STATE GROUND WATER DISTRICT 63-S LOW-TEMPERATURE GEOTHERMAL AQUIFER MONITORING AND REPORTING PLAN

July 18, 2008 Draft

Designated Long-Term Monitoring. Commencing on January 1, 2009, aquifer pressure and withdrawal monitoring data shall be collected at all of the wells owned and operated by the three major low temperature geothermal users (Terteling, Edwards, and Quail Hollow) in Ground Water District 63-S. The sections below describe, in more detail, the monitoring plan.

Aquifer Pressure Monitoring. Water level/wellhead pressure monitoring shall be as follows.

1. Continuous (once every six hours) data logger recordings shall be collected.

2. Manual, non-pumping water level/shut-in wellhead pressure data shall be collected monthly. The Water Master will provide a standard data entry chart to the users.

3. Manual, non-pumping water level/shut-in wellhead pressure data shall be collected weekly from January 1 to February 15, and from June 1 to July 15 to ensure capture of the annual high and low aquifer pressures for the year.

4. Each user who owns a non-artesian well will install and maintain a barologger to correct their data and to serve as back-up for the other users in the case of equipment failure.

Withdrawal Monitoring. Withdrawal monitoring shall be as follows: Manual recordings of the instantaneous discharge rate and the gallons-pumped "totalizer" reading shall be collected at least monthly and weekly when weekly pressure readings are required.

Temperature Monitoring. Temperature data shall be collected using data loggers and hand measurements. Frequency of data logger measurements is listed in Table 1. Hand measurements shall be done using a digital thermometer. Hand measurements are to be done twice a year (at the end of the heating season (on or around May 1) and at the end of the irrigation season (on or around October 1). To ensure an accurate temperature, hand measurements shall be collected after the well has been in operation for at least eight hours.

Calibration. Each individual water user is responsible for periodic (annual) calibration of its instruments, gages, sounding tapes, and flow-meters to ensure monitoring accuracy. It is required that hand held instruments be calibrated at least yearly and that back-up sounding tapes are calibrated to the main sounding tape so that measurements are not significantly different when a change to a new instrument is used. The calibration will include (1) comparison measurements of pressure (calibrated gages versus well gage and/or transducer) and (2) calibration checks of flow meters using an ultrasonic flow meter or other means (weir, flume, timed filling of a tank such as a 55 gallon barrel), and (3) comparison of a calibrated water level tape to the digital data-logger measurement of the same time. Calibration checks shall scheduled so that the Water Master can be present. Water users shall document the calibration results and submitted them to the Water Master annually.

Reporting. The parties shall submit monitoring data quarterly to the Water Master. Each data submittal shall include all the digitally acquired and hand-measured monitoring data collected from the previous quarters. The four quarters shall end on March 31, June 30, September 30, and December 31. In addition to the data, the reports will include any monitoring variations during the reporting period, or anything unusual with the dataset. The monitoring data shall be submitted to the Ken Neely, Water Master, within 30 days of the end of the quarter (ken.neely@idwr.idaho.gov).

The IDWR shall prepare an annual summary of monitoring data from the previous water year by December 1.

Compliance. The parties to this plan are agreeing to submit the type of monitoring data and the frequency of monitoring data at the prescribed report times described herein. In the event that a party does not meet the elements of this plan, the Water Master shall notify the Water User in writing of the deficiency, and all Water Users shall be copied on such notices. After thirty (30) days written notice to a party for non-compliance with the aquifer monitoring program data logging and reporting requirements, the Water Master may immediately curtail the non-compliant party's diversion from any well not in compliance with the aquifer monitoring program. Failure to comply with the aquifer monitoring program shall result in a proportional diminution in allowable diversion volume in the following year based upon the proportion of the previous calendar year that the party was in non-compliance. However, a breakdown of monitoring equipment that is promptly repaired shall not be considered a violation under this section.

Monitoring Methodology. Each Water User shall prepare a brief but detailed description of monitoring and calibration methods for the Water User's own wells to IDWR by August 15, 2008. IDWR will send copies of all the plans to all of the water users. IDWR will review the plans and return all comments to the users by September 3, 2008. The water users may submit comments to the other users' plans to IDWR by October 31, 2008.

Each individual Water User monitoring description shall be attached to this plan as Appendices. Each description will include the following information.

1. Identification of monitored wells.

2. Reference point descriptions for water level measurements (with photographs).

3. Description of measuring equipment (including model numbers, serial numbers and calibration information for flow meters and data-loggers).

4. Name, address, and telephone numbers for individuals responsible for acquiring and submitting monitoring data.

5. A description, for each well to be monitored, of the monitoring methods and protocol.

6. All well heads where pressure measurements are taken shall be equipped with quality 0-30 psi double- pressure gage clusters with isolation valves. Diameter of guage and increment of the accuracy of face plate on the gauge (estimate to ½ psi).

7. Water level sounding tubes shall be installed in all wells equipped with downhole pumps. Sounding tubes shall be maintained and replaced as appropriate when downhole pumps are pulled for servicing.

A field trip to each well site will be conducted by the Water Master after January 1, 2009 to obtain standardized photographs and to document equipment installation and measuring points.

Monitoring Equipment: See Appendix A for monitoring equipment recommendations as presented by Ed Squires, Hydro Logic Inc.

Effective Date: This Plan and all of its monitoring elements shall be effective commencing January 1, 2009

Review and Modification. This plan shall be subject to periodic review at the regularly scheduled annual District meetings. This plan may be modified only by

means of a written agreement signed by each of the Parties. A modification shall not be binding upon IDWR unless accepted by the Director.

Appendix A. Recommended Monitoring Equipment (as presented by Ed Squires)

For ease of data manipulation by the Water Master, IDWR, and individual Water Users, and because digital equipment is not in widespread use within the District, it is encouraged that all Water Users employ the same equipment and standardized protocols.

1) Pressure transducer/data-loggers. Solinst Levelogger digital pressure transducer/data-loggers of the appropriate accuracy range for measuring aquifer pressures and/or water levels in wells.

2) Barometers. Solinst Barologger atmospheric pressure transducer and digital data loggers for correction of aquifer pressure data for barometric effect.

3) Monitoring tubes. One-inch diameter, schedule 80, flush-joint PVC monitoring tubes for wells with below ground aquifer pressures. Care must be taken not to compress, bend, or band these tubes during installation of the pumps so that the data-loggers will not be obstructed (it is best if these tubes are "hung" in the well). It is recommended that two such tubes be installed so that the routine and regular water level measurements are not conducted in the same tube that houses the data logger.

4) Water-level sounding tapes. Steel tapes require no calibration as such. Care is taken to ensure that the wetted chalk measurement is accurate and that "held" footage is known with confidence. Only when an unclear first measurement is obtained or when a measurement is markedly different, is a second conformational measurement obtained. Owing to the relatively great depth to water and the time (cost) to carry out routine monitoring runs, the number of repetitive measurements is considered adequate to avoid multiple measurements in each well during each visit. If electric sounding tapes are used, which they are generally not for this monitoring, only complete full-length tapes are used and only when calibrated regularly with a steel tape.

5) Thermometers used to measure water temperature are Model 315, "tpi" brand digital thermometers with a resolution of 0.1 °F, a sampling interval of 1.5 seconds, and a range of -58 °F-to-302 °F. Although the guaranteed accuracy of these thermometers is +/- 2.0 °F, we check calibration of the field thermometers with a VWR Model 61102-005 mercury-filled (non mercury), ASTM-rated thermometer with 0.5 °F accuracy and a Hannah Instruments Model 9023 multi-meter with +/- 0.9 °F accuracy prior to field measurements. We have

consistently found the accuracy of the used digital thermometers to be within 0.5-to-0.75 °F of the guaranteed-accurate thermometers. We have selected these units for field use because non-mercury-filled thermometers do not have the desired accuracy and because of the cost and ease of use.

6) Pressure gauges. In general, we have found that installed (on the well head plumbing) pressure gauges have short-lived accuracy on the geothermal system piping. If only single gauge is used, the monitoring should be considered highly questionable. Rather, we rely on a separate twin set of high-accuracy gauges that are kept in a controlled environment and carried to the well during field visits (Figure 2). In this way, the gauges are calibrated with each measurement. The well head plumbing is equipped with a quick-connect pressure measuring port to which the brace of gauges is connected. With both gauges at the same elevation, they must read identically or one of the instruments is considered faulty. All above ground aquifer pressures are measured using a brace of Ashcroft Duraguage Plus gauges mounted in a manifold capable of measuring pressures simultaneously (Figure 2). The two gauges are direct reading, Model # 1279AS, 0-to-30 psi range, guaranteed accurate to +/- 5% of full scale (~ .35 feet), gages with 4½-inch diameter indicator scales. These are non-fluid filled gages to ensure accuracy at a wide range of temperatures.

STATE GROUND WATER DISTRICT 63-S LOW-TEMPERATURE GEOTHERMAL AQUIFER MONITORING AND REPORTING PLAN

March 13, 2008 Draft

Designated Long-Term Monitoring. Commencing on July 15, 2008, aquifer pressure and withdrawal monitoring data shall be collected at all of the wells owned and operated by the three major low temperature geothermal users (Terteling, Edwards, and Quail Hollow) in Ground Water District 63-S. The monitoring data shall be collected using two methods: 1) continuous measurements using digital pressure-transducer/data- logger units, and 2) manual measurements taken by hand instruments at the well head. Table 1 describes the wells to be monitored, and the type and frequency of monitoring. The sections below describe, in more detail, the monitoring plan.

Aquifer Pressure Monitoring. Water level/wellhead pressure monitoring shall be as follows.

1. Continuous (once every six hours) data logger recordings shall be collected.

2. Manual, non-pumping water level/shut-in wellhead pressure data shall be collected monthly. The Water Master will provide a standard data entry chart to the users.

3. Manual, non-pumping water level/shut-in wellhead pressure data shall be collected weekly begin June 1 and January 1 to ensure capture of the annual high and low aquifer pressures for the year.

4. Each user will install and maintain a barologger to correct their data and to serve as back-up for the other users in the case of equipment failure.

Withdrawal Monitoring. Withdrawal monitoring shall be as follows: Manual recordings of the instantaneous discharge rate and the gallons-pumped "totalizer" reading shall be collected at least monthly and weekly when weekly pressure readings are required.

Temperature Monitoring. Temperature data are desirable but not required. The preferred method of acquiring temperature data is to use a data logger with periodic hand-measurements with a guaranteed accurate thermometer for calibration

Calibration. Each individual water user is responsible for periodic (annual) calibration of its instruments, gages, sounding tapes, and flow-meters to ensure

monitoring accuracy. It is required that hand held instruments be calibrated at least yearly and that back-up sounding tapes are calibrated to the main sounding tape so that measurements are not significantly different when a change to a new instrument is used. The calibration will include (1) comparison measurements of pressure (calibrated gages versus well gage and/or transducer) and (2) calibration checks of flow meters using an ultrasonic flow meter or other means (weir, flume, timed filling of tank), and (3) comparison of a calibrated water level tape to the digital data-logger measurement of the same time. Calibration checks shall be documented and submitted annually.

In addition to calibration checks by the water users, the IDWR and/or the Water Master of the District shall annually visit each well listed in Table 1 over which a Water User has possession or control or to which access is otherwise permitted for purposes of calibration checks of monitoring equipment.

Reporting. The parties shall submit monitoring data quarterly to the Water Master. Each data submittal shall include all the digitally acquired and hand-measured monitoring data collected from the previous quarters. The four quarters shall end on March 31, June 30, September 30, and December 31. The monitoring data shall be submitted to the Water Master within 30 days of the end of the quarter.

The IDWR shall prepare an annual summary of monitoring data from the previous water year by December 1.

Compliance. The parties to this plan are agreeing to submit the type of monitoring data and the frequency of monitoring data at the prescribed report times described herein. In the event that a party does not meet the elements of this plan, the Water Master shall notify the Water User of the deficiency, and all Water Users shall be copied on such notices. Any such incidents will be discussed at the Annual Water District meeting in March, at which time the District members can decide if penalties for non-compliance are to be designated.

Monitoring Methodology. Each Water User shall prepare a brief but detailed description of monitoring and calibration methods for the Water User's own wells by July 15, 2008. These descriptions shall be submitted to IDWR and made available for review to the Water Master and the individual Water District water users. Questions or concerns about a monitoring description shall be addressed to IDWR.

Each individual Water User monitoring description shall be attached to this plan as Appendices. Each description will include the following information.

1. Identification of monitored wells.

2. Reference point descriptions for water level measurements (with photographs).

3. Description of measuring equipment (including model numbers, serial numbers and calibration information for flow meters and data-loggers).

4. Name, address, and telephone numbers for individuals responsible for acquiring and submitting monitoring data.

5. A description, for each well to be monitored, of the monitoring methods and protocol.

6. All well heads where pressure measurements are taken shall be equipped with quality 0-50 psi double- pressure gage clusters with isolation valves.

7. Water level sounding tubes shall be installed in all wells equipped with pumps. Sounding tubes shall be maintained and replaced as appropriate when pumps are pulled for servicing.

A field trip to each well site will be conducted by the Water Master after July 15, 2008 to obtain standardized photographs and to document equipment installation and measuring points.

Monitoring Equipment: See Appendix A for monitoring equipment recommendations as presented by Ed Squires, Hydro Logic Inc.

Effective Date: This Plan and all of its monitoring elements shall be effective commencing July 15, 2008

Review and Modification. This plan shall be subject to periodic review and modification at the regularly scheduled annual District meetings. This plan may be modified only by means of a written agreement signed by each of the Parties. A modification shall not be binding upon IDWR unless accepted by the Director.

Appendix A. Recommended Monitoring Equipment (as presented by Ed Squires)

For ease of data manipulation by the Water Master, IDWR, and individual Water Users, and because digital equipment is not in widespread use within the District, it is encouraged that all Water Users employ the same equipment and standardized protocols.

1) Pressure transducer/data-loggers. Solinst Levelogger digital pressure transducer/data-loggers of the appropriate accuracy range for measuring aquifer pressures and/or water levels in wells.

2) Barometers. Solinst Barologger atmospheric pressure transducer and digital data loggers for correction of aquifer pressure data for barometric effect.

3) Monitoring tubes. One-inch diameter, schedule 80, flush-joint PVC monitoring tubes for wells with below ground aquifer pressures. Care must be taken not to compress, bend, or band these tubes during installation of the pumps so that the data-loggers will not be obstructed (it is best if these tubes are "hung" in the well). It is recommended that two such tubes be installed so that the routine and regular water level measurements are not conducted in the same tube that houses the data logger.

4) Water-level sounding tapes. Steel tapes require no calibration as such. Care is taken to ensure that the wetted chalk measurement is accurate and that "held" footage is known with confidence. Only when an unclear first measurement is obtained or when a measurement is markedly different, is a second conformational measurement obtained. Owing to the relatively great depth to water and the time (cost) to carry out routine monitoring runs, the number of repetitive measurements is considered adequate to avoid multiple measurements in each well during each visit. If electric sounding tapes are used, which they are generally not for this monitoring, only complete full-length tapes are used and only when calibrated regularly with a steel tape.

5) Thermometers used to measure water temperature are Model 315, "tpi" brand digital thermometers with a resolution of 0.1 °F, a sampling interval of 1.5 seconds, and a range of -58 °F-to-302 °F. Although the guaranteed accuracy of these thermometers is +/- 2.0 °F, we check calibration of the field thermometers with a VWR Model 61102-005 mercury-filled, ASTM-rated thermometer with 0.5 °F accuracy and a Hannah Instruments Model 9023 multi-meter with +/- 0.9 °F accuracy prior to field measurements. We have consistently found the

accuracy of the used digital thermometers to be within 0.5-to-0.75 °F of the guaranteed-accurate thermometers. We have selected these units for field use because non-mercury-filled thermometers do not have the desired accuracy and because of the cost and ease of use.

6) Pressure gauges. In general, we have found that installed (on the well head plumbing) pressure gauges have short-lived accuracy on the geothermal system piping. If only single gauge is used, the monitoring should be considered highly questionable. Rather, we rely on a separate twin set of high-accuracy gauges that are kept in a controlled environment and carried to the well during field visits (Figure 2). In this way, the gauges are calibrated with each measurement. The well head plumbing is equipped with a quick-connect pressure measuring port to which the brace of gauges is connected. With both gauges at the same elevation, they must read identically or one of the instruments is considered faulty. All above ground aquifer pressures are measured using a brace of Ashcroft Duraguage Plus gauges mounted in a manifold capable of measuring pressures simultaneously (Figure 2). The two gauges are direct reading, Model # 1279AS, 0-to-30 psi range, guaranteed accurate to +/- 5% of full scale (~ .35 feet), gages with 4½-inch diameter indicator scales. These are non-fluid filled gages to ensure accuracy at a wide range of temperatures.

Table 1. Monitoring Plan for Water District 63S

WELL NAME	WELL OWNERSHIP	MONITORING RESPONSIBILITY	WATER LEVEL/ AQUIFER PRESSURE MEASUREMENTS	WITHDRAWAL MEASUREMENTS	MEASUREMENT FREQUENCY
Edwards	Edwards Greenhouse	Edwards Greenhouse	a) Wellhead pressures using a transducer and data-logger. b) Hand written recording of shut-in pressures from pressure gages.	b) Hand written recording of flow rate and totalized volume.	a) Continuous [1] b) Monthly [2]
Nibbler	Quail Hollow Golf Club	Quail Hollow	a) Water levels using a transducer and data-logger. b) Hand written recording of water level using a measuring tape.	b). Hand written recording of flow rate and totalized volume.	a) Continuous [1] b) Monthly [2]
Office [3]	The Terteling Co., Inc.	Hydro Logic, Inc.	Hand written recording of shut-in pressures from pressure gages.[4]	Hand written recording of flow rate and totalized volume.	Monthly
Pool	The Terteling Co., Inc.	Hydro Logic, Inc.	a) Water levels using a transducer and data-logger. b) Hand written recording of water level using a measuring tape.	b). Hand written recording of flow rate and totalized volume.	a) Continuous [1] b) Monthly [2]
Silkey	The Terteling Co., Inc.	Hydro Logic, Inc.	a) Wellhead pressures using a transducer and data-logger. b) Hand written recording of shut-in pressures from pressure gages.	b). Hand written recording of flow rate and totalized volume.	a) Continuous [1] b) Monthly [2]
Tee Ltd.	Quail Hollow Golf Club	Quail Hollow	a) Water levels using a transducer and data-logger. b) Hand written recording of water level using a measuring tape.	b). Hand written recording of flow rate and totalized volume.	a) Continuous [1] b) Monthly [2]
Tiegs	The Terteling Co., Inc.	Hydro Logic, Inc.	a) Wellhead pressures using a transducer and data-logger. b) Hand written recording of shut-in pressures from pressure gages.	b). Hand written recording of flow rate and totalized volume.	a) Continuous [1] b) Monthly [2]
Windsock	The Terteling Co., Inc.	Hydro Logic, Inc.	a) Water levels using a transducer and data-logger. b) Hand written recording of water level using a measuring tape.	b). Hand written recording of flow rate and totalized volume.	a) Continuous [1] b) Monthly [2]

- [1] Once every six hours.
- [2] In addition to monthly measurements, weekly measurements of shut-in pressure/water levels are to be recorded from January 1 to Feb 15, and from June 1 to July 15.
- [3] Well is not currently planned to be connected for use. If the well is connected, then monthly hand-written measurements will be recorded.
- [4] Since the historic pressure readings from this well mirror the Silkey and Tiegs well, a data logger will not be required.

March 2008

Submitted by Charlie H

Review and Modification. This plan shall be subject to periodic review and modification at the regularly scheduled annual District meetings. This plan may be modified pursuant to procedures set forth in I.C. §42-605 ~~only by means of a written agreement signed by each of the Water Users~~. A modification shall not be binding upon IDWR unless accepted by the Director