Hydro Logic, Inc

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November 12, 2003

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WATER RESOURCES
WESTERN REGION

Mr. Ken Neeley
Technical Hydrogeologist
Technical Services Bureau
Department of Water Resources
1301 N. Orchard Street
Boise, ID 83720-0098

Re. Semi-Annual Review of the Monitoring Data for the Boise Front Geothermal System, January – June, 2003.

Dear Mr. Neeley:

I write in reference to your recent report, entitled "Semi-Annual Review of the Monitoring Data for the Boise Front Geothermal System, January – June, 2003" (September 26, 2003) on behalf of The Terteling Company and the Flora Company.

Thank you for compiling, plotting, and posting the submitted data for the Boise Front Low Temperature Geothermal Resources Ground Water Management Area. We very much appreciate your taking the time to identify inadequacies in the required monitoring and reporting for the geothermal system and for developing the attendant recommendations to rectify those situations where good quality and reliable data are not being secured.

You have pointed out, in your review of the various legal proceedings concerning monitoring/reporting obligations of geothermal water users along the Boise Front (Attachment A), that there are four Departmental Orders, a Groundwater Management Area designation, the creation of Water District 63-S, and a private stipulated agreement among some parties, yet the needed monitoring and reporting envisioned by these proceedings still remains to be implemented. My clients hope that this situation is rectified with the pending reinstatement of the BFGWMA moratorium order presently before the Department.

For our part, I am responding to your inquiries under Recommendations Nos. 5 and 7 for the Terteling Ranch and Flora Company geothermal wells (Attachment A):

5. Flora Company.
You recommend determination of the reason that the manual readings and the data logger readings on the Silkey (Shed) well are not in agreement. I have the following explanation:

First, the data-logger recorded measurements will not "agree" with the shut-in pressure measurements. Two different data sets have been plotted on a single graph in your report. The historic data record, the one dating back to about 1990, consists of "shut-in pressure" measurements obtained and submitted by the Terteling family. These aquifer pressures are measured after arresting the artesian flow, allowing the piezometric aquifer pressure to

recover, and measuring the "recovered" or shut-in pressure after several minutes have passed. The installed pressure-transducer/data-logger, on the Silkey well, records measurements according to a set automatic interval, currently programmed for hourly readings. For these continuous measurements, there is no means to automatically close off the flow each time the data-logger records a measurement. The purpose of these recordings is to economically obtain data points without having to visit the site. In other words, the data-logger is recording lower pressures under flowing conditions; not shut-in conditions. We have submitted (to IDWR) shut-in measurements from our on-site measurements according to the established monitoring plan and these data would be compatible with the historic records submitted by Tom Terteling; i.e. the data that you have plotted and presented in your report (Attachment A). The pressures recorded by the data-logger, under flowing conditions, of course, will not agree (overlay) with "shut-in" pressure measurements. What is more, flowing pressures are not meaningful without a corresponding plot of tabulation of the associated flow-rate (Attachment B.)

Second, and more importantly, we believe there is an error, in the plotted data of your report. It appears to us that the data-logger measurements have been plotted as **psi** rather than **feet**; the units which the Solinst instrument records in. This is why the flowing pressures are higher than the shut-in pressures of your hydrograph. This, of course, cannot be. Both, feet-above-datum and the conversion to psi are tabulated in our previously submitted data spreadsheets (Attachment B). The recorded measurements (in feet) would have to be divided by 2.31 ft/psi to "agree" with the historic data submitted by the Terteling family.

Finally, it is not clear, from the plotted hydrographs, what the measurement datums are or whether the graphed data have been adjusted for changed measurement points over the years of record. We suggest that the measurement datum for each well be specified and that any changed elevations of measuring point be noted and corrected for. According to a wellhead photograph taken by me in October of 1998 (Figure 1) the measurement datum in those years was 4.4 feet above pump house floor. The datum used by us for shut-in pressures and data-logger readings is 3.38 feet above pump house floor (see our submitted spreadsheet data file and Figure 2.); a difference very close to one foot. Therefore, in order to present the data relationally, the data logger measurements, and our hand-measured shut-in pressures since August of 2002 would need to be increased by one foot or 0.43 psi (Figure 3). I am sure the Department's own measurements, during the months of aquifer testing and water calls of the early nineties, have documented the measurement datum for the Silkey well also.

The attached plot (Figure 2) clearly shows that Hydro Logic, Inc.'s observed (during field visits) measurements of the flowing pressures of the Silkey well match perfectly with the data-logger recordings of the same. I expect your recent measurements show this same relationship. Also shown on Figure 2. are our shut-in pressure measurements which are generally higher in elevation depending on the flow rate from the well at the time of measurement. Graphing pressure under flowing conditions, without the attendant flow-rate, is not meaningful. We would suggest, in presenting these data in the future, that you plot flow-rate and pressure on the same graph (Figure 2), for flowing conditions, and graph

only shut-in pressure on a separate graph. We also recommend against "connecting the dots" on hydrographs that contain significant data gaps (Attachment A) as this is both, misleading and confusing. Rather, the missing data should appear as such (missing) because we do not know what happened during this interval of time. (Figure 3).

7. Terteling Ranch.
Record water temperature at the Pool and Windsock wells.

You have correctly observed that we neglected to submit water temperatures for the Terteling Windsock and Pool geothermal wells. Attached please find the plotted groundwater discharge temperature for the Windsock well (Figure 4). We simply forgot to include those data and I will forward a revised spreadsheet including those measurements.

The Pool well temperature measurements are a different story. Not only has the Pool well pump been removed from the well for a significant period this year (for replacement of a worn out pump) but we have also experienced technical difficulties with the installed temperature data logger. Several of the Solinst units purchased by the Terteling have come equipped with faulty batteries which have caused inaccuracies in the recorded data. We are still working through this situation. The newly installed pump well head plumbing will include the means to sample discharge temperature at the well head so that hand-measurements can be obtained during site visits.

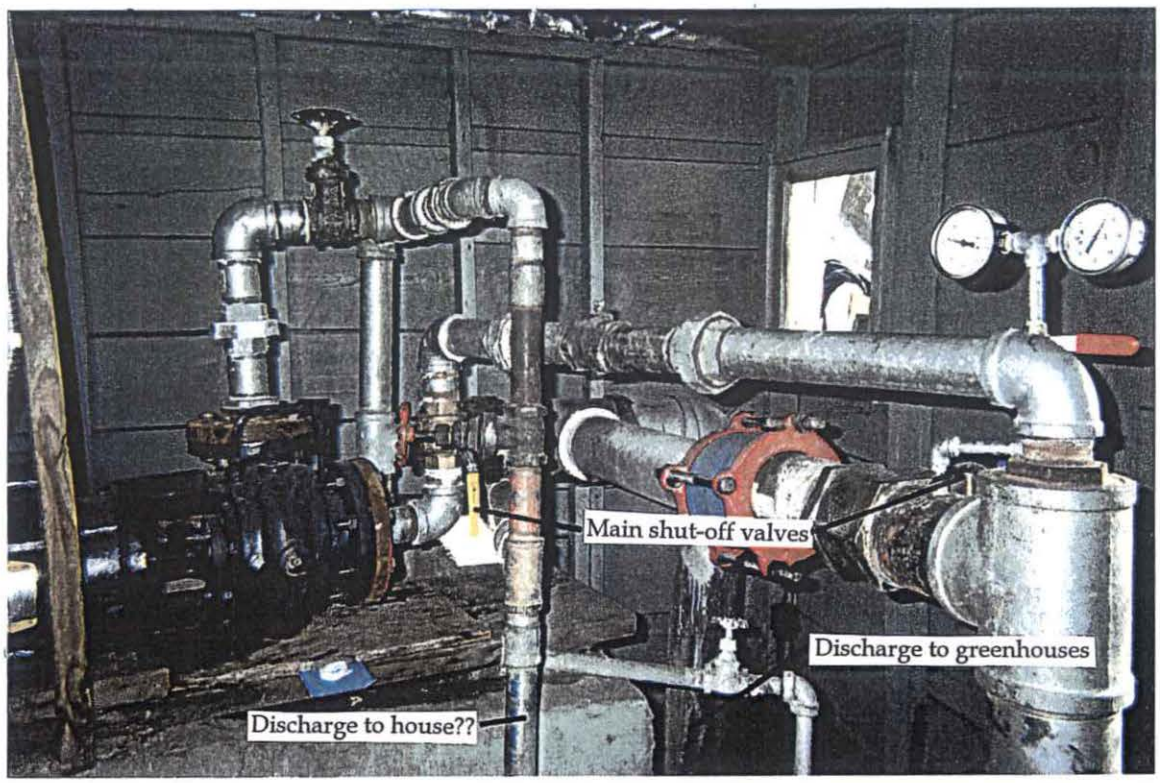
Please call with any questions you may have with respect the above analysis.

Sincerely,

E Squires

Ed Squires
Hydro Logic, Inc.
342-8369

c: Tom Terteling
District 63-S water users (e-mail)
Steve Lester, IDWR – WRO
BFGWMA water users (e-mail)
Charles L. Honsinger, Ringert Clark



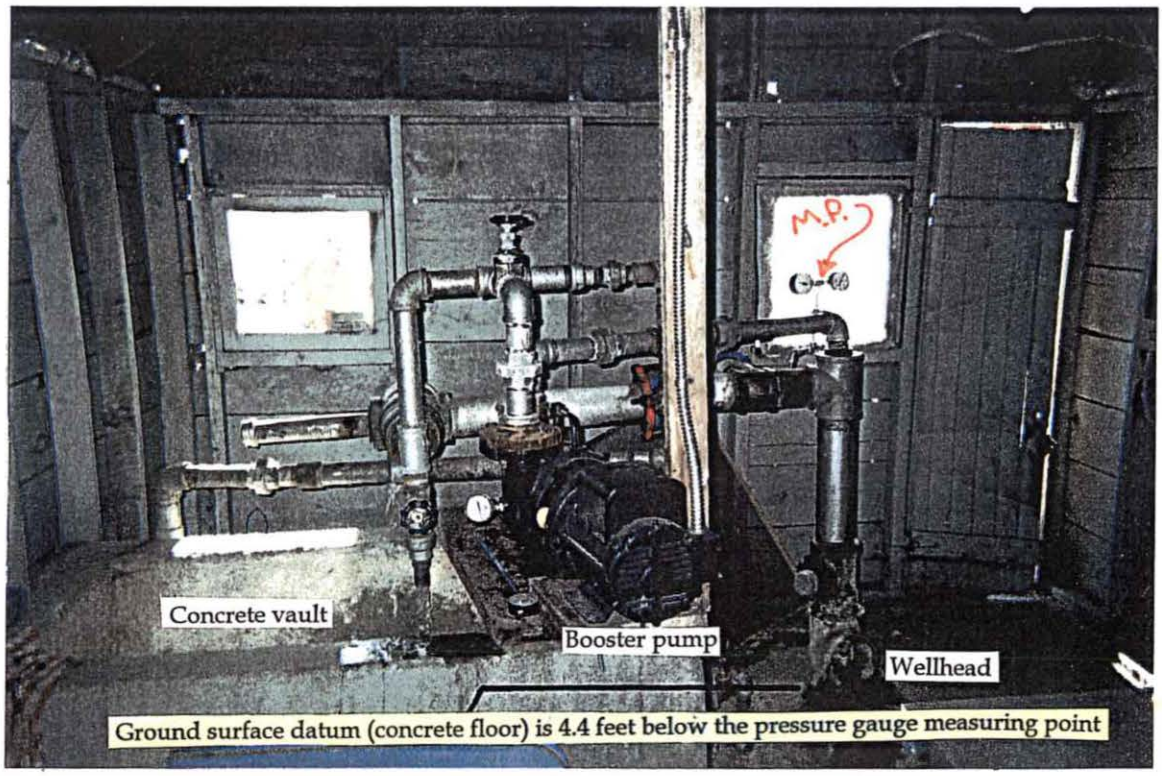


Figure 1.
Wellhead piping configuration for the Flora "SilKey Well (Shed Well??)
October 1998

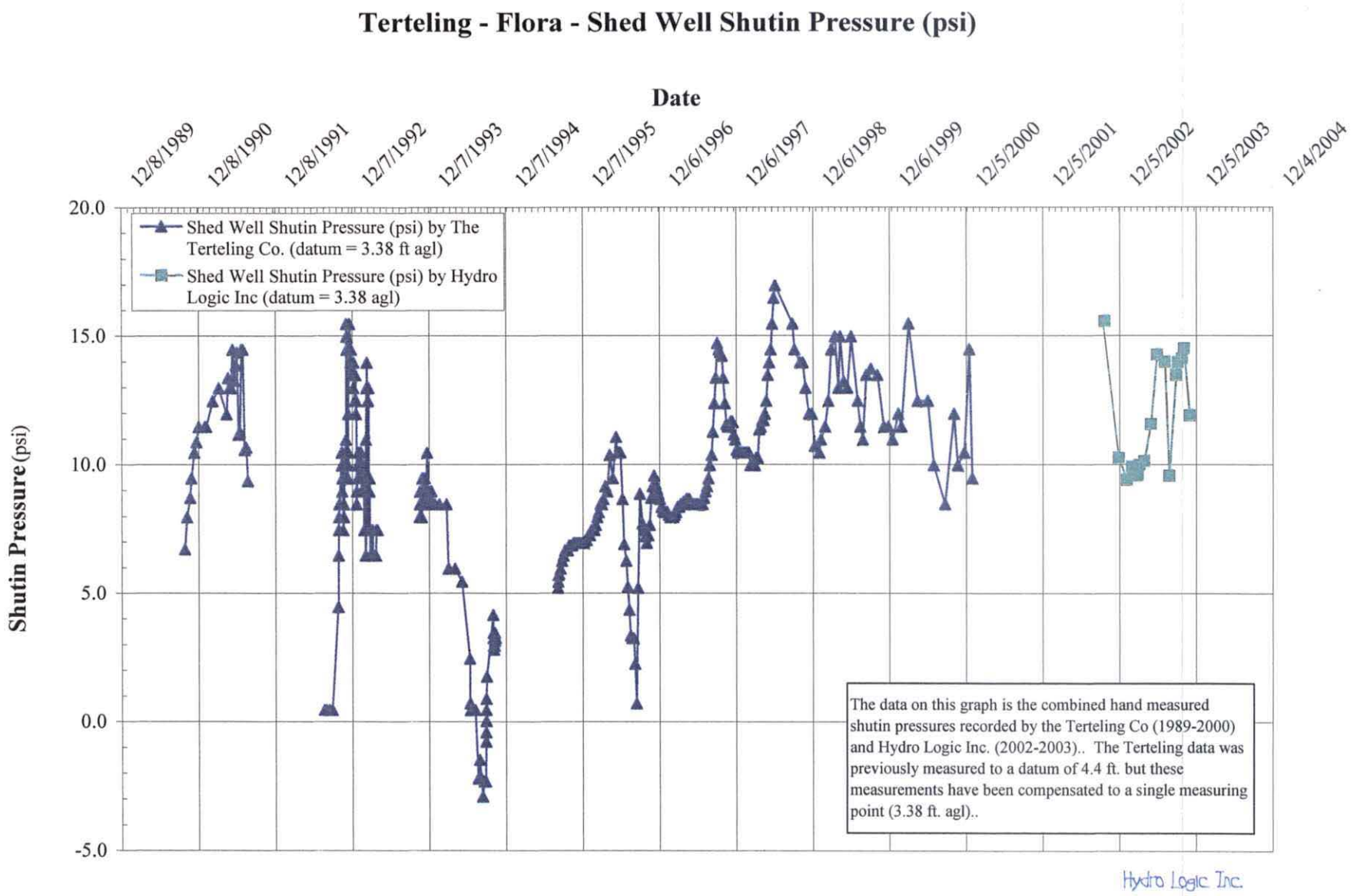
Figure 1.

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Flora Co. - Silkey (Shed) Well

Figure 2.

Figure 3.


Terteling - Flora - Shed Well Shutin Pressure (psi)
Date
12/8/1989
12/8/1990
12/8/1991
12/7/1992
12/7/1993
12/7/1994
12/7/1995
12/6/1996
12/6/1997
12/6/1998
12/6/1999
12/5/2000
12/5/2001
12/5/2002
12/5/2003
12/4/2004
Shutin Pressure (psi)
20.0
15.0
10.0
5.0
0.0
-5.0
Shed Well Shutin Pressure (psi) by The Terteling Co. (datum = 3.38 ft agl)
Shed Well Shutin Pressure (psi) by Hydro Logic Inc (datum = 3.38 agl)
The data on this graph is the combined hand measured shutin pressures recorded by the Terteling Co (1989-2000) and Hydro Logic Inc. (2002-2003).. The Terteling data was previously measured to a datum of 4.4 ft. but these measurements have been compensated to a single measuring point (3.38 ft. agl)..
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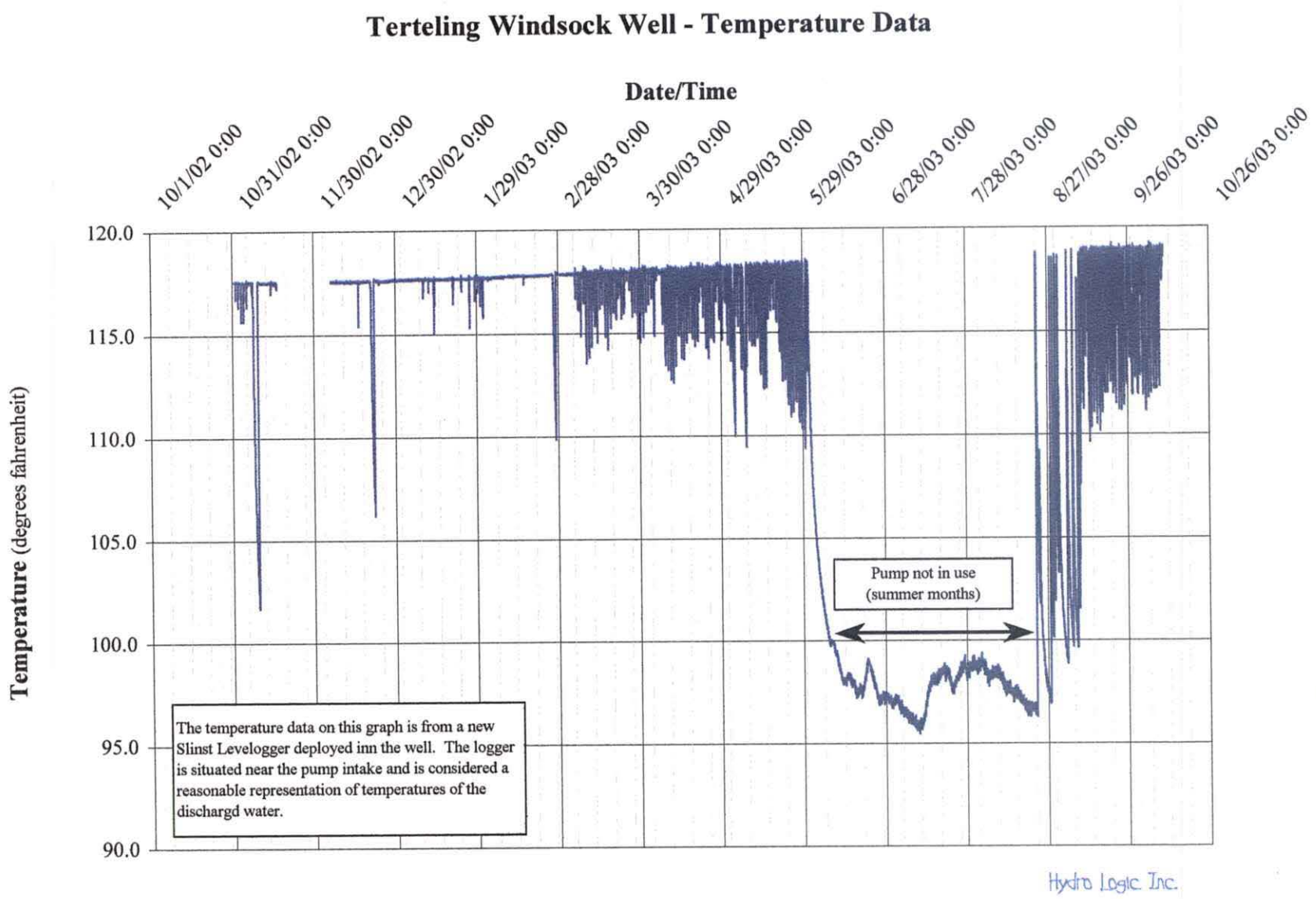

Terteling Windsock Well - Temperature Data
Date/Time
10/1/02 0:00
10/31/02 0:00
11/30/02 0:00
12/30/02 0:00
1/29/03 0:00
2/28/03 0:00
3/30/03 0:00
4/29/03 0:00
5/29/03 0:00
6/28/03 0:00
7/28/03 0:00
8/27/03 0:00
9/26/03 0:00
10/26/03 0:00
Temperature (degrees fahrenheit)
120.0
115.0
110.0
105.0
100.0
95.0
90.0
Pump not in use
(summer months)
The temperature data on this graph is from a new Slinst Levelogger deployed inn the well. The logger is situated near the pump intake and is considered a reasonable representation of temperatures of the dischargd water.
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Figure 4.

Attachment A.

From K. Neeley report of 9-26-03 (3 pages)

3. RECOMMENDATIONS

Monitoring requirements for the geothermal users in the Boise Front system are complex. Users find themselves needing to adhere to one or more of the following legal proceedings:

1. Boise Front Low Temperature Geothermal Resources Ground Water Management Area (GWMA) (June, 1987).
2. Orders requiring monitoring and record keeping for four of the geothermal users in the Boise Front Low Temperature Geothermal Resources GWMA (July, 1987).
3. Order establishing a moratorium in the Boise Front Low Temperature Geothermal Resources GWMA (June, 1988, with five-year extension orders signed in 1993 and 1998).
4. Order establishing Water District 63-S, Stewart Gulch (December, 1989).
5. Order giving the Water Master of Water District 63-S the authority to administer ground water in the district under the terms of the Silky v. Tiegs decree, and to fill senior water rights if artesian pressure is not sufficient (September 1990).
6. Stipulated Agreement in the matter of petition for order authorizing additional use for the City of Boise (July, 2002).
7. Order accepting settlement in the matter of petition for order authorizing additional use for the City of Boise (September, 2002).

Numbers 2, 4, and 6 contain language regarding geothermal monitoring.

- In Number 2, the Boise Warm Springs Water District, City of Boise, State of Idaho Capitol Mall, and Veterans Administration were required to collect: 1) continuous withdrawal rate and withdrawal amounts, 2) continuous casing pressure and/or drawdown measurements on production and injection wells, and 3) temperatures of withdrawn and injected fluids on a daily basis.

- In Number 4, the owners of wells in Water District 63-S were required to "install flow measuring devices and the rate of flow and volume of pressure measuring equipment acceptable to the Department for the measurement of the rate of flow and volume of water diverted from the respective wells". There was no language in the Order regarding the reporting of the data to IDWR.

- In Number 6, each party to the agreement is to "comply with the Monitoring and Reporting Plan attached hereto as Exhibit 1...". Parties to the agreement include: Perkins Coie LLP (representing the City of Boise), Moore Smith Buxton & Turke Chartered (representing the Boise Warm Springs Water District), Hofstetter Law Office (representing the Edwards Family LLC), State of Idaho Department of Administration, State of Idaho Department of Lands, and Ringert Clark (representing the Terteling Company, Inc.). Tables 1-3 provide the details for monitoring the wells owned by the above parties. Table 4 lists Non-Party wells which includes the following owners: USGS, VA, Quail Hollow, and Harris Ranch.

Based on my interpretations of the orders, the following recommendations are made for the collection and reporting of monitoring data:

1. **Boise Warm Springs Water District.**
    a. Data are being recorded on a daily basis on log sheets. Data loggers would allow data to be collected in a more "continuous" fashion as required by the order of 1987.
    b. Check the East Well Signet and Sparling flowmeters for accuracy.
    c. Was West Well Signet checked for accuracy when it was installed in 2002? If not, can it be checked?
    d. It would be helpful to have the daily data entered into a spreadsheet and submitted electronically. The entries that I would like to have included in a spreadsheet are: Date, Time, Water Level, Rate, Totalizer Reading, and Temperature. IDWR could provide a spreadsheet template
2. **Capitol Mall System.**
    a. Check the temperature sensor that measures supply temperatures for accuracy.
3. **City of Boise.**
    a. Re-establish data logger monitoring at the Kanta well.
    b. Collect monitoring data weekly at the BGL #2, #3, and #4 during the two time intervals designated in Table 2 of Exhibit 1.
    c. Check temperature sensor that measures return temperature at the injection well for accuracy.
4. **Veterans Administration** (Non-Party).
    a. Data are being recorded on an average of about 10 readings per month on log sheets. Data loggers would allow more "continuous" collection of monitoring data as required by the order of 1987.
    b. Determine if the air line on the production well is working properly for collecting water level data. Perhaps the well can be shut down for a short time, and static water levels can be taken by using a steel tape and an electric tape, and with the airline procedure that is currently used.
    c. Collect water levels in the injection and test injection wells on a weekly basis.
    d. It would be helpful to have the log sheet data entered into a spreadsheet and submitted electronically. IDWR could provide a spreadsheet template.
5. **Flora Company.**
    a. Determine the reason that the manual readings and the data logger readings on the Shed well are not in agreement.
6. **Edwards Greenhouse**
    a. Can the daily log data be entered into a spreadsheet and submitted electronically? IDWR could provide a spreadsheet template.
7. **Terteling Ranch.**
    a. Record water temperature at the Pool and Windsock wells.
8. **Quail Hollow** (Non-Party).
    a. Since the two wells are "Non-Party" according to Table 4 of Exhibit 1, Mr. Hendrickson believes that Quail Hollow is not required to submit monitoring data. A discussion of the matter with John Homan (attorney at IDWR) and a review of the order for the Ground Water District 63-S monitoring requirements leads me to agree with Mr. Hendrickson's conclusions. As such, all monitoring data (i.e., water levels, instantaneous flows, and totalizer readings) will be collected on a monthly basis by the

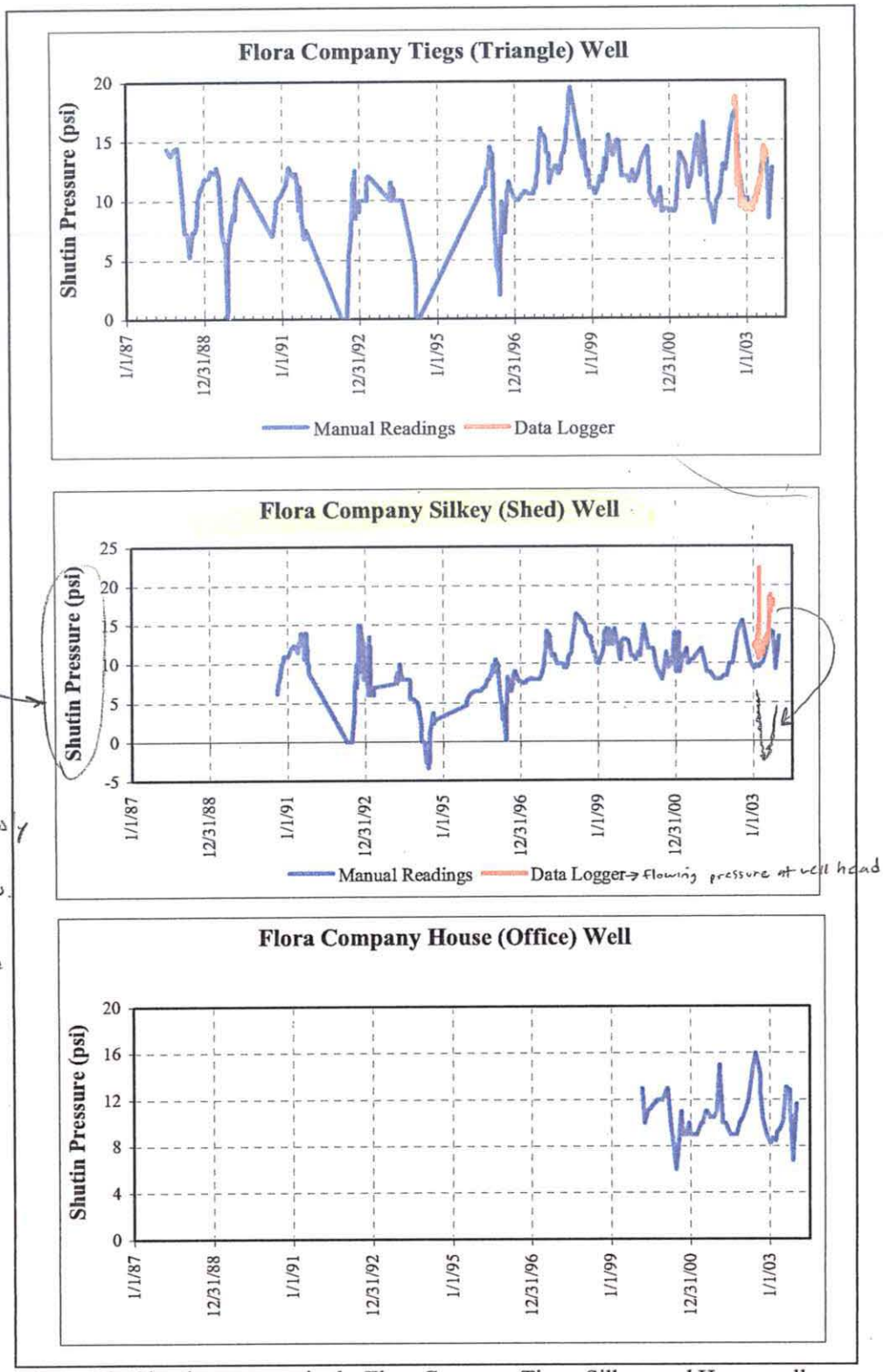


Figure 10. Shut-in pressures in the Flora Company Tiegs, Silkey, and House wells.

Three comments

Datalogger is recording flowing pressure in feet. One would need to divide the pressure in feet by 2.31 ft/psi to convert the data logger data to psi readings. This step appears to have been left out.

Importantly, the data logger to date has been continuously recording flowing pressures and not shut-in pressures. For this graph to be correct, the data logger recordings need to be deleted

There is no indication of a measuring point or datum. This would be valuable to have on the graphs during reviews

FLORA CO. - SILKEY (Shed) WELL

Logger Data		Field Measurements (measuring point (mp) = 3.38 feet above concrete pump house floor)									
Date/Time	Data Logger (ft above mp)	Date/Time (24 hour clock)	Shut-In Pressure Head (ft above mp)	Pressure Head at Flow Rate (ft above mp)	Shut-In Pressure (psi)	Pressure at Flow Rate (psi)	Flow Rate (gal/min)	Totalized Production (gallons)	Volume pumped from last reading (gallons)	Annual Pumped Volume (gallons)	Comments
Silkey Well Data Logger			Silkey Wellhead Shut-In Pressure Head (SWL)	Silkey Wellhead Pressure at Flow Rate (PWL)							
1/10/2003 15:00	12.30	########	35.90		15.55		0.00	84,948,000		**0**	1/10/03-Beginning of data lc
1/10/2003 16:00	12.35	########		21.14		9.15	88.00	85,082,000	134,000	**134,000**	
1/10/2003 17:00	12.33	########		20.67		8.95	78.60	85,885,000	803,000	**937,000**	
1/10/2003 18:00	12.36	########		19.16		8.30	74.87	86,658,000	773,000	**1,710,000**	
1/10/2003 19:00	12.27	########		16.39		7.10	77.11	88,271,000	1,613,000	**3,323,000**	
1/10/2003 20:00	12.33	########	23.67	12.01	10.25	5.20	81.10	92,086,000	3,815,000	**7,138,000**	
1/10/2003 21:00	12.28	########	21.70	11.78	9.40	5.10	77.92	96,468,000	4,382,000	**11,520,000**	
1/10/2003 22:00	12.29	########	22.86	12.70	9.90	5.50	76.90	99,299,000	2,831,000	**14,351,000**	
1/10/2003 23:00	12.29	########	22.28	12.23	9.65	5.30	77.92	99,984,000	685,000	**15,036,000**	
1/11/2003 00:00	12.34	########	22.05	11.43	9.55	4.95	80.40	101,794,000	1,810,000	**16,846,000**	
1/11/2003 01:00	12.34	########	22.17	11.43	9.60	4.95	77.90	102,501,000	707,000	**17,553,000**	
1/11/2003 02:00	12.33	########	23.02	11.36	9.97	4.92	84.50	103,449,000	948,000	**18,501,000**	
1/11/2003 03:00	12.33	########	23.37	11.91	10.12	5.16	85.71	106,092,000	2,643,000	**21,144,000**	
1/11/2003 04:00	12.34	########	26.69	12.84	11.56	5.56	92.30	110,067,000	3,975,000	**25,119,000**	
1/11/2003 05:00	12.31	########	32.90	15.17	14.25	6.57	not recorded	113,832,000	3,765,000	**28,884,000**	
1/11/2003 06:00	12.26	########	32.28	17.51	13.98	7.58	95.20	118,506,000	4,674,000	**33,558,000**	
1/11/2003 07:00	12.25	########	22.08	10.99	9.56	4.76	80.00	121,025,000	2,519,000	**36,077,000**	
1/11/2003 08:00	12.30	########	31.08	15.26	13.46	6.61	91.98	125,023,000	3,998,000	**40,075,000**	
1/11/2003 09:00	12.30	########	32.20	26.33	13.95	11.40	60.00	125,811,000	788,000	**40,863,000**	
1/11/2003 10:00	12.25	########	32.02	27.29	14.10	12.05	63.00	127,580,000	1,769,000	**42,632,000**	
1/11/2003 11:00	12.30	########	32.94	28.30	14.50	12.50	63.00	128,404,000	824,000	**43,456,000**	
1/11/2003 12:00	12.22	########	27.49	23.10	11.90	10.00	60.00	130,843,000	2,439,000	**45,895,000**	11/5/2003 reset logger to 12

Attachment B. Example of Hydro Logic Inc. District 63-S monitoring spreadsheet.

Attachment B.