THERMAL EFFLUENT DISPOSAL

CARLIN HIGH SCHOOL GEOTHERMAL WELL

CARLIN, NEVADA

April 23, 1986

Project No. 86-392

Prepared for:

ELKO COUNTY SCHOOL DISTRICT

Prepared by:

WILLIAM E. NORK, INC.

William E. Nork

WILLIAM E. NORK, Inc.

Reno, Nevada 89503

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FINDINGS

1. The geologic materials in the vicinity of the Carlin High School are suitable for the on-site disposal of the heat-spent thermal effluent derived from the school's geothermal space-heating system.

2. Data derived from four percolation tests and the drilling and test pumping of a test well at the site indicate that disposal via infiltration utilizing a disposal well or leach field will result in a ground-water mound. The height and areal extent of the mound will be limited and will not have any deleterious consequences.

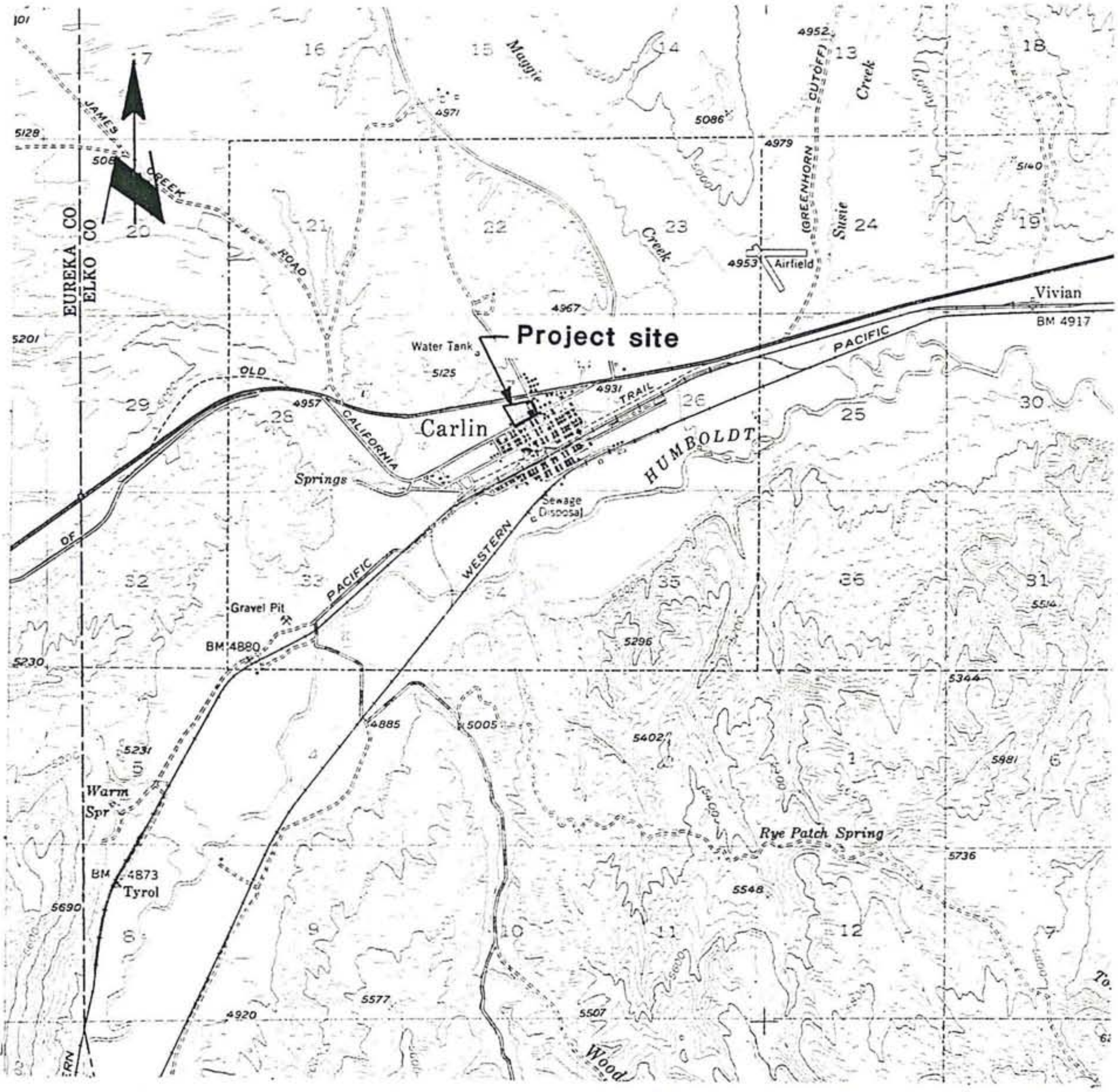
2. No adverse impacts on the chemical quality of the alluvial aquifer beneath Carlin, Nevada are anticipated. Chemical quality of the thermal effluent is significantly better than waters derived from the alluvium down gradient from the proposed disposal site.

3. No adverse impacts on the chemical quality of the springs which supply Carlin with its drinking-water supply are anticipated. The springs are remote and up gradient from the proposed disposal site.

2.Ø INTRODUCTION

The 9Ø4 foot deep geothermal space heating well for the Elko County School District at the Carlin High School was completed in March 1985 (WEN, INC., 1985). Location of the geothermal well and project site is depicted in Figure 1. In the Fall of 1985 pumping equipment was installed in the well. Beginning in December 1985, the well was pumped to enable the mechanical engineering firm who designed the system to test the operation of the heating equipment and fine tune its control system. During this shake-down period, a nearly three-fold increase in the concentration of iron in the ground water derived from the well was observed. This increase in iron concentration required the district to re-evaluate the disposal plans for the thermal effluent which, up until this point, strongly favored introduction of the water into the Carlin community water supply. Although technically feasible, an economic analysis of the iron and hydrogen sulfide removal process indicated this was not a viable alternative. Consequently, investigations focussed on disposing the fluid via infiltration or injection into the shallow alluvial aquifer present beneath the site and vicinity.

The change in the disposal mode requires a discharge permit from the State of Nevada Division of Environmental Protection. This report describes the results of the investigation conducted by WILLIAM E. NORK, INC. relative to the application by the Elko County School District for a discharge permit. The principal sources of data for this investigative effort are lithologic data from test pits and a 52 foot deep test well on the Carlin High School property; chemical and water-level data obtained from the test hole, City of Carlin Well No. 3, and the Wardleigh well located near the Carlin Railroad Yard; and testing of the recently-completed test well at the high school.



(map base: Carlin, NV USGS 15 min. topo. quad.)

scale

1:62,500

Figure 1. Project reference map.

3.Ø TESTING RESULTS

The suitability of the geologic materials at the Carlin High School site was evaluated utiliizing in-situ percolation tests performed in four shallow test pits, one 52 foot deep test well and observed infiltraton of thermal effluent between December 1985 and March 1986. The chemical quality of the ground water derived from the alluvial aquifer was evaluated from water samples collected from the test well, an existing City well, and data derived from water quality investigations at the Carlin Railroad Yard conducted by Hydro-Search, Inc. Water chemistry analyses results are discussed in Section 4.Ø.

3.1 PERCOLATION TESTS

A total of four test pits were excavated at the Carlin High School grounds. A percolation test was conducted in each test pit by Thurston Testing Laboratory. Locations of the test pits are given in Figure 2. Logs of the pits and test data are presented in Appendix A. Average percolation rate for the shallow soils is 29.3 minutes per inch. Utilizing leach field design criteria for septic systems (U.S. Public Health Service, 1969) the recommended application rate,

$$q = 5 / \sqrt{t} = 5 / \sqrt{29.3} = 0.93 \text{ GPD/ft}^2$$

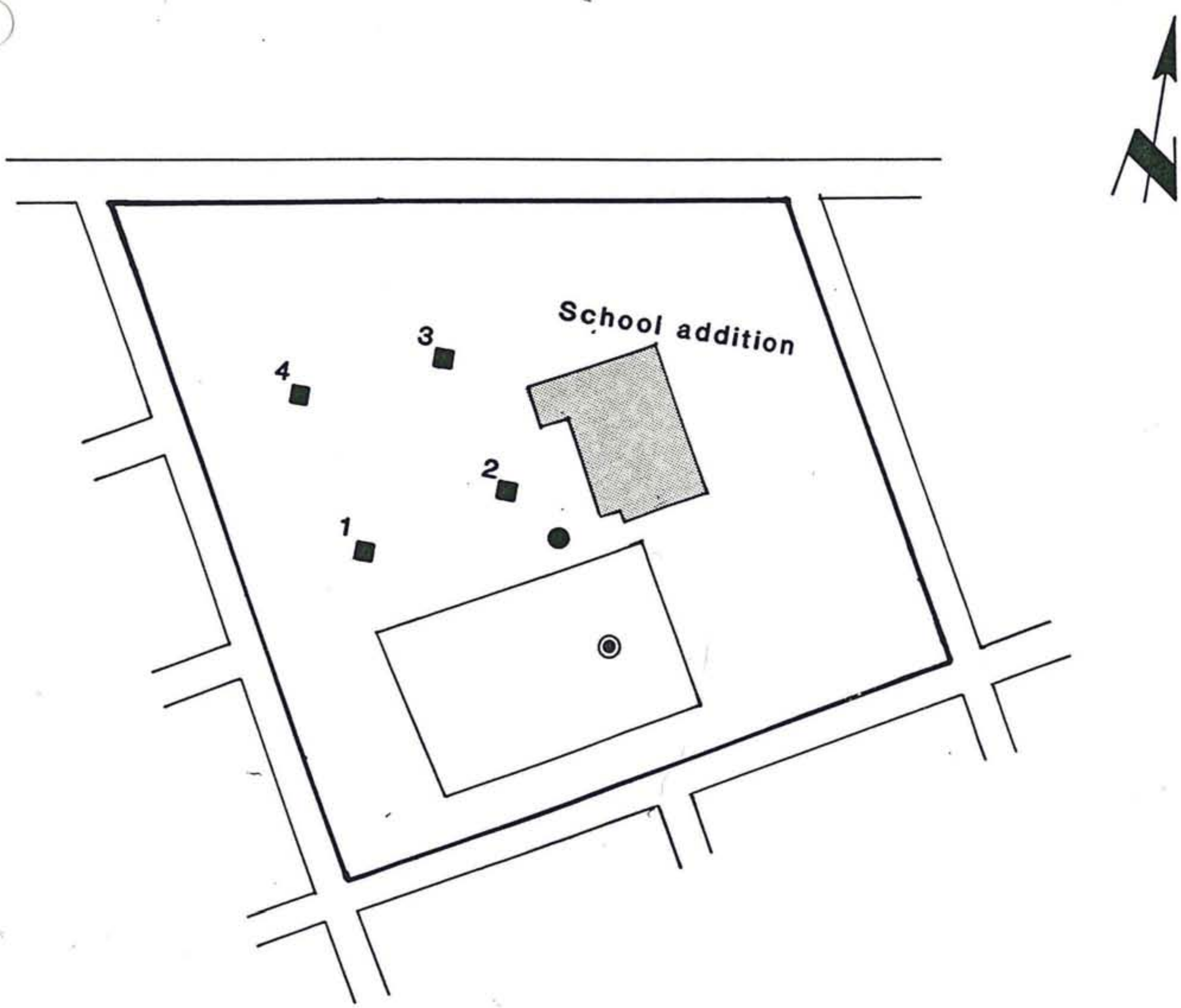
Assuming that the average discharge of thermal effluent is 3Ø gallons per minute (gpm) the recommended trench surface area is

$$A = (30\text{gpm} \times 1440 \text{ min/day}) / 0.93 \text{ GPD/ft}^2 = 46{,}452 \text{ ft}^2$$

Assuming further, the trench extends 12 inches below the distribution pipe, the leach field would require 23,226 feet of leach line laterals. Increasing the depth of the trench to 42 inches below the lateral reduces the length of line to 3Ø per cent of this length or 7,645 feet (id., Table 3, p.2Ø). This represents a substantial leach field that would be cost prohibitive for the school district. However, septic system leach field design is predicated on no mounding of the effluent. A leach field design which allows for mounding will be significantly smaller and is discussed in Section 5.1.

3.2 INFILTRATION TEST WELL

A 52 foot deep test well was drilled by R.D. Reynolds Well Drilling in March 1986. The principal purpose of this test well was to evaluate the chemical quality of the ground water derived from the shallow alluvial aquifer beneath the school site. The



Scale

1 inch 200 feet

EXPLANATION

● Geothermal production well

◉ Infiltration well

■ Test pit

Figure 2. Test pit and infiltration test well locations, Carlin, Nevada

Table 2. Carlin High School infiltration test well casing schedule.

Depth interval (feet)	Description
+Ø.8 - 47.1	Blank 6 5/8-inch O.D. steel casing.
46.9 - 52.3	6-inch telescope size, Ø.Ø2Ø-inch slot stainless steel Cook (T.M.) shaped wire continuous slot screen.

The completed test well was developed with a combination of surging, bailing and backwashing. This was followed by pumping with a submersible pump until the discharge was clear and sand-free.

A short-duration constant-discharge pumping test was performed on the completed test well in conjuncton with sampling the formation waters. Testing results are summarized below.

> Testing commenced Ø75Ø hrs 3/2Ø/86. Pumping rate was held constant at 3.5 gpm. Drawdown after 3ØØ minutes was 5.27 feet. Testing was terminated at 125Ø hrs 3/2Ø/86. Recovery water level data were measured for one hour after pumping ceased.

Drawdown and recovery data are tabulated in Appendix C and drawdown data plotted in Figures 3 and 4. Values for the aquifer transmissivity are tabulated below in Table 3.

Table 3. Calculated transmissivity of the alluvial aquifer beneath the Carlin High School site.

Data	Analysis method	Transmissivity
Drawdown	Cooper-Jacob	942 GPD/ft
Drawdown	Theis	933 GPD/ft
Residual-drawdown	Theis recovery	942 GPD/ft
	Average	939 GPD/ft

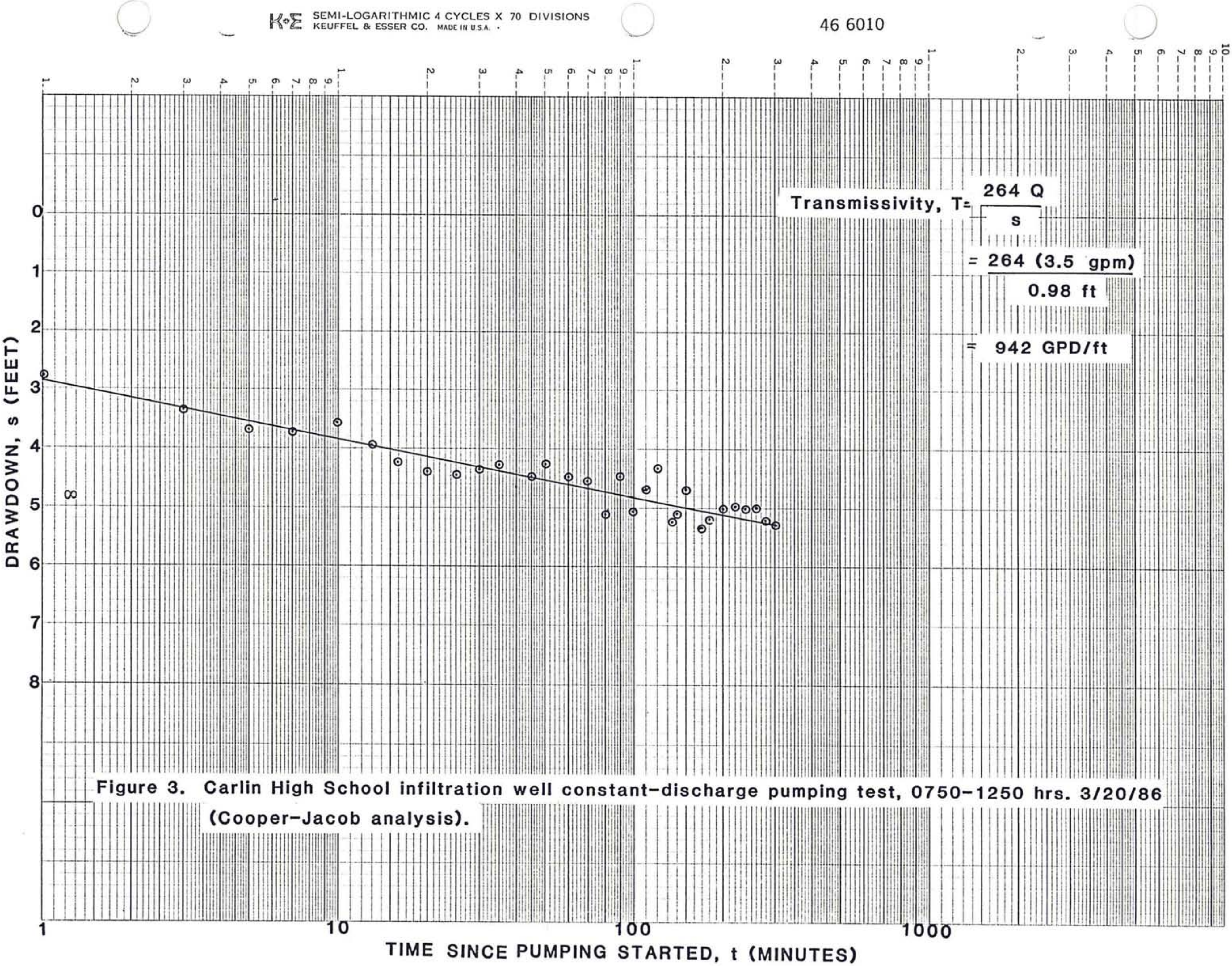


Figure 3. Carlin High School infiltration well constant-discharge pumping test, 0750-1250 hrs. 3/20/86 (Cooper-Jacob analysis).

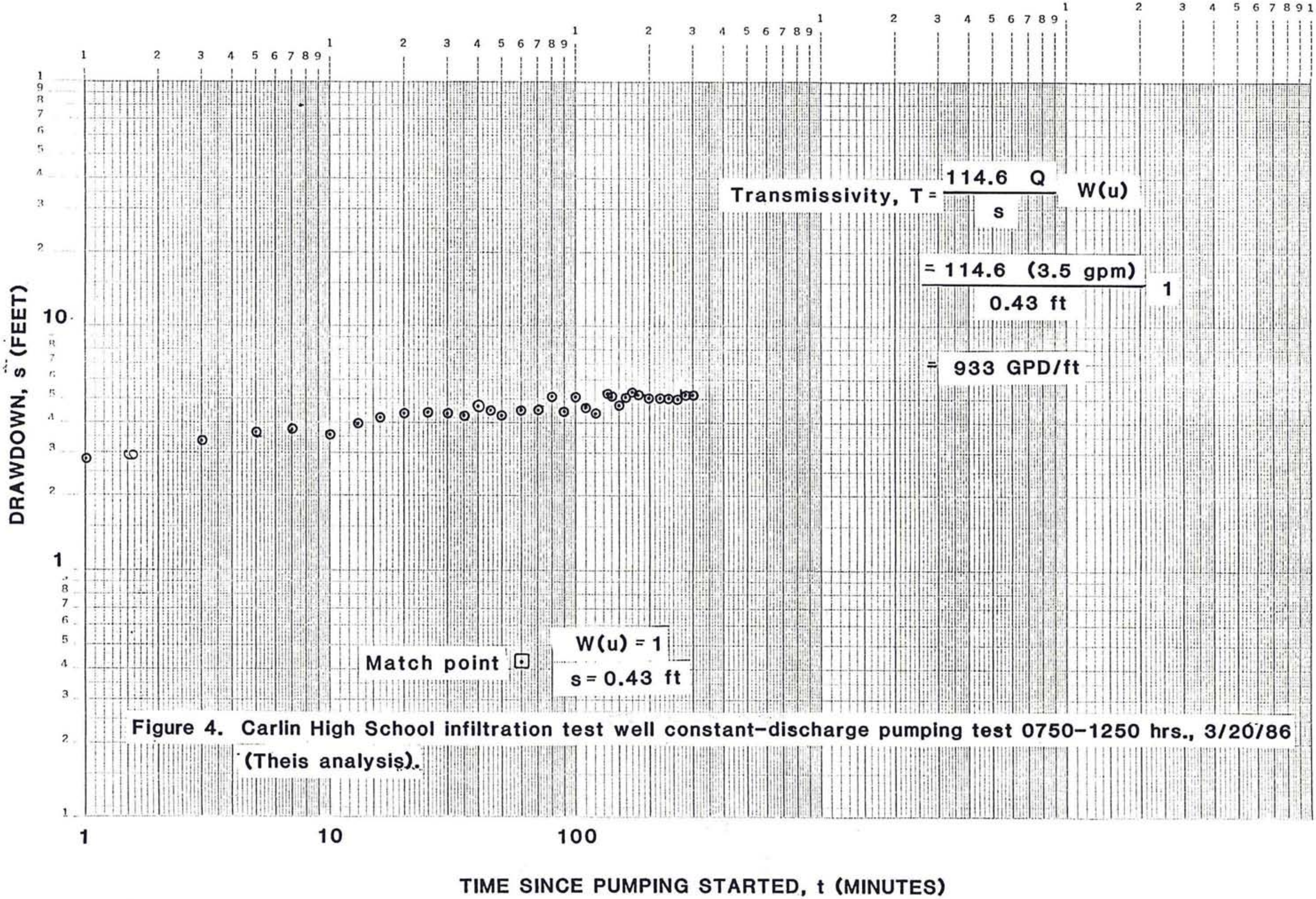


Figure 4. Carlin High School infiltration test well constant-discharge pumping test 0750–1250 hrs., 3/20/86 (Theis analysis).

Assuming the thickness of the aquifer stressed by the well is equal to the saturated thickness above the bottom of the well screen, the the hydraulic conductivity,

$$K = T / b = 939 \text{ GPD/ft} / 14 \text{ ft} = 67.6 \text{ GPD/ft}^2$$

which is typical of poorly sorted silty sand and gravel.

4.Ø WATER QUALITY

Water chemistry data from the test hole and two other wells down gradient from the high school space heating well were compared with the geothermal fluid to evaluate the potential impact of disposal on the chemical quality of the shallow aquifer. The two additional sample sources are:

1. The Wardleigh well located approximately 1,7ØØ feet south of the High School near the Carlin Railroad Yard, and

2. Carlin City Well No. 3 located at the City Park, approximately 2,7ØØ feet south-southwest of the high school.

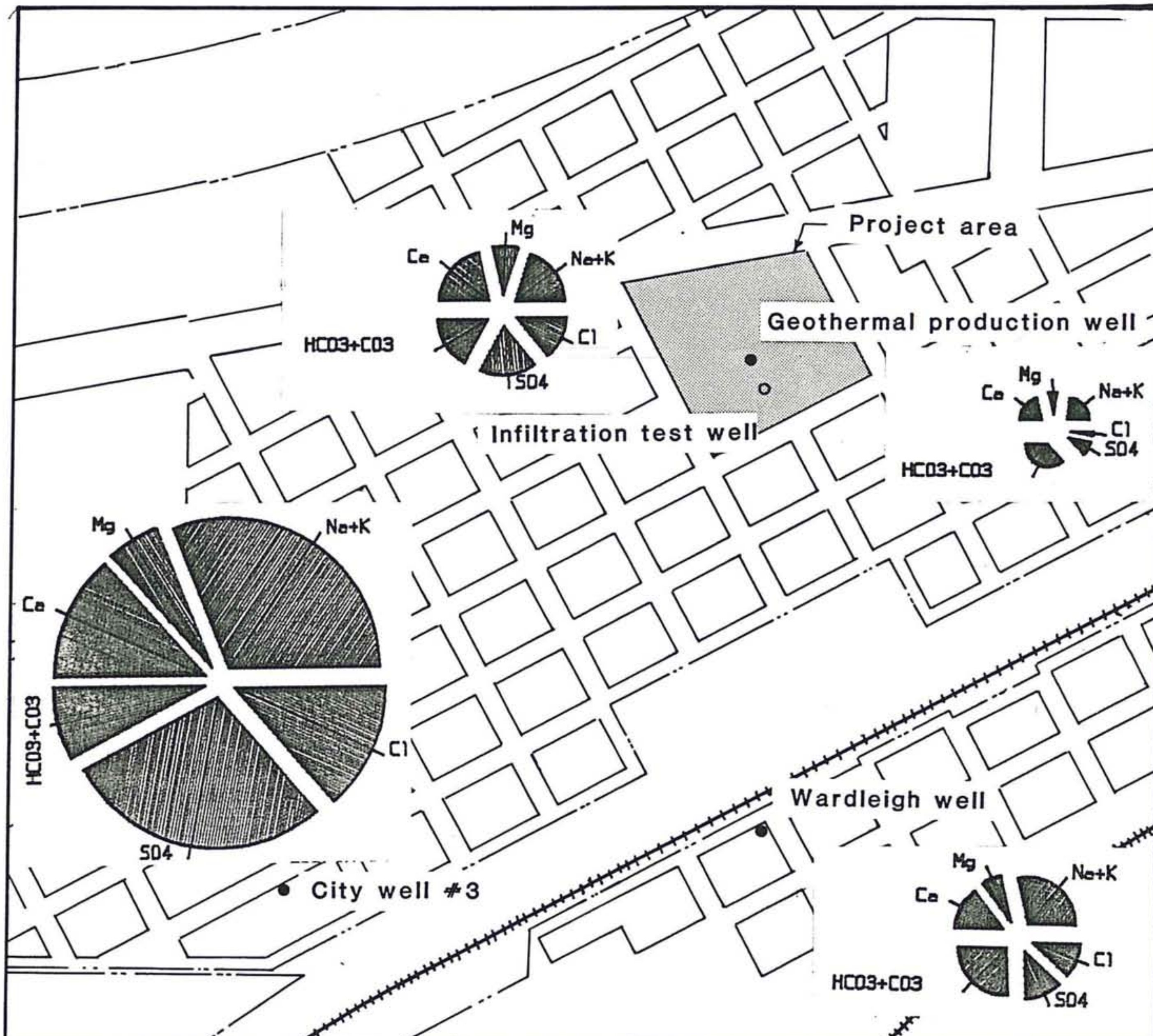
Locations of the sample sources are depicted in Figure 5 and chemical data are tabulated in Table 4. From the data it is obvious that the chemical quality of the thermal effluent is significantly better than the ground water derived from the shallow alluvial aquifer, particularly that derived from the city well used to irrigate the park.

Table 4. Chemical data, alluvial aquifer, Carlin, Nevada.

Sample	Carlin H.S. geothermal well	Carlin H.S. test well	Wardleigh well*	City Well No. 3	Drinking Water Standard
Date	2/12/85	3/20/86	4/28/83	3/17/86	
Time	1230	1130		1330	
Temperature (°C)	29	16.0		14.0	
E.C. (mho/cm)		1150	1500	3470	
pH	7.5	7.2	7.4	7.4	
TDS	390	997	940	2890	1000[2]
Ca	63	134	93	253	
Mg	10.5	31	26	64	150[2]
Na	66	135	200	650	
K	20	14	17	26	
Fe	1.7	0.77		0.04	0.6[2]
Mn	0.03	0.04	2.5	<0.02	0.1[2]
HCO3	274	304	418	425	
SO4	61	260	158	1240	500[2]
Cl	12	144	109	437	400[2]
NO3 (as N)	0.2	17	2.5	53	45[1]
F	1.6	0.5	0.4	0.7	1.8[1]
As	0.013	0.011		0.043	0.05[1]
Ba	<0.04	<0.04	<0.04	<0.04	1.0[1]
B		0.4	0.8	2.7	
Cd	<0.01	<0.01	<0.01	<0.01	0.01[1]
Cr	<0.02	<0.02	<0.02	<0.02	0.05[1]
Cu	<0.02	<0.02	<0.02	0.03	1.0[1]
Pb	<0.05	<0.05	<0.05	<0.05	0.05[1]
Hg	<0.0005	0.0008	<0.0005	0.0006	0.002[1]
Se	<0.005	<0.005	<0.005	<0.005	0.01[1]
Ag	<0.01	<0.01	<0.01	<0.01	0.05[1]
Zn	<0.01	0.12	<0.01	<0.01	5.0[2]
SiO2	16	53	48	55	

*source - Hydro-Search, Inc., 1983
1. - USEPA Primary Drinking Water Standard
2. - State of Nevada Secondary Drinking Water Standard

WILLIAM E. NORK, Inc.
Reno, Nevada 89503



scale

0 500 1000 Feet

EXPLANATION

0 50 100

SCALE OF RADII
(TOTAL OF EQUIVALENTS
PER MILLION)

NOTE ERROR (IF ANY) IN CATION/ANION
BALANCE HAS BEEN REMOVED

Figure 5. Water sample locations, Carlin, Nevada.

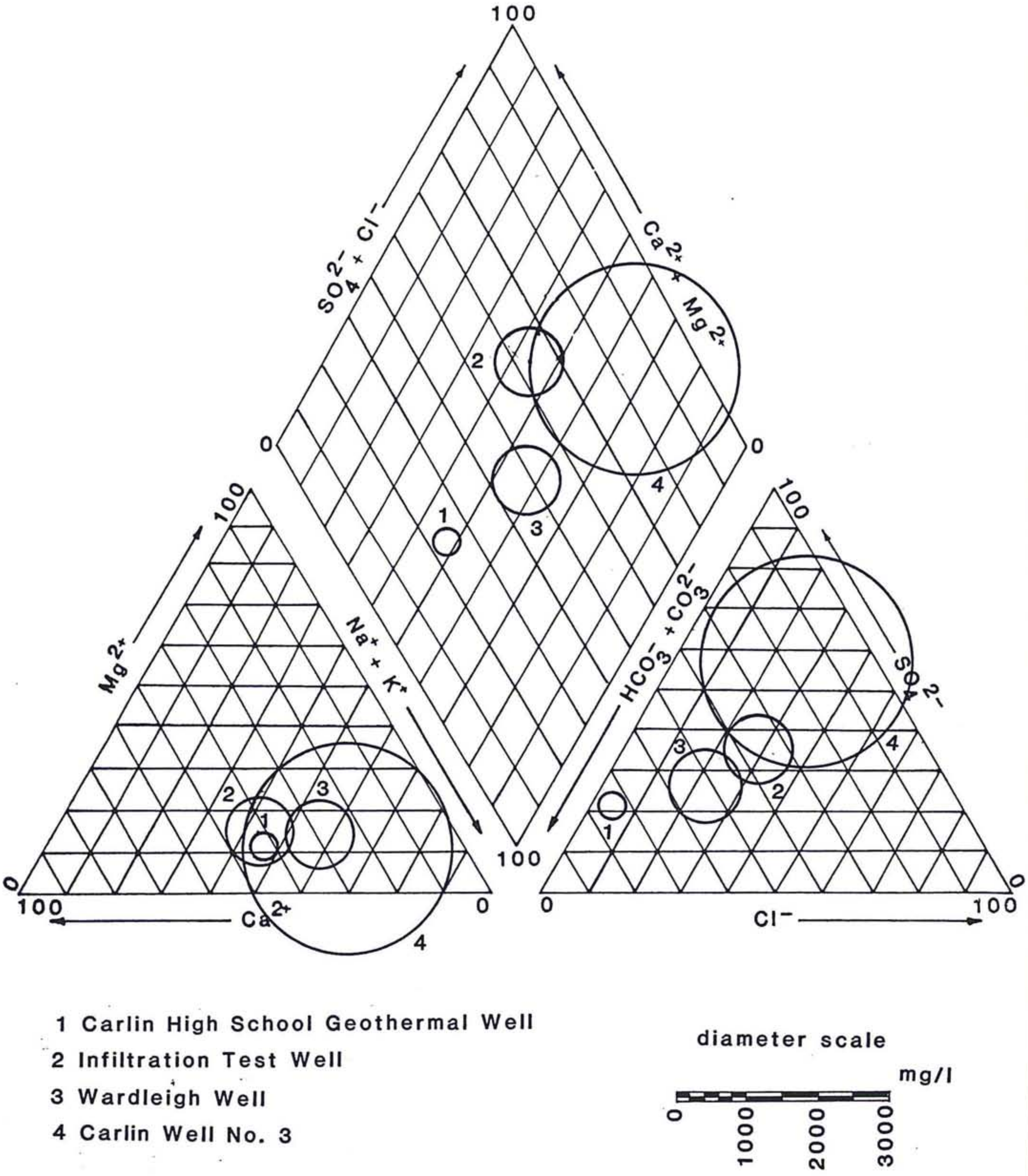


FIGURE 6. Piper diagram

5.0 POTENTIAL ENVIRONMENTAL IMPACTS

5.1 WATER-LEVEL IMPACTS

The two basic disposal system design alternatives under consideration are a leach field or disposal well. As stated in Section 3.1 a leach field based on septic system design criteria does not appear to be a viable alternative on economic grounds. However, a smaller leach field which permits controled development of a ground-water mound is practical. The vertical and horizontal extent of the mound was calculated utilizing Hantush's method for evaluating mounding beneath a pond (Prickett, 1981) modified for use on a TI 58C programmable calculator. The leach field area was evaluated in part by trial and error to find the smallest area which would accept the average discharge of the system and not allow the mound to breach land surface in the vicinity of the school and, in part, by the observed infiltration of the discharge during shake-down of the heating system equipment this past winter. The growth of the mound is tabulated below in Table 5.

Table 5. Ground water mound development beneath the proposed infiltration site, Carlin High School, Carlin, Nevada.

Time since infiltration started (days)	Average discharge rate (gpm)	Radial distance from center of leach field (feet)	Water level rise (feet)
365	30	19	19.7
365	30	100	14.0
3,650	30	19	23.2
3,650	30	100	18

Assumptions for the analysis in addition to the standard assumptions relative to a Theisian analysis are:

1. The leach field is approximated by a circular pond having a radius of 20 feet.

2. The loading rate is [(30gpm x 1440 min/day) / 1200 ft^2] or 36 GPD/ft^2.

3. The aquifer transmissivity is 939 GPD/ft.

4. Coefficient of storage of the aquifer is 0.10.

5. The initial water level is 38 feet below land surface.

6. The initial saturated thickness of the aquifer is 14 feet.

From the analysis results, it is obvious that the disposal by this method at the school will have no adverse impacts on nearby structures. In all likelihood, the mound will in fact be smaller than that calculated because the aquifer transmissivity increases two orders of magnitude to the south.

Disposal of the thermal effluent via a disposal well was also evaluated. The buildup of a ground-water mound centered on a disposal well was calculated utilizing the computerized analytical model VARFLOW (IDO, 1982). Assumptions for the analysis, in addition to the standard asumptions for the Theis analysis, are:

1. The well is 150 feet deep and is screened in the interval between 50 and 150 feet.

2. Borehole diameter is 12 inches.

3. The well is 100 percent efficient.

4. Static water level in the well is 38 feet below land surface.

5. Transmissivity of the aquifer is 7,500 GPD/ft; coefficient of storage is 0.10.

6. The disposal rate for the school year (heating season) varies according to the following schedule:

0 to 60 days	constant at 30 gpm
60 to 90 days	uniform increase from 30 to 60 gpm
90 to 150 days	constant at 60 gpm
150 to 180 days	uniform reduction from 60 to 30 gpm
180 to 270 days	constant at 30 gpm
270 to 360 days	no disposal

The purpose of the analysis was to simulate the buildup of a ground-water mound in the vicinity of the disposal well for a typical heating season. Operational experience during the inaugural 1985-86 heating season indicated that an average of 60 gpm is sufficient to meet the heating demand of the school during the coldest months and 30 gpm the remainder of the school year. During the summer months when the school is not in session, discharge to the disposal well will be virtually nil. Results of the analysis are tabulated in Table 6.

Table 6. Rise in water level due to discharge to a disposal well, Carlin High School, Carlin, Nevada.

Time (days)	Radial distance from center of well bore (feet)				
	Ø.5	1.Ø	1Ø	5Ø	1ØØ
3Ø	6.8	6.2	4.1	2.6	1.9
6Ø	7.1	6.5	4.4	2.9	2.3
9Ø	13.7	12.4	8.2	5.2	3.9
12Ø	14.4	13.2	9.Ø	6.Ø	4.7
15Ø	14.8	13.5	9.3	6.3	5.Ø
18Ø	8.7	8.1	5.9	4.4	3.8
21Ø	8.2	7.6	5.5	4.Ø	3.3
24Ø	8.1	7.5	5.4	3.9	3.3
27Ø	8.1	7.5	5.4	3.9	3.2
3ØØ	1.3	1.3	1.3	1.3	1.3
33Ø	1.Ø	1.Ø	1.Ø	1.Ø	1.Ø
36Ø	Ø.8	Ø.8	Ø.8	Ø.8	Ø.8

Given a static water level of 38 feet below land surface, the water level in the disposal well may rise to within approximately 24 feet of land surface under the aforementioned conditions.

For short periods of time the discharge of the heating system may exceed the daily average rate to meet an occasional extreme heating demand. A peak flow rate of 12Ø gpm for a period of six hours was simulated midway through the heating season to evaluate the effect of this transient. The result was an additional rise in the water level in the well of nine feet to within 14 feet of land surface. The residual water level effects of this short-term spike in the flow rate were essentially gone within less than one day of its occurrence. The conclusion that is drawn is that the disposal well may accommodate repeated short-term increases in flow rate necessary to meet relativley large short-term heating requirements that may occur sporatically throughout the heating season.

5.2 WATER CHEMISTRY IMPACTS

Potentiometric head data from the alluvial aquifer indicate that ground water in the alluvial aquifer at Carlin flows in a southerly direction beneath the town (Figure 5). Water chemistry data from the alluvial aquifer (Table 4 above) clearly illustrate that the alluvial aquifer is not a source of high quality ground water in this vicinity and that the chemical quality of the thermal effluent is significantly better than that derived from the alluvial aquifer. Consequently, the thermal effluent will not adversely impact the chemical quality of water derived from wells down gradient from the disposal site.

The principal source of water supply to Carlin are springs located approximately one mile west-southwest of the proposed disposal site. The elevation of the springs is approximately 4920 feet above sea level which places them well upgradient of the disposal site, elevation 4,891 feet. The mound will be sufficiently small not to reverse the southerly ground-water flow direction and cause any impact on the springs considering the 10-year mound elevation of approximately 4,909 feet. This fact coupled with the distance between the proposed disposal site and the springs eliminates even the remotest possiblity of any adverse impact.

6.Ø SOURCES OF INFORMATION

Hydro-Search, Inc., 1983. Private consulting report prepared for Southern Pacific Transportation Company.

IDO, 1982. Low-to-moderated temperature hydrothermal reservoir engineering handbook; U.S. Department of Energy Idaho Operations Office, IDO-1ØØ99, Vol. II.

Nork, William E., Inc., 1985. Carlin High School Geothermal Well; private consulting report prepare for the Elko County School District.

Prickett, T.A., and Associates, 1981. Selected hand-held calculator codes for the evaluation of cumulative strip-mining impacts on ground water; prepared for the Office of Surface Mining, Region V, Denver, Colorado.

U.S. Department of Health Education and Welfare, 1969. Manual of septic tank practice: Public Health Service Publication No. 526.

APPENDIX A

TEST PIT LOGS AND PERCOLATION TEST DATA

WILLIAM E. NORK, Inc.

Reno, Nevada 89503

THURSTON TESTING LABORATORY

CARLIN SCHOOL
Geothermal Water Disposal
2/25/86

SUMMIT ENGINEERING CORP.
572 FIFTH STREET
ELKO, NEVADA 89801
(702) 738-8058

RECEIVED FEB 2 5 1986

Test Pit 1

Test at 2.9'
Gray Clayey Sand

Interval	Drop
30 Minutes	1-3/4"
"	1-5/8"
"	1-3/8"
"	1-1/4"
"	1-1/8"
"	1-1/8"

$\frac{30 \text{ MIN}}{1\frac{1}{2} \text{ INCH}} = 26.7$ MIN/INCH

Test Pit 2

Test at 2.2'
Brown Clayey Sand

Interval	Drop
30 Minutes	7/8"
"	7/8"
"	7/8"
"	5/8"
"	5/8"
"	5/8"

$\frac{30 \text{ MIN}}{5/8 \text{ INCH}} = 48$ MIN/INCH

Test Pit 3

Test at 2.0'
Brown Clayey Sand

Interval	Drop
30 Minutes	1-1/4"
"	1-3/8"
"	1-3/8"
"	1-1/4"
"	1-1/4"
"	1-1/4"

$\frac{30 \text{ MIN}}{1\frac{1}{4} \text{ INCH}} = 24$ MIN/INCH

Test Pit 4

Test at 2.1'
Brown Silty Sand

Interval	Drop
30 Minutes	1-3/4"
"	1-5/8"
"	1-1/2"
"	1-5/8"
"	1-5/8"
"	1-5/8"

Sam Thurston

$\frac{30 \text{ MIN}}{1\frac{5}{8} \text{ INCH}} = 18.5$ MIN/INCH

[illegible] 17,000
000 x

$x = \pm 53{,}000$

PERC RATE_{AV} = 29.3 MIN INCH

LOADING RATE, $Q = \frac{5}{\sqrt{t}} = \frac{5}{\sqrt{29.3}} = $ **0.93** GPD/FT^2

60 GPM x 1440 MIN/DAY = 86,400 GPD

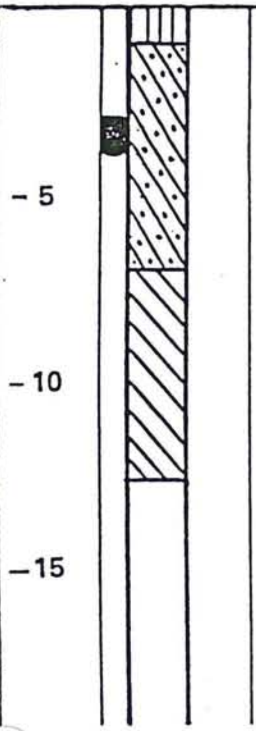
86,400 GPD ÷ 0.93 GPD/FT^2 = 92,903 FT^2

DEPTH (Ft.) | TEST LOCATION

LOG OF TEST PIT 1

EQUIPMENT: Backhoe

DATE: 2/24/86 ELEV.: 99



BROWN SILT (ML). Soft, Wet, Highly Organic.

GRAY CLAYEY SAND (SC). Soft, Wet to Saturated.
Cementation 2.2' to 3.2'.
Moist to Wet below Cementation.

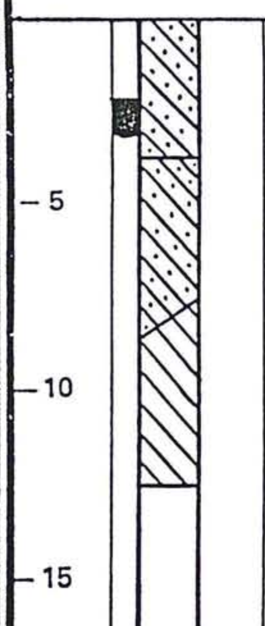
BROWN SANDY CLAY (CL). Soft, Wet.

Bottom of Test Pit at 12.5'. No Free Water.
Percolation Test at 2.9'.
All Soils Visually Classified.

LOG OF TEST PIT 2

EQUIPMENT: Backhoe

DATE: 2/24/86 ELEV.: 100



BROWN CLAYEY SAND (SC). Soft, Wet.
Fine-Grained Sand Sizes.
Slight Cementation at 3.2'.

BROWN CLAYEY, GRAVELLY SAND (SC).
Soft, Wet. Occassional Gravels Sizes to 3/4".

BROWN CLAY (CL). Soft, Wet.

Bottom of Test Pit at 12.4'. No Free Water.
Percolation Test at 2.2'.
All Soils Visually Classified

THURSTON TESTING LABORATORY
CONSTRUCTION TESTING

FILE NO: 041-16C DRAWN BY: DJT

DATE: 2/24/86 CHKD. BY: DJT

CARLIN SCHOOL

Geothermal Water Disposal

DEPTH (Ft.) | TEST LOCATION

LOG OF TEST PIT 3

EQUIPMENT: Backhoe

DATE: 2/24/86 ELEV.: 103

BROWN CLAYEY SAND (SC). Soft, Wet.

– 5

Lightly Cemented at 6.0'

– 10

– 15

Bottom of Test Pit at 13.0'. No Free Water.
Percolation Test at 2.0'.
All Soils Visually Classified.

LOG OF TEST PIT 4

EQUIPMENT: Backhoe

DATE: 2/24/86 ELEV.: 105

BROWN SILTY SAND (SM). Soft, Wet.

BROWN CLAYEY SAND (SC). Soft, Moist.
Lightly Cemented at 3.1'

– 5

Stiffer below 7.5'.

– 10

Bottom of Test Pit at 10.0'. No Free Water.
Percolation Test at 2.1'
All Soils Visually Classified.

– 15

THURSTON TESTING LABORATORY
CONSTRUCTION TESTING

FILE NO: 041-16C DRAWN BY: DJT

DATE: 2/24/86 CHKD. BY: DJT

CARLIN SCHOOL

Geothermal Water Disposal

APPENDIX B

BOREHOLE LOG AND CONSTRUCTION DATA

WILLIAM E. NORK, Inc.

Reno, Nevada 89503

LOG OF BOREHOLE

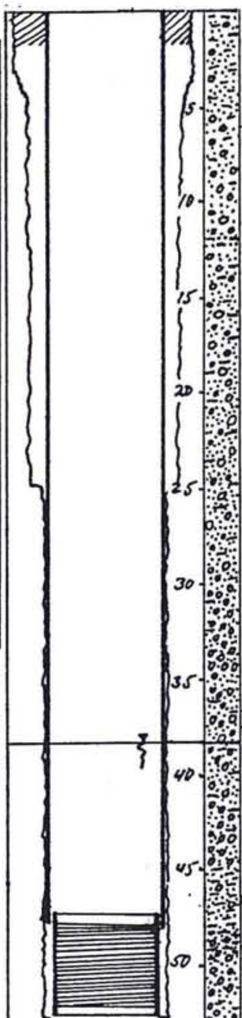
BOREHOLE: Carlin H.S. Geo Chem.

LOCATION: Carlin, NV
LOGGED BY: DCB
PROJECT: Carlin H.S. Fluid Disposal
86-372

LOC. or COORDS. SW¼ Sec. 27, T.33N., R.53E.	DRILLER Reynolds Drilling Wells, NV		START	FINISH
GROUND ELEV.		DATE	3/14/86	3/15/86
		TIME	1010	1653
TOTAL DEPTH 52.25 FT	RIG Cable tool	GEOPHYS LOG	YES	X NO
BOREHOLE DIAM. Nominal 8", 0-25; 6", 25-T.D.	BIT(S) 8" w/ spade, 6" Ø	HOW LEFT See constr. log.		
	FLUID N/A			

DEPTH	PENETRATE	CIRC. RET.	CIRC. LOSS	A-LIFT Q (gpm)	MATERIAL	SYMBOL	DESCRIPTION AND COMMENTS
0		N/A		N/A	clayey gravelly silty sand		Mixture of light brown clay, silt, sand - minor gravel
5					clayey silty, sandy gravel		Mixture of light brown clay, silt, sand & gravel) sand - fine to very coarse gravel - up to 1/2"
10	20 FT/HR						Coarse sand to small gravel. Some balls of clayey silt suggesting silty clay beds or lenses sand & gravel subangular to sub rounded gravel is chert, qtzite & qtz.
15					silty sand & gravel		
	10 FT/HR						Slight Δ in drilling @ 17'. Suspect Δ to cleaner Fm. medium to very coarse sand & gravel. Gravel to ½". Subrounded to subangular. Multicolored chert silt ~ 10-15%
20	5 FT/HR						Note - Drilling rate appears to have slowed partly due to sloughing of loose material into the bottom of the hole. Similar to above but w/ smaller gravel (¼" minus)
25					silty gravel & sand		Note - begin drilling & driving 6" Ø casing @ 25' Fm appears to be heaving @ ~25 ft.
	1 FT/HR						Some cuttings are chips, suggesting large gravel @ 27', possibly as large as ¾"
30					silty sandy gravel		Note - Hole is dry @ 30'. Casing is following the bit down Rate picked up w/ water added to the hole
	2 FT/HR						small to large gravel w/ fine to coarse sand, clean (<5% silt, no clay)
35							
							Possible water @ 38'. Drilled very fast for 1 ft, then filled in
40	5 FT/HR						
					silty, sandy gravel		Similar to above but w/ slight incr. in silt @ 42' color Δ to mod. brown. (silt ~10% +)
45							
					sandy, clayey silt		Δ to lt reddish brown sandy silty clay w/ some gravel good drilling (fines ~ 30%)
					silty sandy gravel		Δ again @ 48'. Back to med. brown color. less fines than above. Obviously saturated.
50							

LOCATION Carlin H.S., Carlin, NV.
PERSONNEL DCB
PROJECT Carlin H.S. Fluid Disposal 86-392



CONSTRUCTION SUMMARY FOR WELL Carlin H.S. Geo.Chem.

LOCATION OR COORDS: SW¼ Sec. 27 T. 33 N., R. 52 E.

ELEVATION: GROUND LEVEL ______

TOP OF CASING L.S.P. + 0.7 FT

DRILLING SUMMARY:

TOTAL DEPTH 52.25 FT

BOREHOLE DIAMETER Nominal 8", 0–25'; 6", 25–T.D.

DRILLER Reynolds Drilling Wells, NV.

RIG Cable-Tool

BIT(S) 8"ϕ, 6"ϕ

DRILLING FLUID N/A

SURFACE CASING None

CONSTRUCTION TIME LOG:

TASK	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING:				
8"ϕ	3/13/86	moved & restarted		
8"ϕ	3/14/86	1010	3/14/86	1415
6"ϕ	3/14/86	1430	3/15/86	1655
GEOPHYS. LOGGING:	NA			
CASING:				
6 5/8"	3/14/86	1420	3/15/86	1655
FILTER PLACEMENT:	NA			
CEMENTING:				
DEVELOPMENT:	3/19/86	1217	3/19/86	1530
OTHER:				
Set Screen	3/19/86	1130	3/19/86	1145
Pull back casing	3/19/86	12.00	3/19/86	1210

WELL DESIGN:

BASIS: GEOLOGIC LOG x GEOPHYSICAL LOG ___

CASING STRING(S): C=CASING S=SCREEN

0.8' to 39.2 C2
39.2 to 47.1 C1
46.95 52.25 S1

CASING: C1 6 5/8" O.D. x 0.250" wall
C2 6 5/8" O.D. x 0.156" wall
C3
C4
S1 6" telescope size, 20 slot Cook SS. screen
S2
S3
S4

CENTRALIZERS None

FILTER MATERIAL Natural Gravel Pack

CEMENT 1 sack of ready mix concrete for temporary surface seal

OTHER

WELL DEVELOPMENT:

Bailed w/ Dart-bottom bailer, surge w/ surge block, Bail, back wash, bail, pump clean w/ sub. pump.

COMMENTS:

C1 IS 7.87' LONG
HOLE WAS MOVED TO NEW LOCATION & DRILLING ACTUALLY STARTED 1010 HRS 3/14/86.
At 25' DEPTH, 6 5/8" CASING WAS INSTALLED W/ THE INTENT TO DRILL & DRIVE TO T.D.
Screen was installed, then exposed by pulling back the 6"ϕ casing.
Water sample for chemical analysis collected after pumping @ 8.5 gpm for 280 minutes

APPENDIX C

PUMPING TEST FIELD DATA SHEETS

Project No. 86-392

PUMPING TEST DATA

WELL NO. Carlin H.S. Geochem

TYPE OF PUMPING TEST Const. Q
(PUMPING)/RECOVERY DATA
M.P. FOR WATER LEVELS Top of stilling well
DISTANCE FROM PUMPING WELL —
LOCATION

(PUMPING)/OBSERVATION WELL
OTHER OBSERVATION WELL(S) NA
PUMP ON: DATE 3/20/86 TIME 0750
PUMP OFF: DATE 3/20/86 TIME 1230

CLOCK TIME	ELAPSED TIME (minutes)		t/t'	WATER LEVEL MEASUREMENT (feet)		PUMPING RATE (gpm)		REMARKS
	t	t'		39.78	(s) or s'	GAL/SM	Q	
0750	0			39.78	0		0	Q measured w/ Bucket & stop watch.
0751	1			42.57	2.79		3	
0753	3			43.15	3.37	2 gl/.5m	4	Valve does not stay put!
0755	5			43.46	3.68		3.5	
0757	7			43.5	3.72	1.	3.5	
0800	10			43.35	3.57		3	
0803	13			43.74	3.96		3.5	E.C. = 1650 MMHO/CM
0806	16			44.00	4.22		3.	
0810	20			44.18	4.40	1.75	3.5	T = 15.5°C EC = 1600 MMHO/CM
0815	25			44.25	4.47	1.6 1.75	3.3 3.5	E.C. = 1500 MMHO/CM
0820	30			44.14	4.36	1.75 −	3.5 −	T = 15°C
0825	35			44.06	4.28	1.75 −	3.5 −	E.C. = 1500 MMHO/CM
0830	40			44.43	4.65	1.75	3.5	
0835	45			44.25	4.47	1.75	3.5	E.C. = 1400 MMHO/CM
0840	50			44.05	4.27	1.75 −	3.5 −	E.C. = 135 MMHO/CM
0845	55							ADD FIREHOSE TO DISCHARGE AWAY FROM WELL HEAD
0850	60			44.28	4.50	1.75	3.5	E.C. = 1350 MMHO/CM
0900	70			44.33	4.55		3.5 −	Δ to measuring Q over 1 minute instead of 30 sec. to incr accuracy
0910	80			44.93	5.15		3.6	Q went to 4 gpm for ~ 4 min E.C. = 1200 MMHO/CM
0920	90			44.21	4.43		3.4	
0930	100			44.92	5.09		3.7	Q dropped to 3.2, incr to 3.7 E.C. = 1200 MMHO/CM
0940	110			44.45	4.67		3.5	
0950	120			44.15	4.37		3.0	E.C. = 1200 MMHO/CM ADJ @ 0951
1005	135			45.05	5.27		4 to 5 gpm	Q varies as valve moved
1010	140			44.87	5.09		3.5	Finally got Q adjusted back to 3.5 @ 1005
1020	150			44.47	4.69		3.4	E.C. = 1150 MMHO/CM
1030	160			44.89	5.11		3.7	
1040	170			45.17	5.39		3.6	
1050	180			45.00	5.22		3.5	
1110	200			49.29	5.11		3.5 −	1150 MMHO/CM
1130	220			49.31	5.02		3.5	E.C. = 1150 MMHO/CM pH = 7.2 T = 12°C

WILLIAM F. NORK, INC.

Project No. 86.392

PUMPING TEST DATA

WELL NO. Carlin H.S. [illegible]

TYPE OF PUMPING TEST Constant-Q

(PUMPING)/RECOVERY DATA

M.P. FOR WATER LEVELS Top of stilling well

DISTANCE FROM PUMPING WELL

LOCATION

(PUMPING)/OBSERVATION WELL

OTHER OBSERVATION WELL(S) None

PUMP ON: DATE 3/20/86 TIME 0750

PUMP OFF: DATE 3/20/86 TIME 12:50

CLOCK TIME	ELAPSED TIME (minutes)		t/t'	WATER LEVEL MEASUREMENT (feet)		PUMPING RATE (gpm)		REMARKS
	t	t'		39.78	(s) or s'		Q	
1150	240			44.84	5.06		3.5	
1210	260			44.74	4.96		3.4	
1230	280			45.00	5.22		3.5	
1250	300			45.05	5.27		3.5	E.C. = 1150 MMHOS/CM

Project No. 85-392

PUMPING TEST DATA

Page 1 of 1

WELL NO. Carlin H.S. Geo[?] ch[?]

TYPE OF PUMPING TEST Constant-Q

PUMPING/(RECOVERY) DATA

M.P. FOR WATER LEVELS Top of stilling well

DISTANCE FROM PUMPING WELL —

LOCATION

(PUMPING)/OBSERVATION WELL

OTHER OBSERVATION WELL(S) —

PUMP ON: DATE 3/20/86 TIME 0750

PUMP OFF: DATE 3/20/86 TIME 1250

CLOCK TIME	ELAPSED TIME (minutes)		t/t'	WATER LEVEL MEASUREMENT (feet)		PUMPING RATE (gpm)		REMARKS
	t	t'		39.78	s or (s')		Q	
1250	300	0	∞	45.05	5.27			
1252	302	2	151	40.37	0.59			
1253	303	3	101	40.15	0.37			
1254	304	4	76	40.01	0.23			
1255	305	5	61	39.93	0.15			
1256	306	6	51	39.85	0.07			
1257	307	7	43.9	39.82	0.04			
1258	308	8						
1259	309	9	34.3	39.78	0			
1300	310	10	31	39.77	-0.01			
1302	312	12	26	39.76	-0.02			
1304	314	14	22.4	39.77	-0.01			
1306	316	16	19.8	39.77	-0.01			
1308	318	18	17.7	39.78	0			
1310	320	20	16	39.77	-0.01			
1315	325	25	13	39.77	-0.01			
1325	335	35	9.6	39.77	-0.01			

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