during Miocene silicic volcanism.

The basin dropped relative to surrounding highlands by isostatic compensation (Malde, 1991) because of thick emplacements of volcanics (Figure 3-1) associated with rifting and overlying sediments (Mabey, 1982). Wood and Clemens (*in press*) describe sediment deposition in the basin. Initial sediments, consisting of interbedded arkose, mudstone, and volcanic ash, are associated with the Chalk Hills formation. A transgressive sequence followed, with "Lake Idaho" levels reaching approximately 3,600 feet in elevation. Most of the exposed sediments in the Boise Foothills appear to have been deposited during this transgressive sequence. These sediments, mapped as the Terteling Springs Formation, include shoreline sand deposits (including some

oolitic sands), small deltaic deposits, and thick accumulations of lake muds basinward. Wood and Clemens (*in press*) hypothesize that Lake Idaho began to recede about 4 million years ago, with the outlet downcutting at a rate of approximately 400 feet per million years. Sediments from the basin margins filled the receding lake, forming interbedded sand and mud sequences and extensive lacustrine deltaic deposits. The Glenns Ferry Formation includes most of the sediments associated with the slowly lowering lake level, and are represented in the Boise Foothills by a 200-foot thick coarse sand unit with Gilbert-type foreset bedding (Pierce Gulch sand). Basinward, Pierce Gulch sands – reworked Terteling Springs sands (E. Squires, *written communication*) – are thought to form the primary aquifer section of the Treasure Valley.

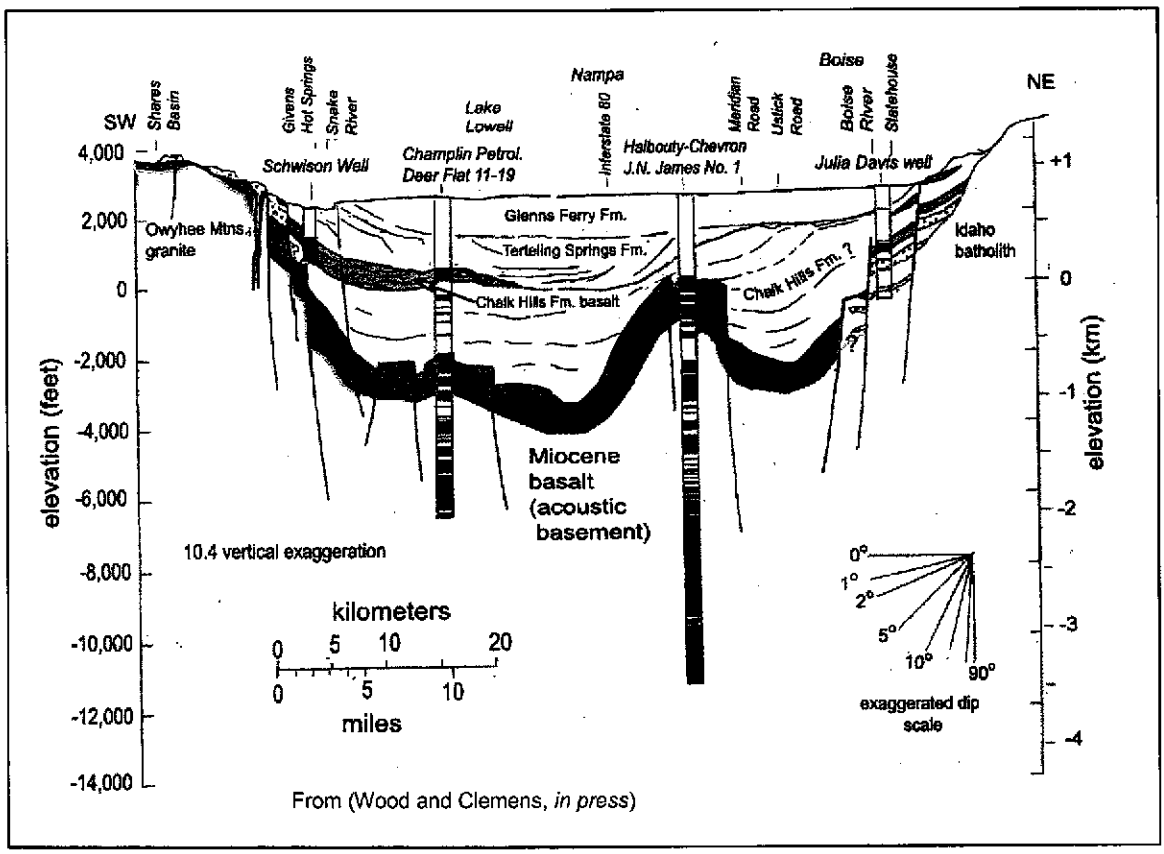



Figure 3-1: Cross-section of the Western Snake River Plain

Volcanic activity returned to the Western Snake River plain during the late stages of Lake Idaho, erupting from a line of vents referred to as the Kuna-Mountain Home volcanic rift (Wood and Clemens, *in press*). These Quaternary basalt flows, assigned to the upper Snake River Group (Malde, 1991, p.266; Malde and Powers, 1962), flowed across portions of the ancestral Snake River Valley in an area that is now south

of the Boise River (Malde, 1991, p.266). The Snake River then changed course, incising at its present location along the southern margin of the basalt flows. More recent eruptions (from Kuna Butte and other local sources) spilled lava into the canyon south of Melba. The Snake River has since incised this basalt (Malde, 1991, p.267).

## 3.3. General Aquifer Description

The Boise Front geothermal aquifers reside in a complex series of igneous rocks and interbedded sediments. Depending on location, geothermal water is found in Cretaceous granite associated with the Idaho Batholith, Tertiary rhyolite and associated sediments, and/or Tertiary basalt and basalt tuffs (Figure 3-2).

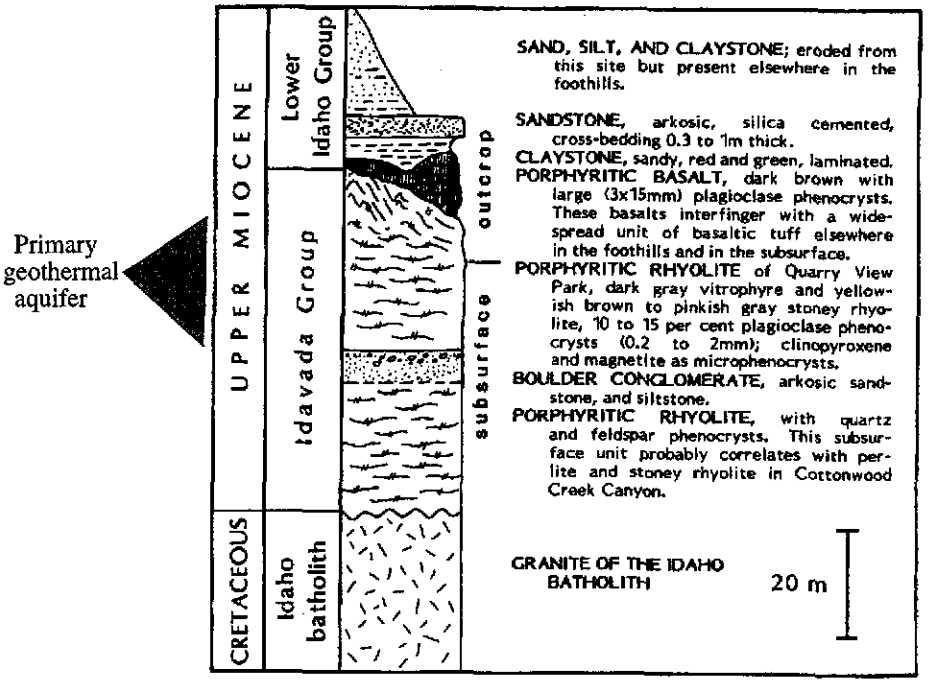



Figure 3-2: Stratigraphic section from rocks related to the geothermal system (Wood and Burnham, 1987)

Geothermal water is associated with fractures along a northwest trending fault zone that marks the northeastern boundary of the Snake River Plain (Figure 3-3). Faults, fractures, and joint systems within the volcanic units presumably serve as conduits for horizontal and vertical ground water movement. The range-front faults have an apparent offset of 200 to 800 feet, based on seismic evidence. The deeper geologic strata appear to dip between four to seven degrees to the southwest on the downthrown side of the primary foothills fault system. Additional minor faults are present on both sides of the main fault system. Because of sedimentary cover, the faults southwest of

the main fault zone are known or inferred primarily from seismic imaging. Most of current successful geothermal production wells in the system are concentrated along the downthrown side of the main fault system.

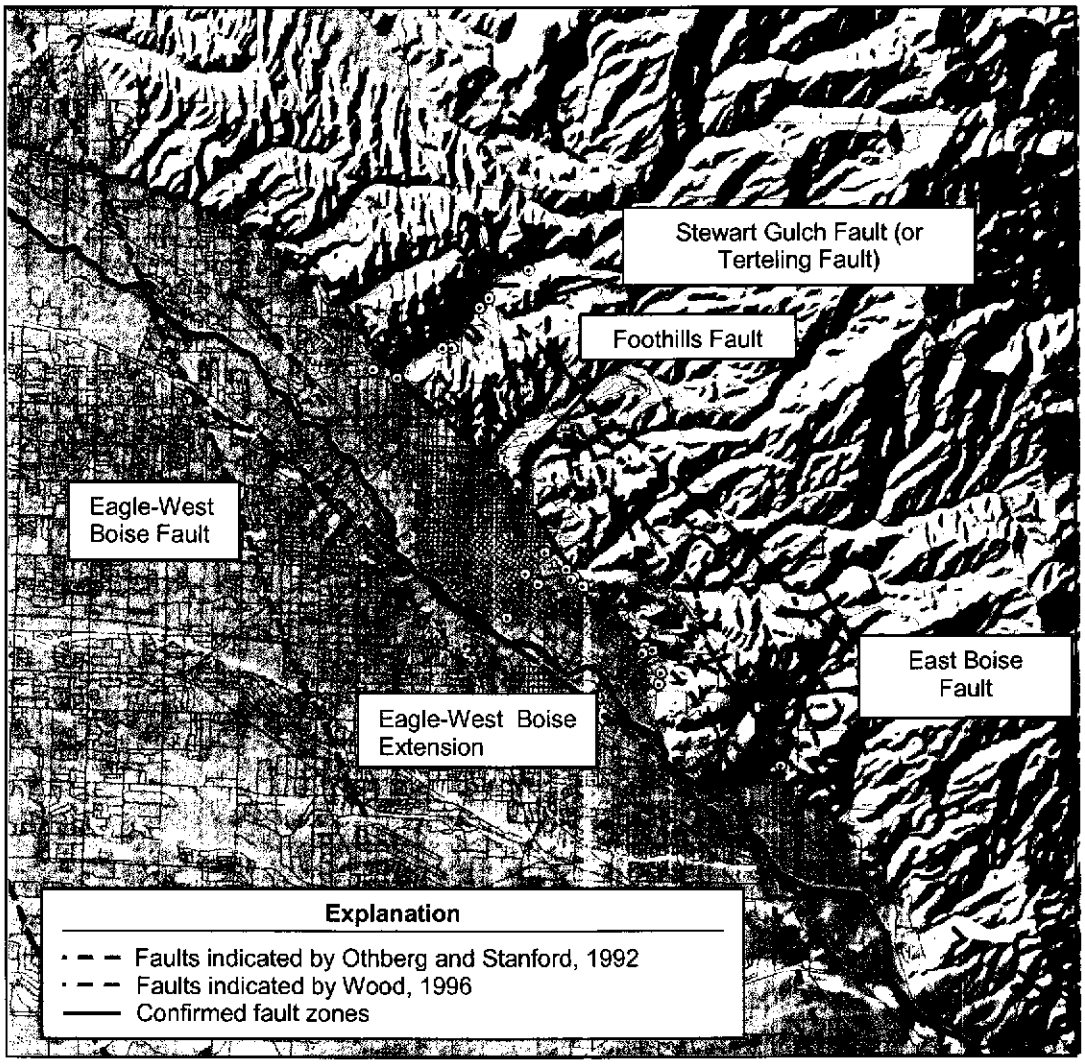



Figure 3-3: Faults in vicinity of Boise Front geothermal aquifer system.

Tertiary Basalt, including fractured and unfractured basalt and basalt tuffs, extends throughout most of the project area. Geothermal wells in the Stewart Gulch area produce geothermal water from this basalt zone (no wells except the Terteling Motorcycle well penetrate through the basalt). Approximate elevations for the upper surface of the Tertiary basalts are shown in Figure 3-4. Tertiary rhyolite and associated sediments are considered the primary geothermal production aquifers in the downtown Boise area (Figure 3-2). The extent of the rhyolite aquifer into the valley is unknown, but no wells in the central portion of the valley have encountered rhyolite. Rhyolite

flows and domes are thought to have erupted near valley margins (Wood and Clemens, *in press*), and as such, may be highly non-uniform in the Boise Front area (Ed Squires, 2002, personal communication). Two rhyolite zones are present in the Boise-downtown area, separated by a boulder conglomerate, sandstone, or siltstone (Wood and Burnham, 1987).

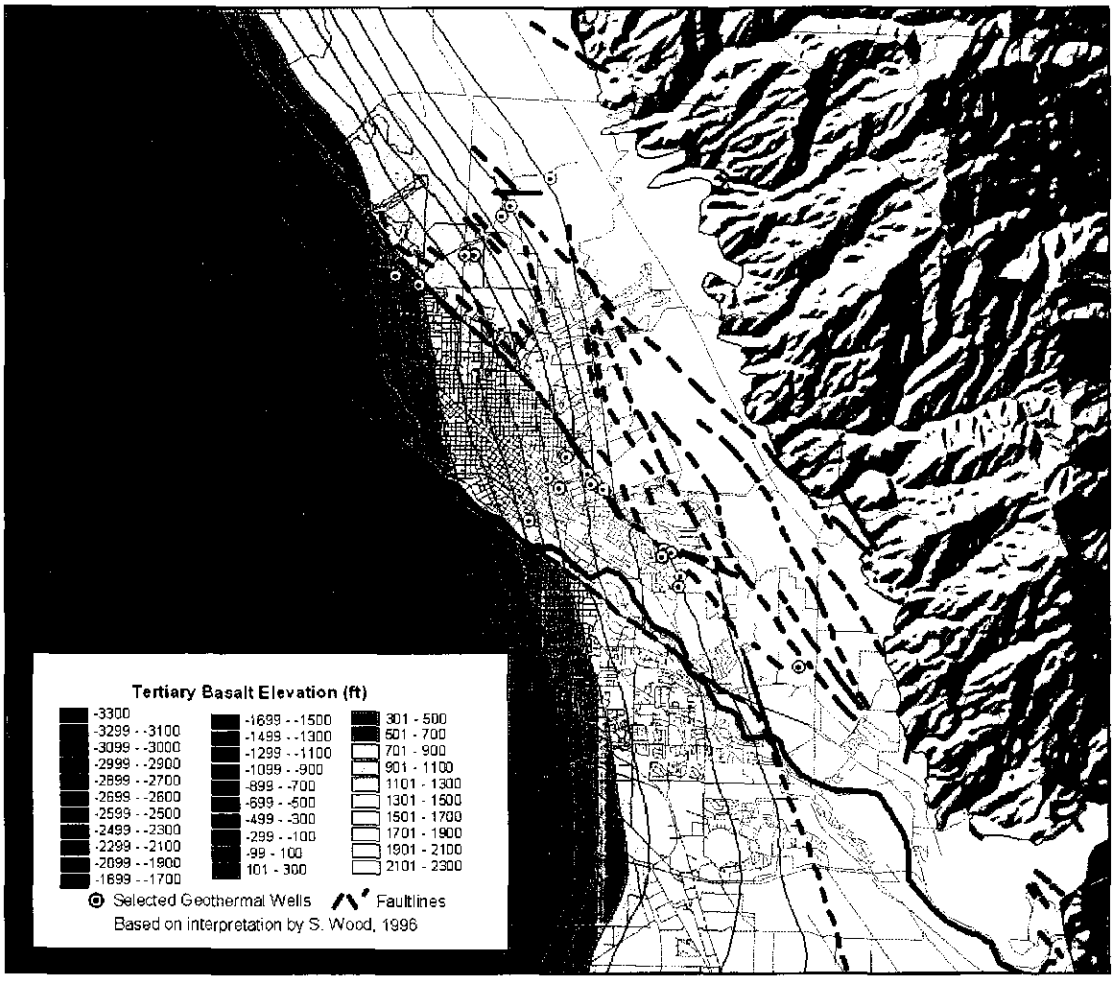



Figure 3-4: Approximate elevations of the upper surface of Tertiary basalt.

There is general consensus that the geothermal flow system is largely dominated by the basin margin fault-fracture zone. Effective permeabilities within the faults (especially in portions of the Foothills Fault) are likely larger than the conductivity transverse to the faults. However, there are insufficient data to quantify the longitudinal or transverse effective hydraulic conductivity tensors or even to determine relative hydraulic conductivities. Development of successful wells located away from exposed faults along the front (e.g., Capitol Mall wells, City Injection, Veteran's, and BLM), and demonstrated hydraulic connection between these wells, demonstrates that the

the main fault zone are known or inferred primarily from seismic imaging. Most of current successful geothermal production wells in the system are concentrated along the downthrown side of the main fault system.

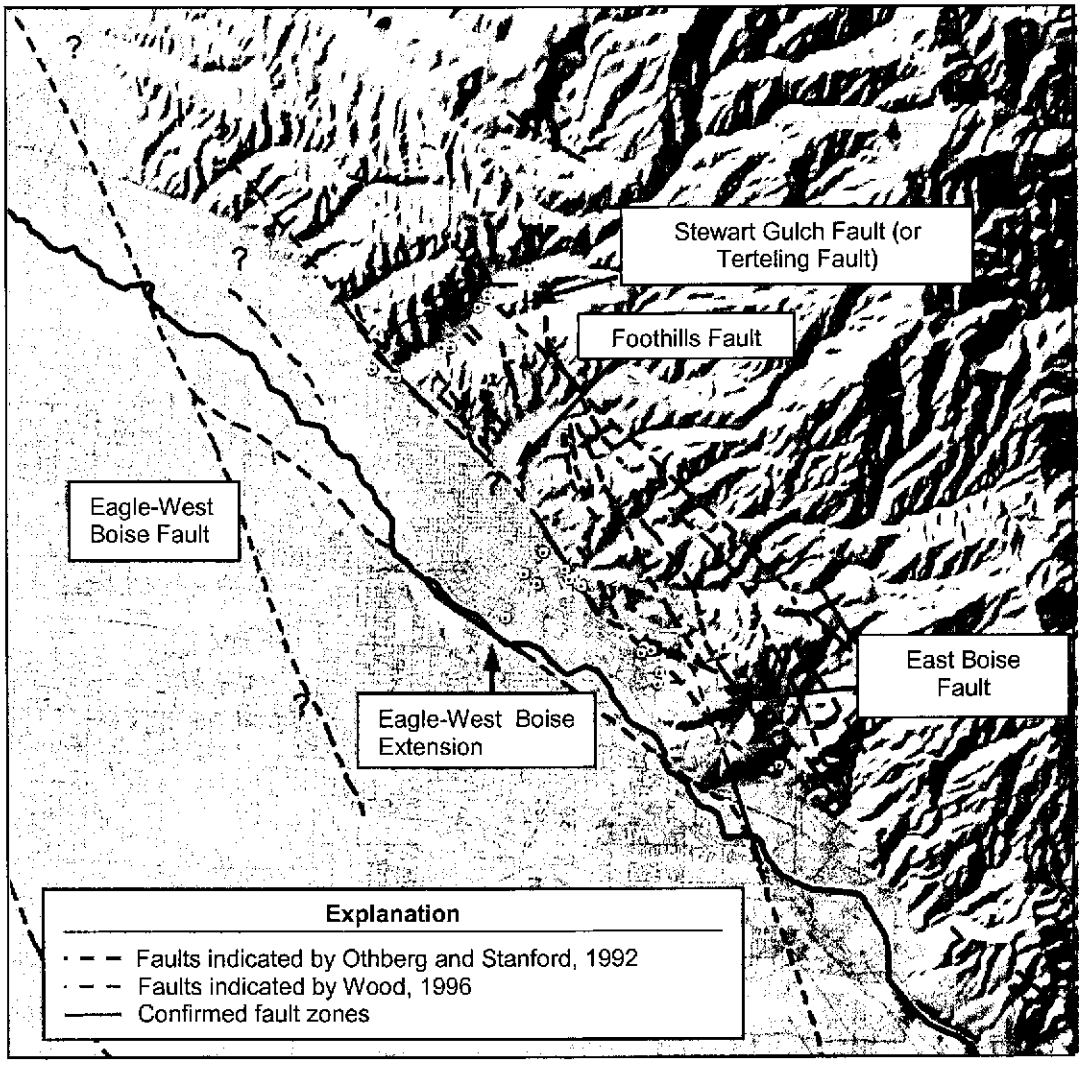



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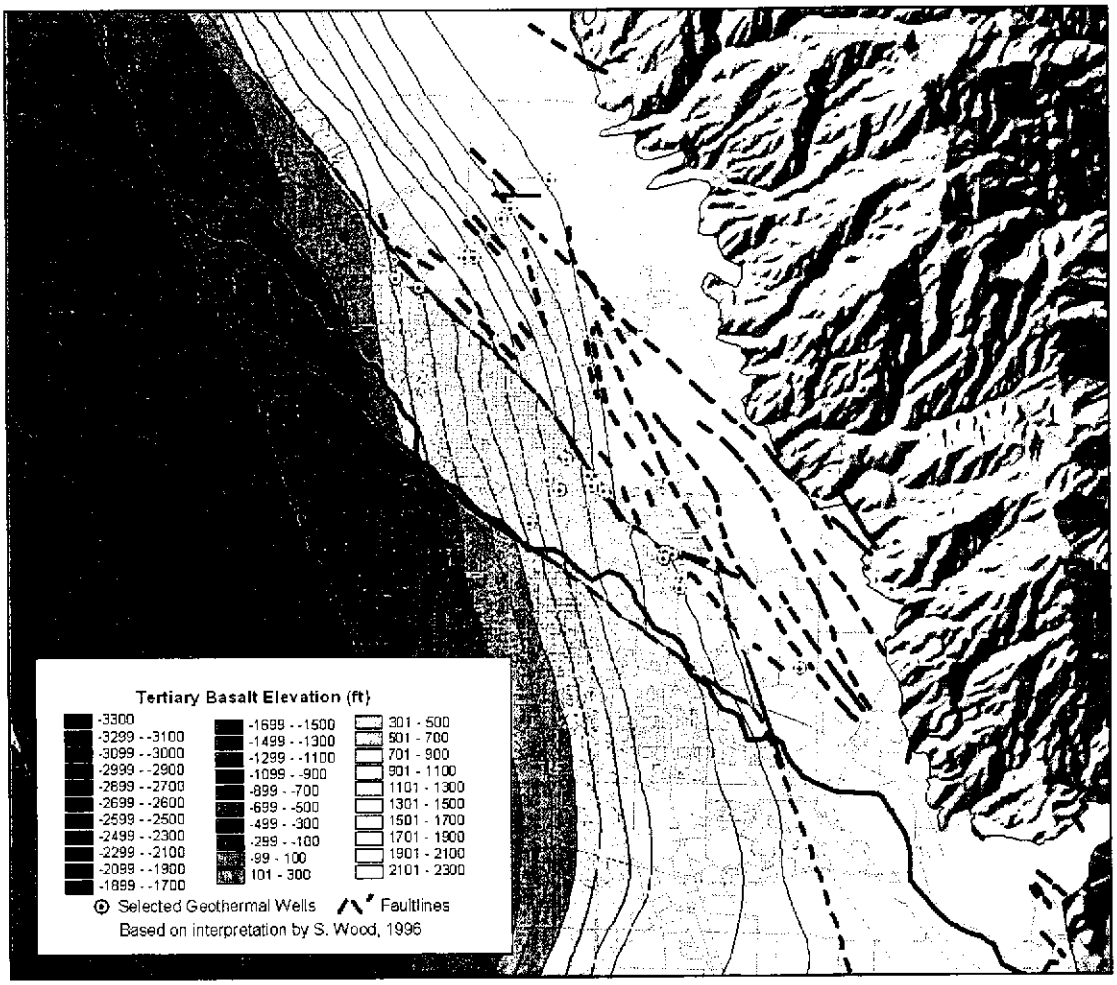



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aquifer is continuous to the southwest (transverse to the main faults) for at least some distance.

## 3.4. Geothermal Water Chemistry

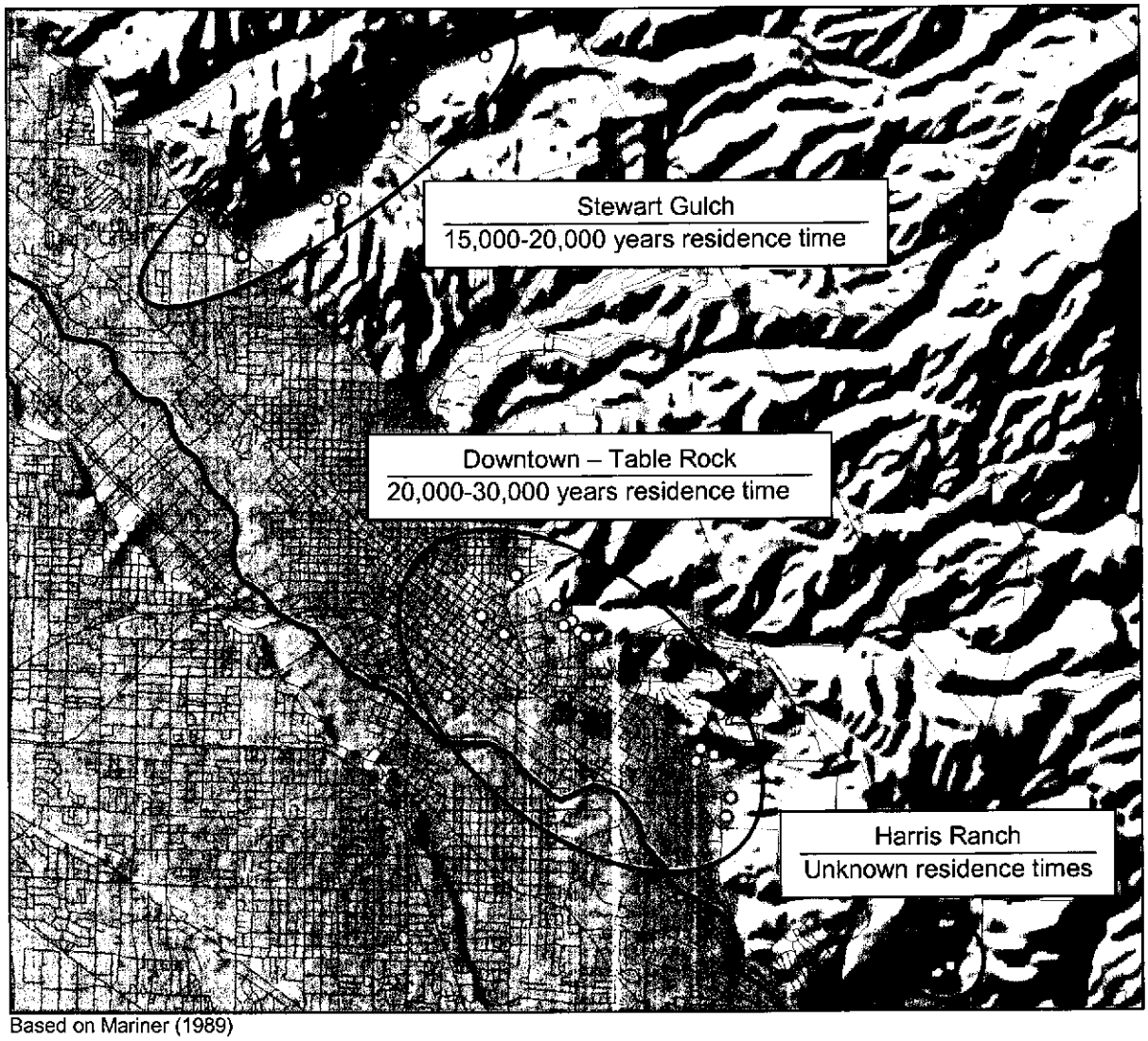
Ground water in the geothermal system is chemically different from water in overlying "cold water" aquifers in the Idaho Group strata. Geothermal water from the rhyolite aquifers generally contains greater concentrations of sodium, bicarbonate, sulfate, chloride, fluoride, silica, arsenic, boron, and lithium than the overlying non-geothermal systems (Wood and Low, 1988). Upper aquifers, even if containing warm water, generally have lower concentrations of calcium and magnesium than the geothermal system. Squires and Wood (1989) note that ground water taken from Ten Mile Ridge wells exhibits warm temperatures (70° to over 90° F), but does not contain the elevated fluoride content associated with geothermal water on the north side of the Boise Valley.

Mayo et al. (1984) presented evidence that fault zones are the primary avenue of upward migration of geothermal ground water. They noted that the thermal waters typically are depleted in calcium and enriched in sodium and fluoride, possibly through ionic exchange during contact with zeolites in the Idavada Volcanics. More recent sampling indicates high sodium and low calcium in several wells in the Micron Technology, Inc. area, although fluoride is not enriched. This suggests some influence of geothermal water in deeper wells (e.g., wells at depths below approximately 1,000 feet) of the east Boise area.

Mariner et al. (1989), based on data in Young et al. (1988), further described geochemical characteristics based on water analyses from 37 thermal-water wells and three nonthermal springs in the Boise area. The thermal waters are dilute, slightly alkaline, and a sodium bicarbonate type, which makes them identical to thermal water in the Idaho Batholith east of the Boise Front. Fluoride concentrations in the thermal water samples taken from the Boise area ranged from 12 to 19 milligrams per liter (mg/l), and those from the Stewart Gulch area ranged from 9.8 to 10 mg/l. Chloride concentrations ranged from 7.2 to 8.6 mg/l in thermal water samples taken from the Boise area, and from 3.6 to 4.3 mg/l in samples taken from Stewart Gulch thermal wells.

Thermal water in the Stewart Gulch area differs from thermal water in the downtown area also on the basis of geochemical radioisotope data (Mariner et al., 1989). Thermal waters in the Stewart Gulch area were estimated to range between 15,000 and 20,000 years (Figure 3-5), compared to between 20,000 to 30,000 years in the downtown Boise area (Mariner et al., 1989). Based on stable isotope (deuterium) and chloride data the authors maintain that the thermal waters of Stewart Gulch cannot be related to

the Boise thermal waters by mixing. Thus, the Stewart Gulch thermal water is of a similar origin to the Boise thermal water, but based on the USGS study (Mariner et al., 1989), water in the Stewart Gulch has experienced little if any mixing with thermal water in the Boise area.



Based on Mariner (1989)

Figure 3-5: Estimated thermal water residence times.

## 3.5. Origin of the Geothermal Water

Both the Idaho Batholith and the Snake River Plain are situated in a region of high geologic heat flow. A geothermal "belt" marked by hot springs and warm water wells is found along the northern margin of the Snake River Plain from Weiser to the northwest to beyond Bliss to the southeast. The concentration of heat flow and hot

springs along the margin of the plain could be caused both by convective heat transfer from upward-moving hot water along fault zones and by the refraction of heat flow that diffuses at the interface of the granite mass with the layered sediments and volcanics (Wood and Burnham, 1987).

The origin of these thermal waters has not been fully explained. Mayo et al. (1984) indicated that at the time "most researchers agree that radiogenic decay in the granitic rocks of the Idaho Batholith is the principal source of heat" in the geothermal system. The source of water is thought to be recharge from precipitation in the mountains to the north that follows a deep path of circulation through the batholith and rises along the frontal fault system. A conceptual geothermal water circulation loop (Figure 3-6) has been proposed (Wood and Burnham, 1987, p.121; Wood and Low, 1988, p.32-33), in which meteoric water from surrounding highlands circulates to a depth of about one mile over a horizontal distance of about six miles, through deep fractures in the Idaho batholith. This concept of a long path of circulation appears consistent with the age-dating based on carbon-14 and dissolved helium concentrations (see section 3.4).

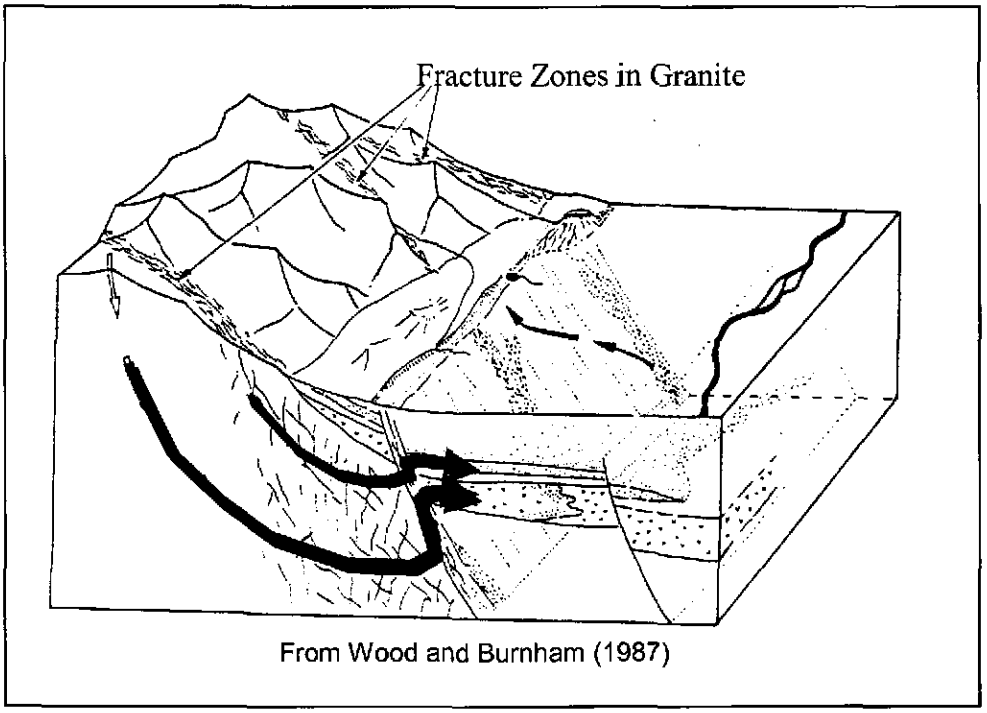



Figure 3-6: Conceptual model of ground water circulation through fractured granite into rhyolite aquifers along the foothills fault beneath the northeastern part of the city.

Smith (1981) also recognized that geothermal heat probably is originating with radioactive minerals within the underlying and surrounding granitic batholith. Smith

notes that regional heat flow is refracted away from poorly conductive sediments (e.g., Idaho and Snake River Group sediments) and towards more thermally conductive silicic rocks (e.g., granitics of the Idaho Batholith).

Thermal water in the Stewart Gulch and the downtown Boise – Table Rock areas appears to have a similar source (Idaho Batholith granitics), but differs in deuterium and chloride concentrations, temperatures, and residence times (see Section 3.4). The difference in residence times and chemistry may reflect shorter (or faster) flowpaths for the Stewart Gulch thermal water compared to the downtown Boise – Table Rock thermal water.

## 3.6. Hydraulic Connection with Overlying Aquifers

In most parts of the lower Boise River Basin there appears to be limited hydraulic interaction between the geothermal, fractured volcanic rock aquifers and the overlying sedimentary, non-geothermal aquifers. This is attributed to low permeabilities of the materials separating the aquifer zones. Miocene basalt and tuffaceous sediments overlying the rhyolite geothermal aquifer have low permeability because of clay alteration and minerals filling the fractures (Squires and Wood, 1989). Low permeability mudstone (which may be more than several hundred feet thick) at the base of the Idaho Group sediments further restricts the vertical permeability and hydraulic connection. However, elevated fluoride and temperature (see next section) in some non-geothermal aquifers along the Boise Front and in an area southwest of Nampa, or elevated sodium and low calcium (such as in the southeast Boise area), suggest that some upwelling does occur, leading to mixing of geothermal and overlying "cold" aquifers.

## 3.7. Thermal Properties

Smith (1981) estimated the thermal properties of rocks along the Boise Front. A summary of his results is listed in Table 3-1.

| Parameter | Basalt | Granite | Silicic volcanics | Sand and clay | clay |
|---|---|---|---|---|---|
| Calculated mean and standard deviation of "in situ" bulk thermal conductivity (cm/sec °C) | 3.62 ± 0.38 | 6.01 ± 0.50 | 4.54 ± 0.24 | 3.49 ± 0.90 | 2.79 ± 0.51 |
| Number of samples | 61 | 33 | 25 | 153 | 61 |
| *From Smith (1981), based on samples analyzed by Brott et al. (1976) and Smith (1981).* | | | | | |

Table 3-1: Calculated thermal properties of Boise Front aquifer materials.

# 4. LOCAL GEOTHERMAL SYSTEM CHARACTERISTICS

This chapter outlines geothermal water use and hydrogeologic characteristics for three areas: (1) downtown Boise – Table Rock, (2) Stewart Gulch, and (3) Harris Ranch (Figure 1-1). These areas are grouped together because of some hydrologic and water use similarities within the areas. The grouping is not intended as an implication regarding a degree of hydraulic connection between the areas.

## 4.1. Downtown Boise – Table Rock Area

### 4.1.1. Description of Use and Development

Geothermal water in the downtown Boise – Table Rock area (hereafter known as the "Boise – Table Rock area") ranges in temperature from 134 to 175°F, and is used for space heating by the (1) Boise Warm Springs Water District (BWSWD), (2) City of Boise (City), (3) State of Idaho Capitol Mall system (CM), and (4) U.S. Division of Veteran's Services (VA). Primary geothermal wells in this area are listed in Table 4-1, and are shown in Figure 4-1.

Geothermal resources in the Boise area were noted at the end of the 19th century. Russell (1903) mentions warm water wells and at least one "tepid" spring located in the Military Reserve area, presumably in the Cottonwood Creek area. These occurrences are also described by Lindgren in 1898 (Russell, 1903). Substantial development of geothermal resources in the Boise area began in 1891 (Table 4-2), when the first geothermal well in this area was drilled at, or near, the site of the present Boise Warm Springs Water District well house. This well first struck warm water beginning at 80 feet, with the water becoming progressively hotter and the flow increasing with depth. A flow of 150 gpm of 154°F degree water was encountered at a depth of 308 feet. However, it was at 400 feet that "a tremendous flow of water" was encountered (Waag and Wood, 1987b, quoting the Idaho Statesman, 1/30/1891). A second well was then drilled 50 feet from the first, with similar results. In combination, the two wells reportedly produced an artesian flow in excess of 800,000 gallons per day (555 gpm) of 170°F water (Wells, 1971). Lindgren reported that the artesian pressure was sufficient for the water level to rise approximately 50 feet above ground surface in 1896 or early 1897 (Waag and Wood, 1987b). Development of the geothermal resource for heating, domestic, and bathing use commenced soon afterward. A third well was drilled in 1895 in order to maintain production.

In approximately 1909, air-lift pumps were installed to maintain or increase production in these wells. The air-lift pumps were not satisfactory, however, as the aerated water was highly corrosive and caused the distribution pipes to fail within four years. At that time (approximately 1913), a new well, 16 inches in diameter, was drilled and one of

the existing wells was enlarged to 16 inches. Both of these wells were equipped with line-shaft turbine pumps. These wells are probably the two wells that are in use today by the Boise Warm Springs Water District (BWSWD). The fate of the other two original wells is unknown.

From the early 1900s until the mid 1980s the BWSWD system was the only major user of thermal water in the Boise – Table Rock area. Production records are scarce or non-existent, but it is assumed that the annual production from the BWSWD wells was approximately 250 to 300 million gallons per year (750 to 900 acre-feet per year, or af/yr). Some additional production also occurred from smaller warm water wells at the Idaho State Penitentiary, and from private wells (Koch, Behrman, etc.) No estimates of production are available from these wells.

| Well | Alternate Name | Entity | Current Use |
|---|---|---|---|
| BWSWD-East | BWSWD#2 | BWSWD | Primary pumping |
| BWSWD-West | BWSWD#1 | BWSWD | Secondary pumping |
| BWSWD#3 | | BWSWD | Monitoring well |
| BGL#1 | Boise Geothermal Ltd #1 | City of Boise | Monitoring well |
| BGL#2 | Boise Geothermal Ltd #2 | City of Boise | Secondary pumping |
| BGL#3 | Boise Geothermal Ltd #3 | City of Boise | Secondary pumping |
| BGL#4 | Boise Geothermal Ltd #4 | City of Boise | Primary pumping |
| Beard | BHW-1 | City of Boise | Test well (adjacent to BGL#4) |
| Boise City Injection | | City of Boise | Injection |
| Capitol Mall 1 | CM-1 | State of Idaho | Injection |
| Capitol Mall 2 | CM-2 | State of Idaho | Production |
| VA Test injection | VA Test | Veteran's Administration | Monitoring |
| VA injection | VA-2 | Veteran's Administration | Injection |
| VA Production | VA-1 | Veteran's Administration | Production |
| BLM | BEH-1 | Bureau of Land Management | Monitoring |
| Kanta | | Idaho Department of Lands | Monitoring |
| Old Pen | Old Pen #1 | Idaho Department of Lands | Monitoring |

Table 4-1: List of primary geothermal wells in the Boise – Table Rock area.

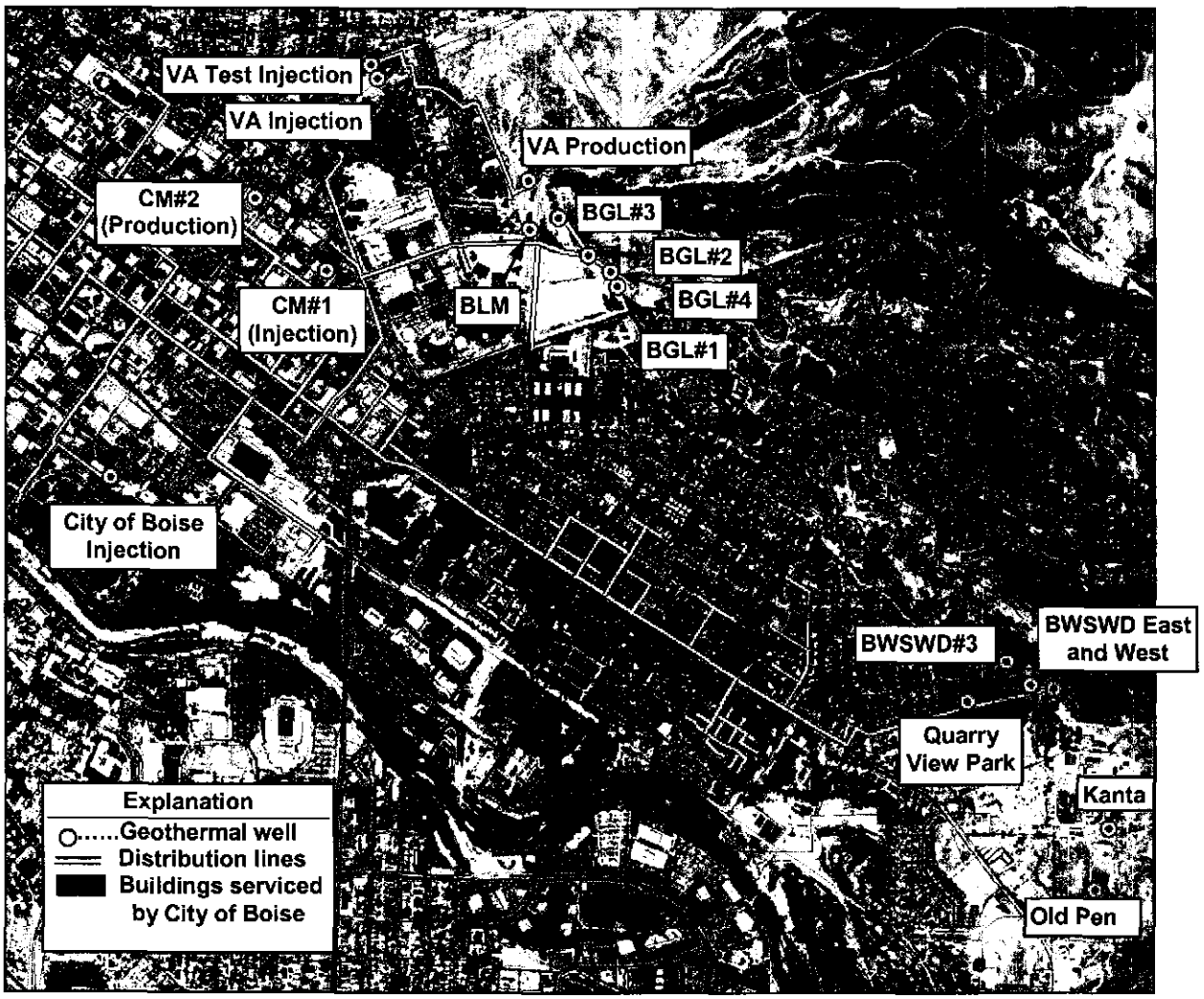



Figure 4-1: Locations of selected geothermal wells in the downtown Boise – Table Rock Area.

The BWSWD currently distributes geothermal water for space heating and domestic use in the eastern part of Boise (Figure 4-1). Spent geothermal water does not return to the geothermal aquifer, but (1) drains into shallow injection wells at points of use; (2) discharges to surface channels draining to the Boise River; or (3) discharges to the Boise River via the municipal sewer system. The primary distribution line along Warm Springs Avenue is connected to the City's geothermal distribution system (although under ordinary circumstances a valve between the two systems remains closed). Production data from the BWSWD system are available beginning in 1978. Production has steadily decreased from a high of 312 million gallons in the 1979 water year to an average of 214 million gallons per water year between 1994 and 2002 (Table 4-3, Figure 4-2). Production slowed between 1986 and 1988 (Figure 4-2), apparently because decreasing water levels caused pumps to break suction; the pumps were

lowered and increased pumping resumed in 1989 (T. Scanlan, C. Brockway, *personal communication*).

| Time | Event | Source |
|---|---|---|
| 1890 | Warm springs and wells in Military Reserve area; Kelly Hot Springs operating | Russell (1903) citing Lindgren (1898), Wells (1971) |
| 1891 | Two BWSWD Wells completed, 0.8 mgd | Wells (1971) |
| 1895 | Third BWSWD well drilled | Hand written notes from BWSWD (1909) - attached to 1909 Tariff Rules |
| 1896-7 | Three BWSWD well in operation; 50 foot shut-in pressure, 550 gpm | Russell (1903) citing Lindgren (1898), also Waag and Wood (1987b)citing Lindgren (1898) |
| 1908 | Air pumps installed on BWSWD wells | Hand written notes from BWSWD (attached to 1909 Tariff Rules) |
| 1913 +/- | New 16-inch well drilled and one existing well enlarged to 16 inches; turbine pumps installed in both wells at the BWSWD | Wells (1971) (citing 1918 Tariff Rules); four years after installation of air pumps |
| 1917 +/- | Kelly Hot Springs dried up | MacGregor (1999, pg 81) |
| 8/6/1965 | Old Pen Irrigation Well Drilled | Drillers report |
| 1976 | BLM and Beard Wells Drilled | Berkeley Group (1990, pg 45) |
| 3/21/1977 | Harris Well 1 constructed | Driller's report; Water right (63-8627) |
| 12/1980 | Capitol Mall Well No. 1 completed/tested | Anderson and Kelly (1981a) |
| 6/1981 | BWSWD No. 3 Completed | Anderson and Kelly (1981b) |
| 9/1981 | Capitol Mall Well 2 Tested | Anderson and Kelly (1981a) |
| 4/1982 | BGL Wells 2 and 4 Tested | Anderson and Kelly (1982b) |
| 11/1982 | Capitol Mall Wells Operating; assume 160-205 Mgal/yr (500 af/yr) | Berkeley Group (1990, pg 21); Neely (1995, pg 17) |
| 9/1983 | VA Production Well completed | Anderson and Kelly (1983) |
| 10/1983 | BGL Wells Operating; 121-189 Mgal/yr (400 af/yr) | Berkeley Group (1990, pg 33);; Neely (2001) |
| 1984 | Quarry View Well On | Scanlan (*written communication*) |
| 1986 | Harris East(?) Well Completed | Waag & Wood (Waag and Wood, 1987b) |
| 1/1987 | VA Injection Well completed | Montgomery Engineers (1987) |
| 11/1988 | VA Wells Operational; 118-204 Mgal/y (500 af/yr) | Berkeley Group, pg. 33; Neely 8/28/01 |
| 2/1988 | Quarry View Well off; pump removed | Scanlan (*written communication*) |
| 1998 +/- | Old Pen Well Off | Scanlan (*written communication*) |
| 4/1998 | City Injection Well Drilled & Tested | Montgomery Watson (1998) |
| 2/1999 | City Injection Well Operational | City of Boise |

Table 4-2: Chronology of geothermal development and/or responses in the downtown Boise – Table Rock area.

| Year | BWSWD | Capitol Mall | Boise City | | | VA | Summary | |
|---|---|---|---|---|---|---|---|---|
| | Production | Production & Injection | Production | Injection | Net With-drawals | Production & Injection | Total Use | Net With-drawals |
| 1978 | 256.1 | | | | | | 256.1 | 256.1 |
| 1979 | 312.2 | | | | | | 312.2 | 312.2 |
| 1980 | 308.1 | | | | | | 308.1 | 308.1 |
| 1981 | 239.4 | | | | | | 239.4 | 239.4 |
| 1982 | 276.0 | | | | | | 276.0 | 276.0 |
| 1983 | 283.5 | 12.8 | | | | | 296.3 | 283.5 |
| 1984 | 300.2 | 164.6 | 166.7 | | 166.7 | | 631.5 | 466.9 |
| 1985 | 281.2 | 175.4 | 121.4 | | 121.4 | | 578.0 | 402.6 |
| 1986 | 253.1 | 192.0 | 176.8 | | 176.8 | | 622.0 | 429.9 |
| 1987 | 183.1 | 169.1 | 188.9 | | 188.9 | | 541.1 | 372.0 |
| 1988 | 199.4 | 138.8 | 123.8 | | 123.8 | | 462.1 | 323.2 |
| 1989 | 278.0 | 154.4 | 158.0 | | 158.0 | 28.48 | 618.9 | 436.0 |
| 1990 | 244.6 | 130.5 | 122.3 | | 122.3 | 118.21 | 615.7 | 366.9 |
| 1991 | 245.7 | 182.7 | 121.3 | | 121.3 | 129.08 | 678.8 | 367.0 |
| 1992 | 243.3 | 139.0 | 123.3 | | 123.3 | 116.69 | 622.3 | 366.6 |
| 1993 | 259.2 | 217.9 | 156.0 | | 156.0 | 137.01 | 770.2 | 415.2 |
| 1994 | 220.8 | 174.5 | 122.5 | | 122.5 | 137.42 | 655.2 | 343.3 |
| 1995 | 221.2 | 154.3 | 127.9 | | 127.9 | 166.715 | 670.1 | 349.1 |
| 1996 | 226.6 | 118.7 | 132.1 | | 132.1 | 186.22 | 663.7 | 358.8 |
| 1997 | 212.8 | 98.6 | 130.7 | | 130.7 | 203.61 | 645.7 | 343.5 |
| 1998 | 184.2 | 111.6 | 131.2 | | 131.2 | 195.95 | 623.0 | 315.4 |
| 1999 | 204.0 | 125.5 | 164.9 | 53.6 | 111.3 | 191.64 | 686.1 | 315.3 |
| 2000 | 210.5 | 117.9 | 188.0 | 145.8 | 42.2 | 186.95 | 703.3 | 252.6 |
| 2001 | 218.7 | 144.8 | 172.0 | 145.6 | 26.4 | 172.96 | 708.5 | 245.1 |
| 2002 | 230.1 | 123.3 | 170.7 | 139.8 | 30.9 | 163.1 | 687.1 | 261.0 |

Units: millions of gallons per water year (October 1 through September 31); all data supplied by users

Table 4-3: Production and injection of geothermal water in the Boise – Table Rock area, 1978-2002.

The Idaho State Penitentiary drilled a warm-water (97°F discharge, 134°F bottom hole temperature) well for irrigation in 1965 (Old Pen Well). The well was used for irrigating approximately 20 acres (80 af/yr +/-) until the early 1970s. This well was later used for irrigating the Idaho Botanical Garden property from the mid 1980s through the late 1990s, with diversion volumes progressively increasing from 2 to 25 acre-feet annually over that period. Another irrigation well in the Penitentiary area, the Quarry View Park well, was operated for irrigation from 1984 through 1987, producing approximately 25 acre-feet annually of 134°F water. The Kanta-Yanke well was completed in 1983, but was never equipped with a pump for production. It produced 161°F water during test pumping (IDWR driller's report).

lowered and increased pumping resumed in 1989 (T. Scanlan, C. Brockway, *personal communication*).

| Time | Event | Source |
|---|---|---|
| 1890 | Warm springs and wells in Military Reserve area; Kelly Hot Springs operating | Russell (1903) citing Lindgren (1898), Wells (1971) |
| 1891 | Two BWSWD Wells completed, 0.8 mgd | Wells (1971) |
| 1895 | Third BWSWD well drilled | Hand written notes from BWSWD (1909) - attached to 1909 Tariff Rules |
| 1896-7 | Three BWSWD well in operation; 50 foot shut-in pressure, 550 gpm | Russell (1903) citing Lindgren (1898), also Waag and Wood (1987b)citing Lindgren (1898) |
| 1908 | Air pumps installed on BWSWD wells | Hand written notes from BWSWD (attached to 1909 Tariff Rules) |
| 1913 +/- | New 16-inch well drilled and one existing well enlarged to 16 inches; turbine pumps installed in both wells at the BWSWD | Wells (1971) (citing 1918 Tariff Rules); four years after installation of air pumps |
| 1917 +/- | Kelly Hot Springs dried up | MacGregor (1999, pg 81) |
| 8/6/1965 | Old Pen Irrigation Well Drilled | Drillers report |
| 1976 | BLM and Beard Wells Drilled | Berkeley Group (1990, pg 45) |
| 3/21/1977 | Harris Well 1 constructed | Driller's report; Water right (63-8627) |
| 12/1980 | Capitol Mall Well No. 1 completed/tested | Anderson and Kelly (1981a) |
| 6/1981 | BWSWD No. 3 Completed | Anderson and Kelly (1981b) |
| 9/1981 | Capitol Mall Well 2 Tested | Anderson and Kelly (1981a) |
| 4/1982 | BGL Wells 2 and 4 Tested | Anderson and Kelly (1982b) |
| 11/1982 | Capitol Mall Wells Operating; assume 160-205 Mgal/yr (500 af/yr) | Berkeley Group (1990, pg 21); Neely (1995, pg 17) |
| 9/1983 | VA Production Well completed | Anderson and Kelly (1983) |
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| 1984 | Quarry View Well On | Scanlan (*written communication*) |
| 1986 | Harris East(?) Well Completed | Waag & Wood (Waag and Wood, 1987b) |
| 1/1987 | VA Injection Well completed | Montgomery Engineers (1987) |
| 11/1988 | VA Wells Operational; 118-204 Mgal/y (500 af/yr) | Berkeley Group, pg. 33; Neely 8/28/01 |
| 2/1988 | Quarry View Well off; pump removed | Scanlan (*written communication*) |
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Table 4-2: Chronology of geothermal development and/or responses in the downtown Boise – Table Rock area.

| Year | BWSWD | Capitol Mall | Boise City | | | VA | Summary | |
|---|---|---|---|---|---|---|---|---|
| | Production | Production & Injection | Production | Injection | Net With-drawals | Production & Injection | Total Use | Net With-drawals |
| 1978 | 256.1 | | | | | | 256.1 | 256.1 |
| 1979 | 312.2 | | | | | | 312.2 | 312.2 |
| 1980 | 308.1 | | | | | | 308.1 | 308.1 |
| 1981 | 239.4 | | | | | | 239.4 | 239.4 |
| 1982 | 276.0 | | | | | | 276.0 | 276.0 |
| 1983 | 283.5 | 12.8 | | | | | 296.3 | 283.5 |
| 1984 | 300.2 | 164.6 | 166.7 | | 166.7 | | 631.5 | 466.9 |
| 1985 | 281.2 | 175.4 | 121.4 | | 121.4 | | 578.0 | 402.6 |
| 1986 | 253.1 | 192.0 | 176.8 | | 176.8 | | 622.0 | 429.9 |
| 1987 | 183.1 | 169.1 | 188.9 | | 188.9 | | 541.1 | 372.0 |
| 1988 | 199.4 | 138.8 | 123.8 | | 123.8 | | 462.1 | 323.2 |
| 1989 | 278.0 | 154.4 | 158.0 | | 158.0 | 28.48 | 618.9 | 436.0 |
| 1990 | 244.6 | 130.5 | 122.3 | | 122.3 | 118.21 | 615.7 | 366.9 |
| 1991 | 245.7 | 182.7 | 121.3 | | 121.3 | 129.08 | 678.8 | 367.0 |
| 1992 | 243.3 | 139.0 | 123.3 | | 123.3 | 116.69 | 622.3 | 366.6 |
| 1993 | 259.2 | 217.9 | 156.0 | | 156.0 | 137.01 | 770.2 | 415.2 |
| 1994 | 220.8 | 174.5 | 122.5 | | 122.5 | 137.42 | 655.2 | 343.3 |
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| 1997 | 212.8 | 98.6 | 130.7 | | 130.7 | 203.61 | 645.7 | 343.5 |
| 1998 | 184.2 | 111.6 | 131.2 | | 131.2 | 195.95 | 623.0 | 315.4 |
| 1999 | 204.0 | 125.5 | 164.9 | 53.6 | 111.3 | 191.64 | 686.1 | 315.3 |
| 2000 | 210.5 | 117.9 | 188.0 | 145.8 | 42.2 | 186.95 | 703.3 | 252.6 |
| 2001 | 218.7 | 144.8 | 172.0 | 145.6 | 26.4 | 172.96 | 708.5 | 245.1 |
| 2002 | 230.1 | 123.3 | 170.7 | 139.8 | 30.9 | 163.1 | 687.1 | 261.0 |

Units: millions of gallons per water year (October 1 through September 31); all data supplied by users

Table 4-3: Production and injection of geothermal water in the Boise – Table Rock area, 1978-2002.

The Idaho State Penitentiary drilled a warm-water (97°F discharge, 134°F bottom hole temperature) well for irrigation in 1965 (Old Pen Well). The well was used for irrigating approximately 20 acres (80 af/yr +/-) until the early 1970s. This well was later used for irrigating the Idaho Botanical Garden property from the mid 1980s through the late 1990s, with diversion volumes progressively increasing from 2 to 25 acre-feet annually over that period. Another irrigation well in the Penitentiary area, the Quarry View Park well, was operated for irrigation from 1984 through 1987, producing approximately 25 acre-feet annually of 134°F water. The Kanta-Yanke well was completed in 1983, but was never equipped with a pump for production. It produced 161°F water during test pumping (IDWR driller's report).

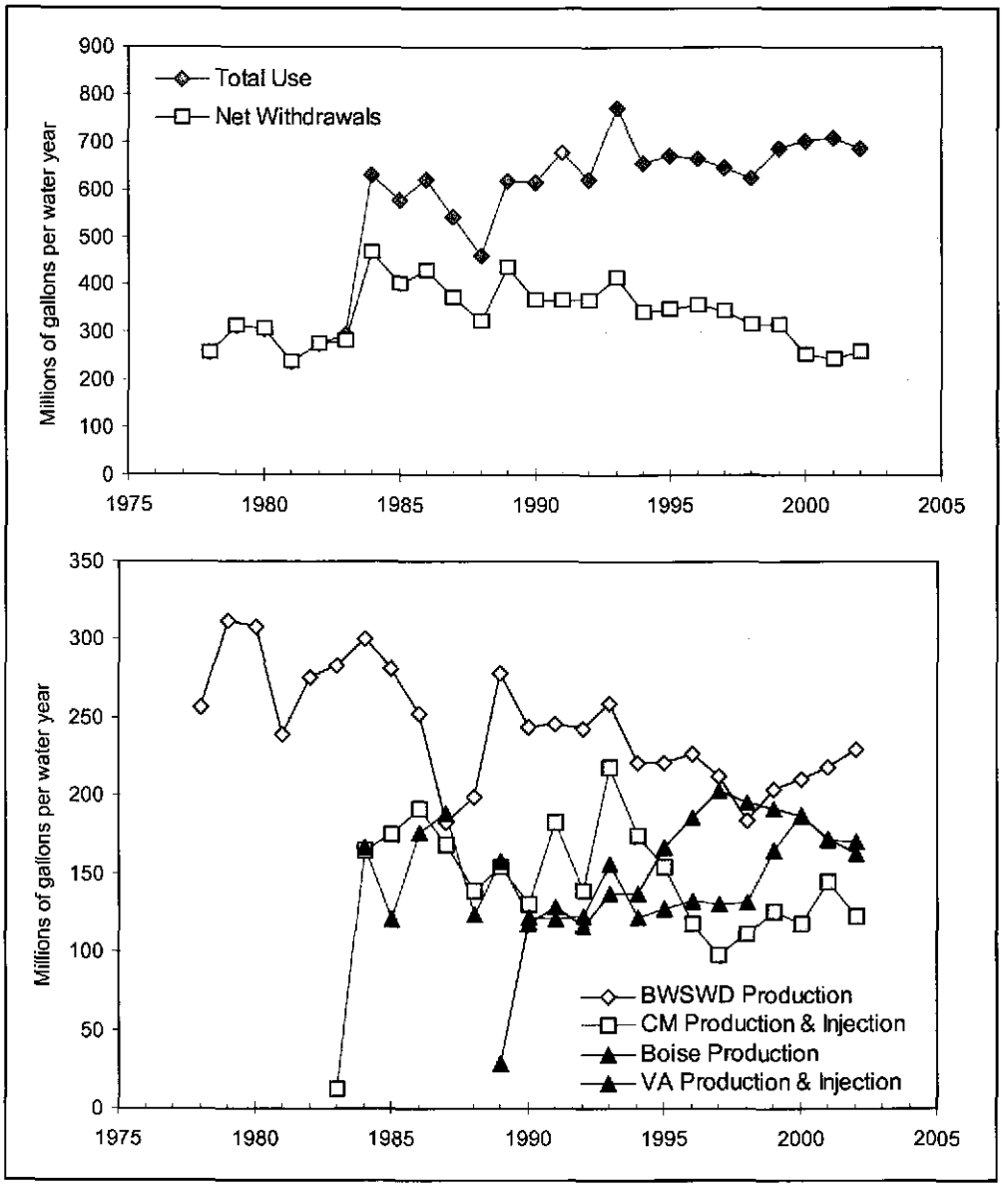



Figure 4-2: Annual geothermal production in the downtown Boise – Table Rock area.

Three new geothermal systems were developed in the downtown Boise area during the 1980s based on results from geothermal exploration during the late 1970s. First, the State of Idaho began heating the state Capitol building and surrounding office buildings with geothermal heat. The State Capitol Mall (CM) system began operation in the fall of 1982, and has withdrawn approximately 150 million gallons per year since that time. Production in the State of Idaho system spiked in 1993, although the reason for the production spike is unclear. All of the effluent is re-injected into the geothermal aquifer through the CM#1 well (Figure 4-1).

Next, the City of Boise (City) system began operation in the fall of 1983. The City system provides water for space heating to a number of downtown government and commercial buildings (Figure 4-1). Production in the first years of operation ranged from 121 to 189 million gallons per water year, and averaged 140 million gallons per year between 1984 and 1998 (Table 4-3). In 1998, the City of Boise drilled an injection well at Julia Davis Park (Figure 4-1). Injection of spent geothermal water began in February 1999, although a portion of the City's production continues to be discharged to the Boise River (Table 4-3). Annual City production increased between 1999 and 2001 (Figure 4-2), but net production (total production minus injection) decreased by approximately 100 million gallons per year during that period (Table 4-3 and Figure 4-2).

The Veterans Administration (VA) system began operation in the fall of 1988. The VA uses geothermal water primarily for space heating at its campus north of downtown Boise. The VA system has withdrawn an average of approximately 142 million gallons per year (Table 4-3 and Figure 4-1). All of the spent thermal water is re-injected into the geothermal aquifer via the VA injection well.

The Quarry View well was reconstructed in 2001 into a two-piezometer monitoring well (Scanlan, 2001). One piezometer was completed between 600 and 700 feet below ground surface; the second pizometer was completed between 813 and 848 feet below ground surface. In 1984 Anderson & Kelly (Castelin, 1984) found temperatures between 131° and 134°F between 620 and 660 feet, and 158°F at about 825 feet. These temperatures were not as hot as the 172°F temperatures in the BWSWD wells, and therefore, despite proximity to the BWSWD wells, probably are not drawing water from the same aquifer zones.

In summary, the net withdrawals from the downtown Boise – Table Rock area (total production minus the amount re-injected) were highest in the mid-1980s, peaking at approximately 467 million gallons in the 1984 water year (Table 4-3 and Figure 4-2). Net withdrawals have decreased since then, averaging 354 million gallons per water year between 1990 and 1999. Net withdrawals between 2000 and 2002 were approximately 253 million gallons, reflecting, in part, the commencement of injection by the City of Boise in 1999.

### 4.1.2. Hydrogeology

Wood and Burnham (1987) developed a general stratigraphic sequence for the downtown Boise area (Figure 4-3). Uppermost sediments may include shallow alluvium (in the vicinity of the Boise River) or coarse-grained Pleistocene sediments of the Snake River Group. These shallow sediments overlie Tertiary-aged sands, silts, and clays. These sediments are remnants of transgressive episodes during the filling of Lake Idaho, and regressive facies as Lake Idaho slowly drained.

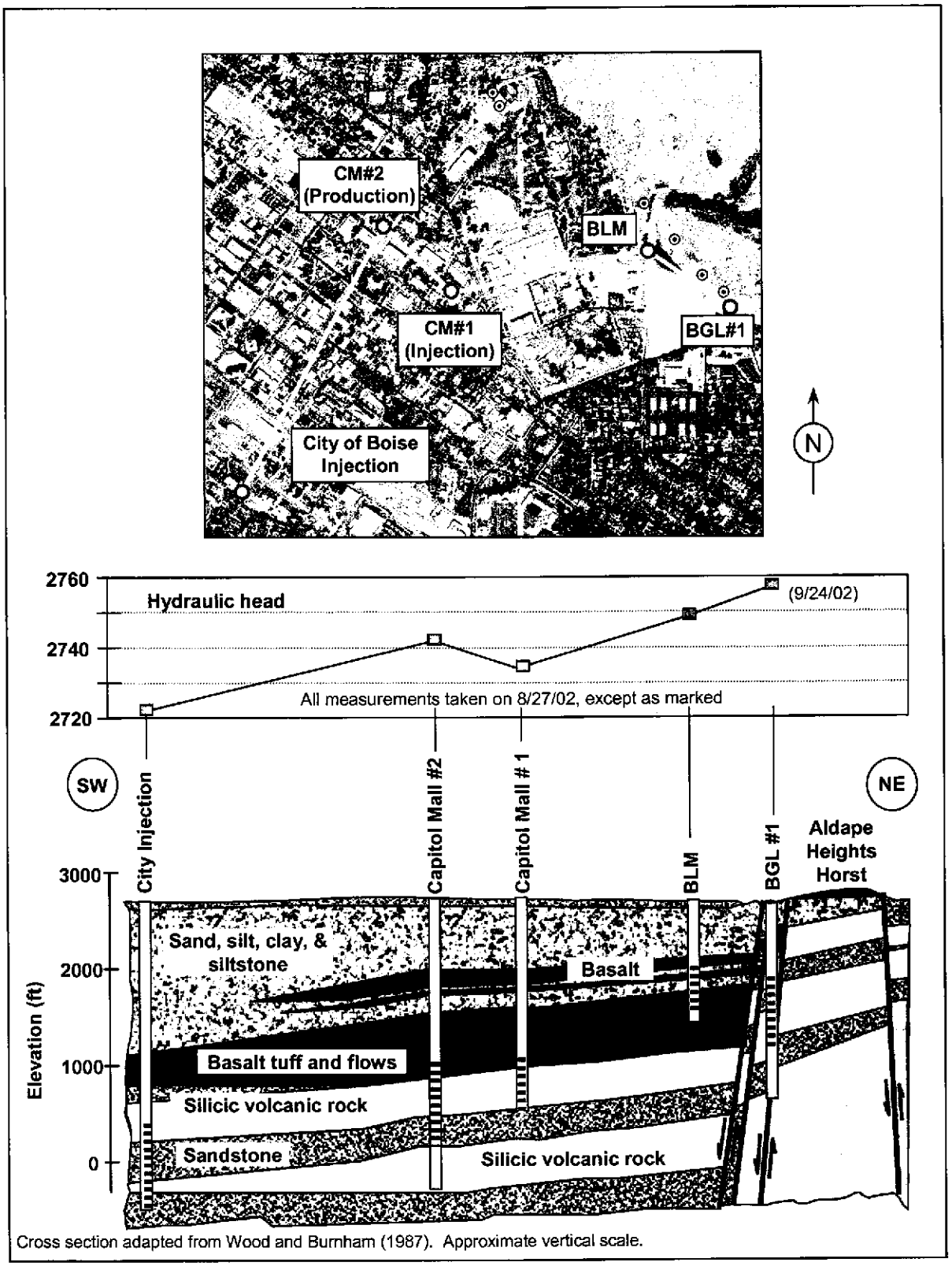



Figure 4-3: Stratigraphy of the Boise Front geothermal aquifer in the downtown Boise area.

Geothermal flow in this area is thought to be dominated by a zone of faulting parallel to the Boise Front (Figure 3-3). In addition, a seismic reflection survey (Liberty, 1996b) from the vicinity of the City geothermal production wells to BSU and from BSU to Ann Morrison Park provided evidence of a major fault offset of approximately 600 feet in the vicinity of 9$^{th}$ Street and Royal Boulevard. Based on offset, location, and inferred orientation, this fault has been interpreted (Wood, 1996a; Wood, 1996b; Wood, 1996c) as an extension of the Eagle-West Boise fault (Figure 3-3). The magnitude of offset suggests that this fault might function as a geothermal system boundary, although the fault also may function as conduit for upward movement of thermal water through the fault zone.

The East Boise Fault (Figure 3-3), a north-northwest trending fault, extends south-southeast to the vicinity of the Old State Penitentiary and beyond to Barber Dam on the Boise River (Squires et al., 1992). In addition, a northeast trending fault is discernible in the vicinity of Warm Springs Creek, from southeast of Table Rock to just west of the Harris well.

In general, the geologic section on the downthrown side of the main frontal fault system along the Boise Front (in the downtown Boise – Table Rock area) consists of the following (top to bottom) sequence (Burnham and Wood, 1983).

1. Recent-age alluvium of the Boise River floodplain and tributary fan deposits extend from ground surface to typical depths of 30 to 80 feet. These deposits are associated with the Snake River Group, and generally consist of coarse-grained sediments with large cobbles. An unconfined cold-water aquifer in these deposits is tapped by irrigation, municipal, commercial, industrial, and domestic wells.

2. Sand, silt, clay and siltstone sediments of the lower Idaho Group underlie the recent-age alluvium. The lower Idaho Group sediments are lake-margin sediments that grade to finer-grained units laterally away from the granitic source in the Idaho Batholith. The base of the Idaho Group sediments extend to depths of a few hundred feet in close proximity to the Front, and to depths of more than 1500 feet at the City of Boise Injection Well. The upper 600 to 1000 feet of these sediments generally contain cold-water aquifers tapped by domestic, municipal, and irrigation wells in the Boise area.

   Silica cemented sandstones of the Idaho Group occur in the eastern foothills in the vicinity of Table Rock. These sandstones were cemented by precipitation of dissolved silica contained in geothermal water.

   One or two Tertiary basalt flows are found near the bottom of the lower Idaho Group. These basalt flows range in thickness from 10 to 150 feet.

3. Basaltic tuffs and flows, with beds of arkosic and tuffaceous sediments, underly the lower Idaho Group. This unit is estimated to be approximately 600 feet thick, and serves as the upper portion of the geothermal system. Where competent and fractured, the basalt unit may yield warm water to wells. However, these volcanic materials have more commonly been altered to low-permeability clay. The basalt tuff unit may function as a cap above the main geothermal aquifer.

4. Two Tertiary rhyolite zones, separated by coarse-grained sediments, form the main geothermal aquifer in most of the wells. This sequence of volcanic rock and sediment is part of the Idavada Group.

   The upper rhyolite is multicolored, generally varying from black to yellowish brown, often with bluish or green colors. Where dark colored, the rock is commonly mistaken for basalt or andesite. This rhyolite is approximately 400 feet thick at the Capitol Mall #2 well and perhaps somewhat thicker at the City of Boise Injection well. The upper rhyolite is reported to be the main geothermal reservoir rock, based on the current wells penetrating this zone.

   Below the upper rhyolite is coarse-grained sandstone and conglomerate, with interbedded silicic tuff. These sediments are approximately 300 feet thick at the Capitol Mall #2 well and 400 feet thick at at the City of Boise Injection well. The coarse nature of these sediments suggests that, if not cemented, they may have relatively high conductivities and porosities.

   The lower rhyolite is approximately 300 feet thick. It generally consists of light gray to dark greenish gray rock with quartz and feldspar phenocrysts. The lower rhyolite is generally believed to be less permeable than the upper rhyolite. In the City of Boise injection well and in BGL No. 1, the lower rhyolite is underlain by at least 200 feet of coarse-grained sediments.

5. Granitic rock of the Idaho Batholith (Cretaceous-aged biotite granodiorite and granite) is generally believed to underlie the volcanic rocks associated with the geothermal aquifer. The granite has been penetrated only in wells drilled into upthrown fault blocks along the frontal fault system, such as BGL #1. Granite of the Idaho Batholith was also penetrated in the lower portion of both of the Harris wells. The water-bearing characteristics of unfractured granitic rock are generally poor, and therefore the granite, where unfractured, may function as the bottom of the geothermal aquifer. However, recharge to the Boise geothermal aquifer is thought to travel as deep circulation through open fractures in the granite from upland areas to the north and east. Locally, the granite may have sufficient fracture permeability along the faults to yield water to wells.

### 4.1.3. Water Levels

Periodic water level measurements or pressure readings have been taken in a number of geothermal wells since the early 1980s. Most of these water level measurements were conducted by geothermal users and well owners, and were obtained from IDWR. Some measurements were conducted by consultants and/or BSU, and in some cases, the data sources are unknown. Measurements conducted on August 27, 2002 were taken by project staff. Hydrographs based on these measurements for wells in the downtown Boise – Table Rock area are provided on pages 28 through 30.

Water levels in the downtown area have reflected the impacts of geothermal production rates:

1. Prior to development, the static water levels in the geothermal system were at least 50 feet above ground surface at the BWSWD, based on Lindgren's report from 1896 or 1897. Since the BWSWD wells had been flowing for several years at that time, actual pre-development static water level may have been more than 50 feet[1].

2. From the early 1900s until 1982, the system is assumed to have been in equilibrium, with an average annual discharge of approximately 275 to 300 million gallons (840 to 920 acre-feet annually). Water levels peaked each August or September at elevations of 2,760 to 2,765 feet, as measured at the BLM well[2] (Figure 4-4, page 28). Artesian flow occurred for several days each summer during this time period at the BWSWD wells (Figure 4-5 and Figure 4-6, page 29).

3. The CM system began pumping in November of 1982 (Table 4-1). The total CM production volume was not recorded for 1982-83, but is assumed to have been similar to that of later years, i.e., approximately 160± million gallons per year (Table 4-3). All spent water was re-injected into the geothermal aquifer. The peak 1983 summer water levels in the BLM well appears to fall in the range of prior years (Figure 4-4), but there are insufficient data from the BLM well between November 1982 and summer of 1983 to identify possible impact from the CM production/injection. There is a very slight decrease in summer peak water levels in the BWSWD wells (Figure 4-5 and Figure 4-6) between 1982 and 1983, although the change appears to be well in the range of normal year-to-year fluctuations. In general, it appears that the

[1] Water level estimates (or assumptions) made for wells under flowing artesian conditions without the use of accurate pressure gauges may be in error – hydraulic head values could be feet or tens of feet above the well casing for wells flowing under artesian conditions.

[2] The BLM well, which has been monitored by the USGS and Boise State University, has one of the longest, better-quality records of water levels in the geothermal aquifer in the Boise area.

CM system did not have a net impact on local geothermal water levels during this period.

4. The City of Boise (i.e., BGL) wells began operating in October of 1983 (Table 4-1). Net geothermal production from the aquifer increased by approximately 180 million gallons between the 1983 and 1984 water years (Table 4-3). Water levels in the BLM well (Figure 4-4) began declining in the winter of 1983 (compared to water levels from 1976 through the summer of 1983), declining a total of approximately 30 feet between 1983 and 1988. Water levels in the BWSWD East (Figure 4-5) and West (Figure 4-6) wells also declined during this period, as did the VA production (Figure 4-9) and Kanta (Figure 4-11) wells. Water levels appear to have declined during this period in the BWSWD #3 (Figure 4-7) and Old pen (Figure 4-10) wells, but the data for these wells are incomplete during this period. The declines appear to have been caused by the increased production from the BGL wells. Artesian flow has not occurred at the BWSWD wells since the City system began operation in 1983.

5. The VA system (Figure 4-9) began operating in the fall of 1988. The total VA production volume was not recorded for the 1988-89 season, but is assumed to have been similar to later years (100 to 200 million gallons, 300 to 600 acre-feet). All production was re-injected. No change in summertime BLM or BWSWD water levels occurred in the fall of 1989 or later years. This suggests that the VA system did not have a net impact on recovered geothermal water levels.

   The VA hydrographs appear to show some spurious water level readings. For instance, a measurement taken by the VA by air line on 7/29/02 shows a water level of 2,682 feet (approximately 75 feet below ground surface), yet two measurements taken by the author on 8/27/02 and 9/24/02 indicated water levels at approximately 2760.6 feet (at ground surface). Flowing artesian conditions were observed at the second measurement, taken while the pump was temporarily removed from the well.

6. Summertime peak water levels in the BLM well (Figure 4-4) were relatively stable at approximately 2735 feet from 1987 through 1998. Water levels began to rise beginning in the fall of 1999, apparently in response to City injection activities (which began in February 1999). Since 1998, water levels at the BLM well have recovered approximately 20 feet, probably in response to a 100 Mgal/yr net production decrease. Similarly, water levels in the BWSWD wells have also recovered by approximately 20 feet.

7. There were three water level measurements taken in the Old Pen well prior to 1988. A static depth-to-water of 73.5 feet was reported when the

well was drilled in the summer of 1965. Two water level measurements in 1983 (Figure 4-10) indicated a depth-to-water of approximately 50 feet, and recent (2002) measurements indicate a depth to water of approximately 50 feet. If the 1983 measurements are accurate, then water levels in the Old Pen well decreased in the 1980s to a level of 70-75 feet below ground surface, but have returned to a depth of approximately 52 feet between 1987 and 2002. These changes could correspond with the beginning of withdrawals by the City of Boise in the early 1980s and partial injection in 1999, or may reflect other local conditions.

8. Recent data from the Quarry View well (Figure 4-12) indicate similar water levels in both Quarry View piezometers over time, which suggests hydraulic connection between the zones in which the Quarry View piezometers are completed. A general decrease in water levels during the summer suggests possible local irrigation influences.

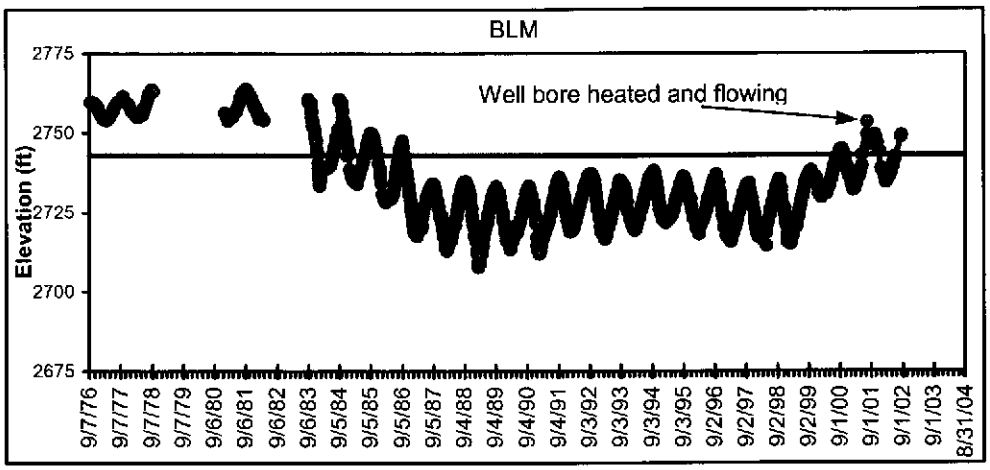



Figure 4-4: Hydrograph for the BLM well.

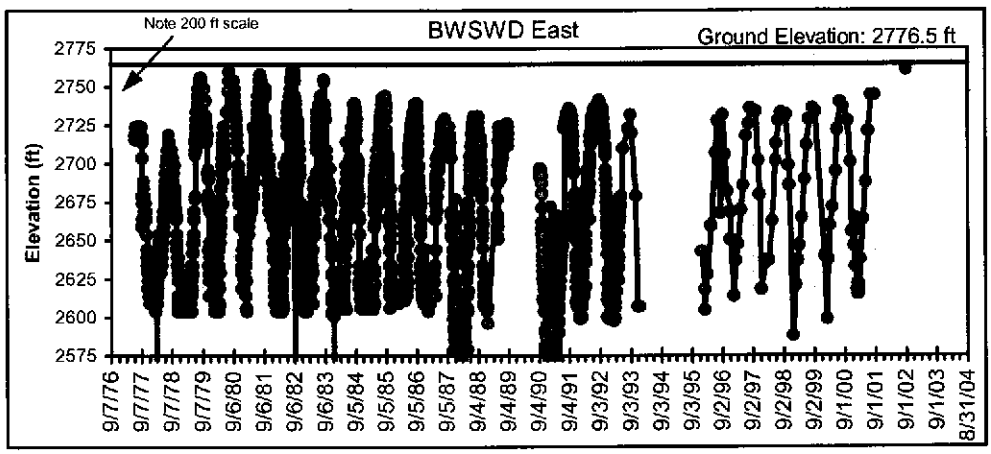



Figure 4-5: Hydrograph for BWSWD East well.

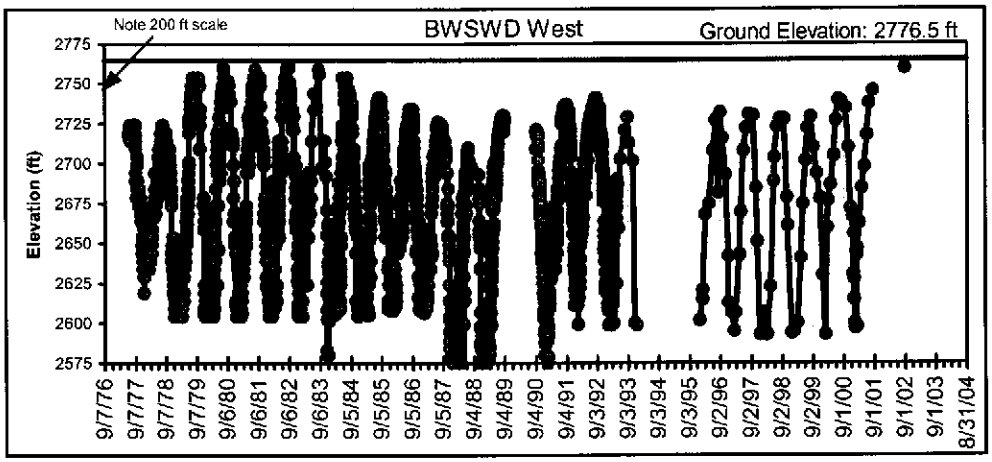



Figure 4-6: Hydrograph for the BWSWD West well.

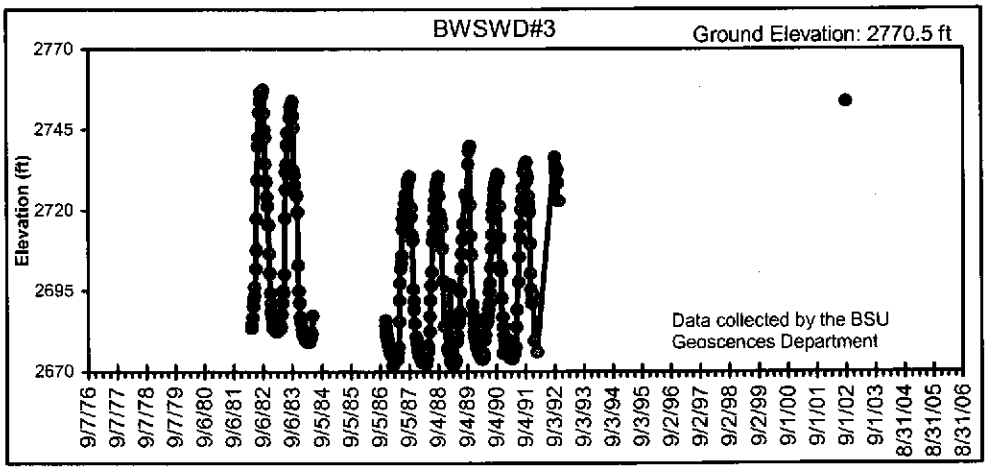



Figure 4-7: Hydrograph for the BWSWD #3 well.

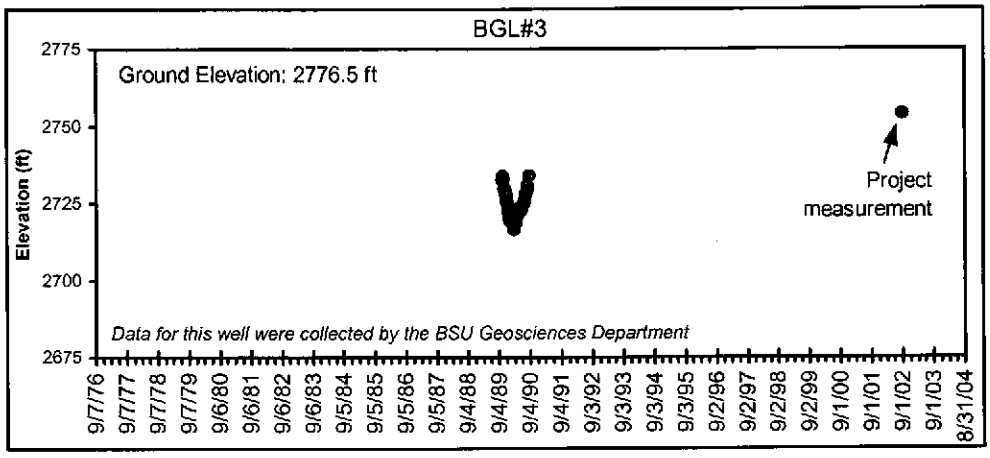



Figure 4-8: Hydrograph for the BGL #3 well.

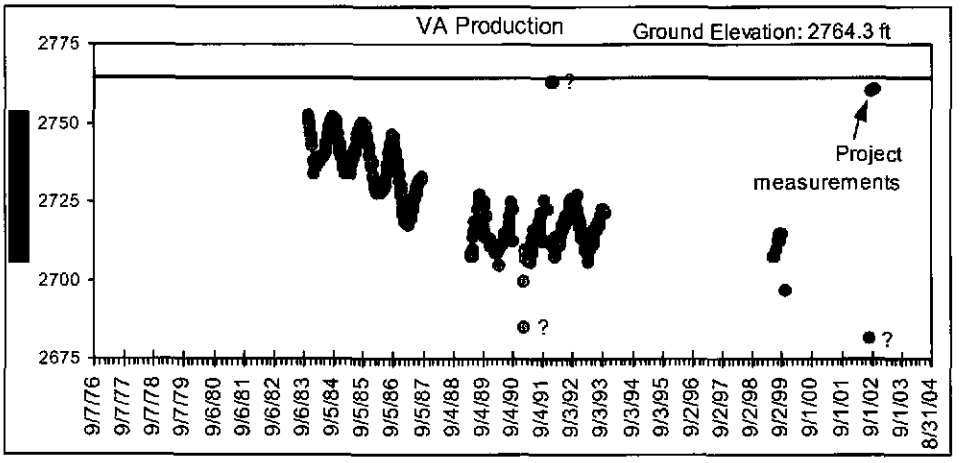



Figure 4-9: Hydrograph for the VA Production well.

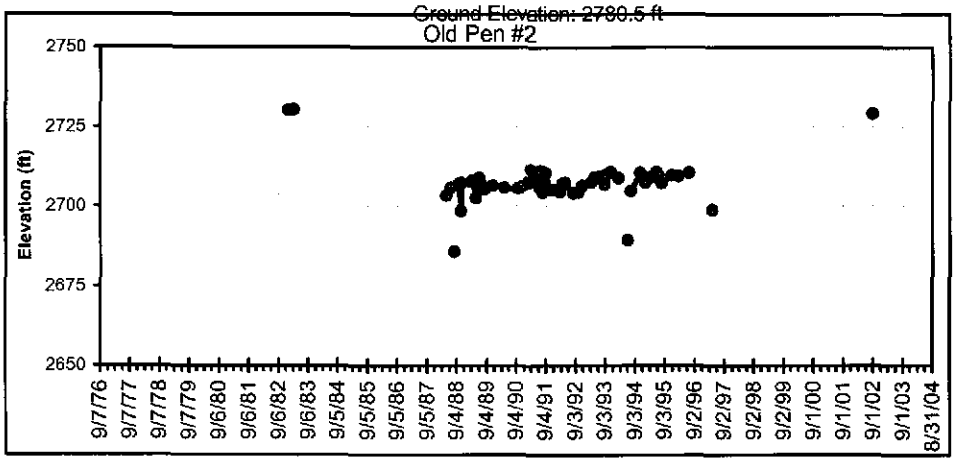



Figure 4-10: Hydrograph for the Old Pen well.

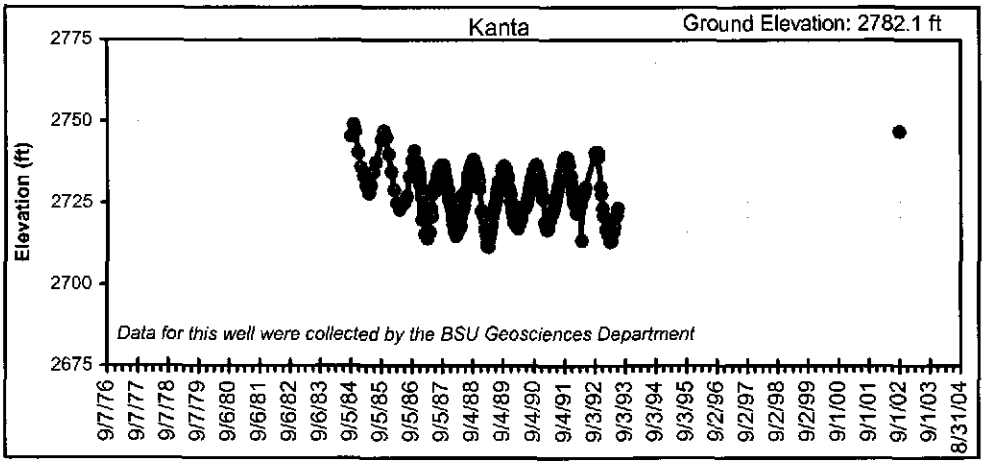



Figure 4-11: Hydrograph for the Kanta well.

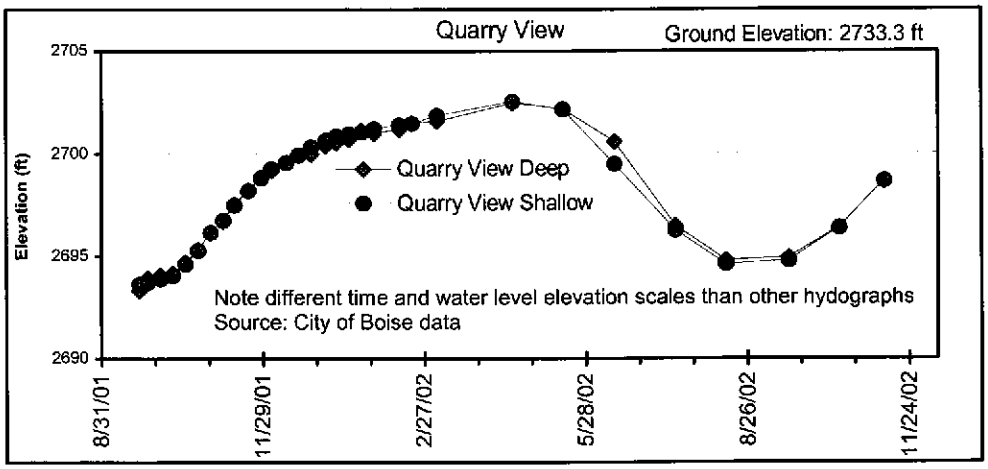



Figure 4-12: Hydrographs for Quarry View wells.

### 4.1.4. Temperature Data

Few current temperature data are available for Boise – Table Rock area wells. One of the only complete long-term records is for water temperatures in the CM #2 well (Figure 4-13). Low recorded temperatures during summer months probably reflect the well bore cooling during times of little or no flow.

There appears to be a downward temperature trend from about 1983-1990 (Figure 4-13). This period may reflect the time that it took for the circulation loop between the two Capitol Mall wells to reach temperature equilibrium. Conversely, the decrease in temperature also corresponds with decreasing water levels in the BLM well, which in turn corresponds with the initiation of pumping in the City wells.

Temperatures since 1990 appear to have remained relatively steady. Temperatures do not appear to have risen after 1999 when the City began re-injecting water[3], and when water levels began to recover. Temperatures in 2002 appear slightly less than previous years – this may reflect a slight decrease or an aging temperature sensor (the temperature sensor in this well should be checked).

Temperatures in the City wells have remained relatively stable since City production began (Kent Johnson, *personal communication*), as have temperatures in the BWSWD wells (Dick Clark, *personal communication*). Of the BWSWD wells, Griffiths (1990) wrote that the "geothermal water comes from the wells at a temperature of

[3] Based on recorded CM #2 temperatures and anecdotal user information.

approximately 172 degrees Fahrenheit and has shown no change during the last thirty years of personal experience."

### 4.1.5. Aquifer Test Data

A summary of the various well and aquifer tests evaluated for this study is provided in Table 4-4. Also included are transmissivity values used in previous modeling efforts. The range of calculated transmissivities reflects the varied nature of the tests and the heterogeneity of the the aquifer. The 7-day test of BGL #2 in 1982, which utilized observation at all BGL wells, the BLM well, and both CM wells for analysis, indicated that hydraulic boundaries or significant lateral changes in permeability are present within the aquifer.

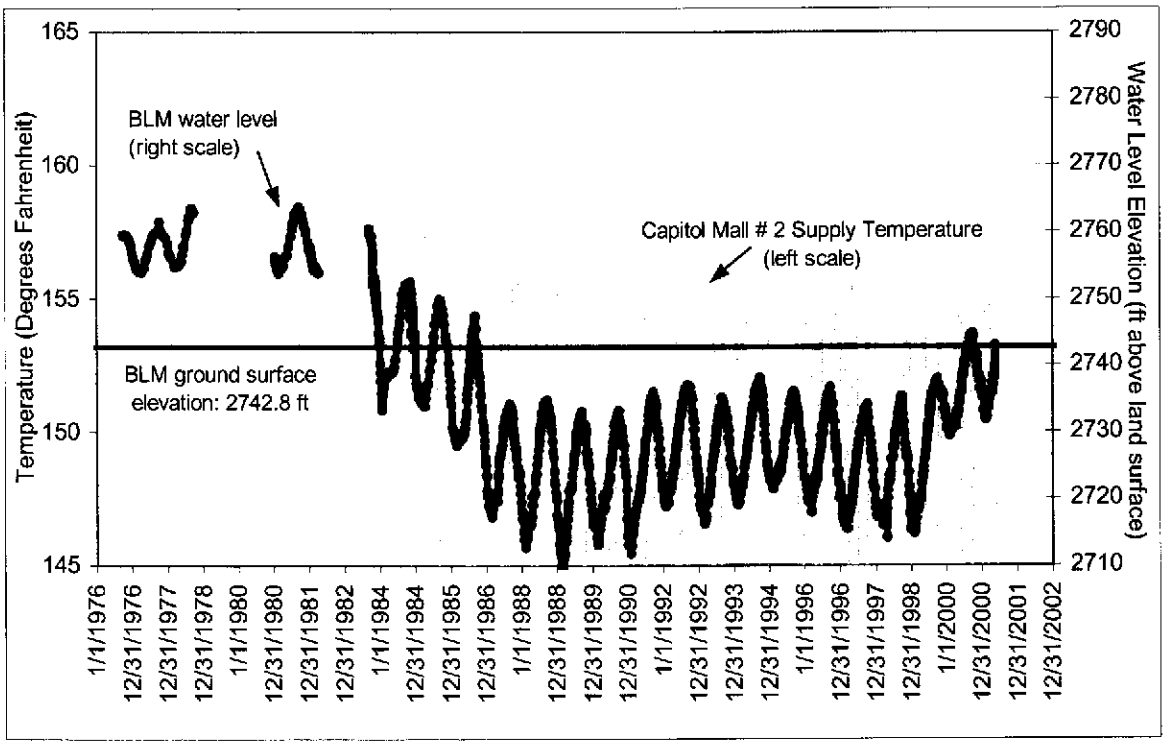



Figure 4-13: CM #2 discharge temperatures and BLM water levels.

## 4.2. Stewart Gulch Area

### 4.2.1. Description of Use and Development

The Stewart Gulch area is located approximately two to three miles northeast of the downtown Boise area (Figure 4-14). Primary thermal water users in this area include

Terteling Ranch, the Flora Company, Quail Hollow Golf Course, and Edwards Greenhouses. Wells in this area include the Terteling Motorcycle, Terteling Pool, Terteling Windsock, Quail Hollow Upper, Quail Hollow Lower, Tiegs, Flora Office, Silkey (Flora shed), and Edwards wells (Figure 4-14). Geothermal water in the Stewart Gulch area is used primarily for space and water heating and irrigation (Table 4-5). Production in the Stewart Gulch area is currently estimated at approximately 250 million gallons of water per year ranging in temperature from approximately 90° to 125°F.

| Pumping Well | Test Rate (gpm) | Date | Reported Transmissivity (gpd/ft) |
|---|---|---|---|
| Beard | 100-380 | 1976-78 | Beard: 6,000 to 8,000<br>BLM: 69,000 to 90,000 |
| BLM | 90-120 | 1977-78 | BLM =600 to 20,500<br>Beard =100,000 |
| BWSWD#1 (West Well) | 250-1,300 | 1979 | BWSWD#1: 15,000-50,000 |
| BWSWD#2 (East Well) | 350-1,600 | 1979 | BWSWD#2: 15,000-30,000 |
| CM-1 | 350-800 | 1980 | CM-1: 5,000 |
| CM-2 | 300-1,450 | 1981 | 50,000-100,000 @ CM-1, BLM, BGL |
| BGL-2 | 400-1,000 | 1982 | 125,000-825,000 @ CM, BLM, BGL |
| BGL-4 | 20-160 | 1982 | 112,000-820,000 @ CM, BLM, BGL |
| VA Prod | 400-1245 | 1983 | 200,000 from specific capacity |
| BWS/Kanta | | 1985 | 3500-25,000 – (Waag and Wood) |
| VA Inj | 180-580 | 1987 | Not calculated from short-term data |
| Aquifer System | | 1989 | Berkeley Group analytical modeling indicated average T=5750 gpd/ft |
| Aquifer System | | 1994 | Montgomery Watson numerical modeling indicated 100,000 to 1,000,000 gpd/ft for downtown-Warm Springs area, 5,000 to 50,000 for outlying areas |
| City Injection | 400-1800 | 1998 | 185,000 near well, 25,000-30,000 long-term |

Table 4-4: Summary of aquifer transmissivities, Boise area.

Geothermal development at the mouth of Stewart Gulch began in the early 1920s with the drilling of the two Silkey Wells in 1921 and 1922 (Table 4-6) at the present Flora Greenhouse site. These wells reportedly flowed 42 miners inches (378 gpm) in 1924 and 1925. No shut-in pressure measurements are available for this time period.

The Edwards well was drilled in approximately 1926, followed by the Tiegs Well in about 1927. A well was also drilled for Ryan in 1927. Alleged interference effects between these wells and water level declines in the aquifer apparently prompted legal action. The resultant Silkey v. Tiegs decree restricted diversions by Edwards, and

prohibited diversions by Tiegs and Ryan. The apparent intent of the decree was to protect artesian pressure in the Silkey Wells.

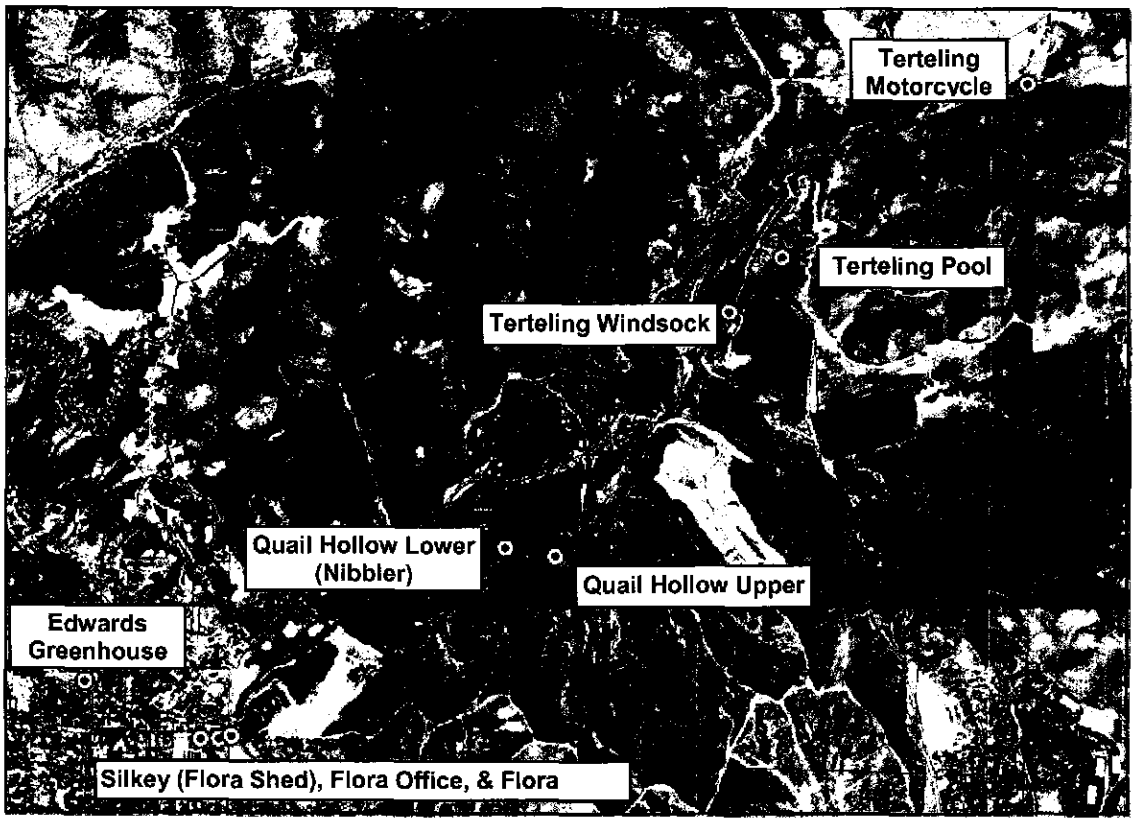



Figure 4-14: Locations of selected geothermal wells in the Stewart Gulch Area.

| Well | Alternate Name | Entity | Current Use |
|---|---|---|---|
| Terteling Motorcycle[4] | | Terteling Ranch | Irrigation |
| Terteling Windsock | | Terteling Ranch | Space heating |
| Terteling Pool | | Terteling Ranch | Water and space heating |
| Quail Hollow Upper | Tee Ltd. | Quail Hollow Golf Course | Irrigation |
| Quail Hollow Lower | Nibbler | Quail Hollow Golf Course | Irrigation |
| Edwards | | Edwards Greenhouse | Commercial (space heating) |
| Flora Office | | The Terteling Company (formerly Flora Greenhouse) | Commercial (space heating) |
| Silkey | Flora Shed | The Terteling Company (formerly Flora Greenhouse) | Commercial (space heating) |
| Tiegs | Flora Triangle | The Terteling Company | Commercial (currently used |

[4] All references to the Terteling Motorcycle well in this report refer to a geothermal well; a cold-water well also is present at the same location.

well was drilled in the summer of 1965. Two water level measurements in 1983 (Figure 4-10) indicated a depth-to-water of approximately 50 feet, and recent (2002) measurements indicate a depth to water of approximately 50 feet. If the 1983 measurements are accurate, then water levels in the Old Pen well decreased in the 1980s to a level of 70-75 feet below ground surface, but have returned to a depth of approximately 52 feet between 1987 and 2002. These changes could correspond with the beginning of withdrawals by the City of Boise in the early 1980s and partial injection in 1999, or may reflect other local conditions.

8. Recent data from the Quarry View well (Figure 4-12) indicate similar water levels in both Quarry View piezometers over time, which suggests hydraulic connection between the zones in which the Quarry View piezometers are completed. A general decrease in water levels during the summer suggests possible local irrigation influences.

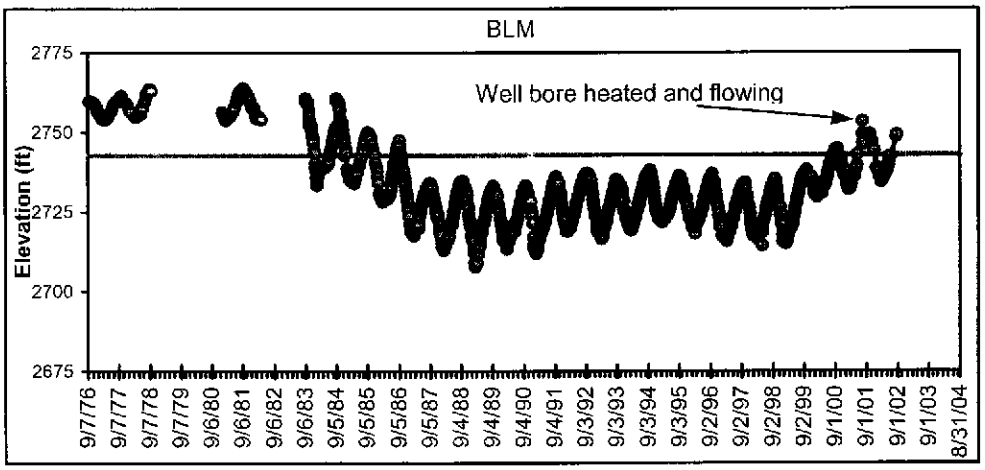



Figure 4-4: Hydrograph for the BLM well.

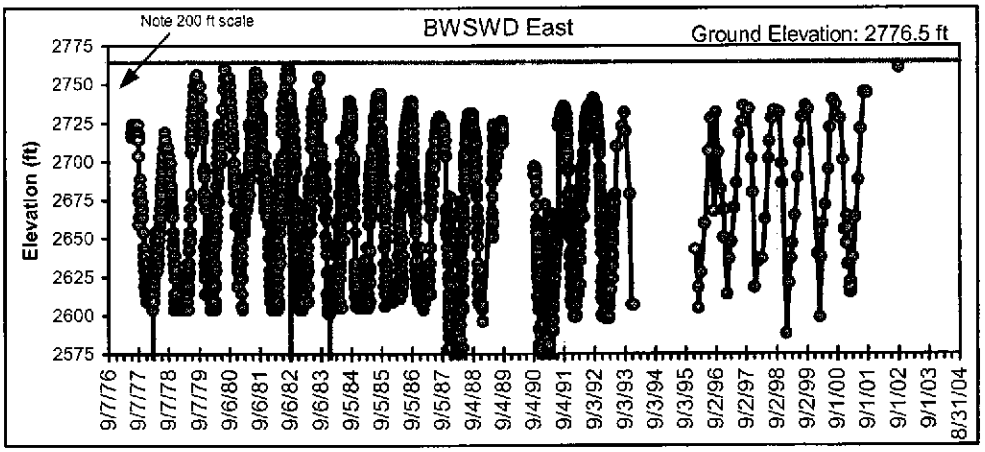



Figure 4-5: Hydrograph for BWSWD East well.

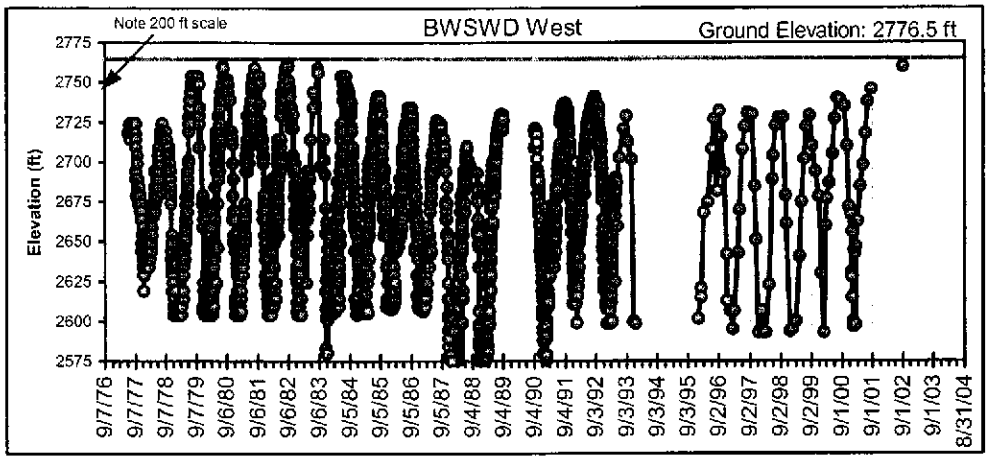



Figure 4-6: Hydrograph for the BWSWD West well.

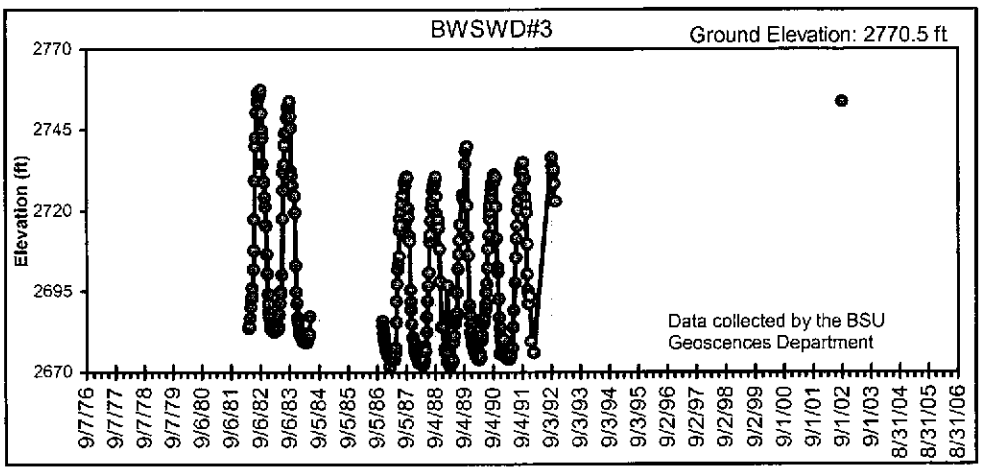



Figure 4-7: Hydrograph for the BWSWD #3 well.

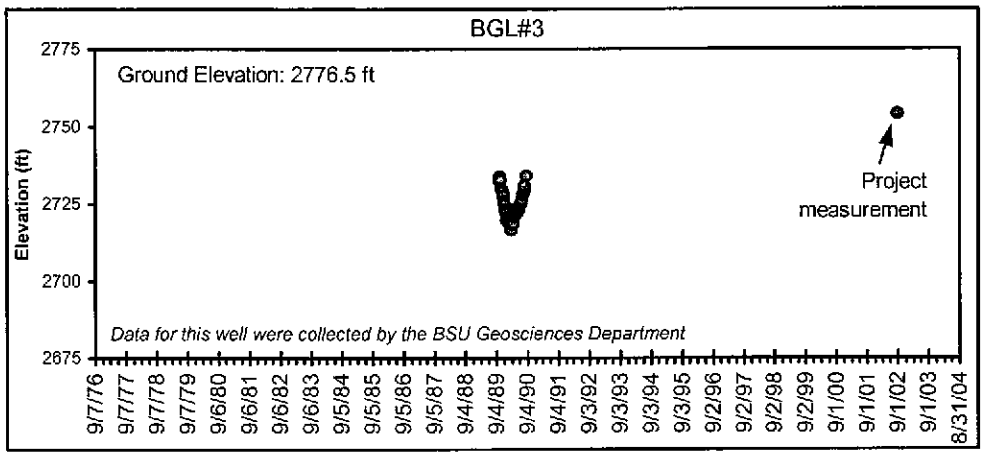



Figure 4-8: Hydrograph for the BGL #3 well.

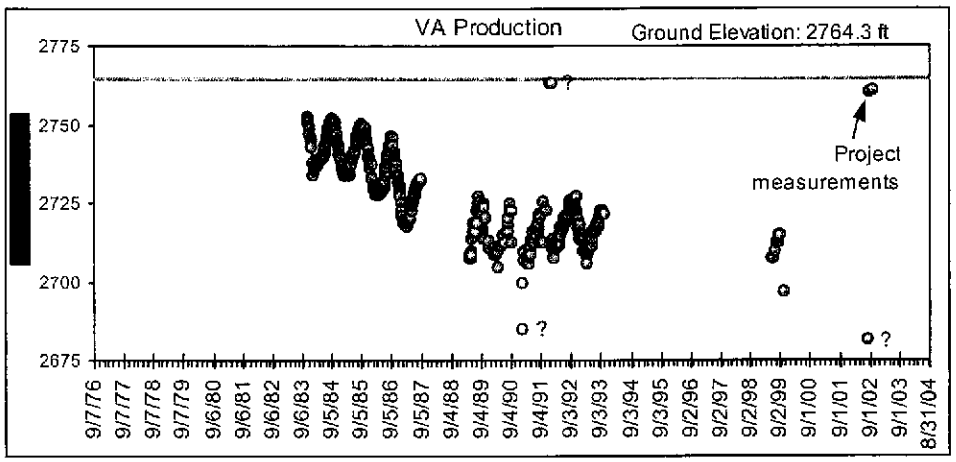



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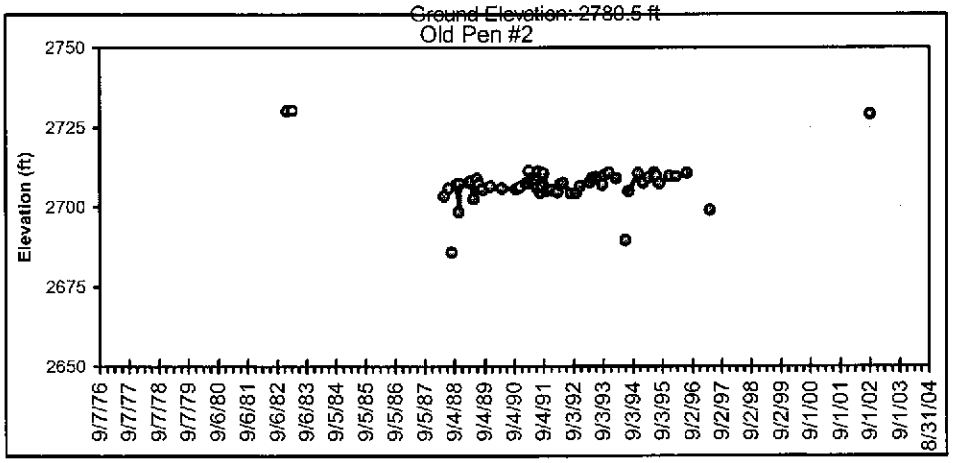



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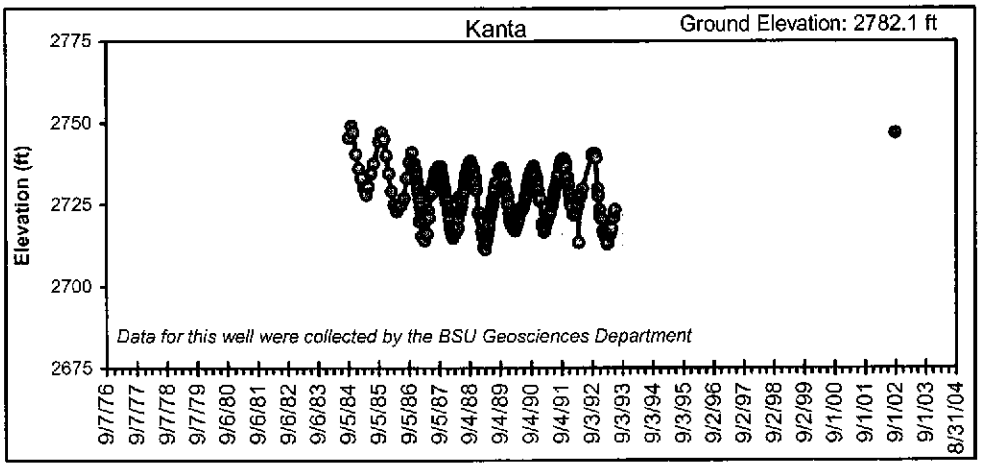



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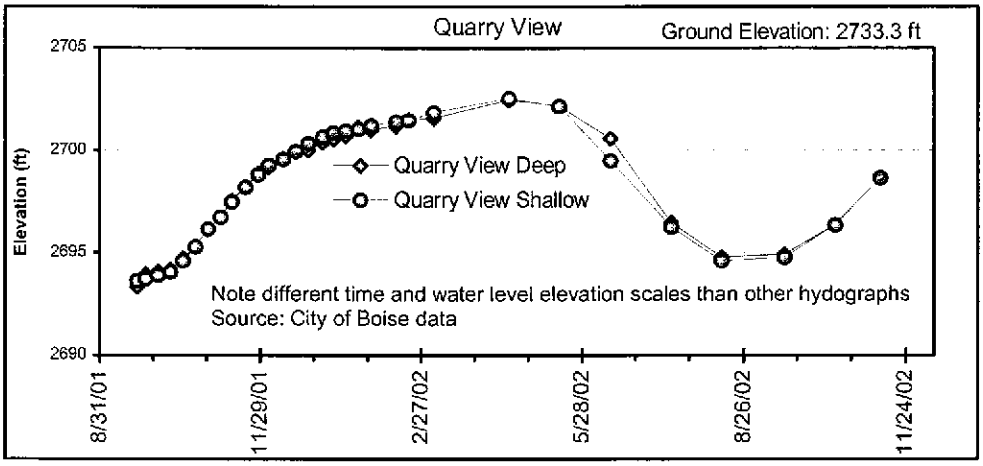



Figure 4-12: Hydrographs for Quarry View wells.

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A summary of the various well and aquifer tests evaluated for this study is provided in Table 4-4. Also included are transmissivity values used in previous modeling efforts. The range of calculated transmissivities reflects the varied nature of the tests and the heterogeneity of the the aquifer. The 7-day test of BGL #2 in 1982, which utilized observation at all BGL wells, the BLM well, and both CM wells for analysis, indicated that hydraulic boundaries or significant lateral changes in permeability are present within the aquifer.

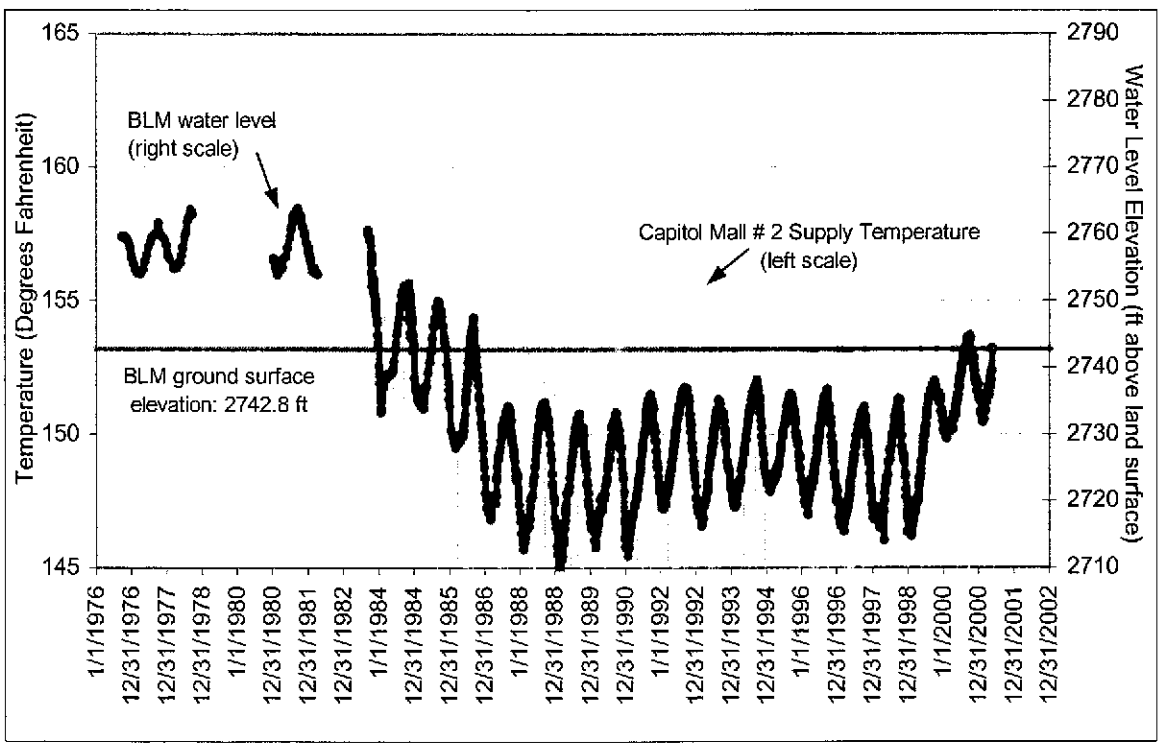



Figure 4-13: CM #2 discharge temperatures and BLM water levels.

## 4.2. Stewart Gulch Area

### 4.2.1. Description of Use and Development

The Stewart Gulch area is located approximately two to three miles northeast of the downtown Boise area (Figure 4-14). Primary thermal water users in this area include

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Table 4-4: Summary of aquifer transmissivities, Boise area.

Geothermal development at the mouth of Stewart Gulch began in the early 1920s with the drilling of the two Silkey Wells in 1921 and 1922 (Table 4-6) at the present Flora Greenhouse site. These wells reportedly flowed 42 miners inches (378 gpm) in 1924 and 1925. No shut-in pressure measurements are available for this time period.

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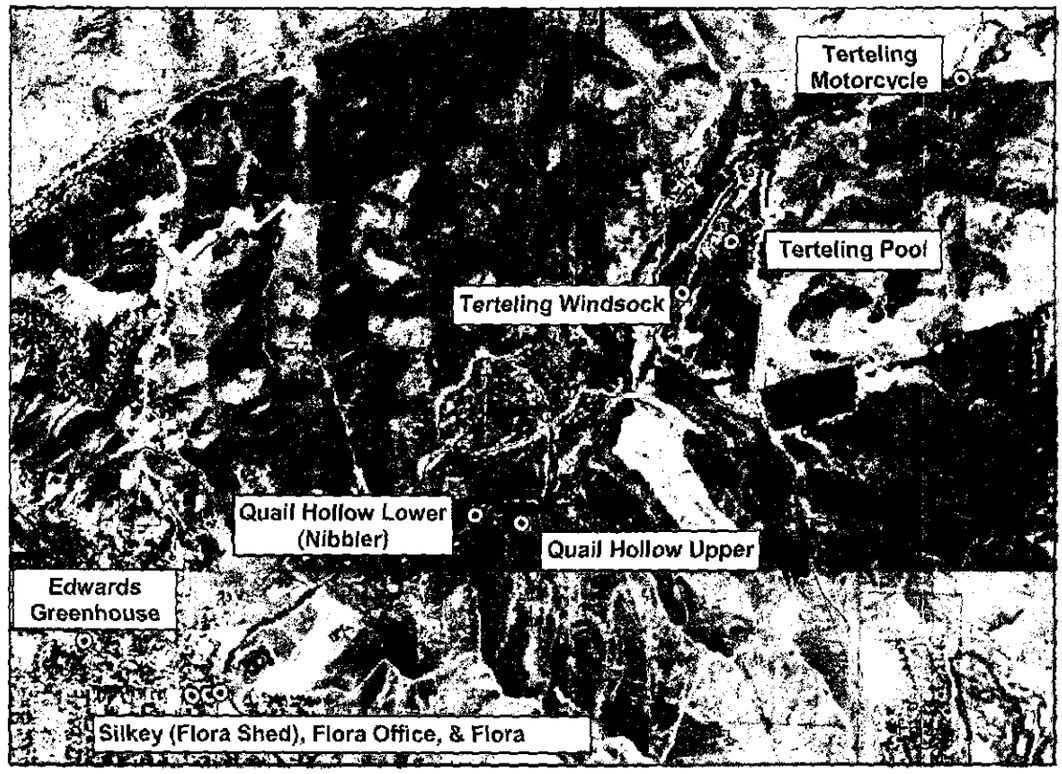



Figure 4-14: Locations of selected geothermal wells in the Stewart Gulch Area.

| Well | Alternate Name | Entity | Current Use |
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| Quail Hollow Lower | Nibbler | Quail Hollow Golf Course | Irrigation |
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| Silkey | Flora Shed | The Terteling Company (formerly Flora Greenhouse) | Commercial (space heating) |
| Tiegs | Flora Triangle | The Terteling Company | Commercial (currently used |

[4] All references to the Terteling Motorcycle well in this report refer to a geothermal well; a cold-water well also is present at the same location.

| | | | |
|---|---|---|---|
| | | (formerly Flora Greenhouse) | only for monitoring) |

Table 4-5: Primary thermal wells in the Stewart Gulch area.

| Timeline of Events or Responses - Boise Front Geothermal Aquifer | | |
|---|---|---|
| Time | Event | Source |
| 1922 | First Silkey Well Drilled | Claim 63-12 |
| 1921 | Second Silkey Well Drilled | Claim 63-13 |
| 1924-25 | Silkey Wells Discharge 42 inches | notes of R.L. Nace (data from District Court records) |
| 11/22/1926 | Edwards Well Drilled | Claim 63-14 |
| 3/23/1927 | Tiegs Well Drilled | Claim 63-15 |
| 8/21/1930 | George Carter Measurement of Silkey at 31 lbs | notes of R.L. Nace (data from District Court records) |
| 10/1/1931 | Nibbler Well Drilled | Claim 63-4037 |
| 11/1/1940 | Terteling Springs Well | Claim 63-31054; 0.055 cfs |
| 10/23/1947 | USGS measurement Silkey/Tiegs; 337 gpm (37.4 m.i.); 30.8 psi | notes of R.L. Nace, USGS in IDWR files |
| 4/24/1948 | Terteling Pool Well | Claim 63-31052; 0.12 cfs |
| 4/26/1967 | Terteling hot water irrigation begins | license 63-3603 priority date |
| 1968 | Terteling Windsock drilled | well log |
| 3/7/1973 | Terteling hot water irrigation expanding | license 63-7595 priority date |
| 1978 | Terteling Motorcycle Hot Well drilled | well log |
| 5/23/1984 | Begin Quail Hollow Upper pumping | Permit 63-9758 approved |
| Sep-88 | Windsock well not used "for years"; Motorcycle Well provides all irrigation | IDWR Terteling Inspection |
| 1997 | Terteling Cold Water Well Constructed | IDWR Well Log Files |
| 1998 | Water District 63-S covering the Stewart Gulch area established | IDWR files |
| 1998 | Quail Hollow Cold Water Well Constructed | IDWR license file |
| 2002 | Transfer of water rights from the Flora Company to The Terteling Company | IDWR files |

Table 4-6: Chronology of geothermal development and/or responses in the Stewart Gulch area.

Artesian pressure was measured at 31 pounds per square inch (psi) in one of the Silkey Wells on August 21, 1930. More than seventeen years later (October 23, 1947), the USGS measured a similar shut-in pressure (30.8 psi), and a combined flow from the Silkey and Tiegs wells of 37.4 miners inches (337 gpm). This flow from the two

Silkey wells and the larger Tiegs well was less than the flow reported for the two Silkey Wells alone in 1924 and 1925. This may suggest that the original shut-in pressure for the Silkey wells was significantly higher than 31 psi. Alternatively, it may indicate measurement error or loss of well efficiency between 1924 and 1947, possibly because of borehole collapse or other causes.

Shut-in pressures at the Silkey and Tiegs wells have been recorded since 1988. Pressure at the Tiegs Well has ranged from 19.5 psi (June 11, 1998) to 0 psi (August-September 1992 and June-July 1994). Pressure at the Silkey Shed Well has ranged from 16.5 psi (38 feet above ground surface) on June 11, 1998 to 3.35 feet below ground surface on August 18, 1994.

Shut-in pressures at the Edwards Well have been recorded since 1981, and have ranged from 29.5 psi (June 11, 1999) to 6.5 psi (August 20, 1994). Bob Griffiths (notes dated 1/19/81) was told by Paul Edwards that the maximum observed shut-in pressure prior to 1981 was 38 psi, but no date was given for this measurement. Pressures at the Edwards Well appear to be approximately 10 psi greater than at the Silkey and Tiegs Wells. Elevation difference would account for 6 or 7 psi of difference.

Diversion from the Silkey and Tiegs wells in recent years was estimated at between 320 and 380 af/yr (Squires, 2002). Recorded discharge from the Edwards Well from 1990 to 2000 ranged from 152 to 234 af/yr (Scanlan, personal data files). In combination, the average production from the Edwards and Flora (Silkey-Tiegs) sites probably totals about 500 af/yr.

Development of the geothermal aquifer in central Stewart Gulch apparently began with drilling of the Nibbler Well (Quail Hollow Lower) at the present site of Quail Hollow Golf Course. A water right permit was not obtained at the time, but a statutory water right claim (63-4037) was filed seeking a priority date of October 1931. The extent of use of the well from 1931 through the early 1980s has not been determined.

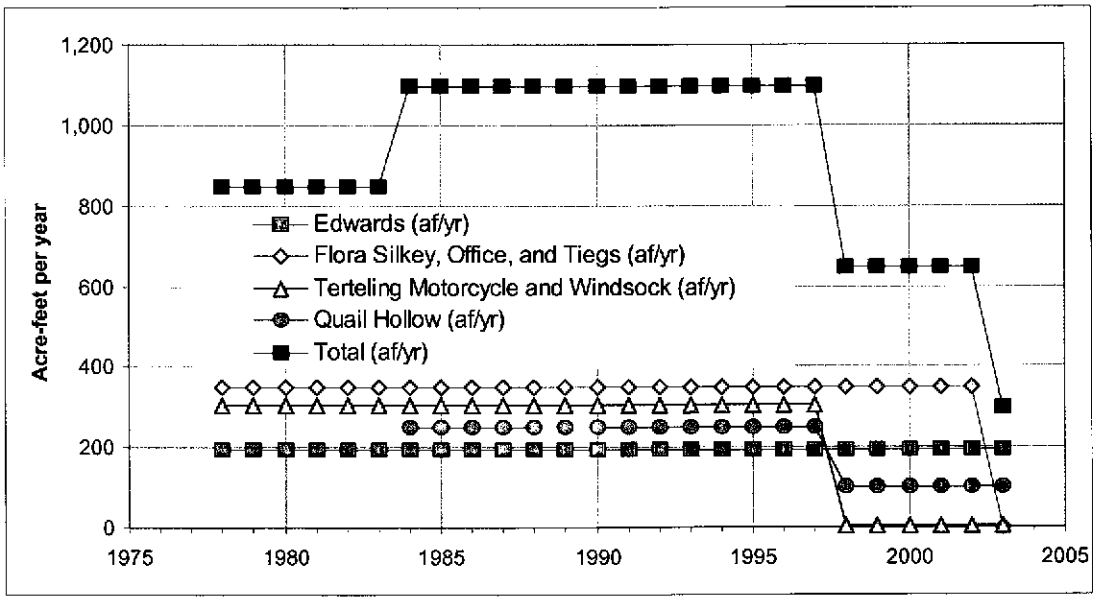
Irrigation of the Quail Hollow Golf Course began sometime in the early 1980s using the Nibbler Well and Tee Ltd Well. The Tee Ltd Well (Quail Hollow Upper Well) was drilled to 710 feet in 1981, but was probably deepened and completed sometime in 1982 or later. The water right permit for the Quail Hollow Upper Well was approved in May 1984. Therefore, irrigation of the golf course may have begun in 1984. The golf course is assumed to cover approximately 100 acres, and therefore requires approximately 350 af/yr (3.5 af per acre) for irrigation. A portion of this supply appears to be derived from surface flow in Stewart Gulch. Therefore, an estimate of 250 af/yr of geothermal water pumping is reasonable. However, the 250 af/yr estimate is far greater than the volumes reported by Quail Hollow. For instance, Quail Hollow reported a total production of 17.5 million in 1995. Assuming that Quail Hollow is

reporting in gallons (rather than cubic feet), the 1995 production would be only 54 acre feet. This volume is adequate for irrigating only about 15 acres.

A cold-temperature ground water source (shallow water well) for Quail Hollow was developed south of Hill Road in 1998. The water is piped to the golf course for irrigation. Average production from this well in 2000 and 2001 was approximately 166 afa (K. Neely, *personal communication*, 2003).

Geothermal development in upper Stewart Gulch on the Terteling Ranch may have begun with drilling of a small artesian well at Terteling Springs in 1940 (claim 63-31054, 0.055 cfs and 17 af/yr), followed by drilling of the Terteling Pool Well in 1948 (claim 63-31052, 0.12 cfs and 3 af/yr). Significant development for irrigation then occurred with drilling of the Windsock Well in 1968 and the Motorcycle Hot Well in 1978. In combination, the two wells were licensed for irrigating 178 acres. Information in IDWR files suggest that nearly all of the irrigation pumping in the 1980s occurred at the Motorcycle Well rather than at the Windsock Well, although it may have been the other way around, i.e., nearly all of the pumping probably occurred in the Windsock well (E. Squires, *written communication*). Assuming that a portion of the irrigation demand was derived from surface water and cold ground water sources, and that approximately 150 acres were irrigated, the geothermal water demand was probably on the order of 300 af/yr. This demand occurred until about 1997 when an additional cold groundwater source (Champagne Well) was developed.

There are very few reliable Stewart Gulch geothermal production rates. Nonetheless, possible production rates were estimated for primary geothermal wells in the previous paragraphs (there is a high degree of uncertainty in some of the estimates). These estimated production rates are illustrated in Figure 4-15. Production in the Flora Silkey, Office, and Teigs wells is shown as dropping to zero; however, production from these wells is or will be transferred to the Terteling greenhouses.




This figure does not include production from the Terteling Windsock well that is now being used to heat the Terteling greenhouses (using water rights formerly held by the Flora Company), nor does it include remaining production at the Flora facility.

Figure 4-15: Estimated geothermal production in Stewart Gulch, 1978 to present.

### 4.2.2. Hydrogeology[5]

Two Tertiary basalt layers appear to be the primary source of thermal water in the Stewart Gulch wells. In contrast to wells in the Boise downtown area, no rhyolite has been confirmed in the Stewart Gulch wells (Stewart Gulch wells have not penetrated through the basalt). Water-bearing zones within the basalt layers appear to be at discrete intervals. For instance, water had to be added to the Quail Hollow well during drilling (with cable-tool) to suspend cuttings prior to reaching the bottom of the well. Down-hole camera footage of the Terteling wells shows most basalt fractures to be filled with calcium carbonate precipitates.

A thick mudstone section of the Terteling Springs Formation overlies the thermal basalt aquifers. Over 1,100 feet of this low-permeability unit overlies the basalt aquifer at the Flora Greenhouses, based on drilling logs from nearby wells and interpretation of natural gamma-ray geophysical logs. Midway up the gulch, at Quail Hollow and lower Terteling Ranch, the mudstone is continuous from land surface to the top of the basalt aquifer at 750 feet. At the upper Terteling Ranch, the basalt aquifer is overlain by sandstone of the sandy facies of the Terteling Springs Formation. At the lower gulch area, Pleistocene floodplain gravels of the Snake River Formation along the Boise River overlie the mudstone. The upper portion of the gulch has a sandy facies

[5] Most of the text in Section 4.2.2 was provided by Ed Squires, Hydro Logic, Inc., with permission from the Terteling family.

associated with the Terteling Springs Formation exposed to ground surface. There appears to be no measurable hydraulic connection between cold and geothermal wells in the Stewart Gulch.

Conspicuous light-colored volcanic ash layers are interbedded within the geologic section and may serve as marker beds. Their tendency to spall into open boreholes is characteristic and problematic to open bore wells (Silkey, Tiegs, Terteling Motorcycle, and Tom Terteling geothermal wells).

Several shallow faults are observed in the Stewart Gulch area (Othberg and Stanford, 1992); several deeper faults are inferred and/or observed (Wood, 1996b). A down-to-basin, east-west trending normal fault appears to exist within the volcanic section between Terteling Motorcycle and Terteling Pool wells. This fault was indicated by a Chevron IB-2 deep seismic line and is exposed along Cartwright Road (E. Squires, *personal communication,* 2002). This fault was confirmed by two shallow seismic surveys conducted by Boise State University (Liberty, 1996c).

The wells in the lower gulch – Terteling Pool, Terteling Windsock, Quail Hollow Upper, Quail Hollow Lower, Silkey (Flora Shed), and Edwards Greenhouse wells – appear to be in direct hydraulic connection, based on several pumping tests (E. Squires, *personal communication*, 2002). The pumping tests failed to show a hydraulic connection between the Terteling Motorcycle geothermal well in upper Stewart Gulch and the other Stewart Gulch wells.

Geothermal aquifer water temperatures range from approximately 110 to 125°F in the lower Stewart Gulch area. Water temperatures in the upper Stewart Gulch fault block (containing the Terteling Motorcycle well) range between 80 to 95°F.

### 4.2.3. Water Levels

Periodic water level measurements or pressure readings have been taken in various Stewart Gulch wells. Hydrographs based on these measurements are provided on pages 42 through 43. Hydrograph data were provided by IDWR from measurements taken by water users (including Edwards Greenhouses and the Terteling family).

Aquifer water levels in Stewart Gulch have fluctuated with changes in geothermal water use. Annual production volumes have not been well documented, and season of use has varied depending on whether users are irrigating or heating with the water. Therefore, relating changes in water levels to specific stress events is not uniformly possible, but some general observations are provided below.

1. Predevelopment shut-in pressures were possibly more than 30 psi at the Silkey, Tiegs, and Edwards wells.

2. Geothermal aquifer development in the 1920s may have reduced aquifer pressures to approximately 31 psi at the Silkey wells by 1930. Pressures remained in this range until at least 1947 (IDWR, 1947).

3. Pumping for irrigation and winter space heating from Quail Hollow-Lower (Figure 4-18) and upper Stewart Gulch, i.e., Windsock (Figure 4-20) and Motorcycle Hot (Figure 4-21), likely reduced maximum annual aquifer pressures by perhaps an additional 10 psi between 1947 and 1980.

4. Increased irrigation pumping in the late 1980s associated with Quail Hollow Golf Course reduced maximum annual aquifer pressures by an additional 5 psi.

5. Reductions in the use of geothermal water for irrigation beginning in 1997 (Terteling) and 1998 (Quail Hollow) resulted in substantial recovery (8 psi) of peak annual water levels. However, slight declines in water levels during 2000 and 2001 (Figure 4-18) suggests a partial resumption of geothermal water use for irrigation purposes (resumption did not occur in the Terteling wells – E. Squires, *personal communication, 2003*).

6. The 1981 through 1997 period of the Edwards Well hydrograph (Figure 4-23) shows more water-level influence from irrigation pumping than from heating pumping[6]. The annual high appears to occur in May or June, and the annual low occurs in late summer. Water level fluctuations between 1998 and 2002 (with the exception of the year 2000) appear to correspond with heating season withdrawals.

7. The Edwards well has one of the longer water levels records in Stewart Gulch. Water levels in the Edwards well (Figure 4-23) show a decline beginning from (approximately) 1984 through 1994. The decline beginning in 1984 coincides with the decline beginning in the downtown Boise area when the City wells began operating. However, the Quail Hollow Upper well also began pumping in 1984 (Table 4-6), which might explain the water level decline in the Edwards well beginning in 1984.

8. Water levels rose in the Edwards well (Figure 4-23) from approximately 1996 through the summer of 2000. The reason for the recovery is

[6] Some have speculated that water levels in Stewart Gulch also may be influenced by warm-water wells used for irrigation in other areas in the Boise Front (Figure 1-1), such as the Simplot and Cartright wells, located near Bogus Basin Road (E. Squires, *personal communication*). These wells were not included in the study because the temperatures are generally less than most of the "geothermal" wells, they are generally used for irrigation in the summer (as opposed to space heating in the winter), lack of data availability, and the owners did not express concern about the City's plans for increased production/re-injection.

unclear, as production records from Stewart Gulch wells are unavailable for this time period. It may be related to decreases in withdrawals at the Quail Hollow (in 1996), Terteling (in 1997) and Silkey (Flora Shed), Office, and Tiegs wells. However, the recovery in the Edwards well preceeds the recovery experienced in several downtown Boise wells following initiation of the City's injection well in 1999, and therefore is not attributed to changes in withdrawals/re-injection in the downtown area.

9. Water levels also rose in the Terteling Windsock (Figure 4-20), and the Terteling Motorcycle (Figure 4-21) wells, beginning in about 1994. Water levels in the Terteling Pool well began rising in approximately 1992 (Figure 4-22). Withdrawals from the Terteling wells may have decreased during this time, and, if so, may have contributed to increases in water levels at the Edwards well. Also, changing levels of withdrawals in other nearby areas (e.g., Cartright Road) may have influence on Stewart Gulch wells (E. Squires, *personal communication*), although there are no data to substantiate this.

10. Water level increases are apparent in the Silkey (Flora Shed) (Figure 4-16) and Flora Tiegs (Figure 4-17) wells, beginning in about 1998 or 1999. These increases seem consistent with increases observed in the Terteling Pool (Figure 4-22), Terteling Windsock (Figure 4-20), Terteling Motorcycle (Figure 4-21), and Edwards (Figure 4-23) wells, all of which began earlier than 1998.

11. Recent rises (in 2002) in the Flora-Silkey (Figure 4-16) and Flora Tiegs (Figure 4-17) wells appear to reflect a cessation of withdrawals from these wells.

The data reported here are insufficient for determining the degree of impact, if any, from withdrawals or injection in the downtown Boise area on water levels in the Stewart Gulch area, or *vice versa*. Declines in the Edwards well beginning in 1983-1984 coincide with increased withdrawals in the Quail Hollow and downtown wells. Water level increases in Stewart Gulch between 1996 and 1999 appear to reflect local changes in withdrawals. Some Stewart Gulch water level increases continue beyond 1999 (when City of Boise injection began), but it is not possible to determine if a portion of these Stewart Gulch water level increases might be attributable to City of Boise injection.

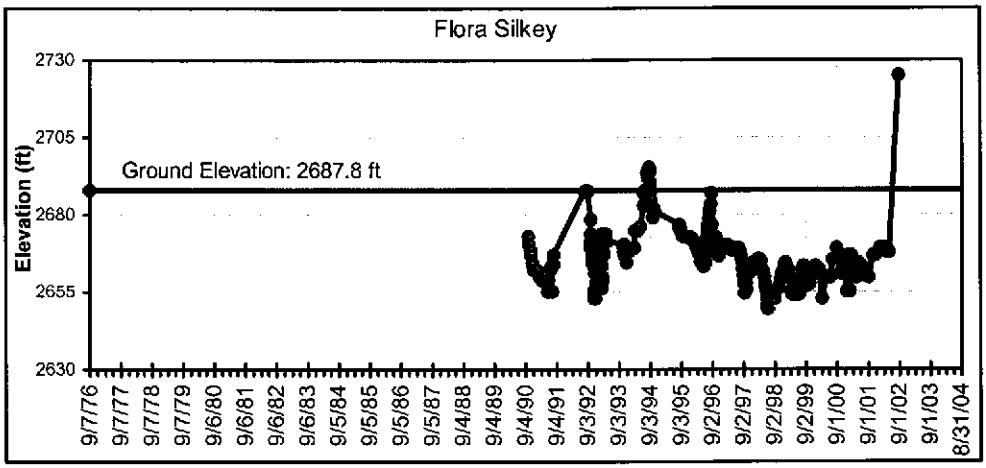



Figure 4-16: Hydrograph for the Silkey (Flora Shed) well.

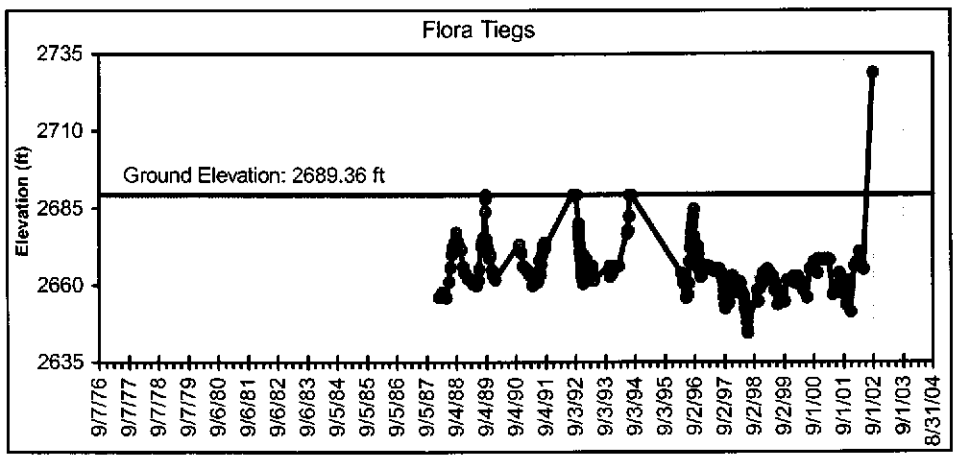



Figure 4-17: Hydrograph for the Flora Tiegs well.

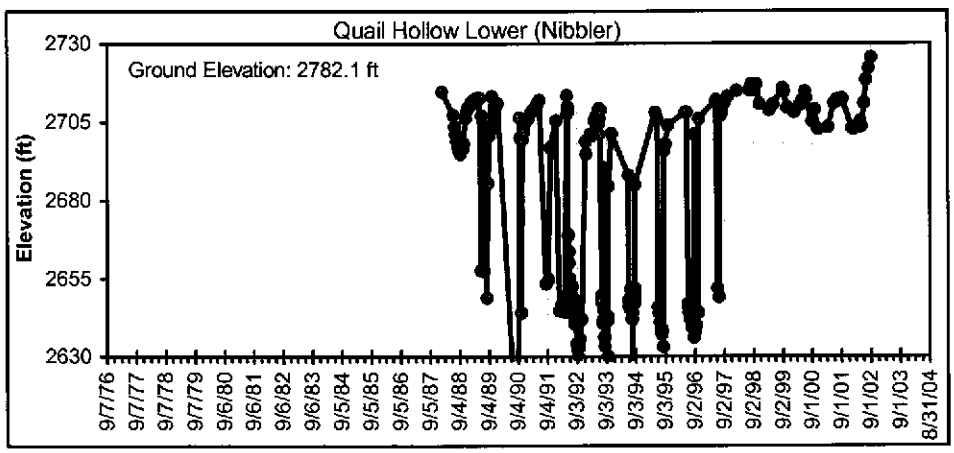



Figure 4-18: Hydrograph for the Quail Hollow Lower (Nibbler) well.

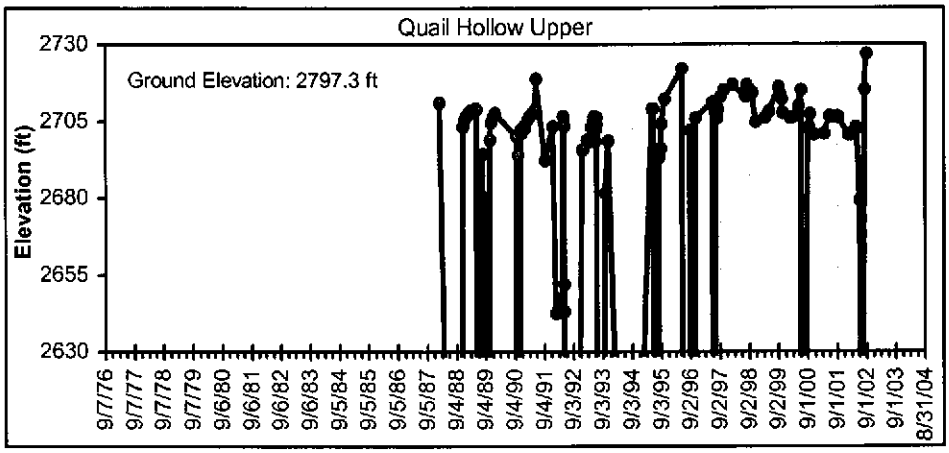



Figure 4-19: Hydrograph for the Quail Hollow Upper well.

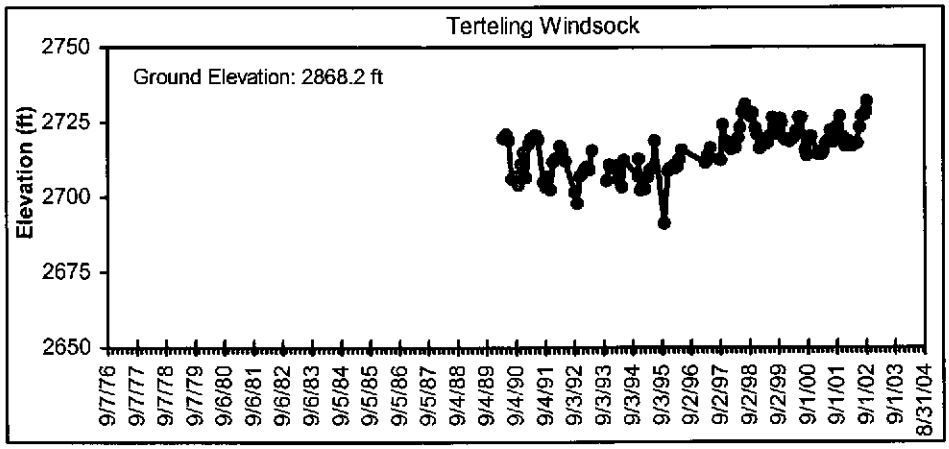



Figure 4-20: Hydrograph for the Terteling Windsock well.

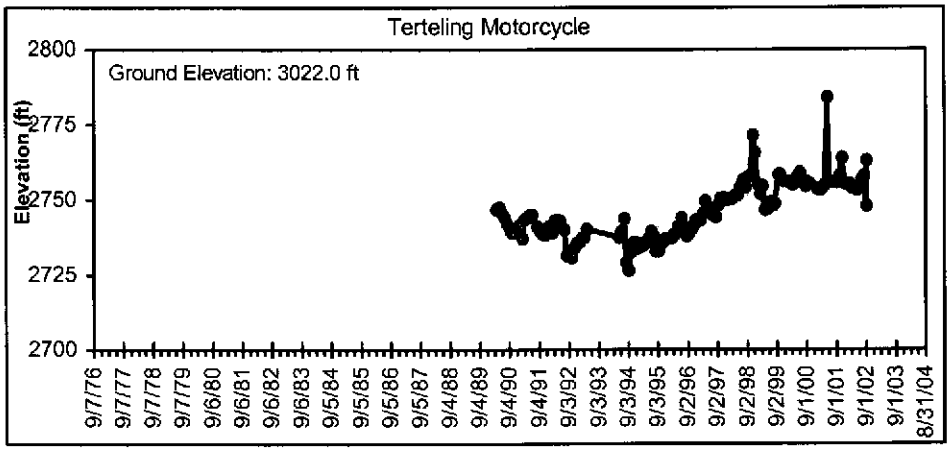



Figure 4-21: Hydrograph for the Terteling Motorcycle geothermal well.

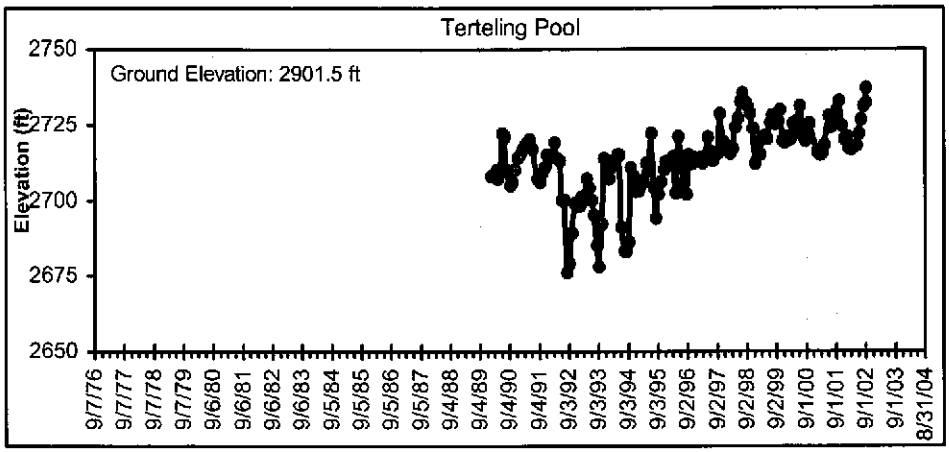



Figure 4-22: Hydrograph for the Terteling Pool well.

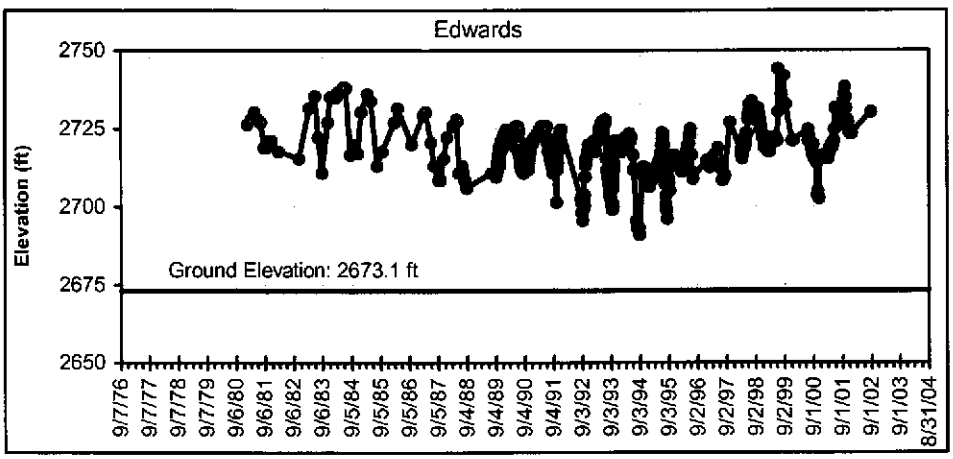



Figure 4-23: Hydrograph for the Edwards Greenhouse well.

### 4.2.4. Temperature Data

Long-term temperature data are not available for this area, although it appears by anecdotal information that temperatures have remained relatively stable.

### 4.2.5. Aquifer Test Data

Several pumping tests have been conducted in the Stewart Gulch area. However, to the author's knowledge, hydraulic property values from these tests have not been calculated.

## 4.3. Harris Ranch

### 4.3.1. Description of Use and Development

The Harris Ranch area includes two geothermal wells, located at the base of Warm Springs Gulch (Figure 4-24). These wells are currently not in use, but have been used for irrigation in the past. The water right for these wells currently is in the State Water Bank. The Harris Ranch development has not finalized their plan for the future use of this water.

Geothermal development in Harris Ranch area has been limited to utilization of hot spring discharge prior to 1918, and irrigation pumping from the Harris Well in the 1980s and early 1990s.

The hot springs near the mouth of Warm Springs Creek were developed by early settlers of the Boise Valley as an outdoor "plunge" for bathing purposes. The plunge and bathhouses were purchased by Judge Milton Kelly in 1889, and subsequently became known as Kelly's Hot Springs (MacGregor, 1999). The springs were described by Lindgren, but no estimate of flow volume was given (Waag and Wood, 1987a). Russell (1903) notes that the springs varied in temperature from 125°F to near the boiling point. MacGregor (1999)indicates that the springs dried up by 1918.

No additional geothermal development occurred in this area until about 1977 when a well was drilled for Dallas Harris at a location within a few hundred feet to the south of the former hot springs. This well ("East" well) was deepened in 1986. There also is a second well at the site (the "West" well), but little is known about this well (it may be collapsed at some unknown depth). The West Well has been used for observation and is not equipped with a pump. The East Well is equipped with a turbine pump, and has been used for irrigation.

### 4.3.2. Hydrogeology

The primary source of geothermal water to the Harris Ranch wells appears to be fractured Cretaceous granite (based on interpretation of 1977 and 1987 Driller's Reports for the Harris West well). No basalt or rhyolite was encountered in this or other nearby shallower wells. The East Boise Fault may bisect the area between East Boise and the Harris Ranch area (the BWSWD-East and BWSWD-West wells appear to be located near this fault).

### 4.3.3. Water Levels

Water-level monitoring at the Harris-West well was conducted from May 1987 through May 1993, and resumed in August 2002. Water level monitoring in the Harris-East well began in August 2002. The water levels did not show any significant seasonal fluctuation (except in those years when the East Well was pumped for irrigation purposes). The water level in late August 2002 (61 feet below top of casing) was approximately 8 feet higher than water levels in late August of 1988, 1991, and 1992. Water levels in the East Well in August 2002 were 10 feet lower than in the West Well.

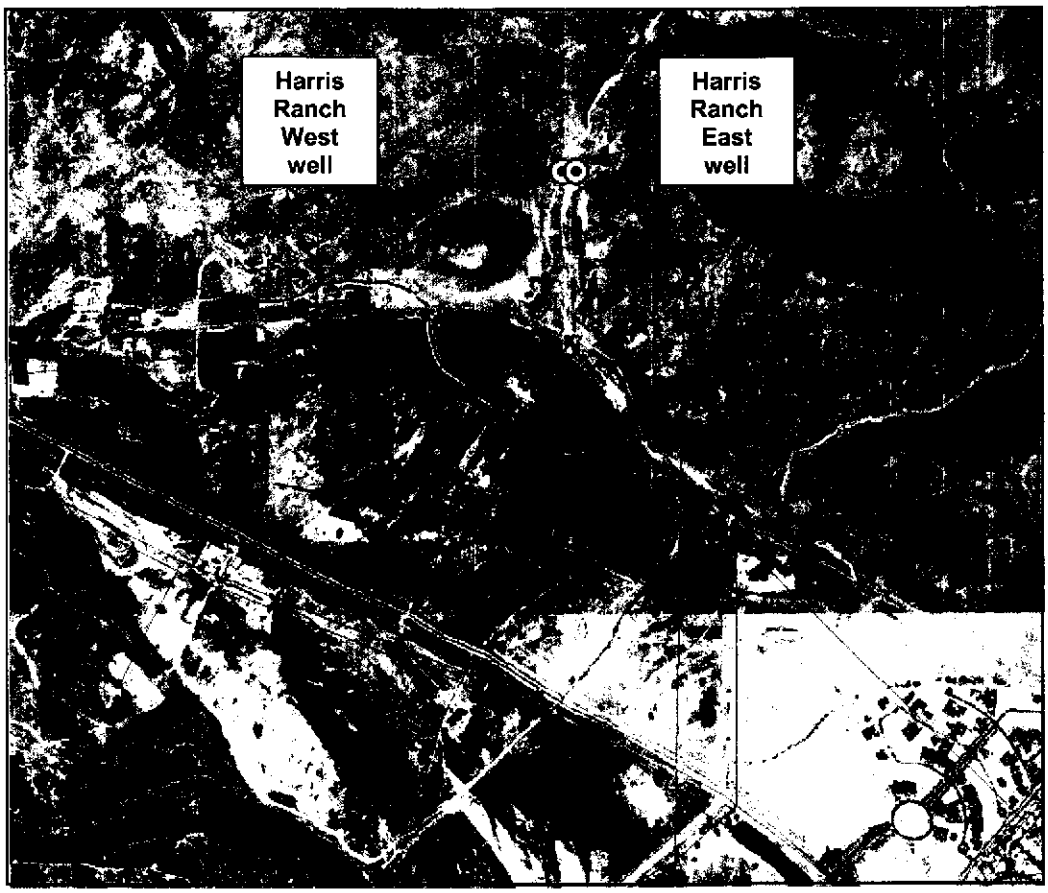



Figure 4-24: Geothermal wells in the Harris Ranch area.

The West Well hydrograph shows that pumping occurred during 1987 and 1990. There is no record of pumping in the Harris East well since that time.

The information above suggests the following:

1. The water level in the geothermal aquifer at the former Kelly's Hot Springs has likely declined by approximately 100 feet since 1891, coinciding with initiation of withdrawals in BWSWD wells. This estimate is based on (1) the 70-foot depth to water in the Harris East Well and (2) an estimated 30 feet of surface elevation difference between the well and the former hot spring. Further investigation of Kelly's Hot Spring (elevation, history from 1890 to 1918, etc.) is warranted.

2. The degree of hydraulic connection between the Harris West Well and the geothermal aquifer in the downtown area can not be determined on the basis of current data. On-going monitoring is needed to determine if heating season fluctuations can be measured at the East or West Well.

3. It is possible that water levels have recovered by approximately 8 feet since the early 1990s (Figure 4-25).

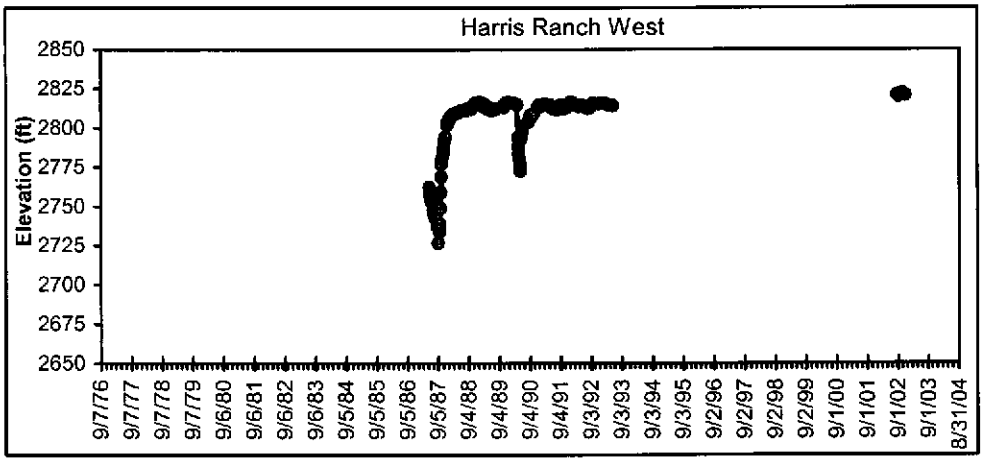



Figure 4-25: Hydrograph for the Harris Ranch West well.

### 4.3.4. Temperature Data

Long-term temperature data are not available for this area.

### 4.3.5. Aquifer Test Data

There are no known aquifer test data for this area.

# 5. MASS GROUND WATER LEVEL MEASUREMENT

## 5.1. Description

A mass measurement of water levels and/or pressure head was taken in 29 geothermal wells on August 27, 2002, with some repeat measurements taken in early September, 2002. Data from these measurements have been included in the project database (Section 2.4). Measurement data are included in Appendices F. Measurement locations for individual wells are described in Appendix H (provided under separate cover).

The timing of the mass measurement was intended to correspond with seasonal high water levels. The wells were turned off for a period of 4 to 24 hours prior to the measurement. Some wells are used for non-heating purposes during the summer (e.g., domestic hot water in the BWSWD, VA, and City systems) and could not be turned off completely for a longer period of time. Status of wells during the mass measurement are given in Appendix F. Water level elevations collected during the mass measurement are based on the new survey elevations (Section 2.2 and Appendix C).

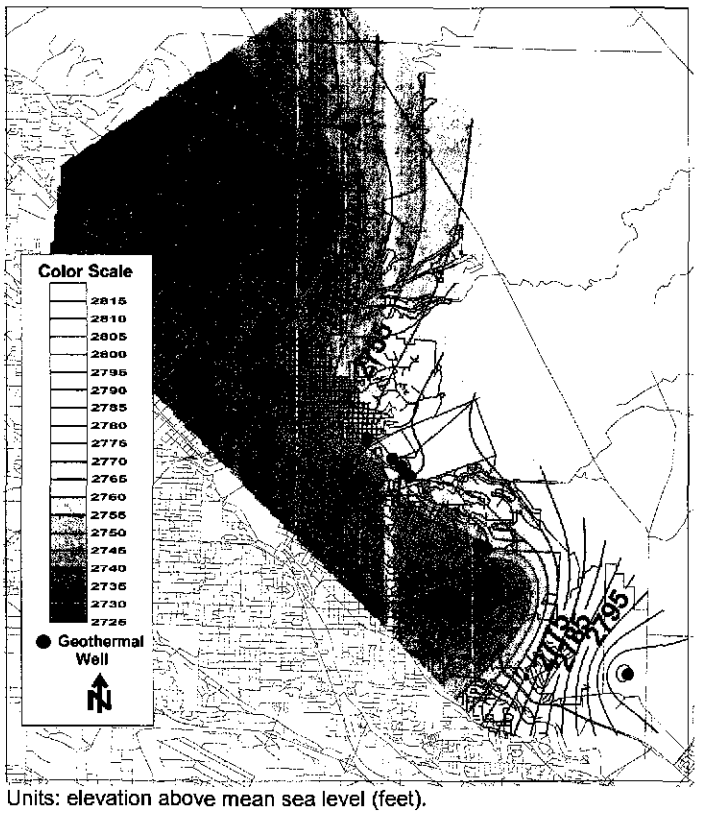
A complicating factor in defining hydraulic head in geothermal wells is that the density of water in the water columns may vary between wells at a given time, or temporally within individual wells. The temperature (and density) of a water column in a geothermal well depends on the temperature of the water entering the well, the flow rate of water entering the well, the distance from the screen to the top of the water column, the temperature of the formation surrounding the borehole, and/or the temperature of the top of the water column. Variations in water column density may introduce error into hydrograph and/or hydraulic gradient plots. Rough estimates suggest that the average error for water level elevations is probably less than about 7 feet, although errors of up to 25 feet may be possible in some individual wells.

Downhole-temperature logs are available for some wells, but the logs may not reflect current temperature conditions in the well, especially if the well is in use. Measurement of temperature profiles are difficult in most wells because installed pumps block access for downhole temperature probes. One way to reduce the error associated with density effects may be to allow wells to flow at a minimal rate until outflow water temperature stabilizes close to the local aquifer water temperature.

## 5.2. Interpreted Hydraulic Gradient

The hydraulic head data collected in the August 2002 mass measurement were used to estimate horizontal hydraulic gradients in the Boise Front geothermal aquifer system. Hydraulic gradients were illustrated using two forms of spatial interpolation: kriging (Figure 5-1) and minimum curvature (Figure 5-2).

In general, the potentiometric surface in Figure 5-1 suggests westerly to southwesterly flow in the Stewart Gulch and Boise – Table Rock areas. There are not enough data points to estimate gradient directions within the Harris Ranch area. Based on these potentiometric surface maps, it appears that there is a hydraulic gradient from the Harris Ranch area toward the Boise – Table Rock area, which is consistent with the general westerly (or southwesterly) gradients observed in the downtown Boise and Stewart Gulch areas. Furthermore, it appears unlikely that there is northwesterly flow from the Boise – Table Rock area toward Stewart Gulch.

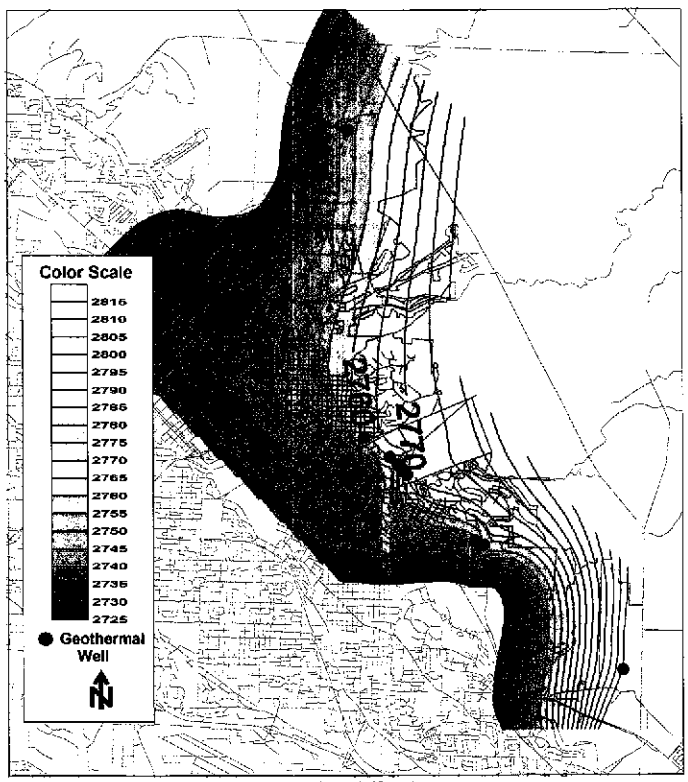


Units: elevation above mean sea level (feet).

Figure 5-1: Potentiometric surface (interpolated with "kriging", using a default linear variogram model).

The horizontal gradient maps may include error associated with (1) water column density differences between wells, (2) different well completion depths, and spatial

interpolation error. First, the mass measurement included wells that had been shut-in for a long time, wells that were flowing (at small rates), and wells that had recently been flowing. Nonetheless, there is general consistency in measurements within groups of wells, suggesting that the hydraulic gradient observations indicated are "in the ballpark." Second, different wells are completed at different depths, so the horizontal gradients indicated may reflect both vertical and horizontal components. Finally, spatial interpolation error may have been introduced because of the relatively small number of points and the spatial distribution (clustering) of the points.



Units: elevation above mean sea level (feet).

Figure 5-2: Potentiometric surface (interpolated with "minimum curvature", using default interpolation values).

# 6. CONCEPTUAL MODEL OF GROUND WATER FLOW

This section describes a conceptual model of ground water flow in the Boise Front geothermal aquifer. The geologic basis for the conceptual model outlined in this section was developed largely by Wood and Burnham (1987), and subsequently described by Montgomery-Watson (1994b). The conceptual model forms the basis for numerical simulation of ground water flows in the geothermal system (Zyvoloski et al., *in preparation*).

## 6.1. Geothermal Aquifer Description

The Boise Front Geothermal aquifer system consists of one or more aquifers present along the Boise Foothills underlying an area between Harris Ranch and Stewart Gulch. Geothermal water is found in (1) Tertiary basalts and underlying basalt tuffs (especially in the Stewart Gulch area), (2) two rhyolite zones and adjacent coarse-grained sediments belonging to the Idavada Group (in the Boise area), and (3) Cretaceous granite belonging to the Idaho Batholith in the Harris Ranch area. In the downthrown side of the Foothills fault zone, the Tertiary basalt and rhyolites tilt basinward at an angle of four to seven degrees.

An exposed northwest-southeast trending fault-fracture zone is present along the entire length of the Boise Foothills in the vicinity of the Boise Front geothermal aquifer. This fault system is thought to represent a primary conduit for geothermal water entering the system. Geothermal springs were present along this fault zone in the late 1800s, and several current geothermal wells are located in or near this fault zone. The role of other faults in the vicinity (Eagle-West Boise, Eagle-West Boise Extension, and East Boise faults) is less clear. Based on aquifer testing in the Stewart Gulch area, the Motorcycle fault appears to inhibit geothermal flow in the Stewart Gulch areas (E. Squires, *personal communication*).

Temperatures of geothermal water are in the 134° to 175°F range in the Boise – Table Rock area, and in the 90° to 125°F range in the Stewart Gulch area. Hydraulic gradients are southwesterly to westerly in the Stewart Gulch area and Boise – Table Rock areas, and westerly (on the basis of one data point) in the Harris Ranch area.

## 6.2. Hydraulic Connection

There are insufficient data to determine the degree of hydraulic connection between the Stewart Gulch and the Boise – Table Rock portions of the aquifer. Thermal water in the basalt aquifers in Stewart Gulch has different temperatures, different ages, and different chemical characteristics than water in the downtown Boise area, although

thermal water in both areas appear to share a common source (Section 3.4). The foothills fault zone appears to extend between these two areas, although the hydraulic properties of faults between these areas are unknown.

Hydrographs from wells in both areas show some similar patterns. For instance, water levels in the Edwards well appear to begin declining at the time when the BGL (City) wells began operation; however, this is also the time that the Quail Hollow Upper well began operation. Similarly, water levels in the Edwards, Terteling Windsock, Terteling Pool, and Terteling Motorcycle wells began to rise in the 1990s. This mirrors the pattern observed in several wells in the Boise – Table Rock area, which begin to rise in 1999, presumably because of the City's re-injection of spent water. However, the Stewart Gulch wells began to rise prior to the start of the City's injection program. Thus, it appears that some similar water level patterns observed in both the Boise – Table Rock and Stewart Gulch areas are probably related to local conditions more than hydraulic influence between these areas.

There is, however, some evidence for hydraulic connection between the Boise – Table Rock area and Harris Ranch. Historical descriptions suggest that early pumping (in the early 1900s) in the BWSWD wells diminished flows in the Kelly Hot Springs, which had been near the current location of the Harris East and West wells. Hydraulic connection does not appear evident in the available hydrograph data. A suspected fault between these wells may inhibit ground water flow.

## 6.3. Boundary Conditions

The lateral extent of the Boise Front geothermal aquifer is unknown. To the east, hot water is known to exist near Mayfield, but information about geothermal zones between Harris Ranch and Mayfield is not available. In the Boise area, the practical extent of the geothermal aquifer to the north probably is the foothills fault zone, although geothermal water may be present in faults and/or granite fractures north of the fault zone (which probably is the source of geothermal water in the Harris Ranch area). Geothermal water extends further north in Stewart Gulch. The Terteling Motorcycle well is the northernmost geothermal well in the Stewart Gulch area. The extent of the geothermal aquifer to the west and south is unknown. Hot water is known to exist further west in the Dry Creek area and further south in areas near the Snake River. The rhyolitic rocks have not been penetrated by deep wells west of the Boise area, although the occurrence of warmer water (greater than 85°F) has been documented in numerous locations in the Western Snake River Plain. Geothermal zones may be terminated, or substantially offset, by the Eagle-West Boise fault southwest of Boise. Several other major faults are present in the geothermal aquifer area (Figure 1-1). The influence that the Eagle-West Boise and the Eagle-West Boise Extension faults have on geothermal ground water movement is unknown.

## 6.4. Inflows and Outflows

Thermal ground water originates in the fractured granitic rock of the Idaho batholith. Primary recharge is thought to occur from the granitic rock through north-south and northeast trending lineaments in the batholith. The specific location and rate of recharge from the Idaho Batholith to the Boise Front geothermal aquifer system is not known. Northwest trending fault systems provide conduits for movement of geothermal waters upward to the surface or into the rhyolite zone. Age-dating of geothermal water suggests that the rate of movement from recharge areas to existing wells is extremely slow.

Primary known discharge is to wells in the geothermal system. Secondary, diffuse discharge may occur to overlying aquifers or horizontally into the basin - the spatial distribution and flow rates, and the extent to which this occurs, is not known. Upward movement of geothermal water above the Tertiary basalt probably is limited by precipitates that have formed as geothermal water has encountered cooler conditions in overlying zones. However, chemical constituents (e.g., fluoride) associated with geothermal water are found in some cold-water aquifer wells.

## 6.5. Aquifer Properties

The geothermal aquifer system can be considered confined or semi-confined, a result of thick Idaho Group sediments and/or other aquitards overlying most of the geothermal system. Several aquifer tests have been conducted in the Boise – Table Rock area; transmissivities in this area have been estimated to range from less than 1,000 to over 800,000 gallons per day per foot (gpd/ft). The geothermal aquifers in the Stewart Gulch and Harris Ranch areas may have different transmissivity ranges because of different geologic materials.

# 7. CONCLUSIONS AND RECOMMENDATIONS

This report represents a summary of geologic and hydrologic conditions in the Boise Front geothermal aquifer. The general conclusion from this study is that the geothermal aquifer appears adequate for supplying current levels of geothermal withdrawals (with accompanying injection). Specific conclusions include the following:

4. Water levels in the Boise – Table Rock area decreased beginning in 1984, apparently in response to new withdrawals by the City of Boise in 1984.

5. Based on water level observations in the BLM well (which serves solely as a monitoring well), water levels in the Boise area stabilized somewhat beginning in the late 1980s, presumably in response to a partially decreased withdrawals – and a more stable level of withdrawals – in this area.

6. Water levels in the Boise – Table Rock area have been recovering since 1999, based on observed water level increases in the BLM, VA, BWSWD, Kanta wells. The recovery appears to be in response to decreased net withdrawals associated with the City's re-injection of a portion of its withdrawals since 1999.

7. Water temperatures in the CM #2 well declined from approximately 1983 – 1990, which may reflect the influence of the City's withdrawals or the time to reach temperature equilibrium in the Capitol Mall couplet.

8. Water levels in the Edwards well also decreased beginning in approximately 1984, but the decrease may have been caused by the start of irrigation in Quail Hollow Upper well.

9. Several Stewart Gulch wells (e.g., Edwards, Quail Hollow Lower, Terteling Windsock, Terteling Pool, and Terteling Motorcycle) experienced water level increases in the late 1990s. These increases began in approximately 1996 (prior to water level increases in the Boise – Table Rock area), coinciding with possible decreases in use at the Terteling, Flora Silkey, Office, and Tiegs wells. Water levels in the Quail Hollow Lower, Terteling Windsock, Terteling Pool, and Terteling Motorcycle began to level off (or drop slightly) beginning in about 1999. It is not possible to determine the contribution, if any, of Boise City injection on water levels in the Edwards or other Stewart Gulch wells.

10. The degree of hydraulic connection (if any) between the Boise – Table Rock area and Stewart Gulch can not be confirmed (or refuted) on the basis of available data. Thermal water in both areas appears to share a

common source, although there are differences in water chemistry, residence times, and temperature.

There are several recommendations that might be considered as part of the management of the Boise Front geothermal aquifer:

1. Continue to monitor water pressure and/or levels of geothermal wells on a regular basis.

2. Continue and/or begin to monitor production rates from geothermal wells.

3. Monitor discharge water temperatures in geothermal wells more closely.

4. Inspect, check, and calibrate installed water level/pressure, temperature, and flow instrumentation on a regular basis.

5. Continue to add data from these measurements to the database created for this project; consider ways to facilitate standardized data collection and reporting.

6. Consider another mass measurement with all wells under uniform temperature conditions. One approach for this would be to create enough flow in each well to allow temperature equlibration within the well prior to measuring water levels and/or pressures.

7. Consider approaches to improving quantification of aquifer and/or fault characteristics through multi-well aquifer tests using existing wells and existing operations.

8. Consider approaches to improving quantification of aquifer and/or fault characteristics through geophysical methods (e.g., seismic surveys).

# 8. REFERENCES


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# Appendices:

A. Abbreviations, Units, and Conversions ..... A1

B. Selected Well Information ..... B1

C. Survey Data ..... C1

D. Water Level Data ..... D1

E. Production Data ..... E1

F. Mass Measurement Data ..... F1

H. Measurement Point Locations for Selected Geothermal Wells ..... (*Under separate cover*)

# Appendix A: Units, Abbreviations, and Conversions

**Volume**

1 cubic foot of water = 7.4805 gallons = 62.37 pounds of water

1 acre-foot (af) = enough water to cover 1 acre of land 1 foot deep.

1 acre-foot (af) = 43,560 cubic feet

1 acre-foot (af) = 325,850 gallons

1 million gallons = 3.0689 acre-feet

**Flow Rates**

1 cubic foot per second (cfs) = 448.83 gallons per minute (gpm) = 26930 gallons per hour

1 cubic foot per second (cfs) = 646,635 gallons per day = 1.935 acre-feet per day

1 cubic foot per second (cfs) for 30 days = 59.502 acre-feet

1 cubic foot per second (cfs) for 1 year = 723.94 acre-feet

1 cubic meter per second (cms) = 25.31 cubic feet per second

1 cubic meter per second (cms) – 15,850 gallons per minute

1 million gallons per day (mgd) = 1,120.147 acre-feet per year

1 miner's inch = 9 gallons per minute

1 miner's inch = 0.02 cubic feet per second

**Hydraulic Conductivity**

1 gallon per day per foot$^2$ (gal/day/ft$^2$) = 0.134 foot/day = 0.0408 meters/day

**Economic**

$0.10 per 1,000 gallons = $32.59 per acre-foot.

# Appendix B: Selected Well Information

| Well Name | Well-ID | IDTM-X (ft) | IDTM-Y(ft) | Ground Surface - NAVD29 (ft) | Measuring Point - NAVD29 (ft) |
|---|---|---|---|---|---|
| Edwards' Well | 1704 | 1047884.25 | 939716.69 | 2673.09 | 2673.09 |
| VA Test Injection Well | 1674 | 1059887.55 | 927071.18 | 2718.23 | 2720.43 |
| VA Injection Well | 1675 | 1059964.08 | 926959.77 | 2716.81 | 2716.81 |
| VA Production Well | 1671 | 1061496.15 | 925788.99 | 2764.32 | 2761.77 |
| Capitol Mall Well #2 | 1670 | 1058599.98 | 925464.38 | 2711.64 | 2714.57 |
| Capitol Mall Well #1 | 1663 | 1059481.78 | 924748.24 | 2718.73 | 2713.89 |
| BGL #2 | 1666 | 1062345.79 | 924855.04 | 2748.48 | 2749.77 |
| BGL #1 | 1664 | 1062708.77 | 924553.79 | 2750.49 | 2751.47 |
| BGL #4 | 1665 | 1062632.22 | 924665.19 | 2749.95 | 2750.03 |
| BGL #3 | 1667 | 1062065.13 | 925263.52 | 2770.54 | 2769.17 |
| Kanta | 1646 | 1068142.18 | 918541.15 | 2782.11 | 2783.28 |
| Dallas Harris | 230 | 1076510.44 | 912126.47 | 2880.37 | 2881.87 |
| Dallas Harris | 229 | 1076510.44 | 912126.47 | 2879.85 | 2881.35 |
| BWSWD#3 | 3322 | 1066998.03 | 920394.09 | 2786.49 | 2789.24 |
| BWSWD#1 | 1652 | 1067521.92 | 920161.66 | 2764.74 | 2765.82 |
| BWSWD#2 | 1653 | 1067521.92 | 920161.66 | 2764.74 | 2764.74 |
| Old Pen Well | 1645 | 1067964.32 | 917816.53 | 2780.49 | 2780.99 |
| Silkey (Flora Shed) | 1698 | 1049403.04 | 939092.30 | 2687.84 | 2691.22 |
| Flora Office | 1697 | 1049403.04 | 939092.30 | 2687.29 | 2690.83 |
| Flora Tiegs | 1696 | 1049561.78 | 939088.03 | 2689.36 | 2689.63 |
| Terteling Motorcycle | 296 | 1058869.84 | 946642.70 | 3022.00 | 3022.95 |
| Terteling Pool | 1714 | 1056038.45 | 944675.96 | 2901.48 | 2901.23 |
| Terteling Windsock | 1712 | 1055411.62 | 943999.85 | 2868.18 | 2868.18 |
| Quail Hollow Upper | 1693 | 1053431.10 | 941208.53 | 2797.25 | 2798.75 |
| Quail Hollow Lower | 1710 | 1052769.73 | 941226.23 | 2770.32 | 2773.32 |
| BLM | 1668 | 1061769.12 | 925089.00 | 2742.88 | 2746.55 |
| Quarry View Shallow | 3342 | 1066822.21 | 919912.96 | 2733.26 | 2729.19 |
| Quarry View Deep | 1651 | 1066822.21 | 919912.96 | 2733.26 | 2729.78 |
| Boise City Injection | 2670 | 1057287.14 | 922438.12 | 2688.34 | 2692.84 |

Table B-1: Survey locations for selected geothermal wells.

# Appendix C: Survey Data

# Appendix D: Water Level Data

# Appendix E: Production Data

# Appendix F: Mass Measurement Data, 8/27/03 to 9/25/03

| Mass Measurement, Boise Front Geothermal Aquifer System, 8/27/02 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Well** | **Date** | **Time** | **Method** | **Depth to Water (ft)** | **Pressure (Gauge 2) (psi)** | **Pressure (Gauge 1) (psi)** | **Avg Pressure (psi)** | **Measurement Point** | **Status** | **Remarks** |
| Old Pen (Botanical Gardens) | 8/27/2002 | 8:29 | E-tape | 51.55 | | | | Bottom of discharge shaft access window, approx 9" above concrete slab | static; BWSWD East operating at approx 155 gpm | turbine oil present on water |
| Quarry View (*tall piezo*) | 8/27/2002 | 8:42 | E-tape | 38.51 | | | | top of 2" casing; 0.75' above steel plate | observation well | piezometer completed from 813 to 848 feet |
| Quarry View (*lower piezo*) | 8/27/2002 | 8:44 | E-tape | 38.14 | | | | top of 2" casing; 0.16' above steel plate | observation well | piezometer completed from 600 to 700 feet |
| BWSWD East | 8/27/2002 | 8:53 | Steel Tape | 10.58 | | | | lowest point of 2" access tube | Q =approx 155 gpm | MP = 13" above pump house floor |
| BWSWD West | 8/27/2002 | 8:56 | Steel Tape | 9.35 | | | | floor level, bottom of blue pump base | not pumping | measure through casing |
| Kanta | 8/27/2002 | 9:08 | Steel Tape | 36.56 | | | | top of 8" casing, east side | static | no turbine oil |
| BWSWD No. 3 | 8/27/2002 | 9:10 | E-tape | 36.32 | | | | top of casing; 1.89' above concrete seal | observation well | |
| BWSWD West | 8/27/2002 | 9:26 | E-tape | 8.25 | | | | floor level, bottom of blue pump base | not pumping | 2 minutes after shutdown of BWSWD East |
| Harris West | 8/27/2002 | 9:44 | E-tape | 61.00 | | | | top of casing | observation well | cascading water audible |
| Edwards | 8/27/2002 | 9:45 | two-60 psi gauges | | 25 | 24.5 | 24.8 | installed gauges | off; recently flowing | |
| Harris East | 8/27/2002 | 9:48 | E-tape | 70.32 | | | | edge of discharge head cut out; 0.51 feet above floor slab | off | depth to oil 70.32, depth to water 70.45, oil thickness 0.13' |

| Well | Date | Time | Method | Depth to Water (ft) | Pressure (Gauge 2) (psi) | Pressure (Gauge 1) (psi) | Avg Pressure (psi) | Measurement Point | Status | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| *Flora- Tiegs* (Triangle) | 8/27/2002 | 10:31 | two-30 psi gauges | | 17 | 17.1 | 17.1 | gauge coupling (new location) 4.5' above pump vault floor | well off | |
| Flora - Office (house) | 8/27/2002 | 10:34 | two-30 psi gauges | | 15.9 | 16 | 16.0 | gauge coupling | recently flowing at a few gpm | Totalizer: 230783x100 |
| Flora -Silkey (Shed) | 8/27/2002 | 10:35 | two-30 psi gauges | | 14.6 | 14.9 | 14.8 | gauge coupling (3.35' above steel plate on ground) | not flowing | totalizer: 084948x100 |
| BGL2 | 8/27/2002 | 10:40 +/- | two-15 psi gages + manometer | -7.14 | 2.9 | 3.1 | 3.0 | pressure gage port in center of 12x12x8 tee, 1.25 feet above floor | pump off for months | 49.5 C (121 F) well head temperature |
| BGL4 | 8/27/2002 | 10:50 +/- | two-15 psi gages | | 6.5 | 7.2 | 6.9 | pressure gage port in center of 12x12x8 tee | pump on at 125 *gpm* +/- | 176 degrees F; pressure fluctuating with pump rate |
| Quail Hollow Lower (Nibbler) | 8/27/2002 | 10:58 | Steel Tape | 47.83 | | | | top of 8" casing | not pumping cold pipes (off since 8/26 pm?) | totalizer: 1068871x100 |
| Quail Hollow Upper (Tee Ltd.) | 8/27/2002 | 11:05 | Steel Tape | 71.89 | | | | top of 14" casing | not pumping - cold pipes (off *since* 8/26 pm?) | totalizer: 2332741x100 |
| BLM | 8/27/2002 | 11:11 | water manometer | -4.15 | | | | top of casing | observation well | 6.33 feet on tape on well house wall; well head temperature is 23 deg C |
| BGL 3 | 8/27/2002 | 11:35 | E-tape | 17.10 | | | | lip of gate valve on access port | pump off for years? | |
| *Terteling* Windsock | 8/27/2002 | 11:40 | Steel Tape | 138.25 | | | | pump base | well off | avg of 2 measurements; totalizer: 665408x100 |
| Terteling Pool | 8/27/2002 | 11:54 | Steel Tape | 168.87 | | | | top of 1/2" riser, located above 0.25' above slab | pump off/pipes cold (probably shut down since 8/26 pm) | avg of 2 measurements; totalizer: 047029x10 |

| Well | Date | Time | Method | Depth to Water (ft) | Pressure (Gauge 2) (psi) | Pressure (Gauge 1) (psi) | Avg Pressure (psi) | Measurement Point | Status | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| City Injection Well | 8/27/2002 | 12:12 | gages and transducer | | 12.9 | 12.9 | 12.9 | gage leve 5.0 feet above floor | average injection rate is 120 gpm | 102 deg F; flow varies 0-170 gpm, pressure varies 12.7-12.9 psi |
| Terteling Motorcycle Hot | 8/27/2002 | 12:28 | Steel Tape | 275.22 | | | | Top of 1" PVC access port in 16" casing, located 0.2' above 16" casing | static | Totalizer: 000000x100 |
| VA Production | 8/27/2002 | 13:11 | E-tape | 2.43 | | | | Lip of access tube, 1.75 feet above pit floor, 3.6 feet below top of grate & floor slab | pump on at 160 gpm | 162 degrees F |
| Well | Date | Time | Method | Depth to Water (ft) | Pressure (Gauge 2) (psi) | Pressure (Gauge 1) (psi) | Avg Pressure (psi) | Measurement Point | Status | Remarks |
| VA Production | 8/27/2002 | 13:19 | Steel Tape | 0.1 | | | | Lip of access tube | pump off | |
| UWID Cartwright (North) | 8/27/2002 | 13:28 | E-Tape | 325.41 | | | | top of well casing; 0.9' above pumphouse floor; 8.75' from pumphouse floor to top of concrete pump house roof | static | no pump in well |
| VA Test Injection | 8/27/2002 | 13:39 | two-30 psi gauges | | | | 16.8 | 0.5' +/- above ball valve on well head | observation well | 22 deg C well head temperature |
| Capitol Mall 1 | 8/27/2002 | 13:55 | two-30 psi gauges | | | | 9.2 | pressure gage port 5.0 feet below well house floor slab | well off for summer | 26 deg C well head temperature |
| Capitol Mall 2 | 8/27/2002 | 14:07 | two-30 psi gauges | | | | 12.9 | pressure gage port 1.75 feet above floor slab | well off for summer | 26 deg C well head temperature |

| Selected measurements taken during afternoon after BWSWD shut-down (BWSWD-East shut down at 9:24 am) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Well** | **Date** | **Time** | **Method** | **Depth to Water (ft)** | **Pressure (Gauge 2) (psi)** | **Pressure (Gauge 1) (psi)** | **Avg Pressure (psi)** | **Measurement Point** | **Status** | **Remarks** |
| Old Pen #1(Botanical Gardens) | 8/27/2002 | 14:20 | E-tape | 51.84 | | | | Bottom of discharge shaft access window, approx 9" above concrete slab | BWSWD East shut down at 9:24am | turbine oil present on water column incoming storm |
| Kanta | 8/27/2002 | 14:28 | E-tape | 36.50 | | | | top of casing | observation well | |
| BWSWD No. 3 | 8/27/2002 | 14:33 | E-tape | 35.55 | | | | top of casing; 1.89' above concrete seal | observation well | |
| BWSWD-West | 8/27/2002 | 14:47 | E-tape | 5.29 | | | | Bottom of pump base (floor level) | BWSWD East shut down at 9:24am | 172-173 deg F incoming storm |
| BWSWD-East | 8/27/2002 | 14:49 | E-tape | 4.99 | | | | Lowest point of 2" measuring tube (13" above floor) | BWSWD East shut down at 9:24am | 172-173 deg F incoming storm; depth to top of oil |

| Selected measurements taken on 9/24/02 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Well** | **Date** | **Time** | **Method** | **Depth to Water (ft)** | **Pressure (Gauge 2) (psi)** | **Pressure (Gauge 1) (psi)** | **Avg Pressure (psi)** | **Measurement Point** | **Status** | **Remarks** |
| Capitol Mall 1 | 9/24/2002 | 9:06 | 30 psi gauge | | 9.6 | 9.7 | 9.7 | gauge port | well off for summer | installed gauge: 5 psi on 100 psi gauge; city system temporarily off |
| Capitol Mall 2 | 9/24/2002 | 9:40 | 30 psi gauge | | 13.6 | 13.4 | 13.5 | gauge port | well off for summer | installed gauge reads 14 psig; city system temporarily off |
| BWSWD West | 9/24/2002 | 10:15 | TS E-tape | 14.21 | | | | blue pump base | running | well inadvertently shut down earlier; current east and west well combined flow approx 250 gpm |
| BWSWD East | 9/24/2002 | 10:26 | TS E-Tape | 18.85 | | | | lowest elevation at top of measurement tube | running | well inadvertently shut down earlier; current east and west well combined flow approx 250 gpm; DTW reading with steel tape is 18.65 ft, oil may be confounding electrical and/or steel tape reading |
| VA Production | 9/24/2002 | 11:02 | | | | | | | | Artesian flow through measurement tube (20 gpm?) beginning 2 minutes after pump shutdown |
| VA Test Injection | 9/24/2002 | 11:14 | 30 psi gauges | | 18 | 18 | 18.0 | gauge height is 0.70 ft above survey point on top of casing | no pump | |
| BGL#1 | 9/24/2002 | 11:40 | 30 psi gauges | | 2.8 | 3 | 2.9 | gauge height is 3.68 ft below iron manhole rim | no pump | top of ring is 0.48 ft above toop of concrete manhole structure; installed city gauge reads 3.4 psi |

| Well | Date | Time | Method | Depth to Water (ft) | Pressure (Gauge 2) (psi) | Pressure (Gauge 1) (psi) | Avg Pressure (psi) | Measurement Point | Status | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| BGL#4 | 9/24/2002 | 11:53 | | | | | | | pumping between approx 200 and 420 gpm | Temp reads 175 ° F; reading taken in BGL#2 pumphouse |
| BGL#2 | 9/24/2002 | 11:53 | installed 15 psi gauges | | 3.1 | 3.3 | 3.2 | gauge height | not pumping | |
| BGL#3 | 9/24/2002 | 11:57 | Installed 100 psi gauge | | 5 (reading in error - reflects stuck gauge) | | | gauge height | not pumping | new measurement access port installed - see data sheets |

| Selected measurements taken on 9/25/02 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Well** | **Date** | **Time** | **Method** | **Depth to Water (ft)** | **Pressure (Gauge 2) (psi)** | **Pressure (Gauge 1) (psi)** | **Avg Pressure (psi)** | **Measurement Point** | **Status** | **Remarks** |
| VA Production | 9/25/2002 | 13:04 | E-tape | 7.82 | | | | top of open casing | off since 7:00am; pump removed | top of open casing is 7.58 ft above new measurement port valve; 4.05 ft above pumphouse floor. Temperature reading was taken by lowering thermometer; temperature at top of water column was approx 52 degrees C (126F), although there seemed to be cooling of the thermometer as it was being withdrawn from the well. |
| BWSWD East | 9/25/2002 | 14:09 | E-tape | 18 | | | | top of measurement tube | running @ approx 220 gpm | Dick Clark's E-tape: 18.0 ft |
| BWSWD West | 9/25/2002 | 14:14 | E-tape | 14.3 | | | | Bottom of pump housing | No pump | East well Q approx 220 gpm; Dick Clark's E-tape reads 14.3 ft DTW |
| BWSWD#3 | 9/25/2002 | 14:42 | E-tape | 40.15 | | | | Top of casing | No pump | East well Q approx 220 gpm; Dick Clark's E-tape reads 40.2 ft DTW |
| Kanta | 9/25/2002 | 14:57 | E-tape | 35.72 | | | | Top of casing | No pump | |

# Appendix G: Geophysical Logs

Geophysical logs taken in geothermal wells were scanned and saved as digital images as part of this project. The logs were made available for scanning by Terry Scanlan (Scanlan Engineering), Spencer Wood (Department of Geosciences, Boise State University), and Ed Squires (Hydro Logic, Inc.). Wells with scanned geophysical logs (and approximate file sizes) are listed below. All of the files with the name "scan" were scanned at the Department of Water Resources. All of the other files were scanned by the Bonneville Blueprint Co. The digital files are available from the Idaho Department of Water Resources.

1. Barnes (1 scan, 2.7 MB)
2. Beard (4 scans, 21.1 MB)
3. BGL#1 (14 scans, 106 MB)
4. BGL#2 (30 scans, 244 MB)
5. BLM (3 scans, 14.7 MB)
6. Capitol Mall (26 scans, 269 MB)
7. Koch (2 scans, 4.03 MB)
8. Old Penitentiary (3 scans, 9.25 MB)
9. Silkey (1 scan, 302 MB)
10. Statehouse (2 scans, 5.45 MB)
11. Terteling (3 scans, 1.08 MB)
12. VA (6 scans, 15.5 MB)
13. Miscellaneous (1 scan, 6.83 MB)