MONITOR WELL CONSTRUCTION AND TESTING
Warm Springs Valley
Washoe County, Nevada

WASHOE COUNTY
DEPARTMENT OF PUBLIC WORKS
UTILITY DIVISION

P.O. BOX 11130 RENO, NEVADA 89520

MONITOR WELL CONSTRUCTION AND TESTING
Warm Springs Valley
Washoe County, Nevada

Prepared by
Washoe County Dept. Comprehensive Planning
Washoe County Dept. Public Works, Utility Division
June 1993

TABLE OF CONTENTS

FIGURES AND TABLES

Figures

Tables

ACKNOWLEDGMENTS

Washoe County would like to thank Greg Moss and Dwight Smith of SEA, Inc., Sparks, Nevada, for their invaluable assistance during this program.

INTRODUCTION

The identification of a nitrate problem in Warm Springs Valley dates back to at least the 1970's. In a study for the TIC Corp., consultants determined that an undefinable source of nitrate existed east of Ironwood Road (Sharp and Krater, 1974). Nitrate levels as high as 90 ppm (as NO3) were found in the area and progressively lower levels were found northward. One conclusion of this work was that the nitrates fluctuated seasonally. Their extensive work did not yield a source of the nitrate. Further sampling in 1992 indicated that the problem still exists (Leonard Crowe, oral communication).

Figure 1 shows concentrations of nitrate from the sampling conducted in 1992. The highest concentrations of nitrate (68 ppm as NO3) are found immediately east of Ironwood Road. This water exceeds the primary drinking water limit of 45 ppm for nitrate (as NO3). To the north of Whisky Springs Road concentrations are as high as 17 ppm. Both areas are within the proposed Terra West development. It is important to further delineate the areas of high nitrate concentration in order to properly site the future quasi-municipal supply of the proposed Terra West housing development.

The primary purpose of this monitoring program was to try to determine if nitrates were concentrated in a particular vertical section of the aquifer. Three or four wells would be completed in discrete areas. The discovery of thick clay lenses or aquitards would help in determining these sections. Secondly, water quality could be monitored to determine if a migration pattern of nitrate exists and if so, how irrigation pumpage affects the migration pattern. Finally, a test well was drilled in an area where no water quality data existed and where a possible production well could be constructed. Figure 2 shows these drill site locations.

DRILLING OPERATIONS

Nevada Drilling was contracted by SEA, Inc., to drill four tests holes and complete as six inch diamter monitor wells. A Midway Model 15 Direct Rotary drilling rig with tri-cone bits were used to drill 12-1/4 inch diameter boreholes. Depths of these boreholes ranged from 150 to 700 feet. The drilling fluid consisted of high yield bentonite clay with minor amounts of synthetic polymer additives.

Washoe County Department of Comprehensive Planning personnel supervised the drilling operations and performed the lithologic sampling. Samples were collected throughout the borehole and bagged at ten foot intervals. Geo-Hydro-Data performed borehole geophysics which included electric and natural gamma logs.

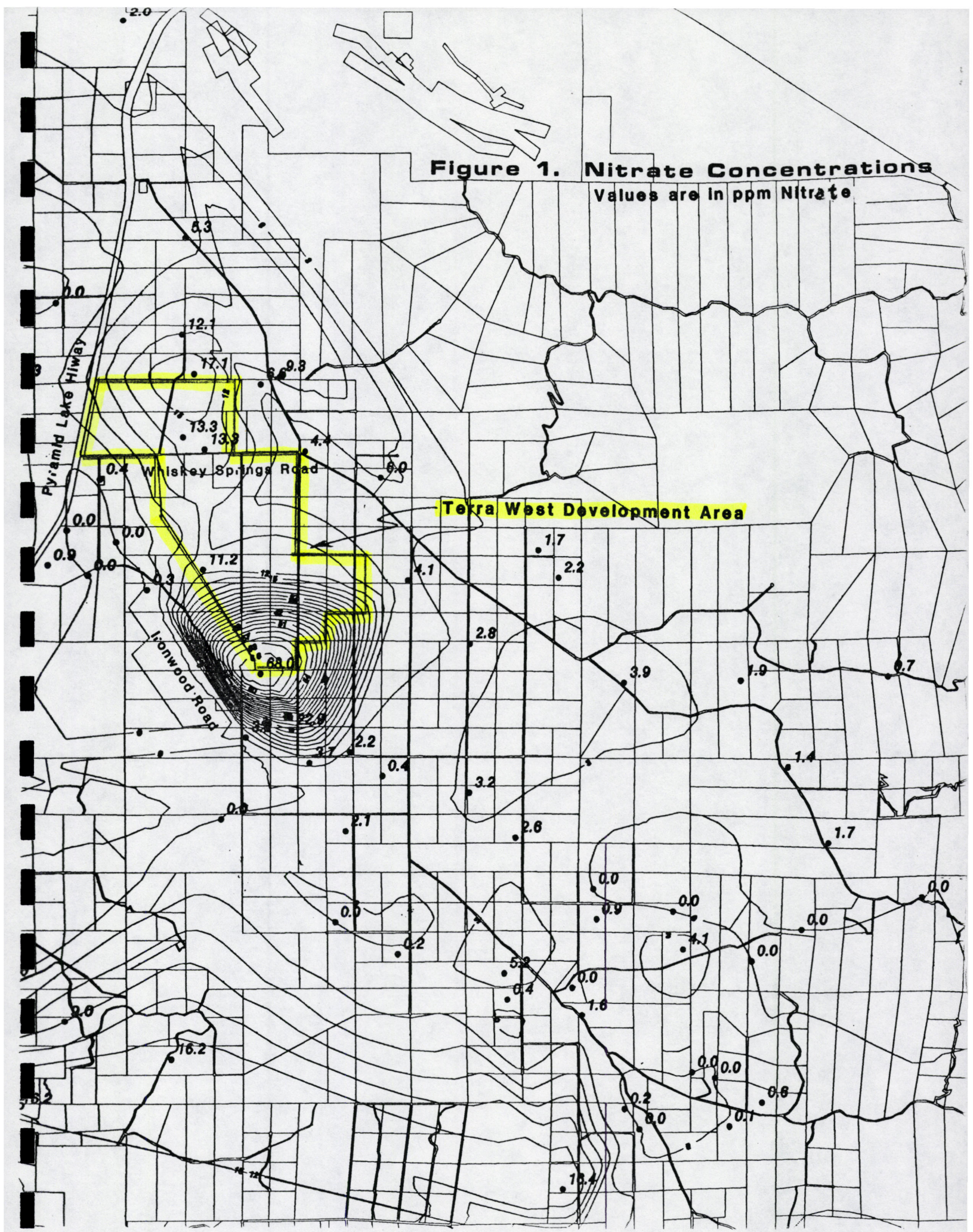
Figure 1. Nitrate Concentrations
Values are in ppm Nitrate
Pyramid Lake Hiway
Whiskey Springs Road
Lionwood Road
Terra West Development Area
2.0
6.3
0.0
12.1
17.1
9.3
13.3
13.3
4.4
0.4
6.0
0.0
0.0
0.9
0.0
0.3
11.2
1.7
2.2
4.1
2.8
68.0
3.9
1.9
0.7
22.9
2.2
2.7
0.4
1.4
3.2
0.0
2.1
2.6
1.7
0.0
0.0
0.9
0.0
0.0
0.2
4.1
0.0
5.2
0.0
0.4
1.6
2.6
16.2
0.0
0.0
0.2
0.0
0.8
0.1
16.2
18.4

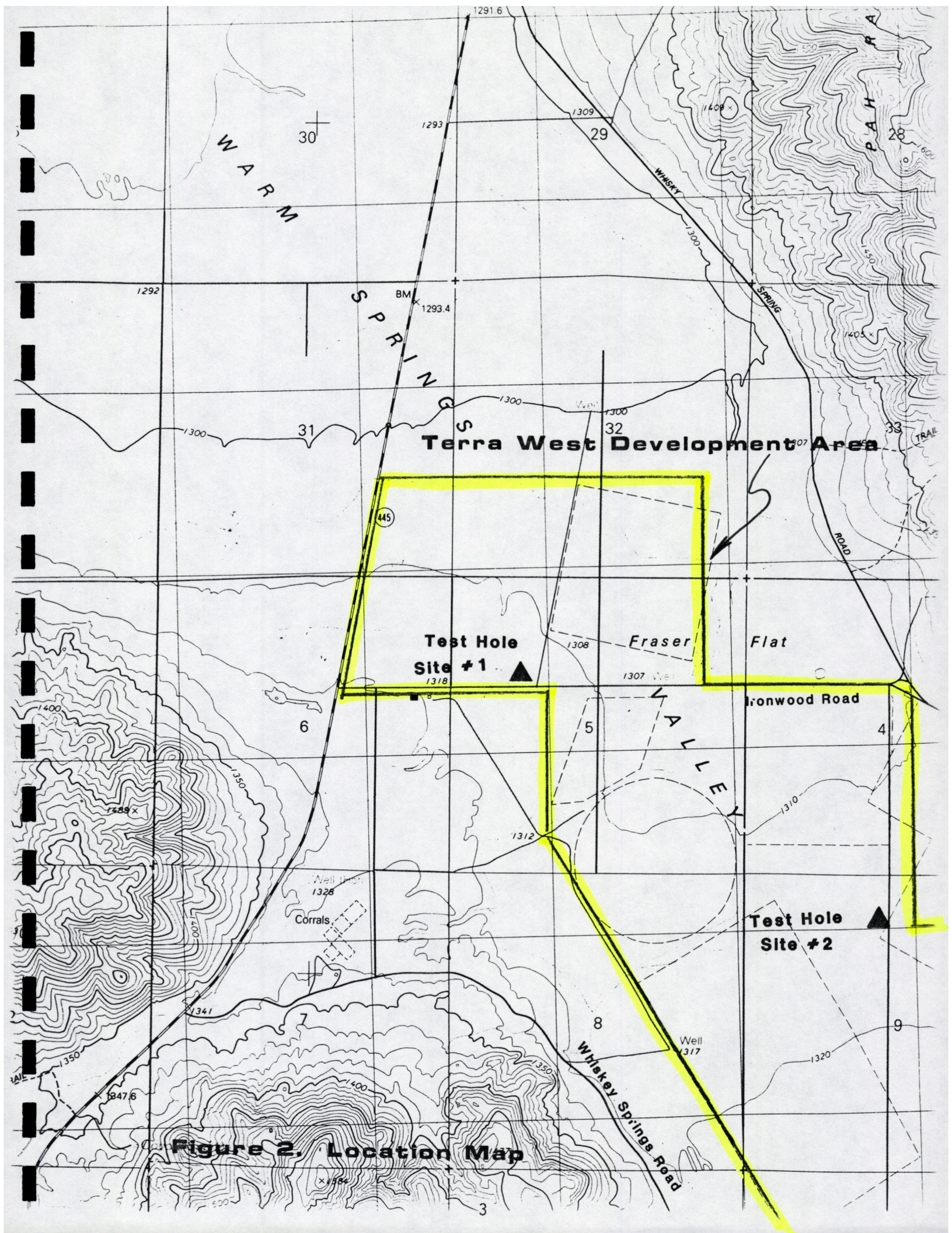

Figure 2. Location Map

The boreholes were then constructed as 6" diameter, steel cased monitor wells. Local 3/8 inch pea gravel was used for the gravel envelope which was tremmied. Seals were then implaced via tremmie. The wells were air lift developed until clean.

DESCRIPTION OF LITHOLOGY

Test Hole 1 The alluvial cuttings collected during the drilling of TH 1 indicate moderate to well sorted granitic and volcanic sands, silts and clay sized particles (see Table 1). Well sorted sand lenses were logged at 125-135 feet and at 195-245 feet. Clayey silts were logged at 135-195 feet, 385-435 feet and 555-590 feet which may act as aquitards. The other sections were mostly silty sands or clayey silty sands. From the electric log (see Figure 3) resistivities ranged from 5-70 ohm-m and mostly 20-40 ohm-m. This log verifies the aquitard material noted above.

Test Hole 2 The alluvial cuttings collected during the drilling of TH 2 indicate poorly to moderately sorted, volcanic clays, silts, sands and gravels. Unlike TH 1, there appeared to be an absence of granitic materials. Sands were mostly mixed with silts and clay sized particles. The electric log (see Figure 4) resistivities ranged almost entirely from 20-40 ohm-m.

WELL CONSTRUCTION

Monitor wells were constructed at the Test Hole 1 site so as to determine and monitor water quality in specific sections of the aquifer. Taking advantage of aquitard materials found at 135-195 feet and 385-435 feet, wells were located and perforated at 120-140 feet, 180-400 feet and 440-600 feet. At Test Hole 2, the well casing was perforated from 320-660 feet. This well completion was troublesome during the gravel implacement and it is believed that the gravel bridged; which will allow migration of aquifer material to enter into the well. Table 3 lists total depth and slot intervals for each well. The "quasi" static is not necessarily a true static due to large scale irrigation pumping in the vicinity. Also, these levels are from well head measuring points, not from land surface.

Table 3
Monitor Well Construction

Mon. Well	Total Depth (ft)	Casing Depth (ft)	Slot Interval (ft)	Seal Depth (ft)	Quasi Static (ft)
1	150	150	120-140	100	140.00
2	410	408	180-400	180	151.47
3	625	620	440-600	440	158.36
4	700	680	320-660	95	170.65

PALOMINO VALLEY OBSERVATION WELLS
TEST HOLE #1 (TH-1)

FEET	LITHOLOGY
000 - 050	Medium to coarse size sands, primarily granitic with minor volcanics; angular; poorly sorted; no clays
050 - 065	A pebbly, silty sand, granitic-volcanic mix; angular; poorly sorted
065 - 125	Medium size sands with minor very fine sands and silt lenses; primarily quartz (granite) with minor volcanics; subrounded; moderately well sorted; minor epidote and biotite, no clays
125 - 135	Very coarse angular basalts intermixed with medium to coarse subangular quartz sands; poorly sorted; no clays
135 - 195	Clayey silts with minor fine sand lenses; yellow-brown color; biotite
195 - 245	Medium to fine grained granitic sands; subrounded; well sorted, no clays
245 - 285	Sandy silt, primarily quartz; moderately rounded; moderately well sorted; minor yellow-brown clays
285 - 385	Silty, clayey sands, primarily granitic with minor volcanics; sands are rounded and moderately well sorted; clays yellow-brown
385 - 435	Sandy clay-mudstone, medium brown color; very slow drilling
435 - 475	Silty, clayey, coarse quartz and basalt sands; subangular-subrounded; moderate-poorly sorted; grey-brown clays
475 - 550	Medium to fine grained quartz and volcanic sands with clay and silt lenses; moderately well rounded and sorted; brownish-orange clays
550 - 610	Interbedded silts and clays with medium to fine grained volcanic sand lenses; yellow-brown clays; very hard drilling

Table 1. Lithologic Log, Test Hole 1

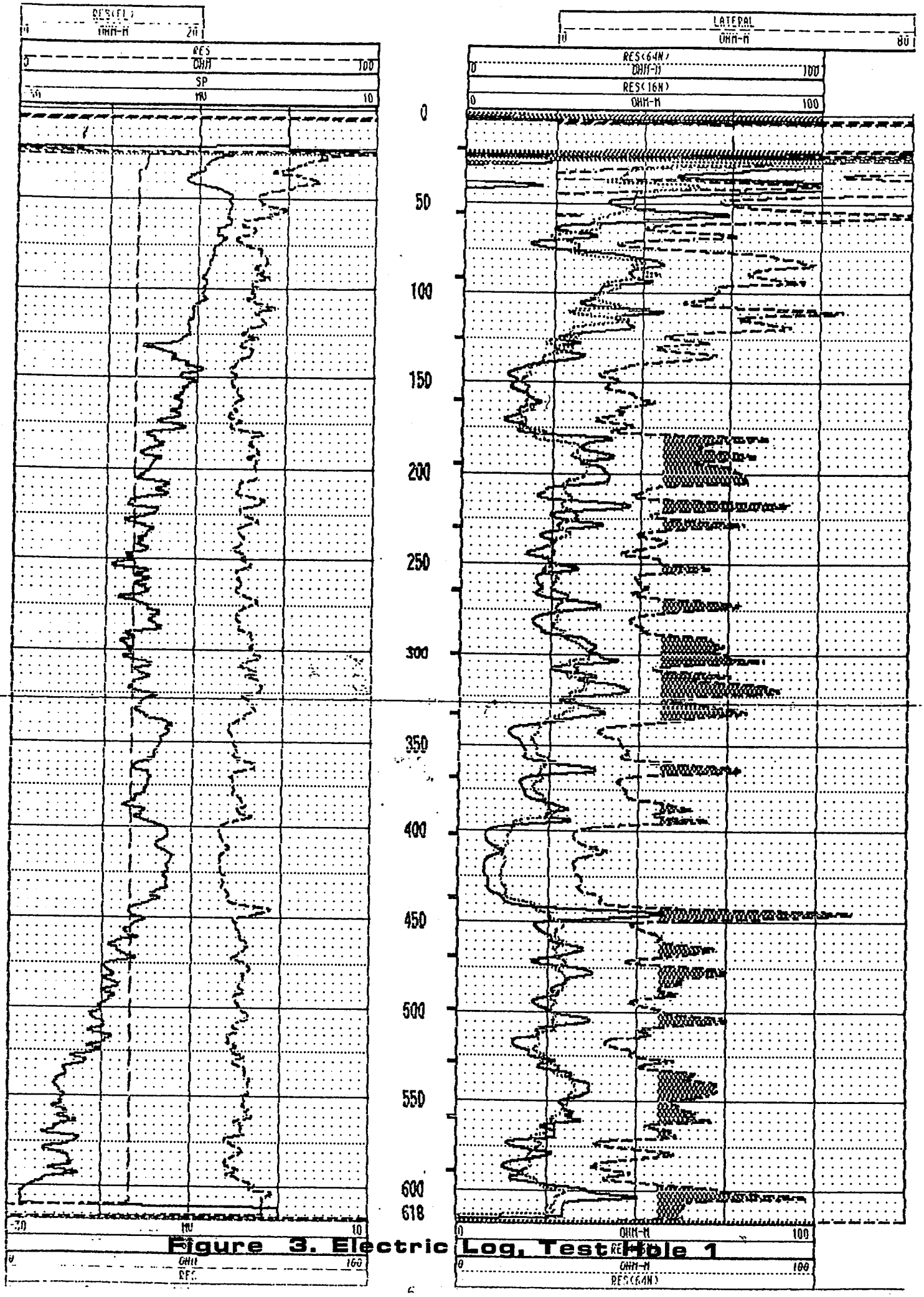

Figure 3. Electric Log, Test Hole 1

PALOMINO VALLEY OBSERVATION WELLS
TEST HOLE #2 (TH-2)

FEET	LITHOLOGY
000 - 055	Sandy gravels, primarily pink rhyolites with minor quartz; angular-subrounded; moderate sorting; no clays
055 - 075	Clayey silt with volcanic gravel lenses; medium light brown clays with platy black minerals (biotite)
075 - 125	Medium size volcanic sands interbedded with gravels and silts; subrounded to rounded; moderate to well sorted; minor red-brown clays with biotite
125 - 145	Very fine sands and silts with clay lenses; volcanics (rhyolite), very hard drilling; reddish-brown clays
145 - 185	Medium to coarse size volcanic sands interbedded with thin lenses of clay; subrounded to rounded; increase in basalts; reddish-brown clays
185 - 240	Clayey silts with lenses of volcanic sands and gravels; red-brown to medium brown clays with biotite; sands basalt and rhyolitic; subangular; poorly sorted
240 - 270	Medium size rhyolitic sands interbedded with thin lenses of very fine volcanic sands; subrounded to rounded; moderately well sorted; minor red-brown clays
270 - 310	Clayey silts interbedded with very fine sands; red-brown clays; minor gravel size angular volcanic sands
310 - 345	Medium to fine grained volcanic sands; rounded and well sorted; increase in quartz, minor clays
345 - 610	Medium sands interbedded with thin lenses of silts, clays and gravels; primarily volcanics with increase in quartz; subangular to subrounded; poorly sorted to moderately well sorted; red-brown clays; hard drilling at times
610 - 700	Silty sands interbedded with clays with minor gravels; primarily volcanics with quartz and biotite; subangular; poor to moderately sorted; red-brown clays

Table 2. Lithologic Log, Test Hole 2

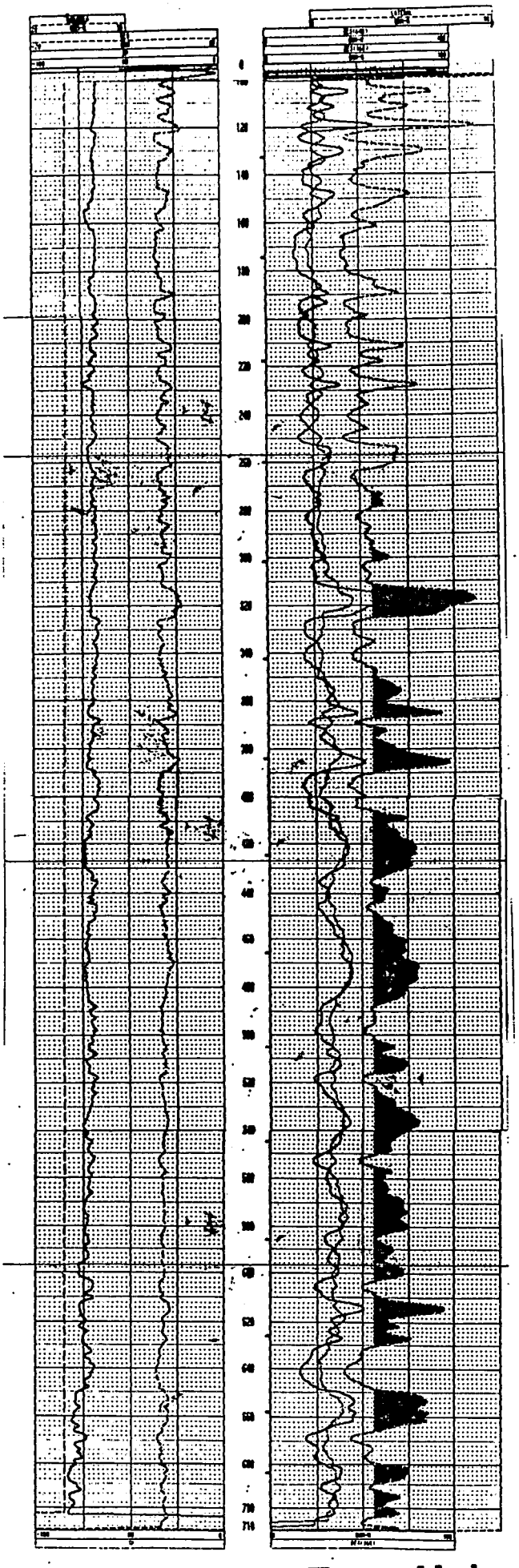

Figure 4. Electric Log, Test Hole 2

WELL TESTING

During the period from May 12-24, 1993, pumping test were conducted on monitor wells 2, 3 and 4.

Prior to testing at the Test Hole 1 Site, the Pratt Irrigation Well, located 1100 feet to the northeast, began seasonal pumping. Insufficient data was taken to determine background drawdown at the monitor wells caused by the pumping from the irrigation well. However, previous pumping test data on the Pratt well indicated that the water levels in the monitor wells were probably fairly stable- plus or minus 0.02 feet (Widmer, 1992).

No testing was done on the shallow 150 ft monitor well. The pumping test on monitor well 4 yielded poor results as the well was still developing and pumped various amounts of mud. Yet, at the end of the testing, the discharge was clear and reasonable free of silt.

Table 4 lists the results from the pumping tests. These results are preliminary and approximate. Figures 5, 6 and 7 show the time vs. drawdown curves for tests on wells 2, 3 and 4, respectively. The field data are included in the appendix.

Table 4
Pumping Test Results

Well	Discharge rate (gpm)	Duration (min)	Drawdown (ft)	Transmisivity (gpd/ft)
2	165	210	4.86	165,000
1			-0.06	
3			0.40	
3	200	240	8.25	50,000
1			0.07	
2			0.24	
4	~30	300	35.59	1,000

Transmissivities were calculated using the Cooper and Jacob Modified Nonequilibrium Equation, which uses assumptions that are not valid for these tests. However, given the preliminary nature of the testing, the equation's results are useful in qualitative comparisons of these three sections of the aquifer. More detailed analysis would require retesting with larger discharge rates at longer durations.

WATER QUALITY ANALYSIS

Table 5 lists various water quality parameters from the samples taken. Full analysis are in the appendix.

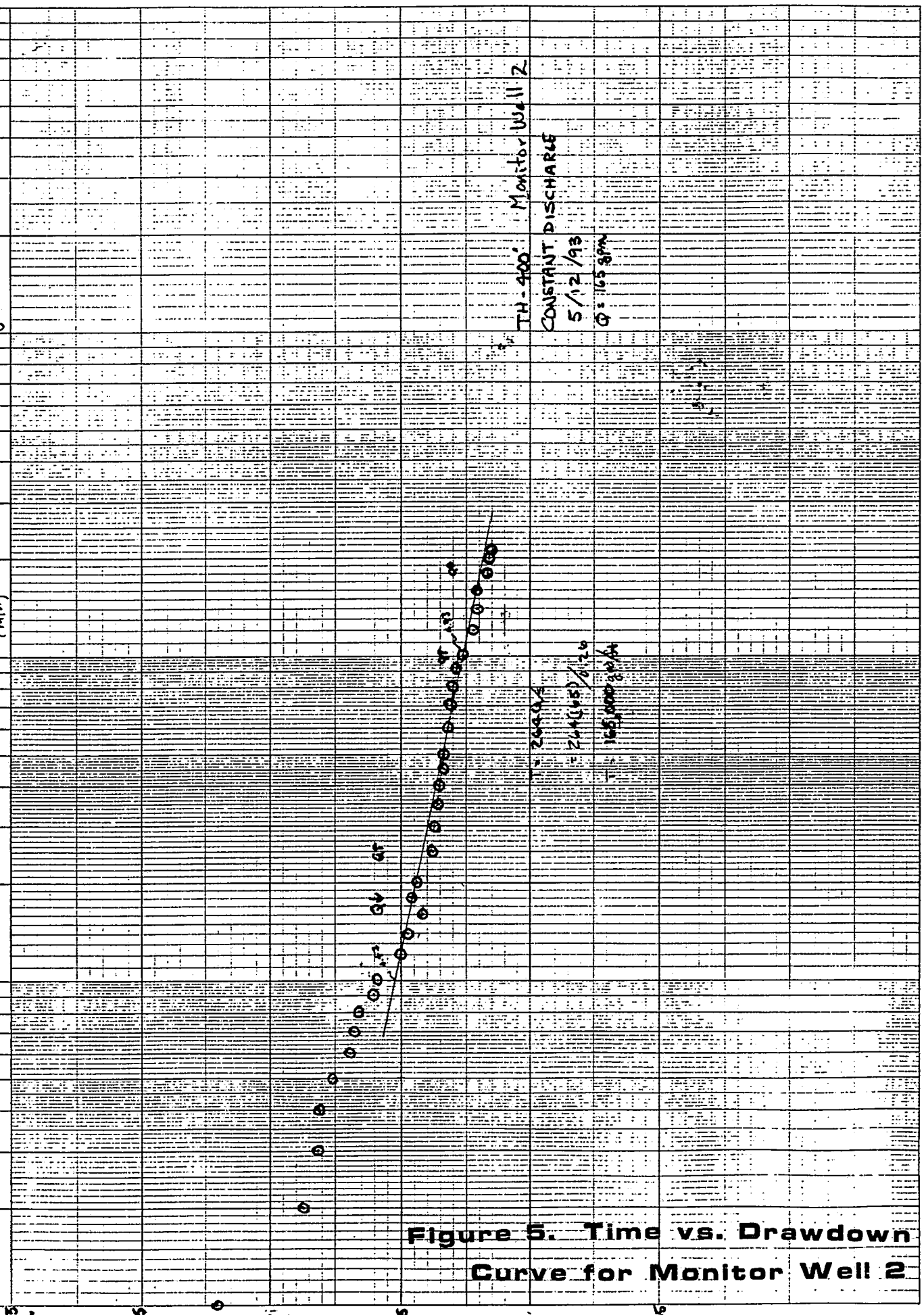

Figure 5. Time vs. Drawdown Curve for Monitor Well 2

Semi-Logarithmic
1 Cycles x 10 to the inch

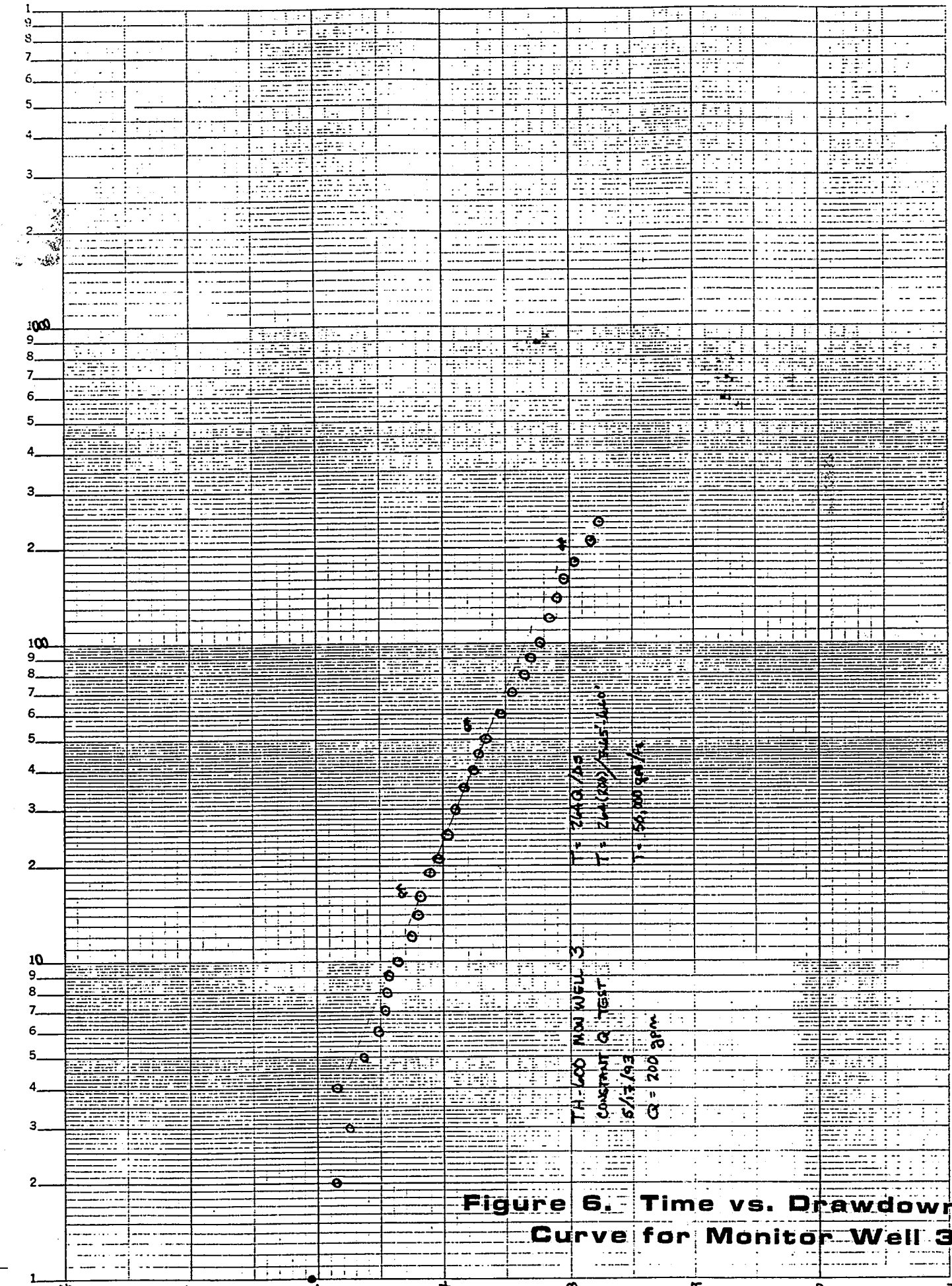

Figure 6. Time vs. Drawdown Curve for Monitor Well 3

Semi-Logarithmic
5 Cycles x 10 to the inch

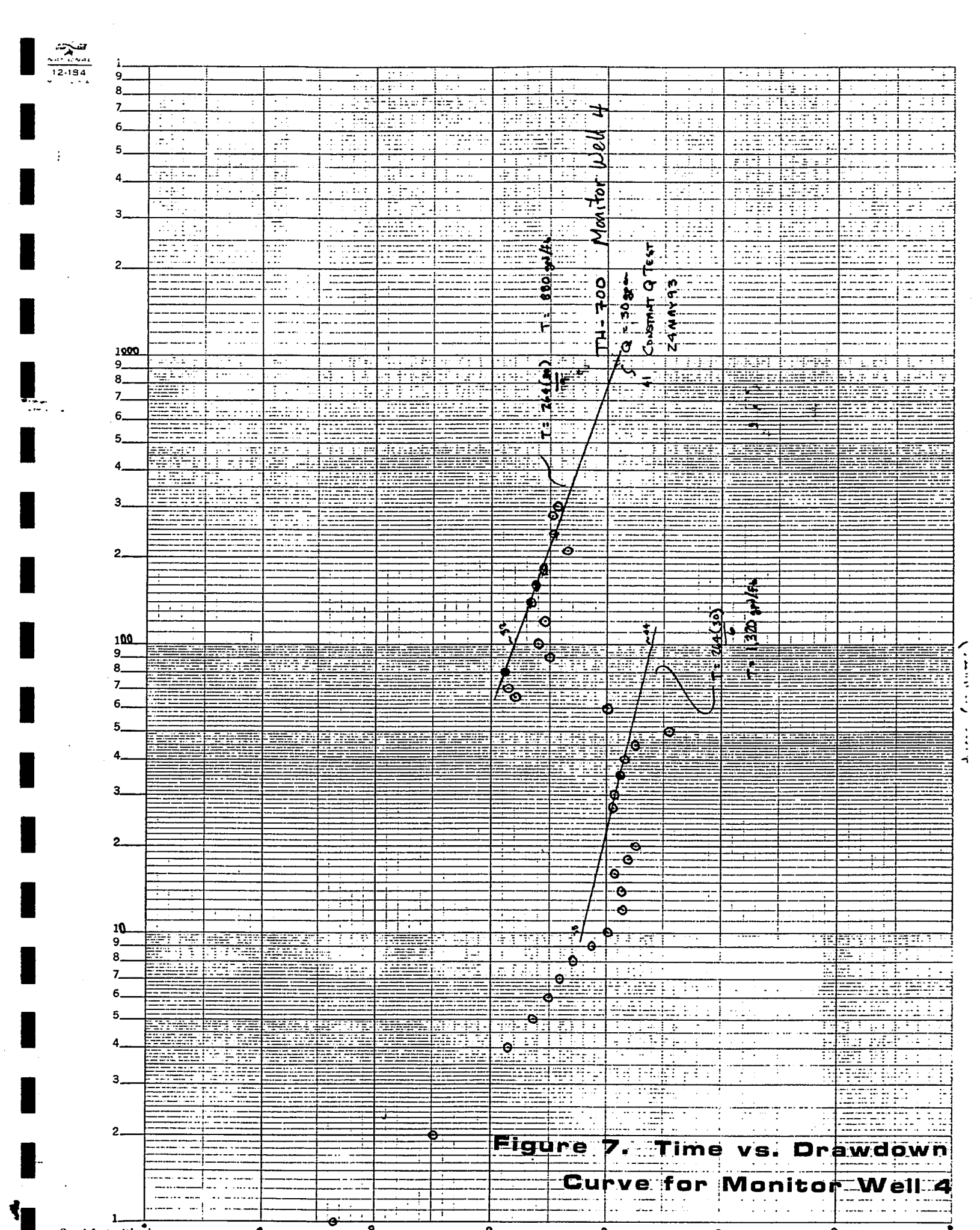

Figure 7. Time vs. Drawdown Curve for Monitor Well 4

Table 5
Water Quality Analysis
(ppm)

Well	PERF(FT)	TDS	NO3	SO4	Cl	HCO3	Na	K	Ca	Mg	As
1	120-140	755	107	186	52	217	56	11	100	35	0.007
2	180-400	380	11.2	60	24	212	31	8	52	20	0.008
3	440-600	343	3.6	42	17	234	30	7	46	18	0.006
4	320-660	285	1.4	39	13	171	39	4	30	9	0.008

DISCUSSION AND CONCLUSIONS

From the water samples taken it is clear that the nitrate is mostly confined to the top section of the aquifer in the area of site 1. Well 1 quality is about double the TDS of the other waters. Figure 8 is a trilinear diagram of the quality from the four wells. Note that well 1 is differentiated from wells 2 and 3 by a larger percentage of sulfate. Well 4 differs with a larger percentage of sodium (see trilinear calcs in appendix). Because the upper portion of the aquifer at Well 4 was not perforated, we cannot determine if nitrate is concentrated at this level as at Site 1.

Quasi static heads in the wells indicates that a downward gradient exists. The pumping tests showed that drawdowns occured in all three wells during the testing of wells 2 and 3. From this data it is reasonable to argue that the pumping of one section of the aquifer induces flow from the other sections of the aquifer. Either the "aquitards" are not laterally extensive or the vertical hydraulic conductivity allows for leakance, or both given the relatively small pumpage rates and durations. Pumping tests of longer duration and of larger pumping rates are needed to more fully understand this relationship.

The transmissivities determined are qualitative. That is to say the equation used to derive the values given is not necessarily the correct equation. The pumping tests conducted were inadequate to analyze the aquifer parameters of each section in any detail. However, given the approximate values determined it is clear that the aquifer section from 200-440 feet is more productive, but at more risk to nitrate contamination than the lower section. With respect to municipal pumpage the lower section would be the preferred section to pump. Constructing a well with a capacity of 400-700 gpm appears reasonable from this lower section.

While site 1 has very favorable hydraulic conditions for municipal pumpage, site 2 is does not. The transmissivity derived is probably low due to well inefficiencies, at times was pumping mud and therefore was not fully developed. Studying the lithologic and electric logs indicates relatively poor aquifer materials; clayey, silty sands of volcanic origin. Further exploration would be necessary to delineate the lateral extent of these deposits.

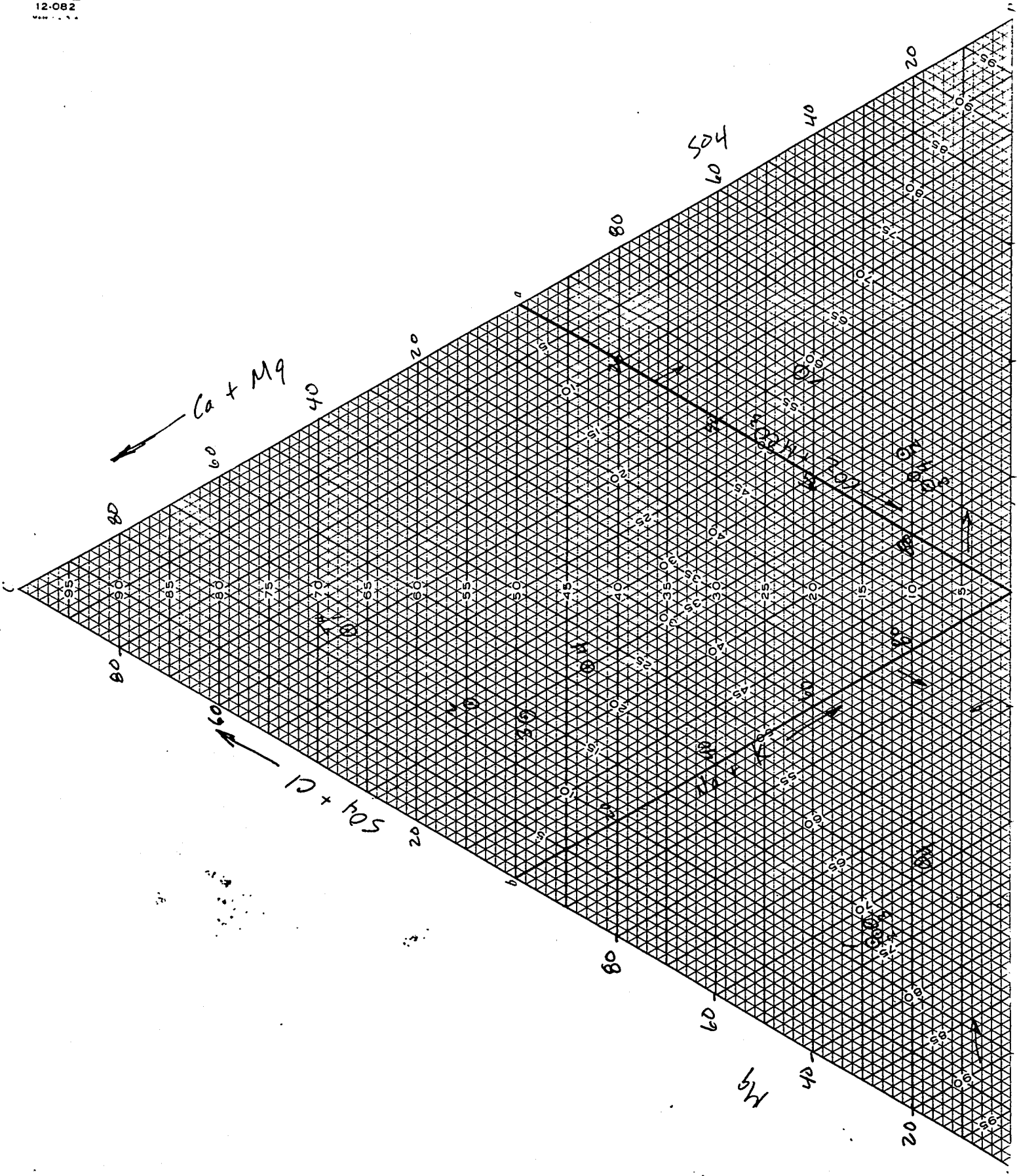

Figure 8. Trilinear Diagram

FUTURE WORK

1. Survey the well heads so as to detail the vertical gradients.

2. Rerun the pumping tests on wells 2 and 3. Well 4 would need more development before re-testing and given the poor aquifer response may not warrant the expense.

3. Sample these wells and the irrigation wells quarterly, collecting detailed records of pumpage rates from the irrigation wells.

4. Develop and initiate a work plan for identifying the source of nitrate.

REFERENCES

Dawson, Karen and Istok, Jonathan. 1991. Aquifer Testing. Lewis Publishers, Chelsea, MI. 344 p.

Sharp, M. and Krater. 1974. Management of Water Quality, Warm Springs Valley Ground Water Basin: Consultant's Report prepared for TIC Corp., by Sharp, Krater and Associates.

Widmer, Michael. 1992. Warm Springs Pumping Tests: Memorandum to Leonard Crowe dated April 9, 1992. Washoe County Utility Division. 4 pages.

APPENDIX

Well Construction Data

Pumping Test Data

Water Quality Analysis

PALOMINO VALLEY OBSERVATION WELLS
TEST HOLE #2 (TH-700)
GRASS VALLEY RD - 700 FEET T.D.

FEET	WELL DESIGN
680 - 700	GRAVEL FILL; NO CASING
660 - 680	BLANK CASING
380 - 660	FACTORY SLOTTED CASING
320 - 380	TORCH-CUT SLOTTED CASING
SURFACE - 320	BALNK CASING

Gravel packed hole from 700 to 95 feet using a two inch diameter pipe. Cement seal from 95 feet to surface. Gravel settled after cement seal was emplaced and another 40 to 50 feet of cement was added.

PALOMINO VALLEY OBSERVATION WELLS
MONITORING WELL (TH-150)
WHISKEY SPRINGS RD - 150 FEET T.D

FEET	WELL DESIGN
140 - 150	BLANK CASING
120 - 140	FACTORY SLOTTED CASING
SURFACE TO 120	BLANK CASING

Gravel packed hole from 150 to 100 feet using a two inch diameter pipe. Cement seal from 100 feet to surface.

PALOMINO VALLEY OBSERVATION WELLS
MONITORING WELL (TH-400)
WHISKEY SPRINGS RD - 408 FEET T.D

FEET	WELL DESIGN
400 - 408	BLANK CASING
180 - 400	FACTORY SLOTTED CASING
SURFACE - 180	BLANK CASING

Gravel packed hole from 408 to 180 feet using a two inch diameter pipe. Cement seal from 180 feet to surface.

PALOMINO VALLEY OBSERVATION WELLS
TEST HOLE #1 (TH-600)
WHISKEY SPRINGS ROAD - 620.5 FEET T.D.

FEET	WELL DESIGN
600 - 620.5	6" BLANK CASING
440 - 600	6" FACTORY SLOTTED CASING
SURFACE - 440	6" BLANK CASING

Gravel packed hole from 620.5 to 440 feet using a two inch diameter pipe. Cement seal from 440 feet to surface.

WASHOE COUNTY

DEPARTMENT OF PUBLIC WORKS
UTILITY DIVISION

PUMPING TEST DATA

WELL TH 405
(PUMPING) / OBSERVATION WELL
PUMPING / (RECOVERY DATA)
PAGE 1 OF 1

TYPE of PUMPING TEST: CONSTANT DISCHARGE
HOW Q MEASURED: 3" X 6" ORIFICE WEIR
HOW WL's MEASURED: ELECTRIC SOUNDER
PUMPED WELL NO.: TH400
RADIUS of PUMPED WELL:
DISTANCE from PUMPED WELL:

M.P. for WL's: TOP 6" CASING elev.:
DEPTH of PUMP/AIRLINE: wrt:
% SUBMERGENCE: initial: ; pumping:
PUMP ON: date 5/12/93 time 1000
PUMP OFF: date 5/12/93 time 1330

TIME t = at t'=0					WATER LEVEL DATA STATIC WATER LEVEL 149.70					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	(S) or S'	Q/s	H"	Q	(NOTE ANY CHANGES IN OBSERVERS)
		1			153.49			3.79		24"	165	
		2			153.82			4.12				Q↑
		3			153.87			4.17				
		4			153.88			4.18				
		5			153.94			4.24				
		6			154.01			4.31				
		7			154.02			4.32				
		8			154.04			4.34				Q↑
		9			154.10			4.40				
		10			154.11			4.41	37			
		12			154.20			4.50				
		14			154.22			4.52				
		16			154.28			4.58				Q↓ 19.5"-19.75"
		18			154.24			4.54				
		20			154.25			4.56				
		25			154.32	155-0.68		4.62				Q↑
		30			154.32	155-0.68		4.62				
		35			154.34	155-0.66		4.64				
		40			154.34	155-0.66		4.64				☆
		45			154.36	155-0.64		4.66				
		50			154.36	155-0.64		4.66				
		60			154.38	155-0.62		4.68				
		70			154.39	155-0.61		4.69				
		80			154.39	"		4.69				PROBE HANGING UP
		92			154.42	-0.58		4.72				Q↑ "
		100			154.44	-0.56		4.74				"
		121			154.47	-0.53		4.77				"
		140			154.49	-0.51		4.79	34			"
		160			154.47	-0.53		4.77				Q↑
		180			~~154.54~~	-0.46		~~4.87~~				
		200			154.54	-0.46		4.84				H_2O SAMPLED @ 200 MIN
		210			154.56	-0.44		4.86				

UTIL-16

WASHOE COUNTY

DEPARTMENT OF PUBLIC WORKS
UTILITY DIVISION

PUMPING TEST DATA

WELL TH-150
PUMPING / OBSERVATION WELL
PUMPING / RECOVERY DATA
PAGE 1 OF _____

TYPE of PUMPING TEST Constant Q
HOW Q MEASURED 3" x 6" ORIFICE
HOW WL's MEASURED ELECTRIC SOUNDER
PUMPED WELL NO. _____
RADIUS of PUMPED WELL _____
DISTANCE from PUMPED WELL _____

M.P. for WL's TOP 6" CASING elev. _____
DEPTH of PUMP/AIRLINE _____ wrt _____
% SUBMERGENCE: initial _____ ; pumping _____
PUMP ON: date 5/12/93 time 1000
PUMP OFF: date 5/13/93 time 1330

TIME t = at t'=0					WATER LEVEL DATA STATIC WATER LEVEL 139.52					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t / t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'			Q	(NOTE ANY CHANGES IN OBSERVERS)
		1										
		2			139.52							
		3										
		4										
		5										
		6										
		7			139.52							
		8										
		9										
		10										
		11			139.52							
		13			"							
		15			—							
		17			139.52							
		20			"							
		27			"							EE
		47			"							
		57			139.51							
		67			139.51							
		78			139.51							
		107			139.50							
		126			139.49							
		147			139.49							
		167			139.48							
		197			139.47							
		207			139.46							

UTIL-16

WASHOE COUNTY

DEPARTMENT OF PUBLIC WORKS
UTILITY DIVISION

PUMPING TEST DATA

WELL TH-600
(PUMPING) / OBSERVATION WELL
(PUMPING) / RECOVERY DATA
PAGE 1 OF 1

TYPE of PUMPING TEST CONSTANT DISCHARGE
HOW Q MEASURED 3" x 6" ORIFICE WEIR
HOW WL's MEASURED ELECTRIC SOUNDER
PUMPED WELL NO. TH400
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL

M.P. for WL's TOC 6" elev.
DEPTH of PUMP/AIRLINE wrt
% SUBMERGENCE: initial ; pumping
PUMP ON: date 5/12/93 time 1000
PUMP OFF: date 5/12/93 time 1330

TIME t = at t'=0					WATER LEVEL DATA STATIC WATER LEVEL 156.65					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME mins / hrs	t	t'	t / t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'			Q	(NOTE ANY CHANGES IN OBSERVERS)
		1			156.65							
		2										
		3			156.65							
		4			156.64							
		5			156.65							
		6			"							
		7			—							
		8			156.66							
		9			"							
		10			"							
		12			"							
		14			"							
		16			"							
		18			156.67							
		20			"							
		28			156.69							EE
		48			156.76							
		55			156.77							
		66			156.79							
		77			156.82							
		94			156.84							
		106			156.88							
		115			156.89							
		130			156.92							
		143			156.93							
		158			156.96							
		172			156.99							
		194			157.03							
		206			157.05							

JTIL-16

DEPARTMENT OF PUBLIC WORKS
UTILITY DIVISION
John M. Collins, Chief Sanitary Engineer

Well Sampling Field Record Form

[redacted] TH400

Job. No.

Date 5/12/93

Well Identification	TH 400							
Casing Size								
Cap Type (footnote A)								
Well Depth								
Gallonage of Prime H_2O Used								
Purge Method								
Purge Rate								
Purge Time								
Purge Duration								
Volume Purged								
Depth to Water Level								
Depth to Liquid Level								
Floating Product (Y or N)								
Floating Product Sampling Method								
Water Sampling Method								
Time of Sampling	110 MIN	150 MIN	180 MIN	210 MIN				
Quantity of Sample								
Type of Preservative (footnote B)								
Field Filtering (Y or N)								
pH	7.20	7.29	7.40	7.43				
Conductivity	.445	.440	.436	.434				
Sample Temperature (°F)	21.6	19.5	19.7	20.2				
Ambient Temperature (°F)								
Turbidity								
Dissolved Oxygen (mg/l)	2.38	3.00	2.37					
SAL	0.01%	0.01	0.01					

Observers to Sampling Event _____

Type and Color of Sample Containers _____

Equipment Decontamination Procedures _____

Disposal Method for Purge Water _____

Split Samples With _____

Field Observations _____

Sampled By [redacted] _____

Footnote A:
1. Standard Threaded Cap
2. Vented Threaded Cap
3. Threaded, Locking Plug
4. Threaded Cap with Hasp
5. Flush Mount Locking Cap

Footnote B:
1. Refrigeration
2. Nitric Acid, HNO_3
3. Sulfuric Acid, H_2SO_4
4. Hydrochloric Acid: HCl
5. Sodium Hydroxide: NaOH

WASHOE COUNTY

DEPARTMENT OF PUBLIC WORKS
UTILITY DIVISION

PUMPING TEST DATA

WELL TH-600
(PUMPING) / OBSERVATION WELL
(PUMPING) / RECOVERY DATA
PAGE 1 OF 1

TYPE of PUMPING TEST: CONSTANT Q
HOW Q MEASURED: 3.5" X 6" ORIFICE
HOW WL's MEASURED: ELECTRIC SOUNDER
PUMPED WELL NO.: TH-600
RADIUS of PUMPED WELL:
DISTANCE from PUMPED WELL:

M.P. for WL's: TOC elev.:
DEPTH of PUMP/AIRLINE: wrt:
% SUBMERGENCE: initial: ; pumping:
PUMP ON: date 17MAY93 time 0910
PUMP OFF: date 17 MAY 93 time 1310

TIME t = at t'=0					WATER LEVEL DATA STATIC WATER LEVEL 158.36					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	s or s'	Q/s	H"	Q	(NOTE ANY CHANGES IN OBSERVERS)
0910		1			164.30			5.94		19"	200 gpm	EE ~25 PSI
		2			164.52			6.16				
		3			164.62			6.26		18½"-19"		Q↑
		4			164.52			6.16		18½-19"		Q↑
		5			164.73			6.37				
		6			164.85			6.49				
		7			164.89			6.53				
		8			164.90			6.54				
		9			164.93			6.57		18.5	200	Q↑
		10			165.02			6.66	30			FLOW STABILIZING @ 18.5"
		12			165.12			6.76		18.5↑		
		14			165.16			6.80				
		16			165.17			6.81				Q↑
		19			165.27			6.91				
		21			165.33			6.97				
		25			165.40			7.04		18.5-19"		Q↑
		30			165.47			7.11				
		35			165.54			7.18				
		40			165.62			7.26				T = 21.7° pH = 7.32 Cond = .390 Turb 3 SAL 0.01%
		45			165.65			7.29				Q↑
		50			165.72			7.36				Q↑
		60			165.83			7.47	27	18.5		
		70			165.92			7.56		18.5		
		80			166.00			7.64				
		90			166.06			7.70				
		100			166.13			7.77				T = 26° pH = 7.43 Cond = .3 Turb 12 SAL 0.01%
		120			166.24			7.86	25	18.5	200	
1130		140			166.29			7.91				T = 23.8 pH = 7.43 Cond = .38 Tu = 5 SAL 0.01%
1150		160			166.33			7.95				
1210		180			166.42			8.04		18½	Q↑	T: 24.0 pH = 7.42 Cond = .37 Turb 7 SAL 0.01%
1240		210			166.56			8.18				
1310		240			166.63			8.25				T = 23.8° pH = 7.42 Cond = .38 Turb 7 SAL 0.01%

UTIL-16

WASHOE COUNTY

DEPARTMENT OF PUBLIC WORKS
UTILITY DIVISION

PUMPING TEST DATA

WELL TH-150
PUMPING / OBSERVATION WELL
PUMPING / RECOVERY DATA
PAGE 1 OF 1

TYPE of PUMPING TEST CONSTANT Q
HOW Q MEASURED 3.5" X 6" ORIFICE
HOW WL's MEASURED ELECTRIC SOUNDER
PUMPED WELL NO. TH-600
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL

M.P. for WL's T.O.C. elev.
DEPTH of PUMP/AIRLINE wrt
% SUBMERGENCE: initial ; pumping
PUMP ON: date 17MAY93 time 0910
PUMP OFF: date 17MAY93 time

TIME t = at t'=0					WATER LEVEL DATA STATIC WATER LEVEL 140.00					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'			Q	(NOTE ANY CHANGES IN OBSERVERS)
		3			140.00							
		6			140.00							
		9			140.00							
		11			140.00			0				
		13			139.99			C.01				
		15			"							
		17			139.93			0.02				
		19			"							
		25			139.98			0.02				
		33			139.99							EE
		53			140.00			0				
		67			139.99			0.01				
		85			140.00			0				
		101			139.99			0.01				
		130			139.98			0.02				
		141			139.96			0.04				
		168			139.95			0.05				
		185			139.95							
		217			139.95			0.05				
		247			139.93			0.07				

JTIL-16

WASHOE COUNTY

DEPARTMENT OF PUBLIC WORKS
UTILITY DIVISION

PUMPING TEST DATA

WELL TH-400
PUMPING / OBSERVATION WELL
PUMPING / RECOVERY DATA
PAGE 1 OF 1

TYPE of PUMPING TEST: CONSTANT Q
HOW Q MEASURED: 3.5" X 6" ORIFICE
HOW WL's MEASURED: ELECTRIC SOUNDER
PUMPED WELL NO.: TH-600
RADIUS of PUMPED WELL:
DISTANCE from PUMPED WELL:

M.P. for WL's: T.O.C elev.:
DEPTH of PUMP/AIRLINE: wrt:
% SUBMERGENCE: initial: ; pumping:
PUMP ON: date 17MAR93 time 0910
PUMP OFF: date 17MAR93 time:

TIME t = at t'=0					WATER LEVEL DATA STATIC WATER LEVEL 151.47					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME mins / hrs	t	t'	t / t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	(S) or S'			Q	(NOTE ANY CHANGES IN OBSERVERS)
		1			151.47			0.00				CW
		2			"							
		3			—							
		4			"							
		5			"							
		6			—							
		7			"							
		8			"							
		9			—							
		10			151.47							
		12			"							
		14			"							
		16			"							
		18			"			0.00				
		20			151.48			0.01				
		25			151.48			0.01				
		32			151.52			0.05				EE
		38			151.52			0.05				
		48			151.54			0.07				
		58			151.54			0.07				
		68			151.56			0.09				
		85			151.57			0.10				
		98			151.57			0.10				
		130			151.62			0.15				
		141			151.65			0.18				
		163			151.66			0.19				
1215		185			151.67			0.20				
		216			151.69			0.22				
		246			151.71			0.24				

JTIL-16

WASHOE COUNTY

DEPARTMENT OF PUBLIC WORKS
UTILITY DIVISION

PUMPING TEST DATA

WELL TH-700
PUMPING/OBSERVATION WELL
PUMPING/RECOVERY DATA
PAGE 1 OF 1

TYPE of PUMPING TEST: CONSTANT Q
HOW Q MEASURED: 1 GALLON CONTAINER
HOW WL's MEASURED: ELECTRIC SOUNDER
PUMPED WELL NO.: TH-700
RADIUS of PUMPED WELL:
DISTANCE from PUMPED WELL:

M.P. for WL's: T.O.C elev.:
DEPTH of PUMP/AIRLINE: 252' wrt:
% SUBMERGENCE: initial: ; pumping:
PUMP ON: date 24 MAY 93 time 0940
PUMP OFF: date 24 MAY 93 time 1440

TIME t = at t'=0					WATER LEVEL DATA STATIC WATER LEVEL 170.65					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'		PSI	Q	(NOTE ANY CHANGES IN OBSERVERS)
0940		0								35	20-30	
0941		1			187.30			16.65				
		2			195.72			25.07				
		3			–			–				
		4			202.20			31.55				RUSTY HEAVY BROWN DISCOLOR
		5			204.42			33.77				
		6			206.64			34.99				
		7			206.60			35.95		28		
		8			207.74			37.09				
		9			209.56			38.91				DARK BRWN DISCHARGE
		10			210.73			40.08				
		12			212.18			41.53			30	1gL IN 2SEC
		14			211.90			41.25				
		16			211.52			40.87				HEAVY BROWN DIS. MUD
		18			212.56			41.91				LOTS OF FINE . FLOW ↓ SLIGHT SAND/SILT
		20			212.94			42.29				
		27			211.17			40.52				
		30			211.32			40.67				
1015		35			211.76			41.11				STARTING TO CLEAN SLIGHTLY
1020		40			212.32			41.67			~30gpm	DIRTY BUT ↓ IN VISCOSITY
1025		45			213.20			42.55				SAND ↓
1030		50			216.10			45.45				MUD TURNS DIRTY BROWN AGAIN
1035		56			210.65	LARGE VOLUME SILT 1/8 TO 1/2 CUP PER GALLON		40.00		!		WATER LEVEL RISING AGAIN
1045		65			202.70	NEXT SAMPLE A LOT MUD		32.05				~2 CUPS SILT/GALLON
1058		78			202.20			31.55				HEAVY FINE SAND/BRWN H2O
1100		80			201.86			31.21				1/4 CUP FINE SAND
1110		90			205.66			35.01		H2O LIGHT BROWN		1/8 - 1/4 CUP FINE SAND
1120		100			204.66			34.01		2-3 TB	SILT/SAND	LIGHT BRWN DISCHARGE
1140		120			205.26			34.61				DISCHARGE CLEARING UP
1200		140			203.95			33.30		1 TB	SILT/SAND	DISCHARGE LIGHT TAN BUT IS CLEARING.
1220		160			204.40			33.75				DISCOLORED BUT CLEARING UP
1240		180			205.14			34.49		1/2 TB	SILT/SAND	CLEANING UP
1310		210			207.02			36.55		1/2-1/4	TBP SILT/SAND	
1340		240			205.68			35.03		1 TBP	SAND/SILT	
1420		280			205.76			35.11				
1440	5	300			206.24			35.59				SAMPLE @ 5 HOURS

UTIL-16

IN TRIPLICATE
(PLEASE PRINT OR TYPE)

3704

NEVADA STATE HEALTH LABORATORY
NEVADA DIVISION OF HEALTH
1660 N. Virginia Street
Reno, Nevada 89503
(702) 688-1335

103704

WATER CHEMISTRY ANALYSIS:

Attn: Fees may apply to some types of samples.

All of the information below must be filled in or the analysis will not be performed.

State NV County Washoe
Township 22 Range 21 Section 5
General Location Whiskey Spring Rd.
Source Address TH - 150

TYPE OF ANALYSIS:

☐ Check here for ROUTINE DOMESTIC ANALYSIS.
Circle the constituents needed for PARTIAL ANALYSIS.

SAMPLING INSTRUCTIONS:

The sample submitted must be representative of the source. Spring and surface water samples should be as free of dirt and debris as possible. Wells should be pumped thoroughly before sampling, changing the water in the casing at least three times. Product water from filters should be sampled after running for about ten (10) minutes.

Sampled by Gail Noonan Date 5/10/93
Owner Pratt Phone
Address Whiskey Spring Rd.
City Reno State NV

REASON FOR ANALYSIS:

☐ Loan
☐ Personal health reasons
☐ Purchase of the property
☐ Rental or sale of property
☐ Subdivision approval
☒ Other

USE OF WATER:

☐ Domestic drinking water
☐ Geothermal
☐ Industrial or mining
☐ Irrigation
☒ Other
Initials

REPORT TO:

Washoe County Comp. Planning
Name attn. Gail Noonan
Address P.O. Box 11130
City Reno
State NV Zip 89520

1003

SOURCE OF WATER:

Filter ☐ Yes ☒ No
Public ☐ Yes ☒ No
Spring
Well X Depth 150 ft.
Hot Cold X
IN USE ☐ Yes ☒ No

Type
Name
Surface
Casing diameter 6 in.
Casing depth 150 ft.

The results below are representative only of the sample submitted to this laboratory.

FOR LABORATORY USE ONLY

-0.0125 681 0.73 31.2 8.9 -3327 103704

Constituent	ppm	Constituent	ppm	Constituent	ppm	Constituent	S.U.	PRINT OTHER DESIRED CONSTITUENTS BELOW: Constituent	ppm
T.D.S. @ 103° C.	755	Chloride	52	Iron	0.12	Color	3		
Hardness	394	Nitrate -N	23.7	Manganese	0.01	Turbidity	1.1		
Calcium	100	Alkalinity	178	Copper	0.00	pH	7.93		
Magnesium	35	Bicarbonate	217	Zinc	0.52	EC	1031		
Sodium	56	Carbonate	0	Barium	0.03				
Potassium	11	Fluoride	0.33	Boron	0.4				
Sulfate	186	Arsenic	0.007	Silica	67				

Fee 20- Billed
Collected by 5/11/93 GL
PWS I.D.
DWA—Pri Sec
1st 2nd 3rd
Date Rec'd 5-11-93 Init. gpp
ppm = parts per million, milligrams per liter
S.U. = Standard Units

Remarks
Eng MC
5/19/93

IN TRIPLICATE
(PLEASE PRINT OR TYPE)

3699

NEVADA STATE HEALTH LABORATORY
NEVADA DIVISION OF HEALTH
1660 N. Virginia Street
Reno, Nevada 89503
(702) 688-1335

103699

WATER CHEMISTRY ANALYSIS:

Attn: Fees may apply to some types of samples.

All of the information below must be filled in or the analysis will not be performed.

State NV County Washoe
Township 22 N Range 21 E Section 5
General Location Whiskey Spr Rd Palomino V
Source Address TH-400

TYPE OF ANALYSIS:

☒ Check here for ROUTINE DOMESTIC ANALYSIS.
Circle the constituents needed for PARTIAL ANALYSIS.

SAMPLING INSTRUCTIONS:

The sample submitted must be representative of the source. Spring and surface water samples should be as free of dirt and debris as possible. Wells should be pumped thoroughly before sampling, changing the water in the casing at least three times. Product water from filters should be sampled after running for about ten (10) minutes.

Sampled by Ed Evans Date 5/12/93
Owner Pratt Phone
Address Whiskey Springs Rd
City Reno State NV

REASON FOR ANALYSIS:

- ☐ Loan
- ☐ Personal health reasons
- ☐ Purchase of the property
- ☐ Rental or sale of property
- ☐ Subdivision approval
- ☒ Other

USE OF WATER:

- ☐ Domestic drinking water
- ☐ Geothermal
- ☐ Industrial or mining
- ☐ Irrigation
- ☒ Other
- Initials

REPORT TO:

Name Washoe County Comp Planning
Address Attn. Gail Noonan
City P.O. Box 11130
State Reno Zip NV 89520

SOURCE OF WATER:

Filter ☐ Yes ☒ No
Public ☐ Yes ☒ No
Spring
Well X Depth 405 ft.
Hot Cold X
IN USE ☐ Yes ☒ No

Type
Name
Surface
Casing diameter 6 in.
Casing depth 405 ft.

The results below are representative only of the sample submitted to this laboratory.

FOR LABORATORY USE ONLY

Constituent	ppm	Constituent	ppm	Constituent	ppm	Constituent	S.U.
T.D.S. @ 103° C.	380	Chloride	24	Iron	0.07	Color	3
Hardness	212	Nitrate –N	2.5	Manganese	0.00	Turbidity	0.3
Calcium	52	Alkalinity	174	Copper	0.00	pH	7.91
Magnesium	20	Bicarbonate	212	Zinc	0.03	EC	539
Sodium	31	Carbonate	0	Barium	0.02		
Potassium	8	Fluoride	0.16	Boron	0.1		
Sulfate	60	Arsenic	0.008	Silica	67		

0.2060 410 0.71 31.1 8.7 202.3 103699

PRINT OTHER DESIRED CONSTITUENTS BELOW

Constituent	ppm

Fee
Collected by
PWS I.D.
SDWA—Pri. Sec.
1st 2nd 3rd
Date Rec'd 5-18-93 Init

ppm = parts per million, milligrams per liter
S.U. = Standard Units

Remarks

5/19/93

IN TRIPLICATE
(PLEASE PRINT OR TYPE)

3821

NEVADA STATE HEALTH LABORATORY
NEVADA DIVISION OF HEALTH
1660 N. Virginia Street
Reno, Nevada 89503
(702) 688-1335

SAMPLE: 103821
TH-600

WATER CHEMISTRY ANALYSIS:

Attn: Fees may apply to some types of samples.

TYPE OF ANALYSIS:

☒ Check here for ROUTINE DOMESTIC ANALYSIS.
Circle the constituents needed for PARTIAL ANALYSIS.

SAMPLING INSTRUCTIONS:

The sample submitted must be representative of the source. Spring and surface water samples should be as free of dirt and debris as possible. Wells should be pumped thoroughly before sampling, changing the water in the casing at least three times. Product water from filters should be sampled after running for about ten (10) minutes.

Sampled by Dan Dragon Date 5/17/93
Owner Pratt Phone
Address Whisky Spring Rd
City Reno State NV

REPORT TO: Washoe County Comp Planning

Name attn. Gail Newman
Address P.O. Box 11130
City Reno
State NV Zip 89520

All of the information below must be filled in or the analysis will not be performed.

State NV County Washoe
Township 22 N Range 21E Section 5
General Location Whisky Spring
Source Address TH-600

REASON FOR ANALYSIS:

☐ Loan
☐ Personal health reasons
☐ Purchase of the property
☐ Rental or sale of property
☐ Subdivision approval
☑ Other

USE OF WATER:

☐ Domestic drinking water
☐ Geothermal
☐ Industrial or mining
☐ Irrigation
☒ Other Monitoring Well
Initials

SOURCE OF WATER:

Filter ☐ Yes ☒ No
Public ☐ Yes ☒ No
Spring
Well X Depth 600 ft.
Hot Cold X
IN USE ☐ Yes ☒ No

Type
Name
Surface
Casing diameter 6 in.
Casing depth 610 ft.

The results below are representative only of the sample submitted to this laboratory.

FOR LABORATORY USE ONLY

Constituent	ppm	Constituent	ppm	Constituent	ppm	Constituent	S.U.
0.0069	395	0.69	32.2	9.6	6011	103821	
T.D.S. @ 103° C.	343	Chloride	17	Iron	0.15	Color	3
Hardness	189	Nitrate-N	0.8	Manganese	0.00	Turbidity	0.6
Calcium	46	Alkalinity	192	Copper	0.00	pH	7.76
Magnesium	18	Bicarbonate	234	Zinc	0.01	EC	496
Sodium	30	Carbonate	0	Barium	0.02		
Potassium	7	Fluoride	0.14	Boron	0.1		
Sulfate	42	Arsenic	0.006	Silica	69		

PRINT OTHER DESIRED CONSTITUENTS BELOW

Constituent	ppm

Fee 30 - Billed
Collected by 5/17/93 CH
PWS I.D.
SDWA—Pri. Sec.
1st 2nd 3rd
Date Rec'd 5-17-93 Init.

ppm = parts per million, milligrams per liter
S.U. = Standard Units

Remarks

5/21/93

(PLEASE PRINT OR TYPE) 4059

NEVADA STATE HEALTH LABORATORY
NEVADA DIVISION OF HEALTH
1660 N. Virginia Street
Reno, Nevada 89503
(702) 789-0335

SAMPLE ID:
TH-700
104059

WATER CHEMISTRY ANALYSIS:

Attn: Fees may apply to some types of samples.

All of the information below must be filled in or the analysis will not be performed.

State NEVADA County WASHOE
Township 22N Range 21E Section 9
General Location WARM SPRINGS VALLEY
Source Address NEAR WESTERN TUNE FARM.

TYPE OF ANALYSIS:

☒ Check here for ROUTINE DOMESTIC ANALYSIS.
Circle the constituents needed for PARTIAL ANALYSIS.

SAMPLING INSTRUCTIONS:

The sample submitted must be representative of the source. Spring and surface water samples should be as free of dirt and debris as possible. Wells should be pumped thoroughly before sampling, changing the water in the casing at least three times. Product water from filters should be sampled after running for about ten (10) minutes.

Sampled by ED EVANS Date 5/24/93
Owner WASHOE COUNTY Phone 785-4743
Address P.O. BOX 11130
City RENO State NV

REASON FOR ANALYSIS:

- ☐ Loan
- ☐ Personal health reasons
- ☐ Purchase of the property
- ☐ Rental or sale of property
- ☐ Subdivision approval
- ☒ Other WARM SPRINGS STUDY Comp/Planning

USE OF WATER:

- ☐ Domestic drinking water
- ☐ Geothermal
- ☐ Industrial or mining
- ☐ Irrigation
- ☒ Other MONITORING WELL

Initials

REPORT TO:

Name GAIL NOONAN : COMPREHENSIVE / PLANNING DIV WASHOE COUNTY
Address P.O. BOX 11130
City RENO
State NV Zip 89520

SOURCE OF WATER:

Filter ☐ Yes ☒ No
Public ☐ Yes ☒ No
Spring
Well ☒ Depth 600 704 ft.
Hot Cold ☒
IN USE ☐ Yes ☒ No

Type
Name
Surface
Casing diameter 6 in.
Casing depth 600 ft.

The results below are representative only of the sample submitted to this laboratory.

FOR LABORATORY USE ONLY

0.0283 305 0.74 30.7 ppm 7.0 1472 ppm 104059

Constituent	ppm	Constituent	ppm	Constituent	ppm	Constituent	S.U.	PRINT OTHER DESIRED CONSTITUENTS BELOW: Constituent	ppm
T.D.S. @ 103° C.	285	Chloride	13	Iron	0.74	Color	25		
Hardness	112	Nitrate -N	0.3	Manganese	0.09	Turbidity	12		
Calcium	30	Alkalinity	140	Copper	0.00	pH	7.83		
Magnesium	9	Bicarbonate	171	Zinc	0.15	EC	384		
Sodium	39	Carbonate	0	Barium	0.07				
Potassium	4	Fluoride	0.20	Boron	0.1				
Sulfate	39	Arsenic	0.008	Silica	66				

Fee 80- BILLED
Collected by GH 5/27/93
PWS I.D.
SDWA—Pri. Sec.
1st 2nd 3rd
Date Rec'd 5-24-93 Init. ggn
ppm = parts per million, milligrams per liter
S.U. = Standard Units

Remarks

GH 6-2-93
ggn

WASHOE COUNTY

DEPARTMENT OF PUBLIC WORKS
UTILITY DIVISION
John M. Collins, Chief Sanitary Engineer

POST OFFICE BOX 11130
RENO, NEVADA 89520
PHONE: (702) 785-4743

DATE 6-20-95

PAGE 1 OF 1 PAGES

PROJECT Trilinear calculations

Const.	MW #1 mg.	%	MW #2 mg.	%	MW #3 mg.	%	MW #4 mg.	%
Ca ✓	5.0	47	2.6	46	2.3	43	1.5	38
Mg ✓	2.9	27	1.6	28	1.5	28	0.7	18
SO_4	3.9	43	1.2	22	0.9	17	0.8	20
Cl	1.5	17	0.7	13	0.5	10	0.4	10
HCO_3	3.6	40	3.5	65	3.8	73	2.8	70
Na ✓	2.4	22	1.3	23	1.3	24	1.7	42
K ✓	0.3	3	0.2	4	0.2	4	0.1	2
	19.6		11.1		10.5		8.0	

10.6 5.7 5.3 4.0

9 5.4 5.2

anions 9 / cations 10.6 = .85

5.4 / 5.7 = .95 5.2 / 5.3 = .98 4 / 4 = 1