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GW Background & Compliance Report

October 2014

Chavez, Carl J, EMNRD

From:	david janney <dwjanney160@gmail.com>
Sent:	Monday, April 20, 2015 4:31 PM
To:	Griswold, Jim, EMNRD; Chavez, Carl J, EMNRD
Subject:	Alluvial Geothermal Background BTV Report
Attachments:	Alluvial Geothermal Groundwater BTVs Addendum 4-20-2015.pdf

Greetings:

Please find attached the above referenced report. A bound hard copy has been sent to you via FedEx.

Please feel free to contact me with any questions you may have after reviewing the report. We would like to resolve, as soon as possible, any questions regarding the fluoride BTV for shallow alluvial geothermal water.

Sincerely,

David W. Janney, PG
Agent for Lightning Dock Geothermal HI-01, LLC

Mr. Jim Griswold
Environmental Bureau Chief
New Mexico Oil Conservation Division
1220 South Saint Francis Drive
Santa Fe, NM 87505
505-476-3465
Jim.Griswold@state.nm.us

April 20, 2015

RE: Alluvial geothermal groundwater background concentrations at Lightning Dock Geothermal HI-01, LLC, Animas, New Mexico

Dear Mr. Griswold:

On behalf of Lightning Dock Geothermal HI-01, LLC (LDG), Geo-Science Solutions, LLC and Geochemical, LLC submit this document to establish alluvial geothermal groundwater background concentrations of selected compounds listed in NMAC 20.6.3103 at LDG's geothermal power plant located in Animas, New Mexico. This document is intended to be an addendum to the *Groundwater Background and Compliance Report* that was submitted to the New Mexico Oil Conservation Division (OCD) in September 2014.

The September 2014 report provided background threshold values (BTVs) for the geothermal reservoir prior to commercial power generation which began on December 20, 2013. This addendum provides BTVs with supporting calculations for selected constituents in alluvial geothermal groundwater in the vicinity of LDG's production and injection wells based on data collected prior to December 20, 2013.

BACKGROUND

LDG owns 160 acres of surface upon which are located its power plant, its geothermal production well, and two of its shallow alluvial monitoring wells. Rosette, Inc. owns the adjoining property to the east upon which are located all three of LDG's injection wells and five shallow alluvial monitoring wells in the "greenhouse area".

Geothermal water upwells into the alluvium in the greenhouse area and this area is the zone of mixing for the upwelling geothermal water and alluvial groundwater. The result is alluvial geothermal groundwater in the greenhouse area at approximately 65 feet below ground surface. The LDG monitoring wells used for the alluvial geothermal groundwater BTV calculations are shown on Figure 1.

Naturally occurring fluoride, iron, and total dissolved solids (TDS) in the produced geothermal water may exceed the State of New Mexico water quality criteria stated in NMAC 20.6.2.3103. The geothermal reservoir is essentially a confined aquifer that leaks into and mixes with the alluvial groundwater system in the greenhouse area. Since geothermal water naturally upwells into and mixes with alluvial groundwater, it is logical to expect elevated concentrations of fluoride, iron, and TDS in the mixed or alluvial geothermal groundwater. It is also logical that elevated concentrations of these constituents are spatially related to upwelling geothermal groundwater. Concentrations of these constituents are expected to change with depth due to changes in mixing and the greater influence imparted by the geothermal groundwater. Concentrations of these constituents are also expected to be lower up-gradient and significantly down-gradient of the mixing zone. Alluvial geothermal groundwater extends into Section 6, north of the greenhouse area.

ALLUVIAL GEOTHERMAL GROUNDWATER SAMPLING

Each LDG shallow alluvial geothermal groundwater monitoring well was sampled prior to December 20, 2013. All samples were collected in accordance with LDG's *Water Quality Monitoring Program Work Plan* (December 20, 2013). The samples were submitted for analysis to Hall Environmental Analytical Laboratory in Albuquerque, New Mexico. The laboratory analytical results from LDG's monitoring wells presented in Table 1, were used to develop one set of BTVs for selected constituents in alluvial geothermal groundwater.

TABLE 1
Alluvial Geothermal Groundwater Monitoring Wells

Well Name	Well Type	Total Depth	Screened Interval
MW-1	Shallow	85 feet	60-85 feet
MW-1B	Shallow	85 feet	65-85 feet
MW-2	Shallow	80 feet	55-80 feet
MW-3	Shallow	80 feet	55-80 feet
MW-4	Shallow	80 feet	55-80 feet
MW-5	Shallow	78 feet	63-78 feet
MW-6	Shallow	85 feet	60-85 feet

In addition to the wells listed in Table 1, laboratory analytical results from two other shallow alluvial wells in the greenhouse area were used in the calculation of a second set of BTVs in alluvial geothermal groundwater. Wells G3S and G2SE are shown on Figure 1 and details of these wells are included in Table 2.

TABLE 2
Other Alluvial Geothermal Wells

Well Name	Well Type	Total Depth	Screened Interval
G3S (A00036 AS7)	Shallow Burgett Greenhouse	130 feet	90-130 feet
G2SE (A00036 AS5)	Shallow Burgett Greenhouse	600 feet	440-600 feet

While the exact wells from which these samples were collected could not be confirmed, they are believed to have been collected from wells G2SE and G3S as indicated on Figure 1. Both wells were apparently sampled by flowing from a small valve or hose bib on the well head.

LABORATORY ANALYTICAL RESULTS

The laboratory analytical results for LDG's shallow alluvial geothermal groundwater monitoring wells presented in Table 3 provide a baseline for alluvial geothermal groundwater quality in the project area prior to December 20, 2013. A summary of selected constituents from these alluvial geothermal groundwater wells is presented in Table 4 along with the State MCLs.

TABLE 4
Summary of Selected Constituents in Alluvial Geothermal Monitoring Wells

Constituent	Number of Observations	Minimum (mg/L)	Maximum (mg/L)	State MCL (mg/L)
Iron (Fe)	7	<0.02	8.5	1.0
Fluoride (F)	7	1.3	12	1.6
Sulfate	7	510	1200	600
TDS	7	1210	3210	1000

Well G3S was sampled by OCD in 1986 and 1993. Both samples were analyzed by the New Mexico State Scientific Laboratory with a duplicate of the 1993 sample analyzed by Westech Laboratories, Inc. of Phoenix, Arizona. The fluoride concentration detected in the 1986 sample was 12.5 mg/L and the fluoride concentration detected in the 1993 sample was 15.46 mg/L. Well G2SE was sampled by Raser Technologies, Inc. in 2008 and analyzed by TraceAnalysis, Inc. of Lubbock, Texas. The fluoride concentration detected in the 2008 LCD Hot sample was 9.95 mg/L. A summary of selected constituents from these other alluvial geothermal groundwater wells is presented in Table 5 along with the State MCLs. The laboratory analytical sheets for the samples in Table 3 were submitted with the 2014 report and the laboratory analytical sheets for the samples in Table 5 are included in Attachment C.

TABLE 5
Summary of Selected Constituents in Other Alluvial Geothermal Wells

Constituent	Number of Observations	Minimum (mg/L)	Maximum (mg/L)	State MCL (mg/L)
Iron	1	<0.01	<0.01	1.0
Fluoride	3	9.95	15.46	1.6
Sulfate	3	476	675	600
TDS	3	1110	1480	1000

Alluvial geothermal groundwater monitoring well analytical results indicate that TDS is higher than in the deep geothermal reservoir. Alluvial geothermal groundwater monitoring well analytical results also indicate that sulfate exceeds State water quality criteria, however, analytical results indicate that naturally occurring sulfate is higher than in the deep geothermal reservoir. Most iron analyses in the alluvial geothermal groundwater are non-detect. One shallow well (MW-1B) exceeded NMAC 20.6.3103 criteria for iron with an anomalously high value of 8.5 mg/L; far higher than the produced or injected geothermal water. The anomalous value of 8.5 mg/L does not appear to be representative of water quality at this location or in the alluvial geothermal water. Relying on the majority of non-detects for iron, and the concentration of iron in produced geothermal water being below NMAC 20.6.2 standards of 1.0 mg/L, a BTV for iron is unnecessary.

BACKGROUND THRESHOLD VALUES

Since the exceedances of certain regulated constituents in groundwater at LDG are natural in origin, a BTV based on background concentrations is required. The objective of the BTV calculation is to establish an upper percentile limit concentration for each constituent of concern in the Lightning Dock geothermal system. The September 2014 report established BTVs for the geothermal production and injection water and this addendum establishes BTVs for the alluvial geothermal groundwater in the vicinity of the injection wells or greenhouse area.

The expected BTV for dissolved compounds in the Lightning Dock geothermal system can be determined using existing chemical analytical results and EPA-approved procedures. The statistical procedure to calculate BTVs is well documented by the EPA (ProUCL Users Guide, Chapter 1). The appropriate standard for comparison is the 95% Upper Percentile Limit for a Single Observation (UPL95). What is calculated is the value greater than 95% of all expected values if you collected a single sample of alluvial geothermal groundwater in the vicinity of the greenhouse area. There is a 5% probability ($\alpha = 0.05$) that a single sample would have a value higher than the UPL95.

The alluvial geothermal groundwater sample set collected by LDG in December 2013 contains a total of seven samples and one duplicate sample. ProUCL guidance suggests that at least 10 samples are needed to statistically determine a BTV. An insufficient number of samples of alluvial geothermal groundwater was collected by LDG in December 2013. The inclusion of additional historic data from the greenhouse area, however, provides a sufficient number of samples to calculate BTVs for alluvial geothermal groundwater in the vicinity of the injection wells or greenhouse area. The EPA-approved software ProUCL 5.0 was used to calculate the BTVs presented herein. Dr. Gregory Miller of Geochemical, LLC input the data, ran the program, and provided the output results with comments to Geo-Science Solutions, LLC. The data is broken into two groups, monitoring wells (MW's) and monitoring wells combined with three samples from two alluvial geothermally-influenced wells (All). Both groups are carried through the analysis. The raw dataset for this effort is presented in Table 6.

TABLE 6
Summary of Selected Constituents for Alluvial Geothermal Wells

MW F (mg/L)	MW TDS (mg/L)	All F (mg/L)	All TDS (mg/L)	MW Sulfate (mg/L)	All Sulfate (mg/L)
7.7	1780	12.5	1195	670	585
9.3	1520	15.46	1480	540	675
11	1380	9.95	1110	510	476
12	1380	7.7	1780	540	670
4.3	3210	9.3	1520	1200	540
1.3	2010	11	1380	930	510
6.9	1880	12	1380	950	540
		4.3	3210		1200
		1.3	2010		930
		6.9	1880		950

Prior to calculating BTVs, Dixon's tests for outliers were conducted. No outliers for the fluoride or sulfate data were detected. The TDS value of 3210 mg/L was identified as an outlier at the 90% and 95% confidence interval and was removed from the data set. Dixon's test was rerun on the reduced dataset and outliers were not detected. This final reduced dataset is presented in Table 7.

TABLE 7
Summary of Reduced Data for Alluvial Geothermal Wells

MW F (mg/L)	MW TDS (mg/L)	All F (mg/L)	All TDS (mg/L)	MW Sulfate (mg/L)	All Sulfate (mg/L)
7.7	1780	12.5	1195	670	585
9.3	1520	15.46	1480	540	675
11	1380	9.95	1110	510	476
12	1380	7.7	1780	540	670
4.3	2010	9.3	1520	1200	540
1.3	1880	11	1380	930	510
6.9		12	1380	950	540
		4.3	2010		1200
		1.3	1880		930
		6.9			950

Distribution testing is necessary to select the proper statistical test for the data. The reduced dataset of Table 7 was tested for its goodness-of-fit to probability distributions (normal, gamma, and lognormal). All of the reduced datasets were normally distributed at the 95% confidence interval, indicating that use of the 95% Upper Prediction Limit (t-statistic) is the appropriate measure of the BTV for fluoride and TDS. Summary statistics for the reduced dataset are presented in Table 8.

TABLE 8
Summary of Reduced Data Statistics for Alluvial Geothermal Wells

Constituent	Number of Observations	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	SD (mg/L)	SEM (mg/L)	CV (mg/L)
MW F	7	1.3	12	7.5	3.76	1.421	0.501
MW TDS	6	1380	2010	1658	269	109.8	0.162
MW Sulfate	7	510	1200	762.9	266.4	100.7	0.349
All F	10	1.3	15.46	9.041	4.156	1.314	0.46
All TDS	9	1110	2010	1526	306.5	102.2	0.201
All Sulfate	10	476	1200	707.6	239.7	75.8	0.339

Notes: SD = standard deviation, SEM = standard error of the mean, CV = coefficient of variation

The BTVs for the two groups (MW's and All) concentrations of fluoride, sulfate, and TDS are presented in Table 9. The ProUCL output sheets are included in Attachment D.

TABLE 9
BTVs for Selected Constituents in Alluvial Geothermal Groundwater

Constituent	MWs Only (mg/L)	All wells (mg/L)
Fluoride	15.31	17.03
TDS	2244	2127
Sulfate	1316	1168

CONCLUSIONS

The Lightning Dock geothermal system is dynamic and its flow and chemical characteristics may change over time. Factors effecting fluoride, TDS, and sulfate concentrations in alluvial geothermal groundwater include: upwelling flow from the deep geothermal reservoir, sealing of and development of new upward flow paths by mineral precipitation, snow and rain that recharge the shallow groundwater system, and shallow groundwater use in the basin.

It is unlikely that fluoride concentrations in alluvial geothermal groundwater would ever exceed the maximum fluoride concentration of 15.46 mg/L detected in the greenhouse area. It is possible that the alluvial geothermal groundwater BTVs established herein could be exceeded, however any exceedance is expected to be less than two standard deviations for the "All F" data presented in Table 8. A Fluoride BTV of 17.03 is the most practical approach for this constituent since it utilizes all of the analytical data for alluvial geothermal groundwater samples collected from wells in the greenhouse area.

Thank you very much for your assistance in the development of this important energy project. Should you have questions regarding this document or the ProUCL output, please do not hesitate to contact me by email at dwjanney160@gmail.com or by phone at 505. 508.9187.

Respectfully submitted,

David W. Janney

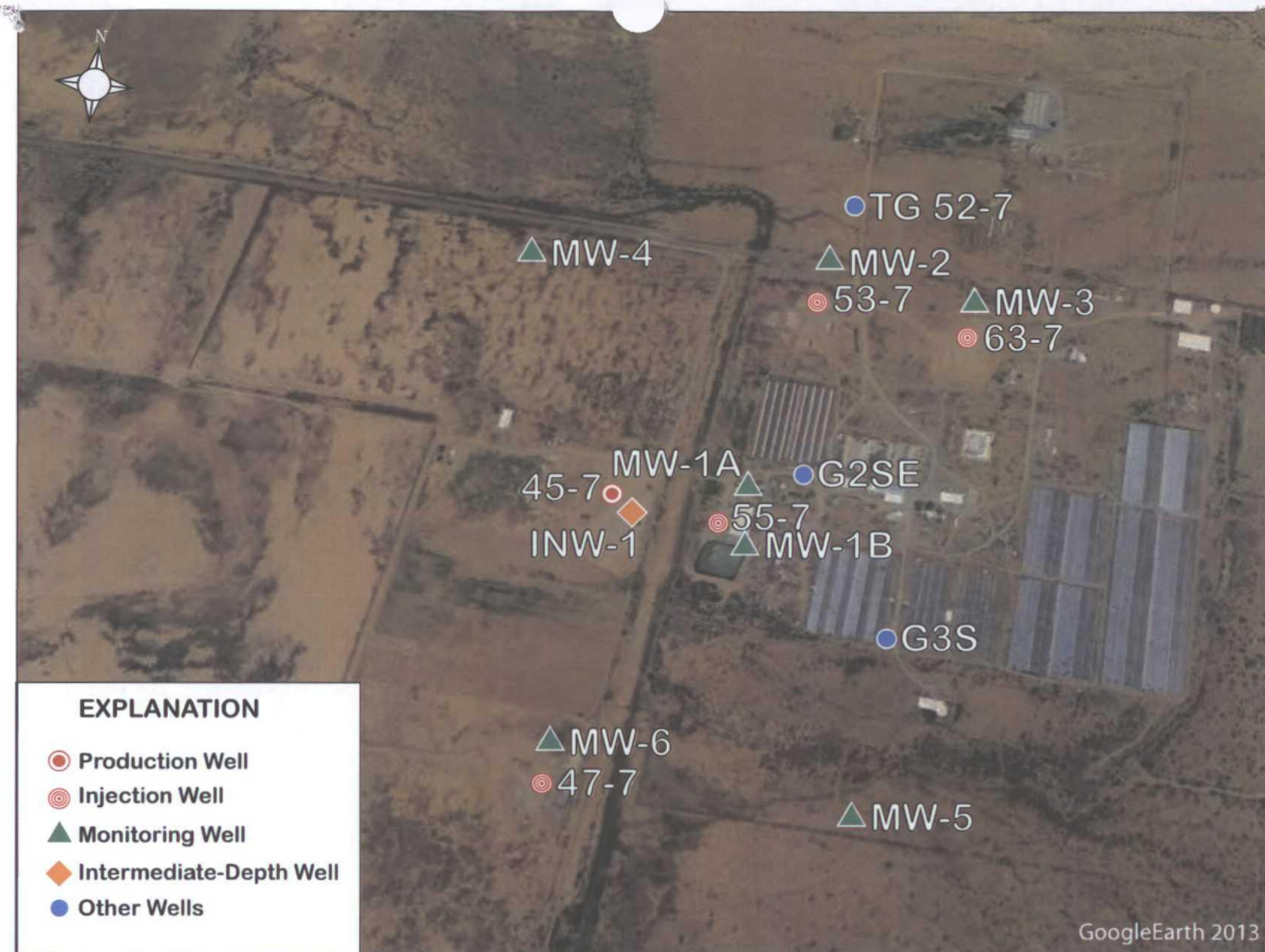
David W. Janney, PG
Principal
Geo-Science Solutions, LLC
Agent for Lightning Dock Geothermal HI-01, LLC

Cc: Carl Chavez – NMOCD
Nick Goodman – Lightning Dock Geothermal HI-01, LLC
Michelle Henrie – Lightning Dock Geothermal HI-01, LLC

Attachments
A: Figure 1
B: Table 3
C: Laboratory Analytical Sheets
D: ProUCL 5.0 Output Files

ATTACHMENT A

FIGURE 1



Geo-Science Solutions, LLC
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Cyrq
Lightning Dock geothermal

PROJECT: Lightning Dock Geothermal HI-01, LLC	DWN BY: KP	DATUM:	DATE: April 2015
	CHK'D BY: DJ	REV. NO.:	CONTRACT NO.:
TITLE: WELL LOCATIONS	PROJECTION:	SCALE: 1" ≈ 700'	FIGURE NO.: 1

ATTACHMENT B

TABLE 3

Summary of Alluvial Geotherma. Groundwater Analytical Results
Lightning Dock Geothermal HI-01, LLC
Animas, New Mexico

			Well ID:	Burgett Geothermal Well	Burgett Produced	LCD Hot	MW-1	MW-1B	MW-2	MW-2 Duplicate	MW-3	MW-4	MW-5	MW-6
		NMAC 20.6.2	Sample Date:	1/28/1986[1]	2/2/1993[2]	3/12/2008[3]	11/25/2013	12/11/2013	11/25/2013	11/25/2013	11/24/2013	11/24/2013	11/24/2013	11/23/2013
	Analyte	Std. Dissolved Concentration	Lab ID:	WC562/HM279		153440	1311B14-001	1312659-001	1311B14-002	1311B14-003	1311B14-004	1311B14-005	1311B14-006	1311B14-007
1	Arsenic (As)	1 mg/l		0.011	< 0.05	< 0.005	0.0055	0.011	0.0082	0.0083	0.019	0.012	0.0060	0.020
2	Barium (Ba)	1 mg/l		NA	< 0.1	0.059	0.063	0.14	0.044	0.043	0.06	0.059	0.041	0.047
3	Cadmium (Cd)	0.01 mg/l		NA	< 0.1	< 0.001	< 0.002	< 0.002	ND	ND	ND	ND	ND	MD
4	Chromium (Cr)	0 5 mg/l		NA	< 0.1	< 0.001	< 0.006	< 0.006	ND	ND	ND	ND	ND	ND
5	Cyanide (CN)	0.2 mg/l		NA	NA	< 0.01	< 0.001	< 0 001	ND	ND	ND	ND	ND	ND
6	Fluoride (F)	1.6 mg/l		12.5	15.46	9.95	7.7	9 3	11	11	12	4.3	1.3	6.9
7	Lead (Pb)	0.05 mg/l		NA	< 0.1	< 0.005	< 0.001	0.0044	ND	ND	ND	ND	ND	ND
8	Total Mercury (Hg)	0.002 mg/l		NA	0.004	< 0.0002	0.00079	0.0016	ND	ND	0.00034	ND	0.0010	0.00077
9	Nitrate(NO3 as N)	10 mg/l		NA	NA	4.2	2.6	15	3.1	3.2	2.1	12	42	42
10	Selenium (Se)	0.05 mg/l		< 0.005	< 0.05	0.046	0.0052	NA	0.0035	0.0035	0.0034	0.033	0.028	0.011
11	Silver (Ag)	0.05 mg/l		NA	< 0.1	< 0 005	< 0 005	< 0 005	ND	ND	ND	ND	ND	ND
12	Uranium (U)	0.03 mg/l		NA	NA	NA	0.011	0.0037	ND	ND	ND	0.0051	0.014	0.0012
13	Radioactivity: Radium 266	30 pCi/l		NA	NA	NA	0.285 ± 0.350 (0.571)	2.00 ± 0.722 (0 566)	0.266 ± 0.377 (0.638)	0.183 ± 0.312 (0.550)	0.102 ± 0.375 (0.720)	1.32 ± 0.615 (0.664)	0.305 ± 0.401 (0.667)	0.140 ± 0.305 (0.562)
14	Radioactivity: Radium 288	30 pCi/l		NA	NA	NA	0.888 ± 0.456 (0.799)	0.711 ± 0.402 (0.727)	0.0585 ± 0.308 (0.702)	0.468 ± 0.385 (0.767)	0.156 ± 0.270 (0.590)	0.542 ± 0.396 (0.772)	0.333 ± 0.452 (0.966)	2.53 ± 0.949 (1.39)
15	Radionuclides: Radon 222	None		NA	NA	NA	238	676	580	567	781	1090	197	507
16	Benzene	1 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
17	Polychlorinated biphenyls (PCB's)	1 ug/l		NA	NA	ND	NA	ND	NA	NA	NA	NA	NA	NA
18	Toluene	750 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
19	Carbon Tetrachloride	10 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
20	1,2-dichloroethane (EDC)	10 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
21	1,1-dichloroethylene (1,1-DCE)	5 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
22	1,1,2,2,-tetrachloroethene (PCE)	20 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
23	1,1,2-trichloroethylene (TCE)	100 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
24	ethylbenzene	750 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
25	Total xylenes	620 ug/l		NA	NA	< 1	< 3	< 3	ND	ND	ND	ND	ND	ND
26	methylene chloride	100 ug/l		NA	NA	< 5	< 6	< 6	ND	ND	ND	ND	ND	ND
27	chloroform	100 ug/l		NA	NA	< 1	28	33	4.9	5.2	21	ND	ND	ND
28	1,1-dichloroethane	25 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
29	ethane dibromide (EDB)	0.1 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
30	1,1,1-trichloroethane	660 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
31	1,1,2-trichloroethane	10 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
32	1,1,2,2-tetrachloroethane	10 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
33	vinyl chloride	1 ug/l		NA	NA	< 1	< 2	< 2	ND	ND	ND	ND	ND	ND
34	PAH's; total naphthalene	30 ug/l		NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
35	benzo-a-pyrene	0.7 ug/l		NA	NA	NA	< 10	< 10	ND	ND	ND	ND	ND	ND
36	TPH 418.1	None		NA	NA	NA	< 1	1.3	ND	ND	1.1	NA	NA	ND
1	Chloride (Cl)	250 mg/l		94.3	110	77	100	120	96	96	94	710	230	130
2	Copper (Cu)	1 mg/l		NA	< 0.1	< 0.005	< 0.006	< 0.006	ND	ND	ND	ND	ND	ND
3	Iron (Fe)	1 mg/l		NA	< 0.1	0.138	< 0.02	8.5	< 0.02	< 0 02	0.24	< 0.02	0.021	0.39
4	Manganese (Mn)	0.2 mg/l		NA	< 0.05	0.012	0 21	0.27	0.041	0.036	0.18	0.15	0 27	0.074
5	Phenol	0 005 mg/l		NA	NA	0.139	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
6	Sulfate	600 mg/l		585	675	476	670	540	510	510	540	1200	930	950
7	Total Dissolved Solids (TDS)	1000 mg/l		1195	1480	1110	1780	1520	1380	1210	1380	3210	2010	1880
8	Zinc (Zn)	10 mg/l		NA	< 0.1	< 0.007	< 0.01	0.015	0.015	ND	ND	0.048	0.023	0.033
9	pH	6-9 pH Units				7.91	7.69	7.66	7.6	7.58	8	7.38	7.62	7.56
1	Aluminum (Al)	5 mg/l		NA	< 0.1	< 0.05	0.034	25	0.049	0.024	0.31	ND	ND	0 63
2	Boron (B)	0.75 mg/l		NA	< 0.05	0.369	0.7	0.45	0.37	0.36	0.44	0.22	0 31	0 39
3	Cobalt (Co)	0 05 mg/l		NA	< 0.05	NA	< 0.008	< 0.008	ND	ND	ND	ND	ND	ND
4	Molybdenum (Mo)	1.0 mg/l		NA	< 0.1	< 0 1	0.058	0 029	0.027	0.026	0.065	0.014	0.031	0.035
5	Nickel (Ni)	0 2 mg/l		NA	< 0.1	< 0.005	< 0.01	< 0.01	ND	ND	ND	ND	ND	ND
6	Bromide	None		NA	NA	NA	< 0.006	NA	ND	ND	ND	2.2	1.2	ND
7	Lithium (Li)	None		NA	NA	NA	0.8	0.533	0.7	0.7	0.5	1.7	0.4	0.8
8	Rubidium (Rb)	None		NA	NA	NA	0.2	0.189	0.1	0.1	0.2	0.4	0.1	0.1
9	Tungsten	None		NA	NA	NA	< 0 006	0.0386	ND	ND	ND	ND	ND	ND
	Notes:													
	NA = not analyzed													
	ND = not detected													
	* total metal not dissolved metal													

Notes:

1 Sample collected by OCD and analyzed by NM State Health and Environment Dept. Lab

2 Sample collected by OCD and analyzed by NM State Health and Environment Dept. Lab and Westech Lab, metals are **Total**

3 Samples collected by Razer and analyzed by Trace Analysis, metals are **Total**

ATTACHMENT D

PROUCL 5.0 OUTPUT FILES

	A	B	C	D	E	F	G
1	MW F (mg	MW TDS (	All F (mg/l	All TDS (m	MW Sulfat	All Sulfate (mg/L)	
2	7.7	1780	12.5	1195	670	585	
3	9.3	1520	15.46	1480	540	675	
	11	1380	9.95	1110	510	476	
	12	1380	7.7	1780	540	670	
6	4.3	2010	9.3	1520	1200	540	
7	1.3	1880	11	1380	930	510	
8	6.9		12	1380	950	540	
9			4.3	2010		1200	
10			1.3	1880		930	
11			6.9			950	

General Statistics on Uncensored Full Data

Date/Time of Computation	3/18/2015 3:10:46 PM
User Selected Options	
From File	ProUCL_IN.xls
Full Precision	OFF

From File: ProUCL_IN.xls

General Statistics for Uncensored Data Sets

Variable	NumObs	# Missing	Minimum	Maximum	Mean	SD	SEM	MAD/0.675	Skewness	Kurtosis	CV
MW F (mg/L)	7	0	1.3	12	7.5	3.76	1.421	4.893	-0.577	-0.372	0.501
MW TDS (mg/L)	6	0	1380	2010	1658	269	109.8	370.6	0.161	-2.197	0.162
All F (mg/L)	10	0	1.3	15.46	9.041	4.156	1.314	3.781	-0.469	0.0899	0.46
All TDS (mg/L)	9	0	1110	2010	1526	306.5	102.2	422.5	0.331	-1.002	0.201
MW Sulfate (mg/L)	7	0	510	1200	762.9	266.4	100.7	237.2	0.687	-0.99	0.349
All Sulfate (mg/L)	10	0	476	1200	707.6	239.7	75.8	152	1.141	0.349	0.339

Percentiles for Uncensored Data Sets

Variable	NumObs	# Missing	10%ile	20%ile	25%ile(Q1)	50%ile(Q2)	75%ile(Q3)	80%ile	90%ile	95%ile	99%ile
MW F (mg/L)	7	0	3.1	4.82	5.6	7.7	10.15	10.66	11.4	11.7	11.94
MW TDS (mg/L)	6	0	1380	1380	1415	1650	1855	1880	1945	1978	2004
All F (mg/L)	10	0	4	6.38	7.1	9.625	11.75	12.1	12.8	14.13	15.19
All TDS (mg/L)	9	0	1178	1306	1380	1480	1780	1820	1906	1958	2000
MW Sulfate (mg/L)	7	0	528	540	540	670	940	946	1050	1125	1185
All Sulfate (mg/L)	10	0	506.6	534	540	627.5	866.3	934	975	1088	1178

	A–E	F	G–K	L
433	Shapiro Wilk Test Statistic	0.898	**Shapiro Wilk Lognormal GOF Test**	
434	5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
435	Lilliefors Test Statistic	0.201	**Lilliefors Lognormal GOF Test**	
	5% Lilliefors Critical Value	0.28	Data appear Lognormal at 5% Significance Level	
	Data appear Lognormal at 5% Significance Level			
438				
439	**Background Statistics assuming Lognormal Distribution**			
440	95% UTL with 95% Coverage	1672	90% Percentile (z)	1007
441	95% UPL (t)	1229	95% Percentile (z)	1127
442	95% USL	1330	99% Percentile (z)	1394
443				
444	**Nonparametric Distribution Free Background Statistics**			
445	**Data appear Normal at 5% Significance Level**			
446				
447	**Nonparametric Upper Limits for Background Threshold Values**			
448	Order of Statistic, r	10	95% UTL with 95% Coverage	1200
449	Approximate f	0.526	Confidence Coefficient (CC) achieved by UTL	0.401
450	95% Percentile Bootstrap UTL with 95% Coverage	1200	95% BCA Bootstrap UTL with 95% Coverage	1200
451	95% UPL	1200	90% Percentile	975
452	90% Chebyshev UPL	1462	95% Percentile	1088
453	95% Chebyshev UPL	1803	99% Percentile	1178
454	95% USL	1200		
455				
456	Note: The use of USL to estimate a BTV is recommended only when the data set represents a background			
457	data set free of outliers and consists of observations collected from clean unimpacted locations.			
458	The use of USL tends to provide a balance between false positives and false negatives provided the data			
	represents a background data set and when many onsite observations need to be compared with the BTV.			

GROUNDWATER BACKGROUND AND COMPLIANCE REPORT FOR THE DALE BURGETT GEOTHERMAL POWER PLANT HIDALGO COUNTY, NEW MEXICO

Owned and Operated by

LIGHTNING DOCK GEOTHERMAL HI-01, LLC
HIDALGO COUNTY, NEW MEXICO

Submitted To:

The New Mexico Oil Conservation Division
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Submitted By

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October 2014

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LIST OF ACRONYMS

ACL	Alternate Concentration Limits
BTV	Background Threshold Values
LDG	Lightning Dock Geothermal HI-01, LLC
MCL	Maximum Concentration Limit
mg/L	Milligrams per liter
OCD	New Mexico Oil Conservation Division
ppm	parts per million
TDS	Total Dissolved Solids
TG	Temperature Gradient

1.0 INTRODUCTION

Lightning Dock Geothermal HI-01, LLC (LDG), a wholly owned subsidiary of Cyrq Energy, has prepared this report to provide background water quality and discharge permit compliance data for the Lightning Dock Geothermal Project (the "LDG Project" or "Project") located in Hidalgo County, New Mexico. The LDG Project is located on private surface with Federal Geothermal leases NM-34790 and NM-108801 which encompass approximately 3,140 acres. This report is required by the New Mexico Oil Conservation Division (OCD) to satisfy the requirements of the Lightning Dock Geothermal No.1 (HI-01) Discharge Permit GTHT-001, dated July 1, 2009.

The objectives of this document are to provide background threshold values (BTVs) for selected elements prior to commercial power generation which began on December 20, 2013 and to provide water quality, groundwater flow direction, and hydraulic gradient data reflecting the first six months of power plant operation. This document meets the requirements of Sections 20.B.ii and 20.B.v of Discharge Permit GTHT-001. The LDG Project is not using a water-cooling tower to cool its working fluid. as anticipated in Discharge Permit GTHT-001; therefore, this report excludes cooling tower-blow-down samples.

1.1 Site Location and Description

The LDG Project is located in Section 7, Township 25 South, Range 19 West of Hidalgo County, New Mexico. The LDG Project is located along the east side of the Animas Valley approximately 13 miles north of Animas, New Mexico, and approximately 18 miles southwest of Lordsburg, New Mexico. LDG owns 160 acres of surface upon which its power plant, some of its geothermal wells, and some of its monitoring wells are located. Rosette, Inc. owns the adjoining property to the east upon which three of LDG's geothermal wells and some monitoring wells are located ("greenhouse area"). The LDG Project location is depicted in Figure 1 and the wells used for the background concentration calculations are shown on Figure 2.

1.2 Background

The Lightning Dock geothermal system is a blind system with no surface manifestations. It was discovered in 1948. Since 1948 a number of investigators have conducted geochemical sampling of fluids, electrical and gravity geophysical surveys, temperature gradient drilling, shallow production well drilling of the resource for direct-use heating for green-housing and aquaculture, and deep geothermal exploratory drilling.

Naturally occurring arsenic, boron, fluoride, sulfate, total dissolved solids (TDS) and pH in the geothermal system may exceed State of New Mexico water quality criteria stated at NMAC 20.6.2.3103. Multiple isolated fresh water aquifers do not exist in the LDG Project area, all waters contain less than 10,000 parts per million (ppm) TDS.

The highest concentrations of fluoride are, therefore, expected to be spatially related to the upwelling geothermal system and will change with depth due to changes in mixing and the greater influence imparted by the geothermal system. These concentrations are expected to be lower up gradient of the greenhouse area and at a significant distance down gradient of the greenhouse area. Higher concentrations of fluoride than detected in the alluvial monitoring well network are reported in shallow alluvial wells (Elston et al. 1983). TDS and sulfate concentrations are generally higher in the alluvial groundwater throughout the Animas Valley (Elston et al. 1983).

2.0 SCOPE OF REPORT

LDG's Discharge Permit GTHT-001 required LDG to collect and analyze groundwater samples from its production, injection, and groundwater monitoring wells. This report was intended to be submitted to OCD by the end of June 2014 but was delayed at OCD's request in order to include additional laboratory analytical results for samples collected from wells LDG 47-7 and LDG 63-7 in September 2014.

LDG's water quality monitoring program describes the protocol for the collection and analysis of these samples. The LDG wells used to develop the background threshold values (BTVs) for selected constituents in the geothermal system are presented in Tables 1 and 2.

In addition to the wells indicated in Tables 1 and 2, other wells with laboratory analytical reports were used in the calculation of BTVs for the geothermal system. This includes temperature gradient well TG-52-7 located approximately 1,600 feet northeast of LDG 55-7. Details of this well are included in Table 3.

TABLE 1
Production and Injection Wells

Well Name	Well Type	Total Depth	Liner Interval
LDG 45-7	Production	2,900 Feet	1,689-2,900 Feet
LDG 53-7	Injection	4,491 Feet	1,500-4,441 Feet
LDG 55-7	Injection	2,349 Feet	1,030-1,649 Feet
LDG 63-7	Injection	3,400 Feet	1,500-3,400 Feet

TABLE 2
Groundwater Monitoring Wells

Well Name	Well Type	Total Depth	Screened Interval
MW-1	Shallow	80 Feet	60-80 Feet
MW-1B	Shallow	80 Feet	60-80 Feet
MW-2	Shallow	80 Feet	60-80 Feet
MW-3	Shallow	80 Feet	60-80 Feet
MW-4	Shallow	80 Feet	60-80 Feet
MW-5	Shallow	80 Feet	60-80 Feet
MW-6	Shallow	80 Feet	60-80 Feet
INW-1	Intermediate	600 Feet	580-600 Feet
LDG 47-7	Deep	3,623 Feet	Cased to 1,589 and open hole to TD

TABLE 3
Other Wells

Well Name	Well Type	Total Depth	Casing Details
TG 52-7	Thermal Gradient	2,900 Feet	Cased to 2,220 and open hole to TD

3.0 METHODS

This section describes the methods used to collect and analyze the groundwater samples. It also describes the methods utilized to calculate BTVs.

3.1 Production, Injection, and Monitoring Wells

Production, injection, and monitoring wells were all sampled prior to start-up of the geothermal power plant. At least three casing volumes were removed from the production well with the production pump prior to sampling. The injection wells were sampled with a low-flow bladder pump or a Kuster flow-through sampling device. Deep monitoring well LDG 47-7 was also sampled using the Kuster flow-through sampling device. The remaining monitoring wells were sampled with a disposable bailer. All samples from these wells were collected in accordance with LDG's *Water Quality Monitoring Program Work Plan* (December 20, 2013). These samples were submitted for analysis to Hall Environmental Analytical Laboratory (HEAL) in Albuquerque, New Mexico.

3.2 Other Wells

Laboratory analytical results from temperature gradient well TG 52-7 were used in the BTV analysis of the geothermal water. Well TG-52-7 was sampled by Roy Cunniff in 2003 using airlifting and the sample was analyzed by the New Mexico State Air, Water, and Soil Testing Laboratory at New Mexico State University. The laboratory analytical sheets for this sample are included in Appendix A. This laboratory has subsequently closed and no other information about this sample was available.

3.3 Background Threshold Value Calculations

The geothermal water at LDG has been shown to naturally exceed several State of New Mexico water quality criteria as published in NMAC 20.6.2.3103. Because the exceedances are natural in origin, a BTV based on background concentrations is allowed.

The objective of the BTV calculation is to establish an upper percentile limit concentration for each constituent of concern in the Lightning Dock geothermal system for the formation of production and injection. Due to the nature of the Lightning Dock geothermal system, this threshold limit may be exceeded; however, any exceedance is expected to be less than three times the BTVs developed herein and would likely be no more than 20 percent greater than these BTVs.

The expected BTV for dissolved compounds in the Lightning Dock geothermal system can be determined using existing chemical analytical results and EPA-approved procedures. The statistical procedure to calculate BTVs is well documented by the EPA (ProUCL Users Guide, Chapter 1). The appropriate standard for comparison is the 95% Upper Percentile Limit for a Single Observation (UPL95). What is calculated is the value greater than 95% of all expected values if you took a single sample of Lightning Dock geothermal fluid before injection. There is a 5% probability ($\alpha = 0.05$) that a single sample would have a value higher than the UPL95. The EPA-approved software ProUCL 5.0 was used to calculate the BTVs presented herein.

4.0 RESULTS

This section presents the laboratory analytical results for shallow groundwater and geothermal system water, describes the results of the BTVs derived by ProUCL, and provides a description of shallow alluvial groundwater flow direction and gradient. Where the BTV exceeds the NMAC 20.6.2.3103 water quality criteria the BTV is used as the criteria. This switch from the lower water quality criteria to the BTV is commonly referred to as an alternative concentration limit (ACL).

4.1 Laboratory Analytical Results

A summary of laboratory analytical results for the geothermal system wells for samples collected prior to the startup of geothermal power plant operations are presented in Table 4; a summary of laboratory analytical results for the geothermal system wells for samples collected after the startup of the geothermal power plant are presented in Table 5; and a summary of laboratory analytical results for the shallow groundwater monitoring wells collected prior to the startup of geothermal power plant operations are presented in Table 6. A summary of selected constituents in the geothermal production well LDG 45-7 and spent geothermal water prior to injection into LDG 55-7 is presented in Table 7 so that they may be compared for potential changes due to the heat extraction process in the power plant. The laboratory analytical sheets for compliance samples collected in 2013 were submitted to OCD in LDG's *Annual Geothermal Well Report* dated January 31, 2014 and are excluded from this report.

TABLE 7
Selected Constituents in LDG 45-7 and Spent Geothermal Water

Well Name	Constituent	Number of Observations	Minimum (mg/L)	Maximum (mg/L)	State MCL (mg/L)
LDG 45-7	Arsenic	7	0.0031	0.015	1.0
	Boron	7	0.14	0.51	0.75
	Fluoride	7	3.6	13	1.6
	Sulfate	7	140	540	600
	TDS	7	378	1310	1000
LDG 55-7	Arsenic	7	0.011	0.015	1.0
	Boron	7	0.44	0.49	0.75
	Fluoride	7	12	14	1.6
	Sulfate	7	500	530	600
	TDS	7	1280	1320	1000

Note: All samples collected after December 20, 2013

The low concentration of 1,1,2,2 tetrachloroethylene detected in well LDG 63-7 and the low concentrations of phenols detected in wells LDG 47-7 and LDG 63-7 in the samples collected in December 2013 and the low concentrations of total phenolics detected in the samples collected from wells LDG 47-7 and LDG 63-7 in September 2014 are related to the Welaco sampling tool used to collect the samples. Welaco indicated to LDG that diesel fuel or solvents were commonly used to wash sampling tools and that the sampling tool was not steam cleaned prior to use at LDG.

The laboratory analytical results presented in Table 6 provide a baseline for shallow groundwater quality in the project area prior to commercial power generation. A summary of selected constituents in the shallow groundwater prior to commercial power generation is presented in Table 8 along with the State MCLs. The shallow alluvial groundwater sample set contains a total of seven samples and one duplicate sample. ProUCL guidance suggests that at least 10 samples are needed to statistically determine a BTV. In lieu of an insufficient number of samples of shallow groundwater for BTV calculations using ProUCL, the BTVs for the constituents of concern in the shallow alluvial groundwater are preliminarily set to the maximum detected value as shown in Table 8. The use of additional historic data from the greenhouse would provide a sufficient number of samples to calculate BTVs for the shallow alluvial groundwater.

TABLE 8
Summary of Selected Constituents in Shallow Monitoring Wells

Constituent	Number of Observations	Minimum (mg/L)	Maximum (mg/L)	State MCL (mg/L)
Arsenic	7	0.0055	0.019	1.0
Boron	7	0.22	0.7	0.75
Fluoride	7	1.3	12	1.6
Sulfate	7	510	1200	600
TDS	7	1210	3210	1000

Laboratory analytical sheets for results in Table 5 that were collected prior to December 2013 and were not submitted to OCD as part of the 2013 annual geothermal well report are included in Appendix A. The laboratory analytical sheets for the samples collected from the geothermal system after December 2013 are included in Appendix B.

4.2 Background Threshold Values

BTV calculations were conducted using EPA guidance documents and software. This process includes the following steps:

- Group groundwater sampling data by the formation of interest.
- Examine the data for outliers and adjust the data set if appropriate.
- Determine summary statistics (i.e. maximum, median).
- Determine the best distribution fitting the data for calculation of a BTV (e.g. Normal, Lognormal, or Nonparametric).

The results of the UPL95 analysis for geothermal samples, and sampling to date for the alluvial monitoring wells are in Table 9. LDG believes that it is appropriate to use the BTVs presented herein to establish ACLs in the geothermal system for the production and operation of the power plant.

Naturally occurring arsenic, boron, fluoride, sulfate, TDS, and pH in the geothermal system exceed State of New Mexico water quality criteria as published in NMAC 20.6.2.3103. The BTVs derived by Pro UCL for these naturally occurring constituents are presented in Table 9 along with the State MCLs. The complete set of ProUCL output is included in Appendix C.

TABLE 9
Summary of ProUCL Alternate Concentration Limits

Constituent	Number of Observations	Minimum (mg/L)	Maximum (mg/L)	BTV (mg/L)	State MCL (mg/L)	ACL (mg/L)
Arsenic	14	0.0074	0.42	0.42	0.1	0.42
Boron	14	0.12	2.6	2.6	0.75	2.6
Fluoride	15	1.4	17	15.43[1]	1.6	17
Sulfate	16	120	630	630	600	630
TDS	16	321	1572	1572	1000	1572

Note: 1 Normal distribution including outliers

4.3 Groundwater Flow Direction and Hydraulic Gradient

The water-level contour map for the shallow monitoring wells presented in Figure 3 is based on measurements in mid-December of 2013, just prior to the beginning of commercial geothermal power production. These measurements suggest that the water table takes the form of a low ridge sloping from east-northeast to west-southwest across the project area. Presumably the water-table ridge, which may simply be the western part of a water-table mound that would be evident if data were available for locations east of the project area, is the expression of natural upward groundwater flow from the geothermal system into the shallow aquifer.

Monthly pumping and injection amounts for January through June, shown as Figure 4, increased from 119 acre-feet in January to 138 acre-feet in March, then declined in April and were significantly less in May because pumping was suspended during the installation of a new submersible pump in well 45-7 between May 12 and 18. Pumping and injection in June were nearly at the levels of February and March. The water table generally rose after commercial power production began. The orientation of the crest of the water-table ridge appears to have shifted slightly from east-northeast toward the northeast between the pre-operation condition and the June 19, 2014 measurements (Figures 5 through 11), and the difference in elevation across the ridge became somewhat greater as indicated by the water-level change maps (Figures 12 through 17). These maps show that between the pre-operation condition in mid-December 2013, and the configuration of the water table on June 19, 2014, the water table rose by 4 to 6 feet along the crest of the ridge between wells MW-1A and MW-3, but considerably less in the outlying wells MW-4, MW-5 and MW-6. The hydraulic gradients for these time periods are presented in Table 10.

TABLE 10
Hydraulic Gradients December 2013 through June 2014

Date	Gradient	Flow Direction Ranges
December 9-11, 2013	0.005	South to West-Northwest
December 28, 2013	0.005	South to West-Northwest
January 27, 2014	0.005	South to West-Northwest
February 22, 2014	0.004	South to West-Northwest
March 17, 2014	0.004	South to West-Northwest
April 17, 2014	0.005	South to West-Northwest
May 11, 2014	0.005	South to West-Northwest
June 19, 2014	0.005	South to West-Northwest

Water-level hydrographs of the shallow monitoring wells (Figures 18 and 19) show that the rate of water-level rise was nearly uniform over time in the wells farthest from the principal injection well (MW-4 and MW-5), but that the rate of rise appears to have become less after the January measurements in the closer monitoring wells MW-1A, MW-1B, MW-2, and MW-4 even though the February and March injection amounts were greater than the January amount. A decline was seen in all of the shallow monitor wells during and after the non-pumping period in mid-May. The rates of rise between late January and early May for the more distant wells, MW-4 and MW-5, are about 2.2 and 1.6 feet per year, respectively and for the wells closer to the injection well ranged up to about 5.7 feet per year. The record is probably too short to assess whether these rates would now be linear for an extended period, or are actually continuing to decrease. None of these changes have been compared with water-level measurements in shallow wells outside the project area.to assess the extent to which they are related to causes other than the geothermal operation, such as seasonal irrigation.

The hydrograph for the intermediate-depth monitoring well, well INW-1 (Figure 18) shows that the water level rose at about the same rate as in the nearby water-table well MW-1A until about the end of January 2014, then declined abruptly and now appears to be declining such that by April 17 the level was nearly 3 feet below the position on December 28. The water level in well INW-1 declined by a little more than 5 feet during the non-pumping period in mid-May, then rose again and appeared to follow the earlier trend after pumping began again.

Water levels in injection wells 53-7 and 63-7, which have received only very small amounts of water, declined during January (Figure 20). The record for well 53-7 shows a decline of roughly 10 feet between the pre-operation measurement in mid-December 2013 and measurements in late January. The water level in well 63-7 declined somewhat less than 2 feet during the second half of January. No measurements were recorded for these wells between mid-December 2013 and June because the wells were on injection. A number of measurements in each well during June showed erratic variation, both above and below the January measurements, over a range of around 30 feet.

5.0 CONCLUSIONS

Fluoride in groundwater at the LDG project is spatially related to natural upward flow from the geothermal system. Based on the single pre-commercial power generation sample from each of the shallow monitoring wells it is not appropriate to apply a statistical analysis using ProUCL or any other method without consideration of all samples collected from shallow groundwater.

It would be appropriate to calculate BTVs for each monitoring well if at least 10 samples had been collected from each well prior to commercial power generation. Any calculations or conclusions drawn about water quality must incorporate the entire body of laboratory analytical results available from reputable sources, with or without laboratory quality assurance/quality control backup.

Groundwater samples were collected by previous investigators from two shallow alluvial wells in the greenhouse area. While the exact wells from which these samples were collected could not be confirmed, they are believed to have been collected from wells G2SE and G3S as indicated on Figure 2. Well G2SE is believed to be 440 feet deep and well G3S is believed to be 250 feet deep.

Both wells were apparently sampled by flowing from a hose bib on the well head. G2SE was sampled by Raser Technologies, Inc. in 2008 and analyzed by TraceAnalysis, Inc. of Lubbock, Texas. Well G3S was sampled by OCD in 1986 and analyzed by the New Mexico State Scientific Laboratory with a duplicate sample analyzed by Westech Laboratories, Inc. of Phoenix, Arizona. The fluoride concentration detected in G2SE was 9.95 ppm and the fluoride concentration detected in well G3S was 15.46 ppm. This further illustrates the variability and high fluoride concentrations in shallow groundwater with respect to spatial relationship to upwelling geothermal water. The laboratory analytical sheets for these samples are also included in Appendix A.

Based on the laboratory analytical data for wells LDG 45-7 and LDG 55-7 presented in Table 5, the extraction of geothermal water has not caused changes to the quality of the geothermal water. The analytical results for the samples collected from LDG 45-7 on 1/7/2014 and 1/28/2014 appear to indicate that the samples were contaminated by de-ionized water during the equipment decontamination process. The analytical results for the sample collected on 2/25/2014 appear to indicate that the sample was largely de-ionized water from the equipment decontamination process.

Based on the comparison of laboratory analytical data in wells LDG 45-7 and LDG 55-7 presented in Table 7, the extraction of heat from the geothermal water by the geothermal power plant causes no changes to the quality of the spent geothermal water.

Going forward, it is most appropriate to sample the shallow monitoring wells for the constituents of concern that are higher in the geothermal system and use the concentrations reported in the samples collected prior to commercial power production as the baseline for comparison.

6.0 REFERENCES

Elston, E., Deal, E., Logsdon, M., Geology and geothermal waters of Lightning Dock region, Animas Valley and Pyramid Mountains, Hidalgo County, New Mexico, 1983, New Mexico Bureau of Mines and Mineral Resources, Circular 177.

EPA ProUCL, Version 5.0, September 2013

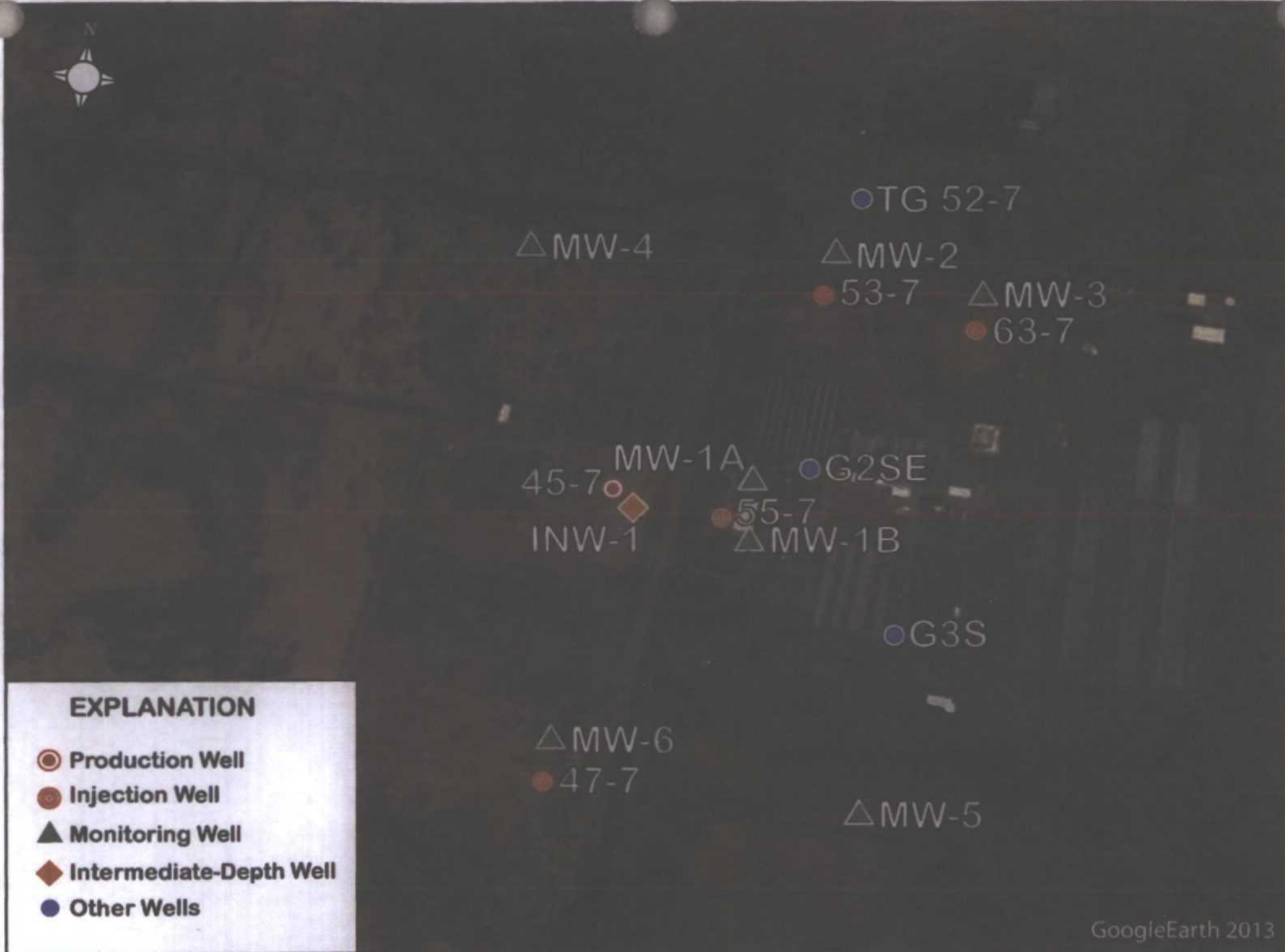
FIGURES

AMEC Environmental & Infrastructure
8519 Jefferson, NE
Albuquerque, NM 87113

amec

Cyrq
Lightning Dock
geothermal

PROJECT: Lightning Dock Geothermal HI-01, LLC	DWN BY: KP	DATUM:	DATE: JUNE 2014
	CHK'D BY: DJ	REV. NO.:	CONTRACT NO.: 11517000102
TITLE: PROJECT LOCATION	PROJECTION:	SCALE: 1" = 5 miles	FIGURE NO.: 1



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Cyrq
Lightning Dock
geothermal

PROJECT: Lightning Dock Geothermal HI-01, LLC	DWN BY: KP	DATUM:	DATE: JUNE 2014
	CHK'D BY: DJ	REV. NO.:	CONTRACT NO.: 11517000102
TITLE: WELL LOCATIONS	PROJECTION:	SCALE: 1" ≈ 700'	FIGURE NO.: 2

Figure 3. Water-level elevation levels shown in shallow monitoring wells (MW- wells) for December 09, 10, and 11, 2013, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet.

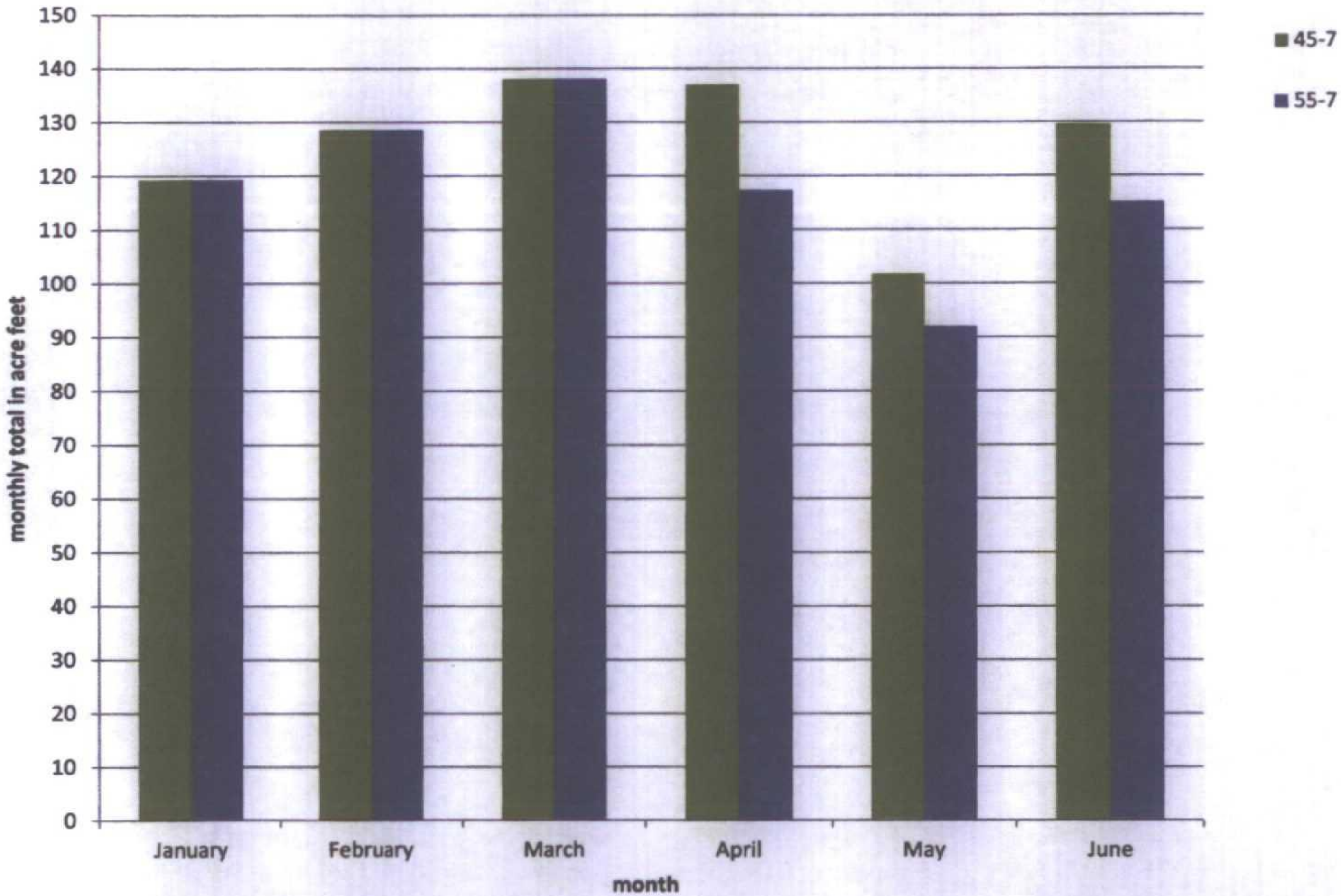

Figure 4. Graph showing pumping from Well 45-7 and injection into Well 55-7 by month, January through June 2014.

For 1% significance level, 120 is not an outlier.

Dixon's Outlier Test for TDS

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 1572 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.277

For 10% significance level, 1572 is not an outlier.
For 5% significance level, 1572 is not an outlier.
For 1% significance level, 1572 is not an outlier.

2. Observation Value 321 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.497

For 10% significance level, 321 is an outlier.
For 5% significance level, 321 is not an outlier.
For 1% significance level, 321 is not an outlier.

Dixon's Outlier Test for pH

Number of Observations = 13
10% critical value: 0.467
5% critical value: 0.521
1% critical value: 0.615

1. Observation Value 9.51 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.087

For 10% significance level, 9.51 is not an outlier.
For 5% significance level, 9.51 is not an outlier.
For 1% significance level, 9.51 is not an outlier.

2. Observation Value 6.6 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.035

For 10% significance level, 6.6 is not an outlier.
For 5% significance level, 6.6 is not an outlier.
For 1% significance level, 6.6 is not an outlier.

Dixon's Outlier Test for Zinc

Number of Observations = 4
10% critical value: 0.879

5% critical value: 0.765
1% critical value: 0.889

1. Observation Value 0.3 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.903

For 10% significance level, 0.3 is an outlier.
For 5% significance level, 0.3 is an outlier.
For 1% significance level, 0.3 is an outlier.

2. Observation Value 0.022 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.018

For 10% significance level, 0.022 is not an outlier.
For 5% significance level, 0.022 is not an outlier.
For 1% significance level, 0.022 is not an outlier.

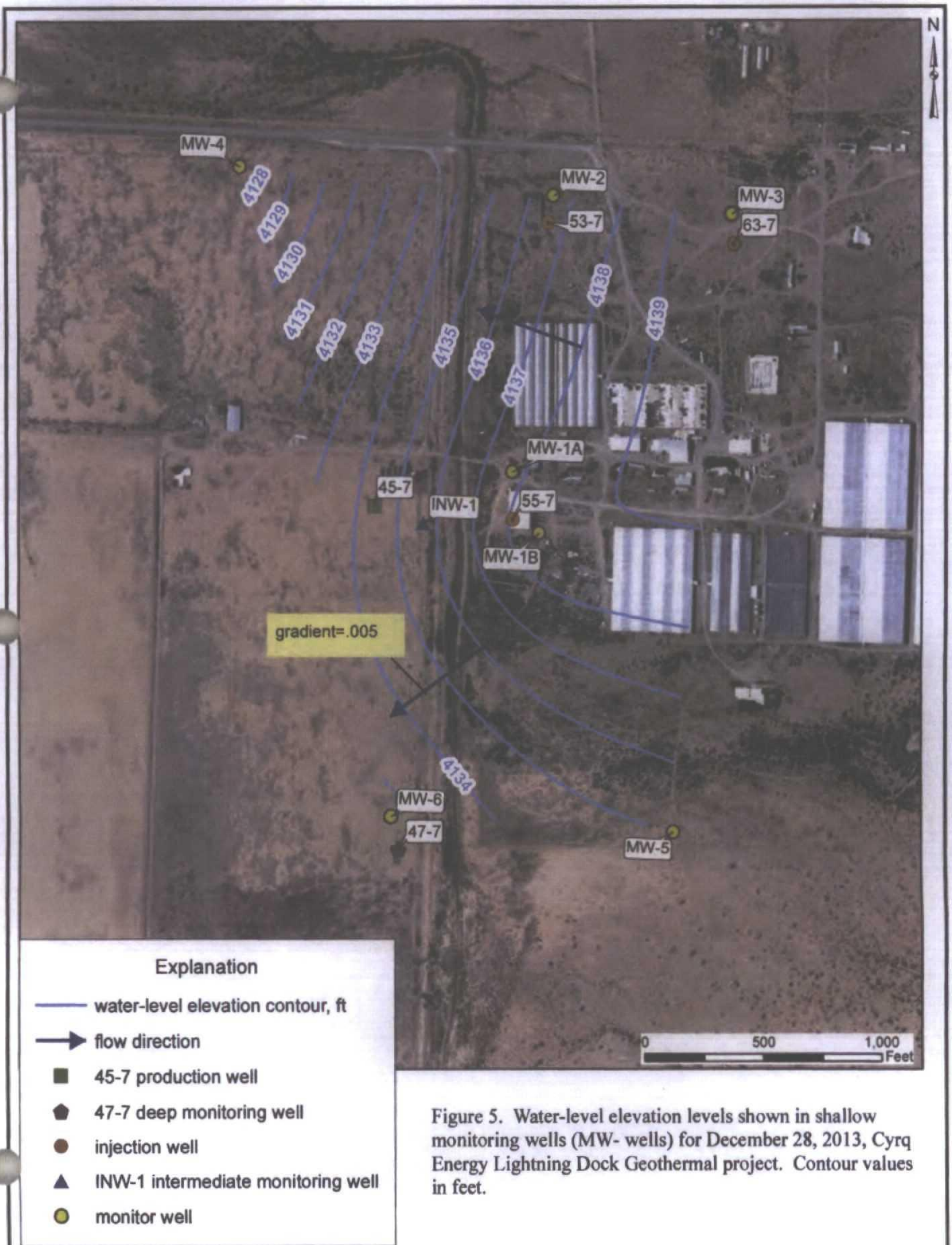

Figure 5. Water-level elevation levels shown in shallow monitoring wells (MW- wells) for December 28, 2013, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet.

Figure 6. Water-level elevation levels shown in shallow monitoring wells (MW- wells) for January 27, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet.

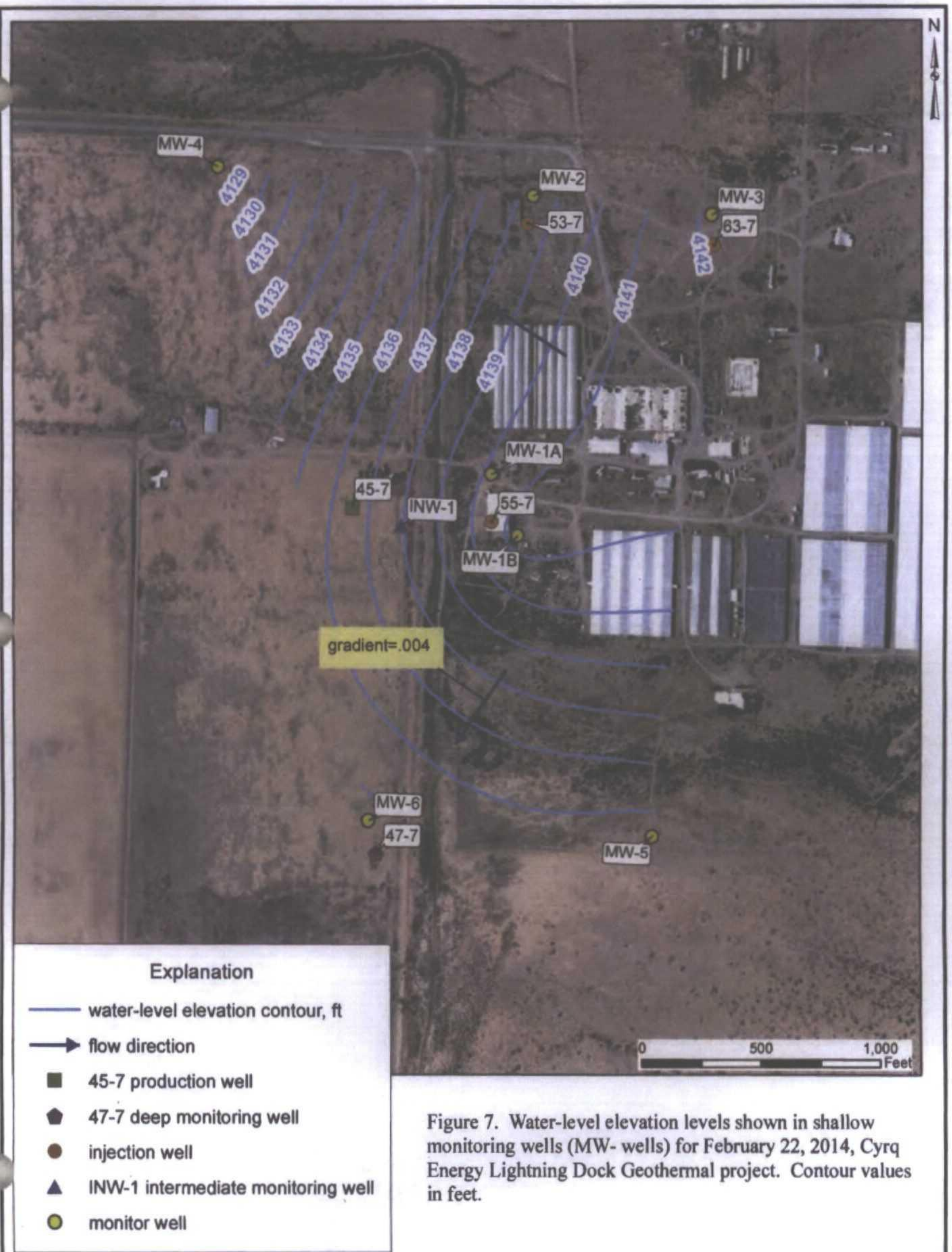

Figure 7. Water-level elevation levels shown in shallow monitoring wells (MW- wells) for February 22, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet.

Figure 8. Water-level elevation levels shown in shallow monitoring wells (MW- wells) for March 17, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet.

Figure 9. Water-level elevation levels shown in shallow monitoring wells (MW- wells) for April 17, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet.

Figure 10. Water-level elevation levels shown in shallow monitoring wells (MW- wells) for May 11, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet.

Figure 11. Water-level elevation levels shown in shallow monitoring wells (MW- wells) for June 19, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet.

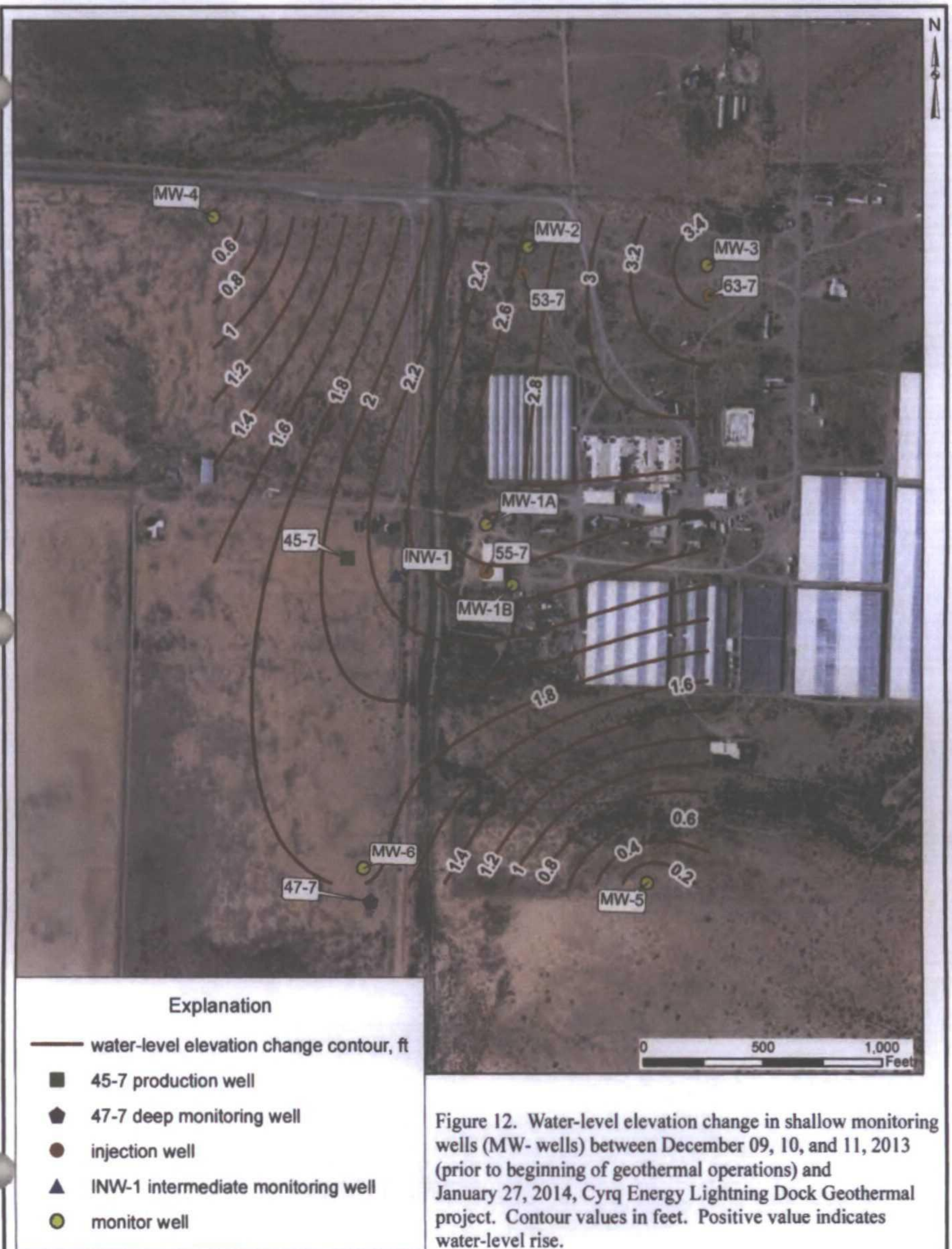

Figure 12. Water-level elevation change in shallow monitoring wells (MW- wells) between December 09, 10, and 11, 2013 (prior to beginning of geothermal operations) and January 27, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet. Positive value indicates water-level rise.

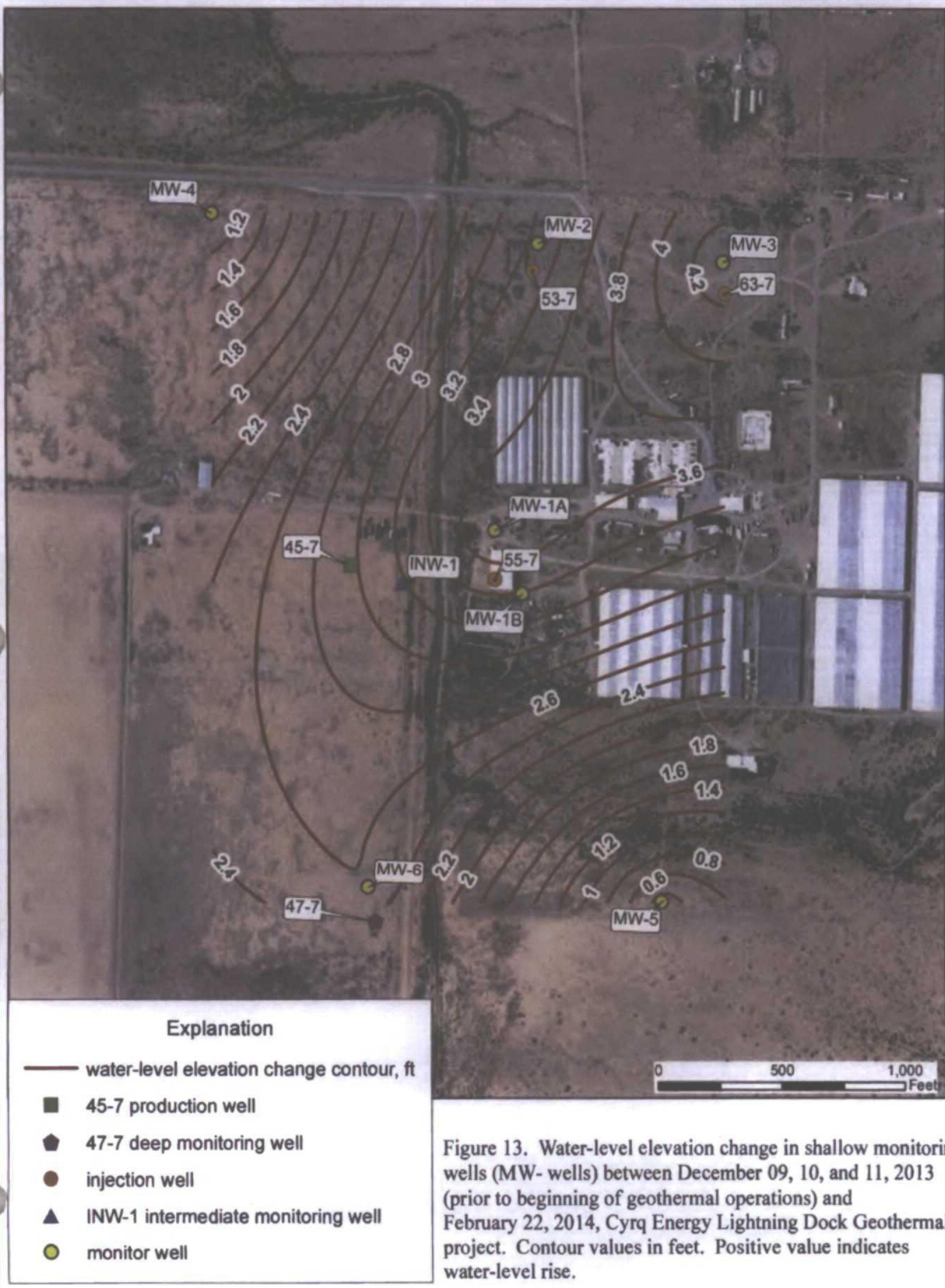

Figure 13. Water-level elevation change in shallow monitoring wells (MW- wells) between December 09, 10, and 11, 2013 (prior to beginning of geothermal operations) and February 22, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet. Positive value indicates water-level rise.

Explanation

- water-level elevation change contour, ft
- 45-7 production well
- 47-7 deep monitoring well
- injection well
- INW-1 intermediate monitoring well
- monitor well

Figure 14. Water-level elevation change in shallow monitoring wells (MW- wells) between December 09, 10, and 11, 2013 (prior to beginning of geothermal operations) and March 17, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet. Positive value indicates water-level rise.

Figure 15. Water-level elevation change in shallow monitoring wells (MW- wells) between December 09, 10, and 11, 2013 (prior to beginning of geothermal operations) and April 17, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet. Positive value indicates water-level rise.

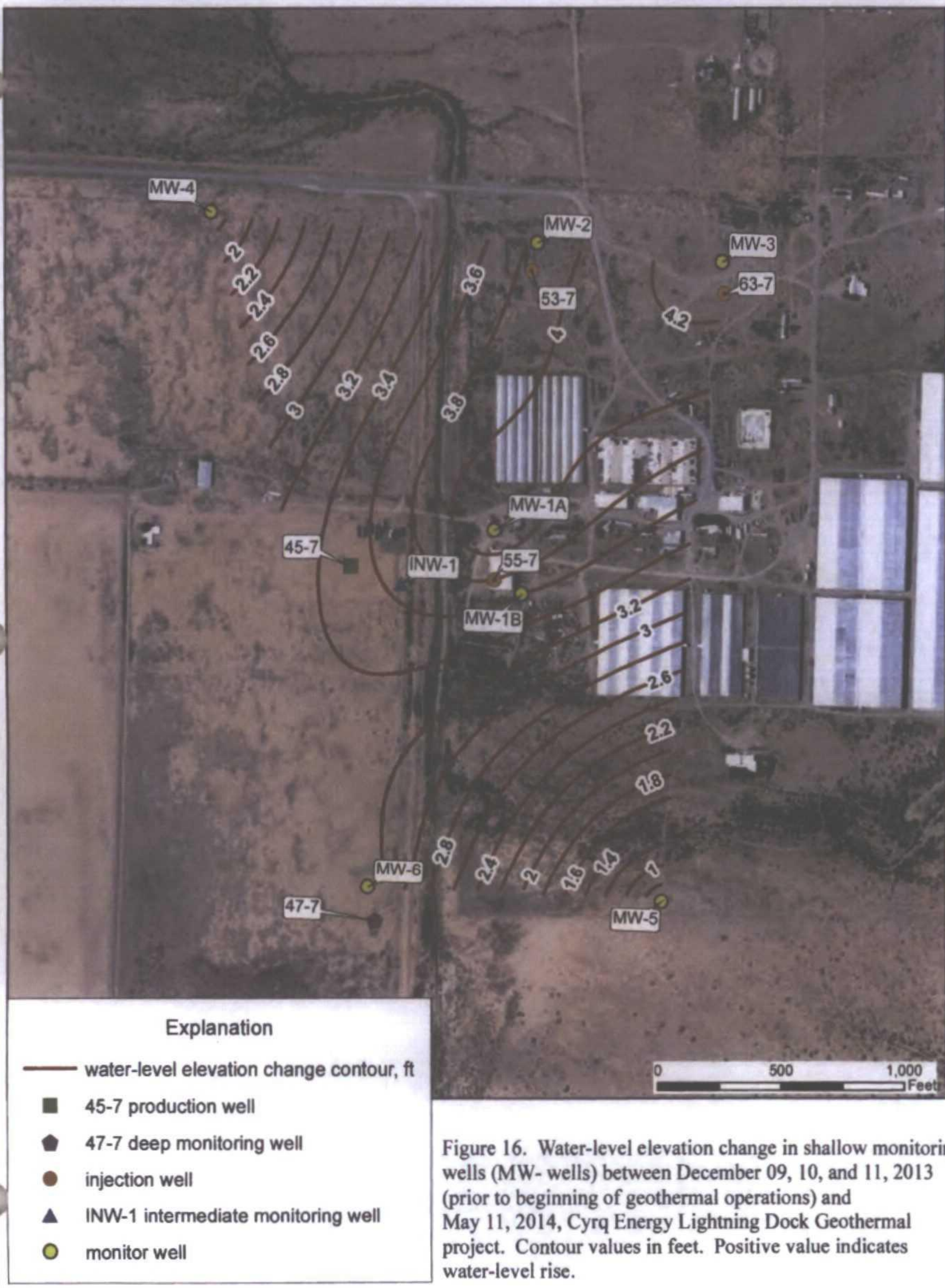

Figure 16. Water-level elevation change in shallow monitoring wells (MW- wells) between December 09, 10, and 11, 2013 (prior to beginning of geothermal operations) and May 11, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet. Positive value indicates water-level rise.

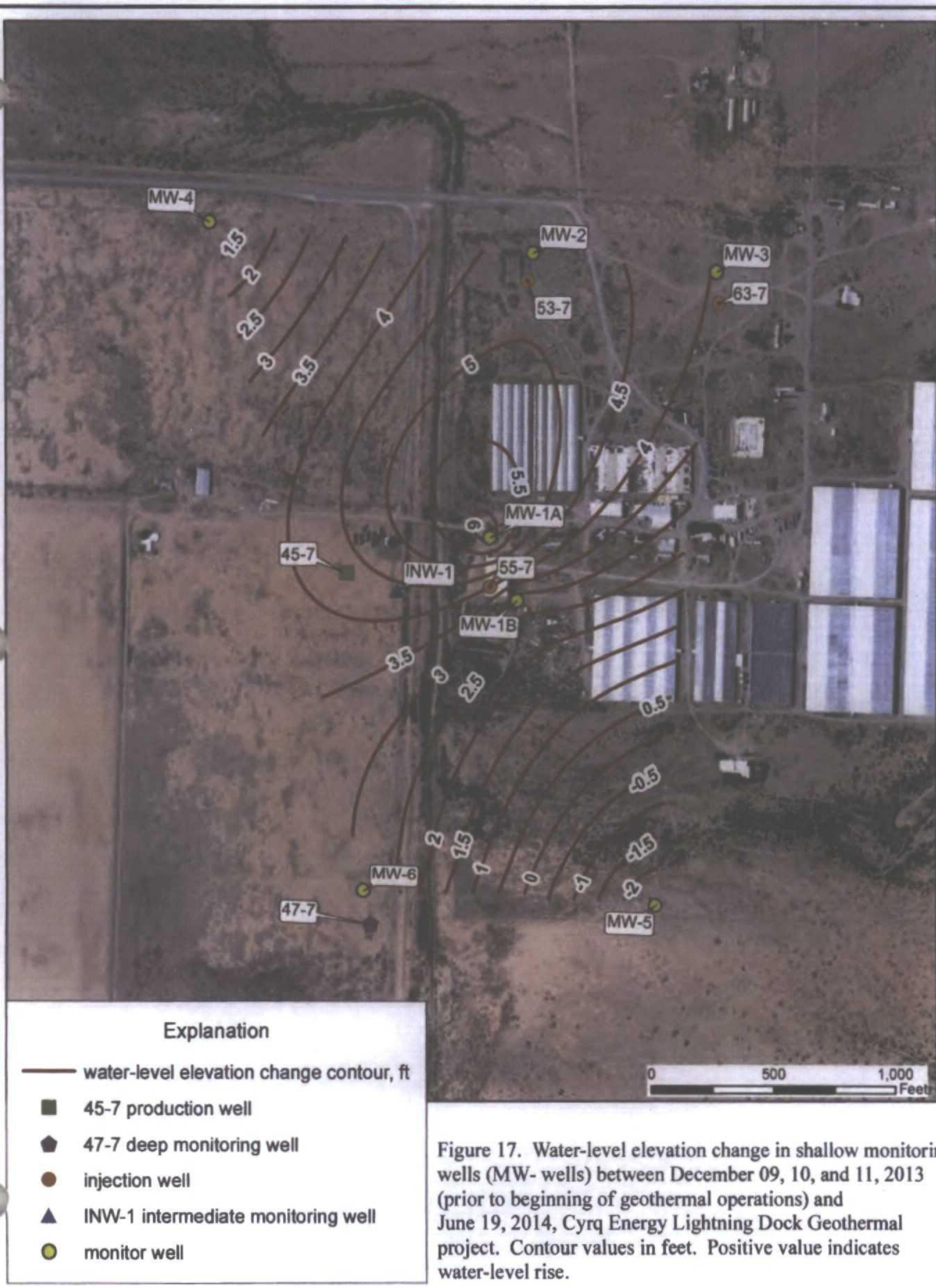

Figure 17. Water-level elevation change in shallow monitoring wells (MW- wells) between December 09, 10, and 11, 2013 (prior to beginning of geothermal operations) and June 19, 2014, Cyrq Energy Lightning Dock Geothermal project. Contour values in feet. Positive value indicates water-level rise.

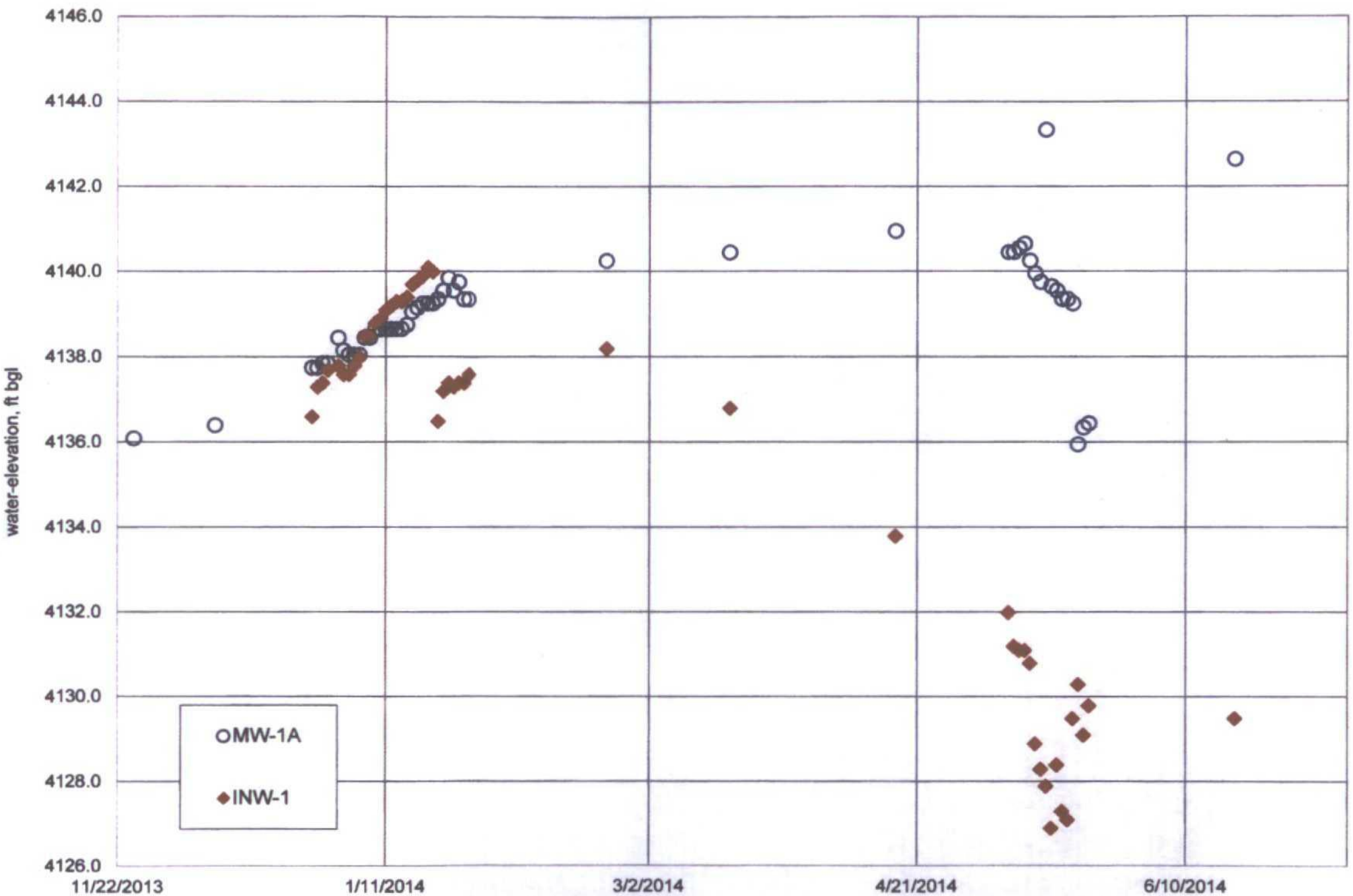

Figure 18. Hydrographs showing water-level elevation in shallow monitoring wells MW-1A and intermediate monitoring well INW-1, November 25, 2013 to June 19, 2014.

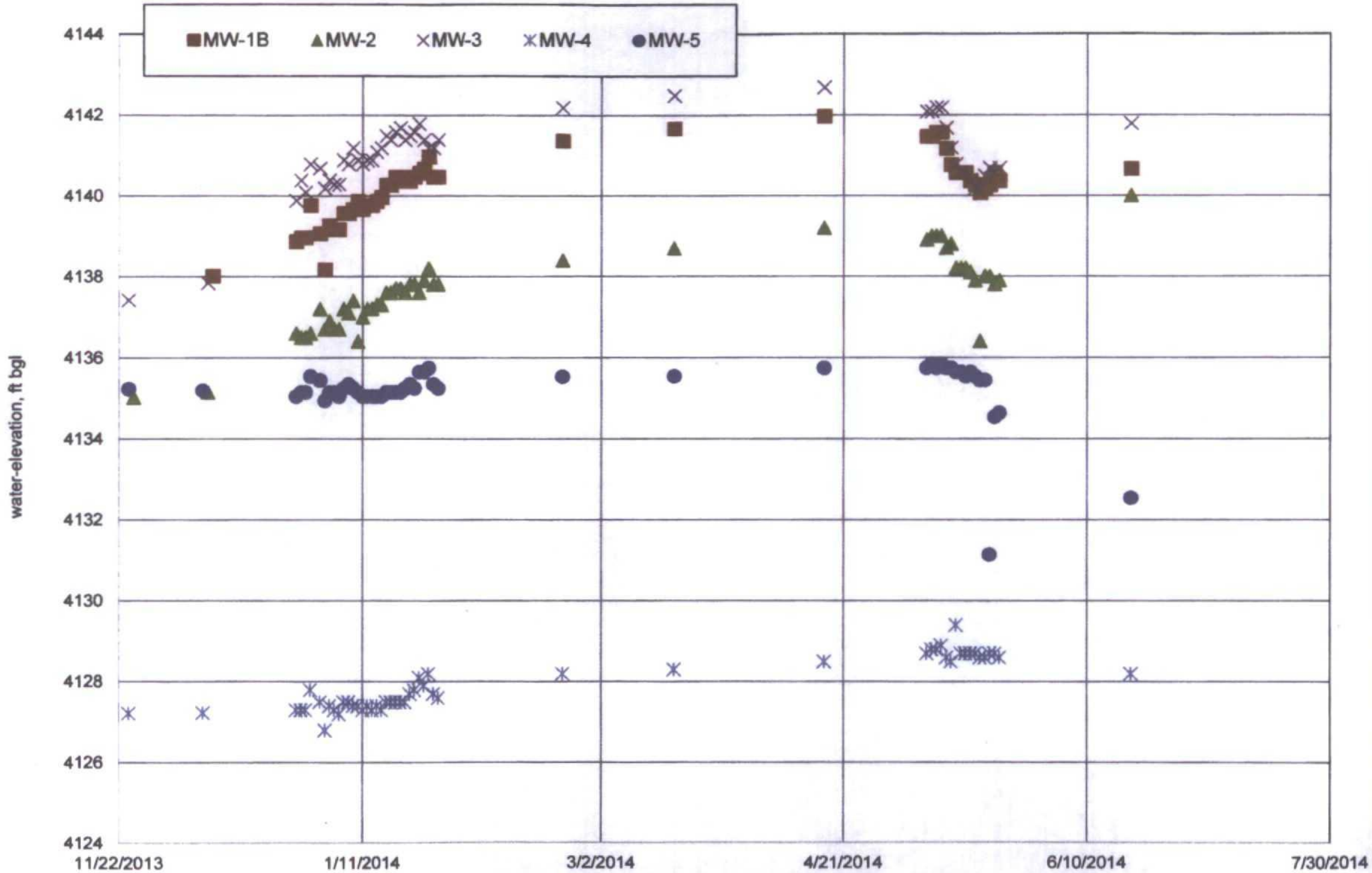

Figure 19. Hydrographs showing water-level elevation in shallow monitoring wells MW-1B, MW-2, MW-3, MW-4, and MW-5, November 24, 2013 to June 19, 2014.

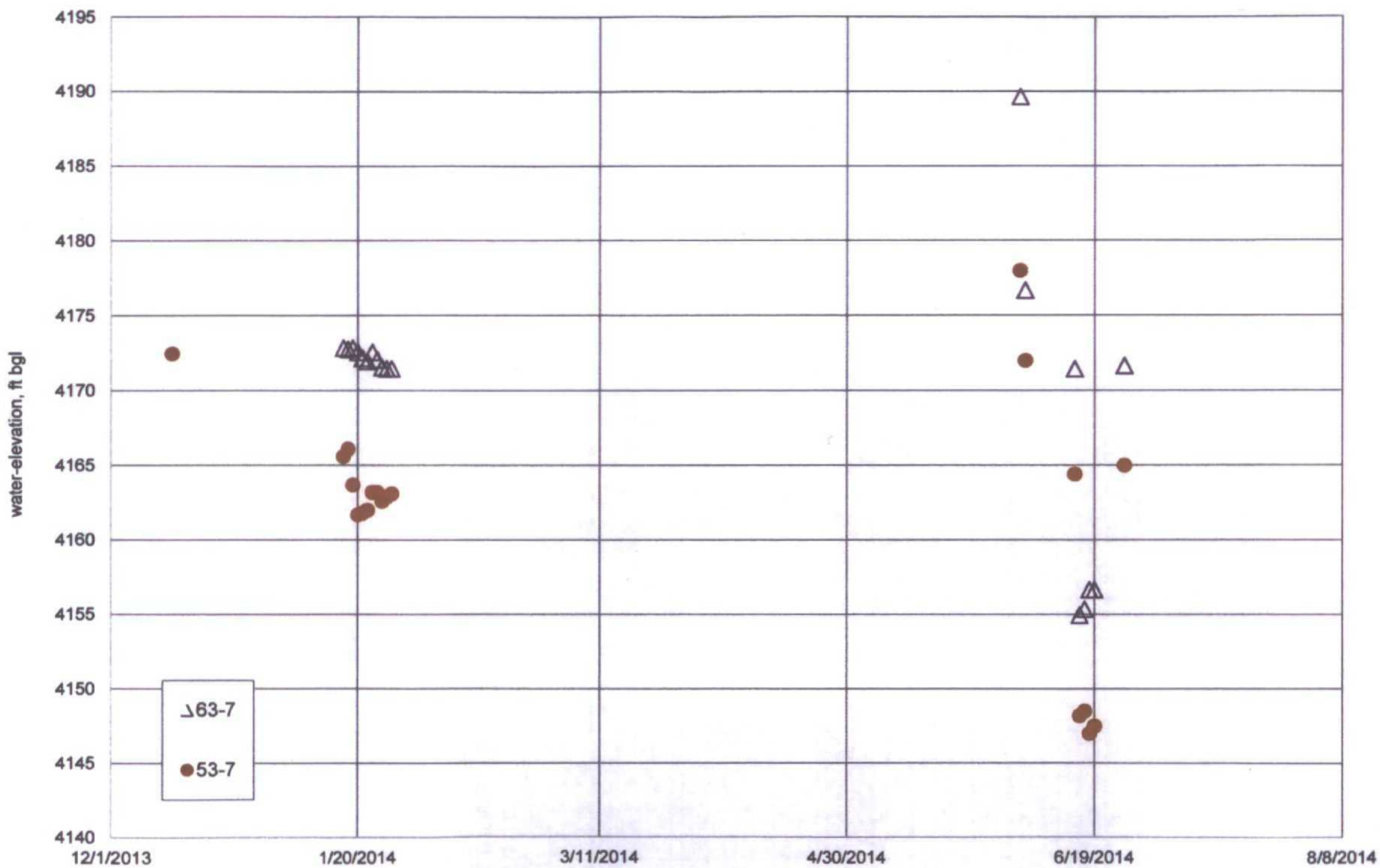

Figure 20. Hydrographs showing water-level elevation in wells 53-7 and 63-7, December 13, 2013 to June 25, 2014.

TABLES

Summary of Geothermal Aquifer Analytical Results Prior to 2014
Lightning Dock Geothermal HI-01, LLC - Hidalgo County, New Mexico
TABLE 4

		NMAC 20.6.2 Standard	Well ID / Fluid Type / Sample ID / Sample Date	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Analyte	Dissolved Concentration																	
A																			
1	Arsenic (As)	0.1 mg/l		0.012	0.018	0.015	0.0098	0.014	0.42	0.07	ND	0.016	0.0074	0.02	0.019	0.018	0.017	3.2	0.056*
2	Barium (Ba)	1.0 mg/l		0.065	0.076	0.061	0.054	0.05861	0.13	[illegible]	0.038	0.042	0.094	0.071	0.071	0.068	0.05	0.051	0.014*
3	Cadmium (Cd)	0.01 mg/l		ND	NA	NA	ND	NA	ND	ND	ND	NA	ND	NA	NA	NA	NA	ND	NA
4	Chromium (Cr)	0.05 mg/l		NA	NA	NA	ND	NA	NA	ND	ND	NA	ND	NA	NA	NA	NA	NA	NA
5	Cyanide (CN)	0.2 mg/l		ND	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	NA	NA	ND	NA
6	Fluoride (F)	1.6 mg/l		14	11.1	11.6	10	11	12	11.82	1.4	11.6	9.5	10.8	10.3	9.37	8.93	17	14.2
7	Lead (Pb)	0.05 mg/l		ND	NA	NA	ND	NA	ND	ND	ND	NA	ND	NA	NA	NA	NA	0.0011	NA
8	Total Mercury (Hg)	0.002 mg/l		ND	NA	NA	ND	NA	ND	[illegible]	ND	NA	ND	NA	NA	NA	NA	ND	NA
9	Nitrate (NO_3 as N)	10.0 mg/l		ND	NA	NA	ND	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	<0.500
10	Selenium (Se)	0.05 mg/l		0.0017	NA	NA	0.0034	NA	ND	ND	NA	NA	0.0038	NA	NA	NA	NA	0.0021	NA
11	Silver (Ag)	0.05 mg/l		ND	NA	NA	ND	NA	ND	ND	ND	NA	ND	NA	NA	NA	NA	ND	NA
12	Uranium (U)	0.03 mg/l		ND	NA	NA	ND	NA	ND	1.77	ND	NA	ND	NA	NA	NA	NA	ND	NA
13	Radioactivity: Radium (Ra 226)	30 pCi/L		6.49 ± 1.35 (0.367)	NA	NA	NA	NA	0.0340 ± 0.481 (0.981)	NA	0.166 ± 0.380 (0.225)	NA	NA	NA	NA	NA	NA	-0.220 ± 0.306 (0.775)	NA
14	Radioactivity: Radium (Ra 228)	30 pCi/L		0.522 ± 0.331 (0.614)	NA	NA	NA	NA	-0.0191 ± 0.378 (0.924)	NA	0.414 ± 0.460 (0.931)	NA	NA	NA	NA	NA	NA	0.0100 ± 0.365 (0.847)	NA
15	Radionuclides: Radon 222	None		2560	NA	NA	NA	NA	-39.4 UH	NA	-67.8 U	NA	NA	NA	NA	NA	NA	78.6 U	NA
16	Benzene	1.0 ug/l		ND	NA	NA	NA	NA	[illegible]	NA	ND	NA	[illegible]	NA	NA	NA	NA	[illegible]	NA
17	Polychlorinated biphenyls (PCB's)	1 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
18	Toluene	750 ug/l		ND	NA	NA	NA	NA	45	ND	ND	NA	3.4	NA	NA	NA	NA	2	NA
19	Carbon Tetrachloride	10 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
20	1,2-dichloroethane (EDC)	10 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
21	1,1-dichloroethene (1,1-DCE)	5 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
22	1,1,2,2-tetrachloroethylene (PCE)	20 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	370	NA
23	1,1,2-trichloroethylene (TCE)	100 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	1	NA
24	ethylbenzene	750 ug/l		ND	NA	NA	NA	NA	1.3	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
25	total xylenes	620 ug/l		ND	NA	NA	NA	NA	19	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
26	methylene chloride	100 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
27	chloroform	100 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
28	1,1-dichloroethane	25 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
29	ethlene dibromide (EDB)	0.1 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
30	1,1,1-trichloroethane	60 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
31	1,1,2-trichloroethane	10 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
32	1,1,2,2-tetrachloroethane	10 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
33	vinyl chloride	1 ug/l		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
34	PAH's: total naphthalene + monomethylnaphthalenes	30 ug/l		ND	NA	NA	NA	NA	ND ?	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
35	benzo-a-pyrene	0.7 ug/l		ND	NA	NA	ND	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
36	TPH 418.1	None		52	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	2.8	NA
B																			
1	Chloride (Cl)	250.0 mg/l		97	86.9	90.1	86	85.8	130	111	33	79	140	90.2	86	89.8	85.6	67	78.1
2	Copper (Cu)	1.0 mg/l		ND	NA	NA	ND	NA	ND	ND	ND	NA	ND	NA	NA	NA	NA	0.029	0.006*
3	Iron (Fe)	1.0 mg/l		ND	0.026	0.021	ND	<0.005	0.32	NA	ND	0.04	0.4	ND	ND	ND	ND	0.29	3.91*
4	Manganese (Mn)	0.2 mg/l		0.018	0.027	0.0082	ND	0.0078	0.14	[illegible]	0.067	0.002	0.13	0.016	0.015	0.0069	0.0066	0.028	0.183*
5	Phenols	0.005 mg/l		ND	NA	NA	ND	NA	14	NA	ND	NA	ND	NA	NA	NA	NA	18	NA
6	Sulfate (SO_4)	600.0 mg/l		540	507	526	510	501	290	545	120	453	630	531	506	526	501	250	303
7	Total Dissolved Solids (TDS)	1000.0 mg/l		1270	1370	1390	1200	1324	1180	1573	321	1200	842	1370	1306	1360	1296	800	1020
8	Zinc (Zn)	10.0 mg/l		ND	NA	NA	ND	NA	0.022	0.30	0.049	NA	ND	NA	NA	NA	NA	0.027	NA
9	pH	between 6-9		6.82	6.64	8.37	6.7	NA	7.33	[illegible]	7.53	9.51	6.89	6.97	NA	6.6	NA	8.41	9.45
C																			
1	Aluminum (Al)	5.0 mg/l		0.21	0.177	0.175	ND	0.167	0.05	0.78	ND	0.209	0.08	NA	NA	NA	NA	0.04	NA
2	Boron (B)	0.75 mg/l		0.46	0.441	0.432	0.46	0.411	2.8	10.10	0.12	0.482	0.65	0.469	0.447	0.467	NA	[illegible]	[illegible]
3	Cobalt (Co)	0.05 mg/l		ND	NA	NA	ND	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA
4	Molybdenum (Mo)	1.0 mg/l		0.026	NA	NA	0.03	NA	0.098	NA	ND	NA	0.046	NA	NA	NA	NA	0.094	NA
5	Nickel (Ni)	0.2 mg/l		ND	NA	NA	ND	NA	0.081	0.01	ND	NA	ND	NA	NA	NA	NA	0.049	NA
6	Bromide	None		ND	NA	NA	NA	NA	0.32	NA	NA	NA	0.46	NA	NA	NA	NA	ND	NA
7	Lithium (Li)	None		0.9	NA	NA	NA	NA	1	NA	0.0887	NA	0.8	NA	NA	NA	NA	0.6	NA
8	Rubidium (Rb)	None		0.25	NA	NA	NA	NA	0.24	NA	0.0127	NA	0.3	NA	NA	NA	NA	0.07	NA
9	Tungsten	None		ND	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA	NA	NA	NA	ND	NA

NOTES
NA = Not Analyzed
NA = Not Detected
* Total metal not dissolved metal
U = Not detected at minimum detectable concentration
H = Anaylsis performed past recommended holding time

Summary of Geothermal Aquifer Analytical Results for 2014
Lightning Dock Geothermal HI-01, LLC - Hidalgo County, New Mexico
TABLE 5

		Well ID	LDG 45-7 Single Phase	LDG 45-7 Single Phase	LDG 45-7 Single Phase (120 day)	LDG 45-7 Single Phase (90 day)	LDG 45-7 Single Phase (60 day)	LDG 45-7 Single Phase (30 day)	LDG 45-7 Single Phase (15 day)	LDG 47-7 Single Phase	LDG 53-7 Single Phase	LDG 53-7 Single Phase (120 day)	LDG 53-7 Single Phase	LDG 53-7 Single Phase (90 day)	LDG 53-7 Single Phase (60 day)	LDG 53-7 Single Phase (30 day)	LDG 53-7 Single Phase (15 day)	LDG 53-7 Single Phase
		Sample ID	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	NMAC 20.6.2 Standard	Sample Date	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1/7/2014	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1/27/14	1/7/14	[illegible]
Analyte	Dissolved Concentration																	
Arsenic (As)	0.1 mg/l		0.013	0.015	0.013	0.012	ND	0.004	0.0031	NA	0.013	0.013	0.015	0.012	0.013	0.013	0.011	NA
Barium (Ba)	1.0 mg/l		0.064	0.061	0.06	0.066	ND	0.022	0.018	NA	0.065	0.059	0.061	0.062	0.065	0.065	0.063	NA
Cadmium (Cd)	0.01 mg/l		ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
Chromium (Cr)	0.05 mg/l		ND	ND	ND	ND	NA	ND	NA	NA	ND	ND	ND	ND	NA	NA	ND	NA
Cyanide (CN)	0.2 mg/l		ND	NA	ND	ND	ND	ND	ND	NA	ND	ND	NA	ND	ND	ND	ND	NA
Fluoride (F)	1.6 mg/l		12	11	12	13	ND	3.9	3.6	NA	12	12	12	12	12	12	14	NA
Lead (Pb)	0.05 mg/l		ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
Total Mercury (Hg)	0.002 mg/l		ND	ND	ND	ND	0.00046	0.00033	0.0003	NA	ND	0.0005	ND	ND	ND	ND	ND	NA
Nitrate (NO_3 as N)	10.0 mg/l		ND	ND	ND	ND	ND	ND	NA	NA	ND	ND	ND	ND	NA	NA	ND	NA
Selenium (Se)	0.05 mg/l		0.0014	0.0016	0.0010	NA	ND	ND	ND	NA	0.0027	0.0011	0.0021	NA	0.0018	0.0014	0.0014	NA
Silver (Ag)	0.05 mg/l		ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
Uranium (U)	0.03 mg/l		ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
Radioactivity: Radium (Ra 226)	30 pCi/L		5.14 ± 1.13 (0.782)	3.23 ± 1.03 (0.699)	4.33 ± 1.41 (0.991)	6.22 ± 1.62 (0.770)	0.224 ± 0.270 (0.412)	1.95 ± 0.862 (0.757)	4.67 ± 1.50 (0.909)	NA	5.15 ± 1.06 (0.577)	5.14 ± 1.32 (0.968)	4.34 ± 1.22 (0.650)	4.17 ± 1.22 (0.954)	4.18 ± 1.17 (0.692)	3.58 ± 1.04 (0.766)	6.94 ± 1.66 (0.798)	NA
Radioactivity: Radium (Ra 228)	30 pCi/L		0.293 ± 0.365 (0.785)	0.478 ± 1.03 (0.699)	0.441 ± 0.432 (0.893)	0.410 ± 0.419 (0.866)	0.369 ± 0.263 (0.507)	0.264 ± 0.349 (0.737)	-0.0117 ± 0.390 (0.913)	NA	0.781 ± 0.409 (0.790)	0.185 ± 0.355 (0.782)	0.615 ± 0.382 (0.711)	(0.647)	(0.791)	0.448 ± 0.252 (0.450)	0.467 ± 0.349 (0.680)	NA
Radionuclides: Radon 222	None		2765 ± 155 (112)	2500 ± 456 (51.3)	2840	2540	3490	6830	6520	NA	2313 ± 144 (112)	2480	876 ± 181 (97.1)	2100	2230	1830	2480	NA
Benzene	1.0 ug/l		ND	ND	ND	ND	[illegible]	8.0	[illegible]	[illegible]	ND	ND	ND	ND	ND	ND	ND	ND
Polychlorinated biphenyls (PCB's)	1 ug/l		ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
Toluene	750 ug/l		ND	ND	ND	ND	ND	2.5	1.2	19	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	10 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane (EDC)	10 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethene (1,1-DCE)	5 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-tetrachloroethylene (PCE)	20 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethylene (TCE)	100 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ethylbenzene	750 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
total xylenes	620 ug/l		ND	ND	ND	ND	ND	ND	ND	7	ND	ND	ND	ND	ND	ND	ND	ND
methylene chloride	100 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	100 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethane	25 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ethlene dibromide (EDB)	0.1 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-trichloroethane	60 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethane	10 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-tetrachloroethane	10 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
vinyl chloride	1 ug/l		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PAH's: total naphthalene + monomethylnaphthalenes	30 ug/l		ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
benzo-a-pyrene	0.7 ug/l		ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
TPH 418.1	None		1.3	ND	1.2	1.9	2.7	9	6.1	NA	ND	4.4	5.7	6	1.6	15.0	3	NA
Chloride (Cl)	250.0 mg/l		79	84	83	89	ND	25	24	NA	81	84	85	84	93	81	81	NA
Copper (Cu)	1.0 mg/l		ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
Iron (Fe)	1.0 mg/l		0.041	0.038	0.023	0.032	0.04	ND	0.032	NA	0.085	0.072	0.12	0.074	0.13	0.17	0.22	NA
Manganese (Mn)	0.2 mg/l		0.02	0.026	0.026	0.025	ND	0.0079	0.011	NA	0.023	0.025	0.027	0.026	0.029	0.026	0.029	NA
Phenols	0.005 mg/l		ND	ND	ND	ND	ND	ND	ND	28	ND	ND	ND	ND	ND	ND	ND	27
Sulfate (SO_4)	600.0 mg/l		490	520	520	540	ND	140	140	NA	510	530	530	520	520	510	500	NA
Total Dissolved Solids (TDS)	1000.0 mg/l		1300	1310	1300	1310	ND	386	378	NA	1300	1300	1280	1310	1320	1310	1310	NA
Zinc (Zn)	10.0 mg/l		ND	ND	ND	ND	ND	NA	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
pH	between 6-9		6.8	6.8	7	7.01	4.62	5.67	5.67	NA	6.99	6.96	6.95	7	6.72	7.00	6.77	NA
Aluminum (Al)	5.0 mg/l		0.21	0.21	0.22	0.23	ND	0.076	0.089	NA	0.23	0.23	0.22	0.23	0.23	0.24	0.22	NA
Boron (B)	0.75 mg/l		0.47	0.46	0.44	0.51	ND	0.18	0.14	NA	0.44	0.44	0.45	0.48	0.47	0.49	0.45	NA
Cobalt (Co)	0.05 mg/l		ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
Molybdenum (Mo)	1.0 mg/l		0.028	0.027	0.027	0.031	ND	ND	ND	NA	0.026	0.024	0.028	0.028	0.028	0.031	0.028	NA
Nickel (Ni)	0.2 mg/l		ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	NA
Bromide	None		0.30	0.26	0.27	0.27	ND	NA	0.14	NA	0.27	NA	0.26	0.26	NA	NA	0.29	NA
Lithium (Li)	None		0.653	0.688	0.672	0.661	ND	0.259	0.203	NA	0.663	0.678	0.669	0.661	0.717	0.747	0.721	NA
Rubidium (Rb)	None		0.355	0.362	0.366	0.346	ND	0.123	0.0986	NA	0.35	0.346	0.365	0.354	0.361	0.356	0.356	NA
Tungsten	None		0.0867	0.0983	0.0785	0.0813	ND	0.0438	0.03	NA	0.0823	0.0791	0.102	0.081	0.0792	0.0831	0.0799	NA

NOTES
NA = Not Analyzed
ND = Not Detected
* Total metal not dissolved metal
U = Not detected at minimum detectable concentration
H = Analysis performed past recommended holding time

Summary of Alluvial System Analytical Results Prior to 2014
Lightning Dock Geothermal HI-01, LLC - Hidalgo County, New Mexico
TABLE 6

		NMAC 20.6.2	Well ID	MW-1	MW-1R	MW-2	MW-2 Duplicate	MW-3	MW-4	MW-5	MW-6
			Lab ID	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Analyte	Std. Dissolved Concentration	Sample Date	11/252013	12/11/2013	11/25/2013	11/25/2013	11/24/2013	11/24/2013	11/24/2013	11/23/2013
1	Arsenic (As)	1 mg/l		0.0055	0.011	0.0082	0.0083	0.019	0.012	0.0060	0.020
2	Barium (Ba)	1 mg/l		0.063	0.14	0.044	0.043	0.06	0.059	0.041	0.047
3	Cadmium (Cd)	0.01 mg/l		ND	ND	ND	ND	ND	ND	ND	MD
4	Chromium (Cr)	0.5 mg/l		ND	ND	ND	ND	ND	ND	ND	ND
5	Cyanide (CN)	0.2 mg/l		ND	ND	ND	ND	ND	ND	ND	ND
6	Fluoride (F)	1.6 mg/l		7.7	9.3	11	11	12	4.3	1.3	6.9
7	Lead (Pb)	0.05 mg/l		ND	0.0044	ND	ND	ND	ND	ND	ND
8	Total Mercury (Hg)	0.002 mg/l		0.00079	0.0016	ND	ND	0.00034	ND	0.0010	0.00077
9	Nitrate(NO3 as N)	10 mg/l		2.6	15	3.1	3.2	2.1	12	42	42
10	Selenium (Se)	0.05 mg/l		0.0052	NA	0.0035	0.0035	0.0034	0.033	0.028	0.011
11	Silver (Ag)	0.05 mg/l		ND	ND	ND	ND	ND	ND	ND	ND
12	Uranium (U)	0.03 mg/l		0.011	0.0037	ND	ND	ND	0.0051	0.014	0.0012
13	Radioactivity: Radium 266	30 pCi/l		0.285 ± 0.350 (0.571)	2.00 ± 0.722 (0.566)	0.266 ± 0.377 (0.638)	0.183 ± 0.312 (0.550)	0.102 ± 0.375 (0.720)	1.32 ± 0.615 (0.664)	0.305 ± 0.401 (0.667)	0.140 ± 0.305 (0.562)
14	Radioactivity: Radium 288	30 pCi/l		0.888 ± 0.456 (0.799)	0.711 ± 0.402 (0.727)	0.0585 ± 0.308 (0.702)	0.468 ± 0.385 (0.767)	0.156 ± 0.270 (0.590)	0.542 ± 0.396 (0.772)	0.333 ± 0.452 (0.966)	2.53 ± 0.949 (1.39)
15	Radionuclides: Radon 222	None		238	676	580	567	781	1090	197	507
16	Benzene	1 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
17	Polychlorinated biphenyls (PCB's)	1 ug/l		NA	ND	NA	NA	NA	NA	NA	NA
18	Toluene	750 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
19	Carbon Tetrachloride	10 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
20	1,2-dichloroethane (EDC)	10 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
21	1,1-dichloroethylene (1,1-DCE)	5 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
22	1,1,2,2,-tetrachloroethene (PCE)	20 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
23	1,1,2-trichloroethylene (TCE)	100 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
24	ethylbenzene	750 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
25	Total xylenes	620 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
26	methylene chloride	100 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
27	chloroform	100 ug/l		28	33	4.9	5.2	21	ND	ND	ND
28	1,1-dichloroethane	25 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
29	ethlene dibromide (EDB)	0.1 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
30	1,1,1-trichloroethane	660 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
31	1,1,2-trichloroethane	10 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
32	1,1,2,2-tetrachloroethane	10 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
33	vinyl chloride	1 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
34	PAH's; total naphthalene + naphthalenes	30 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
35	benzo-a-pyrene	0.7 ug/l		ND	ND	ND	ND	ND	ND	ND	ND
36	TPH 418.1	None		ND	1.3	ND	ND	1.1	NA	NA	ND
1	Chloride (Cl)	250 mg/l		100	120	96	96	94	710	230	130
2	Copper (Cu)	1 mg/l		ND	ND	ND	ND	ND	ND	ND	ND
3	Iron (Fe)	1 mg/l		ND	8.5	ND	ND	0.24	ND	0.021	0.39
4	Manganese (Mn)	0.2 mg/l		0.21	0.27	0.041	0.036	0.18	0.15	0.27	0.074
5	Phenol	0.005 mg/l		ND	ND	ND	ND	ND	ND	ND	ND
6	Sulfate	600 mg/l		670	540	510	510	540	1200	930	950
7	Total Dissolved Solids (TDS)	1000 mg/l		1780	1520	1380	1210	1380	3210	2010	1880
8	Zinc (Zn)	10 mg/l		ND	0.015	0.015	ND	ND	0.048	0.023	0.033
9	pH	6-9 pH Units		7.69	7.66	7.6	7.58	8	7.38	7.62	7.56
1	Aluminum (Al)	5 mg/l		0.034	25	0.049	0.024	0.31	ND	ND	0.63
2	Boron (B)	.75 mg/l		0.7	0.45	0.37	0.36	0.44	0.22	0.31	0.39
3	Cobalt (Co)	0.05 mg/l		ND	ND	ND	ND	ND	ND	ND	ND
4	Molybdenum (Mo)	1.0 mg/l		0.058	0.029	0.027	0.026	0.065	0.014	0.031	0.035
5	Nickel (Ni)	0.2 mg/l		ND	ND	ND	ND	ND	ND	ND	ND
6	Bromide	None		ND	NA	ND	ND	ND	2.2	1.2	ND
7	Lithium (Li)	None		0.8	0.533	0.7	0.7	0.5	1.7	0.4	0.8
8	Rubidium (Rb)	None		0.2	0.189	0.1	0.1	0.2	0.4	0.1	0.1
9	Tungsten	None		ND	0.0386	ND	ND	ND	ND	ND	ND
	Notes:										
	NA = not analyzed										
	ND = not detected										
	* total metal not dissolved metal										

Appendix C

ProUCL Output Results

Production and Injection Formation	NMAC 20.6.2 Std. (mg/L)	Number of Observations	Maximum (mg/L)	Mininimum (mg/L)	Median (mg/L)	BTV	Method	Distribution
Arsenic	0.1	14	0.42	0.0074	0.0175	**0.42**	95% UPL	Nonparametric
Boron	0.75	14	2.6	0.12	0.464	**2.6**	95% UPL	Nonparametric
Barium	1	15	0.13	0.014	3.378	**0.111**	95% UPL (t)	Normal
Chloride	250	15	140	67	86.9	**140**	95% UPL	Nonparametric
Fluoride	1.6	15	17	8.93	11.1	**15.43**	95% UPL (t)	Normal
Iron	1	6	0.4	0.021	0.165	**0.558**	95% UPL (t)	Lognormal
Manganese	0.2	14	0.183	0.002	0.017	**0.249**	95% UPL (t)	Lognormal
Selenium	0.05	**4**	0.0038	0.0017	0.00275	**0.0054**	95% UPL (t)	Normal
Sulfate	600	16	630	120	506.5	**630**	95% UPL	Nonparametric
Zinc	10	**4**	0.3	0.022	0.0995	**0.411**	95% Percentile	Gamma
TDS	1000	16	1572	321	1177	**1572**	95% UPL	*Nonparametric*
pH	6-9 pH units	13	9.51	6.6	7.33	**9.809**	95% UPL (t)	Normal

Notes:

At leaset 9 samples are recommended

BTV = Background Threshold Value

Geothermal System Water An[illegible] Results with Outliers

Location	Date	Arsenic	Boron	Barium	Chloride	Fluoride	Iron	Manganese	Selenium	Sulfate	TDS	pH	Zinc
LDG 45-7 Single Phase	**12/19/2013**	0.012	0.46	0.065	97	14		0.018	0.0017	540	1270	6.82	
LDG 45-7 Single Phase Fluid	**1/26/2012**	0.018	0.441	0.076	86.9	11.1	0.026	0.027		507	1370	6.64	
LDG 45-7 Flashed Fluid	**1/26/2012**	0.015	0.432	0.061	90.1	11.6	0.021	0.0082		526	1390	8.37	
LDG 45-7 Single Phase Fluid	**12/8/2011**	0.0098	0.46	0.054	86	10			0.0034	510	1200	6.7	
LDG 45-7 Total Fluid	**1/26/2012**	0.014	0.411	0.05861	85.8	11		0.0078		501	1324		
LDG 53-7 Single Phase Fluid	**12/13/2013**		0.12	0.038	33	1.4		0.067		120	321	7.53	0.049
LDG 53-7 Single Phase Fluid	**1/26/2012**	0.016	0.482	0.042	79	11.6	0.04	0.002		453	1200	9.51	
LDG 55-7 Single Phase Fluid	**11/27/2013**	0.0074	0.65	0.094	140	9.5	0.4	0.13	0.0038	630	842	6.89	
LDG 55-7 Flashed Fluid	**8/5/2010**	0.02	0.469	0.071	90.2	10.8		0.016		531	1370	6.97	
LDG 55-7 Total Fluid	**8/5/2010**	0.019	0.447	0.071	86	10.3		0.015		506	1306		
LDG 55-7 Flashed Fluid	**8/5/2010**	0.018	0.467	0.068	89.8	9.37		0.0069		526	1360	6.6	
LDG 55-7 Total Fluid	**8/5/2010**	0.017		0.05	85.6	8.93		0.0066		501	1296		
LDG 63-7 Single Phase Fluid	**12/20/2013**	3.2	2	0.051	67	17	0.29	0.028	0.0021	250	800	8.41	0.027
LDG 63-7 Single Phase Fluid	**8/28/2012**	0.056	2.09	0.014	78.1	14.2	3.91	0.183		303	1020	9.45	
LDG 52-7 Single Phase	**11/5/2003**	0.07	10.10	53.1	111	11.82		0.474		545	1572	9.26	0.30
LDG 47-7	**12/21/2013**	0.42	2.6	0.13	130	12	0.32	0.14		250	1190	7.33	0.022

Geothermal System Water Analy... ...sults without Outliers

Location	Date	Arsenic	Boron	Barium	Chloride	Fluoride	Iron	Manganese	Selenium	Sulfate	TDS	pH	Zinc
LDG 45-7 Single Phase	12/19/2013	0.012	0.46	0.065	97	14		0.018	0.0017	540	1270	6.82	
LDG 45-7 Single Phase Fluid	1/26/2012	0.018	0.441	0.076	86.9	11.1	0.026	0.027		507	1370	6.64	
LDG 45-7 Flashed Fluid	1/26/2012	0.015	0.432	0.061	90.1	11.6	0.021	0.0082		526	1390	8.37	
LDG 45-7 Single Phase Fluid	12/8/2011	0.0098	0.46	0.054	86	10			0.0034	510	1200	6.7	
LDG 45-7 Total Fluid	1/26/2012	0.014	0.411	0.05861	85.8	11		0.0078		501	1324		
LDG 53-7 Single Phase Fluid	12/13/2013		0.12	0.038				0.067		120	321	7.53	0.049
LDG 53-7 Single Phase Fluid	1/26/2012	0.016	0.482	0.042	79	11.6	0.04	0.002		453	1200	9.51	
LDG 55-7 Single Phase Fluid	11/27/2013	0.0074	0.65	0.094	140	9.5	0.4	0.13	0.0038	630	842	6.89	
LDG 55-7 Flashed Fluid	8/5/2010	0.02	0.469	0.071	90.2	10.8		0.016		531	1370	6.97	
LDG 55-7 Total Fluid	8/5/2010	0.019	0.447	0.071	86	10.3		0.015		506	1306		
LDG 55-7 Flashed Fluid	8/5/2010	0.018	0.467	0.068	89.8	9.37		0.0069		526	1360	6.6	
LDG 55-7 Total Fluid	8/5/2010	0.017		0.05	85.6	8.93		0.0066		501	1296		
LDG 63-7 Single Phase Fluid	12/19/2013		2	0.051	67	17	0.29	0.028	0.0021	250	800	8.41	0.027
LDG 63-7 Single Phase Fluid	8/28/2012	0.056	2.09	0.014	78.1	14.2		0.183		303	1020	9.45	
LDG 52-7 Single Phase	11/5/2003	0.07			111	11.82				545	1572	9.26	
LDG 47-7	12/21/2013	0.42	2.6	0.13	130	12	0.32	0.14		250	1190	7.33	0.022

General Background Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\Riplee\Desktop\LD1.wst
Full Precision	ON
Confidence Coefficient	95%
Coverage	90%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Fluoride

General Statistics

Total Number of Observations	7.0000000	Number of Distinct Observations	7.0000000
Tolerance Factor	2.7550000		

Raw Statistics		Log-Transformed Statistics	
Minimum	9.3600000	Minimum	2.2364453
Maximum	14.200000	Maximum	2.6532420
Second Largest	13.900000	Second Largest	2.6318888
First Quartile	10.400000	First Quartile	2.3410656
Median	11.100000	Median	2.4069451
Third Quartile	12.750000	Third Quartile	2.5414470
Mean	11.565714	Mean	2.4373796
Geometric Mean	11.443017	SD	0.1567542
SD	1.8488452		
Coefficient of Variation	0.1598557		
Skewness	0.5863223		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.9061331	Shapiro Wilk Test Statistic	0.9266260
Shapiro Wilk Critical Value	0.8030000	Shapiro Wilk Critical Value	0.8030000
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 90% Coverage	16.659283	95% UTL with 90% Coverage	17.623572
95% UPL (t)	15.406407	95% UPL (t)	15.847511
90% Percentile (z)	13.935105	90% Percentile (z)	13.988956

95% Percentile (z)	14.606794	95% Percentile (z)	14.808736
99% Percentile (z)	15.866771	99% Percentile (z)	16.478299

Gamma Distribution Test

k star	26.979007
Theta Star	0.4286931
MLE of Mean	11.565714
MLE of Standard Deviation	2.2266886
nu star	377.70610
A-D Test Statistic	0.3486671
5% A-D Critical Value	0.7075725
K-S Test Statistic	0.1969974
5% K-S Critical Value	0.3114059

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test

Data appear Normal at 5% Significance Level

Nonparametric Statistics

90% Percentile	14.020000
95% Percentile	14.110000
99% Percentile	14.182000

Assuming Gamma Distribution

90% Percentile	14.495313
95% Percentile	15.455362
99% Percentile	17.365792
95% WH Approx. Gamma UPL	15.676631
95% HW Approx. Gamma UPL	15.716728
95% WH Approx. Gamma UTL with 90% Coverage	17.237738
95% HW Approx. Gamma UTL with 90% Coverage	17.326761

95% UTL with 90% Coverage	14.200000
95% Percentile Bootstrap UTL with 90% Coverage	14.200000
95% BCA Bootstrap UTL with 90% Coverage	14.200000
95% UPL	14.200000
95% Chebyshev UPL	20.181072
Upper Threshold Limit Based upon IQR	16.275000

Iron

General Statistics

Number of Valid Data	7.0000000	Number of Detected Data	4.0000000
Number of Distinct Detected Data	4.0000000	Number of Non-Detect Data	3.0000000
Tolerance Factor	2.7550000	Percent Non-Detects	42.86%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0260000	Minimum Detected	-3.649659
Maximum Detected	11.200000	Maximum Detected	2.4159138
Mean of Detected	3.8210000	Mean of Detected	-0.445188
SD of Detected	5.2392912	SD of Detected	2.8209507
Minimum Non-Detect	0.0500000	Minimum Non-Detect	-2.995732
Maximum Non-Detect	0.0500000	Maximum Non-Detect	-2.995732

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Background Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.8384945
5% Shapiro Wilk Critical Value	0.7480000

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	2.1941429
SD	4.2239933
95% UTL 90% Coverage	13.831244
95% UPL (t)	10.968843
90% Percentile (z)	7.6074080
95% Percentile (z)	9.1419935
99% Percentile (z)	12.020621

Maximum Likelihood Estimate(MLE) Method

Mean	-1.486487
SD	7.3585540
95% UTL with 90% Coverage	18.786329
95% UPL (t)	13.799784
90% Percentile (z)	7.9438793
95% Percentile (z)	10.617257
99% Percentile (z)	15.632069

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.2598504
Theta Star	14.704617
nu star	2.0788028
A-D Test Statistic	0.3018501
5% A-D Critical Value	0.6956855
K-S Test Statistic	0.2691496
5% K-S Critical Value	0.4152297

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics with Extrapolated Data

Mean	2.1834290
Median	0.0260000
SD	4.2304284
k star	0.1607778
Theta star	13.580413
Nu star	2.2508893
95% Percentile of Chisquare (2k)	1.7449966
90% Percentile	6.5288908
95% Percentile	11.848887
99% Percentile	27.074879

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.9321360
5% Shapiro Wilk Critical Value	0.7480000

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean (Log Scale)	-1.835341
SD (Log Scale)	2.6429216
95% UTL 90% Coverage	231.80763
95% UPL (t)	38.664594
90% Percentile (z)	4.7194821
95% Percentile (z)	12.328060
99% Percentile (z)	74.665180

Log ROS Method

Mean in Original Scale	2.1955848
SD in Original Scale	4.2231712
95% UTL with 90% Coverage	452.99489
95% BCA UTL with 90% Coverage	11.200000
95% Bootstrap (%) UTL with 90% Coverage	11.200000
95% UPL (t)	60.714723
90% Percentile (z)	5.7323161
95% Percentile (z)	16.836574
99% Percentile (z)	127.05757

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	2.1945714
SD	3.9104202
SE of Mean	1.7066473
95% KM UTL with 90% Coverage	12.967779
95% KM Chebyshev UPL	20.416578
95% KM UPL (t)	10.317871
90% Percentile (z)	7.2059765
95% Percentile (z)	8.6266402
99% Percentile (z)	11.291569

Gamma ROS Limits with Extrapolated Data

95% Wilson Hilferty (WH) Approx. Gamma UPL	15.884740
95% Hawkins Wixley (HW) Approx. Gamma UPL	20.621257
95% WH Approx. Gamma UTL with 90% Coverage	30.262303
95% HW Approx. Gamma UTL with 90% Coverage	47.358089

Note: DL/2 is not a recommended method.

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General Statistics

Total Number of Observations	7.0000000	Number of Distinct Observations	7.0000000
Tolerance Factor	2.7550000		

Raw Statistics		Log-Transformed Statistics	
Minimum	1020.0000	Minimum	6.9275579
Maximum	1450.0000	Maximum	7.2793188
Second Largest	1440.0000	Second Largest	7.2723984
First Quartile	1263.5000	First Quartile	7.1403764
Median	1360.0000	Median	7.2152400
Third Quartile	1405.0000	Third Quartile	7.2474822
Mean	1309.5714	Mean	7.1711191
Geometric Mean	1301.3001	SD	0.1243855
SD	152.25402		
Coefficient of Variation	0.1162625		
Skewness	-1.339019		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,

the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.8646445	Shapiro Wilk Test Statistic	0.8384204
Shapiro Wilk Critical Value	0.8030000	Shapiro Wilk Critical Value	0.8030000
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% UTL with 90% Coverage	1729.0312	95% UTL with 90% Coverage	1833.1685
95% UPL (t)	1625.8559	95% UPL (t)	1684.9834
90% Percentile (z)	1504.6928	90% Percentile (z)	1526.1837
95% Percentile (z)	1560.0070	95% Percentile (z)	1596.7332
99% Percentile (z)	1663.7672	99% Percentile (z)	1737.9874

Gamma Distribution Test		Data Distribution Test
k star	45.283601	Data appear Normal at 5% Significance Level
Theta Star	28.919330	
MLE of Mean	1309.5714	
MLE of Standard Deviation	194.60711	

nu star	633.97042		
A-D Test Statistic	0.5458228	**Nonparametric Statistics**	
5% A-D Critical Value	0.7076584	90% Percentile	1444.0000
K-S Test Statistic	0.2759863	95% Percentile	1447.0000
5% K-S Critical Value	0.3113535	99% Percentile	1449.4000
Data appear Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution		95% UTL with 90% Coverage	1450.0000
90% Percentile	1564.3404	95% Percentile Bootstrap UTL with 90% Coverage	1450.0000
95% Percentile	1645.2510	95% BCA Bootstrap UTL with 90% Coverage	1450.0000
99% Percentile	1804.3037	95% UPL	1450.0000
		95% Chebyshev UPL	2019.0537
95% WH Approx. Gamma UPL	1662.1736	Upper Threshold Limit Based upon IQR	1617.2500
95% HW Approx. Gamma UPL	1667.5334		
95% WH Approx. Gamma UTL with 90% Coverage	1791.7591		
95% HW Approx. Gamma UTL with 90% Coverage	1801.3405		

pH

General Statistics

Total Number of Observations	7.0000000	Number of Distinct Observations	7.0000000
Tolerance Factor	2.7550000		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	6.6000000	Minimum	1.8870696
Maximum	9.4500000	Maximum	2.2460147
Second Largest	9.3500000	Second Largest	2.2353763
First Quartile	6.6700000	First Quartile	1.8976097
Median	6.7900000	Median	1.9154509
Third Quartile	9.0200000	Third Quartile	2.1987746
Mean	7.7457143	Mean	2.0344720
Geometric Mean	7.6482129	SD	0.1706931
SD	1.3485901		
Coefficient of Variation	0.1741079		
Skewness	0.4803344		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data
Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Background Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.7583144	Shapiro Wilk Test Statistic	0.7575215
Shapiro Wilk Critical Value	0.8030000	Shapiro Wilk Critical Value	0.8030000
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% UTL with 90% Coverage	11.461080	95% UTL with 90% Coverage	12.240274
95% UPL (t)	10.547204	95% UPL (t)	10.903250
90% Percentile (z)	9.4740020	90% Percentile (z)	9.5183744
95% Percentile (z)	9.9639476	95% Percentile (z)	10.127325
99% Percentile (z)	10.883004	99% Percentile (z)	11.376657
Gamma Distribution Test		**Data Distribution Test**	
k star	22.744658	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.3405509		
MLE of Mean	7.7457143		
MLE of Standard Deviation	1.6241337		
nu star	318.42521		
A-D Test Statistic	0.9145497	**Nonparametric Statistics**	
5% A-D Critical Value	0.7073280	90% Percentile	9.3900000
K-S Test Statistic	0.3471232	95% Percentile	9.4200000
5% K-S Critical Value	0.3114207	99% Percentile	9.4440000
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution		95% UTL with 90% Coverage	9.4500000
90% Percentile	9.8863602	95% Percentile Bootstrap UTL with 90% Coverage	9.4500000
95% Percentile	10.596349	95% BCA Bootstrap UTL with 90% Coverage	9.4500000
99% Percentile	12.015685	95% UPL	9.4500000
		95% Chebyshev UPL	14.029954
95% WH Approx. Gamma UPL	10.766722	Upper Threshold Limit Based upon IQR	12.545000
95% HW Approx. Gamma UPL	10.798894		
95% WH Approx. Gamma UTL with 90% Coverage	11.928229		
95% HW Approx. Gamma UTL with 90% Coverage	12.000155		

Outlier Tests for Selected Uncensored Variables

User Selected Options

Date/Time of Computation: 6/19/2014 2:58:10 PM

From File: WorkSheet.xls

Full Precision: OFF

Dixon's Outlier Test for Arsenic

Number of Observations = 15

10% critical value: 0.472

5% critical value: 0.525

1% critical value: 0.616

1. Observation Value 3.2 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.982

For 10% significance level, 3.2 is an outlier.

For 5% significance level, 3.2 is an outlier.

For 1% significance level, 3.2 is an outlier.

2. Observation Value 0.0074 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.073

For 10% significance level, 0.0074 is not an outlier.

For 5% significance level, 0.0074 is not an outlier.

For 1% significance level, 0.0074 is not an outlier.

Dixon's Outlier Test for Boron

Number of Observations = 15

10% critical value: 0.472

5% critical value: 0.525

1% critical value: 0.616

1. Observation Value 10.1 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.829

For 10% significance level, 10.1 is an outlier.

For 5% significance level, 10.1 is an outlier.

For 1% significance level, 10.1 is an outlier.

2. Observation Value 0.12 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.158

For 10% significance level, 0.12 is not an outlier.

For 5% significance level, 0.12 is not an outlier.

For 1% significance level, 0.12 is not an outlier.

Dixon's Outlier Test for Barium

Number of Observations = 16

10% critical value: 0.454

5% critical value: 0.507

1% critical value: 0.595

1. Observation Value 53.1 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.999

For 10% significance level, 53.1 is an outlier.
For 5% significance level, 53.1 is an outlier.
For 1% significance level, 53.1 is an outlier.

2. Observation Value 0.014 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.350

For 10% significance level, 0.014 is not an outlier.
For 5% significance level, 0.014 is not an outlier.
For 1% significance level, 0.014 is not an outlier.

Dixon's Outlier Test for Chloride

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 140 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.468

For 10% significance level, 140 is an outlier.
For 5% significance level, 140 is not an outlier.
For 1% significance level, 140 is not an outlier.

2. Observation Value 33 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.578

For 10% significance level, 33 is an outlier.
For 5% significance level, 33 is an outlier.
For 1% significance level, 33 is not an outlier.

Dixon's Outlier Test for Fluoride

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 17 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.393

For 10% significance level, 17 is not an outlier.
For 5% significance level, 17 is not an outlier.
For 1% significance level, 17 is not an outlier.

2. Observation Value 1.4 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.633

For 10% significance level, 1.4 is an outlier.
For 5% significance level, 1.4 is an outlier.

For 1% significance level, 1.4 is an outlier.

Dixon's Outlier Test for Iron

umber of Observations = 7
% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637

1. Observation Value 3.91 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.903

For 10% significance level, 3.91 is an outlier.
For 5% significance level, 3.91 is an outlier.
For 1% significance level, 3.91 is an outlier.

2. Observation Value 0.021 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.001

For 10% significance level, 0.021 is not an outlier.
For 5% significance level, 0.021 is not an outlier.
For 1% significance level, 0.021 is not an outlier.

Dixon's Outlier Test for Manganese

Number of Observations = 15
% critical value: 0.472
% critical value: 0.525
1% critical value: 0.616

1. Observation Value 0.474 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.715

For 10% significance level, 0.474 is an outlier.
For 5% significance level, 0.474 is an outlier.
For 1% significance level, 0.474 is an outlier.

2. Observation Value 0.002 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.036

For 10% significance level, 0.002 is not an outlier.
For 5% significance level, 0.002 is not an outlier.
For 1% significance level, 0.002 is not an outlier.

Dixon's Outlier Test for Selenium

Number of Observations = 4
10% critical value: 0.679
% critical value: 0.765
% critical value: 0.889

1. Observation Value 0.0038 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.190

	A–E
187	For 10% significance level, 0.0038 is not an outlier.
188	For 5% significance level, 0.0038 is not an outlier.
189	For 1% significance level, 0.0038 is not an outlier.
	2. Observation Value 0.0017 is a Potential Outlier (Lower Tail)?
1[illegible]	
19[illegible]	est Statistic: 0.190
194	
195	For 10% significance level, 0.0017 is not an outlier.
196	For 5% significance level, 0.0017 is not an outlier.
197	For 1% significance level, 0.0017 is not an outlier.
198	
199	
200	**Dixon's Outlier Test for Sulfate**
201	
202	Number of Observations = 16
203	10% critical value: 0.454
204	5% critical value: 0.507
205	1% critical value: 0.595
206	
207	**1. Observation Value 630 is a Potential Outlier (Upper Tail)?**
208	
209	Test Statistic: 0.237
210	
211	For 10% significance level, 630 is not an outlier.
212	For 5% significance level, 630 is not an outlier.
213	For 1% significance level, 630 is not an outlier.
214	
215	**2. Observation Value 120 is a Potential Outlier (Lower Tail)?**
	st Statistic: 0.310
218	
219	For 10% significance level, 120 is not an outlier.
220	For 5% significance level, 120 is not an outlier.
221	For 1% significance level, 120 is not an outlier.
222	
223	
224	**Dixon's Outlier Test for TDS**
225	
226	Number of Observations = 16
227	10% critical value: 0.454
228	5% critical value: 0.507
229	1% critical value: 0.595
230	
231	**1. Observation Value 1572 is a Potential Outlier (Upper Tail)?**
232	
233	Test Statistic: 0.277
234	
235	For 10% significance level, 1572 is not an outlier.
236	For 5% significance level, 1572 is not an outlier.
237	For 1% significance level, 1572 is not an outlier.
238	
239	**2. Observation Value 321 is a Potential Outlier (Lower Tail)?**
240	
241	Test Statistic: 0.497
243	or 10% significance level, 321 is an outlier.
244	For 5% significance level, 321 is not an outlier.
245	For 1% significance level, 321 is not an outlier.
246	
247	
248	**Dixon's Outlier Test for pH**

Number of Observations = 13
10% critical value: 0.467
5% critical value: 0.521
1% critical value: 0.615

Observation Value 9.51 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.087

For 10% significance level, 9.51 is not an outlier.
For 5% significance level, 9.51 is not an outlier.
For 1% significance level, 9.51 is not an outlier.

2. Observation Value 6.6 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.035

For 10% significance level, 6.6 is not an outlier.
For 5% significance level, 6.6 is not an outlier.
For 1% significance level, 6.6 is not an outlier.

Dixon's Outlier Test for Zinc

Number of Observations = 4
10% critical value: 0.679
5% critical value: 0.765
1% critical value: 0.889

Observation Value 0.3 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.903

For 10% significance level, 0.3 is an outlier.
For 5% significance level, 0.3 is an outlier.
For 1% significance level, 0.3 is an outlier.

2. Observation Value 0.022 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.018

For 10% significance level, 0.022 is not an outlier.
For 5% significance level, 0.022 is not an outlier.
For 1% significance level, 0.022 is not an outlier.

Outlier Tests for Selected Uncensored Variables

User Selected Options		
Date/Time of Computation	6/19/2014 14:58	
From File		WorkSheet.xls
Full Precision		OFF

Dixon's Outlier Test for Arsenic

Number of Observations = 15
10% critical value: 0.472
5% critical value: 0.525
1% critical value: 0.616

1. Observation Value 3.2 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.982

For 10% significance level, 3.2 is an outlier.
For 5% significance level, 3.2 is an outlier.
For 1% significance level, 3.2 is an outlier.

2. Observation Value 0.0074 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.073

For 10% significance level, 0.0074 is not an outlier.
For 5% significance level, 0.0074 is not an outlier.
For 1% significance level, 0.0074 is not an outlier.

Dixon's Outlier Test for Boron

Number of Observations = 15
10% critical value: 0.472
5% critical value: 0.525
1% critical value: 0.616

1. Observation Value 10.1 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.829

For 10% significance level, 10.1 is an outlier.
For 5% significance level, 10.1 is an outlier.
For 1% significance level, 10.1 is an outlier.

2. Observation Value 0.12 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.158

For 10% significance level, 0.12 is not an outlier.
For 5% significance level, 0.12 is not an outlier.
For 1% significance level, 0.12 is not an outlier.

Dixon's Outlier Test for Barium

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 53.1 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.999

For 10% significance level, 53.1 is an outlier.
For 5% significance level, 53.1 is an outlier.
For 1% significance level, 53.1 is an outlier.

2. Observation Value 0.014 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.350

For 10% significance level, 0.014 is not an outlier.
For 5% significance level, 0.014 is not an outlier.
For 1% significance level, 0.014 is not an outlier.

Dixon's Outlier Test for Chloride

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 140 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.468

For 10% significance level, 140 is an outlier.
For 5% significance level, 140 is not an outlier.
For 1% significance level, 140 is not an outlier.

2. Observation Value 33 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.578

For 10% significance level, 33 is an outlier.
For 5% significance level, 33 is an outlier.
For 1% significance level, 33 is not an outlier.

Dixon's Outlier Test for Fluoride

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 17 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.393

For 10% significance level, 17 is not an outlier.
For 5% significance level, 17 is not an outlier.
For 1% significance level, 17 is not an outlier.

2. Observation Value 1.4 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.633

For 10% significance level, 1.4 is an outlier.
For 5% significance level, 1.4 is an outlier.
For 1% significance level, 1.4 is an outlier.

Dixon's Outlier Test for Iron

Number of Observations = 7
10% critical value: 0.434
5% critical value: 0.507
1% critical value: 0.637

1. Observation Value 3.91 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.903

For 10% significance level, 3.91 is an outlier.
For 5% significance level, 3.91 is an outlier.
For 1% significance level, 3.91 is an outlier.

2. Observation Value 0.021 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.001

For 10% significance level, 0.021 is not an outlier.
For 5% significance level, 0.021 is not an outlier.
For 1% significance level, 0.021 is not an outlier.

Dixon's Outlier Test for Manganese

Number of Observations = 15
10% critical value: 0.472
5% critical value: 0.525
1% critical value: 0.616

1. Observation Value 0.474 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.715

For 10% significance level, 0.474 is an outlier.
For 5% significance level, 0.474 is an outlier.
For 1% significance level, 0.474 is an outlier.

2. Observation Value 0.002 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.036

For 10% significance level, 0.002 is not an outlier.
For 5% significance level, 0.002 is not an outlier.
For 1% significance level, 0.002 is not an outlier.

Dixon's Outlier Test for Selenium

Number of Observations = 4
10% critical value: 0.679
5% critical value: 0.765
1% critical value: 0.889

1. Observation Value 0.0038 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.190

For 10% significance level, 0.0038 is not an outlier.
For 5% significance level, 0.0038 is not an outlier.
For 1% significance level, 0.0038 is not an outlier.

2. Observation Value 0.0017 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.190

For 10% significance level, 0.0017 is not an outlier.
For 5% significance level, 0.0017 is not an outlier.
For 1% significance level, 0.0017 is not an outlier.

Dixon's Outlier Test for Sulfate

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 630 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.237

For 10% significance level, 630 is not an outlier.
For 5% significance level, 630 is not an outlier.
For 1% significance level, 630 is not an outlier.

2. Observation Value 120 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.310

For 10% significance level, 120 is not an outlier.
For 5% significance level, 120 is not an outlier.