January 29, 2013

M E M O R A N D U M

TO: David Anderson, Engineering Manager
DEQ-Twin Falls Regional Office

Bill Allred, Regional Administrator
DEQ – Twin Falls Regional Office

FROM: Adam Bussan, E.I., Scientist
DEQ-State Office of Technical Services

SUBJECT: Staff Analysis for Draft Reuse Permit I-210-02 (Industrial Recycled Water)
Raft River Energy I LLC

1. PURPOSE

The purpose of this memorandum is to satisfy the requirements of the *Recycled Water Rules*, IDAPA 58.01.17.400.05, for issuing reuse permits. This memorandum addresses draft permit WRU I-210-02, for the Industrial Treatment and Reuse System, owned and operated by Raft River Energy I LLC. Raft River Energy I LLC's treatment and reuse system is currently permitted under the terms of Reuse Permit LA-000210-01.

2. SUMMARY OF EVENTS

The Department of Environmental Quality (DEQ) issued Permit LA-000210-01 to Raft River Energy I LLC on February 23, 2007. The permit is for continued operation of the recycled water treatment and reuse system serving Raft River Energy I LLC. The purpose of the current draft permit is to renew Permit LA-000210-01, which expired on February 23, 2012.

A permit renewal application from Raft River Energy I LLC was received on April 2, 2012, and largely serves as the basis for the terms and conditions contained in the draft permit. DEQ determined that the permit application was substantially complete on April 12, 2012 and on May 9, 2012 visited the site on an inspection. As required by IDAPA 58.01.17.400, the *Recycled Water Rules*, the draft permit will be presented for a public comment period. After the comment period has closed, DEQ will provide written responses to all relevant comments and prepare a final permit for Raft River Energy I LLC's wastewater reuse facilities.

Land application began at Raft River facility's infiltration basins in January of 2008 and was expanded to its center pivot systems in May of 2008. There were no hydraulic or nutrient loading limits established in LA-000210-01. The permittee was required to submit a *Plan of Operation*, a *Ground Water Monitoring Network Plan*, a *Runoff Management Plan*, and a *Surface Water Interconnectivity Assessment* and carry out a monitoring program.

The permittee had completed all compliance activities by the date the permit renewal was submitted. See Section 4.2.1 for a more complete description of these activities. As required by Section F, Permit Limits and Conditions in LA 000210-01 and by requirements in CA-210-01 *Plan of Operation*, the permittee submitted a *Grazing Management Plan* before grazing commenced at the land application sites. From the date of issuance, the permit limits and conditions have been met with the exception of late submittals of three consecutive Annual Reports (years 2009, 2010 and 2011) and the failure to obtain DEQ approval of plans and specifications for modification of the reuse system prior to the addition of a reverse osmosis (RO) treatment system, which was put into service during December of 2008.

3. PROCESS AND SITE DESCRIPTIONS

For a complete discussion regarding the geothermal energy production process and the role that cooling water plays in it, refer to the Staff Analysis for the draft version of Reuse Permit LA-000210-01, dated January 23, 2007 (Ogle 2007, TRIM 2012AGH1596). A description of changes made to the facility and an interpretation of monitoring data submitted during the previous 5 years can be found in Sections 3.1 to 3.6 of this Staff Analysis. Please see Section 11 of the Draft Permit for site maps that depict the physical features discussed in this Staff Analysis.

3.1. Process

The Raft River geothermal energy production begins with the pumping of deep, briny, hot water up from the geothermal reservoir to vaporize iso-pentane, a working fluid with a low boiling point. The vaporized iso-pentane drives a turbine to generate electrical energy. Cooling water is needed to condense the iso-pentane working fluid as it is recirculated. Because a high concentration of dissolved minerals in the cooling water can cause scaling, electrical conductivity is continuously monitored as a proxy for the amount of dissolved solids in the cooling water. When the electrical conductivity of the cooling water reaches a set-point, roughly corresponding to a chloride concentration of 840 ppm, the cooling water is drawn off to be applied at the hydraulic management units. This spent cooling water is combined with concentrate from the RO treatment plant and excess un-treated ground water. This combination of waters is designated by the permittee as blowdown water, and is applied at the hydraulic management units.

The cooling water is produced from ground water much shallower than the geothermal aquifer. The cooling water is pumped towards the RO building, where Watertech MPC-892 SI, an on-line RO cleaner, and Sodium Bisulfate, used to de-chlorinate the feed, are added before the stream passes through the RO membranes. Permeate comprises around two-thirds of the flow to the cooling water tower, with the rest of the flow comprised by untreated ground water (Mayfield, Butch, personal communication, May 9, 2012). At the cooling tower, more chemicals are added, including Bromax, a biocide; CWT-280, a Watertech corrosion inhibitor; and sulfuric acid, for pH adjustment. In 2011, roughly ten (10) gallons a week of sulfuric acid were added, along with two (2) gallons a week of Bromax (Nichols, Scott, personal communication, May 15, 2012). In cooling water systems, the ratio of electrical conductivity, or chloride concentration, in the cooling water to that of the makeup water is referred to as the system's cycle of concentration. In early 2012, the Raft River cooling water system was operating at approximately 18 cycles of concentration (Mayfield, Butch, personal communication, May 9, 2012).

3.2. Site Description

The Raft River facility is located in a section of the Raft River Valley roughly six miles north of the Idaho-Utah border and southwest of State Highway 81, bounded by the Jim Sage Mountains to the west and the Black Pine Range to the east. The actual site of the power plant facility is between 2950 South and the Raft River.

Blowdown water generated at the facility is land applied on two (2) fields, each irrigated by a center pivot, or through two infiltration basins. The northernmost hydraulic management unit (HMU), designated as the North Pivot (MU-210-01), is separated by the Raft River from the two other HMUs. One hundred feet south of the Raft River are two parallel infiltration basins, which together are classified as the Infiltration Area (MU-210-03). The South Pivot (MU-210-02) is located south of the Infiltration Area. These three (3) HMUs are together aligned perpendicular to the Raft River's and ground water flow.

The acreage for each HMU is as follows: the North Pivot - 48 acres, the South Pivot - 65 acres, and the Infiltration Area - 2 acres. Within the Infiltration Area, the western most basin is connected to the eastern basin

by an overflow pipe, and the eastern basin is connected to additional bermed acreage by another overflow pipe. No wastewater is allowed to overflow from the eastern basin into the additional bermed acreage as this area is not permitted for use under the terms of I-210-02.

Crested wheat grass is the main crop grown on the North Pivot and South Pivot, with some residual alfalfa growing among the grass. Neither site was grazed or harvested during the first two years of operation under LA-000210-01. During 2010, both sites were grazed, and the crested wheatgrass was grazed and harvested in 2011.

3.3. Hydraulic Loading

The original projection for the volume of blowdown water that would need to be land applied, made during the original permit's approval process, was 210.3 MG (Harrison and Cloonan 2006). No hydraulic loading limit was established in the current permit (LA-000210-01), but the permittee was required to monitor and report the annual volume of blowdown water applied to the hydraulic management units. From 2008 to 2010 inclusively, the total hydraulic loading was consistently reported as being between 130 and 135 MG; however, the portion of the blowdown water sent to the individual management units did vary from year to year. This consistency ended in 2011, when the combined hydraulic loading drastically decreased to105 MG. No explanation for this decrease was offered by the permittee; but even if hydraulic loading rebounds to pre-2011 volumes in 2012 and the following years, the total hydraulic loading rate will likely continue to be less than the hydraulic loading originally projected.

In the time since Raft River acquired the property, irrigation practices at the property have changed significantly. Blowdown water application at 387.3 acre-feet makes up only a fraction of the historic irrigation volume of 1,656 acre-feet. There has been an overall diminishment in irrigation volume as a result of a reduction by 30% of the water rights assigned to the property since it was acquired by Raft River Energy I LLC (Nichols, Scott, personal communication, December 21, 2012).

Application to the Infiltration Area occurs primarily during the non-growing season. On average, slightly less than half of all blowdown water has been applied to the infiltration area, just less than a quarter applied to the North Pivot, and slightly more than a quarter applied to the South Pivot. Hydraulic loading at the North Pivot and South Pivot has been below the irrigation water requirement (IWR) during most years, averaging 22 inches/acre since 2008 compared to an IWR of 33.1 inches/acre for low management grass pasture at the Malta – Agrimet station. In 2011, hydraulic loading was significantly below the IWR for each month (see Figure 1); but in 2010, unbalanced application led to some months having hydraulic loading above the IWR (Wester 2011). Crested wheatgrass does not require high volumes of irrigation water, so deficit irrigation would not be as harmful for the crop as it would be for less drought-tolerant plants.

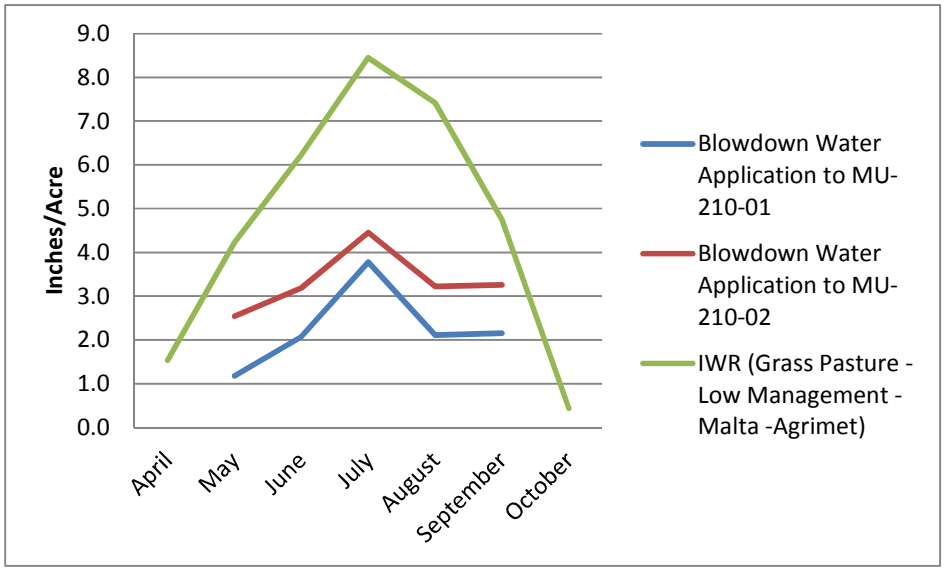


Figure 1: Hydraulic Application vs. IWR in 2011

3.4. Constituent Loading

Though there was not a TDS loading limit established in the current permit (LA-000210-01), the permit was approved on the condition that future TDS loading to the Raft River property would not exceed the total average TDS load applied to the site when it was managed for agriculture only. Before the property was acquired by Raft River I LLC, 2,476 tons/year of TDS were applied to the 928-acre site (Harrison and Petrich 2006). For the first four years after geothermal energy production began, from 2008 to 2011, the application of blowdown water deposited an average of 1,146.3 tons/year of TDS to the permitted management units. Even if the total TDS load includes the loads from other irrigation activities at the site, it is not likely that the historical irrigation TDS load has been exceeded because of a reduction of the water rights assigned to the permittee since then. The expectations, which the original permit was issued with, seem to have been fulfilled.

Though the total TDS loading has not likely exceeded the historic conditions, the TDS loading per acre has increased. Over the entire 928 acres, an average of 5,336 lbs/acre of TDS was loaded to the property before Raft River's acquisition of it. When blowdown water began to be land applied, TDS loading to the permitted hydraulic management units nearly doubled to 10,614 lbs/acre. This increase in the pounds per acre of TDS was the result of the increase in the concentrations of dissolved solids in the blowdown water above those in the historic agriculture water, which was then made up of 95 percent ground water and 5 percent surface water. The average ground water TDS concentration at this time was 1,136 mg/L, and the surface water had a TDS concentration of 617 mg/L resulting in an average irrigation water TDS concentration of approximately 1,101 mg/L. In the blowdown water, the average TDS concentration during the first four years of operation nearly doubled to 2,019 mg/L, with a maximum measurement of 2,789 mg/L (Nichols 2012c). Because salts in the cooling water are concentrated by evaporation, a higher TDS concentration was expected to occur, but none of the average yearly TDS concentrations in the blowdown water have been above 2,568 mg/L, which was the average TDS concentration projected during the original permit application process (Harrison and Petrich 2006).

Because water with higher concentrations of dissolved constituents is being applied, localized changes in ground water quality are likely to have occurred after water reuse began at the facility. There is no evidence though that such changes are greater than what modeling predicted before the permit was approved (Petrich and Harrison 2006).

As can be seen in Table 1, with the exception of the 2008 South Pivot result, TDS loadings at the North Pivot and South Pivot decreased each year over the first four years of operation. This downward trend is mainly a result of decreasing TDS concentrations from 2008 to 2010; but in 2011, primarily due to decreased hydraulic loading.

Table 1: Four Year Summary of Loading Data

Year	Hydraulic Loading MG	Hydraulic Loading in/acre	Nitrogen lbs/acre	Phosphorus lbs/acre	TDIS lbs/acre	TDS lbs/acre
MU-0210-01 (North Pivot)						
2008	44.0	32.3	14.3	4.8	16,371.7	18,560.5
2009	33.5	24.6	25.7	6.9	12,531.0	11,224.2
2010	33.7	24.8	18.1	7.3	9,908.4	9,769.9
2011	14.7	10.8	11.1	8.6	—	6,168.0
MU-0210-02 (South Pivot)						
2008	17.3	10.1	4.5	1.5	5,098.6	5,780.3
2009	50.2	29.3	30.6	8.2	14,919.4	13,363.5
2010	47.6	27.8	20.3	8.1	11,091.8	10,936.8
2011	29.5	17.2	17.7	13.7	—	9,783.8
MU-0210-03 (Infiltration Area)						
2008	72.4	—	588.6	196.2	673,898.9	763,996.5
2009	47.8	—	919.7	245.4	448,044.9	401,319.7
2010	54.0	—	724.8	290.4	396,305.1	390,767.7
2011	60.3	—	1,138.1	881.9	—	630,292.1

Table 1 shows the results of four years of hydraulic and constituent monitoring to the three (3) HMUs. Crops were harvested for the first time from the South Pivot in 2011, so it is not possible to compare crop uptake with nutrient loading. Nitrogen and phosphorus loadings to the North Pivot and South Pivot are low, and the facility does not supplement these nutrients with fertilizer. In 2011 and 2008, hydraulic loading to the infiltration area exceeded the combined loading to the North Pivot and South Pivot. In 2009 and 2010, the opposite was the case. When application to the infiltration area is higher than to the fields, constituent loading is applied to a smaller area. This could result in a rise of localized ground water concentrations. However, when loading is higher to the North and South Pivot, soil salinity on productive land will be raised, which has the potential to decrease the fertility of the soil.

3.5. Soils

The soils that make up the application sites are all well drained, with the North Pivot and South Pivot comprised of Declo and Freedom silt loam and the infiltration basins by Freedom silt loam and Genola silt loam. Soil monitoring units (SMU) have been sampled annually for sodium adsorption ration (SAR), electrical conductivity (EC), Na, Cl, pH, plant available phosphorus, Ca, Mg, and DTPA Fe, and DTPA Mn. No noticeable trends can be seen in the previous five years' soil testing results for these constituents, since the reported data have been highly irregular. Reported values of SAR ranged from 0.32 to 70.3 over all SMUs. This wide range of reported values was not the result of a few isolated samples, there were significant changes between one year's sampling and the next year's sampling as seen in every depth of every soil monitoring unit

(SMU). Over four years of sampling in each depth of each SMU, the highest reported SAR value was nearly always at least 10 times that of the lowest value. Soil monitoring results were not presented in the annual reports for the first two years of reporting, and were not available to check against laboratory reports. Every constituent that was analyzed for in soil monitoring had similar extreme variation (see Table 2 for a representative example).

Table 2: Soil Monitoring Results from the North Pivot, SU-0210-01, at a depth of 0 to 12 inches

Sample Date	SAR	EC umhos / cm	Na meq/100 g	Cl ppm	Plant Available P ppm	Ca meq/100 g	Mg meq/100 g	DTPA Fe ssmg	DTPA Mn ssmg
9/15/2007	0.32	n/a	0	92	7	0.02	0.03	3	5
11/4/2008	9.28	1897	0.28	643	5.47	0.15	0.06	0.26	0.05
11/24/2009	1.75	0.98	2.28	174	10	19.8	3.13	3.4	1.5
2/22/2011	6.59	879	0.12	195	8.9	0.05	0.02	1.32	2.86

Source: Nichols 2012b

Over both the North Pivot and South Pivot, concentrations of sodium were reported to be between 0 and 26.1 meq/100g, and chloride was reported as being between 8.3 and 2,630.0 ppm. Other constituents had less variation, but the variation was still outside of what could be considered normal. There was some discrepancy between the compilation of the first four years soil testing included with the permit renewal materials and the laboratory data sheets included in the 2011 annual report, showing that some of the irregularities in the soil monitoring results were the result of mis-attribution during data entry. A new compliance activity will require that soil testing methods shall be developed in a new Quality Assurance Project Plan to ensure proper sampling, lab analysis, interpretation, and reporting of soil monitoring results. The wide range of reported soil monitoring data makes it difficult to compare the results of later soil monitoring to baseline soil conditions, but improved monitoring in the future can still help to determine whether land application activities are impairing the North Pivot and South Pivot with excessive salt loading.

Table 3: Soil Monitoring Results from February 22, 2011

Depth	Hydraulic Management Unit	Soil Adsorption Ratio (SAR)	Electrical Conductivity (EC)
0-12 inches	HMU-001 (North Pivot)	6.59	879
12-24 inches	HMU-001 (North Pivot)	10.3	1,880
24-36 inches	HMU-001 (North Pivot)	15	2,940
0-12 inches	HMU-002 (South Pivot)	6.1	871
12-24 inches	HMU-002 (South Pivot)	8	1,150
24-36 inches	HMU-002 (South Pivot)	15.4	1,220

Source: Nichols, Scott 2011 Annual Report

As the most recent set of results and in the absence of more complete historical results, the 2011 soil monitoring results can be compared to soil quality indicators. More than one year of data would be required to make any firm conclusions about the status of the soil, but inconsistent background monitoring leaves 2011's results as the best set of data available for comparison with guidelines for soil quality. Soils with SAR values in the range found at the 24 to 36 inch depth (see Table 3) at both pivots are above the value where soil permeability

normally begins to decrease (DEQ 2007, glossary). The electrical conductivities, though, are those of a moderately saline soil (DEQ 2007, Section 7.4.3). Grab samples of blowdown water from 2011 provide magnesium, sodium, and calcium concentrations that allow for the calculation of an SAR value of 5.2 in the blowdown water, that also has an average electrical conductivity of 3.36 dS/M. From Figure 4-5 in Section 4.2.2.5.3 of the *DEQ Guidance for Reclamation and Reuse of Municipal and Industrial Wastewater,* water with these characteristics is not likely to reduce the rate of infiltration at a field. Additionally, Table 4-10, *Crop tolerance and yield potential of selected crops as influenced by irrigation water salinity (EC_w) or soil salinity (EC_e) yield potential* (DEQ 2007), which shows how different soil and water salinities impact crop yields for different crops, does not suggest that crested wheatgrass yields would be significantly impaired by growing in soils irrigated by water with the electrical conductivity values recorded by the permittee. So even though the blowdown water is highly saline, it is suitable for the current irrigation practices at the North Pivot and South Pivot.

3.6. Surface Water

The Raft River separates the North Pivot and the geothermal production facilities from the South Pivot and the infiltration area. The infiltration basins, which are 120 feet from the Raft River at the closest, are nearer to surface water than both the North Pivot, which is 535 feet from the river, and the South Pivot, which is 1,970 feet from the river. The infiltration basins have berms to prevent overflow; and with proper management, should not impact the river. The Raft River has beneficial uses of agricultural irrigation and watering livestock. This section of the river is further characterized in DEQ's Raft River Subbasin Assessment and is subject to TMDL limits for temperature, bacteria, and bed-load sediment (DEQ 2004). Regional irrigation drastically reduces the flow of the Raft River. No-flow conditions often occur not far down river of the land application facility. The portion of the Raft River that flows through the geothermal site is considered a losing section the river, or a segment where the river discharges into the ground water.

The necessary data to determine whether Raft River's reuse operation has had a deleterious effect on the Raft River's water quality are not available because surface water monitoring was not part of LA-000210-01 monitoring requirements. As required by CA-210-04 from LA-000210-01, the permittee performed a surface water interconnectivity assessment by surveying the wells surrounding the reuse facility. This survey showed that while ground water levels in individual wells have been, both recently and historically, highly variable, ground water levels have stayed between 20 and 90 feet below the surface even after geothermal energy production and land application started (Nichols 2012a). Because ground water levels have not significantly changed since energy production started at the site, it is not likely that land application of blowdown water is now impacting surface water.

3.7. Ground Water

Ground water below the facility is shallow and unconfined to 600 feet, where an aquitard begins that extends to 1,500 feet below the surface (Harrison and Cloonan 2006). Below the aquitard are an intermediate aquifer and the geothermal aquifer. Monitoring wells and irrigation wells draw from the unconfined aquifer and have had water levels between 20 and 90 feet below the surface, as described in Section 3.5. In the Raft River Valley, ground water flows are generally the same as the Raft River's direction of flow, which through the Raft River land application site is from the southwest to the northeast.

The highly fluctuating ground water levels shown in Figure 2, were reported by the permittee as being consistent with the results seen in local ground water studies published around 1980 (Nichols 2012a). It is possible that more variable ground water levels found in GW-210-04 and GW-210-01 (both upgradient wells) are the result of these two wells being the closest monitoring wells to the cooling water production wells. Withdrawal of ground water from the production wells, located in the same shallow aquifer as the monitoring wells, could be

depressing ground water levels in the monitoring wells, even though the production wells are drilled 200 feet deeper. Cooling water production wells, 33AAA1-IR, 27CDD1-IR, and 27DBB1-IR, all showed a greater variability in static water levels; this variability could be caused by alternating cooling water production between these wells.

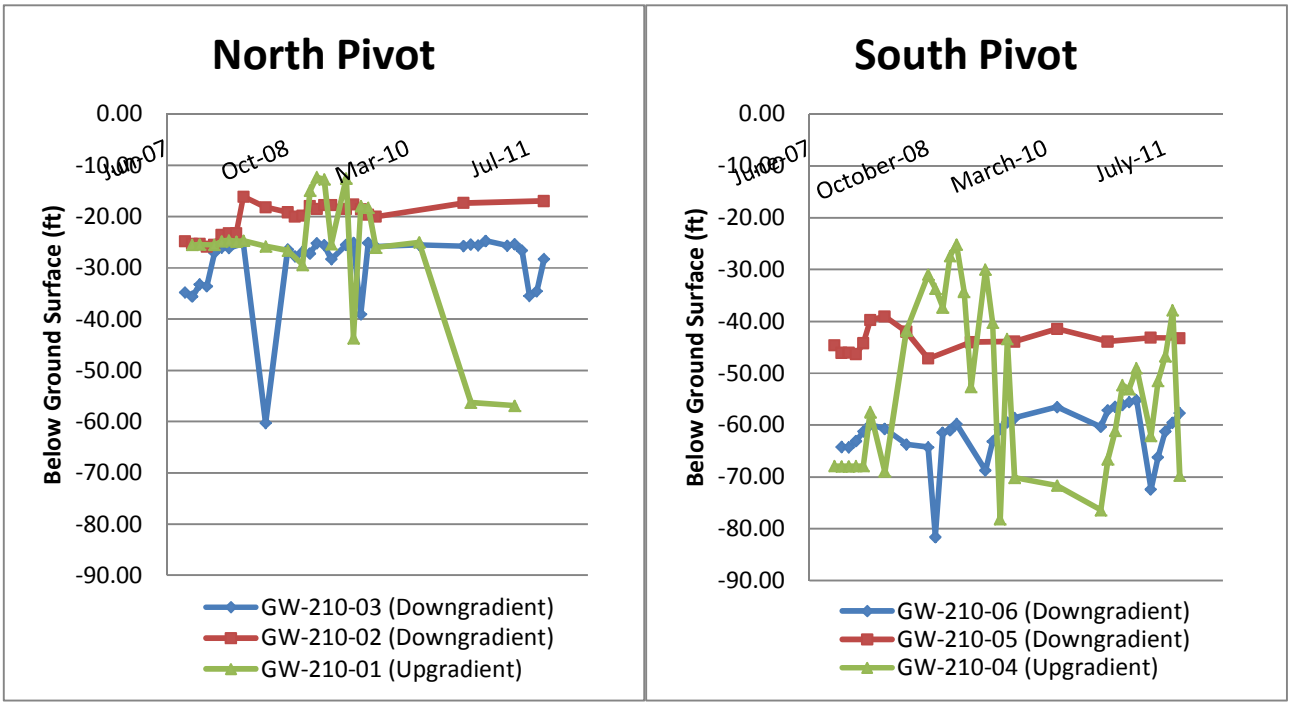


Figure 2: Monitoring Well Static Water Levels (Nichols 2012a)

3.7.1. Ground Water Monitoring

A survey of ground water quality that was undertaken before geothermal production began at the facility revealed that the primary ground water quality standards for lead were exceeded in two wells, 23ABD1-IR and 23ABA1-IR, that are downgradient from the reuse site. Fluoride was also exceeded in 23ABA1-IR and in the upgradient well 27DD1-IR (Ogle 2007). Secondary standards of TDS, iron, manganese, and chloride were exceeded in nearly every ground water sample tested (Harrison and Cloonan 2006).

In the facility's monitoring program that started in 2007, lead measurements above the ground water quality standard of 0.015 mg/L were found in GW-210-04, the South Pivot upgradient well, with measurements of 0.19 mg/L, 0.072 mg/L, and 0.13 mg/L recorded in this well in 2009 and 2010. Additionally, concentrations of fluoride exceeded the 4 mg/L ground water quality standard multiple times in each of the downgradient North Pivot monitoring wells, up to 4.24 mg/L in GW-210-03 and 6.66 mg/L in GW-210-02. Two ground water samples from GW-210-04, the upgradient well for the South Pivot, showed a spike in nitrate concentrations to 9.63 in 2010 and 10 mg/L in 2011, from an average concentration of less than 2 mg/L before 2010. Total iron and manganese measurements have been near the ground water secondary standards in most samples from 2007 to 2011and as high as 6.25 mg/L for dissolved iron and 0.19 mg/L for dissolved manganese. Despite these exceedances and sharp increases towards the ground water quality standard, none of the wells in the ground water monitoring network, or from the other wells the permittee has submitted data from, have shown a noticeable trend in any of the constituents required to be monitored in Section G of LA-000210-01(see Appendix 1 of this Staff Analysis to see charts of ground water constituent concentrations).

The concentrations of arsenic and lead in ground water samples and in the blowdown water were often at their minimum detection limits when reported by the laboratory. Starting in November of 2009 or May of 2010 for arsenic, depending on the well being analyzed, and December of 2010 for lead, the reported minimum detection limits for these constituents were reported an order of magnitude above their respective GWQS. The reason why the practical quantitation limit (PQL) increased so greatly at this time could be because the method for measuring these constituents was changed from EPA Methods 200.9 and 200.8 to EPA 200.7. This change in analytic method occurred at the same time the reported PQL increased. The 0.5 mg/L PQL reported by the laboratory was well above the arsenic GWQS of 0.05 mg/L (EPA 2001). During the same sampling events, the PQL reported for lead increased to 0.1 mg/L in excess of the 0.015 mg/L GWQS. No explanation was given for the reason that the analytic method changed.

Reporting data higher than the ground water quality standard does not meet the purposes of monitoring. During the first two years of operation, concentrations of arsenic and lead were at the PQL, which was still well below the ground water quality standards. Later, though still at the PQL, the reported concentrations in the most recent two years of operation are many times above the ground water quality standard. Monitoring will be continued for arsenic and lead because the monitoring carried out during the previous permit cycle was not adequate to show that constituent concentrations were below ground water quality standards.

3.7.2. Ground Water TDS

A baseline survey of wells at the site showed ground water concentrations of TDS that varied from 646 mg/L to 1,940 mg/L, all above the secondary standard of 500 mg/L for TDS (Harrison and Cloonan 2006). These TDS concentrations are consistent with those measured in Idaho Department of Water Resources' (IDWR) statewide program wells. An IDWR well, ID 420458113240601, located 3,000 feet upgradient from the reuse site, recorded a TDS concentration of 1,080 mg/L in 2006 and ID 420746113195801, located 20,000 feet downgradient from the reuse site, recorded a TDS concentration of 2,350 mg/L in 2008 (IDWR 2012).

Figure 3 below displays the large temporal and spatial variation of TDS concentrations in the ground water at the site based on samples taken from the monitoring wells between 2007 and 2011. The North Pivot's monitoring well network showed downgradient concentrations of TDS to be consistently above upgradient concentrations. This difference in TDS concentration was present in 2007 before land application had begun, and has not noticeably increased since then. There is not a similar relationship between upgradient and downgradient wells in the South Pivot's monitoring network. There does not seem to be a clear explanation for how the reuse operations could be causing the high TDS concentration variability in the South Pivot monitoring wells.

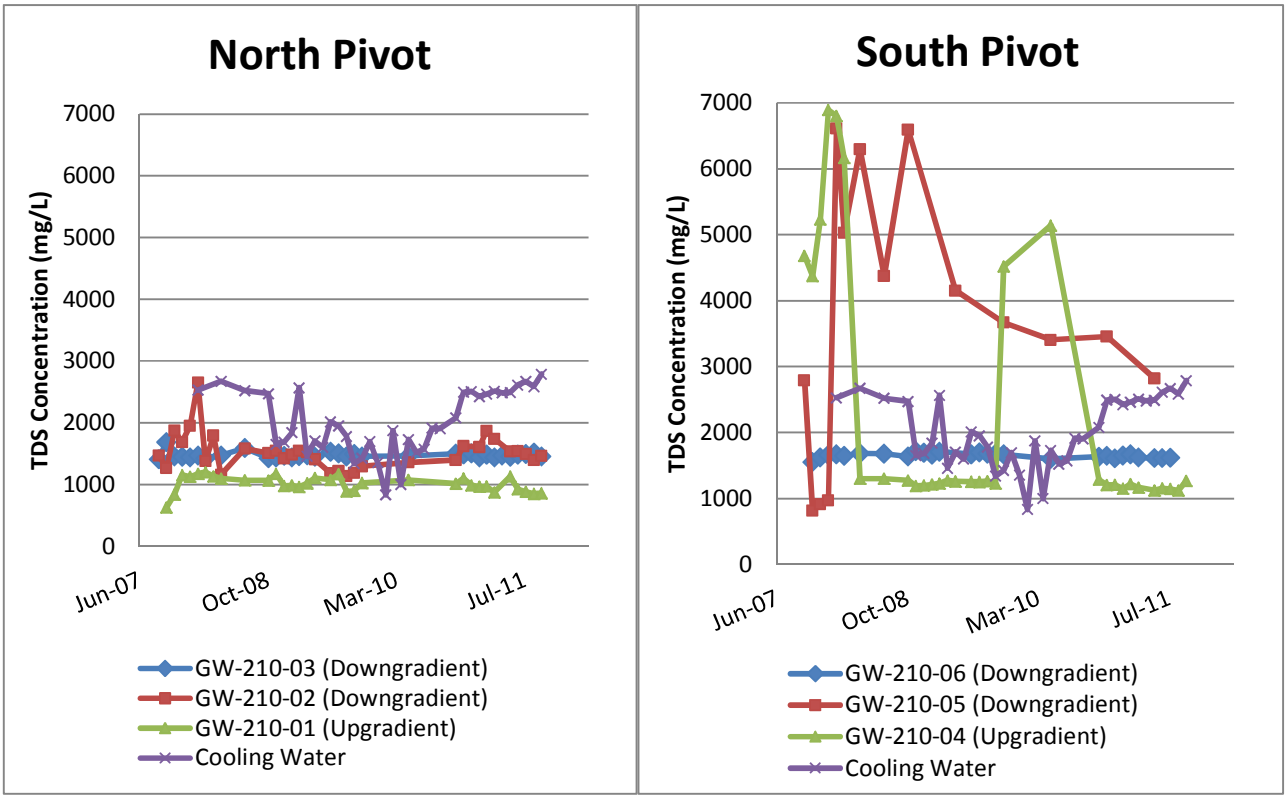


Figure 3: Monitoring Wells and Cooling Water TDS Concentrations (Source: Nichols 2012a)

As the geothermal project was initiated, some concerns were raised that the deep injection process could result in the migration of constituents from the deep geothermal aquifer into the unconfined aquifer through the fractured aquitard. The current ground water monitoring program is not set up to evaluate whether any mixing between aquifers has occurred, nor is it set up to optimally capture potential impacts from the infiltration basins. There are long travel times between the application sites and the monitoring wells, and the flow path of potentially elevated TDS concentrations from the infiltration basins is likely to only be captured on the edges of the plume of impacted ground water. The current monitoring network, though, should be adequate for interpreting general ground water chemistry trends.

4. PERMITTING DISCUSSION

The following sections outline changes made to the terms of the draft renewal permit, based on changes requested by the permittee, evaluations of past performance with previous permit requirements, and/or updates required by changes to the *Recycled Water Rules (IDAPA 58.01.17)*, or any other applicable regulatory standards. Terms and conditions that are unchanged from the previous permit and remain applicable to the facility are not addressed in this document. Changes made to update language and regulatory references are also not addressed in this document.

4.1. Facility Information

Since Permit LA-000210-01 was issued, the facility installed an RO treatment system in December of 2008 as part of the cooling water treatment process. The acreage and configuration of the hydraulic management units have been revised, since the land application system design was finalized after LA-000210-01 was issued.

The listed area of the infiltration area has been decreased from 40 acres to 2 acres, now limited to the actual combined surface area of the two infiltration basins (Nichols 2012b).

4.2. Compliance Schedule for Required Activities

4.2.1. Compliance Activities from Current Permit (LA-000210-01)

Table 5 shows a short description of the compliance activities that were required to be completed in LA-000210-01 and the status of those compliance activities at the time of the permit renewal.

Table 5: Status of Compliance Activities from current permit (LA-000210-01)

Activity Number	Due Date	Description	Status
CA-210-01	Prior to wastewater application	Plan of Operation	Submitted and Approved
CA-210-02	Prior to wastewater application	Ground Water Monitoring Network Plan	Submitted August 2007 and Approved
CA-210-03	February 23, 2007	Runoff Management Plan	Submitted and Approved – Received on February 19, 2008
CA-210-04	September 2011	Surface Water Interconnectivity Assessment	Submitted – Received on March 8, 2012
CA-210-05	August 23, 2011	Permit Renewal Application	Submitted – Received on April 2, 2012

4.2.2. Compliance Activities proposed for new permit I-210-02

CA-210-01 - Six (6) months after the issuance of this permit, the permittee shall prepare and implement a Quality Assurance Project Plan (QAPP) that incorporates all monitoring and reporting required by this permit. A copy of the QAPP along with written notice that the permittee has implemented the QAPP shall be provided to DEQ.

The QAPP shall be designed to assist in planning for the collection, analysis, and reporting of all monitoring in support of this permit and in explaining data anomalies when they occur. At a minimum, the QAPP must include the following:

1. Details on the number of measurements, number of samples, type of sample containers, preservation of samples, holding times, analytical methods, analytical detection and quantitation limits for each target compound, type and number of quality assurance field samples, precision and accuracy requirements, sample preparation requirements, sample shipping methods, and laboratory data delivery requirements.
2. Maps indicating the location of each monitoring, and sampling point.
3. Qualification and training of personnel.
4. Names, addresses and telephone numbers of the laboratories used by or proposed to be used by the permittee.
5. Example formats and tables that will be used by the permittee to summarize and present all data in the Annual Report.

The format and the content of the QAPP should adhere to the recommendations and references in the Quality Assurance and Data Processing sections of the DEQ Guidance.

The permittee shall amend the QAPP whenever there is a modification in sample collection, sample analysis, or other procedure addressed by the QAPP. A copy of the amended QAPP shall be submitted to DEQ.

CA-210-02 - Six (6) months after permit issuance, the permittee shall submit a plan of operations (PO) to the Idaho Department of Environmental Quality (DEQ) for review and approval. The PO shall comply with requirements stated in IDAPA 58.01.17.300.05 and shall address the items in the latest revision of the PO checklist. The PO shall be updated as needed to reflect current operations. The QAPP (see CA-210-01 above) shall be incorporated into the PO.

CA-210-03 - One (1) year prior to the permit expiration date, the permittee shall meet with DEQ to discuss the preparation and submittal of a permit renewal application at least one hundred eighty days (180) days prior to permit expiration, as required in IDAPA 58.01.17.400.01.

4.3. Permit Limits and Conditions

The monitoring period will continue to be from November 1 through October 31, with each year's report to be submitted by January 31. This will allow each annual report to cover one full growing season and one full non-growing season, and will provide continuity for comparisons between the years of operation. An additional requirement has been added to the Draft Permit, Reporting Requirements, Section 6.1.3 that the permittee's responsible official certifies each annual report.

Hydraulic loading limits on the North Pivot and South Pivot shall not exceed the irrigation water requirements (IWR). This is consistent with other permits issued by DEQ, except that since crested wheat grass is a drought-tolerant crop, it does not need to be irrigated substantially at the IWR to maintain crop growth.

No nutrient or TDS loading limits were established in LA-000210-01; and no new limits have been added to I-210-02. Monitoring for these constituents will need to be continued so that a comparison of TDS loading to pre-geothermal energy production levels can still be made.

Buffer zones of 100 feet from the Hydraulic Management Units have been added for protection of the Raft River. The distance is consistent with typical DEQ reuse guidelines and would not place the infiltration area within prohibited space.

4.4. Monitoring Requirements

4.4.1. Blowdown Water Constituent Monitoring

The spent cooling water and RO concentrate streams are proposed to be sampled individually, instead of being sampled after they have been combined in the blowdown water stream. The flow rate of each stream should also be monitored separately, though flow will still be required to be measured at each hydraulic management unit. Because cooling water is bled from the cooling tower at a set electrical conductivity, its quality will likely be more consistent than the combined blowdown water stream, which at different times could be comprised by different ratios of the source waters. The RO concentrate would also likely be less variable in its composition than the blowdown water, even though its ground water sources might change in quality over time or as a result of the cycling between production wells. With the expectation that the constituent concentrations in the RO concentrate and spent cooling water will be more consistent than those in the combined blowdown water, the frequency of sampling can be reduced from monthly to quarterly and composite sampling can be replaced by grab samples.

Constituent loadings should still be reported for each hydraulic management unit, even if the calculations need to be based on estimations of the percentage of the total flow made up by RO concentrate, spent cooling water, and excess untreated ground water. It is not expected that in the absence of sampling the combined blowdown water there will be a significant reduction in the accuracy of the loading calculations, and the additional information gained on the quality of the component streams will be beneficial if treating the different streams

separately is ever considered.

Monitoring of arsenic and lead will be continued for the next permit cycle, and frequency of monitoring will be reduced to quarterly. The measurement of arsenic (As) and lead (Pb) in the blowdown water had the same problems of analysis that ground water had during the initial permit cycle (see Section 3.6.1 of this staff analysis).

Total iron and total manganese are no longer required to be tested in the blowdown water. A sufficient understanding of the concentrations of these constituents in the blowdown water has been acquired; and while some monitoring wells have had concentrations of iron and manganese above secondary standards, the concentrations of iron and manganese in the blowdown water are not typically above background concentrations in the ground water. With iron and manganese likely to be oxidized in the cooling tower, and the blowdown water having a low organic content, which would make it likely to promote reducing conditions, the more mobile reduced forms of the metals are not likely to be applied or reduced *in situ* at the HMUs. Because there is less risk for increased leaching of these constituents into the ground water, they are no longer required to be monitored in the blowdown water.

While nitrogen loadings to the North Pivot and South Pivot are low they are not insignificant, and loading per acre to the infiltration area is very high. Additionally, since there have been some high measurements of nitrate in the monitoring wells, monitoring of total nitrogen should be continued. The chemicals added during the cooling water process may also contribute to the overall nitrogen loading. Nitrate, nitrite, and TKN testing will all be required to be sampled twice yearly.

Total phosphorus testing frequency will be reduced to twice annually. Phosphorus will still be required to be measured because it is also likely a component of some of the chemicals used in the cooling water treatment process.

Fluoride will be required to be analyzed because some wells' samples have had concentrations above the ground water quality standard, and it would be appropriate to continue monitoring the blowdown water to keep track of the effect of the recycled water operations on the unconfined aquifer. Analyzing samples for fluoride will be required twice annually.

4.4.2. Ground Water Monitoring

Water table elevation is now required to be reported with ground water monitoring. Providing water table elevations may require the permittee to survey their monitoring wells to obtain the surface elevation at the well head.

Continuing the ground water monitoring program will be necessary to evaluate whether the facility's reuse operations are having an adverse effect on beneficial uses of ground water. Since four years of detailed data have been acquired, some changes to the parameters tested and frequency of testing can be made. The low concentration of organic material in the blowdown water and the limited potential for hydraulic overloading, except in the small area of the infiltration basins, will not likely result in reducing conditions that cause the mobilization of iron and manganese. Therefore, iron and manganese testing will no longer be required. Chloride and TDS monitoring will be continued though, as parameters that can indicate the impacts of reuse operations are having on ground water quality.

Bromide is an active ingredient of Bromax, a biocide added to the cooling water. Bromide itself is not toxic and does not have a ground water quality standard. Waters with bromide are of concern when oxidizing agents are used for disinfection for drinking water. Known negative human health effects are associated with bromide being incorporated into byproducts of the disinfection process. While ozone can form bromate in the presence of

bromide, most regulated brominated disinfection byproducts require natural organic matter as a precursor. The closest registered public drinking water systems downgradient from the application site do not disinfect and are located nearly 15 miles from the application sites. It is not likely that the use of Bromax would cause bromide contamination of nearby drinking water wells, since the local ground water has a low concentration of organic matter and only 2 gallons of a 14.8% bromide concentration of Bromax is used per week. One bromide sample from each of the monitoring wells is still recommended to be taken to provide a baseline from which future tests could establish whether the facility's operation is causing a change to the ground water bromide levels.

4.4.3. Plant Tissue Monitoring

A description of the crop grown at the facility should be included in the annual report, and if the crop is harvested the yield should also be reported. Estimations of crop uptake of nitrogen, phosphorus, and salt should be added to the annual report, and can be calculated by using published reference values (see *Guidance for Reclamation and Reuse of Municipal and Industrial Wastewater*, Section 7.7.9.1).

4.4.4. Soil Monitoring

Nitrate, ammonia, and plant available phosphorus soil concentrations will be required to be analyzed during monitoring at the North Pivot and South Pivot, but only if fertilizer is added to these hydraulic management units. Soil Monitoring will no longer be required from the infiltration area. With no crops grown at the infiltration basins, the main concern for soil monitoring at the infiltration area would be to track permeability by reporting the performance of the infiltration basins in the discussion section of the annual report. The Plan of Operations should include strategies for monitoring and operating the infiltration basins so that their infiltration rates are maintained.

4.4.5. Reporting

All the chemicals used for wastewater treatment shall be logged and be included with every annual report. The type of chemical, date, amount, and location of addition shall be included in the log.

4.5. Environmental Monitoring Serial Numbers

The descriptions of MU-210-01 and MU-210-02 have been changed from North Irrigation Pivot and South Irrigation Pivot, to North Pivot and South Pivot, for brevity and to be consistent with the permittee's naming conventions used in the annual reports.

A ground water monitoring network had not been established at the time of the original permit's issuance. However, this was established during the completion of the Ground Water Monitoring Network Plan (CA-210-02 in the current permit). The following serial numbers have been designated for the monitoring wells in the network. See Figure 1, Section 11 of the Draft Permit for the location of each well.

- GW-210-01 for 27ACB1-RMW
- GW-210-02 for 23CCD1-MW
- GW-210-03 for 23CAD1-D
- GW-210-04 for 27DDC1-RMW
- GW-210-05 for 26DBB1-RMW
- GW-210-06 for 25BDC1-MW

4.6. Site Maps

New site maps have been created that show the altered ground water monitoring well and management unit serial numbers. The maps can be found in Section 11 of the Draft Permit.

5. RECOMMENDATIONS

Based on review of applicable state rules, staff recommends that DEQ issue draft Industrial Reuse Permit I-210-02 for a public review and comment period. Section 7 of the Draft Permit contains effluent quality requirements for the recycled water treatment system, as well as terms and conditions required for operation of the reuse system. Monitoring and reporting requirements to evaluate system performance and to determine permit compliance have been specified in Sections 5 and 6 of the Draft Permit, and new compliance activities can be found in Section 2 of the Draft Permit.

6. REFERENCES

DEQ (Idaho Department of Environmental Quality). 2004. *Raft River Subbasin Assessment and Total Maximum Daily Loads.*

DEQ (Idaho Department of Environmental Quality). 2007. *Guidance for Reclamation and Reuse of Municpal and Industrial Wastewater.*

EPA (United States Environmental Protection Agency). 2001. *Method 200.7 Trace Elements in Water, Solids, and Biosolids by Inductively Coupled Plasma-Atomic Emission Spectrometry.* Washington, DC: EPA, Office of Science and Technology. EPA-821-R-01-010.

Harrison, Jack and Cloonan, Joan. 2006. *Preliminary Technical Report for Non-contact Cooling Water Reuse at the Raft River Geothermal Project.* Centra Consulting Inc.

Harrison, Jack and Petrich, Christian. 2006. *Revised hydraulic and TDS loading estimates.* HyQual.

IDWR (Idaho Department of Water Resources). 2012. "Statewide Ground Water Monitoring." Accessed October 3, 2012. *http://maps.idwr.idaho.gov/gwqm/*

Nichols, Scott. 2012a. *CA-210-04;Surface Water Interconnectivity Assessment Raft River Energy 1(RRE1); Malta Idaho.* U.S. Geothermal Inc.

Nichols, Scott. 2012b. *Raft River Geothermal Project Wastewater Reuse Application.* Raft River Energy I LLC.

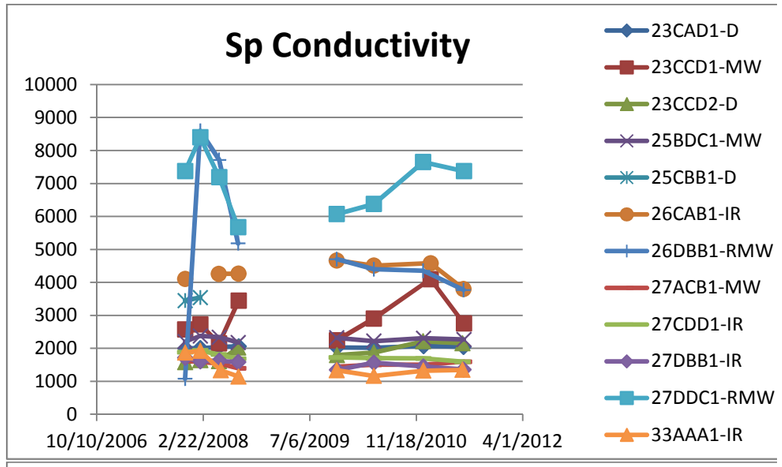
Nichols, Scott. 2012c. *Waste Water Land Application Permit LA-000210-01 CA-210-03 at Raft River Energy 1(RRE1); Malta Idaho.* U.S. Geothermal Inc.

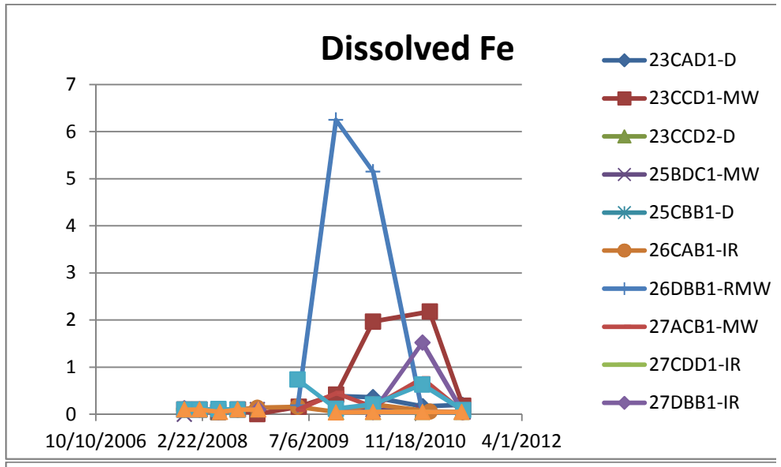
Petrich, Christian and Harrison, Jack. 2006. *Simulation of Ground Water Flow and Transport, Raft River Geothermal Power Project.* SPF Water Engineering, LLC.

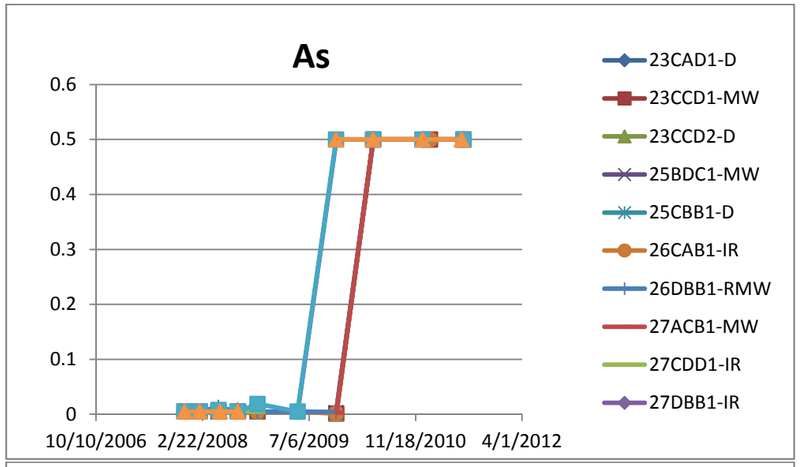
Ogle, Steve. 2007. *Staff Analysis for Wastewater Reuse Permit No. LA-000210-01Raft River Energy ILLC, Malta, Idaho.* Department of Environmental Quality. TRIM: 2012AGH1596

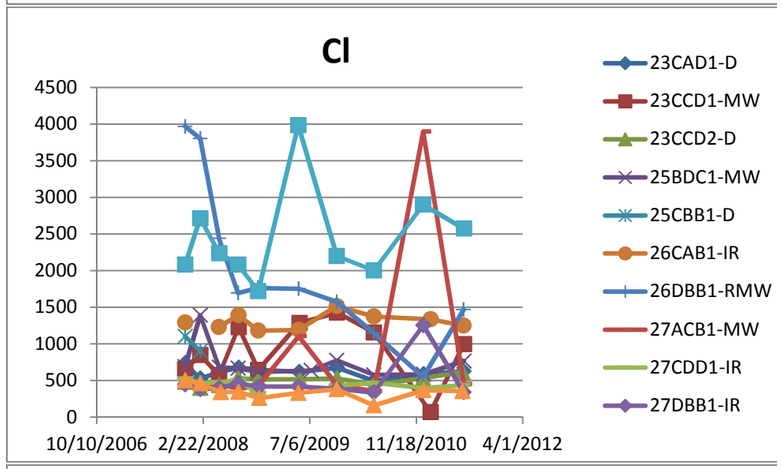
Wester, Jennifer. 2011. *2010 Annual Report Review: Raft River Energy I, LLC.* Department of Environmental Quality.

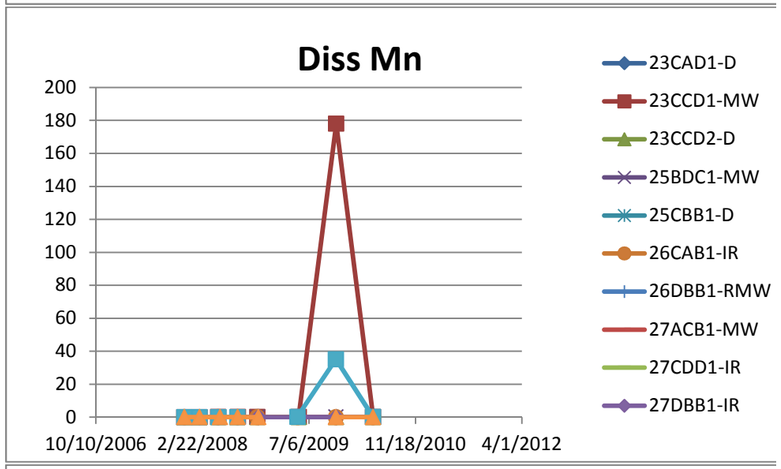
Appendix 1: Charts of Ground Water Quality

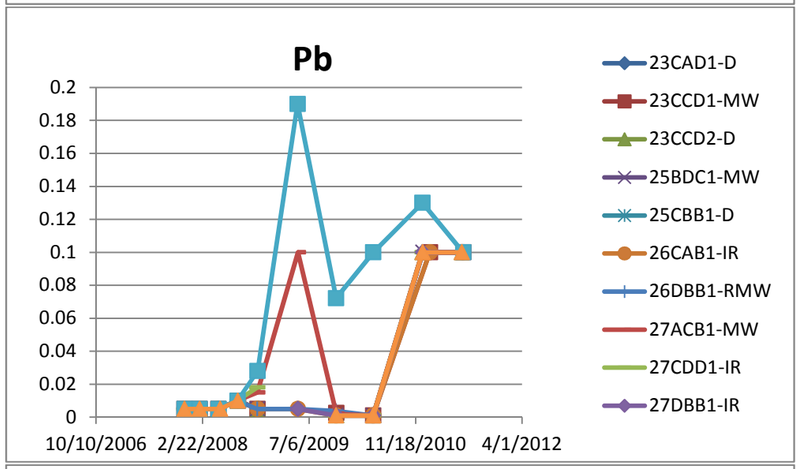

Sp Conductivity
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR
27DDC1-RMW
33AAA1-IR

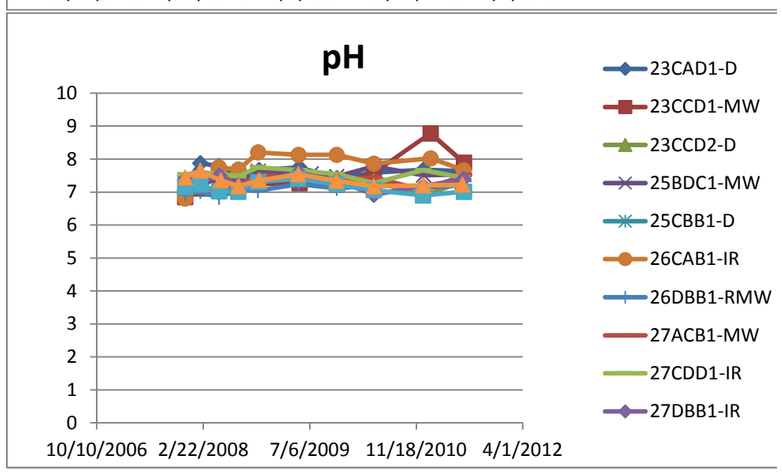

Dissolved Fe
7
6
5
4
3
2
1
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR

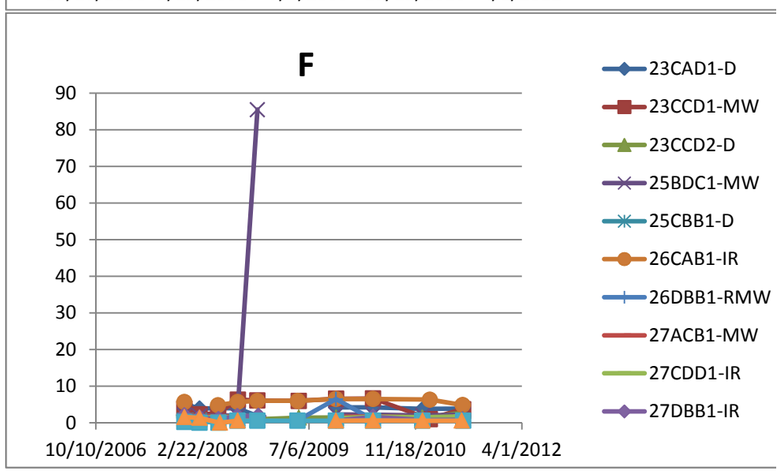

As
0.6
0.5
0.4
0.3
0.2
0.1
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR

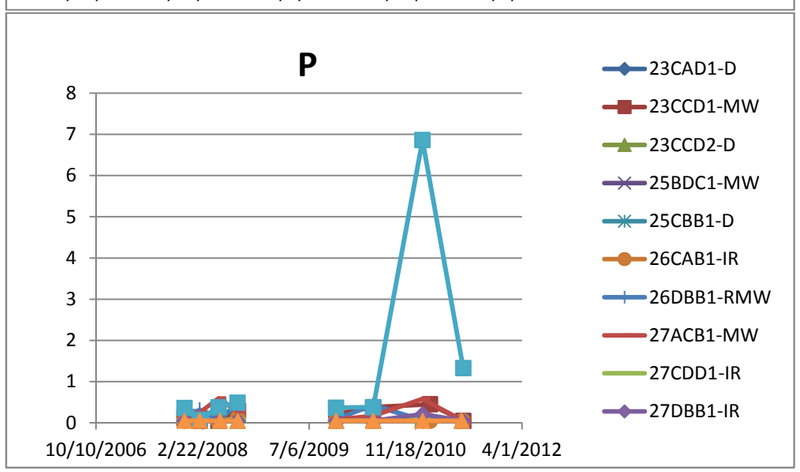

Cl
4500
4000
3500
3000
2500
2000
1500
1000
500
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR

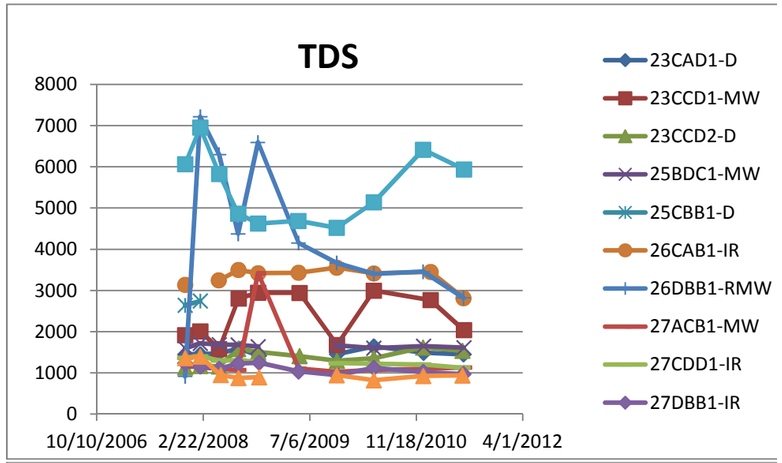

Diss Mn
200
180
160
140
120
100
80
60
40
20
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR

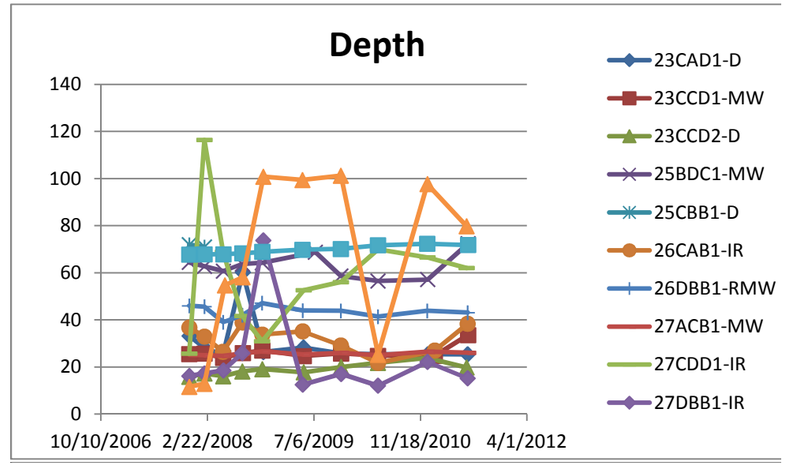

Pb
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR

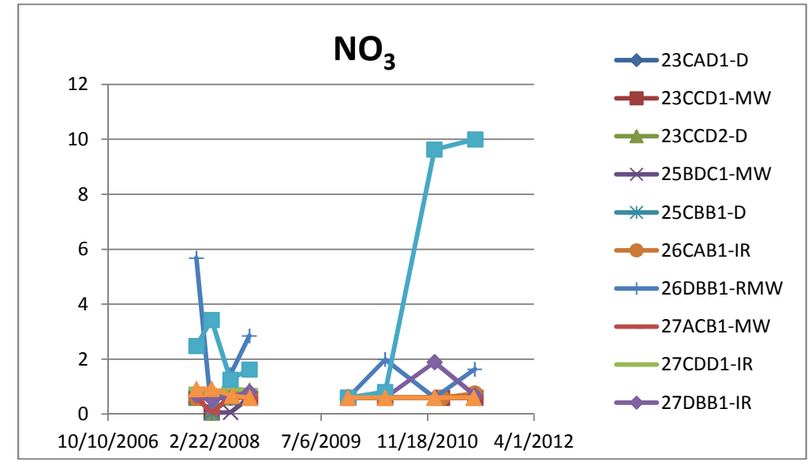

pH
10
9
8
7
6
5
4
3
2
1
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR

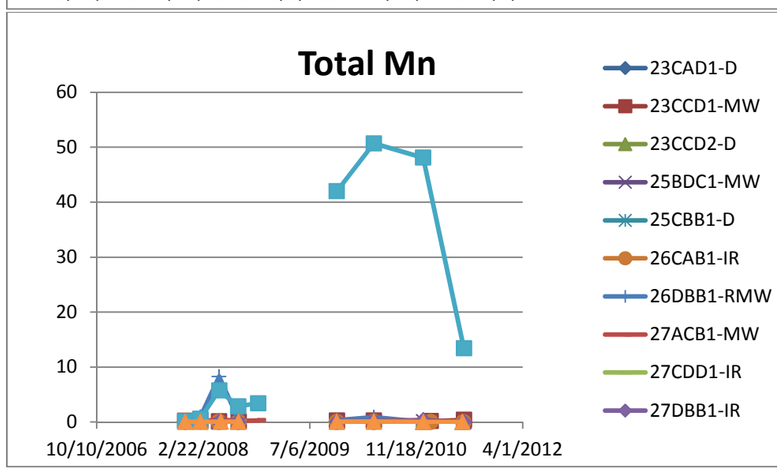

F
90
80
70
60
50
40
30
20
10
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR

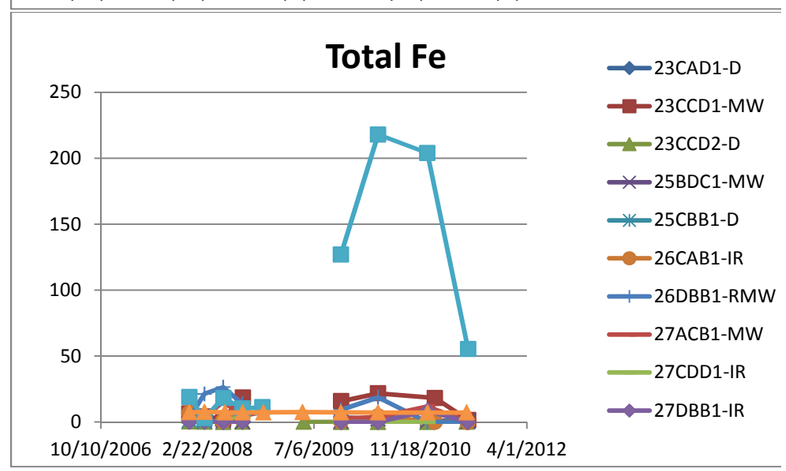

P
8
7
6
5
4
3
2
1
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR


TDS
8000
7000
6000
5000
4000
3000
2000
1000
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR


Depth
140
120
100
80
60
40
20
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR


NO3
12
10
8
6
4
2
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR


Total Mn
60
50
40
30
20
10
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR


Total Fe
250
200
150
100
50
0
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
23CAD1-D
23CCD1-MW
23CCD2-D
25BDC1-MW
25CBB1-D
26CAB1-IR
26DBB1-RMW
27ACB1-MW
27CDD1-IR
27DBB1-IR