

Ground Water Geochemistry of Wells in the Northern Ada County Area of Idaho

Richard K. Glanzman Presentation

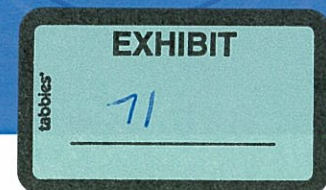
Based on January 20, 2009 report by Dick Glanzman and
Ed Squires

Presentation prepared for:

State of Idaho Department of Water Resources
Boise, Idaho

Application for Water Right 63-32573

May 5, 2009



GROUND WATER GEOCHEMISTRY OF WELLS
IN THE NORTH ADA COUNTY AREA OF IDAHO

January 26, 2009

A report prepared for:



by
Dick Gluzman¹
Ed Squires²

*McKernan Well Drilling, LLC
developing the 2-inch tube
wells of MS Test Well #1
at the old King farm.*

Hydro Logic, Inc.
Boise, Idaho

¹ Gluzman Geochemical, LLC
Denver, CO

² Hydro Logic, Inc.
Boise, ID

OVERVIEW

- Ed Squires presented Hydrogeology
- 84 Chemical analyses
- Recharge
 - Precipitation and Boise River
- Ground Water Geochemistry
 - Pierce Gulch Sand Aquifer (PGSA)
 - Terteling Spring Formation (TSF)
 - Willow Creek Aquifer (WCA)
 - Spring Valley Ranch Wells (SVRW)
 - Emmett Wells

Locations of Wells Sampled For the M3 Eagle
North Ada County Geochemistry Study

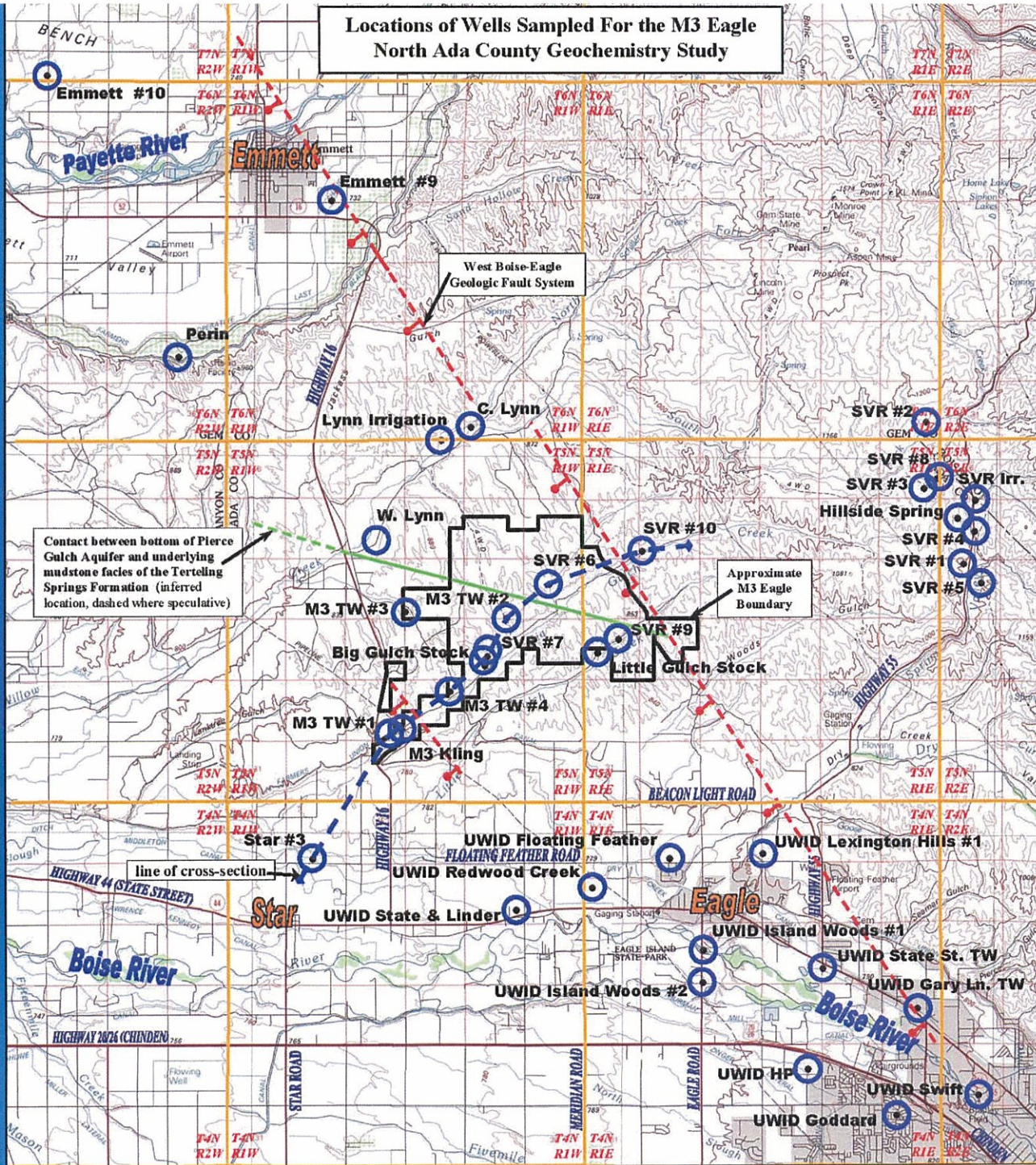


Figure 1 in Glanzman and
Squires, 2009

Hydro Logic, Inc.
Boise, Idaho

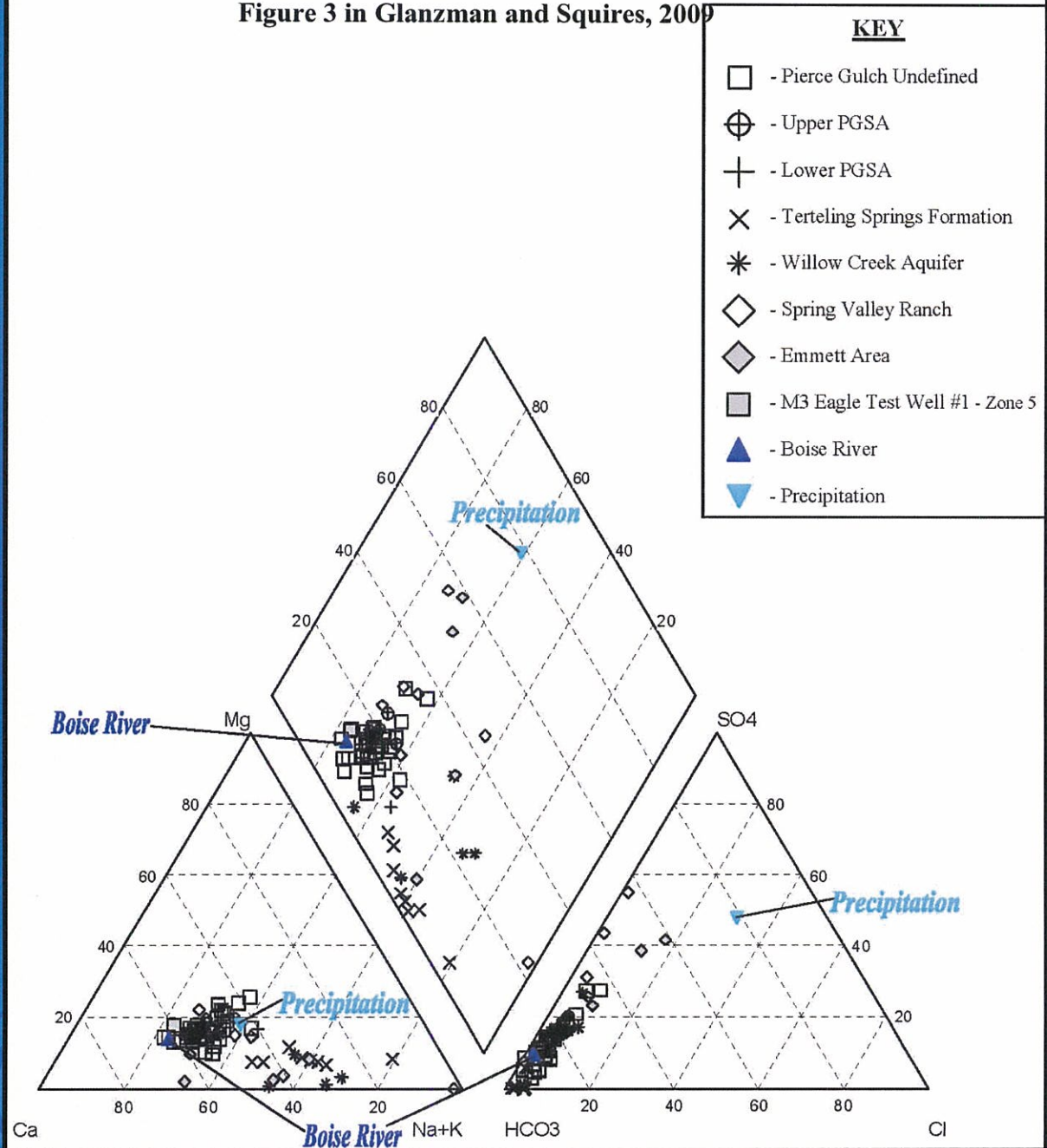
TOTAL DISSOLVED SOLIDS

- Rainfall 5.4 mg/l (Wood and Low, 1988)
- Boise River 52 mg/l (Wood and Low, 1988)

- PGSA 191 (82-404)
- TSF 206 (148-351)
- WCA 119 (70-154)
- SVRW 274 (116-570)
- Emmett 303 (203-340) ⁺³

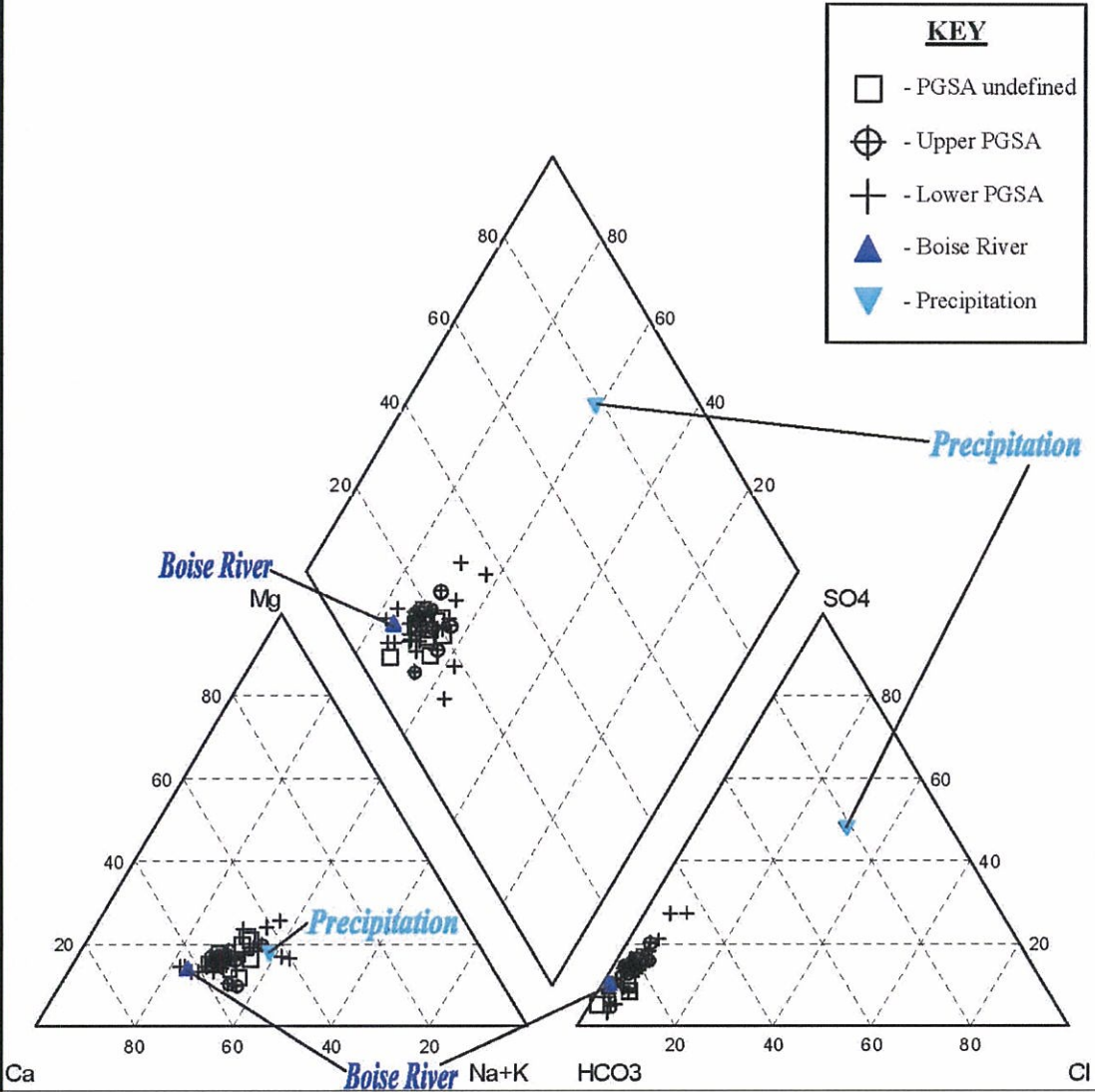
Major Ion Chemistry of Groundwater from Wells Completed in the North Ada County Area

Figure 3 in Glanzman and Squires, 2009



Major Ion Chemistry of Groundwater from Wells Completed in the Pierce Gulch Sand Aquifer (PGSA)

Figure 4 in Glanzman and Squires, 2009

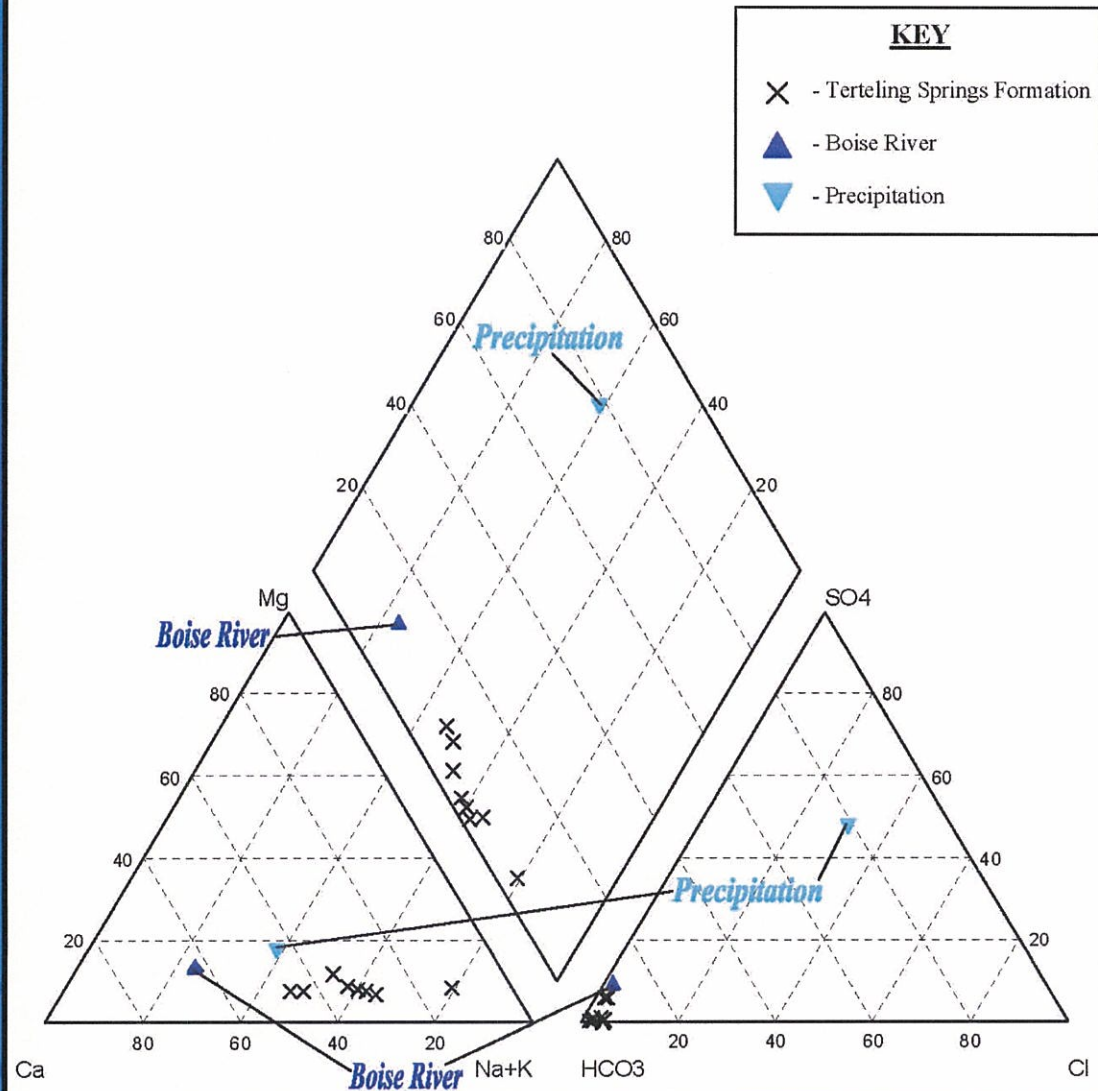


Pierce Gulch Sand Aquifer

- Boise River Recharge
- Discrete Regional Aquifer
- Average TDS 191 (82-404 mg/l)
- Near Neutral pH (7.19) and Oxidized (334 mv)
- Same Major Ion Water Chemistry over TDS and spatial ranges
- Same Mineralogy – Limited clay
- TOC 0.8 mg/l, NO₃N 0.42 mg/l, NH₃N 0.08 mg/l
- Low Iron and Manganese
- Arsenic 0.004 mg/l
- M3 wells GW from same aquifer as UWID wells (Floating Feather, Goddard, HP)

Major Ion Chemistry of Groundwater from Wells Completed in the Terteling Springs Formation

Figure 7 in Glanzman and Squires, 2009

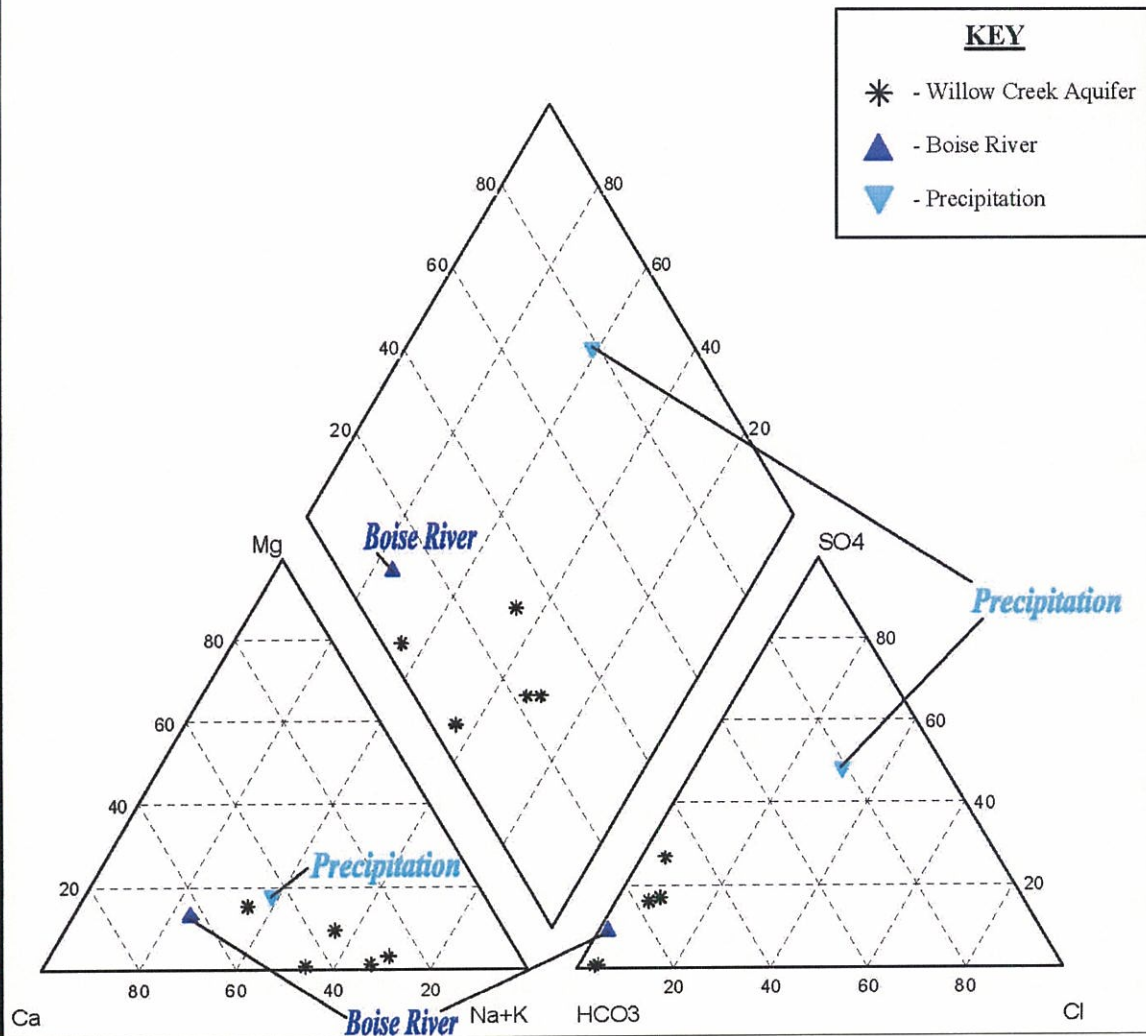


Terteling Springs Formation

- Boise River Recharge
- Major ions indicate ion exchange – linear change in water chemistry type from calcium-bicarbonate to sodium-bicarbonate
- Average TDS 206 (148-361 mg/l)
- Average pH 7.54
- Non-detect NO_3N , NH_3N 3.34 mg/l
- Low Iron, Manganese and Sulfate
- Probably low oxidizing to reducing redox condition
- Arsenic 0.004 mg/l

Major Ion Chemistry of Groundwater from Wells Completed in the "Willow Creek Aquifer" (WCA)

Figure 9 in Glanzman and Squires, 2009



Locations of Wells Sampled For the M3 Eagle
North Ada County Geochemistry Study

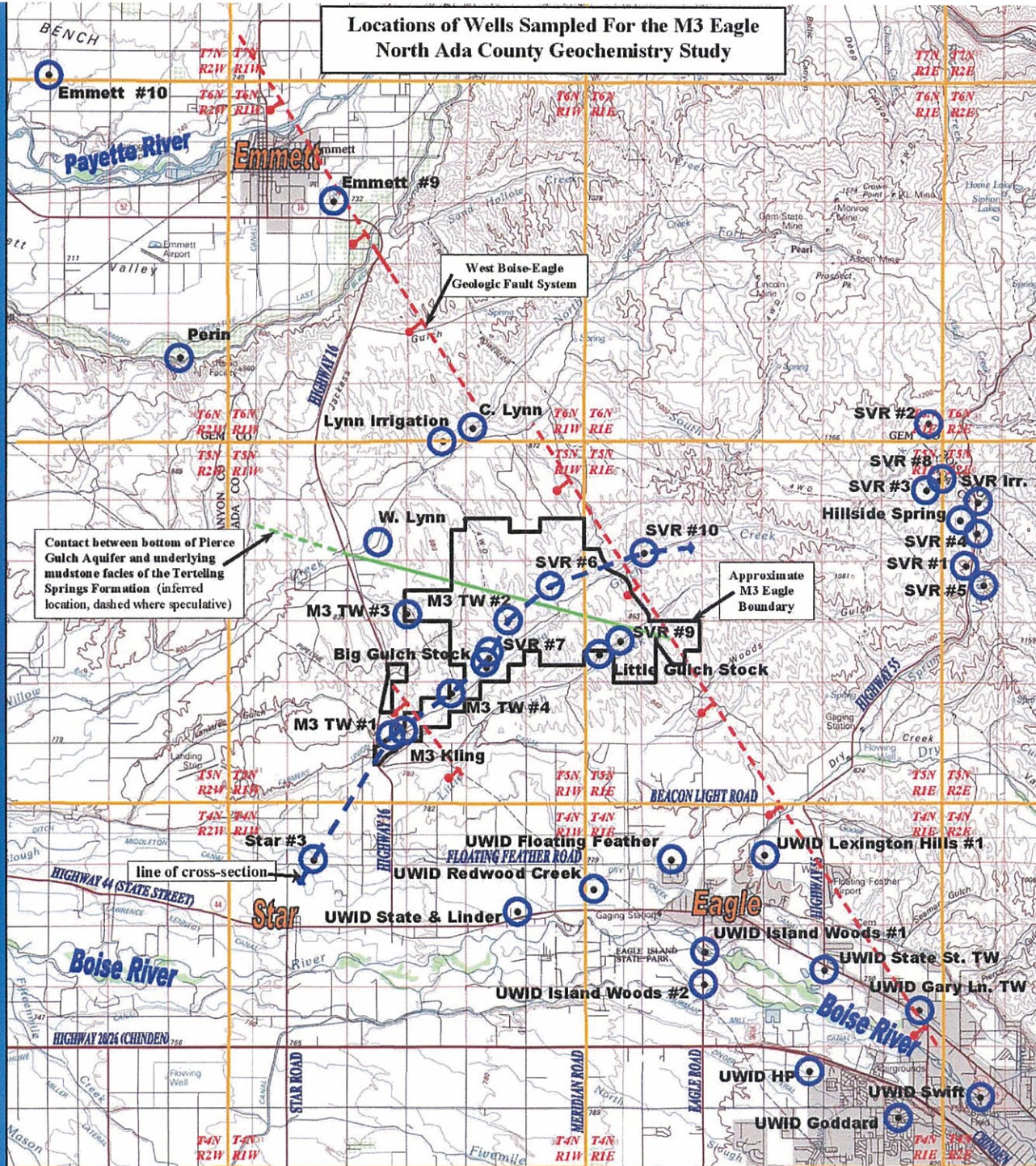


Figure 1 in Glanzman and Squires, 2009

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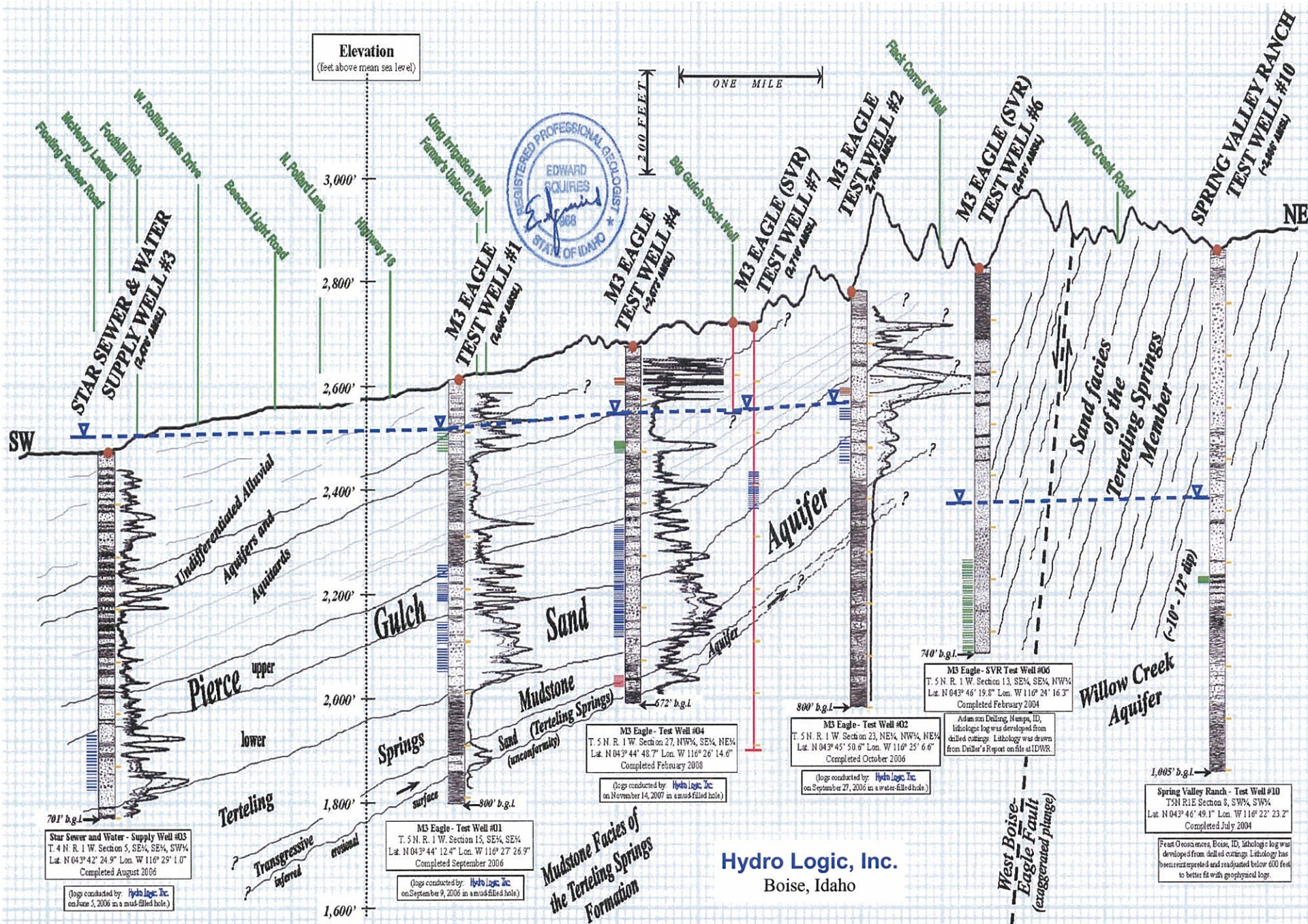
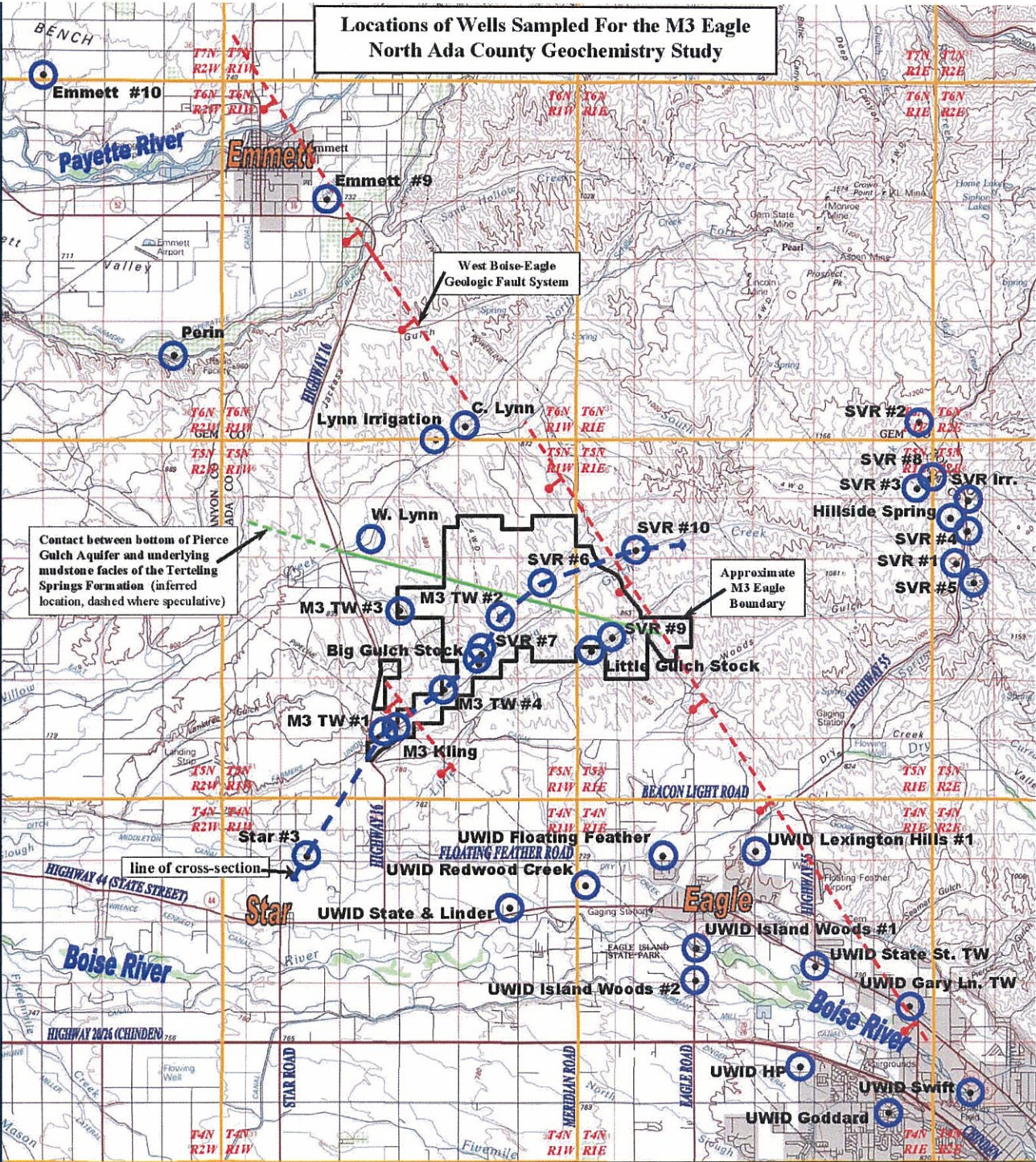


Figure 6 in Glanzman and Squires, 2009 13

WILLOW CREEK AQUIFER

- Up gradient sand facies of the TSF
- Precipitation recharge dominant
- Most dilute GW, TDS 119 (70-154) mg/l
- Average pH 7.60
- NO_3N 1.56 mg/l, NH_3N 0.16 mg/l
- Arsenic 0.025 mg/l exceeds DWS 0.010 mg/l (nondetect to 0.067 mg/l)
- Elevated silica (38 mg/l) and fluoride (1.56 mg/l) compared to other GW suggests volcanic ash component in the aquifer sediment
- No hydraulic connection with the PGSA

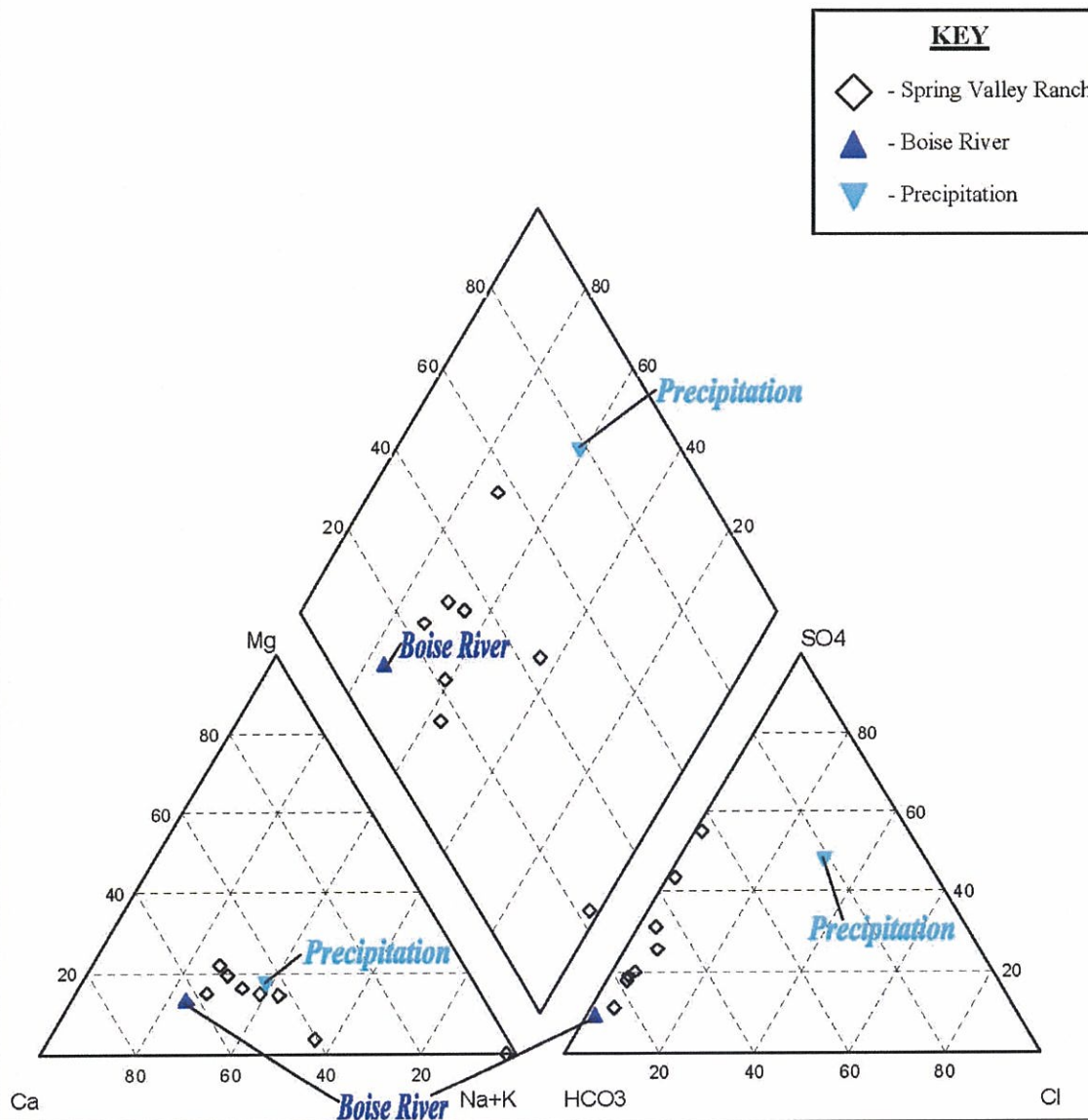
**Locations of Wells Sampled For the M3 Eagle
North Ada County Geochemistry Study**



**Figure 1 in Glanzman and
Squires, 2009**

Major Ion Chemistry of Groundwater from Wells Completed on Spring Valley Ranch (SVR)

Figure 11 in Glanzman and Squires, 2009

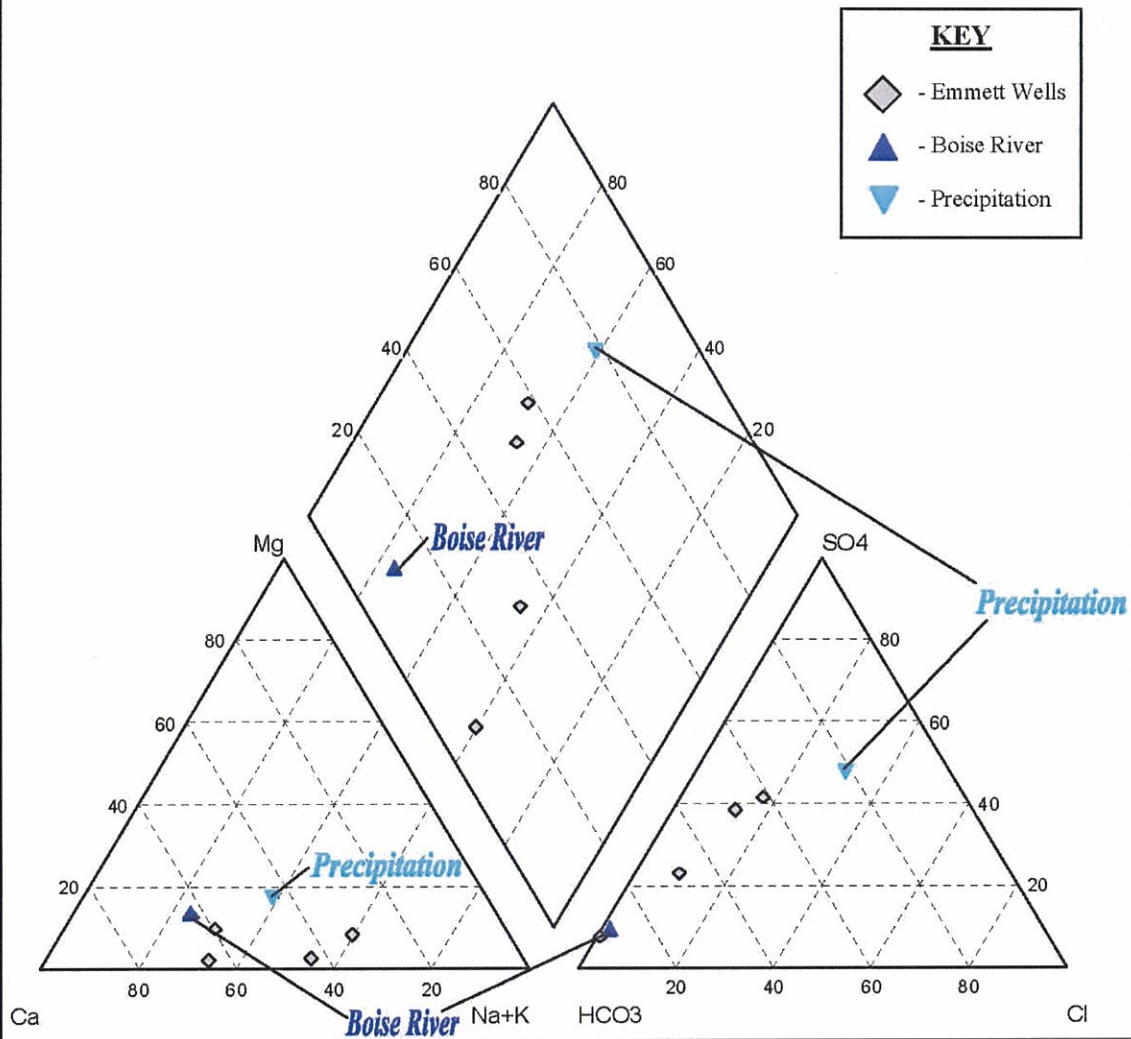


SPRING VALLEY RANCH WELLS

- Precipitation Recharge
- Widely different water chemistry types in GW from a small area
- Highest average TDS 274 (116-570 mg/l)
- Sulfate 65 (9.0-229 mg/l)
- Average pH 7.42
- NO₃N 0.37 mg/l, NH₃N 0.25 mg/l
- **Average arsenic 0.014 mg/l exceeds DWS (non-detect to 0.038 mg/l)**
- Spatially and hydraulically isolated locally and regionally

Major Ion Chemistry of Groundwater from Wells Completed in Emmett

Figure 13 in Glanzman and Squires, 2009



EMMETT WELLS

- GW from three wells
- Precipitation Recharge dominant
- Average TDS 303 (203-385 mg/l)
- Average pH 7.52
- NO₃N Non-detect, NH₃N 0.38 mg/l
- Average arsenic less than 0.0025 mg/l
- GW chemistry trends from near precipitation toward Terteling Spring Formation

SUMMARY

- PGSA GW is a discrete regional aquifer
- Not hydraulically connected to any other designated aquifers/area
- Recharged by the Boise River
- TSF GW also recharged by the Boise River
- WCA GW recharged by precipitation, elevated arsenic above DWS probably originates from volcanic sediments
- SVRW area recharged by precipitation, widely variable chemistry, elevated arsenic above DWS
- Emmett area GW recharged by precipitation, may be TSF sediments

Response to Staff Age Dating Questions

- BOISE RIVER RECHARGE
- Hutchings and Petrich, 2002
- Best Estimated Residence Time of PGSA GW from Goddard No. 2 and HP wells to be from modern to <2,000 and <3000 years, respectively.
- Carbon-14 dating indeterminate at less than 5,000 years
- Residence time of GW from the M3 wells best estimated by hydraulics

Principal Aquifer	Well Name	Top of Water Bearing Zone (feet above msl)	Ground Water Residence Time		
			Minimum	Maximum	Best Est.
North Boise <i>fluvial sands</i>	TVHP 1	2,282	0	1,000	<1,000
	HP	2,065	0	3,000	<3,000
Central and West Boise <i>lacustrine deposits</i>	Goddard 2	2,199	0	2,000	<2,000
	Cassia Monitor	2,226	0	4,000	<3,000
	Meridian 15	2,105	0	4,000	<4,000
	Meridian 19	2,010	0	4,000	<4,000
Southeast Boise <i>alluvial fan deposits</i>	Christiansen	2,636	0	4,000	<2,000
	Guyer	2,565	1,000	5,000	<2,000
	Micron Shallow	2,512	3,000	7,000	<4,000
	Knox	2,567	0	4,000	<5,000
	Blacks Creek	2,510	1,000	5,000	<5,000
South Boise <i>fan-to-lake transition deposits</i>	JR Flat	2,476	0	8,000	6,000
	Market Street	2,382	0	8,000	6,000
	McNabb	2,542	0	8,000	6,000
	MAC	2,372	0	11,000	9,000
	Amity	2,279	0	11,000	9,000
	Sunset West	2,295	0	9,000	7,000
Below Unconformity <i>deep deltaic deposits</i>	Edgeview	2,268	0	8,000	6,000
	Micron Deep	2,266	7,000	13,000	11,000
	Cassia 2	1,901	13,000	21,000	15,000
	Goddard 1	1,771	4,000	10,000	<10,000
Nampa and Caldwell <i>lacustrine deposits</i>	St. Luke's	1,890	7,000	13,000	9,000
	Lete	2,126	4,000	13,000	10,000
	Nampa 9	2,082	6,000	13,000	10,000
Down-valley <i>lacustrine deposits</i>	Caldwell 16	2,012	5,000	13,000	10,000
	Wright	1,898	35,000	47,000	42,000
	Johnson	2,010	28,000	38,000	32,000
	Keuspert	1,985	7,000	16,000	12,000
	Parma 10	2,036	24,000	31,000	26,000
	Uofl	1,984	9,000	19,000	13,000

Table 5. Ground water residence times for principal aquifers in the Treasure Valley regional ground water system. Residence times are based on ^{14}C -age dates using the CMB and $\delta^{13}\text{C}$ -mixing models. Minimum and maximum represent the full range of possible recharge conditions, while best estimates are based on the $\delta^{13}\text{C}$ -mixing model combined with the most appropriate recharge conditions as described in the text.

Response to Staff Isotope Questions

- Isotopes Deuterium (D) and Oxygen-18 (^{18}O)
- Isotope study not initially thought necessary - young age of the PGSA GW and excellent agreement of physical setting, hydraulics and geochemistry, particularly Major Ion Chemistry
- M3 Test Well No. 1, Test Well No. 2 and Test Well No. 3 sampled for D and ^{18}O
- D range -124 to -126 per mil
- ^{18}O range -15.9 to -16.1 per mil
- Wood and Low (1988), Boise River at Eckert Road: D -125 per mil and ^{18}O -16.3 per mil
- Isotopes concur - PGSA GW is from Boise River

Response to Staff Isotope Questions

Wood and Low (1988), Boise River at Eckert Road:
D -125 per mil and ^{18}O -16.3 per mil

Payette River near Payette: D -128 per mil and
 ^{18}O -17.0 per mil

Snake River at King Hill: D -132 and -133 per mil
and ^{18}O -17.3 and -17.4 per mil

Snake River at Weiser: D -126 and -130 per mil and
 ^{18}O -16.4 and -16.6 per mil

D range -133 to -125 per mil

^{18}O range -17.4 to -16.3 per mil

8.0 per mil D and 1.1 per mil ^{18}O differences too
small to provide useful source definition



Ground Water Samples
Taken at Test Well #2
July 24, 2007

Major Ion Chemistry of Groundwater from Wells Completed in the Pierce Gulch Sand Aquifer (PGSA)

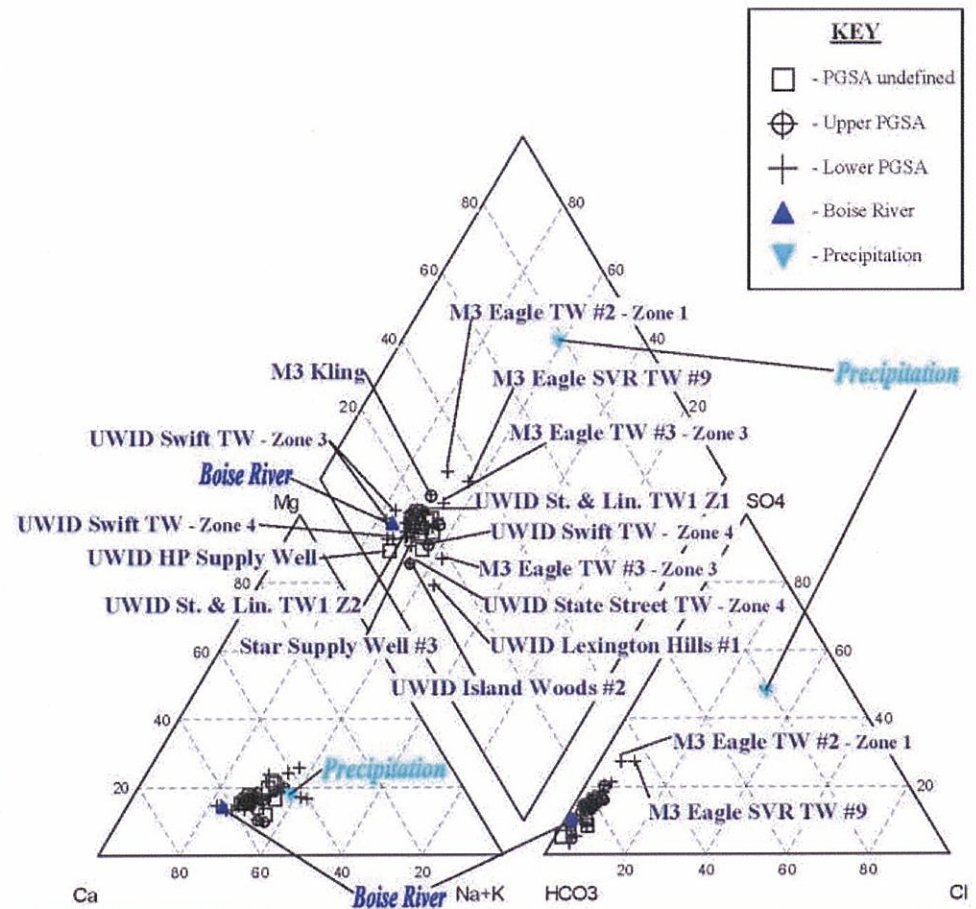


Figure 5. Trilinear diagram showing the major ion relationships of groundwater from the Pierce Gulch Sand Aquifer (PGSA) in the M3 Area compared to that of precipitation and Boise River water with labeling.

Figure 5.

Major Ion Chemistry of Groundwater from Wells Completed in the Terteling Springs Formation

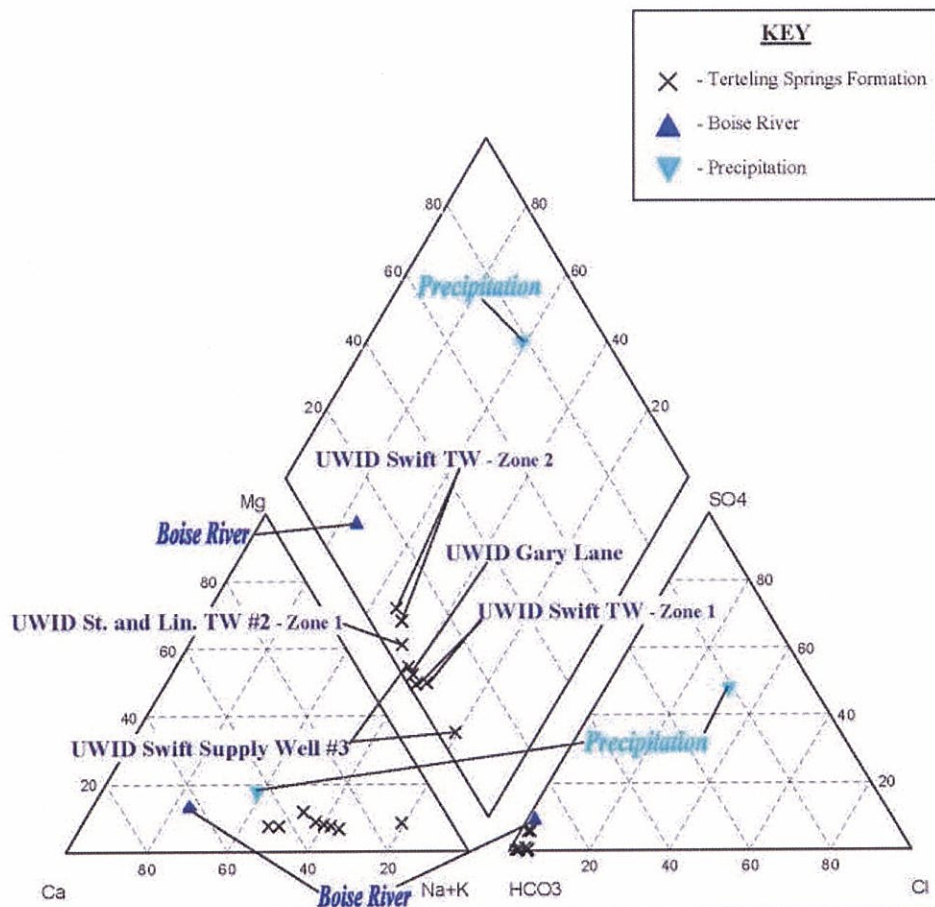


Figure 8. Trilinear diagram showing the major ion relationships of groundwater from the Terteling Springs Formation (TSF) in the M3 Area compared to that of precipitation and Boise River water with labeling.

Figure 8.

Major Ion Chemistry of Groundwater from Wells Completed in the "Willow Creek Aquifer" (WCA)

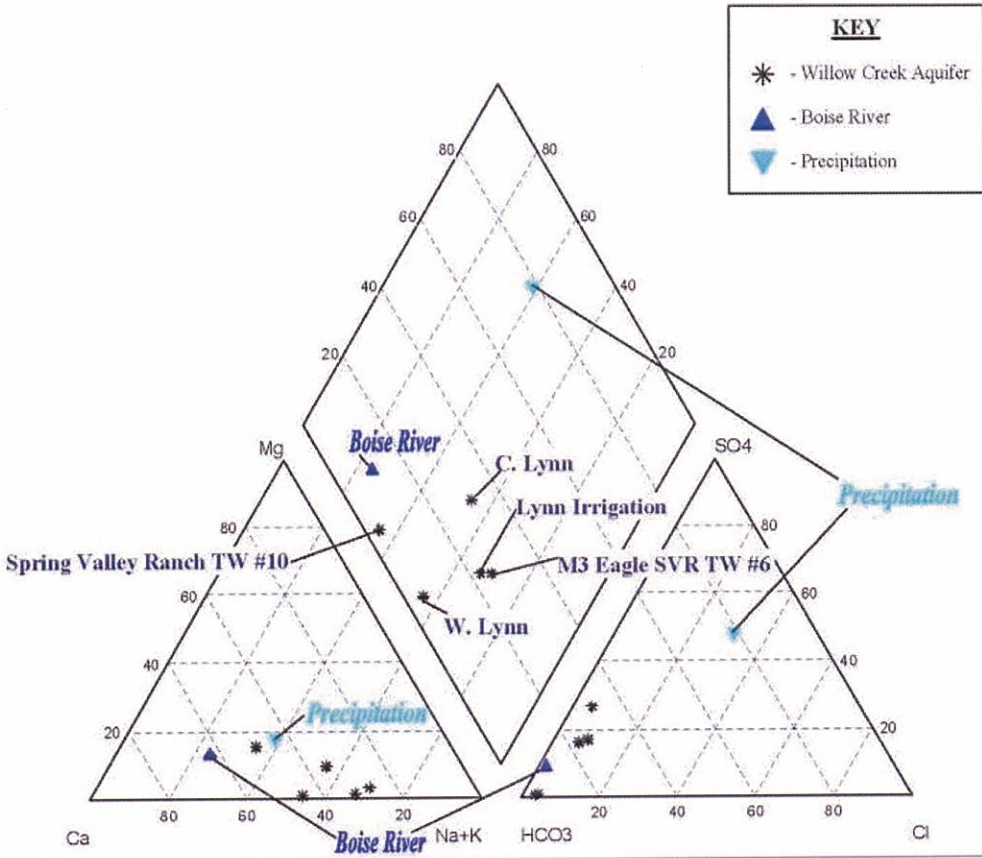


Figure 10. Trilinear diagram showing the major ion relationships of groundwater from the Willow Creek Aquifer (WCA) in the M3 Area compared to that of precipitation and Boise River water with labeling.

Figure 10.

R4W R3W R2W R1W R1E R2E

Figure 2. 2007 Regional Ground Water Level Contours and Ground Water Flow Directions of Major Aquifers

Water Level Data Sources:
M3 Project Area, Eagle, Star and Meridian: Measurements and Survey - Summer of 2007 by HLI

Emmett and Caldwell Areas:
Wells from IDWR Data Base. Locations / Elevations From Google Earth®, MapQuest® and TOPO®

Data contoured by Surfer® with manual contouring near Emmett and Caldwell. Dashed contours where sparse or approximate data appear to yield contours that may or may not be representative.

⊕ Well: surveyed ⊕ Well: estimated location
● Wells in the M3 Area, Emmett Area, Eagle Area, Star Area, and Spring Valley Ranch Area (SVRW)

Approximate Ground Water Flow Directions:

← Pierce Gulch Sand Aquifer
← "Willow Creek Aquifer" and Payette Valley Aquifer

Water Level Contour Elevation in Feet MSL

— 2400 —
(Dashed Where Inferred)

West Boise-Eagle Geologic Fault System

— — — — —
(Dashed Where Inferred)

Contact between bottom of Pierce Gulch Aquifer and underlying mudstone facies of the Tertling Springs Formation (inferred location, dashed where speculative)

— — — — —

Scale: ↑ = 1 Mile
North ↑

January 20, 2009

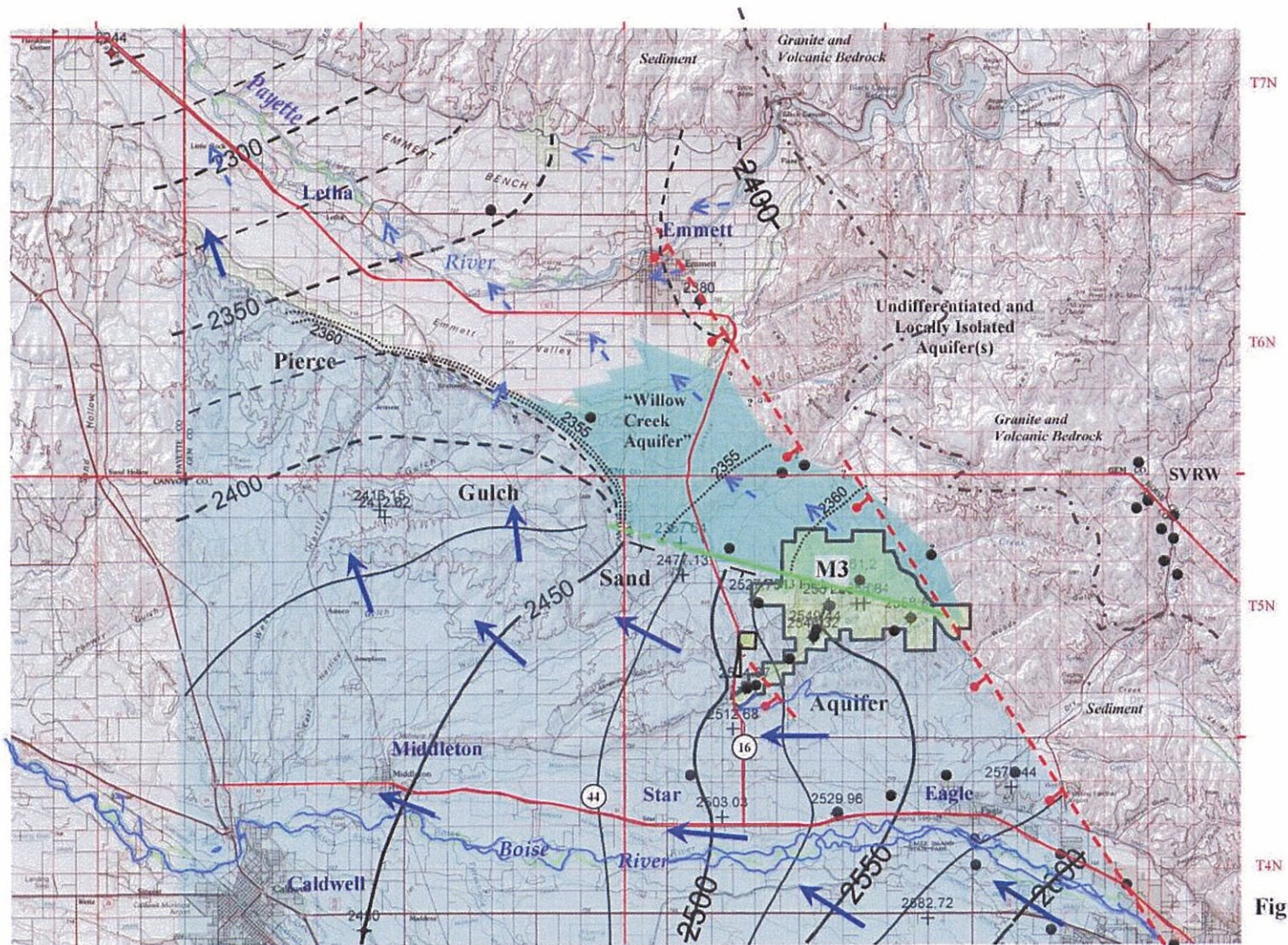


Figure 2.

The black-colored, 50-foot water level contours inside blue shading indicate the northwesterly movement of ground water from the Boise Basin to the Payette Basin north of the Cities of Star, Eagle, and Middleton through the Pierce Gulch Sand Aquifer. The dotted 5-foot water-level contours inside the turquoise area illustrate the relatively flat ground water gradient within the recharge-limited informally named "Willow Creek Aquifer" isolated between low-permeability sediments of the uplands lying to the east of the M3 site and by stratigraphic layering (a day-lighting clay stratum) on the southwest (green solid and dashed line). The boundaries of this aquifer have not been defined as indicated by the "?" symbol.

Hydro Logic, Inc
Boise, Idaho

Major Ion Chemistry of Groundwater from Wells Completed on Spring Valley Ranch (SVR)

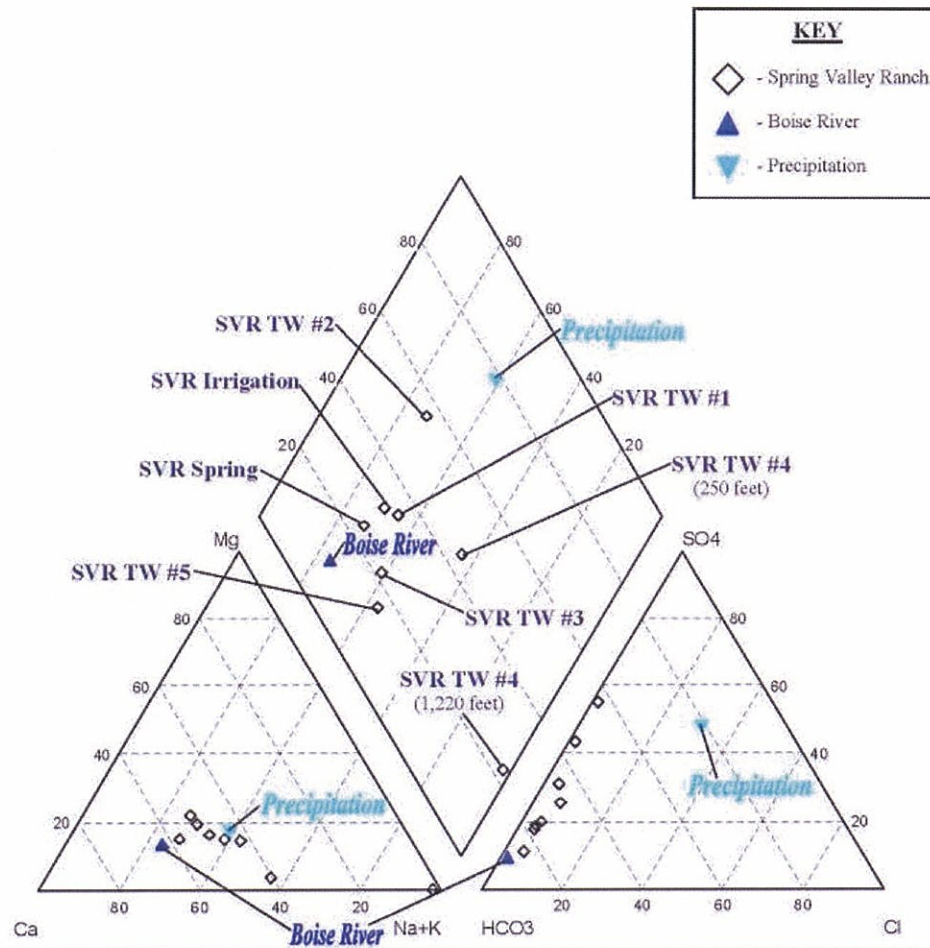


Figure 12. Trilinear diagram showing the major ion relationships of groundwater from the Spring Valley Ranch Wells (SVRW) in the M3 Area compared to that of precipitation and Boise River water with labeling.

Figure 12.

Major Ion Chemistry of Groundwater from Wells Completed in Emmett

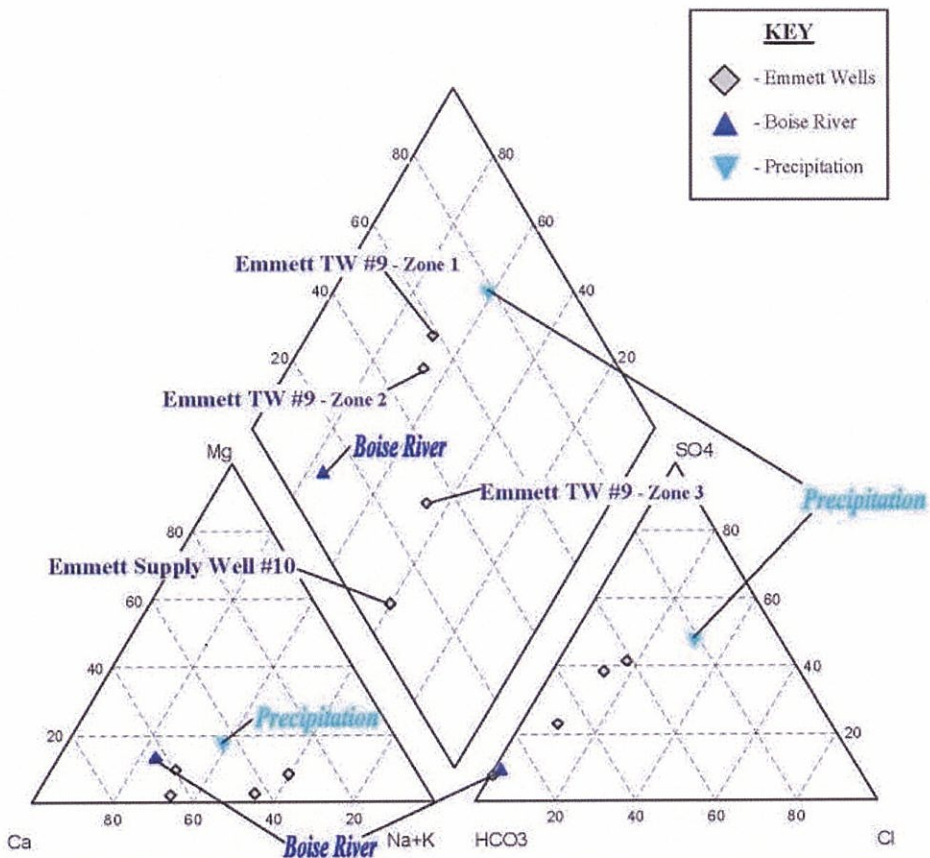


Figure 14. Trilinear diagram showing the major ion relationships of groundwater from the Spring Valley Ranch Wells (SVRW) in the M3 Area compared to that of precipitation and Boise River water with labeling.

Figure 14.